Space and combination heaters
Ecodesign and Energy Labelling

Review Study

Task 1

Scope – Policies & Standards

FINAL REPORT


Prepared by
VHK for the European Commission

July 2019

The information and views set out in this study are those of the author(s) and do not necessarily reflect the official opinion of the European Commission.
Prepared by

Study team
Van Holsteijn en Kemna B.V. (VHK), The Netherlands,
in collaboration with BRG Building Solutions, London (UK)

Authors
Martijn van Elburg, René Kemna, Roy van den Boorn, Rob van Holsteijn, Sanne Aarts (VHK)
Study team contact Task 1: Martijn van Elburg (m.van.elburg@vhk.nl)
Contract manager: Jan Viegand, Viegand Maagøe
Project website: www.ecoboiler-review.eu

Specific contract:
no. ENER/C3/SER/FV 2016-537/08/FWC 2015-619 LOT2/02/SI2.753930

Title:
Review Study existing ecodesign & energy labelling SPACE HEATERS & COMBINATION HEATERS

Contract date:
9.6.2017

Consortium:
Viegand Maagøe, VHK, Wuppertal Institute, Armines, Oakdene Hollins

Cover: Gas-fired central heating boiler [picture VHK 2016-2017].

This study was ordered and paid for by the European Commission, Directorate-General for Energy.
The information and views set out in this study are those of the author(s) and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this study. Neither the Commission nor any person acting on the Commission’s behalf may be held responsible for the use which may be made of the information contained therein.

This report has been prepared by the authors to the best of their ability and knowledge. The authors do not assume liability for any damage, material or immaterial, that may arise from the use of the report or the information contained therein.

© European Union, July 2019.
Reproduction is authorised provided the source is acknowledged.
EXECUTIVE SUMMARY


Task 1 includes product scope, relevant legislation and test standards, but also reviews specific aspects mentioned in Article 7 of the regulations and evaluates the effectiveness of the current regulations in as much as can be derived from available data.

Chapters 1 and 2 describe background and methodology of the study as well as the current product scope.

Chapter 3 gives a comprehensive update of the many relevant policies and measures that interface with the boiler regulations and that have last been discussed in the 2007 preparatory study leading up to the current boiler regulations. In that sense it addresses the following issues that are potentially relevant for a revision of the boiler regulations:

- Over 20 generic pieces of EU legislation relating to energy efficiency, environment and safety issues that have changed since 2007.
- Ecodesign and Energy Label regulations, including lesser known issues such as the residual role of the Boiler Directive, the amendments on labelling of internet sales and on verification of tolerances, the transitional methods, standardisation mandates and Commission guidelines (“FAQ”).
- Per Member State the legislation in the field of the energy performance of buildings (EPB) and the role of heating appliances therein, as well as the national incentives for specific heating solutions.
- Horizontal issues across Member States regarding air pollution, noise, legionella and fuel cells are discussed as well as voluntary endorsement labels and certification schemes.
- The energy policy for space- and combi heating boilers in non-EU countries (US, China, etc.).

Chapter 4 gives a comprehensive overview of over 60 test standards, most of which following the Commission mandates to the European Standardisation but some –e.g. regarding the EPBD-- are also included because they are relevant for reasons of consistency.

Finally, chapter 5 gives a summary of problems identified from the previous chapters, the first stakeholder meeting, position papers of industry associations, bilateral meetings, etc.. Under the header ‘Overview of issues’ the issues are ordered by subject. A final paragraph treats the experiences from market surveillance and round robin tests for verification tolerances.

Main items relate to:

- **Primary energy factor** (PEF) moving from 2.1 to 2.5. Given that the boiler regulations calculate primary energy efficiency this will affect seasonal efficiencies calculated for
electricity using and/or -producing appliances. For EPB building codes Member States can choose their own PEF;

- The Ecodesign boiler regulations will have their share in the steadily decreasing air pollution through NOx-limits, but limits on other emissions may be considered. Especially the abatement of air pollution through fine dust (particulate matter, e.g. PM2.5) may prompt additional action.

- With the newMedium Combustion Plant Directive (MCP, scope 1-50 MW), the existing Large Combustion Plants now part of the Industrial Emissions Directive (IED Chapter III, scope >50 MW) and Ecodesign legislation (4-400 kW) the boiler-related air pollution legislation covers the full boiler input power range >4kW, except for the range between 400kW and 1 MW. This begs the question whether a revised Ecodesign boiler regulation take up the challenge to fill that gap;

- NOx emission correction factors for LPG (Liquefied Petroleum Gas LPG), currently identical to those of natural gas, are probably due;

- Air pollution (fine dust), climate (CO2) and energy efficiency are drivers behind plans to ban/reduce oil-fired boilers in many Member States (many are very old and inefficient). Means are building codes (EPB) to keep them from new buildings and large renovations, incentive schemes (up to €5000 subsidy) to replace them, and in some countries attempts are made to ban them outright (DK, NO, DE);

- Energy labelling of existing boilers may help to promote replacement of >30 years old boilers and has been introduced in Germany and Spain.

- Electrification of heating appliances (heat pumps and hybrids) appears to be the main way forward in many Member States to meet renewables and climate change targets. Background is the rapidly decreasing costs of (esp. offshore) wind farms and PV panels, causing fast expansion of ‘renewable’ electricity. Solar thermal and sometimes micro-CHP solutions are included in incentive schemes but are apparently less popular. Biogas and bio-oil stakeholders are fighting for bonus-points in national EPB and incentive-schemes;

- Implementation of the Ecodesign requirements is relatively unproblematic. Over 96-97% of boilers sold are now condensing, with B1-boilers (the non-condensing exemption) constituting only a small part of the market;

- The main problem is reportedly the shared chimney for the non-condensing C43 and C83 boilers in high-rise buildings with individually owned apartments. The issue was raised by Croatia and Germany, but probably relates to other Central and Eastern European countries as well. There are several technical solutions that are briefly discussed in the report. But they all come at a cost, require installer know-how and some would benefit from outside (e.g. government organised) intervention. Ultimately some form of exemption for C43 and C83 boilers can be considered by the policy makers provided no loopholes are created;

- As regards the Energy Label, there are no EU-wide studies but anecdotal information indicates that the main problem is installers understanding and applying the EU label, especially if the product is a heat pump or a package that goes beyond a simple fossil fuel fired boiler. Some Member States, e.g. the Netherlands, are facilitating training sessions and set up certification to improve the situation. The
- The study team also found manufacturer’s websites can be improved in clarity and completeness.

- Especially the package label is only successful when it is delivered and prepared by one manufacturer. An installer package label where the installer combines components from various manufacturers is not common practice. In fact, for the one component where this very important—the solar thermal collector—the solar industry is reporting that installers don’t want the hassle and that the label-rating with solar is less than generous. At the same time, the complexity of solar thermal test and calculation methods is not diminishing.

- As regards micro-cogeneration (‘mCHP’) the makers of the test standard have chosen to deviate from the method described by the Transitional Method. The legislator must now try to resolve the issue, together with industry and test institutes involved, and decide for a single method that is applied consistently.

- One of the products that is mentioned in the boiler regulations, but not fully implemented because of lack of a test standard for the indirect contribution, is the passive flue heat recovery device (PFHRD). The draft test standard for the integrated or coupled PFHRD is now up for enquiry voting in April 2019. The UK mentions the PFHRD as one of the 4 options to pass requirements of its boiler plus building code. Several manufacturers already use an integrated PFHRD as part of their combi-boiler, even though they don’t officially get the credit for it. Some manufacturers in the UK and Dutch market have sold the PFHRD as a separate device, but only for their own boilers (not as an ‘open’, i.e. universally applicable device). In other words, the PFHRD with indirect contribution now seems ready to be introduced—at least as a specific boiler-certified device—in revised boiler regulations.

- The issues of third-party verification and compliance in general cover a large part of chapter 5, intended to inform policy makers on the various aspects and stakeholder positions involved. Traditionally fossil fuel fired products are tested through third parties and electric boilers/heat pumps through self-declaration. Interestingly also a leading heat pump manufacturer indicated to be in favour of (some form of) third-party verification.

- Interim results from extensive round-robin tests in the extensive ECOtest project suggest that the verification tolerances can often—depending on the boiler-product—be considerably reduced, e.g. from the current 8% to 2% for space heating efficiency of gas/oil fired boilers.

Apart from the above there are several minor adjustments that require the attention of the policy maker such as harmonisation of storage temperatures in hot water storage tanks, definitions, new products and scope limits, possible simplifications and rating conditions in test standards (e.g. hybrids, heat pumps, solar, temperature controls), clarifications needed in the transitional method, etc..
ACRONYMS, UNITS AND SYMBOLS

Acronyms:

- **conv**: 'conventional', meaning not-condensing
- **ASHP**: electric Air Source Heat Pump
- **a**: annum (year)
- **avg.**: average
- **BAT**: Best Available Technology
- **BAU, BaU**: Business-as-Usual (baseline without measures)
- **BC, BaseCase**: the average appliance on the market (per category)
- **BEP**: Break-Even Point (not to confuse with bep, best efficiency point, in reports and regulations for other Ecodesign products)
- **BI**: Built-In
- **BNAT**: Best Not yet Available Technology
- **Cat.**: Category
- **CEN**: European Committee for Standardization
- **CLC, Cenelec**: European Committee for Electro-technical Standardization
- **COMBI**: Combination heater (space and water heating)
- **COP**: Coefficient of Performance
- **DG**: Directorate-General (of the EC)
- **DHW**: Domestic Hot Water
- **EC**: European Commission
- **EIA**: Ecodesign Impact Accounting (Study for the EC)
- **EIWH**: Electric Instantaneous (flow-through) Water Heater
- **EN**: European Norm
- **EoL**: End-of-Life
- **ESWH**: Electric Storage Water Heater
- **eq**: Suffix, means 'equivalent'
- **EU**: European Union
- **GHG**: Greenhouse Gases
- **GIWH**: Gas- or oil-fired Instantaneous Water Heater
- **GSHP**: Ground Source Heat Pump (water/brine-to-water)
- **GSWH**: Gas-fired (or oil-fired) Storage Water Heater
- **GWP**: Global Warming Potential, in Mt CO₂ equivalent
- **HR**: Heat recovery (usually of ventilation air)
- **ICSMS**: Information and Communication System on Market Surveillance
- **aihb**: Accredited in-house body (for product testing)
- **IEC**: International Electro-technical Committee
ISO  
International Standardisation Organisation

LCC  
Life Cycle Costs, in euros

LLCC  
(design option with) Least Life Cycle Costs

mCHP  
micro combined heat and power device, also 'cogeneration'

MErP  
Methodology for Ecodesign of Energy-related products

MEPS  
Minimum Efficiency Performance Standard

msp  
manufacturer selling price

NGO  
Non-Governmental Organization

NPV  
Net Present Value

NLF  
New Legislative Framework

PWF  
Present Worth Factor

R  
Rate, in euro per physical unit (followed by specific suffix)

RES  
Renewable Energy Sources (solar thermal, photovoltaic, wind energy, etc.)

RISE  
Research Institutes of Sweden

SHW  
Sanitary Hot Water (synonymous to DHW)

SME  
Small and Medium-sized Enterprise

SPB  
Simple Payback period, in years

TBS  
Technical Building System (in practice: HVAC components such as boilers, heat pumps, circulators, ventilation systems, solar systems, etc.)

TC  
Technical Committee (in ISO, CEN, etc.)

TR  
Technical Report

VAT  
Value Added Tax

VHK  
Van Holsteijn en Kemna, NL (author)

WEEE  
Waste of electrical and electronic equipment (directive)

WG  
Working Group (of a TC)

yr  
annum (year)

**Units**

- **P-, T-, G-, M-, k-, d-, c-, m-, µ-, n-**  
  Parameter prefixes to indicate $10^{15}$, $10^{12}$, $10^9$, $10^6$, $10^3$, $10^{-1}$, $10^{-2}$, $10^{-3}$, $10^{-6}$

- **CO₂, CO₂**  
  Carbon dioxide (reference for GWP)

- **J**  
  Joule, SI-unit of energy

- **g**  
  gram or gramme, SI-unit of weight

- **h**  
  hour, unit of time (3600 s)

- **kW**  
  kilo Watt, $10^3$ W

- **L, ltr**  
  litres (volume in m³)

- **m**  
  meter, SI-unit of length

- **m²**  
  square meter, unit of surface

- **m³**  
  meter cube, unit of volume

- **Mt**  
  megatonne (10^6 metric tonnes, 10^9 kg)
s  
second, SI-unit of time

t  
metric tonne

TWh  
Tera Watt hour \(10^{12}\) Wh

W  
Watt, SI-unit of power (1 W = 1 J/s)

Wh  
Watt-hour, unit of energy (1 Wh = 3600 J)

Symbol (generic) Parameter

A  Surface, in m²

AE, AEC  Annual Energy consumption, in kWh/a

N  Number (e.g. of cycles)

P  Power, in W

Q  Energy, in kWh

t  Time, in hours (or seconds)

T  Temperature, in °C or K

U  Specific heat loss coefficient, e.g. in W/K, W/m.K, W/m²K

V  Volume, in litre (dm³)

\(\eta\)  Efficiency
Table 1. Calorific value and gross/net ratio of gas families

<table>
<thead>
<tr>
<th>Gas family</th>
<th>Reference gas</th>
<th>Net calorific value (MJ/m³)</th>
<th>Gross calorific value (MJ/m³)</th>
<th>Ratio Gross/Net</th>
<th>Ratio Net/Gross</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>G 110</td>
<td>13.95</td>
<td>15.87</td>
<td>1.138</td>
<td>0.8790</td>
</tr>
<tr>
<td>Second H+E</td>
<td>G 20</td>
<td>34.02</td>
<td>37.78</td>
<td>1.111</td>
<td>0.900</td>
</tr>
<tr>
<td>Second L</td>
<td>G 25</td>
<td>29.25</td>
<td>32.49</td>
<td>1.111</td>
<td>0.900</td>
</tr>
<tr>
<td>Third propane</td>
<td>G 31</td>
<td>116.09</td>
<td>125.81</td>
<td>1.084</td>
<td>0.923</td>
</tr>
<tr>
<td>Third Butane</td>
<td>G 30</td>
<td>88.00</td>
<td>95.65</td>
<td>1.098</td>
<td>0.920</td>
</tr>
</tbody>
</table>


First family: "city gas", very low calorific value, obsolete
Second family: Methane gases, L=low calorific, H=high calorific, E=covers range L and H
Third family: Liquified petroleum gases, highest calorific values

Table 2. Conversion of NOₓ of gas families

<table>
<thead>
<tr>
<th>1 ppm=2.054mg/m³</th>
<th>G 110</th>
<th>G 20</th>
<th>G25</th>
<th>G 30</th>
<th>G 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ppm = 1 cm³/m³</td>
<td>mg/kWh</td>
<td>mg/MJ</td>
<td>mg/kWh</td>
<td>mg/MJ</td>
<td>mg/kWh</td>
</tr>
<tr>
<td>O₂=0% 1 ppm=</td>
<td>1.714</td>
<td>0.476</td>
<td>1.764</td>
<td>0.490</td>
<td>1.797</td>
</tr>
<tr>
<td>1 mg/m³ =</td>
<td>0.834</td>
<td>0.232</td>
<td>0.859</td>
<td>0.239</td>
<td>0.875</td>
</tr>
<tr>
<td>O₂=3% 1 ppm=</td>
<td>2.000</td>
<td>0.556</td>
<td>2.059</td>
<td>0.572</td>
<td>2.098</td>
</tr>
<tr>
<td>1 mg/m³ =</td>
<td>0.974</td>
<td>0.270</td>
<td>1.002</td>
<td>0.278</td>
<td>1.021</td>
</tr>
</tbody>
</table>

**GLOSSARY**

The following definitions (some taken from the Blue Guide\(^1\)) are used in this context, and have been aligned with the Draft Interim Report of the *Special review study: Assessment of appropriateness of a third party conformity assessment procedure for solid fuel boilers and solid fuel local space heaters* \(^2\):

**Conformity assessment body**: a body that performs one or several elements of conformity assessment, including one or several of the following activities: calibration, testing, certification and inspection\(^3\).

**Circumvention** At its most basic, circumvention is referred to as "the act of finding a way of avoiding a difficulty or rule"\(^4\). According to the International Electrotechnical Commission (IEC) \(^5\), circumvention results in: “false and misleading information being provided to regulators and consumers when measurements are undertaken in a test procedure”.

**Notified body**: a conformity assessment body which has been officially designated by its national authority to carry out the procedures for conformity assessment within the meaning of applicable Union harmonisation legislation when a third party is required. They are called ‘notified bodies’ under EU legislation\(^6\).

Notified bodies may demonstrate their competence through accreditation, which is the preferred way to assess their technical competence. Where accreditation is not used to assess the competence of notified bodies, the authority should undertake on-site checks of the subcontractor to the same extent as would be provided for under accreditation.

**Accreditation** is the attestation by a national accreditation body based on harmonised standards that a conformity assessment body has the technical competence to perform a specific conformity assessment activity\(^7\).

**Accreditation**: Accreditation is the formal recognition by an ‘accreditation authority’ to the technical and organisational competence of a conformity assessment body, to carry out a ‘specific service’ in accordance to the standards and technical regulations, as described in their ‘scope of accreditation’. It provides a means to identify a proven, competent evaluator so that the selection of a laboratory, inspection or certification body is an informed choice.

Regulation (EC) No 765/2008 introduced a legal framework for accreditation for the first time. Accreditation of conformity assessment bodies had previously been used in both

---


\(^2\) [https://www.thirdpartysolidfuel.eu/](https://www.thirdpartysolidfuel.eu/)


\(^4\) [Oxford Advanced Learners Dictionary](https://dictionary.oup.com/definition/circumvention)


the regulated and non-regulated domains, but it was not governed by a legal framework at European level\(^8\).

In order to be accredited in different fields of conformity assessment activities, several criteria (independent of the sector) need to be fulfilled, which are set out in harmonised standards published in the Official Journal of the EU following mandate M417\(^9\).

Of particular relevance for testing is EN ISO/IEC 17025 for testing and calibration laboratories. The national accreditation bodies notify the European Commission of which appointed conformity assessment bodies are accredited within each Regulation/directive, hence the names 'Notified Bodies'.

**Conformity assessment:** In the solid fuel heater special review study Conformity assessment is defined as the service the notified bodies offer to any economic operator inside or outside the EU (i.e. suppliers who wish to sell their products on the EU market). The tests themselves can be carried out in the country in which the Notified Body is appointed, in other EU countries or in non-EU countries.

Regulation 813/2013 article 4 states that the conformity assessment procedure [...] shall be the internal design control set out in Annex IV of 2009/125/EC or the management system set out in Annex V of 2009/125/EC without prejudice to products covered by the remaining clauses of 92/42/EEC.

**Verification:** [in this study] defined as the checking of declared performance parameters of a specific product against a required performance. The result can be that the test shows the declared parameters are correct (meet the requirements) or not. Article 5, and Annex II of regulation 813/2013 describe the verification procedure for market surveillance purposes.

**Certification:** [in the solid fuel scoping study] defined as a process that continuous surveillance and approval of the product type. According CLASP certification is: A process for meeting labeling or standards requirements, ensuring consistency, and giving credibility to government and manufacturer claims about energy efficiency. Protects manufacturers by making wilful non-compliance unacceptable.

In this study 'Certification' is the procedure by which a third party gives written assurance that a product, process, system or person conforms to specified requirements. Certification may entail periodic audits/inspections of the product and/or production processes, resulting in a certificate of quality or performance. Certification can be required by authorities in order for the product to be eligible for grants, or subsidies

**Free-riders:** [in this study] defined as parties that place on the market (or put into service) products that have not passed the appropriate conformity assessment procedures, and/or have not submitted correct information on the performance of the product, with an unfair competitive advantage as result.


## Table of Contents

**EXECUTIVE SUMMARY** ........................................................................................................ III  

**ACRONYMS, UNITS AND SYMBOLS** .................................................................................. VI  

**GLOSSARY** ............................................................................................................................... X  

1 INTRODUCTION ......................................................................................................................... 1  
1.1 Study motive ......................................................................................................................... 1  
1.2 Task 1 topics and structure according MEErP ................................................................. 2  
1.3 Evaluation of existing regulations ..................................................................................... 3  

2 PRODUCT SCOPE COVERED BY STUDY ............................................................................... 5  
2.1 Introduction .......................................................................................................................... 5  
2.2 Product scope covered by study ......................................................................................... 5  
2.3 Eurostat product categories ............................................................................................... 6  

3 POLICIES AND MEASURES ...................................................................................................... 8  
3.1 Introduction .......................................................................................................................... 8  
3.2 Generic policies and measures ............................................................................................ 8  
3.2.1 Energy Labelling – 2017/1369/EU ................................................................................. 9  
3.2.2 Ecodesign - 2009/125/EC (ex. 2005/32/EC) ................................................................. 10  
3.2.3 RES – Renewable Energy Sources Directive 2009/28/EC ........................................ 11  
3.2.4 EPBD–Energy Performance of Buildings 2010/31/EU .................................................. 13  
3.2.5 Directive (EU) 2018/844 amending the 2010 EPBD and 2012 EED ....................... 16  
3.2.6 EED- Energy Efficiency Directive 2012/27/EU ......................................................... 16  
3.2.9 NECD - 2016/2284/EU .............................................................................................. 20  
3.2.10 Air Quality - Directives 2008/50/EC and 2004/107/EC ........................................... 23  
3.2.11 MCP- 2015/2193 and LCP (Chapter III of IED - 2010/75/EU) ..................... 24  
3.2.12 RoHS (2)– 2011/65/EU & 2015/863/EU .................................................................. 26  
3.2.13 REACH – 1907/2006/EC ......................................................................................... 27  
3.2.14 WEEE – 2012/19/EU ............................................................................................... 28  
3.2.15 EU Ecolabel - 66/2010 ............................................................................................. 30  
3.2.16 F-gas 517/2014 ........................................................................................................ 30  
3.2.17 GAR - 2016/426 ........................................................................................................ 33  
3.2.18 LVD – 2014/35/EU ................................................................................................. 34  
3.2.19 EMC – 2014/30/EU ............................................................................................... 34
3.2.20 PED – 2014/68/EU .................................................................35
3.2.21 MD – 2006/42/EC .................................................................35
3.2.22 CPD – 89/106/EEC & CPR 305/2011 .................................36
3.2.23 PD – Packaging Directive 2015/720 .....................................36
3.2.24 DWD – Drinking Water Directive – 98/83/EC .........................37

3.3 CE marking ..............................................................................37
3.3.1 New Approach & New Legislative Framework .........................37
3.3.2 Accreditation and certification ................................................42
3.3.3 Conformity assessment modules ...........................................43

3.4 Specific EU policies and measures ...........................................49
3.4.1 BED - Boiler Efficiency Directive 92/42/EEC (incl. before and after).49
3.4.2 Ecodesign Regulation (EU) 813/2013/EC ................................50
3.4.3 Energy labelling regulation (EU) no 811/2013/EC ......................56
3.4.4 Amendments ........................................................................64
3.4.5 Transitional methods space heating (2014/C 207/02) ...............67
3.4.6 M/535 on standards for Regulations (EUR) No 811/2013 and 813/2013 .................................................................73
3.4.7 M/543 on resource efficiency .................................................73
3.4.8 2018 Guidelines and FAQ for space/combination heaters and water heaters .................................................................75

3.5 Related Ecodesign and Labelling regulations .............................77
3.5.1 Circulators – 641/2009, amended by 622/2012 .......................77

3.6 Member State (+ EEA) policies and measures ............................79
3.6.1 Austria ..................................................................................79
3.6.2 Belgium ................................................................................80
3.6.3 Bulgaria ................................................................................84
3.6.4 Croatia ..................................................................................85
3.6.5 Cyprus ..................................................................................86
3.6.6 Czech Republic .....................................................................87
3.6.7 Germany ...............................................................................88
3.6.8 Denmark ..............................................................................93
3.6.9 Estonia ..................................................................................93
3.6.10 Greece ...............................................................................94
3.6.11 Spain ..................................................................................95
3.6.12 Finland ...............................................................................96
3.6.13 France ...............................................................................97
3.6.14 Hungary .............................................................................100
3.6.15 Ireland ..............................................................................100
3.6.16 Italy ...................................................................................101
4 TEST STANDARDS ........................................................................... 156

4.1 Harmonisation of standards ......................................................... 156
  4.1.1 Harmonisation of standards..................................................... 156
  4.1.2 Standards harmonised for Regulation (EU) No 811/2013 and
       Regulation (EU) No 813/2013 .............................................. 156
  4.1.3 Transitional Methods for space/combination heaters/packages .... 157
  4.1.4 Request for standardisation M/535 for space/combination
       heaters/packages .................................................................. 158

4.2 Gas boilers .................................................................................. 158
  4.2.1 EN 15502-1:2012+A1:2015 [ok] ............................................. 158
  4.2.2 EN 15502-2:1:2012+A1:2016 ................................................. 163
  4.2.3 EN 15502-2:2:2014 .............................................................. 164
  4.2.4 EN 303-3:1998 / A2:2004 ..................................................... 165
  4.2.5 EN 676/+A2:2008 ................................................................. 167

4.3 Oil boilers ................................................................................... 168
  4.3.1 EN 303-1:2017 ..................................................................... 168
  4.3.2 EN 303-2:2017 ................................................................. 168
  4.3.3 EN 304: 2017 ................................................................. 169
  4.3.4 EN 267:2009 + A1:2011 .................................................. 171
  4.3.5 prEN 15034:2006 rev ...................................................... 172
  4.3.6 EN 303-4:1999 ................................................................. 172

4.4 Electric boilers (Joule-effect heaters) ............................................ 172

4.5 Electric heat pumps ................................................................... 173
  4.5.1 EN 14511 series ................................................................. 173
  4.5.2 EN 14825:2016 ................................................................. 177
  4.5.3 EN 16573:2017 ................................................................. 179
  4.5.4 EN 12900:2013 ................................................................. 182

4.6 Sorption heat pump (gas-fired) ................................................... 183
  4.6.1 EN 12309 series ................................................................. 183

4.7 Micro CHP .................................................................................. 192
  4.7.1 EN 50465:2015 ................................................................. 192
  4.7.2 Discussion: Other methods for CHP efficiency calculation ....... 202

4.8 Solar thermal .............................................................................. 208
  4.8.1 EN 12975-1:2013 & prEN 12975 rev – for solar collectors ...... 210
  4.8.2 EN 12975-2:2006 (withdrawn, see ISO 9806:2017) .............. 212
  4.8.3 EN ISO 9806:2017 – Solar collectors testing ....................... 212
5 **ISSUES IDENTIFIED** ................................................................. 267

5.1 Introduction ............................................................................. 267
5.2 Issues related to regulatory text .......................................................... 267
  5.2.1 Definitions ................................................................................. 267
  5.2.2 Scattered information requirements .......................................... 267
5.3 Product specific issues .................................................................... 268
  5.3.1 NOx, CO, PM and HC emissions .................................................. 268
  5.3.2 Liquid fuel-fired boilers ............................................................... 274
  5.3.3 Gas-fired boilers ......................................................................... 274
  5.3.4 Hybrid boilers (fuel-electric) ......................................................... 275
  5.3.5 Heat pumps ................................................................................. 276
  5.3.6 Cogeneration boilers ................................................................. 283
  5.3.7 Solar devices .............................................................................. 284
  5.3.8 Buffer tanks ............................................................................... 291
  5.3.9 PFHRD ...................................................................................... 291
  5.3.10 Temperature controls ............................................................... 292
5.4 Cross-category issues ...................................................................... 292
  5.4.1 Maximum load profile for labelling or Ecodesign (2XL vs. 3XL/4XL) 292
  5.4.2 Minimum storage temperature ..................................................... 293
  5.4.3 Product and package label .......................................................... 293
  5.4.4 Primary energy factor - PEF ......................................................... 297
  5.4.5 Definitions ................................................................................. 298
5.5 Conformity assessment ................................................................... 299
  5.5.1 Introduction to "third-party verification" ......................................... 299
  5.5.2 Conformity assessment modules and risk ..................................... 300
  5.5.3 Stakeholder positions ................................................................. 304
  5.5.4 Discussion of relevant elements ................................................... 311
  5.5.5 Summary ................................................................................... 317
5.6 ECOTest - "Round robin" test of measurement uncertainties .......... 321

APPENDIX I – SOLICS, SOLCAL AND OTHER METHODS TO CALCULATE THE SOLAR
CONTRIBUTION TO WATER HEATING (COMBINATION HEATERS) ...................... 325

Solar heating, introduction to calculations ........................................... 325
SOLCAL method .............................................................................. 326
SOLICS method ............................................................................... 329
Water heater energy efficiency $\eta_{wh,nonsol}$ ................................... 329
Product level: Solar water heater efficiency ...................................... 331
Package level: Efficiency of water heater and solar device ............... 332
Space heating and solar devices ......................................................... 332
Discussion solar thermal ................................................................. 334
APPENDIX II – MODULES.............................................................................................................. 339

Modules of Decision 768/2008/EC .......................................................................................... 339

ANNEX III – TESTING COSTS .................................................................................................... 345

ANNEX IV – SPACE HEATING EFFICIENCY OF CHP .............................................................. 347

ANNEX V – REFERENCES .......................................................................................................... 351
LIST OF TABLES

Table 1. Calorific value and gross/net ratio of gas families .................................................. IX
Table 2. Conversion of NOx of gas families ............................................................................. IX
Table 3. Percentage of the urban population in the EU-28 exposed to air pollutant concentrations above certain EU and WHO reference concentrations (minimum and maximum observed between 2014 and 2016) ................................................................. 24
Table 4. Emission limit values of the MCP Directive ................................................................. 26
Table 5. Standards for treatment of WEEE .............................................................................. 29
Table 6 ASHRAE Standard 34-2013 4 Safety classifications ....................................................... 32
Table 7. Names and nr. of Notified Bodies (for BED 92/42/EEC) .............................................. 40
Table 8. Conformity assessment modules .................................................................................. 44
Table 9. Minimum seasonal energy efficiency requirements of Regulation (EU) 813/2013 ......................................................................................................................... 52
Table 10. Maximum NOx emission values of Regulation (EU) 813/2013 ................................. 53
Table 11. Maximum sound power levels for heat pumps ............................................................. 53
Table 12. Seasonal space heating energy efficiency classes of space/combination heaters, in % ...................................................................................................................................................................................... 56
Table 13. Water heating energy efficiency classes of combination heaters, in % ....................... 57
Table 14. Storage tank energy efficiency classes, if (part of) a solar device, in % ....................... 57
Table 15. Parameter table of Commission Communication 2014/C 207/02 ................................... 68
Table 16. Differences in test standards for standing losses of storage tanks ............................. 71
Table 17. Germany PEF values ................................................................................................. 89
Table 18. BAFA subsidies for heat pumps (source: Viessmann.de 2018) ..................................... 91
Table 19. Reference values for heat / power production - Italy ................................................. 102
Table 20. Portugal minimum efficiency requirements heating equipment before and after 2016 .................................................................................................................................................................................. 107
Table 21. Portugal FEE, subsidy proposals for solar thermal installations 2016 ....................... 107
Table 22. Offset applied if declared efficiency is above threshold ............................................ 113
Table 23. Maximum efficiencies allowed in SAP ..................................................................... 113
Table 24. Emission limits for boilers 0-1 MW .......................................................................... 120
Table 25. Evaluation of emissions country by country, part 1 ................................................... 122
Table 26. Evaluation of emissions country by country ............................................................... 123
Table 27 Sound pressure at various distances ......................................................................... 126
Table 28. Minimum requirements for gas-fired boilers (shown up to 733 kW) under the US FEMP programme ................................................................................................................. 134
Table 29. China combi-boiler efficiency grades for the China Energy Label ............................ 137
Table 30. Overview of labs used by Eurovent Certification and NF in 2014 ............................... 141
Table 31. Market share of certification in 2014 ....................................................................... 142
Table 32. Return temperatures of condensing boilers, low temperature boilers and other heaters (standard boilers) ................................................................. 170
Table 33. Standard rating conditions for heat pumps in EN 14511 ........................................... 174
Table 34. Rating conditions for ventilation heat pumps in EN 16573........................................ 181
Table 35. EN 12309 series of standards ..................................................................................... 183
Table 36. NOx emissions classes ................................................................................................. 185
Table 37. NOx weighing factors ................................................................................................. 186
Table 38. EN 12309-3:2012 Standard rating conditions, heating mode .................................... 188
Table 39. Weighing factor $F_{\text{CHP}}$ (Table 18 in FprEN 50465:2014) ........................................ 196
Table 40. Comparing the heating efficiency of an integrated and packaged product, for small SOFC and Stirling cogeneration ......................................................... 199
Table 41. Calculation of NOx emissions (weighting, return temperatures) by mCHP in EN 50465:2015 ......................................................................................... 202
Table 42. Overview of calculated CHP and package heating efficiencies according several methods ............................................................ 206
Table 43. Difference factory made and custom-built solar devices ............................................. 209
Table 44. Overview of ISO 9806 versions, in relation to EN 12975-2 ......................................... 211
Table 45. Building system level standards .................................................................................. 225
Table 46. Test phases .................................................................................................................. 247
Table 47. Suggested brine temperatures for three climate conditions ......................................... 252
Table 48. NOx emission limit values in 813/2013 ....................................................................... 254
Table 49. Emissions of atomizing burners ................................................................................ 256
Table 50. Classification of heat generation functions according EN 15232-1:2017 ..................... 261
Table 51. Definition of temperature control classes, transitional method .................................. 262
Table 52. Overview of standards that are part of the round robin ECOtest ................................. 266
Table 53. Overview of emissions ............................................................................................... 274
Table 54. Maximum exhaust air available .................................................................................. 282
Table 55. Package improvement for simplified solar calculation ............................................... 291
Table 56. Conformity assessment procedures .......................................................................... 302
Table 57. Conformity assessment by risk, PED 2014 ............................................................... 303
Table 58. Summary of positions of stakeholders ...................................................................... 311
Table 59. Conformity assessment procedures in detail ............................................................. 320
Table 60. Overview of standards that are part of the round robin ECOtest ................................. 321
Table 61. $Q_{\text{nonisol}}$ (example) for current and corrected methods .............................................. 323
Table 62. Primary energy consumption and savings according to EIA 2017 ............................. 328
Table 63. Comparing cogeneration and heat pump for output, input and efficiencies ............... 347
Table 64. Weighing factor $F_{\text{CHP}}$ .......................................................................................... 350
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Overview of policies and measures, top-down</td>
<td>8</td>
</tr>
<tr>
<td>Figure 2</td>
<td>EU clean air policy – the policy framework</td>
<td>21</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Emissions 2010-2016 and target levels 2020 and 2030 for five air pollutants regulated under the NEC Directive 2016/2284/EU. Annex I and II ceilings refer to 2010 target levels established under the previous NEC Directive 2001/81/EC</td>
<td>22</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Notified Bodies (for BED 94/42/EEC) per member state</td>
<td>40</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Structure of EU certification and accreditation</td>
<td>42</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Energy labels for the various products in scope of Regulation (EU) No 811/2013</td>
<td>58</td>
</tr>
<tr>
<td>Figure 7</td>
<td>Package fiche space/combination heater</td>
<td>59</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Package fiche Cogeneration package</td>
<td>60</td>
</tr>
<tr>
<td>Figure 9</td>
<td>Package fiche Heat pump package</td>
<td>61</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Package fiche Low temperature heat pump package</td>
<td>62</td>
</tr>
<tr>
<td>Figure 11</td>
<td>Package fiche for any package with combination heaters</td>
<td>63</td>
</tr>
<tr>
<td>Figure 12</td>
<td>Screenshot of energy label generator (eepf-labels)</td>
<td>76</td>
</tr>
<tr>
<td>Figure 13</td>
<td>ENEV labels for existing heaters</td>
<td>92</td>
</tr>
<tr>
<td>Figure 14</td>
<td>Proposed fegeca label for existing boilers in Spain</td>
<td>96</td>
</tr>
<tr>
<td>Figure 15</td>
<td>Share of fossil fuels in final energy use of dwellings 1983-2015</td>
<td>115</td>
</tr>
<tr>
<td>Figure 16</td>
<td>Energy use in the Swedish district heating system 1970-2012</td>
<td>116</td>
</tr>
<tr>
<td>Figure 17</td>
<td>Development of Legionella bacteria by temperature</td>
<td>128</td>
</tr>
<tr>
<td>Figure 18</td>
<td>Ene.field partners</td>
<td>131</td>
</tr>
<tr>
<td>Figure 19</td>
<td>From LabelPackA+, D4-6, opinion on the energy label for space and water heating systems</td>
<td>153</td>
</tr>
<tr>
<td>Figure 20</td>
<td>From LabelPackA+, D4-6, the most important issues with regards to the labelling of heating systems?</td>
<td>153</td>
</tr>
<tr>
<td>Figure 21</td>
<td>Part of figure 2 of Annex IV of Delegated Regulation (EU) No 811/2013</td>
<td>198</td>
</tr>
<tr>
<td>Figure 22</td>
<td>Part of table 6 of Annex IV of Delegated Regulation (EU) No 811/2013</td>
<td>198</td>
</tr>
<tr>
<td>Figure 23</td>
<td>Micro-CHP Standardisation history</td>
<td>201</td>
</tr>
<tr>
<td>Figure 24</td>
<td>SEC and efficiency compared</td>
<td>207</td>
</tr>
<tr>
<td>Figure 25</td>
<td>Simplified test method with temperature zones</td>
<td>224</td>
</tr>
<tr>
<td>Figure 26</td>
<td>Flue/air configurations, based on TR 1749:2014</td>
<td>228</td>
</tr>
<tr>
<td>Figure 27</td>
<td>Test points electrical measurements</td>
<td>239</td>
</tr>
<tr>
<td>Figure 28</td>
<td>Different scoping levels BACS and its potential relationship to European Policy –BACS scoping study</td>
<td>260</td>
</tr>
<tr>
<td>Figure 29</td>
<td>Air change rates in Europe</td>
<td>280</td>
</tr>
<tr>
<td>Figure 30</td>
<td>Ventilation rate for minimum IAQ by total floor area</td>
<td>281</td>
</tr>
<tr>
<td>Figure 31</td>
<td>Comparing Regulation air flow rate and air flow rate for min. IAQ</td>
<td>282</td>
</tr>
</tbody>
</table>
Figure 32. Current and proposed approach for solar+back-up heater package efficiency eta_pack, at a certain back-up heater power (12 or 24 kW) and collector surface Acoll (in m², x-axis) ........................................................................................................................................286

Figure 33. Contribution of solar device to water heating efficiency, for smaller and larger system................................................................................................................................................288

Figure 34. RAC energy label in 626/2011.................................................................................................................................................................................................290

Figure 35. Collector efficiency ..........................................................................................................................................................................................338

Figure 36. Power plant efficiency ..................................................................................................................................................................................348

Figure 37. Heat pump efficiency ..................................................................................................................................................................................348

Figure 38. Cogeneration heater efficiency .................................................................................................................................................................348

Figure 39. Cogeneration heater + heat pump efficiency ("virtual gas heat pump") ......348
1 INTRODUCTION


The complete preparatory review study follows the general structure laid down in the Methodology for Ecodesign of Energy-related Products (MEErP) of 2011\(^\text{10}\) which consists of seven tasks:

1. Task 1 – Scope
2. Task 2 – Markets
3. Task 3 – Users
4. Task 4 – Technologies
5. Task 5 – Base Case LCA & LCC
6. Task 6 – Design Options
7. Task 7 – Scenarios

1.1 Study motive

Article 7 of Commission Regulation (EU) No. 813/2013 requires the Commission to review the Ecodesign regulation in the light of technological progress with heaters and present the result of that review to the Ecodesign Consultation Forum no later than five years from the date of entry into force of this Regulation. In particular, the review shall include an assessment of the following aspects:

- the appropriateness of setting Ecodesign requirements for greenhouse gas emissions related to refrigerants → see Task 4-Products and subsequent tasks;
- on the basis of the measurement methods under development, the level of the Ecodesign requirements for emissions of carbon monoxide, hydrocarbons and particulate matter that may be introduced → see Task 4-Products and subsequent tasks;
- the appropriateness of setting stricter Ecodesign requirements for the energy efficiency of boiler space heaters and boiler combination heaters, for the sound power level and for emissions of nitrogen oxides → see Task 4-Products and subsequent tasks;
- the appropriateness of setting Ecodesign requirements for heaters specifically designed for using gaseous or liquid fuels predominantly produced from biomass → see Task 4-Products and subsequent tasks;
- the validity of the conversion coefficient value ("PEF", currently set at 2.5) → this Task 1 and Task 7 - Policies;
- the appropriateness of third-party certification → this Task 1 plus Task 7 - Policies;

\(^{10}\) http://ec.europa.eu/docsroom/documents/26525
Article 7 of Commission Delegated Regulation (EU) No. 811/2013 requires the Commission to review the Energy Labelling delegated regulation for space heaters and combination heaters in the light of technological progress no later than five years after its entry into force. The review shall in particular assess:

- any significant changes in the market shares of various types of heaters → see Task 2 - Market;
- the feasibility and usefulness of indicating heater efficiency other than heat pump efficiency based on standardised heating seasons → see Task 4 - Products;
- the appropriateness of the package fiches and labels → this Task 1 plus Task 7;
- and the appropriateness of including passive flue heat recovery devices in the scope of this Regulation → see Task 2 – Markets and Task 4 - Products.

In addition to the above the Commission requested in its Terms of reference for this study:

- an assessment of resource efficiency, such as disassembly, recyclability, reparability and durability, following the adoption of the Circular Economy Package in December 2015 and the new Ecodesign Working Plan 2016-2019; → see Task 4 - Technology
- a quantitative evaluation of the impact of the existing regulations. → see Task 2 - Market
- a technology roadmap to show previous technological innovations, current product technologies including best available technologies (BAT) and concentrate mainly on an outlook of technologies yet to enter the market (BNAT) as well as general technological trends in the examined product sector, using the findings from the MEErP as basis. This technology roadmap should give the Commission the basis in terms of a technology overview to develop a strategy on future effective support under the EU research framework programme, Horizon 2020, to foster the development and production of energy efficient, novel technologies within the European Union. → see Task 2 – Market, Task 4 Technology and Task 7

1.2 Task 1 topics and structure according MEErP

Task 1 defines the scope of the study, describes applicable and relevant policies and measures and test standards. As this study is a review study, specific aspects mentioned in Article 7 of the regulations are addressed, elaborated with specific request from the study terms of references.

According to the MEErP 2011 methodology Task 1 entails the following subtasks (numbering in brackets is as in MEErP 2011), with some modifications as this is a review study for existing legislation:

Chapter 2: Product scope (MEErP 1.1)

The scope is defined by the regulations to be reviewed. It shall consider whether exclusions or additions to the scope are required.

For completeness the Prodcom categories are added and the description of test standards include the scope of the standard.

Chapter 3: Policies and measures (MEErP 1.3)
Identify and describe:

a. relevant EU legislation
b. relevant member State legislation
c. relevant third country legislation

Chapter 4: Test standards (MEErP 1.2)
Identify and describe

a. EN or ISO/IEC test standards
b. Request for standardisation (Mandates)
c. if relevant, test standards specific to Member States (intra EU)
d. if relevant, test standards specific to third countries (extra EU)

The standards are to be analysed as regards overlapping on performance, resource use and/or emissions. Also analyse and report on new standards being developed (if involving major changes), issues related to measurement uncertainty, reflection of real-life functioning, and meeting objectives of the request for standardisation.

Chapter 5: Evaluation and outlook (terms of Reference of study)

See section 1.1 on Study motive

This report will follow the MEErP structure in the order mentioned above.
Note that the MEErP methodology was conceived to investigate products new to EU regulation. For review studies there can be shortcuts for subjects sufficiently covered by preceding (preparatory) studies.

### 1.3 Evaluation of existing regulations

Following the Better Regulation Toolbox, it is important for a review of existing regulations to evaluate whether the regulation did/does what it was supposed to do and whether there was no significant negative impact as intended in Article 15 of the Ecodesign Directive.

In this respect Task 1 is relevant as it presents and discusses several issues flagged by stakeholders, ranging from unclear definitions and lack of appropriate standards to interpretation of the meaning of the legal text, etc. Depending on the severity of the problem raised the issue could be relevant for/when revising the Regulation(s).

It is important to realise that Task 1 alone cannot give a full evaluation of the existing regulations because other aspects, such as changes in market shares, energy savings and emission reductions achieved, etc. are part of subsequent tasks.

It is also important to realise that the Ecodesign and Energy Labelling requirements under review applied as of September 2015 and certain stakeholders (even if involved in
the preparatory works that started in 2006\textsuperscript{11}) were only able to understand the full impact of the regulation(s) on their businesses after the final rules were published in 2013, the transitional methods in 2014 and guidelines (FAQ/explanations) in 2015 and 2018. As the most recent market data (sales data) that could be collected and presented to the public (see Task 2) relates to year 2016, the sales data reflect changes after just one year after the first requirements came into force. The sales of 2016 may still include sales of wholesale stock etc. and may not reflect the full impact of the regulations. More recent sales data was not yet available.

\textsuperscript{11} The preparatory study for the current regulations started in January 2006, using market data from 2004. The study was followed by a period of 6-7 years in which many discussions took place and revised proposals were considered. The outline of the current regulations (indicating an increase in use of condensing boilers) became only visible since 2012. The heating industry, based on past experience, relied on the official text from September 2013, and allowing a transitional period of two years. The publication of the Transitional Methods followed in 2014 and further guidelines, including FAQs resolving certain ambiguous matters, were published in January 2015 and 2018.
2 PRODUCT SCOPE COVERED BY STUDY

2.1 Introduction

As this study is part of the review process set out for space heaters and combination heaters (both are from hereafter referred to as space heaters, if not explicitly mentioned separately), the scope of the study is linked to that of the regulations to be reviewed. Unless the analysis requires otherwise, the scope is expected to remain the same.

2.2 Product scope covered by study

The study scope is defined by the regulations to be reviewed and thus covers 'space heaters' and 'combination heaters' for water-based central heating systems, defined as:

- A ‘space heater’ means a device that provides heat to a water-based central heating system in order to reach and maintain at a desired level the indoor temperature of an enclosed space such as a building, a dwelling or a room; and is equipped with one or more heat generators.
- A ‘combination heater’ means a space heater that is designed to also provide heat to deliver hot drinking or sanitary water at given temperature levels, quantities and flow rates during given intervals, and is connected to an external supply of drinking or sanitary water.

The scope of the Ecodesign regulation 813/2013 is limited to space/combination heaters with a rated heat output less than or equal to 400 kW. Cogeneration space heaters with a maximum electrical capacity of 50 kW or above are excluded as well. The scope of the Energy Labelling delegated regulation 811/2013 is limited to a maximum rated heat output of space/combination heaters less than or equal to 70 kW (including packages). The part of the study that provides inputs to the evaluation (such as sales, efficiencies, etc.) is kept identical to the above described regulatory scope. However, an expansion of this regulatory scope is discussed as possible policy option (see also Task 6 on this topic).

Local space heaters (room heaters) and solid fuel fired boilers are excluded as these are covered by other regulations although both may be described in various places in this report to provide a more complete picture. Space heaters designed for using solid fuels or gaseous or liquid fuels from biomass are excluded from the scope of the regulations, but the review requires assessment of appropriateness of setting Ecodesign requirements for heaters specifically designed for using gaseous or liquid fuels predominantly produced from biomass, so these heaters are not excluded from the scope of this study.

The space/combination heaters covered by the study are:

1. Fuel boiler space/combination heaters (including using gaseous/liquid fuels predominantly from biomass origin);
2. Electric heat pump space/combination heaters;
3. Fuel driven heat pump space/combination heaters;
4. Cogeneration space/combination heaters (by definition fuel driven);
5. Electric boiler space/combination heaters;
6. including combinations of the above, with/without controls, solar thermal devices, storage tanks (for labelling).

As said, the scope of the study can be widened to include products not yet covered by the present regulations, but that are considered by stakeholders to be relevant and need to be considered for the review of regulations.

“Boilers”
Throughout this report reference is made to 'boilers'. It should be noted that 'boiler' is a working title and just a short way of saying 'space heater equipped with one or more heat generator(s) to provide heat for a water-based space central heating systems, and/or combination heater, equipped with one or more heat generator(s) to provide heat for a water-based space central heating systems and designed to provide domestic hot water', to distinguish it from all the other central or local, air- or water-based, space heaters being regulated through Ecodesign these days. Also, a 'heat pump boiler', 'gas boiler', etc. should be understood in the same way, i.e. to distinguish from an air-to-air heat pump which is not in the scope. In the end the legislator may decide to use a different expression in the legislation.

2.3 Eurostat product categories
The methodology requires an assessment of product categories as used by official EU statistics on the production of manufactured goods: Prodcom. The term comes from the French "PRODuction COMMunautaire" (Community Production) for mining, quarrying and manufacturing: sections B and C of the Statistical Classification of Economy Activity in the European Union (NACE).

Prodcom uses the product codes specified on the Prodcom List, which contains about 3900 different types of manufactured products.

a) Products are identified by an 8-digit code:
   (1) the first four digits are the classification of the producing enterprise given by the Statistical Classification of Economic Activities in the European Community (NACE) and the first six correspond to the CPA
   (2) the remaining digits specify the product in more detail

b) Most product codes correspond to one or more Combined Nomenclature (CN) codes, but some (mostly industrial services) do not

Water based space heaters ("boilers") are categorised in the Eurostat PRODCOM/Europroms CN8 product code 25.21.12.00, and in the COMEXT database for trade, using HS codes 84031010 (cast iron boilers) and 84031090 (non-cast-iron boilers). Both PRODCOM and COMEXT codes relate to 'Boilers for central heating other than those of HS 8402'.

The category of fossil-fuel fired boilers also include solid-fuel boilers, which are not in the scope of the boiler regulations. Eurostat databases do no longer show a split-up by fuel

---

12 https://ec.europa.eu/eurostat/web/prodcom/data/database
type. Already in 2004, when there were still separate categories for gas-fired, oil-fired and ‘other’ types these datasets were almost empty, except for a few countries.

Water- and ground source heat pumps, usually intended for water-based central heating, are categorised in Eurostat PRODCOM prccode 28 25 13 80 ‘Heat pumps other than air conditioning machines of HS 8415’.

Air-source heat pumps, mostly for air cooling and heating but also for water-based systems, are all classified as ‘air conditioning’ in HS-group 8415 or NACE Rev. 2 group 2825. In that highly aggregated form the category is not relevant for the scope of this study. PRODCOM code 25 25 12 50 refers to "Air conditioning machines with refrigeration unit (excluding those used in motor vehicles, self-contained or split-systems machines)" and may or may not contain heat pumps (reversible air conditioning). In any case the category is "polluted" with non-space heating products.

Electric resistance space heaters are probably a (small) part of the electric immersion heaters, which for the most part consists of electric dedicated water heaters (not in scope here).

For solar thermal panels, not to be confused with solar photovoltaic panels, there is no indication in which cluster they could be placed. The same goes for micro-CHP space heaters.

This means that no PRODCOM data can be presented for air-sourced heat pumps, solar thermal devices and cogeneration space/combination heaters.
3 POLICIES AND MEASURES

3.1 Introduction

The aim of this section is to describe which policies and measures affect the performance and characteristics of space/combination heaters.

Paragraph 3.2 describes generic EU legislation with relevance to space/combination heaters. Paragraph 3.3 addresses product specific legislation such as the Boiler Efficiency Directive and the Ecodesign and labelling (delegated) regulations. Requests for standardisation are also shown.

The sections hereafter describe measures applicable at Member States and extra EU level.

Figure 1. Overview of policies and measures, top-down

<table>
<thead>
<tr>
<th>Specific for space/combi heaters</th>
<th>Generic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labelling 1369/2017</td>
<td>Ecodesign 2009/125/EC</td>
</tr>
<tr>
<td>Space/combi heaters 811/2013</td>
<td>Space/combi heaters 813/2013</td>
</tr>
<tr>
<td>Water heaters 812/2013</td>
<td>Water heaters 814/2013</td>
</tr>
<tr>
<td>M/534 water heaters M/535 space/combi heaters</td>
<td>M/545</td>
</tr>
<tr>
<td>&quot;circular economy&quot; standards currently developed by CEN-CIC TC10/WG1.6</td>
<td>(various mandates)</td>
</tr>
</tbody>
</table>

Test standards product specific standards, can cover both safety and environment/energy

3.2 Generic policies and measures

Space heaters and combination heaters are covered by generic legislation dealing with energy efficiency (as in the Proposal for an Energy Union13), environmental performance, safety and/or functionality.

The Ecodesign Directive and Energy Labelling Regulation are framework directives/regulations that do not prescribe essential requirements themselves but depend on product specific implementing measures to do this, such as Delegated Regulation (EU) 811/2013 (energy labelling) and Regulation (EU) 813/2013 (Ecodesign).

---

13 Proposal for a Regulation on the Governance of the Energy Union (COM(2016) 759 final): Article 27, item 5. If, in the area of energy efficiency, without prejudice to other measures at Union level pursuant to paragraph 3, the Commission concludes, based on its assessment pursuant to Article 25(1) and (3), in the year 2023 that progress towards collectively achieving the Union’s energy efficiency target mentioned in the first sentence of Article 25(3) is insufficient, it shall take measures by the year 2024 in addition to those set out in Directive 2010/31/EU and Directive 2012/27/EU to ensure that the Union’s binding 2030 energy efficiency targets are met. Such additional measures may in particular improve the energy efficiency of: (a) products, pursuant to Directive 2010/30/EU and Directive 2009/125/EC; (b) buildings, pursuant to Directive 2010/31/EU and Directive 2012/27/EU; (c) and transport.
Where these policies or measures prescribe essential requirements, they (indirectly) refer to technical (test) standards according which products can\textsuperscript{14} be tested in order to carry the CE marking and move freely within the internal market.

\textbf{3.2.1 Energy Labelling – 2017/1369/EU}

The former Energy Labelling Directive 2010/30/EU has been replaced by the Energy Labelling Regulation (EU) 2017/1369 on 28 July 2017\textsuperscript{15}.

Like the old directive the new regulation sets out obligations for suppliers and dealers of energy-related products for the labelling of those products and the provision of standard product information regarding energy efficiency, the consumption of energy and of other resources by products during use and supplementary information concerning products, thereby enabling customers to choose more efficient products in order to reduce their energy consumption. Two new elements are that the scope specifically includes 'systems' and that there is an obligation for suppliers to provide data-input for a product database.

The new regulation also presents new rules for the introduction of new labels and introduces a procedure to rescale existing labels. New labels shall no longer allow additional classes above A (A+ etc.), and class A shall be empty when a label is introduced on the market, to avoid too frequent rescaling of labels (class A and B empty if the pace of product change is quick).

For space/combi heaters in particular this means:

\begin{itemize}
\item Suppliers (manufacturers, importers and authorised representatives) are obliged to enter in the database the data of models placed on the market as of 1 Jan 2019. Relevant data of models covered by existing acts placed on the market between 1 Aug 2017 and 1 Jan 2019 shall be entered in the database by 30 Jun 2019. Entry of data of even older models is voluntary. Dealers of packages (sole responsible for the data) are excluded from this.
\item A review of the space/combi heater (and water heater) regulations, with a view to rescaling them, must be presented by 2 August 2025. The Commission must, where appropriate, adopt by 2 August 2026 delegated acts that introduce A to G \textit{rescaled labels}. In any event, the delegated acts introducing A to G rescaled labels shall be adopted no later than 2 August 2030 (Article 11.5).
\end{itemize}

For manufacturers of space and combination heaters currently covered by Delegated Regulation (EU) 811/2013 and 812/2013 this means they must provide relevant data to the database to be established (EPREL) by 2019, and that a study for the rescaling of labelling is announced for completion by 2025.

At present, the EPREL database is being set up and several meetings with stakeholders have been concluded or are announced. The Commission is intent to launch the database on the required date 1 January 2019. As laid down in article 12.5 of regulation

\textsuperscript{14} Ecodesign and Energy Labelling regulations refer to the use of harmonised standards but do not exclude the use of other standards to prove compliance.

2017/1369 the database will comprise a public part containing label information (label + fiche), accessible to all, and a private part, accessible to market surveillance authorities and the European Commission only and containing the technical documentation. The information in the database will be entered by manufacturers. Requests for including additional information (e.g. Ecodesign information, or results from voluntary certification) have been rejected. The energy labelling of space heaters is considered complex because of the labelling of space heater combinations ("package label"). Each combination would need to figure in the database. The same would apply to products belonging to a range (heat pumps that are a configuration of indoor units (several types and numbers possible) and outdoor units (also several types and numbers possible), which is already complex under the current labelling regulation.

The issue of rescaling (and how this is implemented in EPREL) is set aside for the moment as the parties involved prepare for a timely completion of the basic work. There will not be automatic rescaling in EPREL. Rescaling needs a new product development based on a new legislation.

Stakeholders (ECOS) have suggested that the EPREL database could play a larger role in the creation of ‘package labels’ under 811/2013 (space heaters) and 812/2013 (water heaters). In that sense the EPREL database could be the backbone for websites that calculate package label configurations such as www.heizungslabel.de/verbundanlagen.

3.2.2 Ecodesign - 2009/125/EC (ex. 2005/32/EC)

Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 (recast of Directive 2005/32/EC on energy using products) establishes a framework for the setting of eco-design requirements for energy related products which have to be met before they can be placed on the EU market. It does not apply to transport used to carry people or goods.16

The Ecodesign Directive aims to remove disparities between the laws or administrative measures adopted by the Member States in relation to the Ecodesign of energy-related products as these may impact the establishment and functioning of the internal market. The Directive refers in particular to Article 95 of the Treaty establishing the European Community.

Key points of the Directive are:

- Eco-design requirements cover all stages of a product’s life: from raw materials, manufacturing, packaging and distribution to installation, maintenance, use and end-of life. The requirements can be:
  - **specific** e.g. minimum energy efficiency requirements or maximum emission limit values, or criteria related to circular economy (product durability);
  - **generic**, e.g. requiring the provision of relevant product information and may extend to producing an overview of life cycle impacts.

---

- Products which satisfy the requirements bear the CE marking and may be sold anywhere in the EU.

The Directive is a New Approach Directive and requires the use of CE marking and harmonized standards to show conformity with essential requirements. The essential requirements and conformity assessment procedures are specified by the implementing measures and usually leave to manufacturers the choice between the internal design control set out in Annex IV to this Directive (Module A of Council Decision 768/2008/EC) and the management system set out in Annex V to this Directive (the management system assessment includes, besides the same elements as the internal design control, additional elements regarding a management system aimed at improving the environmental performance of products and the organisation; describing policies, planning, implementation and documentation, checking and corrective action).

Other modules as described in Annex II to Decision No 768/2008/EC (Module A to G) are in principle possible, where duly justified and proportionate to the risk.

3.2.3 RES – Renewable Energy Sources Directive 2009/28/EC

The Renewable Energy Sources Directive (RED) 2009/28/EC, which amends and repeals earlier Directives 2001/77/EC and 2003/30/EC, creates a common set of rules for the use of renewable energy in the EU so as to limit greenhouse gas (GHG) emissions and promote cleaner transport. 18

It sets national binding targets for all EU countries with the overall aim of making renewable energy sources account by 2020 for 20% of EU energy and for 10% of energy specifically in the transport sector (both measured in terms of gross final energy consumption, i.e. total energy consumed from all sources, including renewables). These targets range from a low of 10% in Malta to a high of 49% in Sweden.

Each EU country has to make a national action plan for 2020, setting out how to achieve the national target for renewables in gross final energy consumption as well as the 10% target for renewable energy sources in transport. To help achieve targets in a cost-effective way, EU countries can exchange energy from renewable sources. To count towards their action plans, EU countries can also receive renewable energy from countries outside the EU, provided that energy is consumed in the EU and that it is produced by modern/efficient installations. Each EU country must be able to guarantee the origin of electricity, heating and cooling produced from renewable energy sources. EU countries should build the necessary infrastructure for using renewable energy sources in the transport sector.

On 30 November 2016, the Commission published a proposal for a revised Renewable Energy Directive to make the EU a global leader in renewable energy and ensure that the

17 Article 3 of Directive 2009/125/EC specifies that “Member States shall ... ensure that products covered by implementing measures may be placed on the market and/or put into service only if they comply with those measures and bear the CE marking in accordance with Article 5.” Article 5 states that a CE marking shall be affixed before the products is placed on the market and/or put into service.

target of at least 27% renewables in the final energy consumption in the EU by 2030 is met.

Annex VII of 2009/28/EC presents a method for accounting of renewable energy from heat pumps. Only if a heat pump has a seasonal performance factor SPF exceeding 1.15 the renewable heat shall be taken into account.

In Commission Decision 2013/114/EU of 1 March 2013 the minimum SCOPnet of heat pumps is calculated to be 2.5 on the basis of a power system efficiency of 45.5% (indicating a SPF on electricity of 1.15/0.455 = 2.5). For fuel driven heat pumps the conversion = 1, and a SPEF =1.15 applies. The SCOPnet (SPFh2) is calculated without the energy consumption of a supplementary heater and is therefore by definition somewhat higher than the $\eta_s$ for heat pumps.

Member States can use default values ranging from minimum 2.5 for air-water in the cold climate to 3.5 for ground-water heat pumps (any climate). The same table also shows default equivalent full load operating hours ($H_{HF}$) necessary for the calculation. Member states are required to present an inventory of renewable energy (called SHARES), including heat from heat pumps, on a periodic basis to the Commission\textsuperscript{19}.

The calculation is described in Annex VII of 2009/28/EC:

$$E_{RES} = Q_{usable} \times (1 - 1/\text{SPF})$$

Where:

$E_{RES} = $ The amount of aerothermal, geothermal or hydrothermal energy captured by heat pumps to be considered energy from renewable sources for the purposes of this Directive;

$Q_{usable} = $ the estimated total usable heat delivered by heat pumps fulfilling the criteria referred to in Article 5(4), implemented as follows: Only heat pumps for which $\text{SPF} > 1.15 \times 1/\eta$ shall be taken into account

$\text{SPF} = $ the estimated average seasonal performance factor for those heat pumps;

$\eta = $ the ratio between total gross production of electricity and the primary energy consumption for electricity production and shall be calculated as an EU average based on Eurostat data

Annex I.3.2 of Decision 2013/114/EU adds:

$$Q_{usable} = H_{HF} \times P_{rated}$$

Where:

$H_{HF} = $ equivalent full load hours of operation [h]

$P_{rated} = $ capacity of heat pumps installed, taking into account the lifetime of different types of heat pumps [GW] (this calculation is used for calculating RES at Member State level)

---

\textsuperscript{19} The SHARES tool has been developed for this- http://ec.europa.eu/eurostat/web/energy/data/shares
3.2.4 EPBD—Energy Performance of Buildings 2010/31/EU

The Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (EPBD) is a recast of the 2002 Directive and promotes the energy performance of buildings in the EU, taking into account outdoor climate and local conditions, as well as indoor climate requirements and cost-effectiveness.

The Directive is the European Union’s main legislation covering the reduction of the energy consumption of buildings, by setting a holistic framework to improve the energy performance of buildings. First of all, it requires Member States to establish cost-optimal minimum energy performance requirements for buildings and building units and for the main envelope elements, this requirement applies both to buildings and existing buildings undergoing major renovation.

In addition, Energy Performance Certificates (EPC), providing information for prospective purchasers or tenants about the building’s or building unit’s energy performance and recommendations for cost-effective improvements, shall be issued when buildings or building units are constructed, sold or rented out.

National authorities must establish schemes to regularly inspect heating and air-conditioning systems above certain thresholds of system capacity. However, these energy inspection reports have often been found to be of “very limited impact”.

The Directive also provides a common general framework for the calculation of energy performance of buildings, ensuring that the calculation of energy performance is based on the energy demand to meet needs under typical use and reflecting heating, cooling and domestic hot water needs. Additional aspects that should be taken into consideration include mechanical and natural ventilation and built-in lighting. The framework also requests to take into account the positive influence of heating and electricity systems based on renewable energy.

Finally, the Directive provides a ‘future-proof’ vision for the building sector: new buildings owned and occupied by public authorities should achieve nearly zero-energy standards by 31 December 2018 and all new buildings 2 years later.

While there are regional differences, the rate of new buildings added to the stock is about 0.5% per year and the rate at which existing buildings undergo a major renovation is about 1% per year. Existing buildings and buildings undergoing only ‘minor’ renovations are not affected by the minimum requirements set by the Member States under the EPBD. Such minor renovations, which include one or two measures (boiler replacement

---

21 A section, floor or apartment within a building which is designed or altered to be used separately
22 Article 2 of the EPBD recast defines major renovation, as either a renovation in which “the total cost of the renovation relating to the building envelope or technical systems is higher than 25% of the value of the building, excluding the value of the land upon which the building is situated”, or a renovation in which “more than 25% of the surface of the building envelope undergoes renovation”.
24 Ecofys (2016) EU Pathways to a Decarbonised Building Sector, pp. 18-20.
and double glazing) account for 85% of the renovation market.\(^{25}\) To conclude, the provisions of the EPBD and its minimum energy performance requirements only affect a small share of the EU’s buildings stock.

Nearly zero-energy buildings (NZEB) are defined in Article 2 of the EPBD as buildings that have a very high energy performance, and where remaining energy needs are covered to a very significant extent by energy from renewable sources including renewable energy produced onsite and nearby. The requirement for a building to be a NZEB includes establishing a numerical indicator for primary energy needs, expressed in kWh/m²/year.

In addition, Member States have to draw up national plans for the increasing the number of NZEB. These plans shall include, inter alia, intermediate targets for improving the energy performance of buildings and information on policy, financial and other measures that will support the promotion of NZEB (including national measures and requirements concerning the use of RES in new and existing buildings undergoing major renovation). The Directive allows some flexibility on the application in practice of the definition of NZEB in Member States.

Although the EPBD itself does not set minimum requirements for space heating products, or requires Member States to do so, the requirement for new buildings and major renovations to comply with cost-optimal minimum energy performance levels can certainly impact the choice of heating systems in buildings. The impact of the provisions of the EPBD on NZEB on space and combination heater technologies are further discussed in the sections dealing with Member States legislation.

In relation to the EPBD, it is worth highlighting some examples of sectors and stakeholders that can have an interest for the Ecodesign and energy labelling regulations for space/combination heaters, such as:

- Municipalities and their building inspectors responsible for examining and issuing permits for new constructions and major renovations that have to comply with minimum energy performance requirements. This can include inspections in case heating systems are replaced or upgraded (e.g. if a collective chimney needs to be changed to accommodate condensing boilers).
- Independent experts for the energy certification of buildings under Article 17 of the EPBD, i.e. private companies or physical persons that give out Energy Performance Certificates for existing buildings and building units, in the scope of a sale or rent to a new owner or tenant, can also be helped by the energy label.
- Boiler-inspectors carrying out the mandatory periodical inspections under Article 14 of the EPBD (e.g. in Germany e. the ‘chimney sweeps’ (Schornsteinfeger\(^{26}\)) can equally rely on energy labels to assess the energy efficiency of the boiler.
- The above also signifies a need to ensure that the data required under Ecodesign and Energy labelling are used for calculations required under (national implementations of) the EPBD.


\(^{26}\) There are around 8000 Schornsteinfeger in Germany dealing with boiler inspection. Source: Gesetzentwurf der Bundesregierung, Entwurf eines Ersten Gesetzes zur Änderung des Energieverbrauchskennzeichnungs-gesetzes, Germany, 2015.
On 30 November 2016 the European Commission proposed a revision of the EPBD Directive 2010/31/EU.

The proposals for amending the EPBD aims to tap into the significant energy-saving potential that still remains unused in the building stock, given that annual renovation rates are only between 0.4 and 1.2%, depending on the Member State.

The changes proposed to the EPBD aim to make it more:

- Smart, by encouraging the use of ICT and modern technologies, including building automation and charging infrastructure for electric vehicles, to ensure buildings operate efficiently;
- Simple, by streamlining or deleting provisions that have not delivered the expected output; and
- Supportive of building renovation, by strengthening the links between achieving higher renovation rates, funding and energy performance certificates as well as by reinforcing provisions on national long-term building renovation strategies, with a view to decarbonising the building stock by mid-century.

A controversial change is to limit Article 14 on the energy inspections of heating systems only to large buildings. Stakeholders argue that this does not introduce the necessary measures to accelerate the modernisation of old and inefficient heater systems, installed in existing single and multi-family buildings. Dedicated policies need to be developed to accelerate the replacement rates of old heating appliances in existing buildings, which are not undergoing a major renovation.


In the context of the EPBD there is some concern over the flexibility that Member States have been given to fill in the PEF value as they see fit. A recent case-in-point (Nov. 2018) is the discussion in the Netherlands where new EPB (‘BENG’) policy proposals now move in the direction of a PEF of 1.45 (69% efficiency of electricity generation). Compare: the previous Dutch PEF was 2.56 (39%), the just agreed EU-wide default is 2.1 (47.6%) and the Netherlands appears not on track to meet 2020 renewables target.

More on building regulations in Member States is provided in section 0 of this Task 1.

---

30 In 2016 RES share on gross energy consumption is 7%, while 2020 national target is 14%; the 2015 RES share in electricity production is almost 15% while EU average is 28% according to the SHARED 2016 project.
3.2.5 Directive (EU) 2018/844 amending the 2010 EPBD and 2012 EED

As stated before this Directive of 30 May 2018 amends both the EPBD 2010/31/EU and the EED 2012/27/EU. Among others this amendment introduces elements to the definition of building systems (adding BACS, on-site electricity generation, etc.) and definitions for heating systems and heat generator, amongst others it requires Member States to set up a long-term renovation strategy, to ensure that the feasibility of high-efficiency systems is taken into account before the work starts and requirements apply for technical building systems, electromobility and a methodology/indicator for smart readiness.

The threshold for mandatory inspection of heating, ventilation and air-conditioning systems is raised from 20 kW (Article 14 under the former 2010 EPBD) to systems of 70 kW and larger, and systems over 290 kW are equipped with monitoring equipment.

The amendment thus updates the 2010 EPBD on various points and relaxes the requirements for inspection considerably.

As regards the amendment to the 2012/27/EU EED Directive, Article 4 concerning the long-term strategy for mobilising investment in the renovation of buildings has been amended: "A first version of the Member States’ long-term strategies for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private, shall be published by 30 April 2014 and updated every three years thereafter and submitted to the Commission as part of the National Energy Efficiency Action Plans."

3.2.6 EED- Energy Efficiency Directive 2012/27/EU

The 2012 Energy Efficiency Directive\(^{31}\) establishes a set of binding measures to help the EU reach its 20% energy efficiency target by 2020. Under the Directive, all EU countries are required to use energy more efficiently at all stages of the energy chain, from production to final consumption. The Directive introduces several targets for Member States, energy distributors and retail energy sales companies.


The present Directive is relevant for Ecodesign and labelling for space/combination heaters as it defines the PEF (primary energy coefficient, on which the CC conversion coefficient from electricity to primary is based) and it defines (in its Annex II Methodology for determining the efficiency of the cogeneration process) an important part of the 'micro-cogeneration' efficiency which falls in the scope of Ecodesign and labelling.

---

Definition (39) defines ‘micro-cogeneration unit’ as a cogeneration unit with a maximum capacity below 50 kW e. This is aligned with 813/2013. According the EED Annex II the primary energy savings provided by cogeneration are calculated as:

\[
PES = \left(1 - \frac{1}{\frac{CHP_{H\eta}}{Ref_{H\eta}} + \frac{CHP_{E\eta}}{Ref_{E\eta}}}\right) \times 100\%
\]

Where:
- \( PES \) = primary energy savings
- \( CHP_{H\eta} \) = Efficiency of heat generation by cogeneration
- \( CHP_{E\eta} \) = Efficiency of electricity generation by cogeneration
- \( Ref_{H\eta} \) = Efficiency of heat generation by reference process
- \( Ref_{E\eta} \) = Efficiency of electricity generation by reference process

Calculation example: A cogeneration process with a 70% heat efficiency and 20% electricity efficiency (overall 90% efficiency) results in 27% primary energy savings when compared with reference processes of 80% heating efficiency and 40% electricity efficiency.

The EED requires that for cogeneration units the comparison with separate electricity production shall be based on the principle that the same fuel categories are compared.


<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Heat</th>
<th>Power (2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaseous fuels (G10: Natural gas, LPG, LNG and biomethane)</td>
<td>NCV 92% (hot water, from 2016)</td>
<td>NCV 53%</td>
</tr>
<tr>
<td></td>
<td>GCV 83.6%</td>
<td>GCV 48.2% (PEF 2.075)</td>
</tr>
<tr>
<td>Liquid fuels (L7: Heavy fuel oil, gas/diesel oil, other oil products)</td>
<td>NCV 85% (hot water, from 2016)</td>
<td>NCV 44.2%</td>
</tr>
<tr>
<td></td>
<td>GCV 80.2%</td>
<td>GCV 41.7%</td>
</tr>
</tbody>
</table>

The delegated regulation also prescribes a correction of the reference values taking into account climate conditions, and correction factors for avoided grid losses (differentiated for on-site and off-site electricity consumption).

The EED is also potentially relevant for Ecodesign and labelling of space/combination heaters -–and vice versa-- because in the National Energy Efficiency Action Plans (NEEAPs) that Member States have to submit under the EED, direct incentives (e.g. subsidies for space heating/combi equipment) and support activities (chimney renovation for collective dwellings, training and certification of installers, etc.) count.

On 30 November 2016 the Commission proposed an update to the Energy Efficiency Directive, including a new 30% energy efficiency target for 2030, and measures to update the Directive to make sure the new target is met.

\(^{32}\) OJ L 333/54-61 of 19.12.2015
It also included a proposal to revise the default European primary energy factor (PEF) of electricity of 2.5 which is used in the calculation of seasonal efficiencies of electric products under Ecodesign and labelling into 2.1 (see also the section on Directive 2018/2002/EU). In addition, the EED review proposal gives full credit for “policies that accelerate the uptake of more efficient products” (Annex V.2.e). This will help to consider in the ‘energy savings obligation’ measures that motivate consumers to replace their old heating system before it breaks down. These proposals have been put into regulation as Directive 2018/844/EU.

On 14 June 2018 the Commission, the Parliament and the Council reached a political agreement which includes a binding energy efficiency target for the EU for 2030 of 32.5%, with a clause for an upwards revision by 2023.

In the European Parliament legislative resolution of 13 November 2018 on the proposal for a directive of the European Parliament and of the Council amending Directive 2012/27/EU on energy efficiency (first reading)\(^3\), this target is documented as an amendment to Art. 1. As amendment to Art. 3 this resolution mentions 31 October 2022 as the evaluation date for achieving the 2020 efficiency target (sub 4), translates the 32.5% target into ‘no more than 1,273 Mtoe of primary energy and/or no more than 956 Mtoe of final energy’ \(^4\)(sub 5) and sets 2023 as a year for possible revision of the 2030 target if needed for technical, economical or decarbonisation policy reasons.


In 2018 the former EED Directive 2012/27/EU was also amended by Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018. This Directive is relevant for Ecodesign and/or energy labelling of space/combination heaters (and water heaters) because of the discussion regarding the establishing of the PEF (Primary Energy Coefficient, which is equal to the Conversion Coefficient CC applied in Ecodesign and Labelling). Although the wording of the amending Directive refers to the use in national context, it does mention its possible effects on measures under ecodesign and/or energy labelling (see bold text below).

Annex IV, footnote 3 of Directive 2012/27/EU is replaced by the following:

"(3) Applicable when energy savings are calculated in primary energy terms using a bottom-up approach based on final energy consumption. For savings in kWh electricity, Member States shall apply a coefficient established through a transparent methodology on the basis of national circumstances affecting primary energy consumption, in order to ensure a precise calculation of real savings. Those circumstances shall be substantiated, verifiable and based on objective and non-discriminatory criteria. For savings in kWh electricity, Member States **may apply a default coefficient of 2.1** or use the discretion to define a different coefficient, provided that they can justify it. When doing so, Member States shall take into account the energy mix included in their integrated national energy and climate plans to be notified to the Commission in accordance with Regulation (EU) 2018/1999. By 25 December 2022 and every four years thereafter, the

---


\(^4\) Following the Brexit, the equivalent projections for the EU27, excluding the United Kingdom, show that primary energy consumption should be no more than 1,128 Mtoe and final energy consumption should be no more than 846 Mtoe in 2030. ([http://europa.eu/rapid/press-release_IP-18-6406_en.htm](http://europa.eu/rapid/press-release_IP-18-6406_en.htm))
Commission shall revise the default coefficient on the basis of observed data. That revision shall be carried out taking into account its effects on other Union law such as Directive 2009/125/EC and Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU (OJ L 198, 28.7.2017, p. 1)."

In the current Ecodesign and Energy Label regulations a PEF of 2.5 is used. The limit values are based on primary energy use and all electricity consumption is converted to primary energy using the PEF-value 2.5. If the PEF value is now assessed to be 2.1 then the limit values of all forms of electricity consumption in the scope, i.e. electric resistance boilers/water heaters, electric heat pumps, auxiliary electricity use (fan, valves, controls) have to be converted –if all other issues are equal—by a factor (2.5/2.1). For instance, the theoretically maximum achievable primary energy efficiency of an electric resistance boiler, using a PEF of 2.5, was 40%. With a PEF of 2.1 this becomes 47.6%.

Possibly, but not necessarily –it depends on the methodology adopted as discussed in section 4.7.2 — the new PEF-value may also have an impact on the efficiency of (micro) cogeneration.


In 2018 the former RES Directive 2009/28/EC was recast. It was discussed and published at the same time as the recast of the 2012 Energy Efficiency Directive.

The 2018 RES Directive "establishes a common framework for the promotion of energy from renewable sources. It sets a binding Union target for the overall share of energy from renewable sources in the Union’s gross final consumption of energy in 2030. It also lays down rules on financial support for electricity from renewable sources, on self-consumption of such electricity, on the use of energy from renewable sources in the heating and cooling sector and in the transport sector, on regional cooperation between Member States, and between Member States and third countries, on guarantees of origin, on administrative procedures and on information and training. It also establishes sustainability and greenhouse gas emissions saving criteria for biofuels, bioliquids and biomass fuels." (Article 1, Subject matter).

Its relevance for Ecodesign or energy labelling of space/combination heaters (and water heaters) is fairly indirect. However, the 2018 RES prescribes methods for Calculation of the share of energy from renewable sources. These methods of course apply to heat pumps and solar devices but also to fuel driven products, using biofuels, including cogeneration products.

It is in both ANNEX V Rules for calculating the greenhouse gas impact of biofuels, bioliquids and their fossil fuel comparators, point C. 1.b,iii & 16, and ANNEX VI Rules for calculating the greenhouse gas impact of biomass fuels and their fossil fuel comparators, point B,d,iii that the Directive prescribes the use of Carnot efficiencies to allocate greenhouse gas emissions to heat and electricity produced from cogeneration. In Annex V is written:

*Where a cogeneration unit [...] produces excess electricity and/or excess useful heat, the greenhouse gas emissions shall be divided between the electricity and the useful heat according to the temperature of the heat (which reflects the usefulness (utility) of the heat). The useful part of the heat is found by multiplying its energy content with the Carnot efficiency, Ch, calculated as follows:*
where:

\[ E_{\text{Ch,el}} = \text{Total greenhouse gas emissions from the final energy commodity.} \]

\[ E = \text{Total greenhouse gas emissions of the bioliquid before end-conversion.} \]

\[ \eta_{\text{el}} = \text{The electrical efficiency, defined as the annual electricity produced divided by the annual fuel input based on its energy content.} \]

\[ \eta_{\text{h}} = \text{The heat efficiency, defined as the annual useful heat output divided by the annual fuel input based on its energy content.} \]

\[ C_{\text{el}} = \text{Fraction of exergy in the electricity, and/or mechanical energy, set to 100 \% (} C_{\text{el}} = 1) \]

\[ C_{\text{h}} = \text{Carnot efficiency (fraction of exergy in the useful heat).} \]

The Carnot efficiency, \( C_{\text{h}} \), for useful heat at different temperatures is defined as:

\[ C_{\text{h}} = \frac{T_{\text{h}} - T_{0}}{T_{\text{h}}} \]

where

\[ T_{\text{h}} = \text{Temperature, measured in absolute temperature (kelvin) of the useful heat at point of delivery.} \]

\[ T_{0} = \text{Temperature of surroundings, set at 273,15 kelvin (equal to 0 °C)} \]

For the purposes of that calculation, the following definitions apply:

(a) ‘cogeneration’ means the simultaneous generation in one process of thermal energy and electricity and/or mechanical energy;

(b) ‘useful heat’ means heat generated to satisfy an economical justifiable demand for heat, for heating and cooling purposes;

(c) ‘economical[ly] justifiable demand’ means the demand that does not exceed the needs for heat or cooling and which would otherwise be satisfied at market conditions.


3.2.9 NECD - 2016/2284/EU

The emission-related requirements of the Ecodesign regulation on boilers (and water heaters) are embedded in the framework for the EU clean air policy.
The figure below illustrates the policy framework, with source-specific emission standards, the National Emission Ceilings Directive (NECD) and the Air Quality Directives (AQD).

![Image of policy framework]

(Source: EEA, Air Quality in Europe, 2018)

**Figure 2. EU clean air policy – the policy framework**

The relevant source-specific emission standards include the Industrial Emissions Directive (including Chapter III on Large Combustion Plants LCP), the Medium Combustion Plants Directive MCPD and the Eco-design Directive that are discussed in separate paragraphs in this chapter.

The new National Emission Ceilings (NEC) Directive 2016/2284/EU[^35] sets national emission reduction commitments for Member States and the EU for five important air pollutants: nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), sulphur dioxide (SO2), ammonia (NH3) and fine particulate matter (PM².5). These pollutants contribute to poor air quality, leading to significant negative impacts on human health and the environment. Emission ceilings are set for 2020 and 2030. The new directive transposes the reduction commitments for 2020 agreed by the EU and its Member States under the 2012 revised Gothenburg Protocol under the Convention on Long-range Transboundary Air Pollution (LRTAP Convention). The more ambitious reduction commitments agreed for 2030 are designed to reduce the health impacts of air pollution by half compared with 2005. Further, the Directive requires that the Member States draw up National Air Pollution Control Programmes that should contribute to the successful implementation of air quality plans established under the EU’s Air Quality Directive.

There are no emission ceilings for carbon monoxide (CO) but there is a reporting requirement. In addition to PM².5, there should be reporting on PM10 and , if available,

black carbon (BC) and total suspended particulate matter (TSP). Furthermore, also reporting obligations for heavy metal emissions (Cd, Pb, Hg and possibly As, Cr, Cu, Ni, Se and Zn) as well as POPs, selected PAHs, dioxins and furans, PCBs and HCB are included in the NECD.

Reporting of emissions and inventories under the new NECD started in 2017 and takes place annually, except for large point source emission (LPS, starting 2017) and the National air pollution control programmes (starting 2019) where reporting is due every 4 years. Monitoring of impacts is reported every 4 years, starting 1 July 2018 for site locations and 1 July 2019 for reporting selected monitoring data.

Figure 3. Emissions 2010-2016 and target levels 2020 and 2030 for five air pollutants regulated under the NEC Directive 2016/2284/EU. Annex I and II ceilings refer to 2010 target levels established under the previous NEC Directive 2001/81/EC

Member States report to the EEA (European Environmental Agency) in Copenhagen(DK), which is supported by the ETC/ACM (European Topic Centre on Air Pollution and Climate Change Mitigation).

36 https://www.eea.europa.eu/themes/air/national-emission-ceilings
The EEA 2018 status report mentions that Projected emissions reported by all Member States in 2017 and 2018 show that 20 of them do not consider themselves on track towards meeting their reduction commitments set for 2020 for one or several of the pollutants (NO\textsubscript{x}, NH\textsubscript{3}, NMVOCs, SO\textsubscript{2} and/or PM) on the basis of policies and measures currently in place. Similarly, 27 Member States are not on track for one or more of their 2030 commitments. Additional emission reduction measures clearly need to be implemented so that these countries reach their future emission reduction commitments.

Under the 2016 NEC Directive, until the end of 2019, the EU must continue to meet aggregated 2010 emission ceilings for the four key pollutants NO\textsubscript{x}, NMVOCs, SO\textsubscript{2} and NH\textsubscript{3}. In each year since 2010, total EU emissions of these pollutants were below their respective ceilings (Figure 1). In 2016, EU emissions of NMVOCs and SO were already below the 2020 reduction commitments set for these pollutants. For both PM and NH3, a reduction of 2% compared with the 2016 level is required in order to meet the 2020 EU commitment, whereas, for NO\textsubscript{x}, EU emissions need to be reduced by a further 6% compared with 2016 levels. In contrast, additional efforts are needed for all pollutants if the EU is to achieve its 2030 emission reduction commitments (i.e. for NO\textsubscript{x} a reduction of 40% compared with 2016 emissions; for NMVOCs, 15%; for SO, 34%; for NH, 16%; and for PM, 36%).

### 3.2.10 Air Quality - Directives 2008/50/EC and 2004/107/EC

The Air Quality Directives (AQD) set the maximum concentrations of ambient air pollutants.

- Directive 2008/50/EC on ambient air quality and cleaner air for Europe including the following elements:
  - The merging of most of existing legislation into a single directive (except for the Fourth Daughter Directive) with no change to existing air quality objectives.
  - New air quality objectives for PM\textsuperscript{2.5} (fine particles) including the limit value and exposure related objectives.
  - The possibility to discount natural sources of pollution when assessing compliance against limit values.
  - The possibility for time extensions of three years (PM\textsubscript{10}) or up to five years (NO\textsubscript{2}, benzene) for complying with limit values

Furthermore, there are two pieces of legislation in support of the two AQD mentioned above:

The table below gives, for a number of EU-regulated pollutants, the typical EU reference values and the average exposure of EU citizens compared to those EU reference values. It also gives the WHO reference values and the exposure to those WHO limit values. The pollutants are particulate matter with a size smaller than 2.5μm (PM2.5), particulate matter with a size smaller than 10μm (PM10), Ozone (O3), Nitrogen dioxide (NO₂ as indicator for NOx), polycyclic aromatic hydrocarbons PAHs (BaP as indicator for PAHs) and sulphur dioxide (SO₂).

The table does not include all regulated pollutants. Directive 2008/50/EC also handles lead (Pb, reference 0.5 μg/m³), benzene (reference 5 μg/m³) and carbon monoxide (CO, reference 5 mg/m³). Directive 2004/107/EC addresses, apart from PAHs (Bap target 1 ng/m³), also references for the heavy metals arsenic (As, target 6 ng/m³), cadmium (Cd, target 5 ng/m³), nickel (Ni, target 20 ng/m³), mercury (Hg).

Note that PM10 includes typically 50-70% wt. fraction PM2.5. Measurement of PM2.5 must include at least the total mass concentration and concentrations of appropriate compounds to characterise its chemical composition.

Table 3. Percentage of the urban population in the EU-28 exposed to air pollutant concentrations above certain EU and WHO reference concentrations (minimum and maximum observed between 2014 and 2016)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>EU reference value</th>
<th>WHO AQG</th>
<th>Exposure estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM2.5</td>
<td>Year (25)</td>
<td>Year (10)</td>
<td>6-8</td>
</tr>
<tr>
<td>PM10</td>
<td>Day (50)</td>
<td>Year (20)</td>
<td>13-19</td>
</tr>
<tr>
<td>O₃</td>
<td>8-hour (120)</td>
<td>8-hour (100)</td>
<td>7-30</td>
</tr>
<tr>
<td>NO₂</td>
<td>Year (40)</td>
<td>Year (40)</td>
<td>7-8</td>
</tr>
<tr>
<td>B(a)P</td>
<td>Year (1)</td>
<td>Year (0.12 RL)</td>
<td>20-24</td>
</tr>
<tr>
<td>SO₂</td>
<td>Day (125)</td>
<td>Day (20)</td>
<td>&lt; 1</td>
</tr>
</tbody>
</table>

Key: < 5 % | 5-50 % | 50-75 % | > 75 %

Notes: (*) in μg/m³, except B(a)P in ng/m³.

The reference concentrations include EU limit or target values, WHO air quality guidelines (AQGs) and an estimated reference level (RL). For some pollutants, EU legislation allows a limited number of exceedances. This aspect is considered in the compilation of exposure in relation to EU air quality limit and target values.

The comparison is made for the most stringent EU limit value set for the protection of human health. For PM₁₀, the most stringent limit value is for the 24-hour mean concentration, and for NO₂ it is the annual mean limit value.

The estimated exposure range refers to the maximum and minimum values observed in a recent 3-year period (2014-2016) and includes variations attributable to meteorology (as dispersion and atmospheric conditions differ from year to year), and to the number of available data series (monitoring stations and/or selected cities) that will influence the total number of the monitored population.

As the WHO has not set AQGs for B(a)P, the reference level in the table was estimated assuming WHO unit risk for lung cancer for polycyclic aromatic hydrocarbon mixtures and an acceptable risk of additional lifetime cancer risk of approximately 1 in 100 000.

(Source: EEA, Air Quality in Europe, 2018)

3.2.11 MCP- 2015/2193 and LCP (Chapter III of IED - 2010/75/EU)


37 B(a)P or Bap=Benzo(a)pyrene (a marker for PAHs)
38 Target values relate to For the total content in the PM10 fraction averaged over a calendar year.
emissions from the combustion of fuels in plants with a rated thermal input equal to or greater than 1 megawatt (MWth) and less than 50 MWth.

Medium combustion plants are used for a wide variety of applications (electricity generation, domestic/residential heating and cooling, providing heat/steam for industrial processes, etc.) and are an important source of emissions of sulphur dioxide (SO\textsubscript{2}), nitrogen oxides (NOx) and dust. The estimated number of MCPs in the EU is around 143,000.

The emission limit values set in the MCP Directive will have to be applied from 20 December 2018 for new plants and by 2025 or 2030 for existing plants, depending on their size. It regulates emissions of SO\textsubscript{2}, NO\textsubscript{x} and dust into the air with the aim of reducing those emissions and the risks to human health and the environment they may cause. It also lays down rules to monitor emissions of carbon monoxide (CO).

It is relevant for the Lot 1 review study, because it is intended to ‘fill the regulatory gap at EU level between large combustion plants (LCPs > 50 MWth)\textsuperscript{39}, covered under the Industrial Emissions Directive (IED-2010/75/EU) and smaller appliances (heaters and boilers <1 MWth) covered by the Ecodesign Directive.’\textsuperscript{40} This means that there should ideally be consistency in the limit values.

More importantly, however, the current Ecodesign regulations do not cover the scope up to 1 MWth rated thermal input calculated in Net Calorific Value NCV of the fuel (the lower limit of the MCP-scope). The upper limits of the scope of the Ecodesign regulation is 400 kW thermal output\textsuperscript{41}. The Ecodesign regulation scope-limit refers to heat output. This means that the efficiency is a factor in determining the scope. To add to the confusion, the Ecodesign efficiency calculation uses the Gross Calorific Value GCV in its efficiency calculations, which means that there should be a conversion factor, depending on the type of fuel, to convert from GCV to NCV or vice versa. The emission limits (not the scope) are expressed in mg per kWh fuel input (in GCV) for the Ecodesign regulations and in mg per Nm\textsuperscript{3} flue gas output for the MCP Directive.

In any case, it needs to be determined if and how the remaining gap between MCP and a possibly revised Ecodesign regulation needs to be filled.

The table below gives MCP limit values for new medium-sized combustion plants.\textsuperscript{42}

\textsuperscript{39} There are almost 33,000 LCPs in 2015 (source: EEA 2018) https://www.eea.europa.eu/data-and-maps/data/lcp
\textsuperscript{40} http://ec.europa.eu/environment/industry/stationary/mcp.htm citation
\textsuperscript{41} 500 kW thermal output for solid fuel boilers.
\textsuperscript{42} The MCP also has limit values for existing MCP, which are much more lenient.
Table 4. Emission limit values of the MCP Directive.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Solid biomass</th>
<th>Other solid fuels</th>
<th>Gas oil</th>
<th>Liquid fuels other than gas oil</th>
<th>Natural gas</th>
<th>Gaseous fuels other than natural gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO₂</td>
<td>200 (€)</td>
<td>400</td>
<td>—</td>
<td>350 (€)</td>
<td>—</td>
<td>35 (€)</td>
</tr>
<tr>
<td>NOₓ</td>
<td>300 (€)</td>
<td>300 (€)</td>
<td>200</td>
<td>300 (€)</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Dust</td>
<td>20 (€)</td>
<td>20 (€)</td>
<td>—</td>
<td>20 (€)</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

(€) The value does not apply in the case of plants firing exclusively woody solid biomass.
(€) Until 1 January 2025, 1 700 mg/Nm³ in the case of plants which are part of SIS or MIS.
(€) 400 mg/Nm³ in the case of low calorific gases from coke ovens, and 200 mg/Nm³ in the case of low calorific gases from blast furnaces, in the iron and steel industry.
(€) 100 mg/Nm³ in the case of biogases.
(€) 500 mg/Nm³ in the case of plants with a total rated thermal input equal to or greater than 1 MW and less than or equal to 5 MW.
(€) Until 1 January 2025, 430 mg/Nm³ when firing heavy fuel oil containing between 0.2% and 0.3% N and 360 mg/Nm³ when firing heavy fuel oil containing less than 0.2% N in the case of plants which are part of SIS or MIS.
(€) 50 mg/Nm³ in the case of plants with a total rated thermal input equal to or greater than 1 MW and less than or equal to 5 MW; 30 mg/Nm³ in the case of plants with a total rated thermal input greater than 5 MW and less than or equal to 20 MW.
(€) 50 mg/Nm³ in the case of plants with a total rated thermal input equal to or greater than 1 MW and less than or equal to 5 MW.

As a reminder, in the Ecodesign boiler regulation 813/2013 the maximum emission limits for NOₓ –implementation from 26 Sept. 2018-- are 56 mg/kWh GCV for boilers with gaseous fuels and 120 mg/kWh GCV for liquid fuel fired boilers. As an order of magnitude this is more stringent than the values in the MCP Directive.

For cogeneration with internal combustion engines the 813/2013 regulation gives relatively lenient limit values of 240 (gas) and 420 (liquid fuel) mg/kWh GCV, whereas the MCP gives relatively more stringent values of 95 (gas) and 195 (oil) mg/Nm³ for new engines.

3.2.12 RoHS (2)– 2011/65/EU & 2015/863/EU

In February 2003 the first RoHS Directive 2002/95/EC entered into force, restricting the use of hazardous substances in electrical and electronic products. The legislation requires heavy metals such as lead, mercury, cadmium, and hexavalent chromium and flame retardants such as polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE) to be substituted by safer alternatives.

In 2011 this Directive was repealed by Directive 2011/65/EU43 (RoHS 2) which clarified certain terms, introduced new definitions and introduced a wider scope of products (open ended scope). The list of restricted substances was widened in 2015 by an amendment (Commission Delegated Directive (EU) 2015/863 of 31 March 2015) that added four phthalate types (DEHP, BBP, DBP and DIBP) to the list.

The RoHS requires demonstration of compliance by affixing the CE marking, plus related documentation.

43 OJ L 174, 1.4.2011, p.88-110
The list of products exempted from substance bans is continuously revised and updated. Frequently Asked Questions have been answered in the RoHS 2 FAQ document. Furthermore, consolidated guidance for exemptions applicants and related application format pursuant to RoHS 2 Article 5(8) have been drafted.

In January 2017, the Commission adopted a legislative proposal under the Article 24(1) mandate to introduce adjustments in the scope of the Directive, including clarification on the conditions for exempting the reuse of spare parts, supported by the impact assessment. The proposal was adopted in first reading in the European Parliament on 3 October 2017 and in the Council on 23 October 2017. The final act was signed on 15 November 2017 and was published in the EU Official Journal on 21 November 2017 as Directive (EU) 2017/2102.

The FAQ for the RoHS(2)\textsuperscript{44} indicate that fixed installed heating systems designed exclusively for non-residential use are large scale fixed installations and as a consequence excluded from the scope. Based on this explanation, it is understood that space/combi heaters and water heaters which are not exclusively for non-residential use are within the scope of RoHS from 2019.

3.2.13 REACH – 1907/2006/EC

Regulation (EC) No 1907/2006 establishes the ‘REACH’ (Registration, Evaluation, Authorisation and Restriction of Chemicals) system\textsuperscript{45}. It aims to protect human health and the environment by ensuring greater safety in the production and use of chemical substances.

REACH, which entered into force in 2007, applies to all chemical substances and thus has an impact on many businesses. It requires companies to identify and manage the risks linked to the substances they manufacture and sell in the EU. This information must be sent to the European Chemicals Agency in Helsinki for registration in a database.

Companies must also demonstrate the safe use of the substance and communicate the risk management measures to users. Unregistered substances may not be manufactured in the EU or imported into the EU. There is the possibility to ask for derogations for specific applications.

Authorities (European Commission and the relevant national authorities) identify substances of very high concern and place them on the REACH candidate list. These substances will eventually be phased out of the market. The list serves as an incentive to companies using these substances to look for safer alternatives or innovative solutions.

Once a substance is identified as an SVHC, it is included in the Candidate List. The inclusion in the Candidate List brings immediate obligations for suppliers of the substance, such as:

\textsuperscript{44} \url{http://ec.europa.eu/environment/waste/rohs_eee/pdf/faq.pdf} - in particular FAQ 7.1 is instructive

supplying a safety data sheet;
- communicating on safe use;
- responding to consumer requests within 45 days and;
- notifying ECHA if the article they produce contains an SVHC in quantities above one tonne per producer/importer per year and if the substance is present in those articles above a concentration of 0.1% (w/w).

Per August 2017 43 substances have been placed on the authorisation list (ANNEX XIV) and 68 substances (including several derived substances) on the list of restricted substances (Annex XVII). The REACH candidate list of Substances of Very High Concern (SHVC) for authorisation currently contains 174 substances (Dec 2017).

### 3.2.14 WEEE – 2012/19/EU

The first WEEE Directive (Directive 2002/96/EC) entered into force in February 2003. The Directive provided for the creation of collection schemes where consumers return their WEEE free of charge. These schemes aim to increase the recycling of WEEE and/or re-use.

In December 2008, the European Commission proposed to revise the Directive in order to tackle the fast-increasing waste stream. The new WEEE Directive 2012/19/EU entered into force on 13 August 2012 and became effective on 14 February 2014. This revised WEEE introduced an open-ended scope.

The FAQ document for the WEEE of 2014 explains that the scope is for products that are ‘dependent on electric currents or electromagnetic fields in order to work properly’. This could mean that equipment that needs electric currents or electromagnetic fields (e.g. not petrol or gas) to fulfill their basic function (i.e., when the electric current is off, the equipment cannot fulfill its basic function) are within scope. If electrical energy is used only for support or control functions, this type of equipment is not covered by the Directive. Examples of equipment that does not need electricity to fulfill its basic function, but only requires, for example, a spark to start, include petrol lawn mowers and gas stoves with electronic ignition only (see also Appendix, Part 2).

Most space/comboiners heaters rely on electricity to function as intended (to run the circulator, fan, controls including several safety devices, etc.) but as the WEEE Directive is transposed into national law, Member States have the discretion to specify their own scope and apparently there are differences between member States as regards what space/comboiners heaters are inside/outside the scope of the transposed WEEEA. This is also being re-discussed in some countries because of the WEEE “open scope” in 2018.

---


48 Meaning that they have been identified as SHVC but have not yet reached their ‘sunset date’ (phase-out) See: [https://echa.europa.eu/candidate-list-table](https://echa.europa.eu/candidate-list-table)


50 Comment by EHI, 5 December 2017
On 4 February 2013, the Commission issued a request for standardisation M/518 to the European Standardization Organizations to develop European standards for the treatment of WEEE. These standards have been developed following the preparatory work under the WEEELABEX project, by the so-called WEEE-forum. European standards (EN) and technical Specifications (precursor for possible EN) relevant for WEEE include the following:

**Table 5. Standards for treatment of WEEE**

<table>
<thead>
<tr>
<th>Standard reference</th>
<th>Title or contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 50419:2006</td>
<td>Marking of electrical and electronic equipment in accordance with Article 11(2) of Directive 2002/96/EC (WEEE)</td>
</tr>
<tr>
<td></td>
<td>This standard applies to the application of the &quot;wheelie bin&quot; mainly – Requirements, design and location of the marking</td>
</tr>
<tr>
<td>EN 50574</td>
<td>Collection, logistics &amp; treatment requirements for end-of-life household appliances containing volatile fluorocarbons or volatile hydrocarbons</td>
</tr>
<tr>
<td>TS 50574-2</td>
<td>Collection, logistics &amp; treatment requirements for end-of-life household appliances containing volatile fluorocarbons or volatile hydrocarbons - Part 2: specification for de-pollution</td>
</tr>
<tr>
<td>EN 50614</td>
<td>Requirements for the preparing for re-use of waste electrical and electronic equipment (not yet published)</td>
</tr>
<tr>
<td>EN 50625-1</td>
<td>Collection, logistics &amp; treatment requirements for WEEE - Part 1: General treatment requirements</td>
</tr>
<tr>
<td>TS 50625-3-2</td>
<td>Collection, logistics &amp; treatment requirements for WEEE -- Part 3-2: Specification for de-pollution – Lamps</td>
</tr>
<tr>
<td>EN 50625-2-2</td>
<td>Collection, logistics &amp; treatment requirements for WEEE -- Part 2-2: Treatment requirements for WEEE containing CRTs and flat panel displays</td>
</tr>
<tr>
<td>TS 50625-3-3</td>
<td>Collection, logistics &amp; treatment requirements for WEEE -- Part 3-3: Specification for de-pollution- WEEE containing CRTs and flat panel displays (not yet published)</td>
</tr>
<tr>
<td>EN 50625-2-3</td>
<td>Collection, logistics &amp; treatment requirements for WEEE -- Part 2-3: Treatment requirements for temperature exchange equipment (not yet published)</td>
</tr>
<tr>
<td>TS 50625-3-4</td>
<td>Collection, logistics &amp; treatment requirements for WEEE -- Part 3-4: Specification for de-pollution- temperature exchange equipment (not yet published)</td>
</tr>
<tr>
<td>EN 50625-2-4</td>
<td>Collection, logistics &amp; treatment requirements for WEEE -- Part 2-4: Treatment requirements for photovoltaic panels (not yet published)</td>
</tr>
<tr>
<td>TS 50625-3-5</td>
<td>Collection, logistics &amp; treatment requirements for WEEE -- Part 3-5: Specification for de-pollution- photovoltaic panels (not yet published)</td>
</tr>
<tr>
<td>TS 50625-4</td>
<td>Collection, logistics &amp; treatment requirements for WEEE -- Part 4: Specification for the collection and logistics associated with WEEE (not yet published)</td>
</tr>
<tr>
<td>TS 50625-5</td>
<td>Collection, logistics &amp; treatment requirements for WEEE -- Part 5: Specification for the end-processing of WEEE fractions- copper and precious metals (not yet published)</td>
</tr>
</tbody>
</table>
3.2.15 EU Ecolabel - 66/2010

The EU Ecolabel was created in 1992 and amended by Regulation (EC) No 1980/2000 as part of the Communication on sustainable consumption and production and the sustainable industrial policy action plan (SCP action plan) in 2008. The objective for the EU Ecolabel is: ‘...to promote products with a reduced environmental impact during their entire life cycle and to provide consumers with accurate, non-deceptive, science-based information on the environmental impacts of products’;

The present Regulation (EC) No 66/2010 aims to improve the rules on the award, use and operation of the label. Currently the EU Ecolabel comprises a system of 33 product groups, 2000 licenses and 44000 products. Still, a recent Fitness check showed that the uptake could be better and more efficient, and proposals have been made increase its impacts.

As regards the HVAC sector the EU Ecolabel has not attracted much interest. Criteria were established in 2007 for electric heat pumps, and in 2014 for "water-based heaters".

- Commission Decision 2007/742/EC of 9.11.2007 introduced ecolabel criteria for heat pumps (electrically driven, gas driven or gas absorption) for space and combination heating. This decision attracted a few applicants and the validity was extended to 31 December 2016 by Commission Decision 2014/363/EU. In May 2016, the JRC-IPTS recommended to the EU Ecolabelling Board to not further extend the validity of the EU Ecolabel criteria for heat pumps and to consider including air-based heat pumps products in the scope during a possible revision of the EU Ecolabel criteria for water-based heaters. The reason to not extend the criteria were that the EU Ecolabel criteria date back to 2007 and are outdated, there were no licence holders, previous licences were awarded to water-based heat pumps that are no longer in the scope (since the amendment of 2014, which has limited the scope to air-based heat pumps). The validity of 2007/242/EC ended on 31.12.2016.

- Commission Decision 2014/314/EU of 28.5.2014 introduced criteria for space heaters (referred to as "water-based heaters" which included traditional boilers on gas, liquid and solid fossil fuels, biomass fuels, electric resistance, heat pumps, cogeneration and solar devices). The criteria covered aspects such as energy efficiency (referring to Regulation (EU) No 813/2013) and 811/2013, maximum greenhouse gas emissions (TEWI – Total Equivalent Warming Index), maximum GWP of refrigerants, NOx/CO/OGC/PM limits, noise limits (not in categories but using an equation), hazardous substances and criteria related to information and sustainability. In June 2017, the JRC-IPTS recommended to withdraw the EU Ecolabel for water-based heaters to the EU Ecolabelling Board as it did not attract applicants. The European Commission decided not to prolong nor revise the EU Ecolabel criteria for this product group. Article 4 of the Decision states that the criteria are valid until four years from the date of adoption which means the decision was in force until 28 May 2018.

3.2.16 F-gas 517/2014

The first F-gas Regulation (EC) No 842/2006 is replaced by the Regulation (EU) No 517/2014 applicable from 1 January 2015. The new regulation strengthened the existing measures and introduced a number of far-reaching changes by:
- Limiting the total amount of the most important F-gases that can be sold in the EU from 2015 onwards and phasing them down in steps to one-fifth of 2014 sales in 2030 "quota system". This will be the main driver of the move towards more climate-friendly technologies;
- Banning the use of F-gases in many new types of equipment where less harmful alternatives are widely available, such as fridges in homes or supermarkets, air conditioning and foams and aerosols;
- Preventing emissions of F-gases from existing equipment by requiring checks, proper servicing and recovery of the gases at the end of the equipment's life.

As regards HVAC equipment the F-gas regulation introduces:

- leak checks for equipment that contains more than 5 tonnes CO₂ eq. and is not hermetically sealed (sealed equipment up to 10 tonnes CO₂ eq. is exempted) (article 4);
- large systems (> 500 tonnes CO₂ eq.) shall have leak detection systems in place (article 5);
- if leak checks are required, records have to be kept (article 6);
- refrigerants need to be recovered (article 8);
- member States should ensure proper training for personnel performing the above tasks (article 10);
- certain equipment can no longer be placed on the market (article 11), but:
  - this shall not apply to equipment for which it has been established in Ecodesign requirements adopted under Directive 2009/125/EC that due to higher efficiency during operation its lifecycle CO₂ eq. emissions would be lower than those of equivalent equipment which meets relevant Ecodesign requirements and does not contain hydrofluorocarbons (article 11.2).
  - labelling of refrigerants used is mandatory (article 12);
- equipment charged with refrigerants are accounted within the quota system and are properly documented. This includes pre-charged equipment (article 14);
- quotas apply to F-gas manufacturers or importers, who authorise manufacturers or importers of products containing hydrofluorocarbons (so called 'pre-charged equipment') to use part of these quotas; and the importer/manufacturer has to be known to the Commission (article 15-16). A registry shall be set up and transfer of quotas is permitted (article 17);
- movable RAC shall not contain HFCs with GWP > 150, single split systems shall not contain HFCs with GWP > 750. The requirements for movable RAC are applicable from 2020 and the requirements for single split systems are applicable from January 2025 for systems containing less than 3kg of refrigerants.

Heat pumps are not mentioned in the table in Annex III which lists the products and equipment that are prohibited if they contain refrigerants above a certain GWP. But heat pumps are covered by the quota system since 1 Jan 2017 (if the supplier places more than 100 tonnes of CO₂ eq. on the market annually), limiting the overall GWP of refrigerants placed on the market gradually. The following example calculates the number of (indicative) products to be placed on the market that together meet the 100 tonnes limit:

A charge of 4 kg of R410A at 2088 kg CO₂ eq./kg in a single heat pump system equals 8352 kg CO₂ eq. for this heat pump. A quantity of just 12 products/year equals 100 tonne annual CO₂ eq. The minimum threshold for the quota system is therefore easily exceeded by
manufacturers/importers. Also suppliers of refrigerants (for new installed equipment or maintenance) are affected.

By 2018 the HFC quota is 63% (of the 2015 baseline of 100%), but if pre-charged equipment is included in the assessment, the remaining quota reduces to 56% by 2018. The anticipated shortage of quota has already led to price hikes for the most commonly used HFCs, such as R404A and R407\textsuperscript{51}.

All this results in a shift towards refrigerants with lower GWP. This trend is also made possible by changes in standards such as IEC 60335-2-40 (replacing former rules under EN 378) that allow a larger charge of low GWP refrigerants, such as hydrocarbons, in products.

Possible alternative refrigerants are low GWP blends of HFCs with HFOs, pure HFOs, HCs, ammonia and carbon dioxide, but not every refrigerant is equally suitable as substitute. The short-term solution is most likely a blend of R32 and HFOs\textsuperscript{52}.

The F-gas also requires heat pumps to be labelled appropriately and requires leak checks and recovery of refrigerants by the owners of the equipment.

The latest EEA report on fluorinated F-gases (2017)\textsuperscript{53} shows very good compliance with the quotas, as, in 2016, EU-wide placing on the market of HFCs was 4% below the overall market quota limit for that year. It states that "In 2016, the supply of total F-gases, reflecting the actual use of F-gases by EU industries, increased by 2% in mass but decreased by 2% in CO2e. This indicates a move towards gases with lower GWPs."

In addition, the European Commission (DG GROWTH) adopted the standardisation request M/555 on the wider use of flammable refrigerants in refrigeration, air conditioning and heat pump equipment on 14 November 2017\textsuperscript{54}.

\textbf{Table 6 ASHRAE Standard 34-2013 4 Safety classifications} \textsuperscript{55}

<table>
<thead>
<tr>
<th>Flammability</th>
<th>Lower toxicity</th>
<th>higher toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 3 higher flammability</td>
<td>A3 (R600a, R290, R1270)</td>
<td>B3 (certain hydrocarbons)</td>
</tr>
<tr>
<td>Class 2 lower flammability</td>
<td>A2 (R142b, R152a)</td>
<td>B2 (seldom used)</td>
</tr>
<tr>
<td>lower burning velocity class 2s</td>
<td>A2L (R32, R1234ze, R1234yf)</td>
<td>B2L (R717)</td>
</tr>
<tr>
<td>Class 1 no flame propagation</td>
<td>A1 (R718, R744, CFC's HCFC's)</td>
<td>B1 (seldom used)</td>
</tr>
</tbody>
</table>

A2L and B2L are lower flammability refrigerants with a maximum burning velocity of \leq 10 cm/s

At least one stakeholder made clear that the quota system leads to significant price increases as "under the revised F-gas regulation the "downstream" users (e.g. all the sectors that use HFC in their products including the heat pumps) are faced with severe

\textsuperscript{51}http://r744.com/articles/7888/french_hvacandr_sector_mulls_future_challenges_at_sifa?utm_source=mailchimp&utm_medium=email&utm_campaign=Bi-weekly Newsletter
\textsuperscript{52}TEST REPORT #59, for the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Low-GWP Alternative Refrigerants Evaluation Program (Low-GWP AREP), January 18, 2016
\textsuperscript{54}http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&amp;id=578
\textsuperscript{55}https://www.hpacmag.com/features/considerations-for-next-generation-hvac-refrigerants/
increases of refrigerant prices (including shortages) but at the same time the importers of pre-charged equipment have to pay to purchase quota authorisations from refrigerant companies and their distributors. Therefore [suppliers of F-gas containing equipment, like heat pumps] not only pay a premium for refrigerants but also have to buy the “right” to place heat pumps onto the market as a result of F-gas regulation”.

The combined effect of quota and refrigerant prices on products will be felt most acutely in 2018, 2021, 2024 and through to 2027, corresponding to the timing of steps in phase down.

There is no refrigerant available on the market at the moment that meets all the parameters of non-flammability, no toxicity, pressure and/or efficiency requirements of Ecodesign at the same time. R32 is most likely to be adopted as an intermediate solution as it is comparable in efficiency levels to R410A and has a third of its GWP but R32 is a A2L slightly flammable refrigerant and there are national safety restrictions in some countries which prevent the use of this refrigerant in certain applications.

Therefore, stakeholders expect that, unless a major technological innovation in the refrigerants market in the coming years occurs, the transition to low-GWP will take years, possibly up to 2027. Safety standards will need to be modified/adapted to allow the safe use of A2L and A3 (highly flammable) type refrigerants.

3.2.17 GAR - 2016/426

As of 21 April 2018, the Gas Appliance Directive (GAD) Directive 2009/142/EC will be repealed by the Gas Appliance Regulation (GAR) 2016/426/EU of 9 March 2016 on appliances burning gaseous fuels, laying down the essential requirements.


The GAD requires as certification of conformity EC type-examination (module B) accompanied by an EC declaration of conformity or EC verification.

The GAD is one of the first harmonisation Directives based on the “New Approach” principles and had to be transposed into national law by the EU Member States.

To facilitate proof of conformity, in particular as to the construction, operation and installation of appliances burning gaseous fuels, harmonised standards may be applied so that products complying with them may be assumed to conform to the essential requirements.

The new GAR 2016/426/EU modifies and updates rules set out in Directive 2009/142/EC. The GAR allows standards to contain requirements regarding energy efficiency (“rational use of energy”), but only if there is no specific EU legislation covering the energy efficiency of these appliances (Lex Specialise).

One of the consequences of the gas directive/regulation is that all new appliances have to be able to operate with a normal variation of the gas qualities as set out by Member States (art.1.2.(b)). For new (as of 2016) central heating boilers and water heaters this is hardly a problem. The issue is more relevant for gas ovens and gas hobs.

For example, in the Netherlands, where most gas heaters are fit for use with Groningen gas with lower calorific value (G-gas) the changeover to higher calorific gas (H-gas, as used in most other EU countries) will occur as of 2030. Older boilers may experience problems when the gas quality is changed: For some appliances the modifications will be minor (changing the venturi setting), but for other/older equipment a modification of gas nozzles, burners, electronics, etc. may be required.

### 3.2.18 LVD – 2014/35/EU


The directive creates uniform safety conditions for the placing on the market of electrical equipment designed for use within certain voltage limits. It applies to electrical equipment designed for use with a voltage rating of between 50 and 1 000 V for alternating current and between 75 and 1 500 V for direct current.

It covers all health and safety risks, thus ensuring that electrical equipment is used safely and for the applications for which it was made.

The relevance for space/combination heaters is that electric products are covered by the LVD. For gas appliances the GAD/GAR regulates safety, including electrical safety.

The European Commission is planning to revise the Low Voltage Directive 2014/35/EU in the course of 2018 (roadmap of October 2017).

### 3.2.19 EMC – 2014/30/EU


The directive defines the responsibilities of manufacturers, importers and distributors in regard to the sale of electromagnetic equipment.

The Directive aims to ensure that electrical and electronic equipment complies with an adequate level of electromagnetic compatibility by laying down uniform rules to ensure

---

57 For various Member States the local normal variation is quite narrow. The main gas boiler standard EN 15502-2-1 even excludes from its scope “appliances that are intended to be connected to gas grids where the quality of the distributed gas is likely to vary to a large extent over the lifetime of the appliance”.


59 OJ L 96, 29.3.2014, p.79-106
protection against electromagnetic disturbance so as to guarantee the free movement of electrical and electronic equipment within the EU’s internal market. The equipment covered by this directive includes both apparatus and fixed installations.

The relevance for space/combination heaters is that certain products, that may be very susceptible to, or may affect other equipment through electromagnetic energy, may be covered by the EMC Directive. This may apply to certain variable speed motor drives incorporated into equipment.

3.2.20 PED – 2014/68/EU

The Pressure Equipment Directive 2014/68/EC is a CE marking Directive that lays down essential safety requirements for pressure equipment and assemblies (such as boilers, pressure cookers, fire extinguishers, heat exchangers and steam generators). All stationary pressure equipment must conform to strict specifications if it is to be sold in the EU.

The directive applies to the design, manufacture and conformity of pressure equipment with a maximum allowable pressure greater than 0.5 bar. It covers all pressure equipment and assemblies that are new to the EU market, whether manufactured in the EU or elsewhere. This also includes imported used items.

Manufacturer details (name, registered trade name/trademark and their postal address) must be indicated on the equipment or, where this is not possible, on the packaging or in the accompanying documentation. These must be provided in a language easily understood by consumers and market surveillance authorities (public authorities that ensure products comply with legislation and are safe). Importers must provide their contact details.

The relevance for space/combination heaters is that storage tanks, solar collectors and other parts of the heaters may be covered under the PED, as far as stagnation temperature are above 110 °C.

3.2.21 MD – 2006/42/EC

The "Machinery" Directive 2006/42/EC of 17 May 2006 (recast of Directive 95/16/EC.) introduces essential requirements regarding health and safety for machinery, in order for them to move freely throughout the EU. The Directive promotes harmonisation through a combination of mandatory health and safety requirements and voluntary harmonised standards and applies to products when they are first placed on the EU market.

The directive covers machinery, interchangeable equipment, safety components, lifting accessories, chains, ropes and webbing, removable mechanical transmission devices and partly completed machinery. It does not cover other types of machinery, such as machinery used in fairgrounds, the nuclear industry, laboratories and mines or by the military or police.

---

60 OJ L 189, 27.6.2014, p.164-259
Although the MD mainly applies to products not intended for household use, because there is no “Oil Appliances Directive” as counterpart to the GAD, oil burners and heating boilers with integrated oil burner are covered by the MD, as well as certain solar devices.

Although ensuring product safety is not the primary subject of Ecodesign and/or Labelling Art 15.5.(b) of Directive 2009/125/EC states that health, safety and the environment shall not be adversely affected by requirements.

3.2.22 CPD – 89/106/EEC & CPR 305/2011

The Construction Products Directive 89/106/EEC of 1989 has been replaced by the Construction products Regulation (EU) No 305/2011(CPR). The aim of the regulations is to lay down the essential requirements regarding safety of construction products and works. In doing so, it tries to eliminate technical barriers to trade between member States.

The essential requirements relate to mechanical safety, fire safety, hygiene, health and environment, safety in use, protection against noise and energy economy and heat retention. The actual values or thresholds to be achieved by products are laid down in harmonised standards. European technical Approval applies in cases no harmonised standards nor a recognized national standard exists and is based on ETA guidelines or issued upon common agreement of the approval bodies.

Due to the enormous diversity of construction products and works, the Regulation has various mechanisms for implementation, that take not account the specifics of the many SMEs active in the construction industry (both as supplier of products or as constructor of works).

The relevance of the CPR in this study is that certain products, especially those requiring integration into the building fabric such as solar thermal collectors and flue systems which are part of the building, may be within the scope of the Construction Products Directive.

The European Commission is planning to revise the Construction Product Regulation (CPR) in the course of 2018 (roadmap of June 2017).

3.2.23 PD – Packaging Directive 2015/720

The Packaging directive (EU) 2015/720 amends the original packaging directive 94/62/EC. The initial document sets measures and limitations on the production of packaging waste. It furthermore promotes recycling, re-use and waste recovery in general. All is focussed on using final disposal as a last resort.

The directive applies to all packaging placed on the European market, regardless their source or sector. In includes packaging at industrial, commercial, office, shop, household or any other level and material. The directive sets requirements on the amount waste that needs to be recovered. The amendment of 2015 focuses specifically on the use and distribution of lightweight plastic bags, which is not directly relevant for space or water heaters. The essential requirements for packaging are:

• to limit the weight and volume of packaging to a minimum in order meet the required level of safety, hygiene and acceptability for consumers;
• to reduce the content of hazardous substances and materials in the packaging material and its components;
• to design reusable or recoverable packaging.

3.2.24 DWD – Drinking Water Directive – 98/83/EC
The Drinking Water Directive 98/83/EC of 3 November 1998 concerns the quality of water intended for human consumption. The Directives establishes quality standards at EU level. It consists of 48 microbiological, chemical and indicator parameters that must be tested and monitored regularly in the water sources that are included in the scope, being:

• all distribution systems serving more than 50 people or supplying more than 10 cubic meter per day, but also distribution systems serving less than 50 people/supplying less than 10 cubic meter per day if the water is supplied as part of an economic activity;
• drinking water from tankers;
• drinking water in bottles or containers;
• water used in the food-processing industry, unless the competent national authorities are satisfied that the quality of the water cannot affect the wholesomeness of the foodstuff in its finished form.

The Directive is based on WHO guidelines for clean drinking water and input of the Commission’s Scientific Advisory Committee. Member States can include additional requirements to the EU Directive, but never use lower standards. Furthermore, drinking water quality needs to be reported to the EC every three years.

The European Commission is planning to revise the Drinking Water Directive (DWD) in the course of 2017-2018 (roadmap of February 2017, see here).

3.3 CE marking

3.3.1 New Approach & New Legislative Framework
In 1985 the “New Approach“ to European product legislation was introduced. The basic idea is that legislation sets out the levels of protection that must be achieved ("essential requirements") and does not pre-judge the choice of technical solutions to achieve these levels. The technical solutions are defined in the standards used to ensure compliance to essential requirements.

The New Approach directives covered a large proportion of products marketed in the EU in more than 20 industrial sectors, including electro-technical products, machinery, radio/telecoms equipment, toys, medical devices, construction products and high-speed rail systems. Most products covered by this legislation have CE marking affixed indicating
the product complies with all the applicable safety legislation. In 2005 the 1st Ecodesign Directive 2005/32/EC was added to the list of legislation that applied the New Approach.

In 2008 the New Approach was superseded by the New Legislative Framework (NLF). The NLF was a package of measures aimed at improving market surveillance and boosting the quality of conformity assessments. It also clarified the use of CE marking and created a toolbox of measures for use in product legislation.

The New Legislative Framework consists of:

1. **Regulation (EC) 764/2008** laying down procedures relating to the application of certain national technical rules to products lawfully marketed in another EU country.

   This Regulation lays down the rules and procedures to be followed by the competent authorities of a Member State when taking or intending to take a decision, as referred to in Article 2(1), which would hinder the free movement of a product lawfully marketed in another Member State and subject to Article 28 of the Treaty.

   It also provides for the establishment of Product Contact Points in the Member States to contribute to the achievement of the aim of this Regulation, as set out in paragraph 1.


   This Regulation lays down rules on the organisation and operation of accreditation of conformity assessment bodies performing conformity assessment activities.

   This Regulation provides a framework for the market surveillance of products to ensure that those products fulfil requirements providing a high level of protection of public interests, such as health and safety in general, health and safety at the workplace, the protection of consumers, protection of the environment and security.

   This Regulation provides a framework for controls on products from third countries and lays down the general principles of the CE marking.

3. **Decision 768/2008** (repealing Council Decision 93/465/EEC) on a common framework for the marketing of products, which includes reference provisions to be incorporated whenever product legislation is revised. In effect, the decision is a template for future product harmonisation legislation.

   This Decision sets out the common framework of general principles and reference provisions for the drawing up of Community legislation harmonising the conditions for the marketing of products (Community harmonisation legislation).

   This Decision also describes the different **conformity assessment procedures**, such as Module A Internal production Control to Module H1.

---

It is this Decision that Article 8.2 of Directive 2009/125/EC refers to when specifying the conformity assessment procedures: "The implementing measures shall leave to manufacturers the choice between the internal design control set out in Annex IV to this Directive and the management system set out in Annex V to this Directive. But where duly justified and proportionate to the risk, the conformity assessment procedure shall be specified among relevant modules as described in Annex II to Decision No 768/2008/EC".

Where a manufacturer or supplier places a product on the EU market or puts a product into service that is covered by NLF legislation, he/she has to affix the CE mark and provide a Declaration of Conformity. Depending on the legislation, the product (or manufacturing process) may require certification (a type certificate) by a Notified Body.

The Member States, EFTA countries (EEA members) and other countries with which the EC has concluded Mutual Recognition Agreements (MRAs) and Protocols to the Europe Agreements on Conformity Assessment and Acceptance of Industrial Products (PECAs) have designated Notified Bodies, established per directive. The Notified Body is notified\textsuperscript{63} to the European Commission and lists of Notified Bodies can be extracted from the NANDO web site of the European Commission\textsuperscript{64}. The lists include the identification number of each notified body as well as the tasks for which it has been notified, and are subject to regular update.

The quality, competence and independence of the Notified Bodies is accredited by a national accreditation body, and criteria for accreditation are fixed in Regulation (EC) 765/2008.

At the moment no Notified Bodies under Directive 2009/125/EC on Ecodesign and implementing measures have been registered, as manufacturers of fossil fuel boilers can continue to use the procedures put in place under 92/42/EEC (and currently Regulation EU(No) 813/2013): a Module B 'EC Type-examination’ performed by a Notified Body and a Declaration of conformity in accordance with Module C, D or E.

There are currently 46 Notified Bodies registered on the NANDO pages under the 92/42/EEC Boiler Efficiency Directive\textsuperscript{65}. About 2/3 of these bodies are located in seven member States these being United Kingdom (6), Germany (5), Spain (5), Greece (4), Turkey (4) Poland (4) and Italy (3). There are some 12 other member States with either 1 or 2 notified Bodies, resulting in nine Member States without Notified Bodies.

\textsuperscript{63} Notification is an act whereby a Member State informs the Commission and the other Member States that a body, which fulfils the relevant requirements, has been designated to carry out conformity assessment according to a directive. Notification of Notified Bodies and their withdrawal are the responsibility of the notifying Member State.

\textsuperscript{64} http://ec.europa.eu/growth/tools-databases/nando/index.cfm?fuseaction=directive.notifiedbody&dir_id=11

\textsuperscript{65} http://ec.europa.eu/growth/tools-databases/nando/index.cfm?fuseaction=directive.notifiedbody&dir_id=11
Figure 4. Notified Bodies (for BED 94/42/EEC) per member state

Table 7. Names and nr. of Notified Bodies (for BED 92/42/EEC)

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Name</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB 0036</td>
<td>TÜV SÜD Industrie Service GmbH</td>
<td>Germany</td>
</tr>
<tr>
<td>NB 0048</td>
<td>DANMARKS GASMATERIEL PRØVNING</td>
<td>Denmark</td>
</tr>
<tr>
<td>NB 0049</td>
<td>AFNOR CERTIFICATION SA</td>
<td>France</td>
</tr>
<tr>
<td>NB 0051</td>
<td>IMQ ISTITUTO ITALIANO DEL MARCHIO DI QUALITÀ S.P.A.</td>
<td>Italy</td>
</tr>
<tr>
<td>NB 0053</td>
<td>TÜV SÜD ATISAE, S.A.U.</td>
<td>Spain</td>
</tr>
<tr>
<td>NB 0063</td>
<td>Kiwa Nederland B.V.</td>
<td>Netherlands</td>
</tr>
<tr>
<td>NB 0085</td>
<td>DVGW CERT GmbH</td>
<td>Germany</td>
</tr>
<tr>
<td>NB 0086</td>
<td>BSI</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>NB 0087</td>
<td>GL Industrial Services UK Ltd</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>NB 0099</td>
<td>AENOR INTERNACIONAL</td>
<td>Spain</td>
</tr>
<tr>
<td>NB 0120</td>
<td>SGS United Kingdom Limited</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>NB 0359</td>
<td>INTERTEK TESTING; CERTIFICATION LTD</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>NB 0370</td>
<td>LGAI TECHNOLOGICAL CENTER, S. A./Applus</td>
<td>Spain</td>
</tr>
<tr>
<td>NB 0408</td>
<td>TÜV AUSTRIA SERVICES GMB</td>
<td>Austria</td>
</tr>
<tr>
<td>NB 0424</td>
<td>INSPECTA TARKASTUS OY</td>
<td>Finland</td>
</tr>
<tr>
<td>NB 0461</td>
<td>TECHNIGAS</td>
<td>Belgium</td>
</tr>
<tr>
<td>NB 0476</td>
<td>KIWA CERMET ITALIA S.P.A.</td>
<td>Italy</td>
</tr>
<tr>
<td>NB 0480</td>
<td>BSRIA LTD.</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>NB 0541</td>
<td>LABORATORIO DE TERMOTECNIA DE LA ESCUELA TECNICA SUPERIOR DE INGENIEROS INDUSTRIALES DE MADRID</td>
<td>Spain</td>
</tr>
<tr>
<td>NB 0542</td>
<td>LABORATORIO DEL CENTRO DE INVESTIGACION Y DESARROLLO DE RESPOL BUTANO S.A.</td>
<td>Spain</td>
</tr>
<tr>
<td>NB</td>
<td>Name</td>
<td>Country</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>NB 0558</td>
<td>KIWA LTD T/A KIWA GASTEC</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>NB 0598</td>
<td>SGS FIMKO OY</td>
<td>Finland</td>
</tr>
<tr>
<td>NB 0617</td>
<td>NATIONAL TECHNICAL UNIVERSITY OF ATHENS, LABORATORY OF STEAM BOILERS AND THERMAL PLANTS</td>
<td>Greece</td>
</tr>
<tr>
<td>NB 0618</td>
<td>HELLENIC REGISTER OF SHIPPING</td>
<td>Greece</td>
</tr>
<tr>
<td>NB 0626</td>
<td>Universität Stuttgart Institut für Gebäudeenergetik</td>
<td>Germany</td>
</tr>
<tr>
<td>NB 0909</td>
<td>Gas- und Wärme-Institut Essen e. V. - Module C only</td>
<td>Germany</td>
</tr>
<tr>
<td>NB 1008</td>
<td>TÜV Rheinland InterCert Muszaki Felügyeleti és Tanúsító Korlátolt Felelosségü Társaság</td>
<td>Hungary</td>
</tr>
<tr>
<td>NB 1009</td>
<td>MBVTI Műszaki Biztonsági Vizsgáló és Tanúsító Intézet Kft.</td>
<td>Hungary</td>
</tr>
<tr>
<td>NB 1015</td>
<td>STROJIÈNSKY ZKUSEBNI USTAV s.p.</td>
<td>Czech Republic</td>
</tr>
<tr>
<td>NB 1255</td>
<td>SCHWEIZ. VEREIN DES GAS- UND WASSERFACHES (SVGW)</td>
<td>Switzerland(MRA)</td>
</tr>
<tr>
<td>NB 1299</td>
<td>Technicky skusobny ustav Piestany s.p.</td>
<td>Slovakia</td>
</tr>
<tr>
<td>NB 1312</td>
<td>CERTIGAZ (since 4 December 2017)</td>
<td>France</td>
</tr>
<tr>
<td>NB 1433</td>
<td>URZAD DOZORU TECHNICZNEGO</td>
<td>Poland</td>
</tr>
<tr>
<td>NB 1450</td>
<td>INSTYTUT NAFTY I GAZU-PANSTWOWY INSTYTUT BADAWCZY</td>
<td>Poland</td>
</tr>
<tr>
<td>NB 1451</td>
<td>INSTYTUT TECHNOLOGII ELEKTRONOWEJ ODDZIAŁ PREDOM</td>
<td>Poland</td>
</tr>
<tr>
<td>NB 1452</td>
<td>INSTYTUT ENERGETYKI</td>
<td>Poland</td>
</tr>
<tr>
<td>NB 1506</td>
<td>DANSK GASTEKNISK CENTER A/S</td>
<td>Denmark</td>
</tr>
<tr>
<td>NB 1617</td>
<td>QMSCERT AUDITS-INSPECTIONS-CERTIFICATIONS LTD. (Q-CERT LTD.)</td>
<td>Greece</td>
</tr>
<tr>
<td>NB 1783</td>
<td>TURKISH STANDARDS INSTITUTION (TSE)</td>
<td>Turkey</td>
</tr>
<tr>
<td>NB 1837</td>
<td>&quot;ITEM CONSULT&quot; Ltd. - Departament &quot;Conformity Assessment&quot;</td>
<td>Bulgaria</td>
</tr>
<tr>
<td>NB 1936</td>
<td>TÜV Rheinland Italia SRL</td>
<td>Italy</td>
</tr>
<tr>
<td>NB 2159</td>
<td>S&amp;Q Mart Kalite Güvenlik Sanayi ve Ticaret A. Ş.</td>
<td>Turkey</td>
</tr>
<tr>
<td>NB 2195</td>
<td>Szutest Uygunluk Değerlendirme A.Ş.</td>
<td>Turkey</td>
</tr>
<tr>
<td>NB 2456</td>
<td>TÜV Rheinland Energy GmbH</td>
<td>Germany</td>
</tr>
<tr>
<td>NB 2464</td>
<td>TÜV Croatia d.o.o.</td>
<td>Croatia</td>
</tr>
<tr>
<td>NB 2671</td>
<td>Nova Certifications Single Member Ltd - Module C only</td>
<td>Greece</td>
</tr>
<tr>
<td>NB 2674</td>
<td>Standard Sertifikasyon Muayene Laboratuvar ve Eğitim Hizmetleri Anonim Şirketi</td>
<td>Turkey</td>
</tr>
</tbody>
</table>

The Notified Bodies carry out a Module B - EC Type examination of boilers. Two Notified bodies cannot carry out Module B (EC type examination), but only Module C (verification of type).

If no relevant product tests have been performed for 5 years, the test house could lose their accreditation. The list is of NBs is continuously updated.
3.3.2 Accreditation and certification

In the EU the following system of accreditation and certification applies:

The Decision 2008/768 enabled witness testing at the manufacturers' premises with an authorised representative of the Notified Body present. Larger companies (conglomerations) started to pursue accreditation (ISO 17025) of their own test houses and now almost all product testing for conformity assessment of the major manufacturers now happens as in-house test.

Smaller manufacturers without their own certified test facilities resort to independent test houses (like TUV, DGW, CETIAT, KIWA, etc.) which raises the bar for testing and increases costs relative to those companies who own an in-house facility.

Market surveillance authorities also rely on independent test houses for verification of claims, as performing a witness test of a randomly selected product from manufacturer A in a test-house of manufacturer B is not really an option.

![Diagram](image)

**Figure 5. Structure of EU certification and accreditation**
3.3.3 Conformity assessment modules

The modules of the BED are described as:

Module B – EC Type examination: The manufacturer lodges an application for EC type examination with a notified body of his choice and submits a representative specimen (“type”) of the envisaged production together with technical documentation. The notified body examines the technical documentation, performs appropriate examinations and necessary tests and issues an EC type examination certificate declaring that the type meets the essential requirements of the applicable directive(s)/regulations. The standards used are those the references of which are published in the official journal or another reliable, robust test standard.

Module C – Conformity to type: Before attaching the CE marking, the manufacturer must attest in a written declaration of conformity that the products concerned are in conformity with the type described in the EC type-examination certificate (Module B) and satisfy the requirements of the directive that applies to them.

Additional requirements may be that a notified body tests specific aspects of the product or carries out product checks at random intervals. In those cases, the manufacturer shall affix the identification number of the notified body together with the CE-marking, indicating that the test results were positive.

Certification according these modules results in a CE mark that lists the reference of the Notified Body: "CExxxx" (where "xxxx" stands for the Notified Body reference).

***

Manufacturers of space/combination heaters that are outside the scope of the former 92/42/EEC, but in the scope of Regulation (EU) No 813/2013 can apply Module A as conformity assessment procedure and do not require assessment by a Notified Body.

Module A - Internal Production Control: The manufacturer ensures in a written “declaration of conformity” that a product satisfies the requirements of the applicable directive/regulation. The manufacturer shall retain technical documentation covering the design, manufacture and operation of the product at the disposal of national surveillance authorities for inspection purposes for 10 years.

The technical documentation shall be sufficient to enable the authorities to assess the conformity of the product with requirements if required. The manufacturer shall affix the CE-marking (no reference to Notified Body) to each product. The manufacturer must also take all necessary steps to secure that the manufacturing process ensures that manufactured products comply with the technical documentation and the essential requirements of the applicable directive.

Conformity assessment according this module results in a CE mark without reference to a Notified Body: "CE".

The manufacturer/supplier has to make sure that all relevant requirements are met when the CE marking is affixed, and a Declaration of Conformity is issued. This means that other (essential) requirements than Ecodesign, for instance from the LVD, GAR, CPR, etc. have to be met as well.

Characteristics of these and other modules are shown in the overview on the following pages.
Table 8. Conformity assessment modules

<table>
<thead>
<tr>
<th>Modules Annex II, 768/2008</th>
<th>Manufacturer</th>
<th>Notified body (or in-house accredited body)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Internal production control</td>
<td></td>
<td>(no involvement)</td>
<td>no NB involved</td>
</tr>
<tr>
<td>A1: ..plus supervised product testing</td>
<td></td>
<td>notified body or by in-house accredited body carries out checks of each individual product</td>
<td>NB/aihb tests each product</td>
</tr>
<tr>
<td></td>
<td></td>
<td>if tested by NB: identification number affixed during manufacturing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2: ..plus supervised product checks at random intervals</td>
<td></td>
<td>notified body or by in-house accredited body carries out checks of product at random intervals, decided by the body (in-house or NB)</td>
<td>NB/aihb decides on interval and does tests</td>
</tr>
<tr>
<td></td>
<td></td>
<td>if tested by NB: identification number affixed during manufacturing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. EC Type examination</td>
<td>either assessment of specimen, specimen + technical documentation / evidence, or technical documentation / evidence only</td>
<td>NB examines techn.doc and evidence</td>
<td>NB does type examination of specimen</td>
</tr>
<tr>
<td></td>
<td>- manufacturer lodges application with NB of choice:</td>
<td>- carries out product tests</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- includes technical documentation</td>
<td>- agrees with manufacturer on location of tests/examination</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- includes specimen(s)</td>
<td>- draws up evaluation report</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- includes supporting evidence</td>
<td>- issues EC-type examination certificate if compliant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- informs NB of relevant modifications of product (may result in addition to EC-type examination certificate)</td>
<td>- informs manufacturer of possible need to re-examine conformity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- informs other NBs of EC-type examination certificates issued</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- makes EC type exam. certificates available to NBs, authorities and Commission upon request</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Conformity to type based on internal production control</td>
<td>manufactures product compliant with techn.doc (see Module B)</td>
<td>(no involvement of NB in Module C)</td>
<td></td>
</tr>
<tr>
<td>C1: .. plus supervised product testing</td>
<td></td>
<td>notified body or by in-house accredited body carries out checks of each individual product</td>
<td>NB/aihb tests each product</td>
</tr>
<tr>
<td></td>
<td></td>
<td>if tested by NB: identification number affixed during manufacturing</td>
<td></td>
</tr>
<tr>
<td>C2: .. plus supervised product checks at random intervals</td>
<td></td>
<td>notified body or by in-house accredited body carries out checks of product at random intervals, decided by the body (in-house or NB)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>if tested by NB: identification number affixed during manufacturing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### D. Conformity to type based on quality assurance of the production process

- manufacturer operates an approved quality system for production, final inspection and testing
- lodges application for assessment of QS with NB of choice, includes technical documentation for **EC-type examination + certificate**
- QS ensures products are conform EC-type examination
- manufacturer ensures QS is maintained, informs NB of changes
- affixes required conformity marking
- draws up a declaration of conformity with approved type, available upon request
- keeps info available for 10 years
- notified body assesses the QS, including visit to factory by audit team
- carries out the surveillance of the QS (periodic audits, unexpected visits, product tests)
- informs notifying authorities and other NBs of approved QS

### D1: Quality assurance of the production process

- manufacturer establishes technical documentation (however, does not include specimen, or EC type examination certificate)
- operates a quality system for production, final inspection and testing
- lodges application for assessment of QS with NB of choice, includes technical documentation above
- manufacturer ensures QS is maintained, informs NB of changes
- affixes required conformity marking
- draws up a declaration of conformity with approved type, available upon request
- keeps info available for 10 years
- notified body assesses the QS, including visit to factory by audit team
- carries out the surveillance of the QS (periodic audits, unexpected visits, product tests)
- informs notifying authorities and other NBs of approved QS

### E. Conformity to type based on product quality assurance

- manufacturer operates an approved quality system for final inspection and testing
- lodges application for assessment of QS with NB of choice, includes technical documentation for **EC-type examination + certificate**
- QS ensures products are conform EC-type examination
- manufacturer ensures QS is maintained, informs NB of changes
- affixes required conformity marking
- draws up a declaration of conformity with approved type, available upon request
- keeps info available for 10 years
- notified body assesses the QS, including visit to factory by audit team
- carries out the surveillance of the QS (periodic audits, unexpected visits, product tests)
- informs notifying authorities and other NBs of approved QS

**Type examination required**
- NB assesses QS: visit to factory
| E1: Quality assurance of final product inspection and testing | - manufacturer establishes technical documentation (however, does not include specimen, or EC type examination certificate)  
- operates an approved quality system for final product inspection and testing  
- lodges application for assessment of QS with NB of choice, includes technical documentation above  
- manufacturer ensures QS is maintained, informs NB of changes  
- affixes required conformity marking  
- draws up a declaration of conformity with approved type, available upon request  
- keeps info available for 10 years | - notified body assesses the QS, including visit to factory by audit team  
- carries out the surveillance of the QS (periodic audits, unexpected visits, product tests)  
- informs notifying authorities and other NBs of approved QS | no type examination required  
NB assesses QS |
| --- | --- | --- | --- |
| F. Conformity to type based on product verification | - manufactures product compliant with techn.doc (see Module B)  
- affixes conformity marking (if tested by NB: identification number added)  
- draws up a declaration of conformity with approved type, available upon request | - notified body verifies conformity of product to EC-type examination of every product or on statistical basis  
- issues certificate of conformity | type examination required  
NB verifies products  
no in-house accredited lab |
| F1: Conformity based on product verification | - establishes technical documentation (no specimen supplied, no EC-type examination required)  
- manufactures product compliant with requirements  
- declares conformity to essential requirements  
- affixes required conformity marking | - notified body verifies conformity to requirements by examination of every product or on statistical representative sample  
- issues certificate of conformity | no prior type examination required  
NB verifies products  
no in-house accredited lab |
| G. Conformity based on unit verification | - establishes technical documentation (no specimen supplied, no EC-type examination required), including analysis of risks  
- manufactures product compliant with requirements  
- declares conformity to essential requirements  
- affixes required conformity marking | - notified body verifies conformity to essential requirements, with appropriate examinations or tests  
- issues certificate of conformity | no prior type examination required  
NB verifies products  
no in-house accredited lab  
probably intended for machinery as it mentions assessment of risks |
### H. Conformity based on full quality assurance
- operates an approved quality system for production, final inspection and testing
- lodges application for assessment of QS with NB of choice, includes technical documentation (no specimen supplied, no EC-type examination required)
- manufacturer ensures QS is maintained, informs NB of changes
- affixes required conformity marking
- draws up a declaration of conformity with approved type, available upon request
- keeps info available for 10 years
- notified body assesses the QS, including visit to factory by audit team
- carries out the surveillance of the QS (periodic audits, unexpected visits, product tests)
- informs notifying authorities and other NBs of approved QS

### H1 Conformity based on full quality assurance plus design examination
- operates an approved quality system for production, final inspection and testing
- lodges application for assessment of QS with NB of choice, includes technical documentation (no specimen supplied, no EC-type examination required)
- manufacturer ensures QS is maintained, informs NB of changes
- lodges application for design examination with NB
- affixes required conformity marking
- draws up a declaration of conformity with approved type, available upon request
- keeps info available for 10 years
- notified body assesses the QS, including visit to factory by audit team
- carries out the surveillance of the QS (periodic audits, unexpected visits, product tests)
- informs notifying authorities and other NBs of approved QS
- verifies conformity of design
- issues EC-design examination certificate
- informs notifying authorities and other NBs of approved design
3.4 Specific EU policies and measures

3.4.1 BED - Boiler Efficiency Directive 92/42/EEC (incl. before and after)


Council Directive 92/42/EEC of 21 May 1992 on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels addressed these barriers by introducing mandatory horizontal minimum energy efficiency requirements for hot water boilers from 4 to 400 kW in the EU (EEC), conformity to be indicated by the CE marking. It also introduced an efficiency rating scheme using stars (as a precursor to later energy labelling of space heaters).

Excluded were combi-boilers (instantaneous types), local space heaters that can also supply hot water to a central heating system (but are designed to heat the premises in which they are installed) and boilers using solid fuels or other fuels than commonly marketed (biogas, waste gas, etc.).

The minimum requirements for energy efficiency applied to rated output (100% load) at 70°C and part load (30%) at 50°C (for condensing boilers) and 47°C return water temperature (for type B boilers).

The conformity with energy efficiency requirements was certified by third parties in accordance with Module B 'EC Type-examination' by which a notified body ascertains and attests that an example, representative of the production envisaged, meets the relevant provisions of the Directive. The Declaration of Conformity was to be in accordance with Module C (Conformity to type, or DOC, including examination of production by NB), D (Production quality assurance, including audits of quality system by NB) or E (Product quality assurance of each product produced, including audits of quality system by NB).


---

66 OJ L 167 , 22.06.1992, p.17-28
68 OJ L 052 , 21.02.2004, p.50-60
The Ecodesign Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of Ecodesign requirements for energy-using products amended Council Directive 92/42/EEC (and Directives 96/57/EC and 2000/55/EC) as “Directive 92/42/EEC provides for a star rating system intended to ascertain the energy performance of boilers. Since Member States and the industry agree that the star rating system has proved not to deliver the expected result, Directive 92/42/EEC should be amended to open the way for more effective schemes.” Recital (35). The amendment deleted Article 6 regarding the star-rating and the old 92/42/EEC was reshaped to constitute an implementing measure within the meaning of Article 15 of 2005/32/EC, and was later repealed by Directive 2009/125/EC, the present Ecodesign Directive.


In 2013 the 92/42/EEC was repealed and replaced by Ecodesign Regulation 813/2013 (see below). The Ecodesign Regulation 813/2013 however maintained the conformity assessment of the amended Directive 92/42/EEC concerning the energy efficiency requirements (full load and part load) certified by third parties in accordance with Module B ‘EC Type-examination’ applicable to boilers as “The conformity assessment procedure referred to in Article 8(2) of Directive 2009/125/EC shall be the internal design control set out in Annex IV to that Directive or the management system set out in Annex V to that Directive without prejudice to Articles 7(2) and 8 of and Annexes III to V to Council Directive 92/42/EEC”. Article 4 §1. It is Article 7(2) that requires conformity assessment using module B, plus Module C/D/E. Article 8 concerns the notification of conformity assessment bodies with Member States authorities and the Commission.

3.4.2 Ecodesign Regulation (EU) 813/2013/EC


The upper end of the scope of the Regulation is kept identical to that of the older BED it replaced as it was limited to boilers of maximum 400 kW heat output. The lower end of the scope (BED: 4 kW minimum) is kept open.

The technical scope is enlarged to cover combination boilers and electric boilers (both joule-effect and heat pumps) including those integrated in packages.

The regulation does not apply to:

- a) heaters specifically designed for using gaseous or liquid fuels predominantly produced from biomass; these are subject of the present review study;

69 OJ L 239, 6.9.2013, p. 136–161
b) heaters using solid fuels; these are covered by Commission Regulation (EU) 2015/1189 and Commission Delegated Regulation (EU) 2015/1187 (solid fuel boilers);

c) heaters within the scope of Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions (integrated pollution prevention and control); The Directive 2010/45/EU indicates by Annex I, point 1.1, and Annex v, point 2 the industrial scale starts at 50 MW thermal input.

d) heaters generating heat only for the purpose of providing hot drinking or sanitary water; these are covered by regulation 812/2013 (labelling) and 814/2013 (Ecodesign) on water heaters (sanitary water);

e) heaters for heating and distributing gaseous heat transfer media such as vapour or air; these are covered by Commission Delegated Regulation (EU) No 626/2011 (room air conditioners, including reversible units), Commission Regulation (EU) No 206/2012 (air conditioners and comfort fans) and Commission Regulation (EU) 2016/2281 on air heating products and cooling products;

f) cogeneration space heaters with a maximum electrical capacity of 50 kW or above. These were covered by the CHP Directive 2004/8/EC, later on incorporated into the energy efficiency Directive 2012/27/EU;

g) heat generators designed for heaters and heater housings to be equipped with such heat generators placed on the market before 1 January 2018 to replace identical heat generators and identical heater housings. The replacement product or its packaging shall clearly indicate the heater for which it is intended.

The minimum energy efficiency requirements are specific per technology, allowing type B1 space/combination heaters to remain on the market as a solution for consumers using shared, collective, chimneys (recital 12) if accompanied by the product information requirement that the instruction manuals for installers and end-users, and free access websites should provide type B1 boilers and type B1 combination boilers characteristics and the following text “This natural draught boiler is intended to be connected only to a flue shared between multiple dwellings in existing buildings that evacuates the residues of combustion to the outside of the room containing the boiler. It draws the combustion air directly from the room and incorporates a draught diverter. Due to lower efficiency, any other use of this boiler shall be avoided and would result in higher energy consumption and higher operating costs.” (Annex II point 5(a) 4th bullet point).
### Table 9. Minimum seasonal energy efficiency requirements of Regulation (EU) 813/2013

<table>
<thead>
<tr>
<th>Type</th>
<th>26 Sep 2015</th>
<th>26 Sep 2017</th>
<th>26 Sep 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(% = seasonal space heating efficiency)</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fuel boiler space heaters &lt; 70 kW, except type B1 (&lt;10 kW space heater / &lt;30 kW combination heater)</strong></td>
<td>86%</td>
<td>max. NOx</td>
<td></td>
</tr>
<tr>
<td><strong>B1 boiler &lt;10 kW if space heater / &lt;30 kW if combination heater</strong></td>
<td>75%</td>
<td>max. NOx</td>
<td></td>
</tr>
<tr>
<td><strong>electric space/combination heater</strong></td>
<td>30%</td>
<td>36%</td>
<td></td>
</tr>
<tr>
<td><strong>cogeneration space heaters</strong></td>
<td>86%</td>
<td>100%</td>
<td>max. NOx</td>
</tr>
<tr>
<td><strong>heat pumps space/combination heaters, except low-temperature types</strong></td>
<td>100%</td>
<td>110%</td>
<td>max. NOx</td>
</tr>
<tr>
<td><strong>Low-temperature heat pumps space/combination heaters</strong></td>
<td>110%</td>
<td>125%</td>
<td>max. NOx</td>
</tr>
<tr>
<td><strong>Combination heaters water heating efficiency (varies per class XXS-3XL)</strong></td>
<td>22%-32%</td>
<td>32% - 64%</td>
<td></td>
</tr>
<tr>
<td><strong>All</strong></td>
<td>Product information</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A number of stakeholders mentioned the problem of replacing (individually owned) non-condensing C4 type boilers (and C8 types) connected to collective flues that operate under negative pressure and are not condensate-resistant (made of brickwork, fireclay, etc.). Although the issue is comparable to that of B1 type boilers connected to a shared flue, the present regulation has not introduced lower efficiency limits for such C4/C8 boilers.

The reason C4/C8 boilers were not covered by less stringent requirements like B1 boilers is not known. It may be that before 2013 both condensing boilers and non-condensing boilers using collective air/chimney systems were covered under the same C4 or C8 category. Only after 2013 boilers operating under positive pressure (these are primarily condensing boilers) were covered by newly introduced specific air/flue gas categories such as C(10), C(11), C(12), C(13) and C(14). Before 2013 an exception referring to only C4 and/or C8 would have covered the condensing boilers as well, which was not the intention – see also Section 4.10.2 on CEN/TR 1749:2014.
The Regulation (EU) 813/2013 also introduced maximum emission limits for NO$_x$.

Table 10. Maximum NO$_x$ emission values of Regulation (EU) 813/2013

<table>
<thead>
<tr>
<th>Type</th>
<th>Combustion</th>
<th>Fuel</th>
<th>as of 26 September 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Gaseous</td>
<td>Liquid</td>
</tr>
<tr>
<td>Fuel boiler</td>
<td></td>
<td>56</td>
<td>120</td>
</tr>
<tr>
<td>cogeneration</td>
<td>external (e.g.</td>
<td>gaseous</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Stirling engine)</td>
<td>liquid</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>internal (e.g.</td>
<td>gaseous</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>engine)</td>
<td>liquid</td>
<td>420</td>
</tr>
<tr>
<td>Heat pump</td>
<td>external (e.g.</td>
<td>gaseous</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>sorption)</td>
<td>liquid</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>internal (e.g.</td>
<td>gaseous</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>engine)</td>
<td>liquid</td>
<td>420</td>
</tr>
</tbody>
</table>

Although the review includes space/combination heaters using fuels predominantly produced from biomass there is no information available on emissions of heaters using such 'alternative fuels'.

As of 26 September 2015, the maximum sound power of heat pumps ranges from 60/65 dB (indoor/outdoor) if output < 6 kW to max. 80/88 dB for output > 30 kW.

Table 11. Maximum sound power levels for heat pumps

<table>
<thead>
<tr>
<th>Rated heat output</th>
<th>Per 26 Sep 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 6 kW</td>
</tr>
<tr>
<td>Position</td>
<td>indoor</td>
</tr>
<tr>
<td>Sound power level</td>
<td>60</td>
</tr>
</tbody>
</table>

Information requirements apply as of 26 September 2015.

Annex III on Measurements and Calculations prescribes test conditions:

- general conditions (20°C +/- 1°C indoor temperature);
- conversion coefficient CC (same as primary energy factor, PEF) is 2.5;
- consideration of supplementary heater when measuring / calculating rated heat output, seasonal space heating energy efficiency, water heating energy efficiency, sound power level and emissions of nitrogen oxides;
- rounding and testing of separate burner and boiler housing.

Furthermore this Annex III introduces corrections of the active mode energy efficiency in relation to temperature controls, auxiliary electricity, standby heat loss, ignition burner power, and, for cogeneration, a correction for electricity production "by adding the electrical efficiency..." (more on this later on – see standard EN 50465). The actual
calculation of the effect of correction factors on seasonal efficiency is however described in the Transitional Methods 2014 and not in the regulation.

For heat pumps the annex III presents several definitions and test conditions, and tapping patterns for combination heaters, combined with a short explanation on how the testing should be performed.

The conformity assessment is the internal design control set out in Annex IV to Directive 2009/125/EC or the management system set out in Annex V to that Directive but kept the original certification for fossil fuel fired space heaters as required by Articles 7(2) and 8 of and Annexes III to V to Council Directive 92/42/EEC:

Recital (22) mentions on this "Directive 92/42/EEC should be repealed, except for Articles 7(2) and 8 thereof and Annexes III to V thereto, and new provisions should be laid down by this Regulation to ensure that the scope is extended to heaters other than boilers, to further improve the energy efficiency of space heaters and combination heaters, and to improve other significant environmental aspects of space heaters and combination heaters."

Article 4 of 813/2013 on Conformity assessment reads: "1. The conformity assessment procedure referred to in Article 8(2) of Directive 2009/125/EC shall be the internal design control set out in Annex IV to that Directive or the management system set out in Annex V to that Directive without prejudice to Articles 7(2) and 8 of and Annexes III to V to Council Directive 92/42/EEC."

Article 7.2 of 92/42/EEC reads:

2. The conformity of series-produced boilers shall be certified by:

- examination of the efficiency of a boiler type in accordance with module B - EC type-examination as described in Annex III,
- a declaration of conformity to the approved type in accordance with module C, D or E as described in Annex IV (Module C: Conformity to type / Module D: Production quality assurance / Module E: Product quality assurance).

For boilers burning gaseous fuels, the procedures for assessing the conformity of their efficiency shall be those used to assess conformity to the safety requirements laid down in Directive 90/396/EEC on the approximation of the laws of the Member States relating to appliances burning gaseous fuels.

Article 8 reads:

1. Each Member State shall notify the Commission and the other Member States of the bodies it has appointed to carry out the tasks relating to the procedures referred to in Article 7, hereinafter called 'notified bodies'.

   The Commission shall allocate identification numbers to those bodies and shall inform the Member States thereof.

   Lists of the notified bodies shall be published by the Council in the Official Journal of the European Communities and shall be continually updated.

2. Member States shall implement the minimum criteria laid down in Annex V (Minimum criteria to be taken into account by Member States for the notification of bodies) for the appointment of such bodies. Bodies which
satisfy the criteria laid down in the corresponding harmonized standards shall be deemed to comply with the criteria laid down in that Annex.

3. A Member State which has notified a particular body must withdraw that notification if it finds that the body concerned no longer satisfies the criteria referred to in paragraph 2. It shall immediately inform the other Member States and the Commission accordingly and shall withdraw the notification.

The partial repeal resulted in a difference in certification between boilers previously covered by 92/42/EEC (mandatory third-party) and heaters added to the scope of 813/2013 (self-declaration).

Annex V describes the verification procedure which generally requires testing of a single appliance and when values are not met, testing of another three randomly selected values. This annex was amended by Regulation 2016/2282\(^70\) which added some clarifications as regards the tolerances and the possible use of this by manufacturers.

Annex V shows the benchmarks for seasonal space heating energy efficiency (145%), water heating efficiency (35% for 3XS to 130% for 4XL), sound power levels and NO\(_x\) emissions (14 mg/kWh for boilers using gaseous fuels and 50 mg/kWh when using liquid fuels).

As customary Article 7 on review states the elements that need to be considered in a review:

a) the appropriateness of setting Ecodesign requirements for greenhouse gas emissions related to refrigerants;

b) on the basis of the measurement methods under development, the level of the Ecodesign requirements for emissions of carbon monoxide, hydrocarbons and particulate matter that may be introduced;

c) the appropriateness of setting stricter Ecodesign requirements for the energy efficiency of boiler space heaters and boiler combination heaters, for the sound power level and for emissions of nitrogen oxides;

d) the appropriateness of setting Ecodesign requirements for heaters specifically designed for using gaseous or liquid fuels predominantly produced from biomass;

e) the validity of the conversion coefficient value;

f) the appropriateness of third-party certification

Member States may allow placing on the market heaters that are in conformity with national measures until 26 Sep 2015 with regard to energy efficiency and 26 Sep 2018 with regard to NO\(_x\) requirements.

The effect of the Regulation in market terms is described in Task 2 and for energy savings in Task 7.

3.4.3 Energy labelling regulation (EU) no 811/2013/EC

Commission Delegated Regulation (EU) No 811/2013 of 18 February 2013 supplementing Directive 2010/30/EU describes the rules for the energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device.\(^7^1\)

The scope of products of the labelling regulation is virtually the same as for Regulation (EU) 813/2013 but is limited to products with a maximum heat output ≤ 70 kW (for space heating).

Other differences are that the Delegated Regulation (EU) 811/2013 for labelling of combination heaters does not mention a maximum storage size (for water heating efficiency of combination heaters) whereas the scope of Delegated Regulation (EU) 812/2013 for labelling of water heaters is limited to hot water storage tanks of max. 500 l (and the Regulation 814/2013 Ecodesign regulation for water heaters limits the scope to storage tanks of max 2000 l).

The delegated regulation sets out responsibilities for suppliers (mainly provision of a printed label and product fiche and technical documentation for market surveillance purposes). The requirements differ per the product regulated (space/combination heaters, controls, solar devices, packages of these, etc.), responsibilities for dealers (display of information, also for online retail).

The space heating energy efficiency classes are determined on the basis of the seasonal space heating energy efficiency of space heaters, as follows:

<table>
<thead>
<tr>
<th>Energy efficiency class</th>
<th>Space heating (except LT-heat pump)</th>
<th>LT heat pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+++</td>
<td>( \eta_s \geq 150 )</td>
<td>( \eta_s \geq 175 )</td>
</tr>
<tr>
<td>A++</td>
<td>( 125 \leq \eta_s &lt; 150 )</td>
<td>( 150 \leq \eta_s &lt; 175 )</td>
</tr>
<tr>
<td>A+</td>
<td>( 98 \leq \eta_s &lt; 125 )</td>
<td>( 123 \leq \eta_s &lt; 150 )</td>
</tr>
<tr>
<td>A</td>
<td>( 90 \leq \eta_s &lt; 98 )</td>
<td>( 115 \leq \eta_s &lt; 123 )</td>
</tr>
<tr>
<td>B</td>
<td>( 82 \leq \eta_s &lt; 90 )</td>
<td>( 107 \leq \eta_s &lt; 115 )</td>
</tr>
<tr>
<td>C</td>
<td>( 75 \leq \eta_s &lt; 82 )</td>
<td>( 100 \leq \eta_s &lt; 107 )</td>
</tr>
<tr>
<td>D</td>
<td>( 36 \leq \eta_s &lt; 75 )</td>
<td>( 61 \leq \eta_s &lt; 100 )</td>
</tr>
<tr>
<td>E</td>
<td>( 34 \leq \eta_s &lt; 36 )</td>
<td>( 59 \leq \eta_s &lt; 61 )</td>
</tr>
<tr>
<td>F</td>
<td>( 30 \leq \eta_s &lt; 34 )</td>
<td>( 55 \leq \eta_s &lt; 59 )</td>
</tr>
<tr>
<td>G</td>
<td>( \eta_s &lt; 30 )</td>
<td>( \eta_s &lt; 55 )</td>
</tr>
</tbody>
</table>

While classes A to G cover the various types of conventional boilers when not combined with cogeneration or renewable energy technologies, classes A + and A ++ should promote the use of cogeneration and renewable energy sources. Further classes A +++ and A + are added after four years (from 26 Sep 2019) to the seasonal space heating and water heating classes, unless the review of the Regulation proves otherwise, to

\(^7^1\) OJ L 239, 6.9.2013, p. 1.
accelerate the market penetration of high-efficiency space heaters and combination heaters using renewable energy sources (Recital (5) and (7) of Delegated Regulation (EU) No 811/2013).

The water heating energy efficiency classes (of combination heaters) are determined on the basis of the water heating energy efficiency, as follows:

### Table 13. Water heating energy efficiency classes of combination heaters, in %

<table>
<thead>
<tr>
<th>Class</th>
<th>3XS</th>
<th>XXS</th>
<th>XS</th>
<th>S</th>
<th>M</th>
<th>L</th>
<th>XL</th>
<th>XXL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+++</td>
<td>≥ 62</td>
<td>≥ 62</td>
<td>≥ 69</td>
<td>≥ 90</td>
<td>≥ 163</td>
<td>≥ 188</td>
<td>≥ 200</td>
<td>≥ 213</td>
</tr>
<tr>
<td>A++</td>
<td>≥ 53</td>
<td>≥ 53</td>
<td>≥ 61</td>
<td>≥ 72</td>
<td>≥ 130</td>
<td>≥ 150</td>
<td>≥ 160</td>
<td>≥ 170</td>
</tr>
<tr>
<td>A+</td>
<td>≥ 44</td>
<td>≥ 44</td>
<td>≥ 53</td>
<td>≥ 55</td>
<td>≥ 100</td>
<td>≥ 115</td>
<td>≥ 123</td>
<td>≥ 131</td>
</tr>
<tr>
<td>A</td>
<td>≥ 35</td>
<td>≥ 35</td>
<td>≥ 38</td>
<td>≥ 38</td>
<td>≥ 65</td>
<td>≥ 75</td>
<td>≥ 80</td>
<td>≥ 85</td>
</tr>
<tr>
<td>B</td>
<td>≥ 32</td>
<td>≥ 32</td>
<td>≥ 35</td>
<td>≥ 35</td>
<td>≥ 39</td>
<td>≥ 50</td>
<td>≥ 55</td>
<td>≥ 60</td>
</tr>
<tr>
<td>C</td>
<td>≥ 29</td>
<td>≥ 29</td>
<td>≥ 32</td>
<td>≥ 36</td>
<td>≥ 37</td>
<td>≥ 38</td>
<td>≥ 40</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>≥ 26</td>
<td>≥ 26</td>
<td>≥ 29</td>
<td>≥ 33</td>
<td>≥ 34</td>
<td>≥ 35</td>
<td>≥ 36</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>≥ 22</td>
<td>≥ 22</td>
<td>≥ 26</td>
<td>≥ 26</td>
<td>≥ 30</td>
<td>≥ 30</td>
<td>≥ 32</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>≥ 19</td>
<td>≥ 19</td>
<td>≥ 23</td>
<td>≥ 27</td>
<td>≥ 27</td>
<td>≥ 27</td>
<td>≥ 28</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>&lt; 19</td>
<td>&lt; 19</td>
<td>&lt; 23</td>
<td>&lt; 27</td>
<td>&lt; 27</td>
<td>&lt; 27</td>
<td>&lt; 28</td>
<td></td>
</tr>
</tbody>
</table>

The energy efficiency classes of solar hot water storage tanks, if (part of) a solar device, are determined on the basis of its standing loss, as follows:

### Table 14. Storage tank energy efficiency classes, if (part of) a solar device, in %

<table>
<thead>
<tr>
<th>Standing loss S in Watts, with storage volume V in litres</th>
<th>Standing loss (W) per storage volume (l)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80</td>
</tr>
<tr>
<td><strong>A+</strong> &amp; 5,5 + 3,16 ⋅ V^{0.4} ≤ S &lt; 8,5 + 4,25 ⋅ V^{0.4}</td>
<td>&lt;23.7</td>
</tr>
<tr>
<td><strong>A</strong> &amp; 5,5 + 3,16 ⋅ V^{0.4} ≤ S &lt; 8,5 + 4,25 ⋅ V^{0.4}</td>
<td>&lt;33.0</td>
</tr>
<tr>
<td><strong>B</strong> &amp; 8,5 + 4,25 ⋅ V^{0.4} ≤ S &lt; 12 + 5,93 ⋅ V^{0.4}</td>
<td>&lt;46.2</td>
</tr>
<tr>
<td><strong>C</strong> &amp; 12 + 5,93 ⋅ V^{0.4} ≤ S &lt; 16,66 + 8,33 ⋅ V^{0.4}</td>
<td>&lt;64.7</td>
</tr>
<tr>
<td><strong>D</strong> &amp; 16,66 + 8,33 ⋅ V^{0.4} ≤ S &lt; 21 + 10,33 ⋅ V^{0.4}</td>
<td>&lt;80.6</td>
</tr>
<tr>
<td><strong>E</strong> &amp; 21 + 10,33 ⋅ V^{0.4} ≤ S &lt; 26 + 13,66 ⋅ V^{0.4}</td>
<td>&lt;104.8</td>
</tr>
<tr>
<td><strong>F</strong> &amp; 26 + 13,66 ⋅ V^{0.4} ≤ S &lt; 31 + 16,66 ⋅ V^{0.4}</td>
<td>&lt;127.1</td>
</tr>
<tr>
<td><strong>G</strong> &amp; S &gt; 31 + 16,66 ⋅ V^{0.4}</td>
<td>&gt;127.1</td>
</tr>
</tbody>
</table>
The labels (design, size, format) are described in Annex III:

As of 26 Sep 2015: Class A++ to D (9 classes)

As of 26 Sep 2019: Class A+++ to D (7 classes) for space heating and A+ to F (7 classes) for water heating (combination heaters)

Figure 6. Energy labels for the various products in scope of Regulation (EU) No 811/2013
Annex IV presents the product fiche. The information referred to as product fiche has to be provided in a specific order and included in the product brochure or other literature provided with the product.

Fiches for products are listed in the Annex as text, but fiches for packages are only available in graphic form, and completion requires several calculations which are not explained in full (the calculation of some parameters is described in text elsewhere). The product fiches are:

<table>
<thead>
<tr>
<th>Seasonal space heating energy efficiency of boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature control</td>
</tr>
<tr>
<td>From fiche of temperature control</td>
</tr>
<tr>
<td>Class I = 1 %, Class II = 2 %, Class III = 1,5 %, Class IV = 2 %, Class V = 3 %, Class VI = 4 %, Class VII = 3,5 %, Class VIII = 5 %</td>
</tr>
<tr>
<td>Supplementary boiler</td>
</tr>
<tr>
<td>From fiche of boiler</td>
</tr>
<tr>
<td>Seasonal space heating energy efficiency (in %)</td>
</tr>
<tr>
<td>( I' - 'I' ) × 0,1 = ± 'II'</td>
</tr>
</tbody>
</table>

| Solar contribution                          |
|From fiche of solar device                  |
|Collector size (in m²)                      |
|Tank volume (in m³)                         |
|Collector efficiency (in %)                 |
|Tank rating: A² = 0,96, A = 0,91, B = 0,86, C = 0,83, D-G = 0,81 |
| Supplementary heat pump                    |
|From fiche of heat pump                     |
|Seasonal space heating energy efficiency (in %) |
| ( I' - 'I' ) × 'II' = + 'III'               |

| Solar contribution AND Supplementary heat pump |
|Select smaller value                         |
| 0,5 × + OR 0,5 × -                          |

| Seasonal space heating energy efficiency of package |

| Seasonal space heating energy efficiency class of package |

| Boiler and supplementary heat pump installed with low temperature heat emitters at 35 °C? |
|From fiche of heat pump                          |
| + ( 50 × 'II' ) = ± 'IV'                        |

*The energy efficiency of the package of products provided for in this fiche may not correspond to its actual energy efficiency once installed in a building, as the efficiency is influenced by further factors such as heat loss in the distribution system and the dimensioning of the products in relation to building size and characteristics.*

**Figure 7. Package fiche space/combination heater**
Seasonal space heating energy efficiency of cogeneration space heater

Temperature control
From fiche of temperature control
Class I = 1%, Class II = 2%, Class III = 1.5%, Class IV = 2%, Class V = 3%, Class VI = 4%, Class VII = 3.5%, Class VIII = 5%

Supplementary boiler
From fiche of boiler
Seasonal space heating energy efficiency (in %)

Solar contribution
From fiche of solar device
Collector size (in m²) Tank volume (in m³) Collector efficiency (in %)

Tank rating:
A* = 0.95, A = 0.91, B = 0.86, C = 0.83, D-G = 0.81

( 'III' × + 'IV' × ) × 0.7 × ( /100 ) × =

Seasonal space heating energy efficiency class of package

The energy efficiency of the package of products provided for in this fiche may not correspond to its actual energy efficiency once installed in a building, as the efficiency is influenced by further factors such as heat loss in the distribution system and the dimensioning of the products in relation to building size and characteristics.

Figure 8. Package fiche Cogeneration package
The energy efficiency of the package of products provided for in this fiche may not correspond to its actual energy efficiency once installed in a building, as the efficiency is influenced by further factors such as heat loss in the distribution system and the dimensioning of the products in relation to building size and characteristics.

Figure 9. Package fiche Heat pump package
Seasonal space heating energy efficiency of low temperature heat pump

Temperature control
From fiche of temperature control
Class I = 1%, Class II = 2%, Class III = 1.5%, Class IV = 2%, Class V = 3%, Class VI = 4%, Class VII = 3.5%, Class VIII = 5%

Supplementary boiler
From fiche of boiler
Seasonal space heating energy efficiency (in %)

Solar contribution
From fiche of solar device
Collector size (in m²)
Tank volume (in m³)
Collector efficiency (in %)
Tank rating
A⁺ = 0.95, A = 0.91, B = 0.86, C = 0.83, D-G = 0.81

Seasonal space heating energy efficiency of package under average climate

Seasonal space heating energy efficiency class of package under average climate

Seasonal space heating energy efficiency under colder and warmer climate conditions
Colder: 'V' - 'V' = %
Warmer: 'VI' + 'VI' = %

The energy efficiency of the package of products provided for in this fiche may not correspond to its actual energy efficiency once installed in a building, as the efficiency is influenced by further factors such as heat loss in the distribution system and the dimensioning of the products in relation to building size and characteristics.

Figure 10. Package fiche Low temperature heat pump package
Annex V describes the Technical Documentation that has to be provided to the market surveillance authorities at request.

Annex VI lists the information to be presented where end-users cannot be expected to see the product displayed (which is often the case for space/combi heaters acquired through an installer). The information is largely identical to the product fiches required under Annex IV for space heaters and combination heaters. No such information is however required for temperature controls and solar devices. For packages some generic
information and the information of the 'elements' of the product fiche must be presented. 'Elements' is not defined as term.

The measurements and calculations required under Annex VII are roughly the same as for 813/2013 (Ecodesign). Certain calculations required for establishing the efficiency of a package are presented under Annex IV 'product Fiche'.

Annex VIII explains the verification procedure for market surveillance authorities which requires testing of a single appliance and when values are not met, testing of another three randomly selected products. This annex was amended by Regulation 2017/254 which added clarifications as regards the tolerances and the possible use of this by manufacturers.

The review shall address technological progress, significant changes in the market shares of various types of heaters, heat pump efficiency for other heating seasons, the appropriateness of the package fiches and labels and the appropriateness of including passive flue heat recovery devices in the scope of this Regulation.

### 3.4.4 Amendments

#### 3.4.4.1 Delegated Regulation 518/2014 on Distance Labelling of energy-related products on the internet


Under the original regulations it was specified that in the case of distance selling the information on the label is to be presented in a specific order. However, there was no requirement to display the label itself or the product fiche. The amendment corrects this.

#### 3.4.4.2 Regulation 2016/2282 & 2017/254 verification by market surveillance

In 2016 and 2017 two regulations were introduced that repealed the existing Annexes of Regulations (EU) No 811/2013 and 813/2013 on Verification procedures for market surveillance purposes: Regulation (EU) No 2016/2282 for Ecodesign and Delegated Regulation (EU) No 2017/254 for labelling regulations.

The regulations amend the existing Ecodesign and energy labelling regulations (all groups) with the aim to harmonise the annex regarding market surveillance and the verification tolerances in particular. The amended text explicitly forbids the use of tolerances to present a better performance on product information sheets and labels than was established during testing.

The explanatory memorandum in the draft Commission Delegated Regulation C(2016) 7765 final (dated 30.11.2016) 72 explains that certain forms of misuse of the verification tolerances had been identified (such as: claiming higher label classes than tested, better energy efficiency than tested, or better values in the product fiche than tested). The explanatory memorandum makes clear that verification tolerances are only meant to take into account inevitable differences in the measurement equipment used by

---

Suppliers and by surveillance authorities across the EU so that unduly penalisation of manufacturers is avoided. As a consequence, the variability in test results because of variations in product quality is not included in the tolerance allowed for market surveillance.

Although the explanatory memorandum refers to differences caused by "measurement equipment" and "differences in calibration" it should be noted that differences in test results (of the same product) may also be caused by differences in the personnel doing the testing (the operator), the conditions during testing (actual room temperature as well as humidity, air pollution will always vary a bit, etc.) and the time elapsed between measurements. This is referred to as repeatability (same product, same laboratory) and reproducibility (same product, different test laboratory). Most test standards give guidance on acceptable values/ranges for measurement equipment, calibration and test conditions. The measurement uncertainties should not exceed the verification tolerances.

In order to clarify the meaning of terms, the following document has been consulted: JCGM 100:2008 (GUM 1995 with minor corrections), Evaluation of measurement data — Guide to the expression of uncertainty in measurement, First edition September 2008, © JCGM 2008

This document defines the following terms:

B.2.14 **Accuracy of measurement**

closeness of the agreement between the result of a measurement and a true value of the measurand

NOTE 1 “Accuracy” is a qualitative concept.

NOTE 2 The term precision should not be used for “accuracy”.

B.2.15 **Repeatability** (of results of measurements)

closeness of the agreement between the results of successive measurements of the same measurand carried out under the same conditions of measurement

NOTE 1: These conditions are called repeatability conditions.

NOTE 2: Repeatability conditions include:

— the same measurement procedure
— the same observer
— the same measuring instrument, used under the same conditions
— the same location
— repetition over a short period of time.

NOTE 3: Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results.

B.2.16 **Reproducibility** (of results of measurements)

closeness of the agreement between the results of measurements of the same measurand carried out under changed conditions of measurement
NOTE 1: A valid statement of reproducibility requires specification of the conditions changed.

NOTE 2: The changed conditions may include:
— principle of measurement
— method of measurement
— observer
— measuring instrument
— reference standard
— location
— conditions of use
— time.

NOTE 3 Reproducibility may be expressed quantitatively in terms of the dispersion characteristics of the results.

NOTE 4 Results are here usually understood to be corrected results.

B.2.18 uncertainty (of measurement) parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

NOTE 1 The parameter may be, for example, a standard deviation (or a given multiple of it), or the half-width of an interval having a stated level of confidence.

NOTE 2 Uncertainty of measurement comprises, in general, many components. Some of these components may be evaluated from the statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information.

NOTE 3 It is understood that the result of the measurement is the best estimate of the value of the measurand, and that all components of uncertainty, including those arising from systematic effects, such as components associated with corrections and reference standards, contribute to the dispersion.

In the review study for small air conditioners the aspect of tolerances is addressed in the Task 7 report73.

73 Review of Regulation 206/2012 and 626/2011 Air conditioners and comfort fans Task 7 report SCENARIOS Final version Date: May 2018
With present measurement uncertainties, tolerance levels can be set as follows:

- **split air conditioners:**
  - SEER tolerance: 8 % below 2 kW cooling capacity, 6 % between 2 and 6 kW and 4 % between 6 and 12 kW.
  - SCOP tolerance: 8 % below 2 kW cooling capacity, 7 % between 2 and 6 kW and 6 % between 6 and 12 kW.

For space/combo heaters the ECOtest project provides new information on obtainable and realistic tolerances for test results.

### 3.4.5 **Transitional methods space heating (2014/C 207/02)**


A similar communication was published for water heaters (2014/C 207/03) – see the Lot 2 review study.

In the following sections of this report, the space heater document may be referred to as **TM2014sh**, to set it apart from the transitional methods for water heaters **TM2014wh**.

#### 3.4.5.1 **General**

The Commission Communication (2014/C 207/02) sets out the standards and additional elements for measurements and calculations related to the seasonal space heating energy efficiency of boiler space heaters, boiler combo heaters and cogeneration space heaters, for the implementation of Regulation (EU) No 813/2013, and in particular Annexes III (Measurements and calculations) and IV (Verification procedure for market surveillance) thereof, and for the implementation of Regulation (EU) No 811/2013, and in particular Annexes VII (Measurements and calculations) and VIII (Verification procedure for market surveillance) thereof.

The communication presents a table of parameters and the reference to standards or methods to establish performance or compliance (item 1, 2 and 3 of Communication 2014/C 207/02), followed by paragraphs that outline test points and calculation methods for essential requirements (item 4 and 5), definitions (item 6) and permissible deviations of tested parameters and/or measurement uncertainty (item 7).

---


<table>
<thead>
<tr>
<th>Parameter to be verified</th>
<th>Reference to standard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boiler space heaters and boiler combination heaters using gaseous fuel</strong></td>
<td></td>
</tr>
<tr>
<td>Useful heat output P (at rated heat output for 80/60°C regime P4, and 30% of rated heat output at ‘low temperature regime’ P1)</td>
<td>EN 15502-1:2012</td>
</tr>
<tr>
<td>Useful efficiency η (at rated heat output for 80/60°C regime η4, and 30% of rated heat output at ‘low temperature regime’ η1)</td>
<td></td>
</tr>
<tr>
<td>design types</td>
<td></td>
</tr>
<tr>
<td>Standby heat loss Pstby</td>
<td></td>
</tr>
<tr>
<td>Ignition burner power consumption Pign</td>
<td></td>
</tr>
<tr>
<td>NOₓ emissions</td>
<td></td>
</tr>
<tr>
<td><strong>Boiler space heaters and boiler combination heaters using liquid fuel</strong></td>
<td></td>
</tr>
<tr>
<td>Standby heat loss Pstby</td>
<td>EN 304:2017 (announced)</td>
</tr>
<tr>
<td>Seasonal space heating energy efficiency in active mode ηson for standard/LT boilers</td>
<td></td>
</tr>
<tr>
<td>Seasonal space heating energy efficiency in active mode ηson for condensing boilers</td>
<td>EN 303-2:2017</td>
</tr>
<tr>
<td><strong>Electric boiler space heaters and electric boiler combination heaters</strong></td>
<td></td>
</tr>
<tr>
<td>Seasonal space heating energy efficiency ηs</td>
<td>Point 4 of the Communication</td>
</tr>
<tr>
<td><strong>Cogeneration space heaters (microCHP)</strong></td>
<td></td>
</tr>
<tr>
<td>Useful heat output at rated heat output</td>
<td>FprEN 50465:2013</td>
</tr>
<tr>
<td>Useful efficiency at rated heat output</td>
<td></td>
</tr>
<tr>
<td>Electrical efficiency at rated heat output</td>
<td></td>
</tr>
<tr>
<td>Standby heat loss Pstby</td>
<td></td>
</tr>
<tr>
<td>Ignition burner power consumption Pign</td>
<td></td>
</tr>
<tr>
<td>Emission of nitrogen oxides NOₓ</td>
<td></td>
</tr>
<tr>
<td><strong>Boiler space heaters, boiler combination heaters and cogeneration space heaters</strong></td>
<td></td>
</tr>
<tr>
<td>Auxiliary electricity consumption at full load elmax, at part load elmin and in standby mode PSB</td>
<td>EN 15456:2008: Heating boilers - Electrical power consumption for heat (for oil boilers?)</td>
</tr>
<tr>
<td></td>
<td>EN 15502:2012 for gas boilers.</td>
</tr>
<tr>
<td></td>
<td>FprEN 50465:2013 for cogeneration space heaters</td>
</tr>
<tr>
<td>Sound power level LWA</td>
<td>EN 15036 - 1</td>
</tr>
<tr>
<td>Seasonal space heating energy efficiency ηs</td>
<td>Point 4 of the Communication</td>
</tr>
<tr>
<td><strong>Heat pump space heaters and heat pump combination heaters</strong></td>
<td></td>
</tr>
<tr>
<td>for electric motor driven heat pumps and (gas) engine driven heat pumps</td>
<td>EN 14825:2013</td>
</tr>
<tr>
<td>EERbin(Tj) and COPbin(Tj)</td>
<td></td>
</tr>
<tr>
<td>SCOP (electric) or SPER (engine driven)</td>
<td></td>
</tr>
<tr>
<td>(gas)engine heat pumps</td>
<td>In accordance with table 3 Annex III of Commission Regulation 813/2013 with Engine rpm equivalent (Erpm equivalent)</td>
</tr>
<tr>
<td>Emission of nitrogen oxides NOₓ</td>
<td></td>
</tr>
<tr>
<td>fuel sorption heat pumps</td>
<td>prEN 12309-4:2013</td>
</tr>
</tbody>
</table>
fuel sorption heat pumps | prEN12309-6:2012
---|---
SPER | prEN 12309-2:2013
fuel sorption heat pumps | prEN12309-6:2012
Emission of nitrogen oxides NOX | prEN 12309-2:2013
Seasonal space heating energy efficiency ηs | Point 5 of the Communication
Sound power level (LWA) | EN 12102:2013
Other
Temperature controls | Point 6 of the Communication
Water heating energy efficiency ηwh of combination water heaters, Qelec and Qfuel | Commission Regulation No 814/2013 and Communication 2014/C 207/03

The transitional method elaborates more on the levels of variations that can be defined in the measurements of product data. It presents the uncertainty of measurement (accuracy), permissible deviation (average over test period) and permissible deviations of individual measured values from average values:

a) uncertainty of measurement (accuracy) is the precision of the instrument (or a sequence of instruments) compared to a value measured with highly calibrated instruments;
b) permissible deviation (average over test period) is the maximum allowed difference between a measured parameter, averaged over the test period, and a predefined value;
c) permissible deviations of individual measured values from average values are the maximum differences allowed between a measured value and the average value over that test period.

The transitional method presents a table with a set value for different relevant parameters for space/combination heater calculations, such as power, gas temperature, test solar irradiance etc. Additionally, it gives maximum allowed values for two categories of variation.

The \textit{TM2014sh} presents various equations to be used for calculating the seasonal efficiency. These rules are not set out in the related (delegated) regulations.

For boiler space heaters the rules introduce a weighting of full load and part load efficiency, reflecting the conventional wisdom that most of the boilers operate in part load most of the time, and full load is only reserved for the coldest days (and for reheating the dwelling after a period of standstill) –depending on the type of control of heat output of the boiler.

For heat pumps the regulations prescribe, through many definitions and calculation rules, the use of the so-called “bin-method” which was introduced in the regulations for room air conditioners in 2012 and for which the appropriate standard EN 14825 was harmonised in 2013.

For cogeneration the \textit{TM2014sh} deviates from the EN standard, now published as EN 50465:2015 in that the \textit{TM2014sh} and EN 50465:2015 apply different calculations to correct for electricity production, auxiliary power and standby heat losses. The section on EN 50465 presents more information.
3.4.5.2 SOLICS and SOLCAL

For the determination of solar water heating efficiencies, the contribution of the solar part needs to be taken into account. The Regulation (EU) No 811/2013 refers to:

- collector aperture area (Asol);
- collector efficiency: \( \eta_{\text{col}} \) (%);
- annual non-solar heat contribution: \( Q_{\text{non sol}} \) (kWh/a, GCV or primary energy) for load profiles M-XXL, average climate conditions;
- pump power consumption, solpump (W);
- standby power, solstandby (W);
- annual electricity consumption, Qaux (kWh/a in final energy = kWh_elec);

The calculation of the solar contribution \( Q_{\text{non sol}} \) is not described in the regulation but is covered in the transitional method, which describes two methods: SOLICS for factory-made systems, the components of which cannot be tested separately and SOLCAL for custom-built systems (components).

Both methods as described in the transitional methods have been criticised by solar experts: SOLCAL for errors in the calculations/equations, and SOLICS for lack of reference conditions (SOLICS is an hourly method, the Commission documents provide information for a monthly method, and the load profiles do not match either). For both methods updates have been described in EN 15316-4-3 and EN 12976-2 (for SOLCAL and SOLICS respectively – see also the 'solar' standards).

3.4.5.3 Storage volume

The storage volume is relevant for the calculation of the energy label of storage tanks (Regulation (EU) No 811/2013 and Regulation (EU) No 812/2013) the maximum standing losses (Regulation (EU) No 814/2013) and the solar contribution of space/combination heaters according the product fiches (Regulation (EU) No 811/2013). However, none of the regulations specify the method to determine the storage volume.

Only in the transitional methods for water heaters a storage volume for heat pump water heaters and electric water heaters has been described (reference to EN 50440:2015), and reference is made to EN 15316-4-3 for the volume of a solar storage tank. The method to be used to determine the storage volume of tanks for space heating and other types of water heater storage tanks has not been defined.

3.4.5.4 Standing loss of storage tanks

The TM2014wh, which is relevant for combination heaters under Regulation (EU) No 811/2013 and Regulation (EU) No 813/2013, lists four possible test standards as method to be used for determination of the standby heat loss of a storage tank:

1) EN 12897:2006;
2) EN 12977-3:2012;
3) EN 15332:2007; and

Experts disagree on whether these standards can be applied indifferently or that the context of the use of the tank must be considered (as heat store, or solar store, etc.).
Depending on the standard selected for determination of the standing loss, the values for the loss and the resulting energy label class may differ up to one class for the same storage tank. This can be attributed to differences in test methods described in these standards:

**Table 16. Differences in test standards for standing losses of storage tanks**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope</strong></td>
<td>heated warm water storage tank up to 1000 l</td>
<td>warm water storage up to 1500 l</td>
<td>warm water store volume 50 to 3000 l</td>
<td>electric storage water heater</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td>connections should be insulated</td>
<td>connections should be insulated</td>
<td>connections should be insulated</td>
<td>(no insulation connections required)</td>
</tr>
<tr>
<td><strong>Test</strong></td>
<td>immersion heater 3 kW, or external flow through heater 65ºC +/- 2K 24 h stabilisation measurement uncertainty for energy &lt;2%, multiple tests of 24 h may be required</td>
<td>electric immersion heater in lower third of tank hysteresis &lt; 0.8 K start/end of test based on temperature control switching</td>
<td>heated by external heater (full heating possible) test sequence: conditioning – heating – standby – conditioning</td>
<td>energy supply measured over 48 h at minimum, start/end on basis of thermostat switch</td>
</tr>
<tr>
<td><strong>Ambient conditions</strong></td>
<td>20ºC +/- 2K</td>
<td>20ºC +/- 5K</td>
<td>20ºC +/- 2K</td>
<td>20ºC +/- 2K</td>
</tr>
<tr>
<td><strong>Storage temperature</strong></td>
<td>25 mm below outlet</td>
<td>according instructions or in upper third, minimum 65ºC</td>
<td>not required</td>
<td>must be 65ºC +/- 3K in upper part of tank</td>
</tr>
<tr>
<td><strong>Other measurement values</strong></td>
<td>(-)</td>
<td>(-)</td>
<td>inlet and outlet temperatures, every 10 s</td>
<td>(-)</td>
</tr>
<tr>
<td><strong>Results</strong></td>
<td>energy consumption for keeping temperature constant for 24 h</td>
<td>energy consumption for keeping temperature constant for 24 h</td>
<td>parametric approach for identification of thermal loss parameters</td>
<td>energy consumption for keeping temperature constant for 24 h</td>
</tr>
<tr>
<td><strong>Uncertainty of temperature measurement</strong></td>
<td>+/- 1K</td>
<td>+/- 0.1K</td>
<td>absolute temperatures: +/- 0.1K temperature difference +/- 0.05 K time step &lt; 10 s</td>
<td>+/- 1K</td>
</tr>
</tbody>
</table>
Uncertainty of energy measurement

<table>
<thead>
<tr>
<th></th>
<th>+/- 0.01 kWh</th>
<th>+/- 0.01 kWh</th>
<th>Volume flow: +/- 2.0 %</th>
<th>+/- 0.01 kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result of a comparison test of a 300 l tank</td>
<td>2.44 kWh/24h = D</td>
<td>2.25 kWh/24h = C</td>
<td>2.60 kWh/24h = D</td>
<td>[not tested]</td>
</tr>
<tr>
<td>Result of a comparison test of a 500 l tank</td>
<td>2.53 kWh/24h = C</td>
<td>2.71 kWh/24h = C</td>
<td>2.85 kWh/24h = D</td>
<td>[not tested]</td>
</tr>
<tr>
<td>Possible factors contributing to differences</td>
<td>No verification that start and end temperature are identical</td>
<td>Heated volume is not precisely defined</td>
<td>External loading / unloading introduces extra losses</td>
<td>[not tested]</td>
</tr>
</tbody>
</table>

Other differences may exist, the overview is not exhaustive

As the EN 60379 is intended for electric storage heaters only it should not be used for measurement of thermal stores of another kind, with other types of heat generators or heat transfer equipment present.

EN 12897 and EN 15332 are fairly comparable in the sense they both register heat losses over a 24h period. Differences are found in the requirements for installation (distance to walls, etc.), the number and position of temperature sensors and the loading of the storage tank. CEN TC 57 WG 8 and TC 164 are working together to align both methods.

The latest published version of EN 12897:2016 (not the 2006 version included in the comparison test) has an improved test methodology, in particular Annex B, to bring the standing heat loss test requirements in line with those required by the EU directives for the Ecodesign and labelling of hot water storage tanks. The standard now refers to (clause 6.2.8 Standing heat loss) the procedure given in either: Annex B; EN 60379:2004, Clause 14; EN 15332:2007, 5.4.

Annex B states the electrical element or immersion heater should be placed at the lowest possible point, allowing at least 85 % of the storage water heater’s contents by volume above this heater.

EN 12977-3 follows a fundamentally different approach: Starting from a defined start-up condition (20ºC) the heater is continuously heated until the tank is fully loaded. The tank is then allowed to cool down so that between 40% to 60% of stored energy is lost to the ambient. Subsequently the tank is emptied completely and brought back into start-up condition (20ºC). Various temperatures and flows are registered and using a mathematical model, thermal parameters are identified. These parameters are adjusted so that the calculated values and test values match. The benefit is that this test allows determining heat losses of a family of products (up- and downscaling procedure, up to 600 l).

The comparison tests on the same cylinder shows that the tests according EN 12977-3 show the highest losses. This can be attributed to the external loading and unloading of the store which introduces heat loss points for the 4 inlet/outlet points. The EN 12897:2006 tests result in lower loss values for the smaller tank and higher values for the larger tank. This can be attributed to the fact that the EN 12897 test follows a 24 h test schedule and does not use the actual store temperatures as begin/end of the test –
the above test results indeed showed that the store temperature at the end of the 500 l tank test was slightly lower than at the beginning, resulting in lower standby losses (Note: the issue was addressed in the 2016 version of the standard). The allowed switching hysteresis is also much higher than for EN 15332. As the EN 15332 starts and ends with a switching of the controller, the temperature inside the tank should be fairly equal, even if the complete test takes longer than 24 h (the loss values are of course corrected to 24 h). In EN 15332 the "lower third" of the tank is not defined, which causes some variability due to possible differences in the heated volume of water. In EN 12897 the volume of heated water should be equal to the volume used for determining the hot water performance.

CEN TC57/WG8 is working on a single standard that aims to resolve the issues mentioned above.

3.4.6 M/535 on standards for Regulations (EUR) No 811/2013 and 813/2013

Before standards can be harmonised, there needs to be a request by the Commission to European standardisation organisations for (harmonised) standards\(^7\). Therefore, in April 2015 the Commission published a standardisation request M/535\(^7\) to the European standardisation organisations as regards space heaters, combination heaters, packages of space heaters, temperature control and solar device and packages of combination heater, temperature control and solar device in support of Regulation (EU) No 813/2013 and Delegated Regulation (EU) No 811/2013. This request was published as Commission Implementing Decision C(2015) 2626 of 27 April 2015\(^7\).

The request for standardisation M/535 describes the required deliverables, the main points being coverage of regulated parameters related to energy efficiency, emissions, heat outputs, sound power, auxiliary and parasitic consumption or losses, and various information elements. Additionally, the standards to be developed under this request for standardisation should present the measurement uncertainties of the standard.

A similar request for standardisation M/534 has been issued for water heater standards: C(2015) 2625 final.

3.4.7 M/543 on resource efficiency

Request for standardisation M/543 was issued on 17 Dec. 2015 and requested standardisation on material efficiency aspects for energy-related products in support of the implementation of Directive 2009/125/EC of the European Parliament and of the Council (a previous version was not accepted by the ESOs).

The request for standardisation requires development of standards, general in nature (later on to be a basis for more product-specific standards) which have to include/describe:

\(^7\) See Blue Guide 2016, Section 4.1.1. 'Definition of Essential Requirements' and 4.1.2. 'Conformity With The Essential Requirements: Harmonised Standards', Brussels, 5.4.2016, C(2016) 1958 final
\(^8\)http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=555
\(^77\)http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2014.207.01.0002.01.ENG
• Definition of parameters and methods relevant for assessing durability, upgradability and ability to repair, re-use and re-manufacture of products;
• Provision of guidance on how standardisation deliverables for assessing durability, upgradability and ability to repair and re-manufacture of products can be applied to product-specific standards;
• Ability to access or remove certain components, consumables or assemblies from products to facilitate repair or remanufacture or reuse;
• Reusability/recyclability/recoverability (RRR) indexes or criteria, preferably taking into account the likely evolution of recycling methods and techniques over time;
• Ability to access or remove certain components or assemblies from products to facilitate their extraction at the end-of-life for ease of treatment and recycling;
• Method to assess the proportion of re-used components and/or recycled materials in products;
• Use and recyclability of Critical Raw Materials to the EU, listed by the European Commission;
• Documentation and/or marking regarding information relating to material efficiency of the product taking into account the intended audience (consumers, professionals or market surveillance authorities).

The standards are currently in development and have to be ready by March 2019. A CEN/CLC joint technical committee TC 10 and 6 Working groups are currently writing the standards.

Topics covered in the CEN-CLC 45550 to 45559 series are inter alia, product durability, reparability, reusability, recyclability, recycled content, ability to remanufacture, and product lifespan. While various important topics in the context of material efficiency are covered in the standards of the CEN-CLC 45550 to 45559 series, other subjects of material efficiency, e.g. renewable resources, biodegradable plastics, light weighting and multi functionality, are not covered for the moment, despite their potential impact on material efficiency.

In October 2018 some 2 technical reports and 7 draft standards have been prepared for enquiry voting:
• TR45550 – Definitions
• TR45551 – Guide for product specific standards
• prEN45552 – Durability
• prEN45553 – Reparability
• prEN45554 – Remanufacturability
• prEN45555 – Recyclability & recoverability
• prEN45556 – Re-used components
• prEN45557 – Recycled material content
• prEN45558 – Use of critical raw materials
• prEN45559 – Communication.
3.4.8 2018 Guidelines and FAQ for space/combination heaters and water heaters

The regulations of 2013 and the Transitional Methods of 2014 still left several stakeholders with questions on how to interpret certain requirements and articles or how to conduct the conformity assessment.

The Commission Services published on September 2015 guidelines\(^78\) to help stakeholders to implement the Regulations (for both space heaters and water heaters) in practice. In April 2017, the European Commission circulated a proposal to revise the guidelines and clarify additional questions. Many stakeholders shared their comments on these proposed changes in 2017. The European Commission published the updated guidelines beginning of 2018.

The 2015 guidelines explain various elements of the calculation of energy efficiency of the products. More specifically it highlights the method for calculating water heating efficiency for packages that comprise a space heating boiler (not combination boiler) or heat pump used in conjunction with a solar device (section 5.4 of the guidelines).


Section 6 of the guidelines deals with frequently asked questions (FAQ). Some of these questions can be answered by referring to the corresponding articles or annexes and require thorough reading. Others however deal with interpretation of terms or other aspects not clearly defined or deductible from the legal texts and the FAQ provides the interpretation by the Commission Services.

Online tools by the EC

To assist people in establishing the correct values to be presented to consumers, and assist them in labelling of such appliances, the Commission also produced an online energy label generator: https://ec.europa.eu/energy/eepf-labels/

An example of how this tool is applied for Low-temperature heat pumps is shown below (screenshot).

---

Figure 12. Screenshot of energy label generator (eepf-labels)
3.5  Related Ecodesign and Labelling regulations

3.5.1  Circulators – 641/2009, amended by 622/2012


The requirements are based on the Energy Efficiency Index (EEI). EEI is the average power input calculated on a load profile divided by a reference power input\(^{79}\).

The EEI is valid for ‘Standalone circulators’ and ‘circulators integrated in products’ and is calculated as follows:

\[
EEI = \frac{P_{L,avg}}{P_{ref}} \times C_{20%}
\]

EEI =

\(P_{L,avg}\) = weighted average electrical input power of the relevant circulator

(considering standardized load profile having 4 operating points and reference pressure control curve)

\(P_{ref}\) = Reference power

is the average input power of circulators having the same hydraulic output power as the relevant circulator

\(C_{20%}\) = “Calibration factor” = 0.49 the calibration factor - fixed by the legislation – ensures that only 20% of a certain type have an EEI = 0.20 (Benchmark)

EEI for ‘Circulators integrated in products’ designed for primary circuits of thermal solar systems and for heat pumps has to be calculated as:

\[
EEI = \frac{P_{L,avg}}{P_{ref}} \times C_{20%} \times (1 - e^{-3.8(n_q^{30})^{1.36}})
\]

Where \(n_q\) = specific speed

\[
n_q = \frac{n_{100\%}}{60} \times \sqrt{\frac{Q_{100\%}}{H_{100\%}^{0.75}}}
\]

And n100\% is rotational speed in rpm (rotations per minute) here defined at Q100\% and H100\%.

\(^{79}\) Text and equations as presented in Europump document titled: Circulators - How to apply ecodesign regulations for your pumps, Dr. Niels Bidstrup, Regulatory and Technical Affairs, Grundfos Holding A/S
The above equation includes a "compensation factor shown in the below graph. The objective is to create a function which asymptotically converges toward 0.49 which is the calibration factor for standalone circulators. A typical circulator for thermal solar and heat pump application has an nq between 15 and 20. A circulator with a low nq with the same high-efficiency motor as a standalone, would not meet the requirement without an nq compensation. With the compensation, also circulators used in thermal solar and heat pump applications will be able to meet the minimum efficiency requirements introduced on 1 August 2015. Without this calibration factor, these circulators would have to be oversized in order to comply with the requirements, leading to higher energy consumption.

The weighted average electrical input power is measured according to a time load profile. The load profile describes the percentage of time a certain flow is needed in the system. The reference control curve (P_ref) is a standardized control curve, which describes the desired head at the flows defined in the load profile.

**Table 17. Flow distribution profile**

<table>
<thead>
<tr>
<th>Relative flow Q/Q_{100} [%]</th>
<th>Relative operate time [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>6</td>
</tr>
<tr>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td>25</td>
<td>44</td>
</tr>
</tbody>
</table>

\[ P_{L,\text{avg}} = 0.06 \times P_{L,100\%} + 0.15 \times P_{L,75\%} + 0.35 \times P_{L,50\%} + 0.44 \times P_{L,25\%} \]

The applicable standard is EN 16297 Part 1, 2, 3.

The energy efficiency requirements are:

- From 1 January 2013, glandless standalone circulators, with the exception of those specifically designed for primary circuits of thermal solar systems and of heat pumps, shall have an energy efficiency index (EEI) of not more than 0.27.
  - The 2013 benchmark level was set at EEI ≤ 0.20 (indicative only).
- From 1 August 2015, glandless standalone circulators and glandless circulators integrated in products shall have an energy efficiency index (EEI) of not more than 0.23 (for integrated circulators intended as replacement, the EEI 0.23 applies as of 1.1.2020).

Fixed speed circulators operate at best efficiency point (BEP) with slight variations of the flow rate around the nominal value, where variable speed circulators operate at a widely varying demand of flow rate. As the EEI calculation is based on a load profile with wide variation in flow rates the variable circulators are more efficient compared to fixed speed. The fixed speed circulators are not explicitly banned from the market they just can’t

---

80 Text copied from: WORKING DOCUMENT ON A POSSIBLE COMMISSION REGULATION AMENDING COMMISSION REGULATION (EC) No 641/2009 of 22 July 2009 with regard to ecodesign requirements for glandless standalone circulators and glandless circulators integrated in products.
reach the EEI requirements set in 641/2009, from the 1st of August 2015 the EEI allowed is not more then 0.23 (from 1st of January 2020 this is also valid for replacements of circulators integrated into products).

According the (now defunct) energy label for circulators, the old variable speed circulator was class C and used up to 3 times more energy than the modern high efficiency variable speed circulator (class A). The fixed speed circulator used about twice as much (class B) as the modern high efficiency variable speed circulator.

Europump has issued two guidelines:

- Guideline on the application of COMMISSION REGULATION 641/2009/EC and the amendment 622/2012/EC with regard to Ecodesign requirements for circulators
- Energy Efficiency of Circulators

### 3.6 Member State (+ EEA) policies and measures

As of 26 September 2015 (and 26 September 2018 for nitrogen emissions) Member States must respect the harmonised requirements for heaters as established by the Ecodesign regulations. Still, Member States exert through building energy performance regulation a great deal of influence on what kind of heating installations are allowed in new builds or large renovations. Furthermore, Member States can introduce rules for the decommissioning of boilers, as is the case in Germany.

The following sections provide an (non-exhaustive) overview of measures at Member State focusing on efficiencies of technical building systems as extracted from various sources:

- https://www.epbd-ca.eu/archives/1859 (country reports)
- https://www.euroobserver.org/euroobserver-policy-files-for-all-eu-28-member-states/
- http://www.iea-shc.org/country-reports
- https://www.iea.org/policiesandmeasures/renewableenergy/

[Note: The texts below may contain fragments from above sources]

#### 3.6.1 Austria

The regulations on building energy efficiency in Austria have been harmonised since 2008 and the latest guidelines were published in March 2015 as part of the general OIB Guidelines. Part 6 concerns the energy performance of buildings. The OIB Guideline 6\(^1\) sets requirements for space and water heating systems in buildings and U-values for building elements. It covers topics such as heat recovery, district heating and the use of highly efficient heating systems. They are required to be able to meet the target values, but there are no values related to a minimum energy efficiency for these systems.

\(^1\) https://www.oib.or.at/sites/default/files/richtlinie_6_26.03.15.pdf
Compliance with the requirements of the OIB Directive 6 can be achieved by two methods:

- Through the provision of the maximum permissible final energy demand of the building. In this case the focus relies on the insurance of a tight building envelope in order to reduce the space heating demand (HWB) (not considering the fGEE factor).
- Through the installation of a very efficient or renewable heating system. In this case the total energy efficiency factor (fGEE) has to be taken into account, which reflects the type of energy use and production. In this method, a slightly higher space heating demand of the building is acceptable.

In both cases, the maximum values for primary energy demand and CO2 emissions are defined.

Starting 1 January 2017, the building codes currently specify that either 50% of heating and warm water should be produced from biomass, heat pump, district heating based on RES, district heating cogeneration, or 10% of warm water is covered by solar thermal, photovoltaic energy, or from heat recovery.

**Incentives**

Austria has incentive schemes to support heating and cooling from renewable energy sources, both on the state level and on the level of the individual federal states ("Länder"). Small-scale RES heating and cooling is supported by the Environmental Assistance in Austria (UFI) programme. This created special investment incentives for solar thermal installations, heat pumps, geothermal and biomass heating plants. Minimum requirements for systems in order to receive subsidies have been defined in the provinces.

In the spring of 2018, the Austrian government presented its Integrated Climate and Energy Strategy (Integrierten Klima- und Energiewirtschaftskonzept IKES). Apart from subsidies for building insulation measures, IKES contains several incentives to get out of oil-fired heating. In particular there is a ‘Raus aus Öl’ bonus –indicatively €5000 from June 2018-- for private and business customers switching from oil to wood, district heating, solar or heat pumps.  

The OMV Aktiengesellschaft, the largest Austrian oil & gas company, is not going to continue subsidising the so-called ‘Heizen mit Öl’ campaign, which has been providing funding for replacement of outdated jet burner boilers since 2009. In October 2018, OMV announced it would not extend this subsidy beyond 2019.

### 3.6.2 Belgium

The Belgium National Energy Efficiency Action Plan is composed of three parts, one for each region: Flanders, Walloon and the Brussels Capital region. The implementation of the EPBD includes requirements for space and water heating appliances. The regions aim to align their regulations as much as possible. This, for example, has resulted in the...
collaborative development and usage of software for calculating the energy performance of buildings.

In the **Brussels Capital region** the EPBD regulations are implied in three ways. There are regulations on certification, technical installations and activities.

The regulation on activities focuses on the implementation of the energy performance requirements for buildings. These requirements are obliged for new and rigorously renovated buildings for which a building permit has been requested after the 1st of January 2008. The requirements originally applied to housing, office and service, or educational functions. From 2017 onwards, the requirements concerning energy performance apply to all residential and non-residential buildings.

The requirements that need to be taken into account are the net energy demand of the building unit, the primary energy consumption for installations (heating, sanitary water etc.), insulation values Umax and Rmin, ventilation, risk on overheating, the limitation of thermal bridges at construction nodes and the installation of measuring devices for energy consumption.

In 2015 a new system for minimum requirements was set per unit type, based on maximum kWh/m² (e.g. the net heating requirement is 15 kWh/m²*y, the primary energy consumption is max. 45 kWh/m²*y, etc.).

In **Flanders** each building project (new built or large renovation) must achieve at least one of four targets:\(^84:

1. produce 15 kWh/m² (residential) or 20 kWh/m² (non-residential) using PV, solar thermal, HP, biofuels or district heating;
2. meet the entire heat demand using HP, biofuels or district heating on 100% renewable energy;
3. install a solar thermal boiler sized at minimum 2.5% of gross floor area (150m² floor area means 3.75 m² solar thermal);
4. or participate in renewable energy projects (special conditions apply).

The energy performance of a building is expressed in the E-value. This value represents the maximum allowed energy performance of the building and compares it with the energy performance of a reference building. The lower the E-value, the more efficient the energy performance of the building. Specially developed software is used to calculate the E-value. Factors that influence the calculation are the thermal insulation, air tightness, compactness, orientation, irradiance, ventilation losses and fixed installations such as space and water heating systems.

The E-values are obliged since 2006 for new and rigorously renovated parts of buildings that are an individual housing unit or have a designated functionality. From 2017 onwards, a maximum E-value requirement applies to all non-residential buildings (‘EPN-buildings’). These new requirements are calculated by the EPN-Method\(^85\).

---

\(^84\) https://www.energiesparen.be/EPB-pedia/hernieuwbare/overzicht-eisen  
\(^85\) see https://www.energiesparen.be/EPB-pedia/E-peil
Beside the general requirements on housing there are specific requirement for installations:

The heating installation has to have a minimum "efficiency" of 84% calculated as:

\[ \eta_{\text{inst}} = f_{\text{NCV/GCV}} \left[ \eta_{30\%} + 0.003(\theta_{30\%} - \theta_{\text{ave,boiler}}) \right] - f_{\text{loc}} - f_{\text{reg,burn}} - f_{\text{insulation}} - f_{\text{reg}} - f_{\text{hyd}} \]

where

- \( f_{\text{NCV/GCV}} \) = factor to convert NCV based values to GCV, for gas 0.90 (Annex F or Annex V of method EPW)
- \( \eta_{30\%} \) = efficiency at 30% load; must be minimum 100% (NCV) to attain threshold value of 84% with corrections as shown below
- \( \theta_{30\%} \) = return (inlet) temperature for 30% value; for calculation = 30°C
- \( \theta_{\text{ave,boiler}} = 6.4 + 0.63 \times \theta_{\text{return,design}} \) in °C; for calculation = 50.5°C
- \( \theta_{\text{return,design}} \) = design return (inlet) water temperature; for calculation = 70°C
- \( f_{\text{loc}} \) = correction for location; for calculation= 0;
- \( f_{\text{reg,burn}} \) = correction for standby heat loss, for calculation = 0 (can cool down completely);
- \( f_{\text{insulation}} \) = correction for pipe insulation, for calculation = 0;
- \( f_{\text{reg}} \) = correction for boiler water temperature control, for calculation = 0;
- \( f_{\text{hyd}} \) = correction for hydraulic balancing, for calculation = 0;

This means that boilers must have a minimum efficiency of 100% NCV at part load (and 30°C temperature regime) for it to be allowed as heating system in buildings (or 88% NCV if the 30% load is measured at 70°C). The requirement appears not stricter than the Ecodesign regulations imposed upon boilers.

For heat pumps the minimal SPF (seasonal performance factor) depends on the type, e.g. 3.3 for ground-to-water and 2.8 for air-to-water heat pumps. The SPF is calculated as:

\[ \text{SPF} = f_{\theta,\text{heat}} * f_{\Delta \theta} * f_{\text{pumps}} * f_{\text{AHU}} * f_{\text{dim,gen,heat}} * \text{COP}_{\text{test}} \]

where:

- \( f_{\theta,\text{heat}} \) = correction for required indoor temperature and condenser temperature according test EN 14511 = 1+0.01*(43 - \theta_{\text{supply,design}})
- \( f_{\Delta \theta} \) = correction for temperature variability = 1+0.01*(\Delta \theta_{\text{design}} - \Delta \theta_{\text{test}}), default 0.93
- \( f_{\text{pumps}} \) = correction for pump energy to evaporator
- \( f_{\text{AHU}} \) = correction for air flow (for heat pump using ventilation air)
- \( f_{\text{dim,gen,heat}} \) = correction for dimensioning, now default 1
- \( \text{COP}_{\text{test}} \) = COP under test EN 14511, table 3, 5 or 7: brine-to-water B0/W35, water-to-water W10/W35 and (outside)air-to-water A2/A35,

As the correction factors are determined to a large degree by building specific parameters, and no defaults are given for each factor, no minimum COP could be established. Nonetheless it is expected that these requirements do not exceed the efficiency limits in the Ecodesign regulations as reference is made to these regulations in the Flanders technical calculations.

---

86 https://www.energiesparen.be/EPB-pedia/installatie-eisen/overzicht
For direct electric heating the heating power is limited to maximum 15 W per m² useful floor area.

The performance of solar devices for warm water heating can be included in the calculations of residential and non-residential buildings. The calculation requires the input of several parameters, bases on the EU standard prEN15316-4-3:2014. The input is also dependent of the storage type and volume. This input is specified for storage types that are not covered by Ecodesign.

For the input of heat pump water heaters, the Ecodesign data can be used. Together with other (environmental) data the efficiency of the heat pump for a specific building can be calculated by the specified software.

In the Walloon region the requirements are related to the type of building and its function and split in several parameters related to efficiency in the building structure:

- The E\text{spec} sets the maximum primary energy demand per heated or cooled floor area (in m²).
- The E\text{w} sets the primary energy consumption of the building compared to a Walloon reference building.
- The K-value is equal to the parameters used in the Brussels and Flemish region and represents between the U-value (heat losses in the envelope) and the compactness of the building. Compactness is described as the ratio of the conditioned space and the external area of the envelope of the building.
- The U-values itself also have their limits, for different elements of the building’s envelope.
- Requirements on ventilation rates and
- A maximum value for overheating.

From the 1\text{st} of May 2016, requirements on technical building systems went into force. This comparable with the regulation on installations in the Flemish region. The regulation applies to several space heating and hot water appliances also regulated under CR 813/2013 and CR 814/2013.

For gas and liquid fuel boilers the requirements are identical to Flemish requirements with \( \eta_{\text{inst}} \geq 0.84 \). For electric heaters the installed capacity is less than/equal to 15 W/m² climatised floor area.

More specifically, for heat pumps (space heating) a minimum energy efficiency has to be reached, based on a test using EN 14511 with indoor heat exchanger supply temperatures at 35°C and outdoor heat exchanger supply temperatures at 2°C for air, 0°C for brine and 10°C for water (these are not seasonal performances). Limit values are for soil-to-water HPs, COP \( \geq 4.3 \) and for water-to-water HPs, COP > 5.1.

The implementation of the EPBD in the three Belgian regions incorporates elements that rule out the use of inefficient space and water heating appliances, but mostly in an indirect way (the calculation of the requirement includes aspects beyond the product boundaries, related to their installation in a specific building).
Incentives
The regions and provinces have several incentives to promote renewable and cleaner technologies in the form of loans and subsidies. In 2018 the Flander’s subsidies (‘Energiepremies’) for e.g. heat pumps is €4250-4750 (exact amount income-dependent, max. 50% of purchase cost). There are subsidies for condensing boilers (€500-€700), monobloc heat pump water heaters (€1400-1600), room-thermostats (€25-100), thermostatic radiator valves (€10-30/unit), solar heating (€2500-€3500 for up to 4 m², €200/m² extra). For renovation of collective chimneys the subsidy is between 30 and 40% of total costs. There is a generic loan-programme to realize Near Zero Energy (Bijna Energie Neutraal) houses with a maximum of €15.000,- at 0-2% interest (interest depending on income).

In Flanders the use of oil-fired boilers in new buildings and renovations (not in simple replacement situations) will be forbidden from 2021, through the EPB, according to its 2018 energy plan. At interregional Belgian level there are plans to forbid the sales of all oil-fired boilers, including replacements, in 2035.

3.6.3 Bulgaria
The Energy Efficiency Act (following 2006/32/EU) specifies the energy saving priorities which includes the creation and maintenance of a list of buildings, industrial systems, hot water boiler heating systems and air-conditioning systems which must be brought into conformity with energy efficiency requirements.

The legislation on buildings in Bulgaria differentiates buildings by state (new or existing) and use (residential, non-residential and public). The energy performance of building is indicated by:

- \( EP_{\text{max},r} \) that represents the maximum energy performance calculated with the last issued U-values in kWh.m\(^2\)
- \( EP_{\text{max},s} \) that represents the maximum energy performance calculated with the U-values that were active at the time of commissioning of the building in kWh.m\(^2\)

These energy performances are, besides the U-values, calculated with several parameters including the climate zone, indoor air temperature, envelope characteristics, net volume of the conditioned space, thermal bridges and shading devices.

New buildings must achieve class "B". NZEB must achieve class "A" and not less than 55% of the energy consumed (supplied) for heating, cooling, ventilation, domestic hot water and lighting is energy from RES produced on-site or near the building.

For domestic water heating and space heating systems the requirements for technical building systems are relevant. These requirements apply to technical systems in new and renovated buildings. The requirements are specified in ordinance 7, as amended in 2015 (State Gazette No. 27/14.04. 2015, corrected State Gazette No. 31/28.04.2015. 2015, supplemented State Gazette No.35/15.05.2015). These requirements focus on:

---

87 https://www.iea.org/policiesandmeasures/renewableenergy/?country=Belgium
- Parameters related to solar domestic water heating systems;
- Seasonal efficiency of electrical heat pumps in heating mode with a \( \text{SPF}_{\text{min}} \) of at least 3.5 and for fuel driven heat pumps an \( \text{SPF}_{\text{min}} \) of 1.15;
- Seasonal efficiency of the air-to-air recuperators of ventilation and AC systems in heating mode \( \eta_{r,\text{min}} \geq 70\% \);
- The calculation of the integrated energy efficiency indicator for boilers - minimum requirements are given depending on the type and capacity of the boilers and the average temperature of the heated water;
- Reference values for heat transfer through transparent enclosing structures;
- Use of products in the buildings which must provide a high degree of environmental and health safety.

The Energy Efficiency Act states that the following energy efficiency improvement measures shall be assessed as regards their technical and economic appropriateness:

- Decentralised systems for energy production and use from RES;
- Electricity and heat cogeneration installations;
- District or block heating and cooling, including those that are based entirely or partially on energy from RES;
- Heat pumps.

These assessments are applicable for improvement measures that are recommended upon each change of use, deep renovation, or major renovation of a building (or part of a building) in use.

Any investment project for a new building with a total floor coverage of over 1000 m² must comply with the possibilities of using decentralised systems for the use of renewable energy. In these buildings, at least 15 % of the total heating and cooling needed for the building shall have to be produced from renewable sources.

**Incentives**

The use of renewable energy for heating and cooling is promoted through a grant from the Bulgarian Energy Efficiency Fund and through an exemption for building owners from property tax. In general, all heating technologies are eligible for support.

### 3.6.4 Croatia

The Building Act sets the legislative basis for the implementation of all articles of the EPBD. In 2015, new values for the energy performance of buildings were established as follows:

- Maximum annual primary energy consumption per usable floor area of a building (\( E^\text{prim} \));
- Maximum delivered energy per of usable floor area of a building (\( E^\text{del} \));
- Maximum annual energy needs for heating per usable floor area of a building (\( Q^\text{H,nd} \)), for new buildings and for existing buildings undergoing renovation; and
- Maximum \( E^\text{prim} \) for NZEB and the share of RES in the total energy consumption.

Also prescribed within the Building Act are: the need for lighting, efficiency of technical building systems, energy efficiency class of the building automation and control systems. The study on the application of alternative energy supply systems is mandatory for buildings with a useful floor area of \( \geq 50 \text{ m}^2 \).
For buildings equipped with heating systems with air-to-air heat pumps, the seasonal coefficient of the performance of individual heat pumps (SCOP) should be $\geq 4.0$; for heating systems with air-to-water, water-to-water and soil-to-water heat pumps, the seasonal performance factor (SPF H3) of individual heat pumps should be $\geq 3.0$. SCOP includes the heat pump, regulation, auxiliary heating unit and other parts of the system, such as pumps and ventilators on the side of the heat storage tank. SPF H3 is the factor which influences the calculated limit that includes the heat pump, regulation, auxiliary heater, and all parts of the system, including pumps and fans on the side of the tank’s thermal sources (air, water, soil). Air-to-air systems do not contain the listed parts (they contain freon) and have no impact on the factor.

NZEB are defined as having at least 30% of the annual primary energy covered using RES generated on-site (i.e., by the building itself or somewhere in its vicinity). The application of highly efficient alternative systems in existing buildings should be considered and taken into account in so far as they are technically, economically and functionally feasible.

**Incentives**

There are currently no support schemes for renewable heating and cooling. There are soft loan and investment subsidy facilities (grants and loans) for producers of renewable heating.

Croatia mentioned that they have a park of close to 200,000 individually owned C4/C8 boilers connected to collective chimneys.

### 3.6.5 Cyprus

In Cyprus, the ‘Grant Scheme for Promoting the Renewable Energy Sources’ is in force since 2012. For the 2014 to 2020 period, a support scheme ‘Save – Upgrade’ is launched to aid in the upgrade of the energy performance of existing buildings. The EU is helping in the funding of this support scheme.

The first minimum energy performance requirements for new buildings have been adopted on 21 December 2007, whereby maximum permissible $U$-values for new buildings were determined for the first time, making thermal insulation of the building envelope and the installation of double-glazed windows virtually mandatory. In 2010, energy class B for the EPC was added to the minimum requirements. The results of calculating the cost-optimal levels of minimum energy performance requirements, which took place in 2013, have been the catalyst for further tightening these requirements.

Also, according to the requirements for non-residential buildings, at least 3% of the total energy consumption should come from RES. From 1 January 2017, the $U$-values of the building envelope will be reduced even further, closely approaching the requirements for NZEB. Additionally, the minimum proportion of total energy consumption that should come from RES, both for residential and non-residential buildings, has significantly increased.
For several technical heating systems there are requirements on the dimensioning (Regulation K.Δ.Π. 111/2006⁸⁹), installation and performance. For central heating boilers the efficiency must be no less than 92%. Since 2010 the installation of a solar water heater for domestic hot water is required⁹⁰.

Additionally, there is the ‘Guide for adjusting and controlling central heating systems with boilers’ that requires the inspection of boilers with a rated heating output larger than 20 kW on their optimum performance every 2 years.

**Incentives**

There is a solar thermal system support scheme (currently 90% of households own a solar water heater, and 50% of hotels)⁹¹.

### 3.6.6 Czech Republic

In Czech Republic there are several regulations and action plans to stimulate energy efficiency in water heating appliances.⁹² It is obliged to use renewable heating in buildings and of public authorities have an exemplary role in this. Renewable heating & cooling installations in buildings are eligible for an exemption from property tax for building owners.

The implementation of the Buildings regulations is transposed through the Energy Management Act No. 406/2000. The last amendment went in to force in 2015 and mainly expands the scope of the original document⁹³.

After the implementation of the EU Building Directive the Czech legislation also followed the model of the Energy Performance calculation. Factors that influence the total energy performance are:

- total primary energy per year;
- non-renewable primary energy per year;
- delivered energy (for a new building and renovation of an existing building);
- U-value of a whole building envelope (for a new building and renovation of an existing building);
- U-value of each element (only for changed elements);
- efficiency of technical systems (only for replaced technical systems).

The requirement and regulations are divided over several documents, the most relevant being:

- the Energy Management Act no. 406/2000 Coll;
- Decree 78/2013 on Energy Performance of Buildings;
- Decree 193/2013 on the control of air-conditioning systems;
- Decree 194/2013 on the control of boilers and heat distribution networks;

---

⁹² Czech Convergence Programme (Nov. 2005)
The Czech standard ČSN 73 0540-2/Z1:2011 and other standards or Technical Standardising Information.

Act No. 406/2000 Coll. on Energy Management and Decree No. 78/2013 on Energy Performance of Buildings stipulate that any new building over 250 m² and undergoing a major refurbishment, as well as newly rented building units have to undergo a renewable energy use assessment.

It is required that 20% of total energy needs are covered by RES, including specifications for space/DHW heating: ≥25% of demand is either covered by solar radiation; or ≥30% biogas; or ≥50% solid biomass; or ≥70% geothermal energy; or ≥50% environment heat.

**Incentives**

In 2018, the Minister of the Environment introduced measures to improve air quality in the country. Air quality is still unsatisfactory and fails to meet the European air pollution limits. The government is therefore planning to continue its Boiler Subsidy in 2019 with over CZK 3 bln (115 M€) allocated for replacement of old fossil fuel boilers in hopes to displace up to 30,000 inefficient heating systems. Subsidies for households can reach up to CZK 127,500 (~€5000) and the latest round is expected to start at the beginning of 2019.

**3.6.7 Germany**

The Renewable Energy Heat Act ("EEWärmeG") requires new buildings to source a share of their total energy demand for heating and cooling systems from renewables, such as geothermal heat pumps, solar PV or solar thermal installations. The proportion varies by technology:

- Minimum 15% of total heating and cooling demand must be met by solar thermal energy, or
- Minimum 30% of the total demand when biogas is used, or 50% when solid or liquid biomass is used.

Also allowed are substitute measures such as energy from waste heat or CHP (minimum 50% of demand) or district heat from renewables/waste/CHP (100% of demand).

The regulations concerning the percentage of RES use – including possible substitute measures – are subject of the Renewable Energies Heat Act, last amended in 2010. All other efficiency requirements for new buildings are given by the Energy Saving Ordinance, which was subject to a major amendment in 2013, fixating the January 2016 requirements.

New buildings have to meet, apart from the above mentioned minimum renewable/substitute share in energy demand, a minimum quality of envelope, and a maximum non-renewable primary energy demand, which is determined individually for each building using a reference building with similar building geometry, orientation and use, but with a certain quality of all energy-relevant systems and components. It is calculated using computer software and takes into account the following primary energy factors:
### Table 18. Germany PEF values

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Total PEF</th>
<th>non-renewable PEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil fuels except brown coal</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>brown coal</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>biofuels (on-site, nearby)</td>
<td>1.2 – 1.5</td>
<td>0.2 – 0.5</td>
</tr>
<tr>
<td>electricity</td>
<td>2.8</td>
<td>1.8 (2016) to 2.8 (for CHP)</td>
</tr>
<tr>
<td>environmental energy</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>district heat CHP</td>
<td>0.7</td>
<td>0.0 (renewable) to 0.7</td>
</tr>
<tr>
<td>district heat heating plant</td>
<td>1.3</td>
<td>0.1 (renewable) to 1.3</td>
</tr>
</tbody>
</table>

The following requirements have to be met, even without the “trigger” of a relevant modernisation:

- Water-based central heating systems have to be equipped with controls that adjust the temperature of the heating medium based on time and outside temperature, and which shut down circulating pumps accordingly; there are exemptions.
- Water-based central heating systems have to be equipped with room-temperature controls; there are exemptions for small rooms with floor heating, old floor heating and for non-residential buildings, where rooms of similar type and use may share controls.
- AC systems with more than 12 kW output and due to influence humidity must have controls with separate set-points for humidification and dehumidification.

The following requirements must be met in case of relevant changes to the system:

- Circulation pumps in water-based heating systems with more than 25 kW heat output must be controlled automatically; there are exemptions.
- Circulation pumps in domestic hot water systems must have a time-control.
- Newly installed heating and domestic hot water pipes, as well as cold water pipes in AC systems must be insulated; there are exemptions especially for heating pipes in a heated space.
- AC systems with more than 12 kW output and ventilation systems with more than 4,000 m³/h supply air must meet the following requirements in case of first-time installation and major changes:
  - the specific fan power (SFP) value may not exceed class SFP 4 (EN 13779: 2007);
  - the airflow must be controlled automatically according to thermal and sensible load if the hourly flow exceeds 9 m³/m²; there are exemptions;
  - the systems must be equipped with heat recovery units of class H3 (EN 13053: 2007) or better.

The Federal Government intends to combine these two legal sectors in order to simplify their application. This is foreseen in a new legal act, the “Gebäudeenergiegesetz”, which also includes the concrete definition of the NZEB-level for public buildings; the current verbal definition does not give details on the required value. If this legal act is accepted by both chambers of the German parliament, it should come into force by 2018.
**Incentives**

With a volume of over 300 million euros per year, the Market Incentive Program (MAP) by the Federal Office of Economics and Export Control (BAFA) is a key tool for development of renewable energies (biomass, solar, heat pumps) in the heating market, where it is better known as the BAFA-subsidies. As an example, the table below gives an overview of BAFA-subsidies for heat pumps.
### Table 19. BAFA subsidies for heat pumps (source: Viessmann.de 2018)

<table>
<thead>
<tr>
<th>Eligible for subsidy</th>
<th>Basic subsidy</th>
<th>Innovation subsidy</th>
<th>Innovation subsidy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heat Pumps (HP) max. 100 kW</strong></td>
<td><strong>Existing buildings</strong></td>
<td><strong>Existing buildings</strong></td>
<td><strong>New buildings</strong></td>
</tr>
<tr>
<td>Air-Water-WP (with inverter) - JAZ: ≥ 3.5</td>
<td>40 €/kW or 1.500 € per installation (max. 37.5 kW)</td>
<td>60 €/kW or 2.250 € per installation (max. 37.5 kW)</td>
<td>40 €/kW or 1.500 € per installation (max. 37.5 kW)</td>
</tr>
<tr>
<td>Air-Water-WP (other) - JAZ: ≥ 3.5</td>
<td>40 €/kW or 1.300 € per installation (max. 32.5 kW)</td>
<td>60 €/kW or 1.950 € per installation (max. 32.5 kW)</td>
<td>40 €/kW or 1.300 € per installation (max. 32.5 kW)</td>
</tr>
<tr>
<td>Ground-Water-WP (vertical) - JAZ: ≥ 3.8 (in non-residential ≥ 4.0)</td>
<td>100 €/kW or 4.500 € per installation (max. 45 kW)</td>
<td>100 €/kW or 6.750 € per installation (max. 45 kW)</td>
<td>100 €/kW or 4.500 € per installation (max. 45 kW)</td>
</tr>
<tr>
<td>Ground-Water-WP (Sonstiges) - JAZ: ≥ 3.8 (non-residential: ≥ 4.0)</td>
<td>100 €/kW or 4.000 € per installation (max. 40 kW)</td>
<td>100 €/kW or 6.000 € per installation (max. 40 kW)</td>
<td>100 €/kW or 4.000 € per installation (max. 40 kW)</td>
</tr>
</tbody>
</table>

JAZ= *Jahresarbeitszahl* (Seasonal efficiency). source: https://www.viessmann.de/de/wohngebaeude/waermepumpe/foerderung.html (translated VHK)

The German Development Bank (KfW) offers financial support for renovations of housing for better energy efficiency (including heating systems) in the form of low-interest loans up to €100.000 with redemption grants (D. *Tilgungszuschuss*) up to €27.000. The KfW also manages some investment grants (D. *Investitionszuschuss*) that are relatively modest (e.g. 10% of costs). Note all BAFA and KfW support measures can be combined.

### Replacement of old boilers

According to ENEV 2014, par. 21, installers, energy auditors and chimney sweepers were per 1.1.2016 entitled to attach "energy labels" to installed heating appliances older than 30 (in 2016) to 15 years (in 2024)\(^94\). As of 1.1.2017 certified chimney sweepers are required to attach such labels (mandatory). The energy label for boilers in the building stock is implemented by “Energieverbrauchskennzeichnungsgesetz” §§ 16 to 19. Its metrics and efficiency classes are the same as of regulation 2013/811/EU but with default values of EN 15316-4-1 (if not provided by the manufacturer).

The technical scope of the measure is identical to that of Regulation (EU) No 811/2013. The assessment and affixing of the label are free of charge but the inspector has to have access to the boiler.

---

\(^94\) [http://www.enev-online.com/news/15.08.19_bundesregierung_beschliesst_novelle_energieverbrauchskenzeichnungs_gesetz.htm](http://www.enev-online.com/news/15.08.19_bundesregierung_beschliesst_novelle_energieverbrauchskenzeichnungs_gesetz.htm)
The QR code on the label links to: [www.bmwi.de/heizungsetikett](http://www.bmwi.de/heizungsetikett).

The efficiency class to be placed on existing boilers can be found, using an app, which links to a database of (in particular) older equipment.

BUND estimates some 12.7 million heating boilers are older than 15 years. The measure is expected to increase the replacement rate from 3% to 3.7%. The cost of the measure is expected to be 63.3 million Euro for the period 2017-2023.

According a draft of the measure over 70% of installed space heaters are classified as C, D or E. The average age is 17.6 years and 36% of the installed base is even older than 20 years. Considering that at maximum some 3% of boilers are replaced annually it would take over 25 years to have this installed base renewed.

In Germany chimney sweepers are required to check exhaust and combustion temperatures, pressure and emissions of boilers. This includes a check on particulate matter (if the boiler is solid fuel fired) or soot (if the boiler is oil-fired and > 4 kW) and carbon monoxide. In Germany, boiler inspection is implemented as alternative measure via measurement of steady-state thermal efficiency according to “1. BImSchV” not via the energy label according to “Energieverbrauchskennzeichnungsgesetz”.

The Nachrüstpflicht introduced under the EnergieSparVerordnung (EnEV, since 2002) requires replacement of heating boilers older than 30 years (in 2015 this means boilers installed before 1985). Excluded are boilers with an output of less than 4 kW or more than 400 kW, low-temperature boilers, condensing boilers, boilers for special fuels, dedicated water heaters, combined cooking hobs/heaters and other local space heaters.

Homeowners of small 1-2 family dwellings may be excluded from the Nachrüstpflicht, under certain conditions.97

97 See also [https://heizung.de/heizung/wissen/enev-heizkessel-nach-30-jahren-tauschen/](https://heizung.de/heizung/wissen/enev-heizkessel-nach-30-jahren-tauschen/)
The German VdZ - Forum für Energieeffizienz in der Gebäudetechnik e.V. introduced a web portal\textsuperscript{98} \url{www.heizungslabel.de} to facilitate the generation of package labels (fiches). It simplifies issuing package labels for installers by collecting product data (provided by manufacturers) in a database and offering interfaces to installers’ commercial software.

3.6.8 Denmark

The minimum energy performance sets the limit for maximum allowed primary energy demand for a building, including, e.g., thermal bridges, solar gains, shading, infiltration, ventilation, heat recovery, cooling, lighting (for non-residential buildings only), boiler and heat pump efficiency, electricity for operating the building, and sanctions for overheating.

Since 2013 it has not been permitted to install oil or natural gas boilers in most new buildings, and by 2016 it will be illegal to replace an existing oil boiler with a new one if there is access to district heating or natural gas.

There are specific energy-related requirements for boilers based on gas, oil, coal, biomass and similar fuels. The requirements for boilers operating on gas or oil, means that only condensing boilers can be used in Denmark, both for new buildings and new installations in existing buildings. Boilers operating on coal, biofuels and biomass should, as a minimum, meet the energy requirements of boiler class 5 in EN 303-5. In addition to this, there are requirements for heat pumps, elevators and cooling systems.

Incentives

Renewable energy sources for heating purposes are exempt from tax obligations on the production, supply and use of energy sources, thereby receiving a tax benefit in comparison to other fuels for heating purposes. In Denmark low electricity taxes apply for heat pump users for a total household consumption above 4000 kWh/year. The tax reduction reduced consumer prices with 0.61 DKK/kWh (0.08 €/kWh incl. VAT) for these consumers.

3.6.9 Estonia

The energy performance of buildings acts in Estonia takes into account the energy needs for space heating, domestic hot water, cooling, lighting, ventilation, and electrical appliances. The minimum energy performance value characterises the primary energy use of the building and is based on the primary energy factors for the following "fuels":

- Renewable energy (wood, biofuel) 0.75
- District heating 0.9
- Electricity 2.0
- Fossil fuels (oil, gas, coal) 1.0

The maximum primary energy consumption for new builds is 160 kWh/m\(^2\) for detached houses, 150 kWh/m\(^2\) for apartment buildings etc. A NZEB has reduced requirements: 50 kWh/m\(^2\) for detached houses, 100 kWh/m\(^2\) for apartment buildings etc. m\(^2\).

\textsuperscript{98} \url{http://www.heizungslabel.de/VerbundAnlagen?anlagefunktion=Heizung&anlagetyp=Heizkessel&language=de}
For detached and terraced houses, compliance with the minimum energy performance requirements can also be demonstrated by a simplified calculation of the specific heat loss through the building envelope. This method requires only envelope heat transfer coefficients (U) to be subjected to heat loss calculations for conduction and infiltration losses, and can be used if a mechanical supply and exhaust ventilation system with specified heat recovery and specific fan power is used. Depending on the heat source, specific heat loss values are set, so that they comply with minimum energy performance requirements. With this method, no further energy calculation is required. For example, the maximum specific heat loss value to be fulfilled in the case of a ground source heat pump serving as the heat source is 1.0 W/(m².K), and in the case of a gas boiler, it is 0.6 W/(m².K). It is important to note that these values are not U-values, but specific conduction (average U-value of building envelope including thermal bridges) and infiltration heat loss values calculated per heated floor area.

For the heating and hot water systems, the requirement is that the heat source’s primary energy efficiency (the efficiency or performance coefficient of the heat source divided by the primary energy factor of the energy carrier) must be at least 0.8. This means a gas boiler must be 80% efficient (80%/1.0=0.8) and an electric heat pump at least 160% (160%/2 = 0.8, based on SCOP presumably). For ventilation systems, the requirement is that the performance efficiency of the heat recovery must be at least 70%. If the ventilation system requires the use of a liquid-coupled heat exchanger, then the efficiency of the heat recovery must be at least 50%. Specific fan power of the air-handling unit may not exceed 2.5 kW/(m³/s).

**Incentives**

Renewable heating is stimulated by investment subsidies and consumer subsidies. Investment subsidies are granted notably to CHP and district heating installations using renewables as well as to municipal community centres, child day care centres, and to households and apartment buildings for the installation of heating installations using biomass as well as solar and geothermal heating installations.

### 3.6.10 Greece

New buildings or building units must meet minimum energy performance requirements set out in the “Regulation on the Energy Performance of Buildings” (KENAK) (class B). In combination with the obligation set in Law 4122/2013, these regulations ensure that every new building of the public sector, from 1 January 2019 should be NZEB. This obligation applies also for all new buildings constructed after 1 January 2021.

At the stage of issuing a building permit for new buildings or building units, there must be additional documentation prepared and submitted to the relevant Building Office Authority. This documentation accompanies the energy study and contains the technical, environmental and economic feasibility of the installation of at least one of the following alternative energy supply systems:

- decentralised energy supply systems based on RES;
- combined heat power (CHP);
- heating or cooling systems in the region or block;
- heat pumps that meet the minimum eco-labelling requirements (2007/742/EC, which requires for air/water at 2 °C outdoor temp. a COP of 3.1 at 30/35 °C and 2.6 for
40/45 °C, and for brine/water at 0/-3 °C source temp. a COP of 4.3 at 30/35 °C and 3.5 for 40/45 °C, etc.).

For new buildings or building units, it is obligatory, since 2011, to cover part of the hot water needs from solar, thermal or other RES/CHP systems. The minimum percentage of the solar share of annual hot water needs is 60%. Non-application of the above rate requires adequate technical documentation in accordance with current legislation and the prevailing conditions.

No further requirements have been issued for systems and/or building components for new buildings since December 2014. According to the results from a cost-optimal study, new energy performance requirements are expected to be implemented for both the building components and electromechanical systems for heating, cooling and ventilation, taking also into account the Ecodesign Directive (Directive 2009/125/EC).

For existing buildings the KENAK has set minimum requirements for building elements, as well as for energy losses and gains for the whole building envelope and minimum requirements for the efficiency of heating, cooling and hot water production systems. These are set for all building uses, together with lighting requirements for the tertiary sector buildings.

**Incentives**

Heating and cooling installations sector using renewable energy sources are supported by two tax relief mechanisms and by investment subsidies. The 2016 Development Law stipulates support for combined heat and power plants and renewable heating and cooling installations in the form of two types of tax credits or investment subsidies. A database of PV installers and RES professionals (including RES installers) was developed and updated by the Centre for Renewable Energy Sources (CRES). The introduction of new energy efficiency standards promotes, or even imposes the installation of RES in new buildings and in public buildings. Apart from that, incentives are offered for the installation of RES in existing buildings. In addition, Greece is supporting RD&D activities.

**3.6.11 Spain**

As a supplement to the Technical Code for Construction 2006, a regulation (Royal Decree 1027/2007) on heating systems was published in 2007. It is known as Regulation of Thermal Installations in Buildings (RITE), and it addresses more technical issues related to heating and cooling systems. It not only established production systems’ energy efficiency requirements, but also established the obligation to carry out maintenance and schedule inspections of air conditioning (AC) systems in buildings in Spain. The RITE (Royal Decree 1027/2007) was updated through Royal Decree 238/2013, with tightening of energy efficiency requirements, and the review of the scope of the maintenance system.

Spain transposed the EPBD through several laws and building codes, amongst them the "Código Técnico de la Edificación" (CTE). The CTE introduces minimum requirements for the use of solar thermal energy in domestic hot water production. These minimum requirements are from 30% to 70% depending on the climatic zone and type of building. Some specific regions or cities may set additional, more stringent requirements.
Incentives

The Spanish solar thermal market is highly dependent on the new construction sector because of the enactment of Royal Decree No. 314 dating back to 2006 of a new building regulation as part of its technical building code (CTE). The text introduced the obligation to install renewable hot water production systems in new buildings and for solar thermal, an obligation to cover 30–70% of the building’s domestic hot water needs.

According to the FEGECA (the Spanish Association of Manufacturers of Heat Generators and Emitters) in its 2017 publication on the Spanish heating market, a clear trend towards individual heating with more efficient technologies, such as condensing boilers, was noticeable in Spain in 2017.

Also, in 2018, FEGECA proposed a new label for existing boilers with the intention to stimulate replacement demand of inefficient boilers and sanitary water heater systems with more efficient technology. The aim of the campaign is to identify the level of efficiency and inform Spanish consumers about more advanced technologies. 99

![Proposed fegeca label for existing boilers in Spain](image)

3.6.12 Finland

Finland’s National Building Code has set minimum requirements for the thermal insulation and ventilation of new buildings since 1976. These requirements have been amended and enhanced several times to improve the energy efficiency of buildings.

On top of that the National Building Code of 2017 sets maximum values for overall energy consumption (E-values) calculated using the primary energy factor:

- fossil fuels 1.0
- electricity 1.2
- district heating 0.5
- district cooling 0.28
- renewable fuels 0.5

The maximum values depend on the building type and, for single-family houses, on the area of the building. The new building code does not exclude any heating sources; however, the code encourages the use of RES and district heating, which have better primary energy factors than other energy sources. Other renewables (e.g., solar heating and power) are taken into account when calculating a building’s primary energy needs.

The requirement for row houses is 105 kWh/m², for apartment buildings 90 kWh/m² and for single houses the value depends on the size of the house: 110 to 92 kWh/m².

For NZEB using a simple method to assess compliance with the regulations, the method limits the use of heating sources to district heating, ground source heat pumps or air-to-water heat pumps.

The efficiency of heating systems must be improved where possible when the related equipment and systems are renewed. After renewal, the ratio between efficiencies of the building’s main heating system and the main heat distribution system must be at least 0.8. The ratio is the quotient of the annual efficiencies of the heating system and heat distribution system.

There are also requirements set for other technical systems, e.g., for different temperature levels of Domestic Hot Water (DHW) systems or for apartment-specific water meters.

**Incentives**

For heat production in CHP plants a so-called “heat bonus” is provided.

Finland is on track to meet its climate and energy 2020 targets. Renewable energy is developing faster than expected. However, the majority is from bioenergy, which may increase forest logging in the future and has negative repercussions on air pollution.

In 2014 only a few thousand oil-fired boilers were sold in Finland and no gas-fired boilers (see Task 2).

### 3.6.13 France

The RT 2012 is the French implementation of the EPBD and is the main building code for new buildings. The structure of RT 2012 for new buildings is based on three performance requirements:

- The requirement for minimum energy efficiency of buildings, which imposes a limitation on energy demand (heating, cooling and lighting) based on the bioclimatic conception (Bbio) of the project, whereby the Bbio value has to be lower than a maximum value called Bbiomax.
- The requirement for primary energy consumption, which imposes a limitation on primary energy consumed (Cpe) for the combined use of heating, cooling, domestic hot water, lighting and auxiliaries (pumps and fans), whereby the Cpe has to be lower than a maximum value called Cpemax.
- The requirement for summer comfort, where the ambient indoor temperature of the building, reached after the 5 hottest days of the year (Tic), cannot exceed a reference level calculated for each project, whereby Tic has to be lower than a maximum reference value called Ticref.
The three coefficients are calculated through TH-BCE, a dynamic hourly methodology. The values of $B_{\text{biomax}}$ and $C_{\text{pemax}}$ are based on benchmarks depending on the building type, local climate, altitude and environment factors. The RT2012 does not specify requirements on systems efficiency nor on building components.

The RT 2012 includes requirements for renewable energy use, depending on the energy type (for example a minimum of for solar panels), but it should amount to at least 5 kWhEP/m².year. However, Eurobserv'ER reports that "rollout of the RT 2012 waiver in the collective sector, authorizing more energy to be used for multi-occupancy dwellings (57.5 kWh/m² p.a. instead of 50 kWh/ m² p.a.) and the lack of any obligation to incorporate renewable technologies in new build, have practically ousted renewable heat from this segment".

Existing buildings are covered by a Réglementation Thermique par élément or globale. Which one applies depends on the size of the renovation work (% of building value), surface area and age of building.

The Global Thermal Regulation is based on the overall consumption with minimum requirements for each component of the building (envelope and technical systems). Energy performance is assessed using a complex hourly methodology, called TH-CE ex, based on the new buildings’ methodology. The TH-CE-ex methodology is currently under review, the main purpose being to make it consistent with the Th-BCE methodology for new buildings.

The two regulations share rules regarding domestic hot water, setting maximum heat loss depending on the boiler size, and giving European Norms 89 and 26 as a reference for some systems’ performance.

The Regulation by Building Component sets a minimum efficiency around 90% for boilers and a coefficient of performance of 3.2 for heat pumps on heating mode.

The energy performances of boilers and heat pumps (as well as for other products and materials) are penalized if not certified or verified by third party. The RT 2012 describes the following three methods:

1. The value determined by a certified organisation, accredited under NF EN 45011 by COFRAC or any other organisation recognised as accreditation body;
2. The value minus 10% determined by an organisation accredited under NF EN ISO/CEI 17025 by COFRAC or any other organisation recognised as accreditation body;
3. A correction on the declared value: The value used in the calculations is the lowest value of either 0.8*declared value, or a default value (for boilers: 90% for full load or 93% for part load).

At the moment, the public authority is shaping France’s new thermal regulation, RE2020. The general idea of this new regulation – named environmental regulation (RE2020) – is to promote innovation though more flexible rules. To do so, constructors can achieve the E+ C- aim by concentrating on one criterion, be it energy or carbon, or by finding the right balance between them. Furthermore, the analysis of lifecycle of shell constructions.

100 https://www.rt-batiment.fr/index.php?id=144&faqid=313
should be extended to more than 50 years. Experiments with the new concept are ongoing. 101

Incentives

Article 200 of the Code Général des Impôts establishes a tax reduction through which some 30% of the costs for energy refurbishment is returned for works of maximum € 8000 (single person) or € 16000 (couples) over a 5-year period in the timeframe 2005-2017. This tax credit is prolonged in 2018 for HPWH and will be reformed in 2019 by a premium of the same amount (conditions to be specified in 2018). This measure covers almost all RES individual equipment (individual wood stoves or wood boilers, solar thermal collectors and ambient heat). Moreover, lower VAT rates were implemented for RES-H&C materials and also zero rates eco-loan to improve overall energy performance of housing.

According to Code général des impôts, Annex 4, Article 18bis 103 the tax relief applies to space/combi heaters with a minimum seasonal efficiency for heating (for boilers: 90% if ≤ 70 kW, 87% at full load and 95.5% at 30% load if > 70 kW; for heat pumps: 111% if 55 °C heat pump, 126% if 35 °C heat pump, including with backup heaters).

The finance project act for 2018 intends to extend the CITE (credit d’impôt transition énergétique) until the 31st December 2018. The rate of the tax credit is of 30% of all eligible expenses. In 2017, products covered were heating and water heating equipment using wood / biomass (stoves, solid fuel boilers) or solar thermal energy, heat pumps (all except air-air heat pumps), condensing (gas) boilers and Micro CHP. The equipment eligible for this extension will be defined by decree. Jet burner (oil) boilers were originally excluded for 2018, but following protests from MPs there is now a transitional measure 2017-2018 for these types. 104

Refrigerants

The French fire safety regulation in public access buildings (article CH 35) prevents the installation of heating or cooling equipment using alternative refrigerants with medium GWP HFCs or low GWP HFOs because they are considered flammable. The heating industry considers this an important stumbling block in French law, which should be urgently tackled by the Ministry of Ecological and Solidarity Transition in order to help meet 2018 F-Gas quotas.

France has discussed an HFC-tax (comparable to the Danish tax) but so far draft bills do not include such a tax.

102 In reference to Annex 4, Article 18 states that the tax relief applies to space/combi heaters with a seasonal efficiency equal to or higher than 90% (< 70 kW) or 87% nominal efficiency and 95.5% part load efficiency if > 70 kW
103 https://www.legifrance.gouv.fr/affichCodeArticle.do?idArticle=LEGIARTI000023374187&cidTexte=LEGITEXT000006069576
104 https://www.impots.gouv.fr/portail/particulier/credit-dimpot-transition-energetique
3.6.14 Hungary

Hungary has implemented for new buildings and major renovations requirements for building components and a primary energy target. The calculation takes into account shading, solar gains etc. For NZEB the following requirements also apply:

- At least 25% of the energy need of the building should be covered from RES, that is, compared to the calculated value of the specific yearly primary energy need. The “renewable share” is defined as the quotient of renewable/non-renewable energy. During the calculation of the value of the energy need, the renewable primary energy need is not taken into account. Even if the specific primary energy consumption is less (e.g., half) than the threshold value, the building is not approved as NZEB unless the above 25% is fulfilled, which leads to extra measures in order to further decrease the non-renewable energy consumption; the utilised passive solar gain is to be taken into account while calculating the “renewable share” (this can lead to double counting).

- Regarding the primary energy factors, some cases are defined on national level for district heating. If the level of co-generation is at least 50% and the source of heat is gas, coal, oil, nuclear, other renewable, non-biomass waste, then \( e=0.83 \); under 50% co-generation \( e=1.26 \).

- If the level of co-generation is at least 50% but the source of heat is biomass, wood pellets, agricultural pellets, biogas, other renewable, landfill gas or sewage sludge, then the primary energy factor is \( e=0.5 \), under 50% co-generation \( e=0.76 \). For off-peak grid electricity the primary energy factor is \( e=1.8 \). In case of heat pumps, the primary energy conversion factor of electric energy is excluded from the calculation of the renewable energy share. Unless it is based exclusively on biomass, the energy from district heating is not counted as renewable unless: a) there are other renewable sources, too, and b) the systems are typically bivalent, combining renewable and non-renewable sources (the precise data of most of the Hungarian systems are available, e.g., for 13 systems only in Budapest); for the calculation of the renewable share the following RES factors should be used: \( e_{RES}=0.1 \) if the national electric grid is used; moreover \( e_{RES}=1 \) if firewood, biomass, biogas, pellets or agripellets as well as solar, wind, water, geothermal, hydrothermal energies are used.

For existing buildings a rulebook has been developed. The regulations include requirements on technical building systems elements (e.g., on balancing, control, pumps, airtightness of ventilation ducts). The rulebook does not set any direct system performance requirements; only the upper threshold of the total primary energy consumption of the building is defined.

The requirements of the ErP directive on boilers, water tanks, heat pumps, pumps, ventilations systems, etc., have a much more significant impact on the construction sector than element requirements set in the rulebook.

3.6.15 Ireland

The Building Regulations Part L - Conservation of Fuel and Energy for new residential buildings were strengthened on three occasions in the period 2005 – 2011. The primary energy consumption and related CO emissions for a whole new residential unit (houses and apartments) performance is calculated using the Dwelling Energy Assessment Procedure (DEAP). The use of Renewable Energy Sources (RES), fabric insulation
including the limitation of thermal bridging, airtightness, minimum boiler efficiency, building services controls, insulation of pipes, ducts and vessels, and mechanical ventilation systems are specified as required minimum performance levels for these individual components or aspects.

The current minimum energy performance level is a 60% improvement relative to 2005 standards. This equates approximately to an Energy Performance Coefficient of 0.4, a Building Energy Rating (BER) of A3 with 63 kWh/m².year primary energy needs and a mandatory 10 kWh/m².year (thermal equivalent) energy contribution from RES or 4 kWh/m².year of electrical energy.

The requirements for existing residential units apply to extensions, material alterations, material changes of use, and window and door replacement. The key areas to be addressed are reasonable levels of fabric insulation in all new construction, limitation of thermal bridging, minimum boiler efficiency and building services controls.

New or replacement oil or gas-fired boilers must achieve a minimum seasonal efficiency of 90%. This is an improvement from the 2008 requirement for new or replacement boilers (86% efficiency). The seasonal efficiency for biomass boilers should be not less than 77%. Heating controls should provide automatic space heating temperature control, automatic control of stored hot water temperature, separate and independent time control for space and hot water heating, and shutdown of the heat source when there is no requirement for space and hot water.

**Incentives**

Renewable energy sources for heating purposes are promoted through a grant and a tax return.

**3.6.16 Italy**

Complementing Law 90/2013, Decree 26/06/2015 “Minimum Requirements” strengthened the previous acts and provided an updated energy performance calculation methodology, the rules for taking into account the use of RES in buildings and the system boundary, new stricter minimum energy performance requirements for buildings, building systems and building components, as well as conversion factors. The new legislation also defined NZEB.

New minimum energy performance requirements for new buildings (and major renovations) are based on the application of the cost-optimal methodology results (EPBD, Article 5), with the use of a reference building. The following energy services are taken into consideration: heating, cooling, domestic hot water and ventilation for residential buildings; plus lighting and internal transports (lifts, escalators) for non-residential buildings.

The regulation specifies the primary energy factors (1.05 for most fuels and 2.42 for electricity (non-renewable part is 1.95), the maximum thermal transmittance for building components (which vary per geographic area) and the efficiency of technical buildings systems. The mean efficiencies of the technical systems for heating (ηH), cooling (ηC) and domestic hot water (ηC) must be higher than those calculated for the reference building.
The reference values for various generation systems relevant in this study are:

**Table 20. Reference values for heat / power production - Italy**

<table>
<thead>
<tr>
<th>Generation system</th>
<th>Thermal energy production η&lt;sub&gt;θp&lt;/sub&gt;</th>
<th>Water</th>
<th>On site electricity production η&lt;sub&gt;e&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid fuels</td>
<td>0.82</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Gaseous fuels</td>
<td>0.95</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td>Electric HP</td>
<td>3.00</td>
<td>2.5 (chiller)</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>indirect: 0.60 η&lt;sub&gt;θp&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>direct: 0.60</td>
<td></td>
</tr>
<tr>
<td>Absorption HP</td>
<td>1.20</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>indirect: 0.60 η&lt;sub&gt;θp&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>direct: 0.60</td>
<td></td>
</tr>
<tr>
<td>CHP</td>
<td>0.55</td>
<td>0.55</td>
<td>0.25</td>
</tr>
<tr>
<td>Electric heating</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar collectors</td>
<td>0.3</td>
<td></td>
<td>0.3</td>
</tr>
</tbody>
</table>

The new legislation in force requires the calculation of the following energy performance indicators:

- Specific energy needs for heating (EPH,nd), cooling (EPC,nd) and domestic hot water (EPW,nd);
- Energy performance indexes for heating (EPH), cooling (EPC), domestic hot water (EPW), ventilation (EPV), plus lighting (EPL) and transport (EPT) for non-residential buildings, expressed in non-renewable and in total primary energy [kWh/m²];
- Global energy performance index EPgl = EPH + EPC + EPW + EPV + EPL* + EPT* expressed in non-renewable and in total primary energy [kWh/m²] (lighting and transport services for non-residential building only).

A new building (or major renovated building) satisfies the minimum requirements if the specific energy needs for heating and cooling (EPH,nd, EPC,nd) and the global energy performance EPgl are lower than those calculated values for the reference building. New buildings further need to have a fixed minimum ratio of RES for the supply: According to the legislative decree no. 28/2011 on renewable energy sources (RES), 50% of energy demand for DHW and 50% of the sum of energy demands for DHW, space heating and space cooling must be covered by RES (from 1<sup>st</sup> January 2017). In addition, the minimum electrical power of a system fed by RES (like a PV system), calculated in function of the building footprint area on ground, is prescribed.

In case the RES integration is not feasible, the building has to adhere to a proportionally lower EPgl limit value.

**Incentives**

A tax regulation scheme provides incentives for small RES-H sources, as well as a guarantee fund for district heating.

At the local level, in March 2018 the Commune of Milan decided to ban all (3500) oil-fired boilers from its territory by 1.10.2023 — a measure supported by a generous subsidy
Main reason for the measure is the contribution of these boilers (4% of total) to the already high air pollution from other sources.

Note that for all building activities, including the price of installation products like boilers, there is a reduced VAT-tariff of 10% in Italy.

**3.6.17 Lithuania**

The Building Technical Regulation STR 2.09.02:2005 “Heating, Cooling and Air Conditioning” is applied to design and construction of heating, hot water, AC and ventilation systems in buildings. All minimum requirements set for heating, cooling, hot water and ventilation systems are described in this regulation and are in line with the Regulation (EU) No 305/2011, and are mandatory for new, refurbished, replaced and upgraded Technical Building Systems (TBS).

**3.6.18 Luxembourg**

Each new oil, wood or gas fired heating system in new and existing buildings is submitted to an acceptance procedure. The acceptance procedure checks the conformity of the security equipment, the location, the smoke evacuation, the combustion quality and efficiency. Dimensioning is not checked at this stage, but is checked within the periodic inspection. Since Luxembourg imports nearly all appliances and equipment, European standards and standards of the countries of origin are applicable in Luxembourg.

The minimum combustion efficiency for gas boilers must be 89% if between 4-25kW, up to 91% if above 3 MW. For oil boilers this is 90% if 7-50 kW and 91% if above 50 kW. Wood boilers have to be minimum 85% (7-1000 kW) and 90% if above 1000 kW. Local space heaters using solid wood may be between 70-85% depending on type and fuel. No minimum requirements for heat pumps found.

**Incentives**

Four subsidy instruments are applied to foster renewable heating and cooling:

1. Investment subsidies for aerothermal and geothermal heat pumps as well as renewable energy plants generating heat from solar thermal energy or various types of biomass.
2. Companies investing in renewable energy plants are eligible for investment grants, with the exception of aerothermal and hydrothermal energy
3. Subsidies for companies investing in renewable energies for the production of heat or for the combined production of heat and power (CHP)
4. The Law of 31 May 1999 has introduced the creation of a fund to support Luxembourg municipalities in their investments for environmental protection, including installations producing renewable heat.

The financing mechanism in place for technologies based on Renewable Energy Sources (RES - solar panels, heat pumps, wood fired boilers, etc.) also sets different energy efficiency requirements. Consequently, e.g., solar panels have to be certified by an

---

independent institution, be equipped with a calorimeter, and their minimal collector surfaces must be set to 9 m² for plane collectors and 7 m² for tubular collectors in order to be considered eligible for financing. Heat pumps have to fulfill, among others, efficiency requirements (COP > 4.3 for ground source heat pumps and > 3.1 for air/water heat pumps). Wood fired boilers have to fulfill, among others, emission (CO, NO, particulate matter) and efficiency requirements.

3.6.19 Latvia

Energy performance requirements for ventilation, cooling, lighting and hot water systems in Latvia are not yet exactly defined. The “Latvian Building Norms and Construction Law” gives specific system values, which affect energy performance ratings, but it does not specify the precise energy performance rating levels of those systems. The systems have to be designed in such a way that under normal operating conditions.

Incentives

As for renewable heating and cooling, suppliers of heat from biomass or biogas are eligible for a reduced VAT (value added tax).

3.6.20 Malta

Malta launched a National Energy Policy in December 2012, aimed at diversifying the energy mix used in Malta while accelerating a shift in the energy culture. The national energy policy is based on the principles of diversification, security of supply, efficiency and affordability.

Malta aims to achieve its 2020 renewable energy target through different technologies, mainly solar, heat pumps, biofuels and waste to energy projects. It is expected that a relatively high number of small capacity renewable energy sources are distributed across the Maltese Islands. These shall be mainly integrated in existing building infrastructures due to Malta’s limited space and the conflicting use by other activities.

For renewable heating, grants for solar water heating systems to private householders are provided, whereas support for renewable energy in the transport sector is provided through a substitution obligation on importers and wholesalers of fossil fuels, where a specific percentage of biofuels shall be included in imported or wholesaled petrol and diesel.

3.6.21 The Netherlands

The Netherlands have energy efficiency requirements for new buildings and large renovations since 1995, which are based on a point-system (EPC) and with an ambition level that is gradually increased every few years. The current level (0.4 for residential buildings, 0.8 for office, 0.7 for schools and 1.7 for shops, etc.) still allows condensing fossil fuel boilers in practice. New installation products are rated for their EPC, based on test results and under supervision of independent commission of experts has to approve the results of the test before official publication. Since 2014 new and existing buildings have to be energy labelled.

As of 2021 the Netherlands will use a new building code based on near-zero energy building (NL: BENG = Bijna Energie Neutraal Gebouw) requirements. The code introduces requirements at 3 levels:
1. The first BENG indicator concerns heat demand, determined by building transmission and ventilation losses and gains. The minimum level for residential buildings shall probably be a heat demand of 25 kWh/m² per year.

2. The second BENG indicator relates to fossil primary energy demand which shall not exceed 25 kWh/m². This indicator can be met by both gas or electric heating systems, but usually requires either solar photovoltaic or a building at Passive House level if gas is used.

3. The third indicator is the share of renewable energy, which should be minimal 50% by 2021 for new builds. The kWh renewable heat may be subtracted from the second indicator on primary energy.

The current government –in place since October 2017-- decided in May 2018 to remove the mandatory gas grid connection of new buildings by 1 July 2018, also in the light of the reduction of natural gas extraction in the Groningen province. Currently some 35% of new buildings is still designed with gas-heating in mind.

In the Netherlands, sales of heat pumps (including hybrids) is booming, from 15,000 in 2016 (double as much as in 2015) to 50,000 in 2017. The Dutch Heat Pump Association (DHPA) is expecting a stock of 200,000 installed heat pumps in 2020 and 1.3 million in 2030.\(^{106}\) Main concern is the know-how and training of installers.\(^{107}\)

Having said that, 75% of all space heater sales are still ‘normal’ condensing gas-fired boilers, also in newly built dwellings. There is a strong lobby to ban the conventional fossil fuel fired boilers completely and allow only hybrids (heat pump + gas boiler) or heat pumps (typically air-water). The former give the lowest overall costs in the existing dwellings according to a study by consultants Berenschot.\(^{108\ 109}\)

**Incentives**

The Netherlands introduced a subsidy scheme to promote the use of heat pumps including hybrids, solar thermal, pellet heaters and biomass boilers: ISDE\(^{110}\). Provides both private persons and small-scale business with a subsidy for the purchase of solar thermal collects, heat pumps, biomass boilers, and pellet stoves.

The available sums depend on type of appliance and performance. For heat pumps, including hybrids, the sums are between 1000 to 2500 EUR. For a solar thermal system producing some 1000 kWh it is approximately 700 EUR and it may go up to a maximum of 2400 EUR for a 3500 kWh system. Although not in scope of this study, the sum available for pellet heaters is between 500-700 EUR and for biomass boilers it is 2500 EUR for a 12 kW boiler exceeding 50000 EUR for a 500 kW system.

---


3.6.22 Poland

According to the regulation concerning the technical conditions that buildings must meet, the energy performance requirements for new buildings apply both to the fabric of the building itself and to its heating, ventilation and AC and domestic hot water systems.

In general, heating, domestic hot water, lighting, ventilation and AC equipment used in the systems shall fulfil requirements set by separate national regulations which implement other European directives, e.g., eco-design, etc.

Incentives

For the promotion of renewable heat, the following instruments are used:

- Three subsidy schemes for installation or refurbishment of renewable heat installations, such as solar heat collectors
- Soft loans from the National Fund for Environmental Protection and Water Management to support investments in renewable heat installations.

Emissions

Poland is the EU Member State with the highest air pollution, expressed in PM$_{2.5}$ concentration, from the residential sector. This includes emissions from combustion in fireplaces, medium and single-house boilers, cooking and heating stoves. The reason is that 29% of space heating is coal-fired.\(^{111}\) Within the EU this is an exceptionally high fraction. The other Member States with coal-fired space heating are Bulgaria and Ireland, but the share is at the most 7-8%.

Apart from the air pollution in general, small coal-fired installations are in particular hazardous for the health because of the mercury-emissions\(^{112}\). More details will be provided in the Task 3 report.

The Polish government will take action in this respect, as a new 1000 MW coal-fired power plant has just been commissioned.\(^{113}\)

3.6.23 Portugal

Portugal assumes in the reference buildings used for energy performance assessment a minimum solar energy contribution for domestic hot water of 0.65 m$^2$/occupant.

The table below gives Portuguese minimum efficiency requirements heating equipment before and after 2016.

---


\(^{112}\) Ireneusz Pyka, Krzysztof Wierchowski, Estimated mercury emissions from coal combustion in the households sector in Poland, Central Mining Institute, Plac Gwark. Journal of Sustainable Mining 15 (2016) 66-72.

https://www.researchgate.net/publication/305891961_Estimated_mercury_emissions_from_coal_combustion_in_the_households_sector_in_Poland

\(^{113}\) https://lenergeek.com/2017/12/21/pologne- unite-a-charbon-europe/
Table 21. Portugal minimum efficiency requirements heating equipment before and after 2016.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heat pump – space heating</strong></td>
<td>COP ≥ 2.8</td>
<td>COP ≥ 3.0</td>
</tr>
<tr>
<td><strong>Heat pump – DHW</strong></td>
<td>COP ≥ 2.3</td>
<td></td>
</tr>
<tr>
<td><strong>Boiler</strong></td>
<td>≥ 86% (nominal)</td>
<td>≥ 92% (nominal)</td>
</tr>
<tr>
<td><strong>DHW gas heater &lt; 10 kW</strong></td>
<td>≥ 82%</td>
<td></td>
</tr>
<tr>
<td><strong>DHW gas heater &gt; 10 kW</strong></td>
<td>≥ 84%</td>
<td></td>
</tr>
<tr>
<td><strong>Electric storage water heater</strong></td>
<td>max. standby heat loss</td>
<td></td>
</tr>
</tbody>
</table>

Incentives

No direct support scheme for RES in the heating sector is currently in place (as of January 2017). The Energy Efficiency Fund (FEE) provided a subsidy to investments in solar water heaters through "Efficient Buildings 2016" that opened for new applications on 8 July 2016. The funding was rather small, 1M€ and supported 60% of the investment up to defined maximum’s per category.

Three categories were possible, and for all of these the product and package label were required:

- **A1 (residential)/ B1 (offices):** Acquire only a solar thermal system to have as a backup the already existing conventional water heater (the package label was required, minimum A class. For this a simplified methodology based on the EPBD was provided to assume the existing heater energy class “indicative labelling”);
- **A2 (residential)/B2 (offices):** Acquire a complete package, meaning new solar thermal and new conventional heater; (the package label was required, minimum A+ class, totally in line with the regulation)
- **A3 (residential):** Acquire a conventional water heater (the product label was required, minimum A class (which was at the time the highest class)

425 proposals were received for new solar thermal maintaining the existing conventional heater and 468 proposals for fully new systems (packages at the light of the new regulation), so almost 50% of request for solar only systems. Although the EU energy label (and Solar Keymark) was required, in roughly one-third (364) of the proposals it was lacking.\(^\text{114}\)

Table 22. Portugal FEE, subsidy proposals for solar thermal installations 2016.

<table>
<thead>
<tr>
<th>Nr. of received proposals</th>
<th>Proposals lacking the energy label</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 - residential</td>
<td>407</td>
</tr>
<tr>
<td>A2 - residential</td>
<td>448</td>
</tr>
<tr>
<td>A3 - residential</td>
<td>113</td>
</tr>
<tr>
<td>B1 - offices</td>
<td>18</td>
</tr>
<tr>
<td>B2 - offices</td>
<td>20</td>
</tr>
</tbody>
</table>

In April 2018 the Portuguese Government launched the Efficient House 2020 ‘Casa Eficiente 2020’ program with a funding amount of 200 million euros.\footnote{BRG HVAC Newsletter 2018.} Half of the subsidies are provided by the European Bank of Investment (BEI) and the other half by Portuguese commercial banks that are affiliated to the program. The aim is to support individual or collective households with access to loans at below market interest rates for investments that benefit the environmental performance of residential buildings. This includes energy efficiency and the use of renewable energy for self-consumption, water efficiency and waste management. The Efficient House 2020 program is likely going to improve the renovation sector with benefits for the HVAC sector.\footnote{https://jornaleconomico.sapo.pt/noticias/governo-lanca-programa-casa-eficiente-com-fundos-de-200-milhoes-de-euros-263128}

There is a minimum renewable energy contribution required for DHW, based on a minimum solar thermal panel area for each building occupant.

Portugal is one of the EU’s frontrunners in electricity from renewables. In March 2018, Portugal produced more power from renewable energy sources than it needed to cover electricity demand in the country. In fact, renewable energy output reached 4,812GWh, surpassing Portugal’s total electricity needs for March, which only topped 4,647GWh (data from the Iberian nation’s transmission system operator, REN).\footnote{https://www.euractiv.com/section/energy/news/portugal-breaks-100-renewables-mark-but-remains-isolated/}

\subsection*{3.6.24 Romania}

For the design of new buildings, the technical regulation in force is the Code for thermal calculation of building elements (C 107-2005). In 2010, it was amended to improve the thermal resistance values and was then further amended in 2013 to introduce a catalogue of new thermal bridges.

For these buildings, code requirements represent energy performance indicators for the design of building elements (transparent and opaque area) and the entire heated air volume. In terms of minimum energy performance requirements, the code does not include a global indicator that gathers the consumption from individual elements such as heating, Domestic Hot Water (DHW), ventilation, or lighting, where applicable. However, the code does include a series of restrictions upon individual elements.

NZEB shall cover at least 10\% of its total calculated primary energy needs by renewable energy sources. The RES shall be used according to their technical, economic and environmental feasibility and produced on the building site or nearby.

\textbf{Incentives}

Support for the use of renewables in the heating and cooling sector is provided by investment subsidy programmes of the Romanian Environmental Fund and of the National Rural Development Programme.
3.6.25 Slovakia

Specific energy requirements, based on primary energy, are provided for all building categories listed in the EPBD. There are also specific indicators which have been set separately for different technical systems (heating, DHW, ventilation and cooling, and lighting).

There are no regulations defining the minimum efficiency of any Technical Building System (TBS) as a whole, but only specific requirements in regulations related to individual elements (heating, cooling and ventilation, as well as for DHW, pipework insulation). Regulations 422/2012 and 328/2005 define minimum combustion efficiencies of boilers, while Regulation 282/2012 defines the technical requirements on thermal insulation of the distribution network for heating and DHW. TBS requirements are mainly based on European (EN) or national (STN) standards. In addition, the building designer must assess the possibility of technical, environmental and economic utilisation of high-efficiency alternative energy systems (active solar systems and other heating systems, electrical systems based on RES, combined generation of electricity and heat, as well as district or block heating and cooling) before the construction begins.

Incentives

For the promotion of renewable heat successfully applying developers of renewable heat producing projects an investment subsidy instrument is available from the Operational Programme Quality of Environment funded by the ERDF. RES-H building obligations foster renewable heat and roof-top PV. A professional training programme is available to RES-installers.

Policies and measures to foster the production and use of renewable heat include:

- The certification of RES installers applies to installers of boilers and furnaces for biomass, PV and solar thermal installations, shallow geothermal plants and heat pumps.
- Energy performance certification is required for public buildings with a total floor area of more than 250 m², newly constructed or renovated buildings as well as all other buildings that are sold or rented to a new tenant. This stimulates energy efficiency and renewable energy production and use. The details on the calculation of the energy performance of buildings and the content of energy certificates are set as per decree by the Ministry of Construction and Regional Development of the Slovak Republic.

3.6.26 Slovenia

The most substantial support for RES heating and cooling in Slovenia is a financial incentive from the Ministry of Infrastructure via public (state owned) energy companies and a (soft) loan scheme financed by the Eco Fund.

Policies and measures promoting the use of renewables for producing final heating and cooling energy:

- The Eco Fund provides investment grants for the use of RES-H in one-family and multi-family houses by residents, for environmental investments and projects by legal entities and environmental investments of local communities. At the moment there are 5 public calls open covering a loan and subsidy scheme in the field of RES-H in Slovenia. Subsidies may also be competed for in tendering processes organised
by state owned energy companies who publish public calls and tenders on a regular basis.

- There is a training programme for installers of RES-installations, which is offered as a course for any interested installers on some schools in Slovenia either as part of the normal curriculum for installers or a special course.
- RES-H building obligation obliges owners of new or renovated buildings to build energy efficient buildings and also to use RES as their main source of energy.
- A RES-H infrastructure is promoted by the Ministry of Infrastructure and Spatial Planning via tenders.

RES used for space heating, space cooling and Domestic Hot Water (DHW) is obtained in one of the following ways: 25% from solar energy, 35% from gas biomass, 50% from solid biomass, 70% from geothermal energy, 50% from heat from the environment (through heat pumps), 50% from Combined Heat and Power (CHP), or 50% from energy efficient district heating/cooling.

3.6.27 United Kingdom (England, Scotland, Wales, N-Ireland)

In the UK, a subsidy and price-based mechanisms are available for supporting RES-H installations. The Non-domestic Renewable Heat Incentive (RHI) is the world’s first Feed-in-Tariff for renewable heat, introduced in 2011 (non-domestic) and 2014 (domestic). The government announced in late 2015 that the RHI scheme would be extended to 2020/21. The budget is to increase from £430 million in 2015/16 to £1.15 billion in 2020/21.

Moreover, a certification scheme for solar thermal installations and an R&D policy are currently available. A plan for vocational training of installers is being developed.

In the UK there are currently two methods used for establishing a seasonal energy efficiency of space heating boilers: First there is the SEDBUK seasonal efficiency of boilers, which has been in use since 1998 and is also used for SAP calculations. The second is the ErP seasonal efficiency, as introduced by regulations 811/2013 and 813/2013. Both schemes are operated simultaneously, although SEDBUK no longer applies the A-G rating.

**SEDBUK**

On behalf of the UK Government a method for estimating the annual efficiency of domestic boilers (SEDBUK - Seasonal Efficiency of Domestic Boilers in the UK) was developed in 1998. Calculated efficiency values for boilers were determined with reference to test data arising from the Boiler Efficiency Directive and resulted in an A-G rating. The efficiency values have been used for UK Building Regulation minimum standards and also for the purpose of SAP assessments. The SEDBUK method has historically been published as an appendix within the SAP specification, though this will change for the next SAP update and a separate document will be issued.

The details of the scheme were updated in 2015 with the coming into force of the ErP regulations and since then the ErP information was used to calculate SEDBUK boiler rating.

The SEDBUK-10 method (to be published formally this year), as with SEDBUK-2009, produces a Winter and Summer Efficiency for use within SAP calculations. For product comparison purposes, it also produces a Comparative Hot Water Efficiency and Annual
Efficiency estimate. Further changes to the SEDBUK-10 Annual Efficiency method for condensing boilers are currently being considered, and in addition to those consulted on last year. These would incorporate EN13203 test data and to better reflect energy savings from Flue Gas Heat Recovery Systems (FGHRS) when integrated within a boiler.

The SEDBUK-10 method includes a correction on maximum part and full load test efficiency values. According to BRE there are theoretical limits of efficiencies, of 97.3% (gross) and 88.3% (gross) derived respectively, as per the Briefing Note available on bre.co.uk. Therefore, the UK holds the view that Ecodesign seasonal space heating efficiency values (with 0.85/0.15 weighing of part and full load efficiency) exceeding 92.5% are likely to be scientifically indefensible.

In Consultation Paper – CONSP:02 "SAP heating efficiency calculation for condensing boilers Issue 1.1" it was concluded that "... the efficiency determined for Ecodesign regulations is not the same as the efficiency required for SAP and cannot be used directly for a number of reasons, including:

- The regulation is concerned with the energy performance of a boiler product, though in some cases (as chosen by the supplier) as a boiler package, whereas SAP is concerned with the energy efficiency of a dwelling heating system.
- The regulation includes the electricity consumption of the boiler package within the label and assumes a fixed primary energy factor of 2.5. Whereas the SAP space heating efficiency is the ratio of useful heat extracted to fuel input. Electrical consumption is dealt with separately and is based on SAP’s CO2 emission factors.
- The energy efficiency of a condensing boiler is affected by the characteristics of heating controls which may not form part of the boiler package as sold. The effect of any controls that are part of the package are added to the weighted average efficiency. The technical basis of these adjustments for controls (Table 1) is unclear.
- The regulation covers three climate zones within the EU and EEA. The northern and eastern parts of the UK correspond closest to the middle EU zone (Strasbourg) and southern and western parts of the UK correspond closest to southern EU zone. No zone is particularly representative of the UK average.
- The regulation applies a weighting factor of 85% to the active efficiency at 30% part load and 15% to the active efficiency at full load to derive a weighted average efficiency. This means the weighted average is heavily reliant on the part load measurement which has a larger measurement uncertainty than the full load measurement. These weighting factors effectively assume the average heating load is 40% and return water temperature is 34.5ºC. The consequences of the assumed weighting factors are discussed in chapter 6.– the UK’s typical heating load will exceed the assumptions within the Ecodesign regulations.

As regards the temperature control classes it is recommended for SAP 2016 (in terms of boiler efficiency adjustment only) that:

- Classes II to VIII, excluding IV, are separately identified and recognised;
- Class I (a minimum requirement under the Building Regulations) and Class IV do not need identification for SAP assessments since they do not compensate;
- Class VIII is recognised as being equivalent to Class V for the purposes of SAP.
An hourly calculation method was developed to explore the annual variation in boiler water return temperature and its effect upon heating efficiency. This method utilises the design flow temperature of the heat emitter system and is similar to the revised heat pump calculation method, which is based on prEN15316-4-2. The calculation method uses hourly weather data (East Pennines) to determine the hourly heat load and required flow temperature. The method is also influenced by prEN15316-4-1, which includes an allowance for on/off cycling losses.

Calculation results showed that heat emitters sized in accordance with common practice (design flow temperature of 80 °C) may have inadequate heat output to produce sufficient heat over an 11-hour period (standard SAP heating hours) during the coldest days of the year. Therefore, for consistency with the annual efficiency calculation methods for Heat Pumps and Micro-cogeneration (also known as microCHP) in SAP, it is recommended that variable heating hours are introduced to the boiler annual efficiency calculation for SAP 2016.

Utilising this calculation method for a range of condensing boilers currently entered in the SAP Product Characteristics Database (PCDB) has led to the recommendation (for SAP 2016) that an amendment to the SAP/SEDBUK 2009 seasonal efficiency calculation is made, whereby the offset term is amended. The calculation is otherwise an average of both full and part load efficiency test results. Using the hourly calculation method for each new boiler entered into the PCDB was found to be unnecessary.

Additionally, a generic range of corrections should be applied to the calculated seasonal space heating efficiency. Determining a correction for individual boilers in the PCDB was also found to be unnecessary. This correction is based on the Ecodesign Control Class, the design flow temperature (80°C, 70°C, 55°C, 45°C, 35°C), the fuel (mains gas, LPG and oil) and boiler firing control (modulating or on/off). Efficiency adjustments are calculated on the basis that they achieve almost ideal weather compensation, no compensation, or halfway in-between.

No changes are proposed for the treatment of non-condensing boilers in SAP 2016.

The electricity consumption of boilers is measured as a requirement of the Ecodesign regulation; though circulation pump power is not. These measurements should be used for the purposes of SAP 2016, replacing the annual electricity default assumption.

Water heating data is included in the Regulation’s requirements for combination boilers but this does not affect SAP, since this data can already be recognised (provision for EN13203 test data was introduced in SAP 2009, though only for Tapping Schedule M or Schedule M and S or L).

The Energy Balance Validation (EBV) method was introduced to improve the reliability of part load and full load test efficiency values, which are subsequently processed for entry in the PCDB. Boilers are entered in the PCDB if the direct measure is not more than 4 and 2 percentage points (net efficiency) higher, for part and full load test respectively, than an efficiency value derived from the Flue Loss Method. It is recommended that the EBV method is extended to LPG and oil boilers, and that the part load efficiency allowance is reduced to 2.5 percentage points."

Furthermore, in STP09-B01 is stated: "Evidence collected over a period shows a significant discrepancy between results from boiler efficiency tests carried out independently and those used by boiler manufacturers to obtain entries in the Boiler
Efficiency Database. The differences lead to the conclusion that there is a systematic upward bias in results from manufacturers. Although the SEDBUK formulae limit the effect of this by capping, some of the figures submitted for inclusion in the Boiler Efficiency Database for SAP are too high. This conclusion is supported by further evidence from boiler monitoring projects run by the Carbon Trust and Energy Saving Trust".

In SAP 2009 and SAP 2016 an off-set is applied if the full-load or part-load efficiency is above a threshold value.

Table 23. Offset applied if declared efficiency is above threshold

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Threshold efficiency (GCV)</th>
<th>Offset / correction if declared efficiency above threshold</th>
<th>Threshold efficiency (GCV)</th>
<th>Offset / correction if declared efficiency above threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>86.0455%</td>
<td>-0.673*(declared eff. – threshold eff.)</td>
<td>87.0366%</td>
<td>-0.213*(declared eff. – threshold eff.)</td>
</tr>
<tr>
<td>LPG</td>
<td>87.9555%</td>
<td></td>
<td>88.9686%</td>
<td></td>
</tr>
<tr>
<td>Oil</td>
<td>89.4835%</td>
<td></td>
<td>90.5142%</td>
<td></td>
</tr>
</tbody>
</table>

SAP 2016 also gives maximum values of gross efficiency for each fuel that may be used. Any greater value (after adjustment according to table above) shall be adjusted to the appropriate value given in the table below\(^\text{118}\).

Table 24. Maximum efficiencies allowed in SAP

<table>
<thead>
<tr>
<th>Max. efficiency (GCV)</th>
<th>Condensing boilers</th>
<th>Non-condensing boilers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural gas</td>
<td>LPG</td>
</tr>
<tr>
<td>Full load</td>
<td>88.30%</td>
<td>90.26%</td>
</tr>
<tr>
<td>Part-load</td>
<td>97.31%</td>
<td>97.63%</td>
</tr>
</tbody>
</table>

Sources:
https://www.bre.co.uk/filelibrary/SAP/2016/CONSP-02---Seasonal-efficiency-of-condensing-boilers---V1.1.pdf
https://www.bre.co.uk/sap2016/page.jsp?id=3619

Boiler plus requirements

1) All gas boilers installed into existing systems in England to have an ErP efficiency of at least 92%.
2) All gas and oil boilers require time and temperature controls to be installed at the same time, if not already present and working.
3) Combination boiler replacements to include the provision of an additional energy efficiency measure to be installed at the same time, for example:
   a) Flue gas heat recovery
   b) Weather compensation
   c) Load compensation
   d) Smart controls with automation and optimisation functions

\(^\text{118}\) CALCM-02—SAP-2016-SEASONAL-EFFICIENCY-VALUES-FOR-BOILERS—ALL-FUELS—DRAFT8
Changes to technical standards under Building Regulations Approved Document L1b (also known as Boiler Plus) are due to come into effect in April 2018 and will apply to England only.

**Incentives**

The UK Government recently increased incentives for households that installed renewable energy systems, making ground source and air-to-water heat pumps very attractive solutions. The Renewable Heat Incentive (RHI) payments are transferred to homeowners for seven years after installation. New rates were introduced at the end of 2017 to encourage the switch from fossil fuels and help the government meet its sustainable energy targets. The source mentions the example of a ground source heat pump fitted in a three-bedroom house could generate annual payments of around £2,173 per year, which is £15,215 over seven years. An air source heat pump fitted in a typical three-bedroom home could generate an income of more than £961 per year, which is £6,727 over seven years.\[119\]

**3.6.28 Sweden**

Tax exemptions are the main incentives to support renewable energy for heating purposes as well as for promoting biofuels for transport purposes. Tax exemptions include income tax deduction of installation works in apartments and single-family houses when replacing conventional heating with heating based on renewable energy sources, exemption of energy and CO2 taxes and nitrous oxide tax.

In Sweden the definition of a nearly zero energy building has been in force since 1 Jul 2017. It is based on the calculation of primary energy needs and allows for different primary energy factors for different energy carriers.

The basic calculation is:

\[
EP_{pet} = \sum_{i=1}^{6} \left( \frac{E_{uppv,i}}{F_{geo}} + E_{kyl,i} + E_{tvv,i} + E_{f,i} \right) * PE_i \]

Where:
- \(E_{uppv,i}\) is the space heating energy for energy carrier \(i\)
- \(E_{kyl,i}\) is the space comfort cooling energy for energy carrier \(i\)
- \(E_{tvv,i}\) is the domestic hot water heating energy for energy carrier \(i\)
- \(E_{f,i}\) is the building property energy for energy carrier \(i\)
- \(F_{geo}\) is a geographic correction factor
- \(PE_i\) is the primary energy factor for energy carrier \(i\)
- \(A_{temp}\) is the “floor area” intended to be heated to more than 10 \(\circ\)C

The primary energy factor for 2017 until 2021 is ‘1.0’ for all energy carriers, apart from ‘1.6’ for electricity. This ensured a smooth transition from the preceding building

\[119\] https://www.yorkshirepost.co.uk/lifestyle/homes-gardens/greener-heating-systems-boosted-by-government-incentives-1-8964091
regulations. The geographic corrections range from 0.8 in the very south to 1.9 in the very north and has a much higher resolution than before (factors now set at commune / province level, in 12 levels, whereas this was only 4 regions before).

The maximum primary energy consumption (PETmax) is 90 kWh/m² for single family houses (some 55 kWh for heating and DHW if electrically heated), down to 80 kWh/m² for other buildings. A minimum requirement for insulation level still applies, which is (average) 0.4 W/m²K for single family houses. Depending on the type of space heater and correction factor tighter insulation values may be required to meet the energy performance.

There is no mandatory requirement to use/produce renewable energy on-site, but the use of it does lower the PET value.

**Incentives**

In the 1970s oil was the main heating fuel in Sweden, both directly in boilers and indirectly as a source for district heating. Since then Sweden has applied a policy of discouraging the use of heating oil. In 2015, oil was only 2% of the final energy use in dwellings, down from 36% in 1983 (see figure below)\(^{120}\). In district heating there is a similar trend (see figure below).

In 2014 only 200 oil-fired boilers were sold and 900 gas-fired boilers (see Task 2).

Sweden is on the right track to meet its domestic climate and energy targets for 2020, and it has a high share of renewable energy in its energy mix, also from very recent and planned investments in wind energy. It has set domestic emission reduction targets beyond the EU requirements and is calling for more ambitious action at the EU level.\textsuperscript{121}

\subsection{3.6.29 Norway (EEA)}

Although the first EPBD Directive 2002/91/EC was fully implemented in Norway since 2010, its successor Directive 2010/31/EU has not been included in the EAA Agreement yet, and is thus not implemented in Norway. The Norwegian Government has decided to incorporate the directive into the EEA Agreement with necessary adaptations.

The Norwegian building regulation, mandatory since 2017, includes two options to fulfil the requirements. For non-residential buildings, only the first option is allowed.

- The first option contains specific energy limits for different building types. The requirements are set in kWh/m\textsuperscript{2} useful energy demand per year within the building envelope, considering heat recovery from ventilation systems but not considering system losses and energy export. If this option is chosen, a set of absolute minimum requirements must also be fulfilled.
- The second option (only for residential buildings) addresses different components of the building envelope as well as requirements for technical installations and solutions. The requirements will be considered fulfilled, if it is proven that 9 specific

\textsuperscript{121} https://www.euractiv.com/section/energy/news/swedes-set-to-smash-renewable-target-12-years-early/
energy measures are applied. In addition to requirements concerning insulation and envelope airtightness, there are specific requirements for the heat recovery of ventilation air in the ventilation apparatus (yearly mean heat recovery rate) and the specific fan power (SFP) factor.

In order to ensure flexibility in heating systems and to facilitate systems based on renewable energy, all buildings larger than 1,000 m² shall have flexible heating systems, normally waterborne, and must be able to utilise low-temperature heating distribution systems. Single-family houses need to have a chimney flue, unless flexible heat distribution is installed. Installation of heating systems prepared for fossil fuels is not allowed. As Norwegian electricity production is almost exclusively based on renewable energy and fossil fuels are to be phased-out from buildings, primary energy factors are not used in the regulations.

The Building Code in Norway, TEK‘17, does not allow the use of fossil fuels (for space and water heating) in new and refurbished buildings (the building code for new buildings apply if more than 50% of the value of the building is refurbished). The prohibition to use fossil fuel in heating systems for **new dwellings** started in 2010. On 15 of June 2017 the government announced the prohibition to use mineral oil fuel in **existing heating** systems after 01.01.2020. The regulation is written, published and subject to a public inquiry process as well as an EEA ESA approval, both expected by end of 2017.

The most important part relevant for heating systems and sanitary heating systems are laid down in **Section 14-4 Requirements for energy supply solutions**

1) The installation of fossil fuel heating installations is not permitted.
2) Buildings with a heated gross internal area of more than 1,000 m² shall:
   a) have multi-source heating systems; and
   b) be adapted for use of low-temperature heating solutions.
3) The requirements in the second paragraph do not apply to small houses.
4) Dwelling units in small houses must have a chimney. This requirement does not apply if:
   a) the dwelling unit has a water-borne heating system; or
   b) the annual net energy requirement for heating does not exceed the requirements for passive houses, calculated as specified in Norwegian Standard NS 3700:2013 Criteria for passive houses and low energy buildings – Residential buildings

In the guidelines supporting **Section 14-4 Requirements for energy supply solutions** clarifies what kind of energy sources that can be used in a multi-source heating system, and what a low-temperature heating solution is in the context of the building code.

"Low temperature heating solutions" ensures that flexible energy use is possible with more than one energy source, such as “waste heat”, solar heat or heat from the surroundings (air, ground, water sea). Where heat is transferred by radiation panels (NB not water-filled radiators), the rule about low temperature distribution does normally not apply.
The reason for setting aside a minimum area for the technical utility/boiler room in the building, is to provide enough space for a heating central that can accommodate real energy flexibility in terms and not only be restricted to an electrical resistance heater.

**Pre-accepted solutions**

The following criteria have to be fulfilled:

1. The energy flexible system has to cover at least 60% of the standardized energy need for space- and water- heating, calculated following NS3031:2014;
2. Low temperature heating systems must have supply temperatures of less than 60°C or lower at dimensioning conditions. This does not apply for domestic hot water (DHW);
3. The minimum area set aside for the utility/boiler room shall be at least 10m² + 1 percent of the heated area up to a total of 100 m²;
4. The roof height in the utility/boiler room shall be a minimum 2,5 meters;
5. Door openings for all doors into the utility/boiler room shall be at least of 1 meter width.

**Previous legislation**

Previous legislation also had restrictions on use of direct electric resistance heating and water heating, but due to ample surplus and very low electricity prices, this is no longer an issue.

The idea is that power peaks will be regulated via pricing signals once the majority of electricity subscribers have installed the new advanced metering systems in 2018 and the proposed legislation for combined energy and power tariffs are introduced shortly thereafter.

The previous building code TEK’10 valid from 2010 to 2017 had requirements to “new renewable” energy sources to cover 40% of the required net heating demand for building less than 500 m², and for 60% of the required net heating demand for buildings over 500 m². Direct electrical resistance heating was not regarded as “new renewable”. Several studies showed that demanding energy flexible heating systems in Norway was a financial burden for new developments.

The government introduced a simplified legislation that allows direct electrical resistance heating for smaller buildings as:

- energy flexible heat generators and distribution systems have relative high product costs and in particular high installation costs;
- the market has very low electricity costs;
- most of the electricity is from renewable sources (98% of production from central hydroelectric and wind power production).

District heating plants over 10 MW had to have a license to operate in a designated area, and the building code regulated that buildings in this designated area where these plants operated, had to be able to connect to the heating grid of these plants. This rule was abolished in the 2017 building code. It is now up to the municipalities to decide this in local building codes.
The Task 1 Water heater review study has a specific section on Norwegian requirements for water heaters.

**Carbon intensity of electricity in Norway**

The Norwegian electrical power generation (150 TWh) is 98% renewable in 2016, and projected to be close to 100% renewable due to requirements in the RES directive by 2020. The internal consumption is 133 TWh in 2016 (purchased electricity). However, most of the power purchased in Norway (some 84%) is not backed by Guarantees of Origins (GOs). The system implies, that consumers and businesses who do not buy GOs, officially owe their electricity supply to a mix of mainly fossil sources regardless of the physical location of the consumer or business. Some 112 TWh of power purchased in Norway is believed to be a residual energy mix of 64% fossil fuel production, 21% nuclear and 14% renewable energy\(^\text{122}\). According RE-DISS the residual mix of Norway is 24% renewable, 19% nuclear and 57% fossil fuel, resulting in a CO2 (direct) intensity of average 441,58 gCO2eq./kWh or a GWP LCA intensity of 506 gGWP/kWh (which is between Spanish and Italian intensities)\(^\text{123}\).

### 3.7 Horizontal issues

#### 3.7.1 Emission limits

The following tables give an overview of emission limits (status Oct. 2017) and main assessment methodologies (status June 2018) for boilers in EU-member states, Switzerland and Turkey.

---

\(^{122}\) Analysis of the trade in Guarantees Origin, Economic analysis for Energy Norway, OE-report 2017-58, Oslo Economics, 16 January 2018

\(^{123}\) European Residual Mixes 2016, Association of Issuing Bodies (website of the RE-DISS project http://www.reliable-disclosure.org)

See:

- https://www.aib-net.org/web/portal/facts/european_residual_mix
### Table 25. Emission limits for boilers 0-1 MW

**Source:** CEN TC 109 WG1, presentation 1.11.2018, pers. comm. W. Linke, EHI

<table>
<thead>
<tr>
<th>Country &amp; kW range (all 3% O2, boiler temperature reference 80°C/60°C)</th>
<th>Heating oil EL</th>
<th>Natural gas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOx</td>
<td>CO</td>
</tr>
<tr>
<td></td>
<td>mg/Nm³</td>
<td>mg/Nm³</td>
</tr>
</tbody>
</table>

#### European Union

**ErP 2013/813 (LOT 1) from 26.09.2018**

| 0-1 - 2 MW | 119.3 | - | - | - | - | 55.8 (1) | - | - | - |

**ErP 2013/814 (LOT 2) from 26.09.2018**

| 0-1 - 2 MW | 119.3 | - | - | - | - | 55.8 (1) | - | - | - |

**Ecolabel (voluntary label)**

| 0.1 - 2 MW | 35.9 | - | - | - | - | - | - | - |

#### Belgium

- Wall hung boiler < 400 kW (from 1.1.2012)
  - 70
- Floor standing boilers < 400 kW (*
  - 70
- Fan burner <70 kW
  - 120
- Atm. gas burner <70 kW
  - 150
- Fan burner 70–400 kW
  - 120
- Atm. gas burner 70–400 kW
  - 150

#### Flanders from 1.5.1999

- 0.1 - 2 MW
  - 250
- 0 - 120 kW
  - -
- 0.12 - 5 MW
  - 181
- 0.12 - 5 MW
  - 411

#### Denmark

- 0 - 120 kW
  - -
- 0.12 - 5 MW
  - 181
- 0.12 - 5 MW
  - 411

#### Germany

- < 120 kW
  - 107
- 120 kW - 400 kW
  - 117

#### France

- 87 kW - 2 MW
  - -
- 87 kW - 2 MW
  - -
- 87 kW - 2 MW
  - -

#### Greece

- Boiler (3% O2)
  - 305
- Automatic feed installations (10% O2) (2)
  - -
- < 50 kW
  - -
- 50 - 150 kW
  - -
- 150 - 300 kW
  - -

#### United Kingdom <20 MW

- 300-400

#### Italy

- National (DL 151/2016) 1 < MW < 5 (3)
  - 500
- Piemonte: Piano regionale 20.1.2017
  - 80 mg/kWh
- Piemont KW < 35 (Natural gas, LPG)
  - -
- Piemont 35 < kW (Natural gas, LPG)
  - -
- Lombardia D.G.R. 6501/2001 – ANNEX C
  - 200
- Lombardia MW < 3 (natural gas)
  - -

#### Netherlands < 0.9 MW

- > 0.4 MWth
  - 120
- > 5 MWth
  - 120

#### Austria LRV K

- 0.35 MW - 1 MW
  - 150
- FAV < 2 (3) MW
  - 150
- § 15a <350 kW (1400 kW)
  - 129
- Poland < 5 MW (fuel oil)
  - 400
- Sweden
  - 250

**Notes:**

1. [1]
2. [2]
3. [3]
| Switzerland LRV (1992) | Medium temperature < 110 °C (fan burner) | 120 | 80 | - | - | 1 | 80 | 100 | - | - |
| | > 110 °C (max. limit per canton) | 150 (120) | 80 | - | - | 1 | 110 (80) | 100 | - | - |
| Slovenia | < 120 kW | - | - | 60 | 100 | - | - | - | - | - |
| | 120 kW < 400 kW | - | - | 80 | 100 | - | - | - | - | - |
| | > 400 kW | - | - | 120 | 100 | - | - | - | - | - |
| Czech Republic | < 300 kW (from 1.1.2014) | 130 | 100 | - | - | - | 120 | 100 | - | - |
| | 0.2 - 5 MW | 500 | 175 | 1700 | 100 | - | 200 | 100 | 35 | 50 |
| Croatia 0.1 - 3 MW (fuel oil) | 250 (350) | 175 | - | 1 | 200 | 100 | - | - | - | - |
| Turkey | 15 - 70 kW (Directive for Heating Originated Air Pollution Control, OJ 25699, 13.1.2005) | 185 | 110 | - | - | 2 | - | - | - | - |
| | 30 - 70 kW ( * ) | - | - | - | - | 260 | - | - | - | - |
| | 70 - 1000 kW (gas max. soot 2) ( * ) | 250 | 110 | - | - | 1 | 260 | 1070 | - | - |

European countries with no information about emission regulation in relevant power range:
Bulgaria, Cyprus, Estonia, Finland, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Malta, Portugal, Romania, Slovakia, Spain

[1] = European Union: Same value also for LPG
[2] = Greece: Manual-feed boilers < 50 kW Nox < 340 mg/m³ at 10% O₂
[3] = Italy: All plants with an output > 1 MW (oil) or > 3 MW (gas) need an emission permission by ARPA. The ARPAs can locally fix lower limits. Any Region can fix their own limits
Table 26. Evaluation of emissions country by country, part 1

<table>
<thead>
<tr>
<th>Standard/Rule/Law</th>
<th>Deutschland / Germany</th>
<th>Austria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reference conditions (e.g. O2 content, air temperature, dry or wet flue gas, etc.)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Status: 14.06.2018</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard conditions (273K; 1013 mbar)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emissions based on 3% O2 in the dry exhaust gas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NOx is calculated as NO2 in dry exhaust gas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emissions related to 3% O2 in dry exhaust gas (EN267 / 676 refers emissions to mg / kWh, therefore reference oxygen content is not necessary!)</td>
</tr>
<tr>
<td><strong>Uncertainty of measurement</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NO\textsubscript{X} : ± 10 ppm CO: ± 10 ppm Soot: ± 0,2</td>
<td></td>
</tr>
<tr>
<td><strong>Generation of evaluation value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Arithmetic averaging in the field of work (averaging of measured values on the performance (low, medium and full load))</td>
<td>Validation of daily and half-hourly mean values according to Annex II.</td>
</tr>
<tr>
<td></td>
<td>Three individual measurements at different load levels (low, medium and full load) as half-hour mean values; none of the individual measurements may exceed the limit value</td>
<td></td>
</tr>
<tr>
<td><strong>Correction of nitrogen content for oil</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reference value: 140 mg/kg; Correction according to Annex B3 possible (EN267)</td>
<td>Reference value: 140 mg/kg; Korrektur möglich</td>
</tr>
<tr>
<td></td>
<td>Bezugswert: 140 mg/kg; Korrektur möglich</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not possible</td>
<td>Not mentioned</td>
</tr>
<tr>
<td><strong>Correction of influence of temperature on NOx emissions (in the range of 15°C - 30°C)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>According to Annex B2 or G possible (EN267 / 676)</td>
<td>Only possible for oilburners following Annex B2 (EN267) (see also BdH Informationsblatt nr. 16)</td>
</tr>
<tr>
<td></td>
<td>Not possible</td>
<td>Not possible</td>
</tr>
<tr>
<td><strong>Correction of influence of humidity in combustion air on NOx emissions (in the range of 5 g/kg to 15 g/kg)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>According to Annex B2 or G possible (EN267 / 676)</td>
<td>Only possible for oilburners following Annex B2 (EN267) (see also BdH Informationsblatt nr. 16)</td>
</tr>
<tr>
<td></td>
<td>Not possible</td>
<td>Not possible</td>
</tr>
</tbody>
</table>

Source: CEN TC 109 WG1, presentation 1.11.2018, pers. comm. W. Linke, EHI
Table 27. Evaluation of emissions country by country
Source: CEN TC 109 WG1, presentation 1.11.2018, pers. comm. W. Linke, EHI status 14.06.2018

<table>
<thead>
<tr>
<th>Standard/Rule/Law</th>
<th>Slovakia</th>
<th>Poland</th>
<th>Switzerland</th>
<th>Spain</th>
<th>France</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reference conditions (e.g. O2 content, air temperature, dry or wet flue gas, etc.)</strong></td>
<td>315/2017 Z.z. (complements Z.z. 410/2012)</td>
<td>POS (Prawo Ochrony Środowiska – Law for Safety of Environment)</td>
<td>LRV2018</td>
<td>R.D. 1042/2017</td>
<td></td>
</tr>
<tr>
<td>Emissions based on 3% O2 in the dry exhaust gas NOx is calculated as NO2 in dry exhaust gas</td>
<td>Standard conditions (273K; 1013mbar)</td>
<td>Standard conditions (273K; 1013mbar)</td>
<td>Standard conditions (273K; 1013mbar)</td>
<td>Standard conditions (273K; 1013mbar)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emissions based on 3% O2 in the dry exhaust gas NOx is calculated as NO2 in dry exhaust gas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Burner range: 0.3-14.9 MW and then from 50.0 MW: two individual measurements at low load and at full load as half-hour mean values; none of the individual measurements may exceed the limit value</td>
<td>none of the measured values may exceed the limit value</td>
<td>The emissions are at steady state in each individual firing in those</td>
<td>Not mentioned</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.0-49.9 MW: three individual measurements at different load levels (low, medium and full load) as half-hour averages; none of the individual measurements may exceed the limit value</td>
<td>none of the measured values may exceed the limit value</td>
<td>To measure load ranges, which are important for the assessment. Usually are at least the highest and the lowest load point, in which the system under usual operating conditions is operated.</td>
<td>Not mentioned</td>
<td></td>
</tr>
<tr>
<td><strong>Uncertainty of measurement</strong></td>
<td>Measurement uncertainty must be maintained NOx: ± 10% CO: ± 5%</td>
<td>no concrete statement about measurement uncertainty (… taking into account the measurement uncertainty …)</td>
<td>no statement about the measurement uncertainty</td>
<td>no concrete statement about measurement uncertainty</td>
<td></td>
</tr>
<tr>
<td><strong>Generation of evaluation value</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burner range: 0.3-14.9 MW and then from 50.0 MW: two individual measurements at low load and at full load as half-hour mean values; none of the individual measurements may exceed the limit value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.0-49.9 MW: three individual measurements at different load levels (low, medium and full load) as half-hour averages; none of the individual measurements may exceed the limit value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Correction of nitrogen content for oil</strong></td>
<td>Currently no info, but oil burning plants are very rare in Slovakia</td>
<td>Not possible</td>
<td>Not possible</td>
<td>Not mentioned</td>
<td>Not possible</td>
</tr>
<tr>
<td><strong>Correction of influence of temperature, on NOx emissions (in the range of 15°C - 30°C)</strong></td>
<td>Currently no info, but oil burning plants are very rare in Slovakia</td>
<td>Not possible</td>
<td>Not possible</td>
<td>Not mentioned</td>
<td>Not possible</td>
</tr>
<tr>
<td><strong>Correction of influence of humidity in combustion air on NOx emissions (in the range of 5 g/kg to 15 g/kg)</strong></td>
<td>No</td>
<td>Not possible</td>
<td>Not possible</td>
<td>Not mentioned</td>
<td>Not possible</td>
</tr>
</tbody>
</table>
3.7.2 *Indoor/outdoor noise*

Sound power is the total acoustical energy emitted by a sound source and is an absolute value. It is not affected by the environment or the location of the listener. Ecodesign requirements regulate and labelling information relates to sound power.

Sound pressure is what you hear and is affected by the sound power, the environment or the location of the listener. More and more communities and Member States are introducing limits to the sound pressure perceived at (the plot boundaries or windows) of neighbouring properties.

Indoor sound is often regulated in national building codes. Most often indoor sound pressure from equipment that is installed close to or in habitable rooms should not exceed 30 dB.

Outdoor sound from installations is now receiving more attention from regulators as well: Certain member states (Austria, Germany, United Kingdom and Switzerland) have introduced maximum sound pressure limits for outdoor heat pumps as they noticed outdoor noise becoming a bigger problem when more homes in a neighbourhood turn to heat pump or hybrid solutions involving compression of refrigerants. At the coldest moments (night-time) more and more compressors will run at higher capacities, producing more sound:

- In Austria the noise from the (air-source) heat pump should not vastly exceed the background noise level, and criteria for distance, depending on installation circumstances, are provided\(^{124}\). Maximum noise pressure levels vary per region, and limits may apply to the property border or the facade of the neighbouring property. A map of sound limits (at day and/or night) sets the outdoor sound power from all sources. When installing a heat pump, a neighbour has to clarify the accepted outdoor sound power level by a legal expert measuring the sound of the surroundings, on a case by case basis. This brings uncertainty for the acceptable sound power levels.

- In Germany the “Guideline for Improving Protection against Noise from Stationary Equipment”\(^{125}\) of the German Federal State Joint Committee for Immission Protection (LAI). The guideline of the Bundesverband Wärmpumpe (BWP) e.V., based on that official Guideline sets maximum noise (pressure, or “immission”) levels depending on day/night operation and surroundings: For a residential area the maximum level is 35 dB(A) at night-time (from 22 to 6 h). The Bundesverband Wärmpumpe (BWP) e.V. has published a guideline to establish / calculate indicative noise levels\(^{126}\).

- In the UK the installation of an air source heat pump does not require prior permission if the requirements of MCS 20 are met\(^{127}\): MCS20 means the maximum sound pressure one metre external to the centre point of an y door or window to a habitable room of a neighbouring property as measured perpendicular to the plane of

---


\(^{125}\) https://www.lai-immissionsschutz.de/documents/leitfaden_1503575952.pdf


\(^{127}\) https://www.planningportal.co.uk/info/200130/common_projects/27/heat_pumps/2
the door or window is maximum 42 dB(A)\textsuperscript{128}. The MCS20 describes the procedure which takes into account corrections of the unit sound power level for directivity, distance, barriers, background noise (40 dB(A)) and a correction for the higher value.

- The Netherlands has decided to introduce a maximum sound pressure level of 40 dB for neighbouring homes\textsuperscript{129}. This includes possible tonality of the sound source, which if present, adds 5 dB(A) to the sound pressure. This means that most heat pumps (which emit sound with a tonal character) cannot emit more than 35 dB(A) at the property boundary. For an average heat pump in a dense area this means a reduction of 9 to 14 dB(A) is needed\textsuperscript{130}.

The sound pressure at a certain distance, for a certain location, can be calculated using the following equation\textsuperscript{131}:

\[ L_{PA} = L_{WA} - 10 \times \log(P \times 3.14 \times R^2) \]

Where:

- \( L_{PA} \) = sound pressure, in dB(A)
- \( L_{WA} \) = sound power, in dB(A);
- \( P \) = correction for nearby reflecting surfaces (corner position is 1/8 sphere \( P = 0.5 \); placed on surface against wall is 1/4 sphere \( P = 1 \); placed on surface, no walls is 1/2 sphere \( P = 2 \));
- \( R \) = the distance to the source;

The sound pressure of units that meet the maximum sound power limits set by the regulations are:

<table>
<thead>
<tr>
<th>Table 28 Sound pressure at various distances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat output range (max. outdoor sound power)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>up to 6 kW (65 dB(A))</td>
</tr>
<tr>
<td>between 6 and 12 kW (70 dB(A))</td>
</tr>
</tbody>
</table>

Assume an outdoor unit produces 62 dB(A) sound pressure (which would have a sound power / emission of approximately 7- dB(A)), measured at 1 m distance. This unit is placed at 3 m distance from the property boundary at which a sound pressure (immission) limit of 35 dB applies. The sound pressure level is reduced by 6 dB when doubling the distance from the source. Following this the sound pressure (of 1 m distance) is reduced by 9.5 dB. In the example an additional noise reduction of 17.5 dB(A) would be needed (35 dB = 62dB − (9.5dB + 17.5dB).

\textsuperscript{128} MCS 20 Planning Standards, by the Department of Energy and Climate Change (DECC), United Kingdom, 2008

\textsuperscript{129} https://www.rijksoverheid.nl/actueel/nieuws/2019/05/21/strengere-geluidseisen-voor-buitengeplaatste-warmtepompen-en-airco%E2%80%99s

\textsuperscript{130} https://stillewarmtepomp.nl/blog/geluidsoverlast/merford-ontwikkelt-oplossing-geluidsoverlast-warmtepompen

\textsuperscript{131} https://nsg.nl/nl/geluidsaspekten_van_warmtepompen
This is however only correct if the sound source is not installed near one or more reflecting surface (e.g. a wall of a building) which would add 3 dB each to the sound pressure level. In the example (outdoor unit with a sound power level of 70 dB(A) between two buildings, 3 m distance), you would need a technical reduction of 23.5 dB(A) or more.

Besides reducing the sound power of units placed on the market, there are retrofit or installation specific ways of reducing sound pressure, such as applying a sound canopy or enclosure. Sound pressure reductions of 15 dB(A) are achievable\textsuperscript{132}. Aftermarket sound canopies demand a lot of space and should be adapted to each design of a heat pump. They should not impede air flow as the heat pump energy efficiency could be lowered. Mounting (no known solutions for wall hung installations) and cost issues need to be considered from heat pump to heat pump.

Such solutions should not be generalised to all heat pumps and are not necessary in all cases. The market (the installer, supplier, manufacturer, customer) should be allowed to act either at product level or installation level, depending on the site-specific building codes.

As stated elsewhere the sound power of most (electric) heat pumps is measured at 'standard rating conditions' which is +7º outdoor temp, and (for variable speed or inverter driven units) a part load ratio 0.35 (as in EN 14825, point C, at +7ºC),

Stakeholders have argued that the sound emitted at 35% load is much less than at 100% load (at design temperature or bivalent point). And that the 100% load noise level is more likely the level that may create problems for neighbours (as it may occur at night, when outdoor temperatures are at their lowest and no solar gains apply). Industry stakeholders argue that increasing the Ecodesign requirements for maximum noise levels (e.g. at 100% load) has knock-on effects on the amount and type of refrigerant charges: More specifically, a lower noise level requires a larger evaporator, which is accompanied by a larger refrigerant charge. But as F-gas requirements aim at reducing the refrigerant charge these are conflicting trends. Ultra-low GWP refrigerants in general do not offer the same level of energy efficiency as high GWP refrigerants such as R410. Manufacturers do support information requirements, so that installers can make more realistic assessment of noise \textbf{pressure} to be experienced by neighbours, taking into consideration distance, orientation, surroundings, abatement measures, etc. Some Member States consider tonality of the sound produced as well, which requires more information for making correct assessments.

At the moment no EN standards exist to make this calculation (form general sound power to actual sound pressure on site) and manufacturers or communities apply their own methods. But there is an International Standard\textsuperscript{133} which each national environment protection authority uses for that purpose. Nevertheless, that task is none of the European Ecodesign regulation or any other European product regulation. Noise exposure protection is the responsibility of the Member States.

\textsuperscript{132} https://stillewarmtepomp.nl/
\textsuperscript{133} https://www.iso.org/standard/20649.html
Examples of online noise calculation tools are:

- https://www.waermepumpe-austria.at/schallrechner-v2
- http://lwpapp.webyte.de (from Saxony-Anhalt)

### 3.7.3 Legionella prevention and control

Cold domestic water may contain bacteria responsible for Legionnaire's disease. Storage of water at temperatures between 20-55°C allows growth of these bacteria with a peak growth rate around 37°C. Temperatures at 50-55°C stop growth and beyond 55°C bacteria count is reduced, also depending on the duration of exposure to elevated temperatures. Thermal disinfection (total removal of bacteria) requires temperatures of minimum 70°C (curative measure).[^134]

![Figure 17. Development of Legionella bacteria by temperature](https://www.zorg-en-gezondheid.be/handboek-best-beschikbare-technieken-voor-legionellabeheersing)

Member States are responsible for a safe design of water systems and national/local building codes (or the standards referenced by them) specify the technical conditions to be met. These technical conditions may be different from Member State to Member State.

- In Germany DVGW info sheet no. W 551 promotes a storage temperature above 60 °C at all times and DVGW info sheet no. W 553 aims to ensure that the pipe network is calculated and hydraulically synchronised.
- In the UK cold water systems should be maintained, where possible, at a temperature below 20 °C. Hot water should be stored at least at 60 °C and distributed so that it reaches a temperature of 50 °C (55 °C in healthcare premises) within one minute at the outlets[^135].

[^135]: Health and Safety Executive, Legionnaires' disease Part 2: The control of legionella bacteria in hot and cold water systems (www.hse.gov.uk/pubns/priced/hsg274part2.pdf)
In France the RT2012 requires a minimum DHW supply temperature at the tapping point of 52.5°C which requires a storage temperature of at least 55°C or higher (depends on heat loss between store and tapping point). According certain sources the storage temperatures must be raised to 60°C on a daily basis.

In Denmark the standard requires circulation pipes should be kept at no less than 50 °C, and the storage tank should be kept at 60 °C for buildings with a large DHW volume.

In the Netherlands the minimum temperature of DHW for washing up and cleaning must be 55°C at the tapping point, for personal hygiene it may be lower according NEN 1006 (annex C). If there’s a risk for contamination with legionella bacteria, the temperature of the water must be minimal 55°C (in dwellings) or 60°C (in nursing homes). For collective systems the supply and return temperature must be minimum 60°C. There is an exception provided for low water volumes (< 1 litre). If the abovementioned temperatures cannot be reached a periodic thermal disinfection may be applied (between 60°C to 70°C depending the duration, combined with a weekly thermal disinfection period of 5-20 minutes).

Authorities may require more stringent measures, such as periodic (e.g. daily) heating up to 60°C and ability to be sanitised using 70°C water depending on the risk profile (medium risk: collective DHW systems; high-risk: DHW for elderly or persons with reduced health).

Generally speaking, lower temperatures can be allowed if stagnation (a low refresh rate of stored volume) is avoided. Where stagnation is possible/expected, higher storage temperatures should apply. Design solutions are therefore: minimisation of DHW stored volume (instantaneous heating, high refresh rates), or temperature boosting (central or local).

Challenges are:

- Sanitising DHW requires a good mixing of water in storage tanks (to avoid 'cold' spots), but for heat pumps and solar devices a good stratification is beneficial for energy efficiency.
- Higher water temperatures (e.g. above 65°C) contribute to scaling (calcium deposits) which is not beneficial for sanitising, as legionella bacteria may be present in biofilms.

The 55°C tapping temperature as prescribed in the tapping patterns (minimum value according 2018 Guidelines) is not necessarily prescribing a storage (or circulation) temperature. Minimum storage temperatures are covered by Member States requirements regarding DHW safety. However, if the tap water temperature is measured close to the device (which is usually the case, as in EN 13203-2) then storage temperatures during testing may be set close to 55°C, whereas local requirements may prescribe higher temperatures. This creates a difference in energy consumption of the

136 https://www.mychauffage.com/blog/se-proteger-de-la-legionellose
137 Xiaochen Yang, Supply of domestic hot Water at comfortable temperatures by low-temperature district heating without risk of Legionella, PhD Thesis Department of Civil Engineering 2016 (DTU Civil Engineering Report R-346)
138 https://www.hydroscope.nl/nieuws/duurzaam-warm-tapwater/
test and in real-life. Note that the assessment of standing losses of (DHW) storage tanks, as regulated under 814/2013, is measured according EN 12897 and/or EN 15332 which prescribe a storage temperature set point of 65°C, following the TM2014wh (point 4.9(a), Tstore=65°C).

The Ecodesign Directive 2009/125/EC states in article 15.5(b) that "health, safety and the environment shall not be adversely affected". As the safety of DHW supply is foremost a matter for Member States one cannot conclude that the requirement for a 55°C tapping affects safety negatively as Member States can impose higher storage temperatures. However, the energy consumption will be higher when minimum real-life storage temperatures are higher than tested.

The Energy Label regulation 2017/1369/EU aims at introducing energy labels with A to G classification that corresponds to significant energy and cost savings and that enable consumers to make an informed choice based on the energy consumption of an appliance, therefore the energy consumption assessed should be as realistic as possible. Note: higher storage water temperatures do not have to apply continuously, but can be in the form of a periodic raising of storage temperature (daily, weekly) possibly in relation to the refresh rate of the storage volume.

3.7.4 Incentives for fuel cells

The EU is promoting the use of fuel cells as it allows decentralised generation of power (electricity) and most often allows use of heat as well (cogeneration).

The Ene.field project 139 (September 2015 to October 2017) deployed more than 1,000 residential fuel cell Combined Heat and Power (micro-CHP) installations, from 9 different manufacturers, across 10 key European countries. The Ene.field project also brought together over 30 utilities, housing providers and municipalities to bring the products to market and explore different business models for micro-CHP deployment.

139 http://enefield.eu/category/about/
The Ene.field project identified various issues or barriers that affect the take up of fuel cell cogeneration (FC-CHP). One of these barriers is that countries mix international and European standards with national versions (standards are relevant for funding, approval, installation, etc.). Another barrier is that the FC-CHP industries perceive the current calculation of energy efficiency (as applied for EU energy labelling) as inadequate. This includes the differences in the calculation of efficiencies for product labels and package labels\(^{140}\).

One of the key success factors identified is the spark spread or the difference in rates for electricity and gas. As to be expected the FC-CHP financial becomes more attractive in countries with relatively low gas prices and high electricity process. This is for instance (mostly) the case in Germany and Belgium.

Where the Ene.field project focused on demonstration mainly, its successor PACE will focus on commercialisation of the FC-CHP. PACE is a five-year, € 90 million public-private project co-funded by the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH JU) that will deploy more than 2,500 of the next generation Fuel Cell micro-Cogeneration units in 11 European countries by 2021. The project brings together the four leading European suppliers (BDR Thermea, Bosch, SOLIDpower and Viessmann), and will focus on customer homes and small enterprises. The products will be commercially available models with CE marking, not prototypes.

Manufacturers are supported by five partners – utilities, associations, consultancies, and research community – providing specific expertise (COGEN, DTU, Element Energy and EWE).

---

\(^{140}\) Figure 24 of “Non-economic barriers to large-scale market uptake of fuel cell based micro-CHP technology”, Final report 28/08/2017.
3.8 Policies and measures in non-EU countries

3.8.1 Turkey

Turkey is in a customs union with the EU and plans to apply the Ecodesign and Energy Labelling Regulations for space and water heaters from 21 April 2018 (as well as the Ecodesign rules for integrated circulators and the Gas Appliances Regulation). In number of units, Turkey is the third largest European market for gas-fired heating devices in Europe in 2016, after the UK and Russia but before Italy, France, etc.\textsuperscript{141} DOSIDER, the Turkish Association of Natural Gas Appliances Manufacturers and Businesspeople, expects—based on BRG data—that in 2018 more than 80\% of heating boilers will be wall-hung gas-fired condensing.

3.8.2 USA

MEPS

The USA has had mandatory minimum energy efficiency performance standards (MEPS) for boilers and furnaces since the 1980s. The current standards are contained in the Code of Federal Regulations (10 CFR Part 430 and Part 431) and use the annual fuel utilization efficiency (AFUE) rating. This rating represents a calculation of how efficiently the boiler converts energy into fuel in an average year.

The minimum AFUE requirements for boilers are based on the type of fuel and heating medium they utilize:

- 82\% for a gas-fired hot water boiler
- 84\% for an oil-fired hot water boiler
- 80\% for a gas-fired steam boiler
- 82\% for an oil-fired steam boiler

Non-condensing boilers typically have efficiency ratings that range from 80\% to 88\%, while those of condensing boilers are usually above 88\%, to maximum 95\% AFUE.

In addition, pilots that constantly burn are forbidden for gas-fired boilers and hot water boilers must be able to automatically adjust the water temperature to match the heat load.

The current test procedure in ASHRAE 103-1993 is a comprehensive standard, which is very similar to the ‘Boiler Cycling Method’ in the EN 15316-4-1 (space heating generation).

The ASHREA 103 standard describes the calculation of the annual fuel efficiency AFUE (on Gross Calorific Value) of a single stage boiler/furnace by using test data from steady state conditions, and cool down and heat up tests at the rated input. In the calculation procedure, the average boiler/furnace cycling times are assumed to be 3,87 min ‘on’ and 13,3 min ‘off’ based on the characteristic responses of the room thermostat and a

\textsuperscript{141} Celik, C., Heating Market in Turkey, Opportunities and Perspectives, presentation DOSIDER 2017. https://www.bdh-koeln.de/fileadmin/user_upload/ish/ish2017/vortraege_15_maerz/1_ish2017_heating_market_turkey_celik.pdf
boiler/furnace oversize factor of 0.7 with respect to the building heating load. This results in the boiler/furnace operating at an average of 22.5% of the rated capacity during the heating season. The average US heating season is given as 4160 h/yr (non-heating season 4600 h/yr). For modulating boilers ASHRAE 103-1993 measures at reduced and modulating stages. With condensing boilers, the quantity of condensate is assessed.

The AFUE thus takes into account more variables than the European method for establishing the seasonal efficiency, in particular losses related to cycling (purge losses). Because the ASHRAE 103-1993 also includes the steady-state efficiency – on which efficiencies in the EU are based – the difference with the AFUE is known. Anecdotal evidence suggests that the difference between AFUE and steady-state efficiency can be up to 10-12 percentage points for the type of boilers available in the USA (mainly non-condensing boilers).

The rules are laid down in the Code of Federal regulations (CFR), TITLE 10—Energy; CHAPTER II—DEPARTMENT OF ENERGY, more specifically Part 430, Subchapter D on residential water heaters and boilers (respectively Appendices E and N to Subpart B) and Part 431, Subparts E on commercial packaged boilers and water heaters/storage tanks (respectively Subparts E and G).

Mandatory labels
The US has mandatory energy labelling for furnaces and boilers ‘16 CFR Part 305 - Energy Labelling Rule - 305.12 Labelling for furnaces’.

Procurement and voluntary labels
Apart from the mandatory minimum standards and label, the federal government also has minimum requirements for federal procurement, using the Energy Star label (see section 3.9) and requirements under the Federal Energy Management Program (FEMP). The latter created tables that mirror American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1-2013 tables, which include minimum efficiency requirements for FEMP-designated and ENERGY STAR-qualified heating and cooling product categories. The table below illustrates only the part on hot-water boilers, but there are also sections on air-source and geothermal heat pumps (expressed in US EER or COP which are difficult to compare to EU metrics).

---

Table 29. Minimum requirements for gas-fired boilers (shown up to 733 kW) under the US FEMP programme\textsuperscript{143}

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Size Category (Input)</th>
<th>Efficiency Metric</th>
<th>Minimum Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas-fired Boilers, hot water</td>
<td>(&lt;300,000,\text{Btu/h}) (88,\text{kW})</td>
<td>AFUE</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>(\geq300,000,\text{Btu/h}) and (\leq2,500,000,\text{Btu/h}) (733,\text{kW})</td>
<td>(E_t)\textsuperscript{a}</td>
<td>95%</td>
</tr>
</tbody>
</table>

\(\textsuperscript{a}\) Thermal efficiency \((E_t)\) is based on Hydronics Institute, Method to Determine Efficiency of Commercial Space Heating Boilers (HI BTS-2000, Rev. 06.07).

**Refrigerants**

Under section 612 of the 1990 Clean Air Act, the Environmental Protection Agency EPA manages the Significant New Alternatives Policy (SNAP)\textsuperscript{144} Rule which looks for alternatives and at the same time prohibits the use of many HFCs in stationary refrigeration and air conditioning end uses. Most common HFCs are "unacceptable in certain uses" (this covers R134a, R407A, etc.). In the "what's left category" one finds refrigerants like R32, R513A, R450A, R290 (propane) and other HCs, CO\(_2\) (R744) and ammonia (R717). The current rule affects mostly supermarket refrigeration, but extending the scope to other refrigerant equipment is possible.

Currently, the EPA caps the charge limit for propane in commercial appliances at 150 g, but it is possible that international standards will move the limit for safe use to 500 grams by 2018, if coupled with a condenser fan, early detection system, and properly scaled room.

Four states —California, New York, Maryland and Connecticut— have committed to preserving the EPA’s original HFC restrictions on the state level.

**Fans**

The state of California is considering the introduction of minimum energy efficiency requirements for embedded products such as fans. This may have relevance for fans used as combustion fans in boilers and fans in air-to-water heat pumps.

Docket 17-AAER-06 presents a staff report for proposed standards for commercial and industrial fans and blowers (June 2018).

**Grants, subsidies, tax relief etc.**

Eurovent reports that in the USA the DOE/EPA accepts as proof of compliance evidence from voluntary certification programs as run by AHRI, thus taking away from manufacturers the burden of supplying this proof themselves.

\textsuperscript{143} https://www.energy.gov/eere/femp/incorporate-minimum-efficiency-requirements-heating-and-cooling-products-federal#airsource

\textsuperscript{144} http://www.epa.gov/ozone/snap/regulations.html
As mentioned, the mandatory procurement rules for federal purchases are a strong incentive.

Access to markets / market surveillance

In the "Abstract US 2016 National Trade Estimate Report on Foreign Trade Barriers" (publication by the Office of the President of the United States) is written that the European Union’s approach to standards-related measures, including its conformity assessment framework, and its efforts to encourage governments around the world to adopt its approach, creates a challenging environment for U.S. exporters and has resulted in a lack of reciprocal access to the EU market and processes for U.S. manufacturers and certification and testing bodies. In particular, the USA thinks the EU system creates additional burdens for producers who do not manufacture their products to European regional standards.

More specifically the Office is worried about lack of access to CEN/CLC technical committees, and the EU’s conformity assessment framework, as set out in Regulation (EC) No 765/2008 and Decision 768/2008:

- Regulation 765/2008 requires each Member State to appoint a single national accreditation body and prohibits competition among Member States’ national accreditation bodies and in effect prohibits the use of non-EU accreditation bodies;
- Decision 768/2008 requires that any mandatory third-party conformity assessment be performed by a Notified Body established under national law.

The 40+ pages of trade issues flagged by the USA however do not mention however a single example related to the Ecodesign, energy labelling, Directive 2009/125/EC, Directive 2010/30/EU, or heating appliances.

3.8.3 Australia

According the Standards and labelling overview by CLASP (status Oct 2017) residential gas central heaters are required to meet relatively low-level MEPS, as set out in AS4556, as part of gas safety regulations in most Australian States and Territories.

Gas space heaters, portable air conditioners, standard electric heaters, wood heaters and evaporative air conditioners are not subject to energy efficiency regulation under the E3 framework in New Zealand or under the Australian Greenhouse and Energy Minimum Standards Act 2012 (GEMS Act). A gas energy labelling scheme that aims to provide comparative energy efficiency information presently operates in States and territories in Australia, but not New Zealand, and covers gas space and water heaters. Gas heating appliances used in residential applications are required by State and Territory Gas Technical and Safety Regulators across Australia to be certified before they can be legally sold or installed. The labelling scheme is part of this certification process, which forms a small component of what is primarily a mandatory gas appliance safety program.

A product profile has been issued April 2012 for gas fired space heaters and gas decorative appliances (in EU: local space heaters) and gas ducted heaters (in EU: air heaters). So far, water-based space heaters (‘boilers’ with a central heating system) are not regulated nor is regulation being developed.

For air conditioners with water cooled condensers and water sourced heat pumps (water loop heat pumps) within the scope of AS/NZS 3823.1.3 there are some Minimum AEER and/or ACOP requirements since 1 April 2011. For cooling/heating capacity < 39.0 kW the minimum is 3.5. For larger units up to 65 kW the minimum is 3.2.147

3.8.4 Canada
Canada has implemented the following rules for space/combi heaters148:

- electric boilers: Automatic means for adjusting water temperature
- gas boilers: minimum AFUE 82%
- ground- or water-source heat pumps: Heating COP 3.1 (closed loop, 0ºC entering water) to 3.6 (open system, 10ºC entering water), not greater than 40 kW. Test standard: CAN/CSA-C13256-1 Table 10A, 1st row for the open-loop system, if any and Table 10A, 2nd row for the closed-loop system, if any;
- internal water-loop heat pumps: Heating < 5 kW COP > 4.2 with 20ºC inlet water, > 5kW and < 40 kW COP > 4.2 with 20ºC inlet water. Test standard: CAN/CSA-C13256-1.
- large air conditioners, heat pumps and condensing units: COP at 8.3ºC 3.2 to 3.3 depending ion capacity, and at -8.3ºC 2.05 to 2.25 depending on capacity;
- oil-fired boilers: minimum AFUE 84%

The energy efficiency and other information has to be reported to Natural Resources Canada and be entered into searchable product list149.

Regulated energy-using products imported into Canada or shipped between provinces must bear an energy efficiency verification mark from a certification body accredited for energy efficiency verification by the Standards Council of Canada (SCC), except certain CFL lamps and general service lamps.

3.8.5 China (PRC)
China has two potentially relevant minimum energy efficiency performance standards for boilers:

- GB 20665-2015 Minimum allowable values of energy efficiency and energy efficiency grades for domestic gas instantaneous water heaters and gas fired heating and hot water combi-boilers with a heat load <=70 kW. Entered into force 1.6.2016. Implementation: China Quality Certification CXenter - CQC. In December of 2015 the CQC published amendments for the CQC-Implementation Rules water heaters, gas fired heating and hot water combi-boilers, i.e. the existing CQC-Standard CQC61-

148 http://www.nrcan.gc.ca/energy/regulations-codes-standards/6861
448262-2009 will be replaced by the updated Standard CQC61-448262-2015 from 1.6.2016.\textsuperscript{150}

- GB 24500-2009 Minimum allowable values of energy efficiency and energy efficiency grades of industrial boilers. Scope: steam boilers with steam volume >=0.1 t per h and fixed-type steel hot water boilers with rated water outlet pressure bigger than 0.1 MPa and coal/gasoline or gas fired steam boilers with pressure>0.04 MPa and <3.8 MPa. It entered into force: 1/9/2010. For gas-fired industrial boilers it was revised in 23.12.2014. The implementation is done by the National Development and Reform Commission NRDC and General Administration of Quality Supervision, Inspection and Quarantine of China - ASQSIQ.

GB 24500-2009 applies to large industrial steam-boilers, mostly coal-fired and not necessarily used for space heating purposes. In other words, there is very little overlap with the EU Ecodesign boiler regulation scope, but in some instances it may happen(some gasoline/gas fired hot water boilers). Efficiency numbers are in the range 73-83\%.\textsuperscript{151}

GB 20665-2015 sets minimum requirements for water heaters (see Lot 2 reports), but also sets a (identical) minimum efficiencies of combi boilers for space heating and water heating, i.e. $\eta \geq 84\%$ at rated load, $\eta \geq 82\%$ at partial load.\textsuperscript{152}

The combi-boiler also has a comparative energy label with 3 grades (1=best, 3=minimum efficiency).

\begin{table}
\centering
\caption{China combi-boiler efficiency grades for the China Energy Label}
\begin{tabular}{|c|c|c|c|}
\hline
\textbf{China combi-boiler energy label grades--->} & 1 & 2 & 3 \\
\hline
\textbf{Space heating} & & & \\
Rated Heat Load & 96\% & 89\% & 86\% \\
\hline
\leq 50\% Rated Heat Load & 92\% & 85\% & 82\% \\
\hline
\textbf{Hot water} & & & \\
Rated Heat Load & 99\% & 89\% & 86\% \\
\hline
\leq 50\% Rated Heat Load & 95\% & 85\% & 82\% \\
\hline
\end{tabular}
\end{table}

Also worth mentioning is the GB 26969-2011 MEPS for solar water heaters (solar wh is a possible part of the Ecodesign boiler package), which sets a minimum Coefficient of Thermal Performance (CTP) $\geq 0.10$.

China is the world market leader in solar water heater systems (not just PV but also thermal). Apart from MEPS it has a

\textsuperscript{151} household-electrical-appliances-water-heater-gas-fired-heating-and-hot-water-combi
\textsuperscript{152} Waide, P. et al, Policy Opportunities for More Efficient Residential Water Heating, CLASP study, final report November 2015. Values are presumably on GCV
comparative energy label, endorsement label (see below), requirements in the energy performance of buildings, subsidies, etc.. The 2015 CLASP study gives an overview.\textsuperscript{190}

China applies a certified quality label to water heaters and combi-boilers as operated by the China Quality Certification Centre (CQC), see figure on the right. To be eligible for this certification label products must meet the efficiency limits for grade 1 products under the mandatory energy label.

**Incentives**

Related to space heating the main concern in China is probably air pollution, also termed the ‘war on coal’. Coal-fired boilers of all sizes are the main space heaters in China, but their use is heavily discouraged especially in the big cities.

In the last heating season of 2017, the Sydney Morning Herald reported\textsuperscript{153} unprecedented measures coming into force to curb air pollution and reduce emissions. Steel production were halved in major steel cities, coal was banned in China’s coal capital, factories closed down for failing pollution inspections, and hundreds of officials were sacked for failing to meet environmental targets. Amongst others, three million households using coal for heating were provided with electricity or natural gas heating. Beijing closed its last major coal-fired power plant in March, and will replace coal heating in factories and households at a fast pace. Coal consumption fell to 9.5 million tonnes last year, down from 30 million in 2005.

This development means that the market for gas-fired boilers and electric heat pumps is rising quickly.

In that context it is relevant that major EU manufacturers like Bosch TT, Vaillant, Viessmann, BDR Thermea, Ariston, etc. have not only commercial and distribution activities but also a manufacturing base in China.

### 3.9 Voluntary Labelling and Certification schemes EU

In Europe and abroad there are several independent, voluntary certification schemes that enhance the trust in the performances claimed by the manufacturer/supplier.

#### 3.9.1 Gaskeur HR, CW and SV (Netherlands)

The Gaskeur HR label in the Netherlands is awarded to fuel boilers that achieve an efficiency (on lower heating value) of at least 100% (HR 100), although present products generally achieve HR 107 (107% lhv) or more.

The Gaskeur CW label signifies the water heating performance of a product (a combination of efficiency, tapping limit, and waiting times) and is expressed by a value between 1 (basic performance, < 6 l/min, single tapping point) and 6 (highest performance, > 12.5 l/min, multiple tapping points). The Gaskeur CW label can be

\textsuperscript{153} K. Needham, In China, the war on coal just got serious, Sydney Morning Herald, 13.10.2017
extended by an additional label Gaskeur HRww which signifies a minimum energy efficiency of 61% (higher heating value) and tighter limits for waiting times.

The Gaskeur SV label means the NO\textsubscript{x} emissions of the boiler are less than 40 ppm.

The Gaskeur NZ label can be awarded to combination boilers that can function as an after heater in systems comprising a solar device. The boiler is equipped to deal with the higher incoming water temperatures.

3.9.2 **MCS (United Kingdom)**

The Microgeneration Certification Scheme (MCS) is an industry-led and nationally recognised quality assurance scheme, supported by the Department for Business, Energy & Industrial Strategy (BEIS). MCS itself is a BS EN ISO/IEC 17065:2012 accredited scheme and was launched in 2007.

MCS certifies microgeneration products used to produce electricity and heat from renewable sources. MCS also certifies installation companies to ensure the microgeneration products have been installed and commissioned to the highest standard for the consumer. The certification is based on a set of installer standards and product scheme requirements which are available in the MCS Standards section of this website.

MCS covers electricity generating technologies with a capacity of up to 50kW, and heat generating technologies with a capacity of up to 45kW. Currently, MCS covers heat pumps, microCHP, solar thermal, biomass installations, photovoltaics and wind turbines.

The scheme has by now (February 2018) registered some 60 thousand air-to-water HP installations, 433 exhaust air heat pumps, almost 16 thousand ground-source heat pumps, and 757 microCHP installations\textsuperscript{154}.

3.9.3 **Eurovent Certita Certification (Europe)**

Since 1996 the Eurovent Certified Performance (ECP) mark certifies the performance ratings of air-conditioning and refrigeration products according to European and international standards. The certification activities were initiated in the 1990s by the association Eurovent. The activities are run independently by Eurovent Certita Certification and are accredited according to ISO 17065 standard for certification.

The voluntary third-party certification objective provides for customer confidence by levelling the competitive playing field for all manufacturers and by increasing the integrity and accuracy of the industrial performance ratings.

The Eurovent Certified Performance mark guarantees that the products have been submitted to independent checking and that they have been accurately rated. This mark guarantees specifiers, installers and end users that products marketed by a participant have been accurately rated.

Eurovent Certita Certification runs 42 certification schemes, including heat pumps, air handling units, comfort air conditioners, etc. Eurovent Certification certifies\textsuperscript{155}.

\textsuperscript{154} http://www.microgenerationcertification.org/about-us/statistics

\textsuperscript{155}
1. European heat pumps (Euro-HP)
2. Liquid chilling packages and heat pumps (LCP-HP)

The Eurovent Certified Performance programme applies in particular to:

- Electrically driven heat pumps for space heating, including appliances with a cooling function,
- Electrically driven heat pumps used for heating swimming pool water for seasonal and/or year-round use, installed outdoors or inside a building,
- Electrically driven heat pumps covering both the above uses,
- Dual-mode heat pumps, i.e. designed for space heating and domestic hot water production,
- Gas absorption heat pumps, including appliances with a cooling function,
- Engine-driven gas heat pumps, including appliances with a cooling function.

Standards for performance testing:

- Heat pumps with electrically driven compressors for:
  - Space heating & cooling: EN 14511-1 to 4; EN 14825
  - Domestic hot water units: EN 16147
- Direct exchange ground coupled heat pumps: EN 15879-1
- Gas-fired heat pump: EN 12309-1 to 5

Standards for acoustic performance:

- EN 12102 + EN ISO 9614-1 measurements by points

The main information presented:

- Capacity Ph [kW]
- Electrical Power input Pe [kW]
- Coefficient of performance COP
- Sound power level Lw [dB(A)]
- Minimum continuous operation Load Ratio LRcontmin [%]
- COP at LRcontmin
- Performance correction coefficient at LRcontmin CcplRcontmin
- Seasonal Coefficient of Performance SCOP
- Seasonal efficiency ηs

plus specific data for specific types of heat pumps

When a manufacturer participates in a certification programme, he has to present its list of models or model ranges together with their performance data. The files are evaluated by Eurovent Certification and a predefined number of units are selected for testing by independent laboratories.

---

156 plus some 22 other ‘programmes’ such as Comfort Air Conditioners, Air Handling Units, etc. Eurovent Certita also adds various other appliance / equipment categories, including solid fuel fired, gas-fired, solar driven and thermostatic radiator valves. These products are outside the scope of this study.

If results comply with the relevant standards, models or ranges are listed in the Eurovent Certification online Directory. Models are subject to regular random testing to verify compliance with catalogue data.

The Eurovent Certified Performance (ECP) mark is carried by 1200 ranges of heat pumps, representing 70 brands and over 20,000 models (figures February 2017). It benefits from strong brand recognition, initially in the commercial and industrial sectors but increasingly in the residential sector. It is supported by manufacturers and the brand is recognized in the Middle East, Asia (India) and even Oceania.

According the supporters seminar of September 2014, Eurovent certification used the services of some 8 independent testing laboratories. According information from 2017 there are now 11 laboratories used.

Table 31. Overview of labs used by Eurovent Certification and NF in 2014

<table>
<thead>
<tr>
<th>Test lab</th>
<th>Place</th>
<th>Country</th>
<th>Marking</th>
<th>Products</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIT</td>
<td>Vienna</td>
<td>Austria; NF Heat pumps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CEIS</td>
<td>Madrid</td>
<td>Spain Eurovent, NF Eurovent: Air conditioners, VRF, small chillers; NF: heat pumps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CETIAT</td>
<td>Lyon</td>
<td>France Eurovent Small chillers &amp; heat pumps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMT</td>
<td>Essen</td>
<td>Germany Eurovent Very large chillers &amp; heat pumps; Rooftops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IMQ</td>
<td>Amaro</td>
<td>Italy Eurovent Large chillers &amp; heat pumps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LNE</td>
<td>Trappes</td>
<td>France NF Heat pumps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP</td>
<td>Boras</td>
<td>Sweden NF Heat pumps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TUV Nord</td>
<td>Essen</td>
<td>Germany Eurovent Large air conditioners</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The labs conducted some 140 tests (in 2014) of chillers and heat pumps for Eurovent Certified Performance, and some 75 tests of heat pumps for NF-PAC. There were 8 auditors for NF heat pumps visiting some 75 factories/year.

The value of products covered by NF and Eurovent certification represent a market value of 80% of the European market (for those <100 kW) in 2014.
Table 32. Market share of certification in 2014

<table>
<thead>
<tr>
<th></th>
<th>NF PAC</th>
<th>Eurovent Certification programme</th>
<th>combined</th>
<th>share (value) of certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>air-to-water</td>
<td>1845</td>
<td>1512</td>
<td>3357</td>
<td>80%</td>
</tr>
<tr>
<td>brine-to-water</td>
<td>471</td>
<td>300</td>
<td>771</td>
<td>51%</td>
</tr>
<tr>
<td>direct expansion</td>
<td>(n.a.)</td>
<td>19</td>
<td>192</td>
<td>26%</td>
</tr>
<tr>
<td>domestic hot water</td>
<td>192</td>
<td>560</td>
<td>818</td>
<td>99%</td>
</tr>
<tr>
<td>water-to-water</td>
<td>258</td>
<td>300</td>
<td>771</td>
<td>51%</td>
</tr>
<tr>
<td>swimming pool</td>
<td>34</td>
<td>0</td>
<td>36</td>
<td>99%</td>
</tr>
<tr>
<td>gas</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td>99%</td>
</tr>
<tr>
<td>air-to-air</td>
<td>0</td>
<td>2835</td>
<td>2835</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>2848</td>
<td>5165</td>
<td>8013</td>
<td>79%</td>
</tr>
</tbody>
</table>

According more recent estimates by Eurovent Certita Certification (ECC) some 67% of products placed on the market are now covered by ECC certification. Note that testing is performed on one product, and the family to which it belongs can be certified on the basis of this.

3.9.4 NF Heat Pumps (France)

The NF Heat Pump (NF PAC – NF Pompe a chaleur) is a voluntary and independent certification mark covering electric or gas HPs, intended for space or pool heating and possibly for domestic hot water production (dual-mode), individual or collective. The activities are accredited to ISO 17065.

Based on product testing and factory audits the NF Mark certifies the energy performances and sound power level of the products in accordance with the applicable European standards (EN 14511, EN 14825, EN 15879, EN 15332, EN 12309, EN 12012 with tests carried out annually by ISO 17025 accredited laboratories). It guarantees compliance with the efficiency and sound level thresholds required by Regulation (EU) No 813/2013.

The NF certification mark 157 is carried by 300 ranges of heat pumps representing 40 brands and 1700 models (status February 2017).

3.9.4.1 NF Multi-energy

Launched in 2013, The NF Multi-energy (NF 462)158 is a voluntary and independent certification mark covering hybrid heat pumps, i.e. electric heat pumps combined with gas or fuel boilers intended for space heating and domestic hot water production,

individual or collective. The activities are accredited according ISO 17065. The basis and principles are similar to those applying for NF Heat Pumps.

3.9.5 **NF Micro-cogeneration**

The NF micro-cogeneration\(^{159}\) is a voluntary and independent certification mark covering micro Combine Heat and Power systems (Micro CHP – NF 452) for the simultaneous production of heat and electricity. The tests are carried out according to EN 50465 and EN 15036. The basis and principles are like those applying for NF Heat Pumps. This certification mark was launched at the end of 2017 and no mark has yet been delivered.

3.9.6 **EHPA Quality Label (Europe)**

The EHPA Quality Label is a label, not a certification mark, that shows the end-consumer a quality heat pump unit or model range on the market. The heat pumps that receive the label need to undergo tests according to the international standard EN14511 and EN16147. These tests are executed by EN17025 accredited test centres. The EHPA label originated from the activities of the German, Austrian and Swiss heat pump associations. It was introduced in Sweden (2007), Finland (2008), Belgium and France (2010) and the Netherlands (2012). Currently, 12 countries are involved in the EHPA Quality Label scheme. Except in France, the label is mutually accepted in all the participating countries.

The label can be granted to standardised space heating electrically-driven heat pumps, with or without domestic hot water heating capability, with a capacity up to 100 kW from air, geothermal or water heat sources. In order to qualify for the label, the heat pump in question must comply with EHPA heat pump test criteria and the distributor must provide a defined level of service.

The key requirements are (non-exhaustive list):

a) Conformity of all main components and compliance with the national rules and regulation (CE marking)

b) Minimum efficiency values defined as follows (operating points - required COP), tested in labs accredited to ISO 17025 to perform heat pump test according to standards needed for each method that is applied:

**EN 14511:**
- Brine to Water B0/W35 - 4.30
- Water to Water W10/W35 - 5.10
- Air to Water A2/W35 - 3.10

**EN 14825 (SCOP):**
- Air to air - Needs to fulfil min. energy efficiency class A according to EU Regulations, i.e. SCOP shall not be lower than 3.4

---

EN 15879-1:
- Direct Exchange ground coupled to Water E4/W35 - 4.30

EN 16147:
- Domestic Hot Water heat pump

c) Declaration of sound power level according to EN 12102
d) Existence of sales & distribution, planning, service and operating documents in the local language of the country where the heat pump is distributed.
e) Existence of a functioning customer service network in the sales area that allows for a 24h reaction time to consumer complaints.
f) A two year full warranty which shall include a declaration stating that the heat pump spare parts inventory will be available for at least ten years.

Some 5386 models of various categories carry the EHPA Quality Label, of which over 3000 are air-to-water, over 1500 are brine-to-water, almost 700 are water-to-water, 35 are direct expansion and just 4 are exhaust-air-to-water. Some 32 are domestic hot water heat pumps.

3.9.7 **Heat pump Keymark (Europe)**

The Keymark is a CEN/CENELEC European mark scheme based on European standards, developed by the heat pump industry and now owned by CEN.

The core activity of CEN is the development of European Standard (EN), in some cases harmonised European Standards based on a mandate from the European Commission. The other activities within the scope of CEN are the development of are Technical Specifications (TS), Technical Reports (TR), Guides and CEN and/or CENELEC Workshop Agreements (CWA).

The Council Decision of 18 June 1992 invited the European standards organizations to continue discussions on a possible harmonized expression of conformity with European standards. This has resulted in CEN/CENELEC entering the field of voluntary certification. With time this has developed in the “Keymark” schemes first for solar products in 2003 and for heat pumps in 2016.

The Keymark is a voluntary third-party certification demonstrating to end-users that a product conforms to the relevant European standards and (sometimes) fulfils additional requirements.

The Heat Pump KEYMARK[^160] is a voluntary, independent, European certification mark (ISO type 5 certification[^161]) for all heat pumps, air/air heat pumps (covered under Lot 10), combination heat pumps and hot water heaters (as covered by Ecodesign regulations 813/2013 and 814/2013):

[^160]: http://www.heatpumpkeymark.com/
- Heat pumps covered by Lot 1 and Lot 2;
  - heat pump space heaters providing heat to water-based central heating systems for space heating purposes;
  - heat pump combination heaters providing heat to water-based central heating systems for space heating purposes and water heating;
  - dedicated heat pump water heaters;
- With a thermal capacity up to 400kW.
- In 2017: extension to air-to-air heat pumps covered under Lot 10;
- (future extension possible on industry request).

The Heat Pump Keymark is based on independent, third party testing and demonstrates compliance with product requirements as set in the Heat Pump KEYMARK scheme rules and with efficiency requirements as set by Ecodesign Lot 1 and Lot 2.

The certificates are granted by independent certification bodies to products fulfilling all requirements of the scheme. The scheme is open to all certification bodies in Europe. Manufacturers interested in obtaining the certification should apply with one of the certification bodies listed here.

By the end of 2017 19 brands use the HP Keymark certification, and 312 certificates have been issued.

### 3.9.8 Solar Keymark (Europe)

The Keymark is a CEN/CENELEC European mark scheme based on European standards. The Solar Keymark is a voluntary third-party certification mark for solar thermal products, demonstrating to end-users that a product conforms to the relevant European standards and fulfils additional requirements.

The Solar Keymark aims at reducing trade barriers and promote the use of high quality solar thermal products in the European market and beyond. It is used in Europe and increasingly recognised worldwide.

The Solar Keymark is a CEN/CENELEC European mark scheme, dedicated to:

- Solar thermal collectors,
- Solar thermal systems, storages and controllers.

There are now 12 empowered certification bodies for Solar Keymark certification. The test itself can be performed by another body, also recognised by CEN/CENELEC, and there are now 20 bodies empowered in Europe.

The products that can carry the Solar Keymark are collectors, storage tanks and controllers, and complete systems. On 1 January 2011, over 1200 Solar Keymark licences were granted.

- Solar collectors (according to EN 12975-1)
- Factory made solar thermal systems (according to EN 12976-1)

---

162 As shown on [http://www.estif.org/solarkeymarknew/](http://www.estif.org/solarkeymarknew/) Nov. 2018
CUSTOM BUILT SOLAR SYSTEMS THERMAL SYSTEMS: SOLAR WATER HEATERS AND COMBI SYSTEMS (ACCORDING TO EN 12977-1)

Solar Keymark requires testing of the tank in accordance with EN 12977-3 or -4 (hot water store or combi store). This produces values for standby heat loss, storage tank volume, location of connections etc. Solar Keymark is working on an approach for a Keymark declaration for solar systems, based on the calculation tool used, and 'recognition' of company by Solar Keymark.

A problem of the system declaration is that it relies on inputs from Solar Keymarked components, but that currently many solar tank suppliers have their tank tested in accordance with other methods than EN 12977-3/-4. This means that these suppliers have to retest their products to produce the required inputs for the declaration (it does not mean that the tank has to be changed technically).

Currently the Solar Keymark website shows 10 national solar support schemes that refer to Solar Keymark: Portugal, France, Belgium, Netherlands, Germany, Switzerland, Czech Rep., Italy, Slovakia and Greece.

3.9.9 Nordic Ecolabel (Europe, Sweden)

The Nordic (Swan) Ecolabel 059 Heat Pumps is applicable for heat pumps to water up to 70 kW and heat pumps to air up to 12 kW. It entered into force in March 2014. The criteria document references definitions as found in the EU Ecodesign and Energy Labelling regulations.163,164

3.9.10 Energy Saving Trust Endorsed Products (Europe, UK)

The current Energy Saving Trust endorsement label entered into force in 2015 and applies to efficient gas-, LPG- or oil-fired boilers.165

3.9.11 Energy Star (USA, Canada)

The most recent US Energy Star v3.0 requirement for residential boilers up to 88 kW (300,000 BTU/hr) entered into force 20 Dec. 2013. It requires the boilers to be condensing, i.e. to have a minimum AFUE (Annual Fuel Utilization Efficiency, on GCV) of 90% for gas-fired boilers and 87% for oil-fired boilers.166 Canada also uses the (US) Energy Star endorsement label.

163 www.clasp.ngo
166 ENERGY STAR® Program Requirements Product Specification for Boilers, Eligibility Criteria Version 3.0.
3.9.12 Voluntary certification (Japan)

For heat pump space and water heaters

The Japan Gas Appliances Inspection Association (JIA) conducts inspection and provides voluntary certification of domestic/commercial gas appliances such as gas space / water heaters, fuel cells, cooking stove, etc.\[167\].

3.10 Market surveillance

During the impact assessment phase of the revision of the Ecodesign and energy labelling directives (period 2010-2015), the information collected on level of compliance suggested the following:

- Around 0.6% of the market is surveyed;
- 10-25% of products estimated to be non-compliant with Ecodesign requirements
- 20% energy labels missing in shops;
- 10% less energy savings than envisaged;
- Weak enforcement by Member States;
- Cooperation between market surveillance authorities is limited

The Commission concluded that a shift in focus from adding more regulations to improving, implementing and enforcing existing ones is needed. This requires the following:

- More priority and resources at national level;
- More sharing of 'scarce' resources (e.g. centres of excellence);
- More collaboration on surveillance and enforcement (e.g. joint surveillance actions; 'concerted action model');
- Enforcement actions based on the energy labelling database (e.g. screening of technical documentation).

The cooperation at EU level consists of:

- AdCo - Administrative Cooperation Groups, to develop:
  - Harmonised approaches (e.g. FAQ + Guidance documents);
  - Exchange of information and best practices;
  - Coordinate common actions;
- Formal exchange of information via ICSMS/RAPEX;
- Joint surveillance actions.

The EU has a long list of projects that aim to improve market surveillance and to inform the general public. The list below is non-exhaustive:

- Atlete (refrigeration), Atlete II (washing machines), PremiumLight (demonstration, dissemination, CFL/LED testing), Ecopliant (best practices guidelines), Come On Labels, euro topten.eu (consumer information), Marketwatch (civil society in market

https://www.energystar.gov/products/spec/boilers_specification_version_3_0_pdf
\[167\] http://www.jia-page.or.jp/english/certification/index.html
surveillance), LabelPack A+ (solar devices), MSTYR15 (car tyres), INTAS (large fans, transformers).

- **BOILEFF** - in this project 77 audits showed different short-comings of boiler installations in the form of many defaults were detected in most of the new and old heating systems. The project resulted in a proposal for a high quality declaration (DHUI) and a guaranteed performance quality (GPU).

- **ECOPLIANT** (best practices guidelines) The Ecopliant project was intended to identify best practices in monitoring, verification and enforcement of the Ecodesign Directive among Member States and other EEA countries. Space and water heaters were not part of the Ecopliant project, although EHI was a member of the Advisory Board of the EEPLIANT 2014 project. The follow-up project EEPLIANT includes space heaters in Work Package 6.

- **EEPLIANT1** (LED lamps, heaters, imaging equipment) - joint monitoring, verification and enforcement activities of fifteen Market Surveillance Authorities (MSAs) and one national agency – see section below.

- **EEPLIANT2** (domestic refrigeration, professional refrigeration, network standby) – see section below EEPLIANT1.

### 3.10.1 Activities

EU countries must ensure effective surveillance of their markets. They are required to guarantee that:

- products placed on the market are monitored
- the marking and documentation requirements have been respected
- products have been designed and manufactured in accordance with EU harmonisation requirements
- market surveillance authorities have the necessary powers, resources and knowledge to perform their functions
- procedures are put in place for following up complaints and monitoring accidents
- market surveillance programmes are established, implemented and periodically updated
- the functioning of surveillance activities is reviewed and assessed at least every four years

Member States have to submit, to the European Commission, their latest market surveillance programmes pursuant to Article 18(6) of Regulation (EC) 765/2008. The Commission compiled reviews and assessments of the functioning of market surveillance activities carried out for the 2010 to 2013 period per country and/or sector.

The latest report for sector 23, Ecodesign and Energy Labelling, shows that although most countries engage in activities in this sector, boilers and heat pumps are not a priority.

The latest report for sector 24, on efficiency requirements for hot-water boilers fired with liquid or gaseous fuels (the BED, 92/42/EEC) shows more activities in boiler surveillance:

- In Belgium, 13 products were tested between 2010 and 2013, and 1 was found non-compliant for documentation; The staff available to MSA is 0.2 FTE, and 0.05 FTE for inspectors.
- In Czech Republic 10 boilers were tested in 2010 of which 4 were non-compliant (no cause given);
• Ireland performed 27 to 38 physical checks on boilers in 2012 and 2013 and found all non-compliant. As the matters were resolved by corrective actions from the manufacturers, it appears these were mainly errors in documentation;
• Greece performed 16 checks on boilers between 2011 and 2013 of which 6 were found non-compliant and 1 model was removed from the market;
• In Hungary 27 inspections took place between 2011 and 2013, resulting in 12 non-compliant for documentation;
• Romania inspected 15 boilers between 2010 and 2013, with 11 physical checks. No non-compliant products reported.
• None of the other EU Member States reported activities under the programmes for 92/42/EEC (which is since 2009 and official Ecodesign implementing measure). Especially the lack of reporting from major markets (Germany, France, UK, Italy, Netherlands etc.) is striking.

There is no reporting yet for the years 2014 to 2017. A superficial check of the surveillance programmes (2014, 2015, 2016, 2017) of the Members States gives an indication of the importance attached to regulation 813/2013, but the check has limited relevance as many Member States provide very limited detail of the programme (for instance no specific reference to a surveillance action on 813/2013 in the programme). Most Member States provide only general statements in 50 to 100-page documents, and some do not have updated their programmes. Others mention participation to projects such as EEPlant as (part of) their market surveillance activities. Germany (UBA/BAM) mentioned they did not perform any tests of space heating or water heating products in 2016 and that only documentation and correct labelling of products has been checked.

Another study, about market surveillance of heat pumps in Nordic countries\textsuperscript{168}, mentioned that between 2009 and 2015 some 139 air to air heat pumps were checked in Scandinavia: 129 in Denmark, 10 in Sweden. The 2013 results of Denmark MSA showed that all heat pumps met the applicable requirements. The Swedish results for 2014 showed that 1 of the 4 tested products did not meet the noise levels required, others had minor gaps in technical documentation. In Norway a field test of 15 air/liquid-to-water heat pumps was conducted which study showed a large range in performances, with COPs ranging from a meagre 1.5 to a respectable 4.00.

Based on the previous reporting period 2010-2013, it is expected that MSA of Ecodesign/labelling has limited priority.


One Member State, The Netherlands, commented to the study authors that, besides the costs and time it takes to test products, the technical complexity of products, especially hybrid products, makes market surveillance more difficult. In the EEPLIANT project it was observed that in some cases the manufacturer needed to install the product and set the software in order to enable testing the product. Such practices make independent market surveillance (or testing by consumer organisations) impossible. Also, several products have an ECO mode that is used for assessing compliance whereas in practice this mode is not used.

\textsuperscript{168} https://www.norden.org/en/publication/strategic-nordic-products-heat-pumps
**Eurovent** states that "market surveillance constitutes a key tool to verify the coherence from what is declared by manufacturers and what is sold. Market surveillance is necessary to guarantee a level-playing field and Eurovent support a stronger and more visible market surveillance and inspection.

**Conformity assessment is within the responsibility of the National Market Surveillance Authorities.** Limited financial resources of the Member States and the limited availability of accredited laboratories represent challenges that should be tackled.

*If this is not the case and unless other methods of conformity assessment are being found, it will make little sense to revise and further tighten Ecodesign requirements.*

Voluntary and mandatory third-party certification and verification does not replace market surveillance. However, Eurovent and its members hold that proven certified and verified product information can provide a support to market surveillance activities – in particular where this information can be publicly accessed and results from accredited testing processes."

### 3.10.2 EEPLIANT 1

The EEPLIANT 1 project was a trans-EU market surveillance project which ran from 2017 'till 2017, targeting specific products funded by the EU’s Horizon2020 programme. Its objective was to support delivery of the intended economic and environment benefits of the Energy Labelling and Ecodesign Directives by increasing the rates of compliance with them. This was to be achieved through coordinating the monitoring, verification and enforcement activities of 12 MSAs across the Single Market.

The project was managed by EASME on behalf of the European Commission, with oversight by DG Energy. Advisory Board Members and key stakeholders included: ANEC, ECOS, EHI, EHPA, EPEE, EuroVAprint, LightingEurope. EEPLIANT was preceded by the ECOPLIANT project (Guidelines for MS).

EEPLIANT looked at LED lights (WP4), imaging equipment (WPS) and space heaters (WP6). The heaters covered were gas boilers, combination heat pumps, electric heaters and large gas boilers (> 70 kW). The testing included a round-robin exercise ensuring that all results would be evaluated by the authorities in a consistent way. As for LEDs, a "risk-based" approach has been followed with the goal to try to identify products with a higher likelihood of being noncompliant. The compliance verification for heaters <70 kW included document inspections and laboratory testing. Regarding the bigger gas boilers (70–400 kW), the tests took place "in-situ" on installed boilers for practical reasons. Also, the package label (fiche) and installer response have been assessed.

Inspections and tests:

- Electric heaters for space heating < 70 kW: Tech. doc.
- (Small) Gas boilers < 70 kW: Tech. doc. + lab test
- Big gas boilers up to 400 kW: Tech. doc. + in-situ test
- Heat pumps < 70 kW: Tech. doc. + lab test

---

Plus:

- Survey on installers’ knowledge about packages and package regulation
- Round Robin exercise on document inspection

MSA of six countries (BE, BG, DK, NL, SE and UK) were involved.

Typical flaws found in technical documentation were:

- Suppliers did not inform about performance (e.g. SCOP and annual energy consumption) for warm and cold climate zone. Possible explanation is this is not required in Ecodesign but in the energy labelling regulation;
- CE-declaration missing info about Reference to regulation (EU) nr. 813/2013, Reference to standards;
- An Energy label for a combi heater was missing.

The results of the inspections and tests were:

**Electrical heaters**

- 10 technical dossiers checked
  - 6 compliant (2 required clarification: informal request for clarification or more information)
  - 4 compliant after legal correction (formal request by MSA to correct information)
  - Product category virtually non-existent in many WP6-countries

**Gas boilers 0 - 70 kW**

- 19 technical dossiers checked, total 100% compliant (after legal correction)
  - 5 compliant (2 required clarification: informal request for clarification or more information);
  - 14 compliant after legal correction;
- 10 gas boilers tested at accredited laboratory:
  - 10 compliant with Ecodesign minimum requirements (100%);
  - some non-compliant on declared values:
    - energy efficiency: 9 compliant, 1 non-compliant (NCV, GCV confusion?)
    - sound power: 2 non-compliant (outside permitted tolerance)
    - NOx: all compliant with limit value, 4 non-compliant (outside permitted range);
    - Tolerance on energy efficiency is pretty high

**Heat pumps 0 - 70 kW**

- 18 technical dossiers checked, total 78% compliant (after legal correction)
  - 4 compliant (after clarification: informal request for clarification or more information);
  - 11 compliant after legal correction;
  - 4 non-compliant (22%)

---

170 Presentation: Energy Efficiency Compliant Products 2014 (EEPLIANT 2014) FINAL CONFERENCE 20 June 2017 Brussels
- 7 heat pumps tested at accredited laboratory:
  - 7 compliant with Ecodesign minimum requirements (100%);
  - some non-compliant on declared values:
    - energy efficiency: 5 compliant, 2 (28%) non-compliant (outside permitted range, for other climate/temperature regime, Energy Class still correct)
    - water heating efficiency: 2 non-compliant (outside permitted range)
    - sound power: 2 non-compliant (outside permitted range);

**Large gas boilers 70 – 400 kW**
- In-situ testing of 4 boilers
  - Test method from 10-year-old EC-funded project and BS845-1:1987
  - full-load and part load, indirect method (flue gas loss, casing loss);
  - 4 compliant (100%)
- conditions for testing include accessibility, approval by owner, other practical considerations, etc.

If we limit ourselves to the test results of gas boiler and heat pumps only, it shows that both groups show similar high compliance with main Ecodesign requirements (100%), but for declared values the compliance of self-declared products (heat pumps) is slightly less. Note however that declaration of values outside permitted range occurred in both groups, self-declared and assessed by Notified Body.

As regards the other groups: about 45% of packaging of LED lamps was non-complaint, about 60% of screened products (n=110) were non-compliant for various parameters, and 20% of tested products were non-compliant with the stated/allowed energy efficiency index, plus higher/lower non-compliance for other parameters. About 11% of imaging equipment (n=37) was found (potentially) non-compliant.

EEPLIANT1 received a follow-up as EEPLIANT2, running from September 2017 until early 2020.

3.10.3 **LabelPack A+**
The LabelPack A+ project is not a project that aimed to improve market surveillance, but as it aimed to inform stakeholders about the possibilities and consequences of the space and water heating regulations, it is interesting enough to mention under this heading.

Solar Heat Europe executed the Label Pack A+ project, financed under the Horizon 2020 Programme, aimed to support the implementation of the energy labelling of heating appliances and boosting its impact on solar thermal products by using the “package label”.

The Labelpack A+ project consortium carried out an analysis of experiences, across the countries covered by this project (Austria, France, Germany, Italy, Portugal, United Kingdom), that could highlight strong and weak points of package label implementation. Based on difficulties encountered during each national implementation, proposals for the improvements of the package label from the point of view of different stakeholders, such as consumers, installers & dealers, manufacturers (& distributors) and public authorities (market surveillance and energy agencies) are pointed out.

LabelPack A+ conducted a survey about the reputation and use of the (package)label. This survey in 10 countries and 24 respondents, with interviews in October 2017 and
Jan/Feb 2018, (report D4.6) showed that potential user groups are not familiar with the label or do not recognize its benefits. Moreover, enforcement was considered insufficient.

To improve the implementation of the “package label” the stakeholders suggest that it would be best to intensify marketing efforts in order to increase the awareness of the “package label” among potential user groups. In addition, enforcement needs to be improved and stakeholders suggested that rethinking the overall labelling concept would be beneficial. This would include overhauling the efficiency categories, the design of the label and its calculation methods. If the label is more accepted by consumers/consumer associations, public authorities, like market surveillance, and suppliers/dealers, then the chances that it will be accepted by the market will increase.

The LabelpackA+ consortium concluded the following recommendations:

- Include expected energy consumption: LabelPackA+ thinks this improves the ability of consumers to assess different options (makes visible differences of solutions in same efficiency class). Care should be taken not to make the label more complex and add administrative burden.

![Figure 19. From LabelPackA+, D4-6, opinion on the energy label for space and water heating systems](image)

![Figure 20. From LabelPackA+, D4-6, the most important issues with regards to the labelling of heating systems?](image)
- Review scale of energy efficiency classes system: LabelPackA+ thinks that the smaller energy efficiency class intervals for lower efficiencies and larger intervals for higher efficiencies are counterproductive for high efficiency systems including solar.
- Include different energy classes according to the system location: LabelPackA+ thinks that showing the performance of the product in more than just the average climate is beneficial for consumers (similar to the label for air-conditioners). The calculation of systems (package label) should also allow for a calculation based on location.
- Introducing labelling for existing boilers: LabelPack A+ states that the labelling of existing boilers could help incentivize consumers to replace or upgrade their heating systems (similar to the example in Germany).
- Indicative labelling for new solar thermal systems: LabelPack A+ promotes the possibility to issue labels for the upgrading of existing heating systems with solar devices.
- Connecting Energy Labelling to Energy Performance of Buildings: A better synergy between the two measures (EPBD and labelling) should be achieved.

The group also mentions the relevance of support mechanisms (where a label score is linked to subsidies etc.) but notes that this could create a more uneven playing field as larger 'system' suppliers have more resources available due to the range of solutions offered and larger installer networks, whereas solar specialists do not have these advantages.

Not recommended was the inclusion of economic benefit on the label as this is probably too complex to do right (prices are volatile)

Other reports available at the Labpack A+ website, under "Resources: www.label-pack-a-plus.eu/home/resources, are:
- Recommendation regarding the implementation of the “package label" & Executive Summary
- Package Label implementation assessment report
- Analysis of the implementation of the “package label” in several European countries
- “Common understanding of the heating energy labelling concept, key elements” & FAQS
- Sensitivity analysis on the application of the “package label”
- Implementing the package label for Space and Water Heaters- Short version

### 3.11 Product/fiche Label generators

Several tools (online, offline) aim to streamline the calculation of the product and package label information, often including the design of the label itself. Examples are:

Online-label generators

- [http://www.heizungslabel.de/VerbundAnlagen](http://www.heizungslabel.de/VerbundAnlagen) – calculates the package fiche (on the basis of manufacturer information)
- [https://ec.europa.eu/energy/eepf-labels/](https://ec.europa.eu/energy/eepf-labels/) - creates labels, but does not show the underlying calculations or package fiche
Offline label calculators

- LabelTool_AllHeaters_unprotected.xlsm – This tool is no longer available as download. It was developed by Fraunhofer ISI.

According feedback from several stakeholders the use of these tools, or the use of the package label as a whole, by installers (non-manufacturers) is very limited.

Furthermore, not all label tools give the same results, even if the main input parameters are the same. Differences may be caused by the calculation of factor 'II' that corrects the package seasonal efficiency for the presence of a supplementary heater. Table 5 and 6 of 811/2013 give values for factor 'II' for certain $\frac{Prated}{(Prated+Psupplementary)}$ ratios, but for other ratio's, the table values need to be interpolated. Here small differences occur (sometimes interpolation is not applied, and the nearest value is selected).
4 Test Standards

This Chapter presents test standards relevant for performance assessment of space and combination heaters. The first section deals with the harmonisation of standards, followed by sections describing standards by product group and/or parameter.

4.1 Harmonisation of standards

4.1.1 Harmonisation of standards

Technical standards, laying down constructional requirements on how to assess performance or safety are normally developed by the European Standardisation Organisations (ESOs): CEN, CENELEC and ETSI.

If the Commission has issued a 'request for standardisation' (a 'Mandate') the standard developed by the ESOs at this request is considered 'harmonised' when finalised and published. However, it is only after the publication of the references of these standards in the Official Journal that 'presumption of conformity' can apply. In general terms these two distinct steps are often referred to as a single step called 'harmonisation' (of standards).


There are no references of harmonised standards which have been published in the Official Journal of the European Union for172:

- Hot water boilers (Directive 92/42/EEC);
- Water heaters and hot water storage tanks (Regulation (EU) No 814/2013, Regulation (EU) No 812/2013);
- Space heaters (Regulation (EU) No 813/2013, Regulation (EU) No 811/2013);

Nor for other, related, product groups such as:

- Solid fuel boilers (Regulation (EU) 2015/1189, Regulation (EU) 2015/1187);
- and air heating products, cooling products, high temperature process chillers and fan coil units (Regulation (EU) No 2016/2281).

171 https://www.cencenelec.eu/helpers/Pages/FAQ.aspx
Nevertheless, the European Commission is planning to proceed with the publication of harmonised standards for space heaters and combination heaters.

The only standards currently harmonised for Ecodesign/labelling of heating (and cooling) appliances are those referenced in European Commission Communication 2018/C 092/03 of 9 March 2018 in the framework of the implementation of Commission Regulation (EU) n° 206/2012 with regard to Ecodesign requirements for air conditioners and comfort fans and of Commission Delegated Regulation (EU) n° 626/2011 with regard to energy labelling of air conditioners:

- EN 12102:2017 - Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling - Measurement of airborne noise - Determination of the sound power level;
- EN 12900:2013 - Refrigerant compressors - Rating conditions, tolerances and presentation of manufacturer's performance data;
- EN 14511-2:2013 - Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 2: Test conditions;
- EN 14511-3:2013 - Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 3: Test methods;
- EN 14825:2016 - Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance;
- EN 15218:2013 - Air conditioners and liquid chilling packages with evaporative cooled condenser and with electrically driven compressors for space cooling - Terms, definitions, test conditions, test methods and requirements.

As far as comfort fans are concerned, which are covered by Ecodesign Regulation n° 206/2012 only, Commission Communication 2012/C 172/01 on transitional methods of measurement still applies. Compliance with the standards listed in Communication 2014/C 110/01 provides a presumption of conformity of air-conditioners with both Regulation n° 206/2012 and Regulation n° 626/2011.

4.1.3 Transitional Methods for space/combination heaters/packages


See section 3.4.5 for details.
4.1.4 Request for standardisation M/535 for space/combination heaters/packages

Commission Implementing Decision C(2015) 2626 of 27.4.2015 involves a standardisation request M/535\(^\text{173}\) to the European standardisation organisations as regards space heaters, combination heaters, packages of space heaters, temperature control and solar device and packages of combination heater, temperature control and solar device in support of Regulation (EU) No 813/2013 and Delegated Regulation (EU) No 811/2013\(^\text{174}\).

See also section 3.4.6.

4.2 Gas boilers

Conventional wall hung and floor standing residential (domestic) boilers for space heating and combination heating are primarily covered by the EN 15502 series, of which part 1 gives the general requirements and tests, part 2-1 addresses specific aspects of boilers < 1000 kW and part 2-2 addresses specific aspects of B1 type boilers.

Standard EN 303-3 covers aspects related to a combination of a gas burner and a boiler body.

Standards EN 26:2015 and EN 89:2015 have been excluded from this Task 1 report as they are specific to water heaters. They are dealt with in the present review study for water heaters.

4.2.1 EN 15502-1:2012+A1:2015 [ok]

CEN/TC 109/WG 1

Gas-fired heating boilers - Part 1: General requirements and tests


EN 15502-1+A1 specifies the common requirements and test methods concerning, in particular the construction, safety, fitness for purpose, and rational use of energy, as well as the classification, marking and energy labelling of gas-fired central heating boilers that are fitted with atmospheric burners, fan assisted atmospheric burners or fully premixed burners, and are hereafter referred to as "boilers". This European Standard is to be used in conjunction with the specific Parts 2 (Part 2-1 and following ones). This European Standard applies to boilers of types B and C. a) that use one or more combustible gases of the three gas families at the pressures stated in EN 437; b) where the temperature of the heat transfer fluid does not exceed 105 °C during normal operation; c) where the maximum operating pressure in the water circuit does not exceed 6 bar; d) which can give rise to condensation under certain circumstances; e) which are declared in the installation instructions to be either a "condensing" boiler or a "low temperature boiler" or a "standard boiler" or an "other boiler". If no declaration is given the boiler is to be considered both a "standard boiler" and an "other boiler"; f)


which are intended to be installed inside a building or in a partially protected place; g) which are intended to produce hot water either by the instantaneous or storage principle, the whole being marketed as a single unit. This European Standard applies to boilers designed for sealed water systems or for open water systems. This general standard and the specific standards (see Part 2) provide requirements for boilers with known constructions. For boilers with any alternative constructions, which might not fully be covered by this standard or a specific standard, the risk associated with this alternative construction will need to be assessed. An example of an assessment methodology, based upon risk assessment, is given in Clause 11. This European Standard is not intended to cover appliances intended for connection to gas grids where the quality of the distributed gas is likely to vary to a large extent over the lifetime of the appliance.

General test conditions
The appliance is installed in a test room with an ambient temperature of 20 °C (±5 °C) that is well-ventilated, draft free (air speed below 0.5 m/s) and that can protect the appliance from solar radiation. In general, the appliance is installed according to the instructions of the manufacturer.

During testing, the appliance will be supplied with a reference gas of its category and that is capable of delivering the nominal heat output.

Useful energy
The useful efficiency ($\eta_U$) is the ratio of the useful output to the heat input. The energy input is calculated by multiplying the mass of the water by the specific heat capacity and the temperature difference between the in- and outlet. Heat loses from the test rig are added. The volume of the gas consumption is measured and multiplied with the net calorific value of the gas.

$$\eta_U = \frac{4.186 \times m \times (t_2 - t_1) + D_p}{10^3 \times V_{r(10)} \times H_i}$$

Equation 1. Useful efficiency

<table>
<thead>
<tr>
<th>$\eta_u$</th>
<th>useful efficiency in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m$</td>
<td>mass collected water during test in kg</td>
</tr>
<tr>
<td>$H_i$</td>
<td>net calorific value (inferior, or lower heating value) of the gas in MJ/m³</td>
</tr>
<tr>
<td>$D_p$</td>
<td>heat losses from test rig in KJ</td>
</tr>
<tr>
<td>$V_{r(10)}$</td>
<td>gas consumption corrected to 15°C and 1.013,25 mbar in m³</td>
</tr>
</tbody>
</table>

The energy (gas) input and heat output are measured for both full and part (30%) load. Both efficiencies will be used as an input to calculate the seasonal space heating efficiency.

Full load or at nominal heat input\(^{175}\) is measured at a return water temperature of 60°C and a temperature difference of 20°C in accordance with Regulation (EU) No 813/2013 which specifies a high temperature regime of 60/80°C inlet/outlet.

\(^{175}\) For boilers with a range rating device the efficiency is measured at the maximum heat input and the arithmetic mean of the maximum and minimum heat input.
Part load efficiency is measured at 30% of nominal heat input, with a low temperature regime for return temperature of 30 °C for condensing boilers, 37 °C for low-temperature boilers and 50 °C for "other heaters". The Boiler Efficiency Directive defines, besides condensing and low temperature, also "standard boilers" for which a return temperature of 47°C applies. If the boiler control does not permit operation at a return temperature that is low enough, the test is carried out at the lowest return temperature compatible with the operation of the boiler. A timing device is fitted to the ambient temperature thermostat to obtain a working cycle of 10 min.

The measurement equipment tolerances are chosen in a way which ensures a total tolerance in the efficiency measurement of ± 2 %.

**Standby heat loss**

Standby heat losses are calculated for at a thermal equilibrium of a water temperature of 50 °C and an ambient temperature of 20 °C.

The power of the auxiliary electric boiler ($P_m$) is corrected with the measured temperature difference between water and ambient ($T - T_A$) with regard to the expected temperature difference (50-20=30 °C). If any fan is operational during the test some terms are added to the formulas regarding the indirect efficiency calculation.

$$P_S = P_m \left( \frac{30}{T - T_A} \right)^{1.25}$$

**Equation 2. Standby losses**

- $P_S$ = stand-by losses in Watt
- $P_m$ = electrical power consumed by the auxiliary boiler in Watt
- $T$ = mean water temperature during test in °C
- $T_A$ = ambient temperature during the test °C

**Seasonal space heating energy**

For checking compliance of boilers < 70 kW nominal heat output with the regulations the useful efficiency is converted to seasonal primary efficiency. This requires the conversion of NVC (net calorific value) to GCV (gross calorific value).

In Equation 3, $\eta_{100}$ is the useful efficiency at full load and $\eta_{30}$ at part load. The seasonal space heating efficiency is the weighted average over the time an average appliance operates in either full or part load:

$$\eta_{son} = 0.85 \times \eta_1 + 0.15 \times \eta_4$$

**Equation 3. Seasonal space heating efficiency in active mode**

- $\eta_1 = \eta_{30} \times \frac{H_i}{H_s}$
- $\eta_4 = \eta_{100} \times \frac{H_i}{H_s}$
- $\eta_{son} =$ seasonal space heating efficiency in %
- $V_{v15(10)} =$ gas consumption corrected to 15 °C
This $\eta_{\text{son}}$ then needs to be corrected for several efficiency losses due to temperature controls, auxiliary electricity consumption, standby heat losses and ignition burner power consumption:

\[
\eta_s = \eta_{\text{son}} - \sum F(i)
\]

Equation 4.
Corrected seasonal space heating efficiency

\[
\eta_s = \text{corrected seasonal space heating efficiency in } \%
\]

\[
F_i = \text{correction factors}
\]

\[
\eta_{\text{son}} = \text{seasonal space heating efficiency in } \%
\]

With:

<table>
<thead>
<tr>
<th>Component</th>
<th>Correction Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature controls</td>
<td>$F(1) = 3$</td>
</tr>
<tr>
<td>Auxiliary electricity power</td>
<td>$F(2) = 2.5 \times \frac{0.15 \times e_{l_{\text{max}}} + 0.85 \times e_{l_{\text{min}}} + 1.3 \times P_{SB}}{0.15 \times P_4 + 0.85 \times P_1} \times 100$</td>
</tr>
<tr>
<td>Standby heat losses</td>
<td>$F(3) = 0.5 \times \frac{P_{\text{stby}}}{P_4} \times 100$</td>
</tr>
<tr>
<td>Ignition burner power</td>
<td>$F(4) = 1.3 \times \frac{P_{\text{ign}}}{P_4} \times 100$</td>
</tr>
</tbody>
</table>

For boilers with a nominal heat output $> 70 \text{ kW}$ and $\leq 400 \text{ kW}$ the minimum energy efficiency requirements apply to useful efficiencies at nominal load and at 30% part load.

**Auxiliary electricity consumption**

The auxiliary electrical energy consumption is measured under similar test conditions as for determination of useful energy efficiency. The power consumption of the appliance is measured at full load, part load and standby mode, but excluding the circulator (if integrated).

The standard also describes an auxiliary energy consumption, but this appears to be for other purposes than the Ecodesign and labelling information.

**Load profiles**

In the calculation method for the water heating function of the boiler, the load profile shall be declared in the technical instruction. During the testing of the water heating efficiency, either the maximum load profile or one load profile below maximum shall be
used. The load profiles equal those that are defined in CR 814/2013. This standard refers to the load profiles from 3XS to 4XL.

**Water heating energy**
The water heating efficiency is calculated as in EN 13203-2:2015.

**Energy consumption**

*Annual Fuel Consumption*
The standard refers to the test procedures and calculation methods as described in EN13203-2:2015.

*Annual Electricity consumption*
The standard refers to the test procedures and calculation methods as described in EN13203-2:2015.

**Emissions**
EN 15502-1 defines methods for establishing carbon monoxide emissions (CO). CO is to be expressed as dry, air-free combustion product and is calculated using the measured CO concentration, the measured CO₂ concentration and the maximum CO₂ concentration of the dry, air-free combustion products.

\[
\text{CO} = (\text{CO})_M \times \frac{(\text{CO}_2)_N}{(\text{CO}_2)_M}
\]

\text{CO} = \text{the carbon monoxide concentration of the dry air-free combustion products in \%}

\text{(CO)}_M = \text{the measured concentrations in the samples taken during the combustion test, both expressed in \%}

\text{(CO}_2)_N = \text{maximum carbon dioxide concentration of the dry, air-free combustion products in \%}

\text{(CO}_2)_M = \text{the measured concentrations in the samples taken during the combustion test, both expressed in \%}

Equation 5. Corrected seasonal space heating efficiency

An alternative method is to calculate CO on the basis of the measured CO and the measured oxygen concentration in the combustion products.

The nitrogen emission measurements are only tested for appliances with a nominal heat input exceeding 10,5 kW. The tests are conducted when the appliance is in thermal equilibrium and under the same conditions as the ‘general test conditions’.

If the actual test conditions diverge from the reference conditions the NO₅ measurements need to be corrected.
\[ NO_{x,0} = NO_{x,m} + \frac{0.02 NO_{x} - 0.34}{1 - 0.02 (h_m)} (h_m - 10) + 0.85 (20 - T) \]

*Equation 6. Nitrogen oxides measured*

\[ NO_{x,m} = NO_x \text{ measured at } h_m \text{ and } T_m \text{ in mg/kWh (within the range of 50-300 mg/kWh)} \]

\[ T_m = \text{ temperature during test in °C (within the range of 15-25 °C)} \]

\[ H_m = \text{ humidity during test in g/kg (within the range of 5-15 g/kg)} \]

\[ NO_{x,0} = \text{ corrected } NO_x \text{ value in mg/kWh} \]

Also, the measured NO\textsubscript{x} concentration should be weighted over the different load profiles. These load profiles are relative to the nominal heat input \( Q_n \).

For boilers with variable output the measured emissions may be weighted to an overall.

\[ NO_{x,pond} = 0.15 NO_{x,mes(70)} + 0.25 NO_{x,mes(60)} + 0.30 NO_{x,mes(40)} + 0.30 NO_{x,mes(20)} \]

*Equation 7. Weighting of NO\textsubscript{x} concentrations*

\[ NO_{x,pond} = \text{ weighted } NO_x \text{ value in mg/kWh} \]

\[ NO_{x,mes(x)} = NO_x \text{ measured at 70, 60, 40 and 20% of nominal load} \]

For boilers than cannot modulate down to 20% or range rated boilers an interpolation at the lowest setting applies. The NO\textsubscript{x} concentration is to be expressed on the basis of the GCV of the fuel (conversion applies).

**Sound power level**
The standard refers to the test procedures as described in EN 15036-1.

### 4.2.2 **EN 15502-2-1:2012+A1:2016**

*CEN/TC 109/WG 1*

Gas-fired central heating boilers - Part 2-1: Specific standard for type C appliances and type B2, B3 and B5 appliances of a nominal heat input **not exceeding 1 000 kW**.

EN 15502-2-1:2012+A1 specifies, the requirements and test methods concerning, in particular, the construction, safety, fitness for purpose, and rational use of energy, as well as the classification and marking of gas-fired central heating boilers that are fitted with atmospheric burners, fan assisted atmospheric burners or fully premixed burners, and are hereafter referred to as “boilers”. Where the word boiler is used, it needs to be read as the boiler including its connecting ducts, ducts and terminals, if any.

This standard covers specifically the boiler types C1 up to C9 and the types B2, B3 and B5 which have a maximum nominal heat input of 1000kW. Furthermore, the C10 and C11 types equipped with a gas-air ratio control with a \( \Delta p_{\text{max,saf}} \) (min) of 25 Pa are included.

The differences in this standard with EN 15502-1:2012+A1:2015 are all related to safety issues. All calculations regarding efficiency and energy consumption are equal to the
methodology of the EN 15502-1:2012+A1:2015. Hence there is no need to describe it in detail.

4.2.3  **EN 15502-2-2:2014**

*CEN/TC 109/WG 1*

Gas-fired central heating boilers - Part 2-2: Specific standard for type B1 appliances (up to 70 kW input).

EN 15502-2-2 specifies the requirements and test methods concerning, in particular the construction, safety, fitness for purpose, and rational use of energy, as well as the classification and marking of gas-fired central heating boilers that are fitted with atmospheric burners, fan assisted atmospheric burners and are hereafter referred to as “boilers”. Where the word boiler is used, this is to be read as the boiler including its connecting ducts, ducts and terminals, if any. This European Standard covers gas-fired central heating boilers type B11, B11BS, B12, B12BS, B13, B13BS according to the classification in CEN/TR 1749:2009: a) that have a nominal heat input (on the basis of net calorific value) not exceeding 70 kW; b) that use one or more combustible gases of the three gas families at the pressures stated in EN 437; c) where the temperature of the heat transfer fluid does not exceed 105 °C during normal operation; d) where the maximum operating pressure in the water circuit does not exceed 6 bar; e) which are declared in the technical instructions to be either a “low temperature boiler” or a “standard boiler”. If no declaration is given the boiler is to be considered a “standard boiler”; f) which are intended to be installed either indoors or in a partially protected place; g) which are either not intended to produce hot water, or are intended to produce hot water either by the instantaneous or storage principle, the whole being marketed as a single unit. h) which are designed for either sealed water systems or for open water systems.

CEN/TR 1749:2014 specifies B type boilers as room air dependent. They may be equipped with a down-draught diverter (types B1x) or not (B2x and B3x). The 'x' is determined by the combustion fan presence/location. This standard therefore contains clauses specific to type B11-B13 boilers with a flue diverter, but excluding B14 (covered by EN 15502-1)

This European Standard is to be used in conjunction with the General Requirements Standard EN 15502-1. For applications within the scope of the PED further requirements may be necessary (e.g. situations where the maximum allowable temperature exceeds 110 °C, or where volume times maximum allowable pressure is over 50 bar x litres). This standard provides requirements for boilers with known constructions. For boilers with any alternative constructions, which might not fully be covered by this standard, the risk associated with this alternative construction shall be assessed. An example of an assessment methodology, based upon risk assessment and which covers the essential requirements of the Gas Appliance Directive, is given in Clause 11. This standard does not cover all the requirements for: i) appliances that are intended to be connected to gas grids where the quality of the distributed gas is likely to vary to a large extent over the lifetime of the appliance (see Annex DD of EN 15502-2-1:2012); j) appliances using flue dampers; k) appliances that have a nominal heat input (on the basis of net calorific value) exceeding 70 kW; l) appliances of the types A, B14, B2, B3, B4, B5 and C; m) appliances intended to be connected to a (common) flue having mechanical extraction; n) appliances with gas/air ratio control; o) modular boilers; p) boilers which can give rise
to condensation under certain circumstances; q) boilers intended to be installed in a room with a foreseeable negative pressure relative to the pressure in the flue system.

This European Standard adds clauses or sub clauses to the structure of EN 15502-1:2012 which are particular to this standard. It should be noted that these clauses and sub clauses are not indicated as an addition. Clauses, sub clauses and annexes which are additional to those in EN 15502-1:2012 are numbered starting from 101, respectively are designated as Annex AA, BB, CC, etc.

This standard covers classification (Clause 4), Construction (Clause 5), Electrical safety (Clause 6), Controls (Clause 7), Operational requirements (Clause 8), Useful efficiencies (Clause 9), Electric auxiliary energy (Clause 10), Risk assessment (Clause 11), Marking and instructions (Clause 12) and informative annexes on gas families (Annex I), standards replaced (Annex V), relation to GAD (Annex ZA) and relation to 92/42/EEC (Annex ZB).

This standard replaces various much older standards:

- EN 297:1994
- EN 625:1995
- EN 677:1998
- EN 15417:2006
- EN 15502-2-2:2012 draft

4.2.4 EN 303-3:1998 / A2:2004

The European Standard EN 303 covers 7 Parts:

- Part 1: Heating boilers with forced draught burners - Terminology, general requirements, testing and marking;
- Part 2: Heating boilers with forced draught burners - Special requirements for boilers with atomizing oil burners;
- Part 3: Gas-fired heating boilers - Assembly comprising a boiler body and a forced draught burner;
- Part 4: Heating boilers with forced draught burners - With outputs up to 70 kW and a maximum operating pressure of 3 bar - Terminology, special requirements, testing and marking;
- Part 5: Special heating boilers for solid fuels - Hand and automatically fired - Nominal heat output of up 300 kW - Terminology, requirements, testing and marking;
- Part 6: Heating boilers with forced draught burners - Specific requirements for the domestic hot water operation of liquid-fired combination boilers of nominal heat output not exceeding 70 kW;
- Part 7: Gas-fired central heating boilers equipped with a forced draught burner of nominal heat output not exceeding 1000 kW.

This European Standard does not deal with NOx emissions, as they are treated in EN 676.
4.2.4.1 EN 303-3:1998 / A2:2004

Heating Boilers - Part 3: Gas-fired heating boilers - Assembly comprising a boiler body and a forced draught burner

By CEN/TC 109

EN 303-3 specifies the requirements and test methods for the construction, the safety and the rational energy usage of an assembly made up of a boiler body complying with EN 303-1 and a forced draught gas burner complying with EN 676, using combustible gases, hereafter referred to as a "boiler".

The standard applies to a boiler with a nominal output not exceeding 1 000 kW.

This European Standard does not contain all the necessary requirements for:

- assemblies designed as units;
- condensing boilers and low temperature boilers;
- boilers intended to be installed in the open;
- boilers permanently fitted with more than one flue outlet;
- boilers fitted with a draught diverter;
- boilers intended to be connected to a common flue having mechanical extraction.

This European Standard does not apply to living-space dedicated boilers.

If the boiler body has already been tested with a liquid fuel burner, in accordance with EN 303-1, EN 303-2 and EN 304, only the tests described in annex G (of EN 303-3) need to be performed.

The testing methods defined by this European Standard for the determination of useful efficiencies can be used for low temperature boilers, after being adapted in accordance with annex H.

4.2.4.2 EN 303-7:2006

Heating boilers - Part 7: Gas-fired central heating boilers equipped with a forced draught burner of nominal heat output not exceeding 1000 kW

CEN/TC 109 “Central heating boilers using gaseous fuels”

This European Standard specifies the requirements and test methods for the construction, the safety and the rational energy usage for gas-fired standard and low temperature central heating boilers equipped with a forced draught burner.

These boilers comprise a boiler body and a forced draught gas burner brought together at the producer's assembly facility, the whole being designed and marketed as a complete boiler.

This standard does not apply to the case of the assembly of a boiler body and a forced draught gas burner designed and marketed separately. In this case, EN 303-3 applies.

This European Standard applies to type B23 boilers with a nominal heat output not exceeding 1000 kW with a water temperature at normal operation not exceeding 105 °C and with a maximum water-side operating pressure not exceeding 8 bar.

This European Standard does not contain all the necessary requirements for:

- condensing boilers and combination boilers;
boilers intended to be installed in the open;
boilers permanently fitted with more than one flue outlet;
boilers intended to be connected to a common flue having mechanical extraction;
boilers equipped with several combustion chambers.

This European Standard does not apply to living-space dedicated boilers.

### 4.2.5 EN 676/+A2:2008

**Forced draught burners for gaseous fuels**

*By CEN/TC 131 “Gas burners using fans”*

This European Standard specifies the terminology, the general requirements for the construction and operation of forced draught gas burners and also the provision of control and safety devices, and the test procedure for these burners. This standard is applicable to:

- automatic gas burners with a combustion air fan (hereinafter called "burners") and gas line components, intended for use in appliances of different types, and that are operated with gaseous fuels;
- total pre-mixed burners and nozzle mixed burners.

The standard is applicable to:

- single burners with a single combustion chamber;
- single-fuel and dual-fuel burners when operating only on gas;
- the gas function of dual-fuel burners designed to operate simultaneously on gaseous and liquid fuels, which, for the latter, the requirements of EN 264 also apply.

This European Standard deals with all significant machine hazards, hazardous situations and events relevant to burners, when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer, see Annex J.

This European Standard

- specifies the requirements to be met by the manufacturer to ensure the safety during commissioning, start-up, operation, shut-down and maintenance.
- does not deal with hazards due to specific applications, nor is it applicable to forced draught gas burners which are manufactured before the date of its publication as EN, nor does it apply to burners specifically designed for use in industrial processes carried out on industrial premises.
- deals also with the additional requirements for the burners in the scope with pressurised parts and /or firing pressurised bodies (see Annex K) as well as forced draught burners intended to be used with biogenous gaseous fuels, mixtures with line-conveyed gas and special gaseous fuels.
- deals also with burners equipped to increase the total appliance efficiency (Annex M).
- A revised standard has been published 1-12-2016 (EN 676:2016)
4.3 Oil boilers

4.3.1 EN 303-1:2017

Heating boilers – Part 1: Heating boilers with forced draught burners – Terminology, general requirements, testing and marking

*CEN/TC 57/WG 5*


This standard applies to boilers used for central heating (heating boilers) with forced draught burners with a nominal heat output not exceeding 1 000 kW, which are operated either with negative pressure (natural draught boilers) or with positive pressure (pressurised boiler) in the combustion chamber, in accordance with the boiler manufacturer’s instruction. This standard specifies the necessary terminology, the requirements on the materials and testing of them, and marking requirements for heating boilers.

The relevance of this standard in relation to the regulations lies in that it specifies the marking on the boiler data plate, and the technical documentation of the boilers covered. It provides the link between 813/2013 Annex II, item 5 and the clause 7 (technical information) of this standard. And it provides the link between Regulation (EU) No 811/2013 Annex III and IV to respectively clause 7.4 (Label) and 7.2 (product fiche) of this standard.

4.3.2 EN 303-2:2017

Heating boilers - Part 2: Heating boilers with forced draught burners - Special requirements for boilers with atomizing oil burners

*By CEN/TC 57/WG 2*

EN 303-2 is applicable to boilers used for central heating in accordance with EN 303-1:2017 up to a nominal heat output of 1 000 kW and EN 303-4 up to a nominal heat output of 70 kW with forced draught burners in accordance with EN 267 that are designed for operating with liquid fuels.

The performance requirements of this standard apply to type testing to heating boilers (standard, low temperature and condensing boilers) which are tested on a test rig in accordance with the test code given in EN 304.

This standard applies also to room sealed boilers as defined in EN 15035 regarding efficiency and emissions. This standard can also be used as the basis for evaluation of boiler-/burner units.

Supersedes:
- EN 303-2:1998
- EN 15034:2006
- EN 15034:2006/C1:2008
- EN 303-2:2016 draft

Energy efficiency

The performance tests are carried out using an oil forced draught burner in accordance with EN 267.
The standard specifies minimum energy efficiency requirements for boilers below 70 kW (seasonal space heating efficiency) and between 70 and 400 kW (useful efficiency in full and part load). Although these appear in line with the relevant regulations, the legal text always prevails over minimum efficiencies stated in standards.

The standard also prescribes minimum (useful) efficiency for full and part load for boilers above 400 kW.

The actual test is not described: The standard states that the performance tests are carried out using an oil forced draught burner in accordance with EN 267. And that if the boiler was already tested with a forced draught burner for gaseous fuels in accordance with EN 303-1 and EN 303-3, the tests described in 4.2 (boiler efficiency) and 4.6 (auxiliary electricity consumption) need not be performed.

**Standby heat loss and Auxiliary electricity consumption**

If the default value of EN 15316-4-1 is not used the standby heat loss for boilers shall be measured in accordance with EN 304.

**Sound power level**

The sound power level LWA shall be measured at nominal heat output according to EN 15036-1.

**Emissions**

The test method is described in EN 304:2017, the limit values are stated.

### 4.3.3  **EN 304: 2017**

**Heating boilers - Test code for heating boilers for atomizing oil burners**

*By CEN/TC 57/WG 2*


The test code applies to the determination of the performances of heating boilers and combi boilers fired by liquid fuels. The requirements for the heating performances are laid down in EN 303-1 and EN 303-2.

This code includes the requirements and recommendations for carrying out and evaluating the procedure for testing boilers and also the details of the technical conditions under which the tests shall be carried out.

The requirements and the performance of testing for the sanitary hot water production of combi boilers are laid down in EN 303-6.

**Energy efficiency**

Heat output is measured on the basis of mass flow and temperature rise (inlet/outlet temperature is 60+/-1°C and 80°C+/-2°C. The test room temperature is set at 20+/-5°C. The standard gives the equation for boiler efficiency, equivalent to the useful efficiency at nominal load and at part load (30% of nominal).

The standard describes two methods for establishing energy efficiency in part load conditions of which the first (time-dependent) prescribes a return temperature for "standard boilers" of 47°C (and 37°C for low-temperature and 30°C for condensing boilers), and the second method (load-dependent) prescribes a return temperature of
50°C for standard boilers, 40 °C for low temperature boilers and 30 °C for condensing boilers.

Neither of these two methods appear fully compliant with 813/2013 which requires for "other heaters" a return temperature of 50°C (corresponding to method 2), for "low temperature boilers" 37°C (corresponding to method 1) and 30°C for "condensing boilers" (corresponding to method 1 and 2).

**Table 33. Return temperatures of condensing boilers, low temperature boilers and other heaters (standard boilers)**

<table>
<thead>
<tr>
<th>Return temperatures (at heater inlet)</th>
<th>According 813/2013, ANNEX II Ecodesign requirements, Table 1 Information requirements for boiler space heaters (**)</th>
<th>prEN 304: rev 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensing boiler</td>
<td>30°C</td>
<td>'1' Time-dependent</td>
</tr>
<tr>
<td>Low temperature boiler</td>
<td>37°C</td>
<td>'2' Load-dependent</td>
</tr>
<tr>
<td>Other heater (for EN 304 &quot;standard boiler&quot;)</td>
<td>50°C</td>
<td></td>
</tr>
</tbody>
</table>

**Standby heat loss**

prEN 304 rev 2015 gives two methods for establishing standby heat loss. The first includes burner operation, the second is based on achieving a thermal equilibrium of 30°C above ambient (ambient again 20+/- 2°C) using an electric heater and includes correction for test rig losses.

\[
P_{\text{stby}} = P_m \times \frac{30}{T - T_A}^{1.25}
\]

Equation 8. Standby heat loss

- \(P_{\text{stby}}\) = standby heat loss, corrected to standard conditions
- \(P_m\) = in kW, the electrical power consumed by the auxiliary electric boiler, corrected for the losses of the test rig and the thermal contribution of the pump
- \(T = \) the mean water temperature equal to the mean of the temperature indicated by the two probes at the return and the flow of the boiler during the test, in °C
- \(T_A = \) mean ambient temperature during the test, in °C

**Auxiliary electricity consumption**

The auxiliary electricity consumption at nominal heat output (elmax), the auxiliary electricity consumption at 30% part load (elmin) and auxiliary electricity consumption in standby mode (PSB) are measured without the circulator.
Defaults can also be calculated according EN 15456.

**Emission values of NO\textsubscript{x} and CO**
The emission values of NO\textsubscript{x} and CO are determined by means of methods and instruments as described in EN 267. The calculation of NO\textsubscript{x} is performed according to EN 267, Annex B using the same corrections and reference conditions. The update of EN 267 (candidate EN 267:2018) is ready and is expected to be published early 2018.

**Water heating efficiency**
For combination boilers the water heating energy efficiency shall be determined in accordance with EN 303-6.

**4.3.4 EN 267:2009 + A1:2011**

**Automatic forced draught burners for liquid fuels**

*CEN/TC 47*
This European Standard specifies the terminology, the general requirements for the construction and operation of automatic forced draught oil burners and also the provision of control and safety devices, and the test procedure for these burners.

This European Standard applies to automatic forced draught oil burners supplied with:

- a fuel having a viscosity at the burner inlet of 1.6 mm\textsuperscript{2}/s (cSt) up to 6 mm\textsuperscript{2}/s (cSt) at 20 °C; and
- higher boiling petroleum based first raffinates (viscosity greater than 6 mm\textsuperscript{2}/s), that require preheating for proper atomisation.

This European Standard is applicable to:

- single burners fitted to a single combustion chamber;
- single burners fitted to an appliance with additional requirements, then the relevant standard of this appliance shall be taken into account;
- single-fuel and dual-fuel burners when operating on oil only;
- the oil function of dual-fuel burners designed to operate simultaneously on gaseous and liquid fuels, in which case the requirements of EN 676 will also apply in respect of the gaseous fuel function.

This European Standard deals with all significant machine hazards, hazardous situations and events relevant to burners, when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer, see Annex J.

This European Standard also deals with the additional requirements for the burners in the scope with pressurised parts and/or firing pressurised bodies, see Annex K.

This European Standard specifies the requirements to be met by the manufacturer to ensure the safety during commissioning, start-up, operation, shut-down and maintenance.

This European Standard does not deal with hazards due to specific applications.

This European Standard is not applicable to automatic forced draught oil burners which are manufactured before the date of its publication as European Standard.
The update of EN 267 (candidate EN 267:2018) is ready and is expected to be published early 2018.

4.3.5 **prEN 15034:2006 rev**

*Heating boilers - Condensing heating boilers for fuel oil*

*By CEN/TC 57/WG 2*

This standard is withdrawn and replaced by EN 303-2:2017 and EN 304:2017.

4.3.6 **EN 303-4:1999**

*Heating boilers – Part 4: Heating boilers with forced draught burners – Special requirements for boilers with forced draught oil burners with outputs up to 70 kW and a maximum operating pressure of 3 bar – Terminology, special requirements, testing and marking*

*Supersedes: prEN 303-4:1994*

Is applicable to heating boilers with forced draught oil burners up to a nominal heat output of 70 kW. They are operated, either with negative pressure (natural draught boiler) or with positive pressure (pressurised boiler) in the combustion chamber, in accordance with the boiler manufacturer's instructions. This standard specifies the necessary terminology, the requirements on the materials and testing of them, and marking requirements for heating boilers.

4.4 **Electric boilers (Joule-effect heaters)**

The **TM2014sh** does not mention (references to) standards to be used for establishing performance, and only refers to point 4 of the Communication.

No EN standards have been identified that identify the heating capacity or other regulated parameters of electric (Joule-effect) space/combination heaters.

The Transitional Methods with regard to Ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units (Commission Communication 2017/C 229/01) mentions IEC/EN 60675 ed. 2.1; 1998 par. 16 to be used to establish the 'usable power' at nominal and minimum load. As useful efficiencies for Joule-effect is usually set at default 100% (to be corrected by the PEF or CC for expression on the basis of primary energy), the $\eta_{son}$ can be calculated. The power input will probably have to be corrected for the power requirement of pumps that distribute the fluid and electronic controls where relevant.

Calculation of correction $F(2)$ for auxiliary electricity consumption may be based on IEC 62301:2011-01, to establish the electric power consumption in standby mode.

The standby heat loss $F(3)$ for electric Joule-effect space/combination heaters is not defined in any standard but the abovementioned Transitional Methods list EN 1886:2007 to establish envelope losses.

Concluding, there are no EN standards identified that could be used to show compliance. Some IEC standards have been identified in a Commission Communication for other products that may be used, but whether this is acceptable could not be established as no
market surveillance authority or manufacturer came forward with information regarding compliance verification (conformity assessment) of these products.

4.5 Electric heat pumps
4.5.1 EN 14511 series
Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling

By CEN/TC 113/WG7

4.5.1.1 EN 14511-1:2018 - Part 1: Terms, definitions and classification
Part 1: Terms, definitions and classification
This European Standard specifies the terms and definitions for the rating and performance of air conditioners, liquid chilling packages and heat pumps using either, air, water or brine as heat transfer media, with electrically driven compressors when used for space heating and/or cooling. This European Standard does not apply to heat pumps for domestic hot water, although certain definitions can be applied to these. This European Standard applies to:

- factory-made units that can be ducted,
- factory-made liquid chilling packages with integral condensers or for use with remote condensers,
- factory-made units of either fixed capacity or variable capacity by any means, and
- air-to-air air conditioners which can also evaporate the condensate on the condenser side.

Packaged units, single split and multi-split systems are covered by this standard. Single duct and double duct units are covered by the standard. In the case of units consisting of several parts, this European Standard applies only to those designed and supplied as a complete package, except for liquid chilling packages with remote condenser. This European Standard is primarily intended for water and brine chilling packages but can be used for other liquid subject to agreement.

The units having their condenser cooled by air and by the evaporation of external additional water shall have their performance in the cooling mode determined in accordance to EN 15218. For those which can also operate in the heating mode, EN 14511 applies for the determination of their performance in the heating mode. Installations used for heating and/or cooling of industrial processes are not within the scope of this standard.
4.5.1.2 EN 14511-2:2018 - Part 2: Test conditions

Part 2: Test conditions

This standard is harmonised for use with Commission Regulation (EU) n° 206/2012 with regard to Ecodesign requirements for air conditioners and comfort fans and Commission Delegated Regulation (EU) n° 626/2011 with regard to energy labelling of air conditioners.

This part covers the standard rating conditions, selected applications (only xx-to-water, only standard rating conditions) (Table 7, 8, 9, 12, 13 and 14 of EN 14511-2:2013).

Table 34. Standard rating conditions for heat pumps in EN 14511

<table>
<thead>
<tr>
<th>Standard rating conditions</th>
<th>Outdoor heat exchanger</th>
<th>Indoor heat exchanger /</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>low temperature</td>
<td>medium temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inlet temperature °C (wet bulb)</td>
<td>Outlet °C</td>
</tr>
<tr>
<td>water-to-water,</td>
<td>10</td>
<td>7</td>
<td>30</td>
</tr>
<tr>
<td>brine-to-water</td>
<td>0</td>
<td>-3</td>
<td>30</td>
</tr>
<tr>
<td>outdoor air heat pump</td>
<td>7 (6)</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>exhaust air heat pump</td>
<td>20 (12)</td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>

There is also a 'very high temperature'-type with standard rating condition inlet/outlet temperatures of 55-65 °C.

4.5.1.3 EN 14511-3:2018 - Part 3: Test methods

Part 3: Test methods

This standard is harmonised for use with Commission Regulation (EU) n° 206/2012 with regard to Ecodesign requirements for air conditioners and comfort fans and Commission Delegated Regulation (EU) n° 626/2011 with regard to energy labelling of air conditioners.

This Standard specifies the test methods for the rating and performance of air conditioners, liquid chilling packages and heat pumps using either air, water or brine as heat transfer media, with electrically driven compressors when used for space heating and cooling. These test methods also apply for the rating and performance of process chillers. It also specifies the method of testing and reporting for heat recovery capacities, system reduced capacities and the capacity of individual indoor units of multisplit systems, where applicable. This Standard also makes possible to rate multisplit and modular heat recovery multisplit systems by rating separately the indoor and outdoor units.

Changes in correction of integrated or external fan or pump

EN 14511-3:2013 specifies the heating (or cooling) capacity shall be corrected for the heat from the fan or pump:
a) if the fan or pump at the indoor heat exchanger is an integral part of the unit, the same power (calculated in 4.1.5.2 or 4.1.6.3) which is excluded from the total power input shall be also subtracted from the heating capacity;

\[
correction\ if\ integral = \frac{q \cdot (\Delta p_e - ESP_{min})}{\eta}
\]

Where:
- \( q = \) the nominal air flow rate, m3/s
- \( \Delta p_e = \) the measured available external static pressure difference, as defined in 2.52 of EN 14511-1:2013, expressed in Pascal
- \( ESP_{min} = \) the minimum external static pressure difference specified in Table 2 or Table 3, as applicable for an indoor unit, or 30 Pa for an outdoor unit, expressed in Pascal
- \( \eta = \) is equal to \( \eta_{target} \); as declared by the fan manufacturer according to the Ecodesign regulation n°327/2011 for fans driven by motors between 125 W and 500 kW, is 0.3 by convention, for fans driven by motors below 125 W

b) if the fan or pump at the indoor heat exchanger is not an integral part of the unit, the same power (calculated in 4.1.5.3 or 4.1.6.4) which is included in the effective power input shall be also added to the heating capacity.

\[
correction\ if\ external = \frac{-q \cdot (\Delta p_i + ESP_{min})}{\eta}
\]

Where:
- \( \Delta p_i = \) the measured available internal static pressure difference, as defined in 2.52 of EN 14511-1:2013, expressed in Pascal

For pumps the respective equations are:

\[
correction\ if\ integral = \frac{q \cdot \Delta p_e}{\eta}
\]

\[
correction\ if\ external = \frac{q \cdot \Delta p_i}{\eta}
\]

Where:
- \( \eta = \) is the efficiency of the pump calculated according to Annex H
- \( \Delta p_e = \) the measured available external static pressure difference, as defined in 2.52 of EN 14511-1:2013, expressed in Pascal
- \( q = \) the nominal liquid flow rate, m3/s
- \( \Delta p_i = \) the measured available internal static pressure difference, as defined in 2.53 of EN 14511-1:2013, expressed in Pascal

The more recent 2018 version of EN 14511-3 has a revised calculation that allegedly reduces the heating (or cooling) capacity by a factor of 0.98-0.99 thus reducing the COP...
or EER calculated for a specific condition. EHPA has asked to consider this effect when reviewing the Ecodesign efficiency requirements.

**Testing with locked inverter or the compensation method**

The seasonal performance of heat pumps is calculated by establishing the capacity, power input and COP at varying load conditions (part load and indoor/outdoor conditions). In order to achieve robust and reliable results a certain (unknown) share of heat pump manufacturers have their machines run at 'locked' compressor speed for a desired 'rated' capacity.

Some stakeholders believe that such tests in 'locked' mode are unrealistic, as shown in experimental studies\(^\text{176}\). Studies of inverter air conditioners (including reversible ones) showed input power deviation in ‘unlocked’ modes versus tests in the ‘locked’ mode for similar output capacity. At full load these differences are minimal, but with increasing part load the difference would increase as well. In addition, even though the units operate without any ‘locked instructions’, some units were noticed to turn off some parasitic power usage and operate under ‘high-efficient locked mode’, whenever they were subjected to standard’s test conditions continuously for more than an hour.

When tested in an ‘unlocked’ mode, the indoor test room is given an almost fixed thermal load and the unit being tested adjusts its speed or power input to match the thermal load. The unit operation is adjusted with the remote controller, to achieve a close match to the indoor-unit room temperature required by the test standard. Temperature resolution on the remote controller (usually ±1ºC) could affect the stability of the final indoor room conditions.

The studies on three appliances showed a deviation in seasonal cooling or heating efficiency of -9% to -36% (these values relate to the Australian/New Zealand Test standards AS/NZS 3823.4

According the author of the studies comparing locked versus field performance there are distinct advantages to the proposed “unlocked” mode of testing the IAC units compared to the existing “locked” mode test method:

- Any calorimeter laboratory can adopt the “unlocked” test method to conduct the performance tests on IAC units for field behaviour. This can also be applied to psychometric or air-enthalpy type (AS/NZS 3823) test methods.
- There is no need for “locked” instructions from the manufacturer or any “special” assistance during the tests.
- Field performance can be obtained for any suitable thermal load and corresponding unit behaviour (power input and efficiency) in meeting that load.
- Use of any circumvention device in the air conditioner system can be more easily identified.
- Rating will show performance in field conditions, which will greatly benefit consumers.

---

\(^{176}\) Dr Satya Prasad Mavuri, Field Behaviour of Inverter Air Conditioners Effect on Seasonal Performance, International Journal of Application or Innovation in Engineering & Management (IJAIME), Volume 4, Issue 8, August 2015
• Creative IAC units receive the credit they deserve, and the poor designs would be eliminated.
• Check testing can be quicker, independent and with more veracity.
• The field performance results obtained with this method could be applied to check MEPS compliance ratings.
• This method will encourage IAC manufacturers to focus on “real” performance rather than the laboratory performance.

The industry is aware of the issue and other methods have been discussed, but so far, the industry’s preference lies with continuation of the present (locked) method.

4.5.1.4 **EN 14511-4: 2018 - Part 4: Operating requirements, marking and instructions**

**Part 4: Operating requirements, marking and instructions**

This European Standard specifies minimum operating requirements which ensure that air conditioners, heat pumps and liquid chilling packages using either air, water or brine as heat transfer media, with electrical driven compressors are fit for the use designated by the manufacturer when used for space heating and/or cooling.

4.5.2 **EN 14825:2016**

**Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance**

*By CEN/TC 113/WG 7*

This European Standard covers air conditioners, heat pumps and liquid chilling packages, including comfort and process chillers. It applies to factory made units defined in EN 14511-1, except single duct, double duct, control cabinet and close control units.

This European Standard gives the temperatures and part load conditions and the calculation methods for the determination of seasonal energy efficiency SEER and SEERon, seasonal coefficient of performance SCOP, SCOPon and SCOPnet, and seasonal space heating energy efficiency ηs. Such calculation methods may be based on calculated or measured values.

In case of measured values, this European Standard covers the test methods for determination of capacities, EER and COP values during active mode at part load conditions. It also covers test methods for electric power consumption during thermostat-off mode, standby mode, off-mode and crankcase heater mode.

The version from 2016 is the current published version, but there are prEN draft versions from 2017, and there will probably be another prEN draft published during 2017.

|The standard EN 14825:2013 is harmonised for use with Commission Regulation (EU) n° 206/2012 with regard to Ecodesign requirements for air conditioners and comfort fans and Commission Delegated Regulation (EU) n° 626/2011 with regard to energy labelling of air conditioners.|

The standard is important is it describes the methods to establish the seasonal energy efficiency of (electric) heat pumps.
The Swedish heat pump test institute RI-SE has a particular opinion on the test point temperatures. EN 14825 is based on test points defined by outlet temperatures. During the course of development of the EN 14825, circulation pumps with a variable flow have become more and more common, and hence it has become more and more common that the heat pumps are operated with a variable liquid flow. This in itself is very often beneficial for the efficiency of the heat pump system. However, to have a fair comparison between different products and control strategies, the heating water temperature for the test points should be defined by the mean temperature (between outlet and inlet temperature to the heating system). This has been discussed to a large extent within the working group CEN TC 113 WG7. However, since a revision of the standard from an outlet temperature approach to a mean temperature approach would result in somewhat different efficiency values for some products, there has been a reluctance to do such a change as long as the present regulations apply. Therefore, this should be taken into account when the regulations are revised in order to be able to introduce this change in the regulations and the standards at the same time and take the somewhat changed efficiency values into account when/if changing the threshold values for Ecodesign and the label classes.

FprEN 14825:2018
This final draft of March 2018 will supersede the 2016 version and adds a calculation of hybrid performance and also adds a calculation for establishing the SEPR for process chillers. It also covers direct expansion-to-water(brine) heat pumps (DX-to-water) as defined in EN 15879-1.

See section 4.9

4.5.2.1 Dynamic testing
A growing number of experts and stakeholders are unhappy with the fact that the testing of (electric) heat pumps requires the manufacturer to provide the correct settings of compressor (and fan, if applicable) speed during testing at various load/temperature conditions.

Not only is this ignoring the way the heat pump responds to inputs from heating controls under normal operating conditions, it also opens up a possibility for circumvention (although no proof of such misuse has been brought forward).

Nonetheless, several experts, in Europe but also outside Europe, have started to develop alternative test methods that much closer monitor and assess how heat pumps respond to actual (changes in) heating demands. Two methods are of interest.

The first method is referred to as the "compensation method" and it closely resembles an out-of-the-box test situation without manufacturer involvement for setting frequencies. The heat pump is subjected to four test conditions with varying indoor/outdoor temperatures and part loads to be delivered. For on-off heat pumps, the heat load in the indoor side calorimeter chamber is increased progressively until it matches the unit capacity. For inverter air conditioners, the procedure includes fixing the frequency. If one performs the test without fixing the frequency, the procedure must be further elaborated: how humidity is added if the unit dehumidifies, keeping heat load constant or variable, indoor room and humidity deviations from set-point must be kept within tolerances, how to deal with the relative ratio of air flow / volume of the room which could affect how the control operates, etc.
The second method is referred to as "Dynamic testing" which involves using the compensation method and subjecting the heat pump to a progressive decrease of outdoor temperature and increase of load representing a seasonal variation of temperatures, instead of 4 or 5 specific test conditions. The test sequence corresponds to bins according EN 14825. The total sequence can be 144 hours within which each condition has a duration of 4 hr. The idea is to avoid interpolation or extrapolation of specific test conditions over the entire heating season (improving representativeness), and include HP controls (possibly including that of auxiliary heating for hybrids in heating mode). The benefit would be that the test, completed in 144 hrs / 6 days, results in an indicative seasonal performance. A more elaborate description is found in the documents provided by UBA-BAM177 on this subject (see project website).

The standardisation organisations (here foremost CEN/TC113/WG10) are willing to investigate these methods further and presentations are made, and results of research have been exchanged. However, the standardisation community and also many manufacturers (individually and organised) currently state that further research is needed before the method(s) is/are sufficiently developed for use in a regulatory context.

Furthermore, if this method is applied, it should be expanded to cover thermally driven heat pumps as well, if applicable. At the moment, much care has been given in aligning the respective methods (EN 14825 etc. and EN 12309) as much as possible.

4.5.3 EN 16573:2017

Ventilation for Buildings - Performance testing of components for residential buildings - Multifunctional balanced ventilation units for single family dwellings, including heat pumps

Prepared by a Joint Working Group of CEN/TC 156 and CEN/TC 113

Scope

EN 16573 specifies the laboratory test methods and test requirements for aerodynamic, energy rating and acoustic performance, of multifunctional balanced units intended for use in a single dwelling. In the case of units consisting of several parts, this standard applies only to those designed and supplied as a complete package with the mounting instructions. It covers units that contain at least, within one or more casing:

- supply and exhaust air fans;
- air filters
- common control system;

and one or more of the additional components:

- air-to-water heat pump;
- air-to-air heat pump;
- air-to-air heat exchanger.

Units including only an air to air heat exchanger and/or an exhaust air to supply air heat pump are covered by EN 13141-7.

177 Besides BAM, Germany are involved AIT, Austria and Fraunhofer, Germany
A non-exhaustive list of possible configurations of multifunctional units covered by this standard is given in Clause 5.

The standard does not cover the thermal aspects of humidity transfer in the air-to-air heat exchanger. This standard does not deal with non-ducted units on supply and extract air side. This standard does not deal with collective units (centralized or semi-centralized systems).

These multifunctional balanced units can be connected to ground heat exchanger for air preheating, solar collector or other heating systems. This standard does not cover the testing with these additional components. This standard does not cover units including combustion engine driven compression heat pumps and sorption heat pump.

**Functions**

The main function of multifunctional ventilation units is the provision of ventilation for a single dwelling. This means, that all additional functions:

- hydronic heating/air heating;
- hydronic cooling/air cooling;
- hot water production;

can operate only during ventilation.

The multifunctional ventilation unit shall be designed and controlled to provide the hygienic ventilation rate for a dwelling or part of a dwelling. That means for example, that the ventilation rate shall not be controlled according to the hydronic heating demand.

If specified by the manufacturer, the unit may use an additional outdoor air volume flow, to provide a higher thermal capacity if needed. This leads to two alternatives:

1) The higher outdoor air volume flow (outdoor exhaust air) does not affect the ventilation function (supply air and extract air).

   Additional tests shall be performed according to the declaration of manufacturer. No further correction needed

2) The air volume flows for ventilation (supply air and/or extract air) increase. In this case the air volume flows shall be measured and documented as a percentage of reference air volume flow.

NOTE This may be needed to allow a correction of system performance according to the EPBD calculation.

**Discussion**

At present, the products described by this standard are considered outside the scope of the space/water heating regulations as their main function is ventilation, not heating, and the heat output is primarily controlled by ventilation demands and not by space heating demand. However, with dwellings having a lower energy demand than before (near-zero or energy positive buildings) such products can, in principle, supply the main heating function, which makes them relevant for space/water heating regulations. Several stakeholders have opted for inclusion of these products in the scope of space/water heating regulations.
The standard recognises the following functions, for which test methods and calculations have been described:

1. Ventilation heat recovery performance (out of scope of space/water heating regulations) (clause 7.3);
2. Ventilation and domestic hot water production (clause 7.4);
3. Ventilation with hydronic space heating/cooling (clause 7.5);
4. Ventilation with supply air heating/cooling (clause 7.6);
5. Ventilation with both hydronic and supply air heating/cooling (clause 7.7)
6. Ventilation combined with heating and hot water production (clause 7.8);
7. Ventilation combined with cooling and hot water production (clause 7.9);

Clause 8 describes acoustic tests.

The standard defines several test conditions of which, depending on function and category, some are mandatory or optional.

Table 35. Rating conditions for ventilation heat pumps in EN 16573

<table>
<thead>
<tr>
<th>Test point nº</th>
<th>Exhaust air &amp; recirculation air dry(wet) bulb temperature</th>
<th>Outside air dry(wet) bulb temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-mandatory</td>
<td>+20(+12)</td>
<td>+7(+6)</td>
</tr>
<tr>
<td>2-cat. II mandatory (regen.) cat. I optional (recup.)</td>
<td>+20(+15)</td>
<td>+2(+1)</td>
</tr>
<tr>
<td>3-optional</td>
<td>+20(+12)</td>
<td>-7(-8)</td>
</tr>
<tr>
<td>4-cold climate: mandatory rest: optional</td>
<td>+20(+12)</td>
<td>-15(-)</td>
</tr>
<tr>
<td>5 –if cooling is applicable</td>
<td>+27(+19)</td>
<td>+35(+24)</td>
</tr>
<tr>
<td>6-optimal for cooling</td>
<td>+27(+19)</td>
<td>+27(+19)</td>
</tr>
<tr>
<td>7- optional for cooling</td>
<td>+29(+19)</td>
<td>+46(+24)</td>
</tr>
</tbody>
</table>

Category applies to EN 13141-7 categories of heat exchangers: Category I is recuperative heat exchangers (now 1a and 1b), category II is regenerative.

The tests are performed for a single reference fresh air volume flow, defined at \( p_{	ext{td}}/2 \) and 70% of declared maximum flow. Performance testing of the ventilation function is in accordance with EN 13141-7, for DHW the performance is established according EN 16147 and for (hydronic) space heating the tests are aligned with EN 14511-2 and the calculations include corrections for pumps as in EN 14511-3.

The possible number of configurations is very large, as it includes several forms of recirculation (of recirculation air to supply air, and/or outdoor air to exhaust air) and several forms of serial or parallel operation of space and/or water heating, using several possible air flow as heat sources.

These heat pumps are primarily ventilation products, as they can only provide heat when providing ventilation (main function). For these reasons some consider these products to be out of scope of the regulations although they meet the definition of heat pumps and the simpler product, an (exhaust)air-to-water heat pump, is covered under the current scope and a seasonal efficiency is established using the standard rating condition.
For “very simple” multifunctional units, the part load measurements and calculation approach used with the bin method could possibly be applied, but this approach certainly cannot be directly applied to all possible products covered under this standard.

If the product however uses a mix of ventilation (exhaust) air and outdoor air as heat source (for instance if the required air flow rate exceeds the maximum available exhaust air flow rate as defined in the regulations) and/or provides heat to both space and water heating (can be simultaneously), then the allocation of energy flows to functions is intricate and not yet solved.

A seasonal performance, which requires identification of part load operation has also not been solved yet. Nonetheless, such products are currently used in (near-)zero energy-buildings and are competing with more conventional solutions (separate ventilation with heat recovery and heat pumps). The difficulties in introducing these products into a (new or existing) ErP regulation are:

- to clearly define the scope of the regulation (currently the regulatory scope is more restrictive than the standard, i.e. excludes cooling or air heating). Furthermore, does the standard cover all possible existing configurations? (e.g. multifunctional units with solar devices for DHW are not covered);
- Which range of capacity to cover?
- Which performance need to be rated? Overall performance (simultaneous operation is ventilation plus secondary function)? Or DHW and space heating in a separate or combined approach? How should ventilation “measurement requirements” be included?
- How to define part load rating if a SCOP approach is envisaged?
- How to compare the units? (especially if different functions apply, i.e. serial or parallel operation).

4.5.4 EN 12900:2013

CEN TC 113 WG 6
Refrigerant compressors - Rating conditions, tolerances and presentation of manufacturer’s performance data

This standard EN 12900:2013 is harmonised for use with Commission Regulation (EU) n° 206/2012 with regard to Ecodesign requirements for air conditioners and comfort fans and Commission Delegated Regulation (EU) n° 626/2011 with regard to energy labelling of air conditioners.

This European Standard specifies the rating conditions, tolerances and the method of presenting manufacturer’s data for positive displacement refrigerant compressors. These include single stage compressors and single and two stage compressors using a means of fluid sub cooling. This is required so that a comparison of different refrigerant compressors can be made. The data relate to the refrigerating capacity and power absorbed and include requirements for part-load operation where applicable.
4.6  Sorption heat pump (gas-fired)

4.6.1  EN 12309 series

The standard for sorption appliances is EN 12309 series, written and maintained by CEN TC 299/WG 2. TC 299 WG 3 works on gas-fired endothermic engine heat pumps (heat pump driven by a gas engine) through standard EN 16905.

The EN 12309 series consists of:

**Table 36. EN 12309 series of standards**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 12309-1:2014 (WI=00299013)</td>
<td>Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 1: Terms and definitions</td>
<td>2014-12-17</td>
</tr>
<tr>
<td>EN 12309-2:2015 (WI=00299019)</td>
<td>Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 2: Safety</td>
<td>2015-05-20</td>
</tr>
<tr>
<td>EN 12309-2:2015/AC:2015 (WI=00299C01)</td>
<td>Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 2: Safety</td>
<td>2015-12-02</td>
</tr>
<tr>
<td>EN 12309-3:2014 (WI=00299018)</td>
<td>Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 3: Test conditions</td>
<td>2014-12-17</td>
</tr>
<tr>
<td>EN 12309-4:2014 (WI=00299014)</td>
<td>Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 4: Test methods</td>
<td>2014-12-17</td>
</tr>
<tr>
<td>EN 12309-5:2014 (WI=00299015)</td>
<td>Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 5: Requirements</td>
<td>2014-12-17</td>
</tr>
<tr>
<td>EN 12309-6:2014 (WI=00299016)</td>
<td>Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 6: Calculation of seasonal performances</td>
<td>2014-12-17</td>
</tr>
<tr>
<td>EN 12309-7:2014 (WI=00299017)</td>
<td>Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 7: Specific provisions for hybrid appliances</td>
<td>2014-12-17</td>
</tr>
</tbody>
</table>

The WG 2 published these standards in line with the request for standardisation and the entry into force of Regulation (EU) no 813/2013 and Delegated Regulation (EU) no 811/2013 for space heaters.

The parts relevant for Ecodesign related performance measurement are part 1 (definitions), part 3-4-5 (test conditions – methods – requirements) and part 6-7 (seasonal performance - special provisions for hybrid appliances).

Currently the WG 2 is working to combine part 3, 4 and 5 into a single document (referred to as part 10).

The approach of the EN 12309 series is largely aligned with that of the EN 14511 and EN 14825 combination that applies to electric heat pumps.

The scope of the EN 12309 series are gas-fired sorption chillers and/or heat pumps (excludes air conditioning using an internal heat exchanger of refrigerant to air – these are covered by EN 14825 if electric). The reason is that ammonia is often used as refrigerant, which offers some benefits if combined with water (easily absorbed in case of leak) and drawbacks if combined to air heat exchanger (ammonia is a dangerous substance).

**4.6.1.1 EN 12309-1: 2014 - Terms and definitions**

Appliances covered by this European Standard include one or a combination of the following: - gas-fired sorption chiller; - gas-fired sorption chiller/heater; - gas-fired sorption heat pump. This European Standard applies to appliances designed to be used for space heating or cooling or refrigeration with or without heat recovery. This European Standard applies to appliances having flue gas systems of type B and C (according to CEN/TR 1749) and to appliances designed for outdoor installations. EN 12309 does not apply to air conditioners, it only applies to appliances having: - integral burners under the control of fully automatic burner control systems, - closed system refrigerant circuits in which the refrigerant does not come into direct contact with the water or air to be cooled or heated, - mechanical means to assist transportation of the combustion air and/or the flue gas. The above appliances can have one or more primary or secondary functions (i.e. heat recovery - see definitions in prEN 12309 1:2012). In the case of packaged units (consisting of several parts), this standard applies only to those designed and supplied as a complete package. The appliances having their condenser cooled by air and by the evaporation of external additional water are not covered by EN 12309. Installations used for heating and/or cooling of industrial processes are not within the scope of EN 12309. All the symbols given in this text should be used regardless of the language used.

This part of this European Standard specifies the terms and definitions for gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW.

**4.6.1.2 EN 12309-2: 2015/AC:2015 - Safety**

Full title: Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 2: Safety

Date: June 2014 (in Dec 2015 the standard was amended to correct table 10 on test gases)
Standard EN 12309-2 on safety of gas-fired sorption heat pump space heaters and combination heaters describes (amongst others) the measurement and calculation of NO\textsubscript{x} emissions.

**NO\textsubscript{x} Emissions**

Clause 6.14 of prEN 12309-2:2013 (E) presents the NO\textsubscript{x} classes, with NO\textsubscript{x} concentration of flue gasses expressed as mg/kWh (NCV) and related to dry, air free products of combustion.

<table>
<thead>
<tr>
<th>Class</th>
<th>Concentration in mg/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>260</td>
</tr>
<tr>
<td>2</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>150</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
</tr>
</tbody>
</table>

The values in the table are maximum values and shall not be exceeded (e.g. 80 mg/kWh is class 4). The numerator 'kWh' is not further defined, but in later versions of the standard it refers to kWh fuel input. The kWh is calculated as NCV as is the case for all fuel related parameters in this standard.

Clause 6.14 is not in line with the Regulations as these require emissions expressed in kWh GCV fuel input, and the regulations require the actual measured emission to be stated, not the class (which has a certain bandwidth).

**Test conditions**

Clause 7.1.2 of EN 12309-2 states that the composition of gases used for the tests shall be as near as possible to those given in EN 437:2003+A1:2009, Table 2. and Clause 7.1.3. adds that the appliance must be correctly adjusted for use of the test gas. Clause 7.1.6. Test conditions specify a room temperature of (20 ±5) °C and a relative humidity of 10 g H\textsubscript{2}O/kg air.

Regulation (EU) No 813/2013 states that the standard rating conditions apply and the same declared capacity for heating shall be used (to ensure a correct link to the unit defined as mg per kWh fuel input).

Table 8 of Clause 7.1.6.3 specifies an indoor heat exchanger inlet/outlet temperature of 35/45°C (Regulation 813 requires either 35 or 55°C as outlet temperature). The outdoor temperatures correspond to Regulation (EU) No 813/2013 standard rating conditions, except for hybrid ground source and solar collector source appliances (higher outdoor inlet temperature than monovalent brine-to-water, respectively 7 and 12°C).

Clause 7.3.12 of EN 12309-2 describes the measurement of NO\textsubscript{x} emissions. For on/off appliances the NO\textsubscript{x} is measured at nominal heat input (clause 7.3.13.2.3), for appliances than can supply heat at multiple rates the emissions are to be established at 70%, 60%, 40% and 20% (if applicable) of nominal heat input. or if these values cannot be attained, the closest lower and higher rate. The NO\textsubscript{x} emissions for each rate are weighted as 0.15,
0.25, 0.30 and 0.30 respectively. The return water temperature also varies from 31º to 29ºC, 26ºC and 23ºC respectively.

\[
NO_{x,m} = NO_{x,m} \times \frac{0.02 NO_{x,m} - 0.34}{1 - 0.02(h_m - 10)} \times (h_m - 10) + 0.85 \times (20 - T_m)
\]

where:
- \(NO_{x,m}\) is the NO\(_x\) measured at \(h_m\) and \(T_m\) in milligram per kilowatt-hour (mg/kWh) in the range 50 mg/kWh to 300 mg/kWh;
- \(h_m\) is humidity during the measurement of \(NO_{x,m}\) in g/kg in the range 5 g/kg to 15 g/kg;
- \(T_m\) is the temperature during the measurement of \(NO_{x,m}\) in °C in the range 15 °C to 25 °C;
- \(NO_{x,0}\) is the value of NO\(_x\) corrected to the reference conditions expressed in milligram per kilowatt-hour (mg/kWh).

The NO\(_x\) concentration is measured at the heat input that is typical for the appliances tested. The standard describes calculation procedures for:
- on/off appliances (NO\(_x\) measured at nominal heat input);
- appliances with several rates (NO\(_x\) measured at the available rates and a weighing factor of the emissions at specific rates is calculated through linear interpolation. The NO\(_x\) emission is the sum of the concentrations and their weighing factors);
- modulating appliances in which the minimum modulating heat input is less than or equal to 20 % of the nominal heat input and (NO\(_x\) concentrations are established at given heat input and weighted accordingly to result in overall concentration);
- modulating appliances in which the minimum modulating heat input is greater than 20 % of the nominal heat input (NO\(_x\) concentrations are established at given heat input and weighted accordingly as far as possible. Values if heat input below 20% are added).

Table 11 in Clause 7.3.12.2 gives the weighting factors:

<table>
<thead>
<tr>
<th>Partial heat input Qpi as a % of Qn</th>
<th>70</th>
<th>60</th>
<th>40</th>
<th>20 if applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weighting factor Fpi</td>
<td>0.15</td>
<td>0.25</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>Return water temperature</td>
<td>31</td>
<td>29</td>
<td>26</td>
<td>23</td>
</tr>
</tbody>
</table>

Clause 7.3.12.7 gives the conversion to GCV of the fuel. If the emissions are to relate to kWh heat supplied, the concentration is divided by the GUEh.

Apart from the indoor heat exchanger outlet temperature, the procedures appear to be in line with the Regulation as part load conditions are not established by Delegated Regulation (EU) No 811/2013 or Regulation (EU) No 813/2013. The method was mentioned in the Transitional Method document (Commission Communication 2014/C 207/02 of 3.7.2014).
The standard does not cover liquid fuel fired appliances, but these do not exist (currently known).

4.6.1.3  EN 12309-3: 2014 - Test conditions
Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 3: Test conditions.
The standard defines Environmental conditions and electrical power supply requirements for appliances designed for indoor installations (range 15º to 30ºC) and for outdoor installations (when cooling 25ºC to 35ºC and heating 0ºC to 7ºC).

This standard has a similar function as standard EN 14511 for electric motor driven heat pumps/chillers/AC as it defines the test conditions.

Test conditions
Clause 4.1. gives rating test conditions for the equipment in the range of 15-30ºC for water/brine-to-water appliances for indoor installations and 0-7ºC for outdoor installations (heating mode). For air-to-water appliances the environmental conditions are equal to the air inlet temperatures.

Clause 4.2. gives the rating conditions which include standard rating conditions and application rating conditions (also for cooling and heat recovery, but that is not relevant for Delegated Regulation (EU) No 811/2013 or Regulation (EU) No 813/2013).
Table 39. EN 12309-3:2012 Standard rating conditions, heating mode

<table>
<thead>
<tr>
<th>Type of appliance</th>
<th>Outdoor heat exchanger</th>
<th>Indoor heat exchanger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inlet dry/wet bulb temperature °C</td>
<td>Inlet/outlet temperature °C</td>
</tr>
<tr>
<td>Outdoor air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low temperature</td>
<td>7 / 6</td>
<td>* / 35</td>
</tr>
<tr>
<td>medium temperature</td>
<td>7 / 6</td>
<td>* / 45</td>
</tr>
<tr>
<td>high temperature</td>
<td>7 / 6</td>
<td>* / 55</td>
</tr>
<tr>
<td>very high temperature</td>
<td>7 / 6</td>
<td>* / 65</td>
</tr>
</tbody>
</table>

Exhaust air

| low temperature  | 20 / 12           | * / 35                |
| medium temperature | 20 / 12         | * / 45                |
| high temperature  | 20 / 12            | * / 55                |
| very high temperature | 20 / 12       | * / 65                |

Water-to-water

| low temperature  | 10 / 7            | * / 35                |
| medium temperature | 10 / 7          | * / 45                |
| high temperature  | 10 / 7            | * / 55                |
| very high temperature | 10 / 7       | * / 65                |

Brine-to-water

| low temperature  | 0 / -3            | * / 35                |
| medium temperature | 0 / -3          | * / 45                |
| high temperature  | 0 / -3            | * / 55                |
| very high temperature | 0 / -3       | * / 65                |

All tests shall be carried out with nominal flow rates indicated by the manufacturer in cubic meter per second, provided that the difference between the inlet and outlet temperatures at the indoor heat exchanger is lower than a maximum temperature difference ($\Delta T_{\text{max}}$) calculated using the following formula:

$$\Delta T_{\text{max}} = 7 + \left( \frac{T_{\text{out}} - 35}{30} \right) \times 10$$

For $T_{\text{out}} = 35$, $dT_{\text{max}}$ is 7 and corresponding $T_{\text{inlet}}$ is 28 or higher. For $T_{\text{max}} = 55$, $dT_{\text{max}}$ is 13.7 and corresponding $T_{\text{inlet}}$ is 41.3 or higher.

In case this condition is not respected, the flow rate shall be increased till when the $\Delta T$ is equal to $\Delta T_{\text{max}}$.

If a nominal flow rate is not indicated by the manufacturer and only a range of flow rates is given, tests shall be carried out at the minimum value provided on condition that the $\Delta T$ is equal to $\Delta T_{\text{max}}$.

If a nominal flow rate is not indicated by the manufacturer, it is intended that tests shall be carried out with a flow rate that assures a $\Delta T$ equal to $\Delta T_{\text{max}}$.

Comparison with regulation standard rating conditions learns that only the low temperature and the high temperature conditions match the regulatory conditions.

The regulations specify a fixed inlet and outlet temperature for the indoor heat exchanger, but the standards allow a variable inlet temperature as long as $dT_{\text{max}}$ is not
exceeded. It may be that the required inlet temperature is reached, but this is not prescribed.

**4.6.1.4 EN 12309-4:2014 - Test methods**

**Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 4: Test methods**

This standard sets out the calculation of heating and cooling capacity, energy input (heat, electrical power, gas), for cyclical and non-cyclical operation and the power consumption in various operating modes (thermostat-off, standby and off mode).

Moreover, it provides a normative calculation of the pump efficiency (when it is or is not an integral part of the appliance).

**Heating capacity**

The *measured heating capacity* is determined using the direct method, i.e. determining the volume or mass flow rate of the heat transfer medium and the inlet and outlet temperatures, taking into consideration the specific heat capacity and density or the enthalpy change of the heat transfer medium.

The effective heating capacity adds a correction related to pump power consumption for circulating the heat transfer medium to the indoor heat exchanger.

The standard defines both rated and nominal capacities, which are a correction of the measured capacities.

**Heat and electrical power inputs**

The heat input is calculated on the basis of the calorific value of the gas, and the mass or volume flow rate.

The electrical power input to the main appliance is the measured total power input (average of multiple scans) corrected by power input corrections related to use of pumps and fans.

For the power input of fans, a difference is made between fans that are not designed for duct connection (no correction applied) and fans designed for duct connection, for which only the power to overcome the internal resistance shall be considered.

A similar correction is applied to pump power input: again only considering the power consumption to overcome internal pressure differences. If the unit is designed to function in a distributing network, then no correction is applied.

**Useful efficiency or GUEh**

The gas utilization efficiency is the ratio of the heating capacity divided by the energy input. But in order to also take into account the power consumption (from heat pumps controls, pumps and fans) an Auxiliary energy factor (for heating): AEFh is introduced, which is the effective heating capacity divided by the effective heating electrical power input.

**Uncertainties**

The standard comprises a table specifying the uncertainty of measurements. For determining the heating capacity, the standard prescribes a maximum overall uncertainty
related to delta T. For a delta T of 7ºC the uncertainty is 3.6%. The gas input is to be determined with an overall uncertainty of 2%\textsuperscript{179}.

4.6.1.5 **EN 12309-5:2014 - Requirements**

Appliances covered by this standard include one or a combination of the following:

- gas-fired sorption chiller;
- gas-fired sorption chiller/heater;
- gas-fired sorption heat pump.

This European Standard applies to appliances designed to be used for space heating or cooling or refrigeration with or without heat recovery. This European Standard applies to appliances having flue gas systems of type B and type C (according to CEN/TR 1749) and to appliances designed for outdoor installations. EN 12309 does not apply to air conditioners, it only applies to appliances having:

- integral burners under the control of fully automatic burner control systems,
- closed system refrigerant circuits in which the refrigerant does not come into direct contact with the water or air to be cooled or heated,
- mechanical means to assist transportation of the combustion air and/or the flue gas.

The above appliances can have one or more primary or secondary functions (i.e. heat recovery - see definitions in prEN 12309 1:2012). In the case of packaged units (consisting of several parts), this European Standard applies only to those designed and supplied as a complete package. The appliances having their condenser cooled by air and by the evaporation of external additional water are not covered by EN 12309. Installations used for heating and/or cooling of industrial processes are not within the scope of EN 12309. All the symbols given in this text should be used regardless of the language used.

This part of EN 12309 specifies the requirements for gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW. This part of EN 12309 deals particularly with the requirements relating to the declaration of capacity and energy efficiency.

4.6.1.6 **EN 12309-6:2014 - Calculation of seasonal performances**

Appliances covered by this standard include one or a combination of the following:

- gas-fired sorption chiller;
- gas-fired sorption chiller/heater;
- gas-fired sorption heat pump.

This European Standard applies to appliances designed to be used for space heating or cooling or refrigeration with or without heat recovery. This European Standard applies to appliances having flue gas systems of type B and type C (according to CEN/TR 1749) and to appliances designed for outdoor installations. EN 12309 does not apply to air conditioners, it only applies to appliances having:

\textsuperscript{179} Both uncertainties combined results in a possible tolerance of GUEh of min -5.5% to max 5.7%.

\[ \text{Related to delta T. For a delta T of 7ºC the uncertainty is 3.6%. The gas input is to be determined with an overall uncertainty of 2%} \]
- integral burners under the control of fully automatic burner control systems,
- closed system refrigerant circuits in which the refrigerant does not come into direct contact with the water or air to be cooled or heated,
- mechanical means to assist transportation of the combustion air and/or the flue gas.

The above appliances can have one or more primary or secondary functions (i.e. heat recovery - see definitions in prEN 12309 1:2012). In the case of packaged units (consisting of several parts), this European Standard applies only to those designed and supplied as a complete package. The appliances having their condenser cooled by air and by the evaporation of external additional water are not covered by EN 12309. Installations used for heating and/or cooling of industrial processes are not within the scope of EN 12309. All the symbols given in this text should be used regardless of the language used.

This part of EN 12309 specifies the calculation methods of seasonal performances for gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW. It deals in particular with the calculation methods of reference seasonal performances in cooling and heating mode for monovalent and bivalent appliances. NOTE This European Standard serves as an input for the calculation of the system energy efficiency in heating mode of specific heat pump systems in buildings, as stipulated in EN 15316-4-2.

### 4.6.1.7 EN 12309-7:2014 - Specific provisions for hybrid heating appliances

This part of EN 12309 deals particularly with the specific provisions of hybrid heating appliances based on gas-driven sorption heat pumps as defined in Part 1. The heating appliances covered by this European Standard are of a hybrid type, an encased assembly or assemblies combining a direct or indirect-fired sorption heat pump for base load and a peak load condensing boiler with only one flue system, electrical supply cable and human machine interface to the end user. The direct- or indirect-fired sorption heat pump integrated in the hybrid appliances in this European Standard could be intermittent or continuously operating absorption heat pump.

The control system of hybrid heating appliances decides on the transition between the heat pump operation mode to/from the mixed operation mode (heating by both sorption heat pump as well as the peak boiler) and the direct heating mode (only peak boiler) depending on the heating fluid inlet or return temperature, temperature of brine entering the indoor heat exchanger (evaporator) of the heat pump, the required outlet or supply temperature dependent on the outdoor temperature as well as the target value of the indoor or room temperature. Upon transition from the heat pump operation mode to the mixed operation mode, the control system decides also on the degree of mixing based on the above-mentioned parameters.

This part specifies a different approach to calculating the seasonal efficiency of sorption-hybrid products than in EN 14825 and derived standards. In clause 4.1 it introduces reference part load ratios of 100%, 75%, 60%, 45%, 30% and 15%, but as EN 12309-6:2014 (based upon EN 14825) and pivot part load ratios where apply to the specific reference heating seasons Cold, Average and Warm.

In clause 4.2 the outlet and inlet temperatures for each reference test condition (linked to pivot part load ratios) and temperature application (low, medium, high and very high).
Assuming fixed flows (volume) and fixes specific heating capacity the delta T over supply return varies per test condition.

The inlet temperatures to the outdoor heat exchanger differ per reference test condition and reference heating season for outdoor air source heat pumps. Ground source heat pumps are tested with a constant 10ºC in all conditions and the brine heat pump has an inlet temperature ranging from 9 (warmest test condition) to 5ºC (coldest test condition).

For solar hybrid sorption heat pumps the temperature differences between the inlet temperature to the outdoor heat exchanger and the outdoor dry-bulb test conditions shall be added to the reference dry-bulb outdoor temperatures (for all test conditions). These are given for a flat place and vacuum tube product, per ratio of collector aperture area divided by maximum heat extraction rate (m²/kW).

Once the performance in the various test conditions is known the calculation of seasonal efficiency largely follows the procedure in EN 12309-6 (comparable to EN 14825 for electric motor driven heat pumps).

The EN 12309-7 thus describes a method for assessment of hybrid appliances (sorption heat pump plus peak demand heater) but it deviates from the EN 14825 assessment of hybrids (referred to in EN 14825 as 'separate method' and 'combined method', plus a draft EN 15502-1-Y 'simplified method') in many ways. One of the differences is that EN 12309-7 defines 6 test conditions for each season (EN 14825 has only 3 conditions for the 'Warmer' season).

Particularly noteworthy is that EN 12309-7 includes a method for solar-assisted hybrids which incorporates a method to take into account an increase in the evaporator supply temperatures and a change in the inlet temperature to the outdoor heat exchanger because of the solar assist.

4.7 Micro CHP

Standards relating to micro CHP are developed by the CEN/CENELEC Joint Technical Committee JTC 17 (previously: Working Group FCGA - Fuel Cell Gas Appliances, which refers to the origin of the standard). This standard covers besides fuel cells also microCHP using combustion engines, both internal (gas engine) as external combustion (Stirling engine).

4.7.1 EN 50465:2015

Fuel Cell Gas Appliances" Gas appliances - Combined heat and power appliance of nominal heat input inferior or equal to 70 kW

EN 50465:2015 (plus Annex J and K added in 2017) specifies the requirements and test methods for the construction, safety, fitness for purpose, rational use of energy and the marking of a micro combined heat and power appliance; (hereafter referred to as "mCHP appliance"). This European Standard applies to mCHP appliances of types B22, B23, B32, B33, B52, B53, C1, C3, C42, C43 C52, C53, C62, C63, C82, C83 and C9 based on the classifications of CEN/TR 1749: - that use one or more supplied gases of the three gas families at the pressures stated in EN 437, where:
• the temperature of the heat transfer fluid of the heating system (heating water circuit) does not exceed 105 ºC during normal operation,
• the maximum operating pressure in the heating water circuit does not exceed 6 bar,
• the domestic hot water circuit (if installed) does not exceed 10 bar,
• which are either intended to be installed indoors or outdoors in a partially protected place,
• which are intended to produce hot water either by the instantaneous or storage principle, which have a maximum heat input (based on net calorific value) not exceeding 70 kW, which are designed for sealed or open water systems.

EN 50465:2015 includes the following significant technical changes with respect to EN 50465:2008:
• inclusion of requirements for „Stirling Engine“ and „Internal Combustion Engine“;
• modification of requirements for fuel cell heating appliances to reflect experience since the first edition;
• partly adaptation to EN 15502-1 and EN 15502-2-1, especially to reflect the new requirements for air proving devices;
• introduction of additional types of combustion air and flue duct systems;
• modification of the total efficiency calculation;
• modifications of NOX weighting and calculation.

Before describing the main method for calculating space heating energy efficiency of CHP as prescribed by EN 50465, the method as prescribed in the Transitional Method for space heaters is described as the discussion on CHP mainly revolves around the differences in the respective approaches.

The calculation of the seasonal space heating energy efficiency in EN 50465:2015 differs from the TM2014sh in the calculation of the correction factors F(2), F(3) and F(4) and how preferential and supplementary heaters are considered in the calculations, but perhaps the largest difference is found in the correction of electricity generation (factor F(5) in TM2014sh).

The **TM2014sh** calculates the seasonal efficiency ηₚ as

$$\eta_p = \eta_{son} - \sum F(i)$$

where:

- $\eta_{son}$ = the seasonal efficiency in active mode, in %
- $F(i)$ = corrections F(1) to F(5), if applicable, expressed in %

The correction factors F(i) relate to:

- F(1): correction factor for temperature controls: reduces the $\eta_{son}$ by 3%;
- F(2): correction factor for auxiliary electricity consumption: reduces the $\eta_{son}$ depending on the value for elmax and $P_{SB}$.

No supplementary heater: $$F(2) = \frac{2.5 \times (elmax+1.3 \times P_{SB})}{P_{CHP100+Sup0}}$$
With supplementary heater: \[ F(2) = \frac{2.5 \times (0.15 \times \text{elmax} + 0.85 \times \text{elmin} + 1.3 \times P_{SB})}{(0.15 \times P_{CHP100+Sup100} + 0.85 \times P_{CHP100+Sup0})} \]

Or a default value as set out in EN 15316-4-1 may be applied.

- \( F(3) \): correction factor for standby heat loss;
  - **No supplementary heater:** \[ F(3) = \frac{0.5 \times P_{stby}}{P_{CHP100+Sup0}} \]
  - **With supplementary heater:** \[ F(3) = \frac{0.5 \times P_{stby}}{P_{CHP100+Sup100}} \]
  Or a default value as set out in EN 15316-4-1 may be applied.

- \( F(4) \): correction factor for ignition burner power consumption;
  - **No supplementary heater:** \[ F(4) = \frac{1.3 \times P_{ign}}{P_{CHP100+Sup0}} \]
  - **With supplementary heater:** \[ F(4) = \frac{1.3 \times P_{ign}}{P_{CHP100+Sup100}} \]

- \( F(5) \): correction factor for electricity generation:
  - **No supplementary heater:** \[ F(5) = -2.5 \times \eta_{el,CHP100+Sup0} \]
  - **With supplementary heater:** \[ F(5) = -2.5 \times (0.85 \times \eta_{el,CHP100+Sup0} + 0.15 \times \eta_{el,CHP100+Sup100}) \]

**Variable F(5) - Correction factor for electricity generation**

The 2014 transitional method prescribes that the seasonal space heating efficiency \( \eta_s \) of micro-CHP is calculated by ‘adding’ the electric output (after conversion to primary energy) to the heat output, divided by the total primary energy input. This is implemented as follows.

In formula: \[ \eta_s = \frac{Q_{heat\ out} + Q_{prim\ in\ for\ electricity}}{Q_{prim\ in\ total}} \]

The conversion of electric output to primary energy is currently done with a PEF 2.5, with reference to the EED 2012/27/EU.

The efficiency values that are calculated with this method place the micro-CHP somewhere in the lower or mid-range of heat pumps and other space heating appliances that have a renewables component. For instance, for a micro-CHP (e.g. gas engine based) with a useful heat output of 60% and an electricity output of 30% the calculated seasonal (primary) energy efficiency number will be 135% (60%+2.5*30%). This is comparable with the primary energy equivalent of an electric heat pump with a seasonal coefficient of performance (SCOP) of 3.37.

However, the majority of experts in the CEN/CLC JTC17 that wrote EN 50465:2015 do not agree with the basic idea behind the above approach. The JTC17 argues that power production by the mCHP avoids primary energy consumption for power production by an alternative system.
JTC 17 refers to Life Cycle Assessment standards ISO 14040 and ISO 14044 that prescribe, in case of multi-output processes, the use of the substitution method, which means that the impacts of an alternative process, that produces one of the outputs, can be subtracted from the main process. In this case primary energy $Q_{\text{prim in for electricity saved}}$ by not using the public grid electricity is subtracted from the CHP’s primary energy input $Q_{\text{prim in for electricity with an impact equal to that of grid electricity}}$. The resulting value is the (remaining) primary energy input to generate the heat output.

In formula: $\eta_s = \frac{Q_{\text{heat out}}}{Q_{\text{prim in total}} - Q_{\text{prim in for electricity}}}$

This gives totally different outcomes from the TM2014sh formula, not only because the numbers above and below the line are much smaller but at some point the denominator can become zero or even negative. This happens when the micro-CHP becomes equal to or more efficient than the average public power plant and grid in producing electricity. If the PEF=2.5 a mCHP with an electric efficiency of 40% results in $\eta_s = 0$ (zero), and for an electrical efficiency beyond 40% $\eta_s$ becomes negative. In such cases the heat produced by the CHP requires no net primary energy input (the electricity is produced with exactly the same primary energy input) and the heat output is therefore 'for free'.

Zero (#DIV0) or negative efficiencies cannot be used in the Ecodesign/labelling context and therefore JTC17 proposed in Clause 7.6.2.2 of EN 50465 a linear extrapolation (derived in Annex EE of EN 50465) for electrical efficiencies beyond 30% (75% of PEF or CC = 75% of today’s 40% = 30%).

For units with electrical efficiencies <30% the basic formula is:

With supplementary heater: $\eta_{eq,CHP+Sup} = \frac{\left(\eta_{Hs,CHP100+Sup100}\right)}{100-\eta_{Hs,el,CHP100+Sup100}} \times 100$

Without supplementary heater: $\eta_{eq,CHP} = \frac{\left(\eta_{Hs,CHP100+Sup0}\right)}{100-\eta_{Hs,el,CHP100+Sup0}} \times 100$

For units with electrical efficiencies >30% the basic formula for cogeneration with supplementary heater is:

$\eta_{eq,CHP+Sup} = 4 \left( \eta_{Hs,CHP100+Sup100} - \frac{75}{CC} \right) + 0.16 \times \left( CC \times \eta_{Hs,CHP100+Sup100} - 100 \right) \times \left( \eta_{Hs,el,CHP100+Sup100} - \frac{75}{CC} \right)$

And for cogeneration with electrical efficiencies >30% without supplementary heater:

$\eta_{eq,CHP} = 4 \left( \eta_{Hs,CHP100+Sup0} - \frac{75}{CC} \right) + 0.16 \times \left( CC \times \eta_{Hs,CHP100+Sup0} - 100 \right) \times \left( \eta_{Hs,el,CHP100+Sup0} - \frac{75}{CC} \right)$

Where:
- $CC =$ the conversion coefficient or primary energy factor (PEF), currently 2.5;
- $\eta_{Hs,CHP100+Sup0} =$ the overall efficiency in the test point (100 % CHP + 0 % Sup) in % [GCV];
- $\eta_{Hs,el,CHP100+Sup0} =$ the electric efficiency in the test point (100 % CHP + 0 % Sup) in % [GCV];
The seasonal space heating energy efficiency in active mode \( \eta_{\text{son}} \) is expressed in % GCV using a correction \( F_{\text{CHP}} \) in accordance with the Regulation 811/2013 table 6.

\[
\eta_{\text{son}} = F_{\text{CHP}} \times \eta_{\text{eq,CHP}} + (1 - F_{\text{CHP}}) \times \eta_{\text{eq,CHP+Sup}}
\]

This correction factor, representing the share in total heat output, is used in the calculation of the other factors \( F(2,3) \) as well. The \( F_{\text{CHP}} \) is based on relative size of the heat generator (assuming the smaller heater fulfills smaller part loads and the larger heater acts as supplementary in cases the smaller heater cannot provide sufficient heat).

Table 40. Weighing factor \( F_{\text{CHP}} \) (Table 18 in FprEN 50465:2014)

<table>
<thead>
<tr>
<th>( \frac{P_{\text{CHP}}}{P_{\text{CHP+Sup}}} )</th>
<th>( F_{\text{CHP}} ) for mCHP without hot water storage tank</th>
<th>( F_{\text{CHP}} ) for mCHP with hot water storage tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (only listed for interpolation purpose)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.1 (e.g. 1 kW CHP + 9 kW supp. heater)</td>
<td>0.30</td>
<td>0.37</td>
</tr>
<tr>
<td>0.2</td>
<td>0.55</td>
<td>0.70</td>
</tr>
<tr>
<td>0.3</td>
<td>0.75</td>
<td>0.85</td>
</tr>
<tr>
<td>0.4</td>
<td>0.85</td>
<td>0.94</td>
</tr>
<tr>
<td>0.5</td>
<td>0.95</td>
<td>0.98</td>
</tr>
<tr>
<td>0.6</td>
<td>0.98</td>
<td>1.00</td>
</tr>
<tr>
<td>( \geq 0.7 )</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Intermediate values are calculated by linear interpolation between two adjacent values.

For range rated units \( P_{\text{CHP+Sup}} \) represents the arithmetic mean of the maximum and minimum nominal heat output of the cogeneration appliance.

**Variable \( b \) in \( F(2), F(3) \) and \( F(4) \)**

Another deviation of EN 50465 from the TM2014 is the introduction of a variable 'b' in the calculation of \( F(2), F(3) \) and \( F(4) \).

EN 50465 includes establishment of \( elmax, elmin \) and \( P_{SB} \) excluding the primary heat and power generator (as otherwise consumption and production are mixed) and the circulator (similar to EN 15502-1).

In EN 50465 factor \( F(2) \) for the auxiliary electricity consumption is calculated as:

\[
F(2) = \frac{CC \times ((1 - F_{\text{CHP}}) \times P_{\text{auxmax}} + F_{\text{CHP}} \times P_{\text{auxmin}} + 1.3 \times b \times P_{SB})}{(1 - F_{\text{CHP}}) \times P_{\text{CHP+Sup}} + F_{\text{CHP}} \times P_{\text{CHP}}} \times 100\%
\]

where:

- \( P_{\text{auxmax}} \) is the average electric auxiliary energy consumed by the mCHP appliance excluding the central heating pump in the test point 100 % CHP + 100 % Sup, expressed in kW, determined according to 7.6.3.3;
- \( P_{\text{auxmin}} \) is the average electric auxiliary energy consumed by the mCHP appliance excluding the central heating pump in the test point 100 % CHP + 0 % Sup, expressed in kW, determined according to 7.6.3.4;
- $P_{SB}$ is the average electric auxiliary energy consumed by the mCHP appliance in standby mode, expressed in kW, determined according to 7.6.3.5;
- $P_{CHP+Sup}$ is the heat output of the mCHP appliance in the test point 100 % CHP + 100% Sup, expressed in kW
- $P_{CHP}$ is the heat output of the mCHP appliance in the test point 100% CHP + 0% Sup, expressed in kW.
- 'b' is the weighting factor reflecting the relative stand-by time of the mCHP appliance, which is dependent of the ratio between minimum heat output and nominal heat output. This weighting factor is calculated as

$$b = 0.5 \times \frac{P_{min}}{P_{CHP+Sup}}$$

where:
- $P_{min}$ is the minimum sustained controlled heat output (which is sustained over a long period at minimum heat demand) of the mCHP appliance, determined according to Clause 7.6.6, expressed in kW.

The reason the EN 50465 introduced the relative size of the preferential/supplementary heat generator ($F_{CHP}$) and the relative stand-by-time ('b') into the equation is that at smaller $P_{min}$ it can be expected the unit is operating more continuously and has lower standby hours.

For the calculation of $F(3)$ standby heat loss, the EN 50465 describes the measurement method for $P_{stby}$ and prescribes a slightly different calculation method, replacing the fixed value of '0.5' in TM2014sh by the variable 'b':

$$F(3) = b \times \frac{P_{stby}}{P_{CHP+Sup}} \times 100\%$$

The same parameter 'b' is applied in the calculation of the correction factor $F(4)$ for ignition burner power consumption (permanent pilot flame) where it replaces the fixed value '1.3':

$$F(4) = 0.5 \times b \times \frac{Q_{pilot}}{P_{CHP+Sup}} \times 100\%$$

Where $Q_{pilot}$ is the permanent ignition burner heat input determined (according to 7.6.5 of EN 50465, expressed in kW), or $P_{ign}$ as in TM2014sh.

$F_{CHP}$

As already used in the calculation of the seasonal efficiency and the factor $F(2)$ EN 50465 has introduced a factor $F_{CHP}$, which is not present in the TM2014sh.

The factor $F_{CHP}$ of EN 50465 replaces the fixed 0.85/0.15 ratio applicable to cogeneration heaters equipped with an integrated supplementary heater (regardless of the actual size of the preferential heater $Prated$ and the supplementary heater $Psup$, and thus regardless of the actual contribution of the heaters in meeting the (seasonal) heating demand) by a factor that is based on the calculation of the package efficiency (using the factor 'II' of the package fiches calculation of 811/2013).
In the fiche calculation of a package of a separate CHP and supplementary heat generator, the efficiency of the package is corrected by a factor 'II' (see below, based on figure 2 of Annex IV of Delegated Regulation (EU) No 811/2013).

The factor 'II' is determined by the ratio of Prated/(Prated+Psup) and whether a hot water storage tank is present or not.

<table>
<thead>
<tr>
<th>Prated/(Prated + Psup) (**)</th>
<th>II. package without hot water storage tank</th>
<th>II. package with hot water storage tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>0.1</td>
<td>0.70</td>
<td>0.63</td>
</tr>
<tr>
<td>0.2</td>
<td>0.45</td>
<td>0.30</td>
</tr>
<tr>
<td>0.3</td>
<td>0.25</td>
<td>0.15</td>
</tr>
<tr>
<td>0.4</td>
<td>0.15</td>
<td>0.06</td>
</tr>
<tr>
<td>0.5</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>0.6</td>
<td>0.02</td>
<td>0</td>
</tr>
<tr>
<td>≥ 0.7</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(*) The intermediate values are calculated by linear interpolation between the two adjacent values.
(**) Prated is related to the preferential space heater or combination heater.

The current approach as prescribed by the TM2014sh for 'integrated products' (using the fixed ratio of 0.85/0.15) and the variable ratio for packaged products means that products with identical efficiencies of preferential and supplementary heaters have different outcomes depending on whether it is an integrated product or a package.

This has allowed unrealistically high shares of heating efficiencies of such integrated cogeneration products (as illustrated in the example in the table below) and the EN 50465 has corrected this by applying the $F_{CHP}$ to all calculations involving a supplementary heater, regardless whether it is integrated or part of a package.
Table 41. Comparing the heating efficiency of an integrated and packaged product, for small SOFC and Stirling cogeneration

<table>
<thead>
<tr>
<th>Parameters</th>
<th>combi heater with small solid oxide fuel cell</th>
<th>combi heater with slightly larger Stirling engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>eta_(th)chp100+Sup0</td>
<td>39.30%</td>
<td>82.0%</td>
</tr>
<tr>
<td>eta_(th)chp100+Sup100</td>
<td>86.60%</td>
<td>89.8%</td>
</tr>
<tr>
<td>eta_el,chp100+Sup0</td>
<td>41.40%</td>
<td>13.70%</td>
</tr>
<tr>
<td>eta_el,chp100+Sup100</td>
<td>2.50%</td>
<td>4.00%</td>
</tr>
<tr>
<td>P_chp100+Sup0 (=Prated)</td>
<td>0.60</td>
<td>6.50</td>
</tr>
<tr>
<td>P_chp100+Sup100 (=Prated+Psup)</td>
<td>23.00</td>
<td>25.30</td>
</tr>
</tbody>
</table>

**If integrated**

| eta_s product /chp+sup integrated | 135% | 114% |

**If packaged**

| eta_s product /chp only | 143% | 116% |
| Prated/Prated+sup | 0.026 | 0.257 |
| factor 'II' | 0.922 | 0.336 |
| eta_s package /chp only + sup | 91% | 107% |

In the above example the small 0.6 kW CHP heat generator operates (almost) continuously and counts for 85%. If the design load is equal to the nominal load of preferential and supplementary heater (23 kW) then, in analogy to the bin-method applied in heat pump calculations, the share of the total annual heat demand that can be fulfilled by a heat generator ≤ 0.6 kW at a P_design of 23 kW in an average climate is approximately 6%, not 85%. The remaining 94% of heat demand requires a heating capacity exceeding 0.6 kW.

In EN 50465 the fixed ratio of 0.85/0.15 is thus replaced by a ‘variable’ ratio based on the relative size of the supplementary heater F_{CHP}, so that performances of separate and packaged products are treated similarly.

**Specific energy consumption instead of efficiency**

The JTC17 describes in the draft EN 50465:2015+A1:2018, Annex K, a revised basis for energy ‘efficiency’. Efficiency is currently defined as useful output divided by of required input.

\[ \eta = \frac{\text{useful output}}{\text{unit of required input}}, \quad \text{e.g.} \quad \frac{14 \text{ km}}{1 \text{ litre}} = 14 \text{ km/l} \]

This can be compared to a fuel efficiency for cars expressed as km/l, e.g. 14 km/l means 14 km output per 1 litre input.

The specific fuel consumption (SEC) is the reciprocal value: required input divided by unit of (useful) output. For the same car this is 7.14 l per 100 km.

\[ \text{specific fuel cons.} = \frac{\text{required input}}{\text{unit of useful output}}, \quad \text{e.g.} \quad \frac{7.14 \text{ litre}}{100 \text{ km}} = \frac{7.14}{100} \text{ l/km} = 0.071 \text{ l/km} \left( = \frac{14 \text{ km/l}}{100} \right) \]
JTC17 considers the **specific energy consumption** a better basis for combining efficiencies of multiple devices each contributing to a similar output, as illustrated by the following example: Assume a car travels 60 km in total of which 30 km uphill with an efficiency of 10 km/l (SEC = 0.1 l/km) and 30 km downhill with 30 km/l (SEC = 0.033 l/km). The current 'averaging of efficiencies' method would result in 30/60*10 km/l + 30/60*30 km/l = 20 km/l (0.05 l/km). In reality the car consumes 3 l going uphill (30*0.1) and 1 l (30*0.033) going downhill. This is a total of 4 l over 60 km or 0.067 l/km. The weighting of efficiencies as in the current approach results over 33% overestimation (0.067/0.05 = 1.33). The weighting of specific energy consumptions results in (30/60*0.1 + 30/60*0.033 = 0.067) which is accurate.

Formulas with and without supplementary heaters are:

\[ SEC_{CHP} = \left( \frac{100}{\eta_{Hs,th,CHP100+Sup0}} - \frac{CC \times \eta_{Hs,el,CHP100+Sup0}}{\eta_{Hs,th,CHP100+Sup0}} \right) \times 100\% \]

\[ SEC_{CHP+Sup} = \left( \frac{100}{\eta_{Hs,th,CHP100+Sup100}} - \frac{CC \times \eta_{Hs,el,CHP100+Sup100}}{\eta_{Hs,th,CHP100+Sup100}} \right) \times 100\% \]

The seasonal specific energy consumption in active mode \( SEC_{son} \) is then calculated as:

\[ SEC_{son} = F_{CHP} \times SEC_{CHP} + (1 - F_{CHP}) \times SEC_{CHP+Sup} \]

The above issue (using SEC instead of efficiencies when 'averaging') actually goes beyond the scope of cogeneration appliances and affects all packages with two different efficiencies of heat generators such as (hybrid) heat pumps and cascading boiler setups. A proposal for calculating package efficiencies is further elaborated in Task 6.

**Annual energy consumption for space heating**

The assumptions and definitions for calculating the *annual reference heat demand* and the *annual energy consumption* in EN 50465:2015 are in line with EN 15502-1 for central heating boilers. EN 50465 adds that the value for the annual energy consumption is only valid for those heaters which are covering the complete reference annual heating demand of a building and is without meaning for heaters which are to be combined with separate supplementary heaters to cover the reference annual heating demand, because in this situation the ratio between Pchp and Pchp+Psup is not defined a priori on product level. In that case the separate annual energy consumption value of the chp part does not reflect the real value of the single component in the package (the same applies for the supplementary heater part).

The annual energy consumption \( Q_{HE} \) for space heating for average climate condition, expressed in GJ is calculated according to the formula below:

\[ Q_{HE} = \frac{H_{ch} \times P_{design}}{\eta_s} \times \frac{3.6}{1000} \]

Where:
- $H_a = 2066\ h/a$, the assumed annual number of hours a boiler has to provide the design load for heating ($P_{design}$) to satisfy the reference annual heating demand ($Q_H$) expressed in h/a for the average climate.

For non-range rated appliances:
- $P_{design}$ is the nominal output $P_{nom}$ multiplied by 800 and divided by 2066 (multiplier 0.39)

or for range rated appliances:
- $P_{design}$ is the arithmetic mean of the maximum and minimum useful heat output $P_a$ multiplied by 800 and divided by 2066, expressed in kilowatts (kW).

The figure hereafter gives an overview of the history of micro-CHP standardisation thus far.

**Micro-CHP Standardisation history map**

![Micro-CHP Standardisation history map](image)

(Source: P. Gelderloos, BDR Thermea, Nov. 2018)

**Figure 23. Micro-CHP Standardisation history**

**NOx emissions**
The measurement of NOx emissions of mCHP depends on how it is linked to the heat load (direct or decoupled) and whether it has multiple heat generators or not. The method assumes that if a supplementary heater is present, this is the dominant source of emissions.
Table 42: Calculation of NO\textsubscript{x} emissions (weighting, return temperatures) by mCHP in EN 50465:2015

<table>
<thead>
<tr>
<th>Weighing of NO\textsubscript{x} and calculation of return temperatures acc. EN 50465</th>
<th>basis for assessment</th>
<th>heat output as % of nominal output, or heat input as % of nominal input</th>
<th>100%</th>
<th>70%</th>
<th>60%</th>
<th>50%</th>
<th>40%</th>
<th>30%</th>
<th>20%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>direct coupling to heat load (instantaneous)</td>
<td>% heat input (of both CHP and sup)</td>
<td></td>
<td>0.082</td>
<td>0.121</td>
<td>0.148</td>
<td>0.165</td>
<td>0.171</td>
<td>0.165</td>
<td>0.148</td>
<td></td>
</tr>
<tr>
<td>decoupled / multiple heat generators</td>
<td>sup heat output</td>
<td></td>
<td>0.15</td>
<td>0.25</td>
<td>0.30</td>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>decoupled / single heat generators (no sup)</td>
<td>CHP heat output</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>return water temperature, °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>if condensing: nominal 60/40°C, part load Tr=0.2Q +20</td>
<td>40°C</td>
<td>34</td>
<td>32</td>
<td>30</td>
<td>28</td>
<td>26</td>
<td>24</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>if non-condensing: nominal 80/60°C, part load (not known)</td>
<td>60°C</td>
<td>(not defined in EN 50465)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.7.2 Discussion: Other methods for CHP efficiency calculation

This section presents some other methods described in Commission Documents or other studies, for calculating cogeneration efficiency, primary energy consumption, energy saving or GHG emissions.

The methods already described in the main text are:

Efficiency based on TM2014sh

The TM2014sh states the seasonal efficiency (of cogeneration heaters) $\eta_s$ is calculated as:

$$\eta_s = \eta_{son} - \sum F(i)$$

For cogeneration space heaters not equipped with supplementary heaters:

$$\eta_{son} = \eta_{CHP100+Sup0}$$

And correction (without supplementary heater) F5 is:

$$F(5) = -2.5 * \eta_{el,CHP100+Sup0}$$

Resulting in:

$$\eta_s = \eta_{CHP100+Sup0} + 2.5 * \eta_{el,CHP100+Sup0}$$
**Efficiency based on EN 50465:2015**

For cogeneration without supplementary heater and electric efficiency > 30% (as this is the area where the basic approach becomes problematic):

\[
\eta_{eq,CHP} = 4 \left( \eta_{Hs,CHP100+Sup0} - \frac{75}{CC} \right) + 0.16 \left( CC \cdot \eta_{Hs,CHP100+Sup0} - 100 \right) \cdot \left( \eta_{Hs,eL,CHP100+Sup0} - \frac{75}{CC} \right)
\]

**PES (compared to reference values)**

In the Energy Efficiency Directive of 2012, Annex II, the primary energy savings of cogeneration are calculated using reference values for separate production (should be based on technologies using the same fuels as the CHP process).

\[
PES = \left( 1 - \frac{1}{\frac{\text{CHP}_{\eta}}{\text{Ref}_{H\eta}} + \frac{\text{CHP}_{E\eta}}{\text{Ref}_{E\eta}}} \right) \cdot 100\%
\]

The resulting 'heating efficiency' \( \eta_{PES} \) of the cogeneration unit can be calculated by taking the reference heating efficiency (as this is where savings relate to) and correct the denominator with the savings calculated:

\[
\eta_{PES} = \frac{\text{Ref}_{H\eta}}{(1 - PES)}
\]

Note that the same savings percentage applies to electricity production as well, regardless of actual outputs of the cogeneration unit.

Other methods are:

**Efficiency based on COP\text{Carnot}**

The power output of a cogeneration device has a higher exergy than the heat output of that device (assuming the temperature of the heat is limited to max. 80°C): This is commonly referred to as a difference in exergy, or quality of energy. Sadi Carnot defined an ideal heat engine, which transforms available heat (from combustion) into 'work', that allows taking into account the exergy of the energy. The reversible heat engine establishes the relation of 'work' (here: power) and heat, which is used here to convert (with COP Carnot) the power output of the device to a value that can be added to the heat output.

The COP Carnot represents the amount of heat that can be moved with one unit of power, assuming an ideal and lossless process. The COP Carnot depends on the difference in temperature of the higher and lower heat reservoir between which heat is moved. As it represents and ideal and reversible cycle the resulting factor is unrealistically high. Correction with a performance factor (sometimes referred to as Carnot efficiency although it is not really an efficiency, but rather a process quality indicator) based on the COP of real processes results in a more realistic COP.
The Carnot heating efficiency is calculated (using absolute temperatures, in Kelvin, hence the correction by +273) as:

\[
\eta_{\text{heat,carnot}} = \frac{273 + T_{\text{sup}}}{(273 + T_{\text{sup}} - 273 + T_{\text{inf}})} \times \eta_{\text{elec}} \times pf + \eta_{\text{heat}}
\]

Where:

- \(T_{\text{sup}}\) is the temperature of the 'hot' reservoir, in °C (here: 70°C, the average supply/return temperature of a high temperature heating system)
- \(T_{\text{inf}}\) is the temperature of the 'cold' reservoir, in °C (here: 5°C, the average outdoor temperature of the Average climate)
- \(\eta_{\text{elec}}\) is the electrical efficiency of the device
- \(\eta_{\text{heat}}\) is the heating efficiency of the device
- \(pf\) is the performance factor (a correction applied to the Carnot factor which assumes an ideal conversion), selected or chosen by the user of the method (0.5 is not bad as Carnot efficiency of heat pumps).

With a lower reservoir temperature of 5°C (the bin-hour weighted average outdoor temperature in the 'Average' heating season) and a higher reservoir temperature of 70°C (the average of a supply/return temperature of 80/60°C) the COP Carnot is 5.28. This the theoretical maximum of units of heat that can be moved with one unit of power, assuming an ideal process. Applied to a mCHP with 30% thermal efficiency and 60% electrical efficiency, the theoretical maximum of heat that can be generated (thermal efficiency) and moved (from outdoor to indoor, using electric power) is 30% + (60%*5.38) = 347% or 3.47. This is much lower than the calculated efficiency according EN 50465 (was 840%).

For real processes the amount of heat that can be moved using a unit of power is even lower as Carnot efficiencies of an ideal process are not achieved in real life. A performance factor of 0.5 results in a COP Carnot of 188%, very close to the current TM2014sh calculation.

Stakeholder BDR Thermea criticises this method as it provides 'virtual heat', is based on an arbitrary 70°C temperature level (this was in the draft and is now corrected and based on bin-method based temperature differences), a virtual performance factor of 0.5, and added that the method 'dilutes' savings over a larger output.


In Annex K of EN 50465:2015+A1:2018 an alternative calculation is presented, based on specific energy consumption (SEC), which is the amount of (primary) energy required for a unit of useful output. Contrary to efficiencies, the SEC simply crosses the zero mark and becomes negative, if \(\eta_{\text{elec}}\) of the CHP equals/exceeds the reference \(\eta_{\text{elec}}\). Efficiencies would follow a vertical asymptote around this point.

SEC is calculated as:

\[
SEC_{\text{CHP}} = \left(\frac{100}{\eta_{Hs,th,CHP100+Sup0}} - \frac{CC \times \eta_{Hs,el,CHP100+Sup0}}{\eta_{Hs,th,CHP100+Sup0}}\right) \times 100\%
\]
The seasonal specific energy consumption in active mode $SEC_{son}$ is then calculated as:

$$SEC_{son} = F_{CHP} \times SEC_{CHP} + (1 - F_{CHP}) \times SEC_{CHP+Sup}$$

**Carnot allocation**

This method is different to applying Carnot factors as above. That previous method is rather similar to calculation of a virtual heat pump.

The *Carnot allocation* discussed in this paragraph intends to allocate a share of the actual fuel input of the CHP to the actual outputs. The allocation is based on the exergy of the output: For electricity Carnot = 1, for heat the Carnot factor depends on the temperature levels. The Carnot factor for heat $C_h$ is calculated as:

$$C_h = \frac{T_h - T_o}{T_h}$$

Where:

$T_h$ is the temperature measured in absolute temperature (kelvin) of the useful heat at point of delivery

$T_o$ is the temperature of the surroundings.

A seasonal $C_h$ can be calculated using the bin-method for outdoor temperatures and weighing) and supply/return temperatures as specified in EN 14825 for (by example) the 45/55ºC heating regime. This results in a seasonal $C_h$ of 0.094 for the Average climate.

The allocation of the share of the fuel for heating $a_{th}$ is then calculated as:

$$a_{th} = \frac{C_h \times \eta_{th}}{(1 \times \eta_{el}) + (C_h \times \eta_{th})}$$

(for electricity it is $1 - a_{th}$)

This method must also be applied when calculating the greenhouse gas emissions of different outputs of CHP (using renewable fuels) as described in DIRECTIVE (EU) 2018/2001 on the promotion of the use of energy from renewable sources (recast).

The calculation of efficiency is then the CHP heat output divided by total input (CHPheat or $\eta_{th}$) divided by the allocation factor $a_{th}$:

$$\eta_{son} = \frac{\eta_{th}}{a_{th}}$$

This method is a purely attributional approach and does not include savings compared to alternative or reference systems.
Overview

The table shows the calculated seasonal space heating efficiencies ("active mode", excluding corrections for auxiliary consumption etc.) for several heat-to-power ratios of several cogeneration products and a reference gas boiler only using the methods described above. The calculations do not depict real products, but can be considered representing certain technologies.

Assumptions:
- all CHP produces 1 kW electric with a fixed total CHP efficiency of 90% (eta_el + eta_th = 90%);
- all packages (CHP + supplementary heater) produce 10 kW thermal, the heat output of the CHP_only is called Pth;
- PEF of avoided electricity production is 2.1;
- Fpref is based on Table 6 of 811/2013, no storage applied;
- Reference efficiency for separate production (based on same fuels): electricity 48.2%, heat 83.6% (all GCV) – for PES only;
- Efficiency supplementary boiler: 90% (GCV);
- Contribution of supplementary heater is calculated using the SEC approach (Note: this deviates from the method in TM2014sh etc, but is preferred to that the SEC method can be included in the comparison).

\[
\eta_{chp+sup} = \frac{1}{\frac{F_{pref}}{\eta_{CHP}} + \frac{(1 - F_{pref})}{\eta_{supp}}}
\]

Table 43. Overview of calculated CHP and package heating efficiencies according several methods

<table>
<thead>
<tr>
<th>CHP type</th>
<th>eta_el</th>
<th>eta_th</th>
<th>eta_tot</th>
<th>Pth</th>
<th>Pth / (Pth+Psup)</th>
<th>Fpref</th>
<th>TM2014sh</th>
<th>EN 50465 / efficiency</th>
<th>PES</th>
<th>Carnot 45</th>
<th>EN 50465 / SEC</th>
<th>Carnot allocation (heat)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>chp</td>
<td>chp + sup</td>
<td>chp</td>
<td>chp + sup</td>
<td>chp</td>
<td>chp + sup</td>
<td>chp</td>
<td>chp + sup</td>
<td>chp</td>
<td>chp + sup</td>
<td>chp</td>
<td>chp + sup</td>
</tr>
<tr>
<td>0</td>
<td>0%</td>
<td>90%</td>
<td>90%</td>
<td>10.00</td>
<td>1.00</td>
<td>1.00</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>1</td>
<td>14%</td>
<td>76%</td>
<td>90%</td>
<td>5.43</td>
<td>0.54</td>
<td>0.96</td>
<td>105%</td>
<td>105%</td>
<td>105%</td>
<td>100%</td>
<td>105%</td>
<td>129%</td>
</tr>
<tr>
<td>2</td>
<td>26%</td>
<td>64%</td>
<td>90%</td>
<td>2.46</td>
<td>0.25</td>
<td>0.64</td>
<td>119%</td>
<td>106%</td>
<td>119%</td>
<td>101%</td>
<td>116%</td>
<td>117%</td>
</tr>
<tr>
<td>3</td>
<td>40%</td>
<td>50%</td>
<td>90%</td>
<td>1.25</td>
<td>0.13</td>
<td>0.36</td>
<td>134%</td>
<td>102%</td>
<td>134%</td>
<td>99%</td>
<td>109%</td>
<td>113%</td>
</tr>
<tr>
<td>4</td>
<td>50%</td>
<td>40%</td>
<td>90%</td>
<td>0.80</td>
<td>0.08</td>
<td>0.24</td>
<td>145%</td>
<td>99%</td>
<td>145%</td>
<td>97%</td>
<td>106%</td>
<td>106%</td>
</tr>
<tr>
<td>5</td>
<td>60%</td>
<td>30%</td>
<td>90%</td>
<td>0.50</td>
<td>0.05</td>
<td>0.15</td>
<td>156%</td>
<td>96%</td>
<td>156%</td>
<td>95%</td>
<td>103%</td>
<td>103%</td>
</tr>
</tbody>
</table>
All methods except "EN 50465 / SEC" result in lower package efficiencies with increasing electric efficiency. This is the result of an increasing share of supplementary heating (because heat output reduces with increasing electric output). The "EN 50465 / SEC" shows an increase (although flattening) heating efficiency of the package as this includes the full avoided fuel use for electricity production ("EN 50465 / efficiency" is based on extrapolation after eta_el > 30%) in the SEC of CHP_only. The inclusion of avoided fuel counterbalances the increasing effect of the supplementary heater.

Note that the above comparison is purely intended to contribute to the discussion on how to take into account CHP benefits, based on current methods, and does not reflect a proposal by VHK (these are described in Task 6).

As the efficiency is the reciprocal value of SEC the difference in behaviour close to the reference efficiency value can be shown in a figure. As the SEC values approaches zero near the reference electric efficiency value, it simply crosses and continues as negative value. The efficiency (reciprocal of SEC) however jerks upwards close to the reference value (actually going to infinity), only to come up as negative efficiency beyond the reference efficiency value.

![SEC and efficiency compared](image)

**Figure 24. SEC and efficiency compared**
4.8 Solar thermal

Solar devices can be split up into factory made systems, tested using the EN 12976 series and custom built, the components of which are tested using the EN 12977 series. The classification of a system as Factory Made or Custom Built is a choice of the final supplier, in accordance with the following definitions:

**Factory Made solar heating systems** are batch products with one trade name, sold as complete and ready to install kits, with fixed configurations. Systems of this category are considered as a single product and assessed as a whole.

If a Factory-Made Solar Heating System is modified by changing its configuration or by changing one or more of its components, the modified system is considered as a new system for which a new test report is necessary. Requirements and test methods for Factory Made solar heating systems are given in EN 12976-1 and EN 12976-2.

A Factory-Made System for domestic hot water preparation may have an option for space heating, however this option should not be used or considered during testing as a Factory-Made system.

Factory made systems are usually:
- assembled by the manufacturer;
- have natural circulation (thermosiphon, no pump);
- are sized for a single family, with a total collector area typically < 4 m²;
- includes ICS (integrated collector storage) types.

Factory-made systems are calculated using the SOLICS method.

**Custom Built solar heating systems** are either uniquely built, or assembled by choosing from an assortment of components. Systems of this category are regarded as a set of components. The components are separately tested and test results are integrated to an assessment of the whole system. Requirements for Custom Built solar heating systems are given in EN 12977-1; Test methods are specified in EN 12977-2, EN 12977-3 (for solar stores), EN 12977-4 for solar combi-stores) and EN 12977-5 (for solar controls).

Custom Built solar heating systems are subdivided into two categories:
- Large Custom-Built systems are uniquely designed for a specific situation. In general HVAC engineers, manufacturers or other experts design them.
- Small Custom-Built systems offered by a company are described in a so-called assortment file, in which all components and possible system configurations, marketed by the company, are specified.

Custom built systems are usually:
- forced circulation type solar thermal systems (pump circulation);
- applied when positioning of tank above collectors is not possible or the length of piping excludes natural circulation;
- can be designed for multi-family housing (easily sizable to larger systems).

Each possible combination of a system configuration with components from the assortment is considered as one Custom Built system.

Custom built systems are usually calculated using the SOLCAL method.
Table 44. Difference factory made and custom-built solar devices

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated collector storage systems for domestic hot water preparation</td>
<td>Forced-circulation systems for hot water preparation and/or space heating, assembled using components and configurations described in an assortment file (mostly small systems)</td>
</tr>
<tr>
<td>Thermosiphon systems for domestic hot water preparation</td>
<td>Uniquely designed and assembled systems for hot water preparation and/or space heating (mostly large systems)</td>
</tr>
<tr>
<td>Forced-circulation systems as batch product with fixed configuration for domestic hot water preparation</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Forced circulation systems can be classified either as Factory Made or as Custom Built, depending on the market approach chosen by the final supplier.

Both Factory-Made and Custom-Built systems are performance tested under the same set of reference conditions as specified in Annex B of EN 12976-2 standard and EN 12977–2:2012, Annex A. In practice, the installation conditions may differ from these reference conditions.

Where factory made or custom built systems include a space heater and/or water heater (which incorporates a heat generator), it can be argued the builders of these systems are 'suppliers' in the meaning of the regulations and are placing on the market (factory made) or putting into practice (custom built) products that fall within the scope and should be in conformity with the applicable regulations.

For space heaters this means a 'package' label (Annex III of Delegated Regulation (EU) No 811/2013) must be supplied, together with a product fiche (Annex IV).


Solar collectors are components covered by the EN 12975 series of which part 1 covers general requirements (mainly safety and correct operation) and part 2 describes test methods. This part 2 was withdraw in 2013 to make way for standard ISO 9806 for collector performance. Many of the parameters that are needed to calculate the contribution of the solar thermal device to space (or water) heating are to be established by ISO 9806.

The descriptions of standards below start with standards for solar collectors (EN 12975-1, -2 and ISO 9806), factory-made systems (EN 12976 series), and custom-built systems (EN ISO 9806 and EN 12977 series).
4.8.1 EN 12975-1:2013 & prEN 12975 rev – for solar collectors

Title: Thermal solar systems and components - Solar collectors – Part 1: General requirements

By CEN/TC 312/WG1

This European Standard specifies performance requirements for fluid heating collectors with respect to mechanical resistance to climatic loads, fire safety, weather tightness, release of dangerous substances, electrical safety, operating pressure, sound level, thermal output and collector efficiency. Fluids included are anti-freeze fluids, thermo-oil, air and water which are not intended for human consumption. The intended use of the solar collector is to heat up the working fluid. This European Standard also includes provisions for evaluation of conformity to these requirements. This European Standard covers only the solar collector consisting of its components: i.e. absorber, frame, insulation and glazing; It does not cover the fluid. It is applicable to glazed and unglazed solar collectors, flat plate solar collectors, evacuated tubular solar collectors, concentrating solar collectors, tracking solar collectors and thermal-electrical hybrid solar collectors (so called PVT solar collectors). It is not applicable to those solar collectors, in which the thermal storage unit is an integral part of the solar collector to such an extent, that the heat production process cannot be separated from the storage process for the purpose of making measurements of these two processes.

It covers Requirements (Clause 5), Evaluation of conformity (Clause 6), Solar collector identification (Clause 7) and informative annexes on solar collector materials and manufacture (Annex A), environmental protection (relating to heat transfer fluids, insulation materials and recycling) (Annex B), repeated tests relevant for collector modifications (Annex C), normative references to international publications (Annex D) and an Annex ZA describing the relationship between this standard and the Construction products Directive 89/106/EEC.

A draft EN 12975-1 was circulated September 2017 to bring the standard up to date with the CPR and ErP Regulations and the PED. This draft introduced among others annexes ZB, ZC and ZD for relationship with regulation (Delegated) Regulations (EU) No 811/2013, 812/2013 and 814/2013 respectively. The draft describes how the former EN 12975-2 results translate to ISO 9806:2013 and ISO 9806:2017.

If the collector was tested in accordance with one of the previous versions of the test standard EN ISO 9806:2017 the following table applies:
Table 45. Overview of ISO 9806 versions, in relation to EN 12975-2

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal pressure tests for fluid channels</td>
<td>Clause 6</td>
<td>Clause 6</td>
<td>Clause 5.2</td>
</tr>
<tr>
<td>Air leakage rate test (air heating collectors only)</td>
<td>Clause 7</td>
<td>Clause 7</td>
<td>--</td>
</tr>
<tr>
<td>Rupture or collapse test (air heating collectors only)</td>
<td>Clause 8</td>
<td>Clause 8</td>
<td>--</td>
</tr>
<tr>
<td>Standard Stagnation Temperature</td>
<td>Clause 9</td>
<td>Clause 10a</td>
<td>Annex Ca</td>
</tr>
<tr>
<td>Exposure and half-exposure test</td>
<td>Clause 10</td>
<td>Clause 11b</td>
<td>Clause 5.4c</td>
</tr>
<tr>
<td>External thermal shock</td>
<td>Clause 11</td>
<td>Clause 12b</td>
<td>Clause 5.5c</td>
</tr>
<tr>
<td>Internal thermal shock test</td>
<td>Clause 12</td>
<td>Clause 13b</td>
<td>Clause 5.6c</td>
</tr>
<tr>
<td>Rain penetration test</td>
<td>Clause 13</td>
<td>Clause 14</td>
<td>Clause 5.7</td>
</tr>
<tr>
<td>Freeze resistance test</td>
<td>Clause 14</td>
<td>Clause 15d</td>
<td>Clause 5.8d</td>
</tr>
<tr>
<td>Mechanical load test with positive or negative pressure</td>
<td>Clause 15</td>
<td>Clause 16</td>
<td>Clause 5.9</td>
</tr>
<tr>
<td>Impact resistance test</td>
<td>Clause 16</td>
<td>Clause 17</td>
<td>Clause 5.10</td>
</tr>
<tr>
<td>Thermal Performance Incidence angle modifier Heat capacity cp</td>
<td>Clause 19-26</td>
<td>Clause 20-27e</td>
<td>Clause 6e</td>
</tr>
<tr>
<td>Pressure drop</td>
<td>Clause 27</td>
<td>Clause 28</td>
<td>Clause 6.2.8</td>
</tr>
<tr>
<td>Final inspection</td>
<td>Clause 17</td>
<td>Clause 18</td>
<td>Clause 5.11</td>
</tr>
</tbody>
</table>

a Round Result to the next higher multiple of 10°
b Tests according to Class A, B, C are considered as Class A, B, C in EN ISO 9806:2017. Class A+ is not possible.
c Tests are considered as Class B in EN ISO 9806:2017
d Tests of heat pipe collectors according to EN ISO 9806:2013 and EN 12975-2:2013 cannot be transferred
e Formula 12, Annex B and Annex G of EN ISO 9806:2017 shall be used to convert the thermal performance parameters into the format required in Table A.6 of the ISO 9806:2017.

The draft Annex ZB, ZC and ZD cover a.o. the collector aperture area, zero loss efficiency, first order coefficient, second order coefficient and incidence angle modifier.
4.8.2  **EN 12975-2:2006 (withdrawn, see ISO 9806:2017)**

**Title: Thermal solar systems and components - Solar collectors - Part 2: Test methods**

*EN 12975-2 was withdrawn in Nov 2013 and replaced by EN ISO 9806:2014.*

This European Standard specifies test methods for validating the durability, reliability and safety requirements for liquid heating collectors as specified in EN 12975-1. This standard also includes three test methods for the thermal performance characterisation for liquid heating collectors. It is not applicable to those collectors in which the thermal storage unit is an integral part of the collector to such an extent that the collection process cannot be separated from the storage process for the purpose of making measurements of these two processes. It is basically applicable to tracking concentrating collectors, thermal performance testing as given in 6.3 (quasi dynamic testing) is also applicable to most concentrating collector designs, from stationary non-imaging concentrators as CPCs to high concentrating tracking designs. Parts of the solar radiation measurement should be adjusted in case of a tracking collector and in case a pyrheliometer is used to measure beam radiation. Collectors that are custom built (built in; e.g. roof integrated collectors that do not compose of factory-made modules and are assembled directly on the place of installation) cannot be tested in their actual form for durability, reliability and thermal performance according to this standard. Instead, a module with the same structure as the ready collector may be tested. The module gross area should be at least 2 m². The test is valid only for larger collectors than the tested module.


4.8.3  **EN ISO 9806:2017 – Solar collectors testing**

**Title: Solar energy - Solar thermal collectors - Test methods**

The text of ISO 9806:2013 has been prepared by Technical Committee ISO/TC 180 “Solar energy” of the International Organization for Standardization (ISO) and has been taken over as EN ISO 9806:2013 by Technical Committee CEN/TC 312 “Thermal solar systems and components”.

This document supersedes  **EN ISO 9806:2013**

This International Standard specifies test methods for assessing the durability, reliability and safety for fluid heating collectors. This International Standard also includes test methods for the thermal performance characterization of fluid heating collectors, namely steady-state and quasi-dynamic thermal performance of glazed and unglazed liquid heating solar collectors and steady-state thermal performance of glazed and unglazed air heating solar collectors (open to ambient as well as closed loop). This International Standard is also applicable to hybrid collectors generating heat and electric power. However, it does not cover electrical safety or other specific properties related to electric power generation. This International Standard is also applicable to collectors using...
external power sources for normal operation and/or safety purposes. This International Standard is not applicable to those collectors in which the thermal storage unit is an integral part of the collector to such an extent that the collection process cannot be separated from the storage process for the purpose of making measurements of these two processes.

The standard specifies general aspects like sequence of tests and particular aspects of collectors (Clause 5), internal pressure for fluid channels (Clause 6), leakage test (Clause 7), rupture or collapse test (Clause 8), high temperature resistance test (Clause 9), standard stagnation temperature of liquid heating collectors (Clause 10), exposure and pre-exposure test (Clause 11), external shock test (Clause 12), Internal shock test (Clause 13), rain penetration test (Clause 14), freeze resistance test (Clause 15), mechanical load test (Clause 16), Impact resistance test (Clause 17), final inspection ((Clause 18), test report (Clause 19), performance testing of fluid heating collectors (Clause 20), collector mounting and location (Clause 21), instrumentation (Clause 22), test installation (Clause 23), performance test procedures (Clause 24), computation of collector parameters (Clause 25), determination of thermal capacity etc. (Clause 26), determination of incident angle modifier (Clause 27), determination of pressure drop (Clause 28) and normative annexes for the test report (Annex A), properties of water (Annex C) and informative annexes on mathematical models (Annex B), general guidelines for uncertainty in assessment (Annex D) and measurement of mean temperature (Annex E).

The gross aperture and IAM are named differently in EN ISO 9806 and the TM2014wh (which refers to EN 12975-2:2006). A correct relation is now established in the current draft of EN 12975-1 which uses regulation names and refers to ISO 9806 for establishment of several parameters.

4.8.4 EN 12976-1:2017

Thermal solar systems and components - Factory made systems - Part 1: General requirements

By CEN/TC 312 “Thermal solar systems and components” WG 2 - Factory made systems

The first edition of the EN 12976 series was published in 2000. The standard series provided an important basis for the assessment of the performance as well as the reliability and durability of Factory made solar thermal systems. In the past 15 years or so, several important technological developments and changes of the framework conditions, such as e.g. the aspect of requiring “Energy Labelling”, the EN 12976 series underwent several important changes.

EN 12976-1 specifies requirements on durability, reliability and safety for Factory Made solar heating systems. The standard also includes provisions for evaluation of conformity to these requirements. The concept of system families is included as well. The requirements in this standard apply to Factory Made solar systems as products.

The installation of these systems including their integration with roofs or facades is not considered, but requirements are given for the documentation for the installer and the user to be delivered with the system (see also 4.6). External auxiliary water heating devices that are placed in series with the Factory-Made system are not considered to be part of the system. Cold water piping from the cold-water grid to the system as well as piping from the system to an external auxiliary heater or to draw-off points is not considered to be part of the system. Piping between components of the Factory-Made
system is considered to be part of the system. Any integrated heat exchanger or piping for space heating option is not considered to be part of the system.

This standard covers Requirements for components, including energy labelling (Clause 4) and informative annexes on Conformity assessment (Annex A), and material combinations with regard to corrosion (Annex B) and a normative annex on system families (Annex C).

The standard has little relevance for Ecodesign or energy labelling purposes.

4.8.5 **EN 12976-2:2017**

**Thermal solar systems and components - Factory made systems - Part 2: Test methods**

*By CEN/TC 312 WG 2*

This European Standard specifies test methods for validating the requirements for Factory Made Thermal Solar Heating Systems as specified in EN 12976-1. The standard also includes two test methods for thermal performance characterization by means of whole system testing.

The standard covers testing, including labelling and yearly performance indicators (Clause 5), and normative annexes on the thermal performance presentation sheet (Annex A), reference conditions for performance prediction (Annex B), and informative annexes on ability to resist extreme climate conditions (Annex C), ageing tests (Annex D), lightning protection (Annex E + F) and normative annexes related to reporting formats for (Delegated) Regulations (EU) No 811, 812 and 814 from 2013 (Annex G) and the **informative annexes ZA, ZB and ZC** on the relationship of this standard and Delegated Regulation (EU) No 811/2013 (Annex ZA), Delegated Regulation (EU) No 812/2013 (Annex ZB) and Regulation (EU) No 814/2013 (Annex ZC).

The CEN standard EN 12976-2 is used to determine the solar contribution of factory-made systems and currently only applies to DHW performance (Note in clause 5.9.3.1, EN 12976-2:2017), for class M to XXL.

This standard allows the use of the so-called SOLICS method, described in TM2014wh which is essentially the application of the DST method as described in ISO 9459-5.

However, the regulations to which the TM2014wh relates to, prescribe an assessment based on **monthly** irradiance and temperature levels (for the three climates considered) whereas ISO 9459-5 is an **hourly** method. Therefore EN 12976-2:2017 describes the criteria for data to be used for the hourly method (Annex B.4 Additional set of reference conditions for annual performance calculations and Table B.8, referring to Meteonorm datasets for Strasbourg and Helsinki[^180]), which have to be consistent (deviations are within acceptable range) with the monthly data required by the regulations.

Similarly, the regulations require assessment based on the tapping patterns, which may include several tappings **within a single hour**, whereas the ISO 9459-5 is using an **hourly** method. The EN 12976-2 includes revised tapping patterns for M to XXL (Annex B.4

[^180]: Athens is already the test reference year
Additional set of reference conditions for annual performance calculations, Table B.5), useable for an hourly context, that result in the same hot water withdrawal as the original tapping patterns.

The reference conditions (including the load profile or tapping pattern and sources of hourly data to be used) are specified in Annex B of EN 12976-2:2017 (or EN 12977-2:2012 for custom built products). For these conditions the following performance indicators are derived from the performance test results:

<table>
<thead>
<tr>
<th>For &quot;solar-only&quot; and &quot;preheat systems&quot;</th>
<th>For &quot;solar-plus-supplementary systems&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>the heat delivered by the solar heating system: Qₜ (to be subtracted from annual water heating demand)</td>
<td>the net auxiliary energy demand Qₐₜₚₚ (Qₐₙₙₜ)</td>
</tr>
<tr>
<td>the parasitic energy (controls, pump if applicable) if any: Qₚₜ</td>
<td>the parasitic energy (controls, pump if applicable) if any: Qₚₜ</td>
</tr>
<tr>
<td>the solar fraction: fₜ</td>
<td></td>
</tr>
</tbody>
</table>

In Clause 5.9.3.2 the calculation of the net auxiliary energy demand for solar-plus-supplementary systems is described. For solar-plus-supplementary systems, the Qₐₚₚ equals Qₐₙₙₜ.

Clause 5.9.3.3 describes the calculation of the solar fraction for solar-only and preheater systems.

In clause 5.9.3.4 Calculation of the parasitic energy Qₚₜ, the electrical parasitic energy is calculated, measured according ISO 9459-5 (DST). The EN 12976-2 does not directly refer to solpump, solhrs and solstandby as defined in the TM2014wh, as it is intended for factory-made systems that mostly do not use a pump. EN 12976-2 allows calculation of parasitic energy (= Qₚ₀) using a numerical simulation in accordance with ISO 9459-5 (with a maximum pump operation time of 2000 h/a, if a reasonable estimation of operation times is not possible). It is understood this is the Qₚₚ as referred to in the TM2014wh. These equations are identical to those used in EN 15316-4-3:2017.

The EN 12976-2:2017 contains errors related to Qₐₙₙₜ and Qₜ:

In clause 5.9.3.5 Calculation of the water heating efficiency of the auxiliary heater, from Table 4, Qₜ is erroneously replaced by Qₐₙₙₜ.

The correct equation for the daily fuel consumption, without solar contribution, in kWh [shall be calculated according to] is: 

\[ Q_{\text{fuel}} = \frac{Q_{\text{ref}}}{\eta_{\text{wh,nonsol}}} \]

---

181 Personal communication with U.Fritzsche, 13-11-2017. In EN 12976-2:2017, clause 5.9.3.5 dealing with Calculation of the water heater efficiency of the auxiliary heater, Qₜ was mistakenly replaced by Qₐₙₙₜ in every equation and table starting with table 4. Starting with clause 5.9.3.6 Contribution of the auxiliary heater, the nomenclature is again right. As etawh,nonsol for an integrated electrical heater is given with fixed 40%, this mistake is not relevant for thermosiphon systems with electrical auxiliary heater.
And the correct equation for the daily electricity consumption without solar contribution in kWh is: 

\[ Q_{elec} = Q_{ref} \]

where \( Q_{ref} \) is the daily heat demand according to Table 4 Daily heat demand for load profiles.

The same \( Q_{nonsol} = Q_{ref} \) error continues in clause 5.9.3.5.4 "Solar-plus-supplementary systems, with external boiler-type auxiliary (backup) heater" and 5.9.3.5.5 "Solar-plus-supplementary systems, with external heat pump type auxiliary heater".

As from 5.9.3.6 "Contribution of the auxiliary heater" \( Q_{nonsol} \) is used correctly again.

The standard identifies the parameters to determine for two main types of water heaters that use solar devices:

1) Solar-only & preheat system. These are systems that are assessed without auxiliary heater. The solar contribution \( Q_L \), the solar fraction \( f_{sol} \) and the auxiliary energy consumption \( Q_{par} \) are determined using the ISO 9459-5 method:
   a) \( Q_d, Q_L \) are calculated by computer simulation, \( f_{sol} \) follows from \( Q_L/Q_d \), \( Q_{par} \) is calculated using measurement of parasitic power and numerical simulation of yearly operating time;
   b) The "solar-only" products in EN 12976-2 do not have an auxiliary heater within the boundaries and thus will not meet the definition of solar water heater, nor that of package of solar device plus water heater.
   c) The "preheater" products in EN 12976-2 are assessed without any water heater related parameters (e.g. storage losses, water heater efficiency and/or consumption).

2) The second group of products are the solar-plus-supplementary systems where an auxiliary heater is included. EN 12976-2:2017 is used to determine \( Q_{aux,net} \) and \( Q_{par} \):
   a) \( Q_{aux,net} \) is calculated directly by computer simulation, \( Q_{par} \) is calculated using measurement of parasitic power and numerical simulation of yearly operating time;
   b) EN 12976-2:2017 also provides for equations to calculate the water heating energy efficiency (the following equations have \( Q_{ref} \) corrected, see above) for the following types:
      i) with integrated fuel fired heater

\[
\eta_{wh,nonsol} = \frac{\eta_{wh,\text{tot}} \cdot (Q_{ref} + US \cdot f_{aux} \cdot \Delta T \cdot 0.024)}{Q_{ref}}
\]

\[
Q_{elec} = \text{as tested}
\]

\[
Q_{fuel} = \frac{Q_{ref}}{\eta_{wh,nonsol}}
\]

\( \eta_{wh,nonsol} \) is maximized at 1 (100%)

i) with integrated electrical resistance heater

\[
\eta_{wh,nonsol} = 40\%
\]
\[ Q_{\text{elec}} = Q_{\text{ref}} \]
\[ Q_{\text{fuel}} = 0 \text{ (zero by default)} \]

iii) with external boiler-type auxiliary (backup) heater

\[ \eta_{\text{wh, nonsol}} = 0.95 \times \frac{Q_{\text{ref}}}{Q_{\text{fuel}} + CC \times Q_{\text{elec}} + Q_{\text{corr}}} \]

\[ Q_{\text{elec}} = Q_{\text{elec,on}} + Q_{\text{elec, sb}} = (24 - t_{\text{on}}) \times PSB + t_{\text{on}} \times el_{\text{max}} \]

\[ Q_{\text{fuel}} = \left( Q_{\text{ref}} + \left( 24 - \frac{Q_{\text{ref}}}{P_4} \times P_{\text{stby}} \right) \times \frac{100}{\eta_4} \right) \]

\[ t_{\text{on}} = \left( Q_{\text{ref}} + \left( 24 - \frac{Q_{\text{ref}}}{P_4} \times P_{\text{stby}} \right) \times \frac{1}{P_4} \right) \]

iv) with external heat pump type auxiliary heater

\[ \eta_{\text{wh, nonsol}} = 0.95 \times f \times \frac{\text{COP}_N}{CC} \times \frac{Q_{\text{ref}}}{Q_{\text{ref}} + S \times 24h} \]

\[ f = \text{depends on HP heat source and climate (if outside air) and ranges from 0.844 to 1.059} \]

These equations are identical to those used in EN 15316-4-3:2017.

4.8.6 EN 15316-4-3:2017

Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-3: Heat generation systems, thermal solar and photovoltaic systems, Module M3-8-3, M8-8-3, M11-8-3

EN 15316-4-3 specifies the: required inputs; calculation method; required and resulting outputs, for heat generation systems, thermal solar systems (for space heating, domestic hot water production and the combination of both) and for photovoltaic systems applied in buildings. Within this standard, 6 methods are specified, and each method has its own range of applicability.

Method 1 is applicable for solar domestic hot water systems characterized by the EN 12976 series (factory made) or EN 12977-2 (custom built). It calculates the solar contribution of solar thermal applications, using system test data. The main output of the method is the solar heat and back up heat contribution to the requested heat use.

Method 2 is applicable for systems for domestic hot water and / or space heating with components characterized by EN ISO 9806 (collector performance) and EN 12977-3 (storage tank) or EN 12977-4 with a monthly calculation time step. The main output of the method is the solar heat and back up heat contribution to the requested heat use. This method is referred to as an updated SOLCAL method.
Method 3 is applicable for systems for domestic hot water and / or space heating with components characterized by EN ISO 9806 with an hourly calculation time step. The main output of the method is collector loop heat supplied to the heat storage. This is an hourly method, so not in line with regulations 811/2013 to 814/2013.

Method 4, 5 and 6 are for photovoltaic systems (Method 4 has an annual calculation time step, Method 5 a monthly calculation time step. Method 6 an hourly calculation time step). The output of the methods is the produced electricity.

For solar water heating the method to be applied is the monthly method 2, using component specifications (the so-called SOLCAL method, as prescribed by TM2014wh).

In Table F.7 of EN 15316-4-3:2017 the calculation of Qnonsol is described as:

\[ Q_{\text{nonsol}} = Q_{W,\text{bu,out}} = \sum_{m=1}^{12} Q_{W,\text{bu,out},m} \]

The Annex F (informative) lays down the calculation procedure for method 2 (monthly, based on component data) to be used for Ecodesign and energy labelling. Section F2 describes the settings and standard conditions. It includes the values for Qref and the monthly average solar irradiance and average outside air temperatures, for three climate conditions. Section F3 describes the calculation of auxiliary electricity consumption and is consistent with calculation of Qaux according TM2014wh. Section F4 describes the determination of the water heater performance parameters without solar contribution.

The following options are described in Annex F:

1. In case of a **preheater type** solar device: The backup water heater shall be tested with an appropriate method and the values for \( \eta_{\text{wh,nonsol}} \), \( Q_{\text{fuel}} \) and \( Q_{\text{elec}} \), and the load profile for which these values are determined, shall be derived from the test report.

2. In case of a **solar-plus-supplementary solar device** with a backup heater in combination with a hot water storage tank:
   a. The backup water heater in combination with the solar hot water storage tank shall be tested with an appropriate method and the values for \( \eta_{\text{wh,nonsol}} \), \( Q_{\text{fuel}} \) and \( Q_{\text{elec}} \), and the load profile for which these values are determined, shall be derived from the test report. To avoid double counting of storage tank standing losses the term \( Q_{W;\text{bu;sto};ls} \) shall be set to zero (EN 15316-4-3:2017, Clause 6.1.2, Formula 32).

   \[
   \eta_{\text{wh,nonsol}} = \text{[according test method]}
   \]

   \[
   Q_{\text{fuel}} = \text{[according test method]}
   \]

   \[
   Q_{\text{elec}} = \text{[according test method]}
   \]

3. In case of a **solar-plus-supplementary solar device** with a backup heater that was tested as a space heater and not as a water heater in combination with the **solar hot water storage tank**, \( \eta_{\text{wh,nonsol}} \), \( Q_{\text{fuel}} \) and \( Q_{\text{elec}} \) are calculated as:
a. in case of an external boiler-type backup heater;

\[ \eta_{\text{wh,nonsol}} = 0.95 \times \frac{Q_{\text{ref}}}{Q_{\text{fuel}} + CC \times Q_{\text{elec}} + Q_{\text{corr}}} \]

\[ Q_{\text{fuel}} = \left( Q_{\text{ref}} + \left( 24 - \frac{Q_{\text{ref}}}{P_4} \right) \times P_{\text{stby}} \right) \times \frac{100}{\eta_4} \]

\[ Q_{\text{elec}} = Q_{\text{elec,on}} + Q_{\text{elec, stby}} \]

\[ Q_{\text{elec,on}} = t_{\text{on}} \times e_{\text{max}} \]

\[ Q_{\text{elec, stby}} = (24 \times t_{\text{on}}) \times P_{SB} \]

\[ t_{\text{on}} = \left( Q_{\text{ref}} + \left( 24 - \frac{Q_{\text{ref}}}{P_4} \right) \times P_{\text{stby}} \right) \times \frac{1}{P_4} \]

The method makes a series of simplifications. The smart control factor is not used as it does not apply in this context. The tank losses are set to 0 as they are already considered in method 2 of this standard.

b. In case of an external heat pump backup heater:

\[ \eta_{\text{wh,nonsol}} = 0.95 \times f \times \frac{COP_N}{CC} \times \frac{Q_{\text{ref}}}{Q_{\text{ref}} + S \times 24h} \]

The adjustment factor \( f \) shall to be chosen according to:

<table>
<thead>
<tr>
<th>Type</th>
<th>Outdoor air</th>
<th>Exhaust air</th>
<th>Brine</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>Average</td>
<td>Colder</td>
<td>Warmer</td>
<td>All</td>
</tr>
<tr>
<td>f</td>
<td>0.919</td>
<td>0.840</td>
<td>1.059</td>
<td>0.888</td>
</tr>
</tbody>
</table>

This method makes a series of simplifications:

— The total energy demand is provided by charging the tank at 60 °C, in consequence, this method does not apply to low-temperature heat pumps;

— At least 0.25 m² of heat exchanger surface are used per kW of thermal capacity;

— The storage losses are pre-determined by standard measurement at a storage temperature of 65 °C;

— The smart factor is not taken into consideration;

— The approach is suitable for heat pumps with electrically driven compressors.

The load profile to be selected shall be according to Table F.6 according to the storage capacity. The load profile to be selected is the next smaller one.
<table>
<thead>
<tr>
<th>Profile</th>
<th>Capacity @ 40°C</th>
<th>Minimum volume [55°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>130</td>
<td>87</td>
</tr>
<tr>
<td>XL</td>
<td>210</td>
<td>140</td>
</tr>
<tr>
<td>XXL</td>
<td>300</td>
<td>200</td>
</tr>
</tbody>
</table>

4. in case of a **solar-plus-supplementary solar device** with an **integrated (backup) heater**, $\eta_{wh, nonsol}$, $Q_{fuel}$ and $Q_{elec}$ are calculated as:

   a. In case of an integrated fuel fired heater (calculated excluding the heat losses of the auxiliary part of the tank):

   $$\eta_{wh, nonsol} = \frac{\eta_{wh, tot} \cdot (Q_{ref} + US \cdot f_{aux} \cdot \Delta T \cdot 0.024)}{Q_{ref}}$$, maximised at a value of 1

   $$Q_{fuel} = \frac{Q_{ref}}{\eta_{wh, nonsol}}$$

   $$Q_{elec} = [\text{according test method}]$$

   b. In case of an integrated immersion electrical resistance heater:

   $$\eta_{wh, nonsol} = 40\%$$

   $$Q_{fuel} = 0 \ (\text{zero})$$

   $$Q_{elec} = Q_{ref}$$

4.8.7 **EN 12977-1:2018**

Title: Thermal solar systems and components - Custom built systems - Part 1: General requirements for solar water heaters and combi systems.

By CEN/TC 312/WG 3

This European Standard specifies requirements on durability, reliability and safety of small and large custom-built solar heating and cooling systems with liquid heat transfer medium in the collector loop for residential buildings and similar applications. This document also contains requirements on the design process of large custom-built systems.

This standard covers system classification (Clause 5) and requirements (Clause 6).
4.8.8  EN 12977-2:2018

Title: Thermal solar systems and components - Custom built systems - Part 2: Test methods for solar water heaters and combi systems

By CEN/TC 312/WG 3

This European Standard applies to small and large custom-built solar heating systems with liquid heat transfer medium for residential buildings and similar applications, and gives test methods for verification of the requirements specified in EN 12977-1. This document also includes a method for thermal performance characterization and system performance prediction of small custom-built systems by means of component testing and system simulation. Furthermore, this document contains methods for thermal performance characterization and system performance prediction of large custom-built systems. This document applies to the following types of small custom-built solar heating systems: systems for domestic hot water preparation only; systems for space heating only; systems for domestic hot water preparation and space heating; others (e.g. including cooling). This document applies to large custom-built solar heating systems, primarily to solar preheat systems, with one or more storage vessels, heat exchangers, piping and automatic controls and with collector array(s) with forced circulation of fluid in the collector loop. This document does not apply to systems with a store medium other than water (e.g. phase-change materials), thermosiphon systems, integral collector-storage (ICS) systems.

This standard covers system classification (Clause 5), test methods (Clause 6), Optional performance test of small custom built solar heating systems (Clause 7), Performance test report (Clause 8) and normative annexes on Reference conditions for performance prediction (Annex A), additional information regarding the calculation of the fractional energy savings (Annex B) and informative annexes Short-term system testing (Annex C) Long-term monitoring (Annex D) and Determination of water wastage (Annex E).

4.8.9  EN 12977-3:2018

Title: Thermal solar systems and components - Custom built systems - Part 3: Performance test methods for solar water heater stores

CEN/TC 312/WG 3

This European Standard specifies test methods for the performance characterization of stores which are intended for use in small custom-built systems as specified in FprEN 12977-1. Stores tested according to this document are commonly used in solar hot water systems. However, also the thermal performance of all other thermal stores with water as storage medium can be assessed according to the test methods specified in this document. The document applies to stores with a nominal volume between 50 l and 3 000 l. This document does not apply to combustors. Performance test methods for solar combustors are specified in FprEN 12977-4.

This standard covers store classification (Clause 5), laboratory store testing (Clause 6), store test combined with system test according ISO 9459-5 (Clause 7), store test according to EN 12897 (Clause 8), test reports (Clause 9) and normative annexes on Store model benchmark tests (Annex A), Verification of store test results (Annex B), Benchmarks for the parameter identification (Annex C) and informative annexes on Requirements for the numerical store model (Annex D), Determination of store parameters by means of up-scaling and downscaling (Annex E) and Determination of hot water comfort (Annex F).
4.8.10 EN 12977-4:2018

Thermal solar systems and components - Custom built systems - Part 4: Performance test methods for solar combi-stores

CEN/TC 312/WG 3

This European Standard specifies test methods for the performance characterization of stores which are intended for use in small custom-built systems as specified in EN 12977-1. Stores tested according to this document are commonly used in solar combi systems. However, also the thermal performance of all other thermal stores with water as storage medium (e.g. for heat pump systems) can be assessed according to the test methods specified in this document. This document applies to combi-stores with a nominal volume up to 3 000 l and without integrated burner.

This standard covers store classification (Clause 5), laboratory store testing (Clause 6) and the test report (Clause 7) and normative annexes on Store model benchmark tests (Annex A), Verification of store test results (Annex B), Benchmarks for the parameter identification (Annex C) and informative annexes on Requirements for the numerical store model (Annex D) and Determination of hot water comfort (Annex E).

4.8.11 EN 12977-5:2018

Thermal solar systems and components - Custom built systems - Part 5: Performance test methods for control equipment

CEN/TC 312/WG 3

The tests described in this document are limited to electrically activated components delivered with or for the system by the final supplier. For the purposes of this document controller and control equipment for solar heating systems and auxiliary heaters, if part of the system, are restricted to the following: a) Controllers as: 1) system clocks, timers and counters; 2) differential thermostats; 3) multi-function controllers. b) Sensors as: 1) temperature sensors; 2) irradiance sensors (for short wave radiation); 3) pressure sensors; 4) level sensors; 5) flow meters; 6) heat meters. c) Actuators as: 1) pumps; 2) solenoid and motor valves; 3) relays. d) Combinations of controllers, sensors and actuators listed above. An additional objective of the procedures described in this document is to verify control algorithms and, together with the accuracy of sensors, to determine control parameters. In addition to verifying the functioning of a controller, its equipment and actuators, the determined parameters may be used for numerical system simulations. Typically, electrical anodes are not part of the control equipment and are not controlled by the control equipment. However, because they are electrical appliances, electrical anodes are included in this document.

The standard provides for classification (Clause 5), requirements (Clause 6), testing of sensors (Clause 7), testing of clocks, timers and counters (Clause 8), function testing of thermostats (Clause 9), function testing of controllers (Clause 10), testing of actuators and additional control equipment (Clause 11), documentation (Clause 12) and a test report (Clause 13). Annex A covers testing the electrical supply voltage dependence.
4.9 Hybrid products (prEN 14825 and EN 15502-2-Y)

This section is to present/discuss the current (draft) standards dealing with 'hybrid products'. Hybrid products is a term not yet defined in regulations. In a general sense all products that comprise more than one type of heat generation technology can be called hybrid products. This thus includes combinations of electric heat pumps and gas boilers, but also gas boilers with solar devices, cogeneration devices combining CHP generators and 'conventional' gas boilers. Even solar heaters that comprise an electric immersion heater could be called a hybrid product according the above interpretation. Some stakeholders favour this broad interpretation, but the majority refers to combinations of fuel boilers and electric heat pumps when speaking about 'hybrids'.

The first standard to describe an approach for hybrid products (fuel boiler combined with a heat pump) is standard EN12309-6, published in 2014 by CEN/TC 299/WG2, and dedicated to hybrid appliances combining absorption heat pumps with condensing boilers.

Current attention is however more drawn to the latest draft EN 14825:2017 by CEN/TC113/WG7 which describes two methods for establishing a seasonal space heating energy efficiency:

- a separate test method in which the heat pump and gas boiler are tested separately;
- or a combined test method in which the heat pump and fuel boiler are treated as a "black box";
- a simplified method with less test points.

The first, separate method applies very fundamental simplifications: The heat pump itself is tested at only the test points within the operating range of the heat pump. The heat demand not covered by the heat pump is regarded to be met by the fuel boiler with a seasonal efficiency based on nominal 80/60°C and part load 37/30°C supply/return water efficiencies and the F(i) correction factors.

The second, combined method applies a "black box' approach and only looks at the ingoing energy (fuel, electricity) and outgoing (useful) heat. This method does not apply the 0.85/0.15 weighing of part load a full load efficiencies of the boiler. and results in a more accurate SCOPon. All tests are however performed using a climate chamber (also if the heat pump is not running, outside its operating range).

In parallel to EN 14825:2017 CEN/TC109/WG1 developed its own approach to hybrid testing, but in 2018 it was decided that the approaches should be discussed together and an Ad Hoc Group 'Hybrid' comprising experts from both CEN/TC 109/WG1 and CEN/TC113/WG7 was formed to develop test methods to establish hybrid boiler performance and efficiency. The Ad Hoc Group agreed that the EN 14825 provides a basis for establishing a seasonal efficiency, but the number of test points requiring climate chambers was considered high.

An alternative method, previously developed as EN 15502-2-Y, was discussed and it was agreed that this simpler method should also be elaborated as both EN 14825 methods require a considerable number of test points (5 to 7 points depending on climate and temperature for boiler shut-off and heat pump shut-off).

This "simplified method" is based on the bin-method as the test points depend on the operating ranges of the boiler and heat pump: the respective shut-off temperatures are used to define three zones, for which a representative outdoor temperature is calculated.
Together with a part load ratio and variable flow temperature (and delta T) the test points are fully defined. It is possible that this simplified method is based on a supply temperature of 80 °C whereas CEN/TC113/WG7 requires a supply temperature of 55 °C.

![Figure 25. Simplified test method with temperature zones](image)

<table>
<thead>
<tr>
<th>EN 14825</th>
<th>Simplified method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test points</td>
<td>Tout</td>
</tr>
<tr>
<td>Tdesign</td>
<td>-10</td>
</tr>
<tr>
<td>A</td>
<td>-7</td>
</tr>
<tr>
<td>E/Thp,off</td>
<td>&quot;-6&quot;</td>
</tr>
<tr>
<td>B</td>
<td>+2</td>
</tr>
<tr>
<td>F/Tfb,off</td>
<td>&quot;+4&quot;</td>
</tr>
<tr>
<td>C</td>
<td>+7</td>
</tr>
<tr>
<td>D</td>
<td>+12</td>
</tr>
<tr>
<td>Total: 7 test points (5 for HP, 2 for FB) of which 5 in climate chamber</td>
<td>Total: 5 test points (2 for FB only, 1 hybrid operation, 2 HP only, of which minimal 2 in climate chamber and 2 points only for capacity check)</td>
</tr>
</tbody>
</table>

Quote from N0675 of CEN/TC113/WG7:

*All three methods need to find a way to properly assess defrosting (whether it can happen and how it is considered in the measurement/calculations), cycling effects (especially in hybrid mode, when both heat generators are working), heat output capacity of hybrid and of heat pump part, the flow rate and supply/return temperatures and how to incorporate changes in the PEF (efficiency as COP?, CC for boilers as well?).*

### 4.10 System level (buildings, components)

The EN 15316 series is reserved for standards relating to building energy performance. Naturally, there is a link to the HVAC technologies that influence/determine building energy efficiency.

In 2014 the Commission mandated the ESOs to develop standards to help Member States in the implementation of the EPBD, which required a more holistic approach to building energy efficiency.

The following standards have been reviewed by CEN TC 228 WG 4 and published in 2017.
Table 46. Building system level standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN15459-1</td>
<td>Economic evaluation procedure for energy systems in buildings</td>
</tr>
<tr>
<td>EN15378-1</td>
<td>Inspection of boilers, heating systems and DHW</td>
</tr>
<tr>
<td>EN15378-3</td>
<td>Measured energy performance</td>
</tr>
<tr>
<td>EN12831-1</td>
<td>Design heat load: space heating</td>
</tr>
<tr>
<td>EN12831-3</td>
<td>Design heat load: water heating</td>
</tr>
<tr>
<td>EN15316-1</td>
<td>General and Energy performance expression</td>
</tr>
<tr>
<td>EN15316-2</td>
<td>Space emission systems (heating and cooling)</td>
</tr>
<tr>
<td>EN15316-3</td>
<td>Space distribution systems (DHW, heating and cooling)</td>
</tr>
<tr>
<td>EN15316-4-1</td>
<td>Space heating generation systems, combustion systems (boilers, biomass)</td>
</tr>
<tr>
<td>EN15316-4-2/AC:2017</td>
<td>Space heating generation systems, heat pump systems</td>
</tr>
<tr>
<td>EN15316-4-3</td>
<td>Thermal and PV solar systems</td>
</tr>
<tr>
<td>EN15316-4-4</td>
<td>Building-integrated cogeneration systems</td>
</tr>
<tr>
<td>EN15316-4-5</td>
<td>District heating and cooling</td>
</tr>
<tr>
<td>EN15316-4-8</td>
<td>Space heating generation systems, air heating and overhead radiant heating systems, including stoves (local)</td>
</tr>
<tr>
<td>EN15316-5</td>
<td>Space heating and DHW storage systems (not cooling)</td>
</tr>
</tbody>
</table>

These standards:

- comprise all relevant HVAC systems of a building;
- are based upon an hourly calculation method;
- the standards work together as modules, and can in principle be combined to result in a single holistic method:

Some 15316 methods are currently of relevance when calculating contributions of auxiliary electricity consumption or solar devices:

EN 15316-4-1 is referenced in **TM2014sh** as alternative method for determining the auxiliary electricity consumption (default value for F(2) or the standby heat loss Pstby);

EN 15316-4-3 is referenced in **TM2014wh** as method that is the basis of the SOLCAL method ('B method'), the solar storage tank volume Vsol,

These methods have been updated recently: for example: prEN15316-5 is a calculation method for a heat storage tank that allows to be combined with other functions. Experts are currently developing an open source tool method to combine for instance prEN15316-4-3 (thermal and PV solar systems) with prEN15316-5 (space heating and DHW storage) to describe a solar combination-heater (tool commissioned by Keymark).
4.10.1 EN 15316-5:2017

Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 5: Space heating and DHW storage systems (not cooling), Module M3-7, M8-7

EN 15316-5 covers energy performance calculation of water-based storage sub-systems used for heating, for domestic hot water or for combination of these. This standard does not cover sizing or inspection of such storage systems.

4.10.2 CEN/TR 1749:2014

European scheme for the classification of gas appliances according to the method of evacuation of the combustion products (types)

CEN/TR 1749 presents a general scheme for the classification of gas appliances according to the method of supplying combustion air and of evacuating the products of combustion. The scheme applies to gas appliances that are intended to be installed within buildings and/or to gas appliances intended for installation in a partially protected place external to a building.

The foreword of CEN/TR 1749 states the scheme is also open and can be used for liquid fuel appliances: "... this appliance classification scheme could be utilised in other circumstances. For example, in the case of: a) Appliances capable of utilising heating oil or kerosene, ..." but the scheme can also apply to other gas appliances such as baking ovens, gas cookers, furnaces, etc.

The Technical Report is a guide for the harmonization of product standards and for the common understanding of the types of gas appliances. The TR is based upon 'Technische Regel für Gasinstallationen' (TRGI) by the German DVGW, first versions of which dating back to 1986.

Boilers have to be type-approved for connection to certain specific types of flues and provisions for supply of combustion air. The categories recognised in the most recent TR 1749:2014 range from A, to B to C(1) to C(15)\textsuperscript{182}:

- Category A are flueless appliances and not relevant in the context of this study.
- Category B boilers are open combustion boilers which draw in combustion air from the room they are installed. Type B1 is still allowed on the EU market as a replacement for (individually owned) boilers in shared chimneys.
- Most modern condensing boilers are approved as category C1, C3, C5 or C6, where C6 allows use of non-manufacturer supplied components (approved separate from boiler);
- C2 and C7 are rare and not generally applied;
- C9 can be considered an elaboration of C3 where part of the combustion air supply duct is formed by an existing constructional chimney.
- C(15) is a variant of C9, where C(15) assumes multiple boilers are connected to a combustion air duct that is an existing duct (possibly former chimney). The individual flue gas ducts are routed through this chimney (e.g. multiple flexible liners of plastic or stainless steel) and operate under positive pressure.

\textsuperscript{182} See also Cerga.News #23 (on www.cerga.be)
- C(10) & C(11) are variants of C4, where the C4 requires an air balancing opening between the air and flue gas duct, and C(10) & C(11) do not have this opening: Flue gas evacuation is always under positive pressure. The difference between C(10) and C(11) is that C(10) is homologated (approved) as separate components whereas for C(11) this is approved in combination.

- C(14) is a variant of C4, where C(14) assumes multiple boilers are connected to a combustion air duct that is an existing duct (possibly former chimney). The single/collective flue gas duct is located in this chimney and operates under positive pressure.

- C(12) & C(13) are variants of C8, with a difference in that C(12) & C(13) systems always operate under positive pressure. The difference between C(12) and C(13) is that C(12) is homologated (approved) as separate components whereas for C(13) this is approved in combination.
The (draft) text regarding the problem of (replacing) boilers connected to shared chimneys has been moved to Task 2 (size of the problem), Task 3 (local infrastructure), Task 4 (product characteristics) and Task 6 (problem description and options).
4.11 Water heating efficiency

4.11.1 EN 13203-1:2015 - Gas combi (performance)

Gas-fired domestic appliances producing hot water - Appliances not exceeding 70 kW heat input and 300 litres water storage capacity - Part 1: Assessment of performance of hot water deliveries

EN 13203-1:2015 applies to performance instead of efficiency and has no further relevance for Ecodesign and Energy Labelling, apart from the determination of the mixed water at 40 °C (V40).

Mixed water at 40 °C (V40) for storage water heaters

Mixed water at 40 °C (V40) is the quantity of water at 40 °C, which has the same heat content (enthalpy) as the hot water which is delivered above 40 °C at the output of the water heater, expressed in litres.

A draw-off is performed until the appliance water temperature rise falls below 30 K. The quantity of water is measured when the appliance temperature rise is above 30 K according to Figure below.

V40 is calculated according to the following formula:

\[
V_{40} = \frac{\int_{t_1}^{t_2} \Delta T_d(t) \cdot D_d(t) \cdot dt}{30}
\]

Equation 9. Mixed water at 40°C (V40)

- \(\Delta T_d(t)\) is the measured water temperature rise at the appliance outlet, in K
- \(D_d(t)\) is the measured water flow rate at the appliance outlet, in l/min
- \(t_1, t_2\) are respectively the starting time and closing time of the enthalpy calculation, in min
4.11.2 EN 13203-2:2015 - Gas combi efficiency

Gas-fired domestic appliances producing hot water - Part 2: Assessment of energy consumption


CEN TC 109 WG 4

Scope

EN 13203-2 is the generic standard for establishing water heating performance for gas-fired combination boilers (and other gas-fired appliances) producing domestic hot water. It applies to both instantaneous and storage tank appliances; waters-heaters and combination boilers that have: (1) a heat input not exceeding 70 kW; and (2) a hot water storage tank capacity (if any) not exceeding 500 l. In the case of combination boilers, with or without storage tank, domestic hot water production is integrated or coupled, the whole being marketed as a single unit.

EN 13203-2 sets out in qualitative and quantitative terms the performance in delivery of domestic hot water for a selected variety of uses. It also gives a system for presenting the information to the user. The present document sets out a method for assessing the energy performance of the appliances. It defines a number of daily tapping cycles for each domestic hot water use, kitchen, shower, bath and a combination of these, together with corresponding test procedures, enabling the energy performances of different gas-fired appliances to be compared and matched to the needs of the user. Where other technologies are combined with a gas-fired boiler or a water heater to produce domestic hot water, specific parts of EN 13203 apply.

General test conditions

The appliance is installed in a test room that is well-ventilated, draft free (air speed below 0.5 m/s) and that can protect the product from solar radiation and radiation from other heat generators. The appliance is installed according to the instructions of the manufacturer.

Combination gas boilers shall only be tested in summer mode, meaning that only the hot water function will be evaluated. The test will be conducted using the settings of the appliance as defined in the technical instruction.

Temperatures of the water will be tested just before the inlet (cold water temperature) and directly after the outlet (hot water temperature).

Load profiles

A load profile is a tapping pattern over a 24h period in which each draw-off is specified in terms of starting time and energy content. The water tap patterns are equal to those defined in CR No 814/2013 to ensure the same measurement conditions. Standard prEN 13203-2:2015 does not include the load profiles 3XS and XXS.

During the testing of the water heating efficiency, either the maximum load profile or one load profile below maximum shall be used. For instantaneous appliances this means the appliance will be set to the nominal heat input, according to the data plate. If the appliance has an adjustable temperature mode, the temperature will not be set higher than 65 °C.
Storage water appliances will also be set to the nominal heat input. When several modes are available, the mode that delivers most hot water in 24 hours will be selected.

Testing can be done according to ‘basin’ or ‘continuous flow’ draw-off. In the basin method an average temperature of the tub is reached, meaning that from the beginning of the draw-off all supplied energy is considered useful. In the continuous flow test only water from a minimum temperature is considered useful. For large draw-offs, such as showering and cleaning, energy is considered to be useful from a 30K temperature increase onwards. For small draw-off, energy is considered useful after a 15K temperature rise.

Fixed vs. adjustable temperature
The initial settings of appliance before testing will depend on the temperature mode of the product. For appliances with an adjustable temperature setting, the tests will be carried out with a minimum temperature increase of 45 K above water inlet temperature and a maximum temperature of 65 °C.

For fixed temperature appliances the tests will be carried out as specified in the documentation, however the minimum temperature increase shall preferably greater than 45 K above water inlet temperature.

For both temperature modes, the XS load profile will have a minimum temperature setting equal to or greater ten 35 °C (or 25K above water inlet temperature).

Water heating energy efficiency
The water heating efficiency calculation is based on GCV and includes primary energy for electricity. The efficiency is calculated as the ratio between energy input ($Q_{fuel}$, $E_{elec}$ and corrections) and the heat demand $Q_{ref}$ (see Equation 10).

$$\eta_{wh} = \frac{Q_{ref}}{(Q_{fuel} + CC \times E_{elec}) \times (1 - SCF \times smart) + Q_{cor}} \times 100$$

**Equation 10. Water heating efficiency**

| $\eta_{wh}$ = water heating efficiency in % | CC = conversion coefficient of 2,5 |
| $Q_{fuel}$ = daily fuel energy consumption over the load profile in kWh | $E_{elec}$ = electricity consumption over the load profile in kWh |
| $Q_{cor}$ = ambient correction term (only for load profiles XS to XL) in kWh | smart = smart control coefficient, which is 0 without smart control and 1 with |
| energy delivered by load profile in kWh | SCF = smart control factor |

The **TM2014wh** states that "In case of combination water heaters, no weighting factors taking into account differences between summer and winter mode shall be considered for the measurement/calculation of $Q_{elec}$ and $Q_{fuel}$." Nonetheless, $Q_{fuel}$ in the abovementioned equation is the seasonally weighted daily gas energy consumption $Q_{gas,p}$ (corrected by GCV/NCV):

$$Q_{gas,p} = Q_{gas,W} \times \frac{D_W}{D_W + D_S} + Q_{gas,S} \times \frac{D_W}{D_W + D_S}$$
Where $Q_{gas, W}$ is the daily fuel consumption in winter mode and $Q_{gas, S}$ is the daily consumption in summer mode, and $D_W$ is 200 days and $D_S$ is 165 days.

$$Q_{gas, p} = Q_{gas, W} \cdot \frac{D_W}{D_W + D_S} + Q_{gas, S} \cdot \frac{D_W}{D_W + D_S}$$

It can be proven that, assuming a nominal (at 100% load) useful space heating efficiency of 88% GCV (70ºC regime) and $Q_{gas, S}$ is 1.25*$Q_{ref}$ (this assumes some 20% loss), that $Q_{gas, W}$ is 5% lower than $Q_{gas, S}$. Applying the $D_W$ and $D_S$ weighting this results in a 2.75% lower value for $Q_{gas, p}$ when compared to values based on $Q_{gas, S}$ only (summer mode, no weighting applied). This is without consideration of other factors such as $Q_{corr}$ as these are assumed to be identical for summer and winter mode.

**Smart control factor**

The smart control factor (SCF) is calculated according to Regulation CR No. 814/2013. The parameter 'smart' is set to '1' if the result from **Equation 11** ≥ 0.07.

$$SCF = 1 - \frac{Q_{fuel, \text{week,smart}} + CC \cdot Q_{elec, \text{week,smart}}}{Q_{fuel, \text{week}} + CC \cdot Q_{elec, \text{week}}}$$

Equation 11. Smart Control Factor

$Q_{fuel, \text{week,smart}}$ = fuel energy consumption in smart mode in kWh

$Q_{elec, \text{week,smart}}$ = electric energy consumption in smart mode in kWh

$Q_{fuel, \text{week}}$ = fuel energy consumption without smart mode in kWh

$Q_{elec, \text{week}}$ = electric energy consumption without smart mode in kWh

The term $Q_{cor}$ is the ambient correction term which is 0 for load profiles XXL to 4XL and can be calculated for load profiles XS to XL. The used parameters are already described for **Equation 10**.

$$Q_{cor} = -0.23 \cdot (Q_{fuel} \cdot (1 - SCF \cdot \text{smart}) - Q_{ref})$$

Equation 12. Ambient correction term
Daily gas consumption in summer mode

In the summer mode the combination boiler is 24 h in domestic hot water mode or standby mode.

The daily gas consumption in summer mode is the ratio between the gas consumption that corresponds to a predefined load profile and the recovered energy from the water:

\[
Q_{gas,s} = \frac{V_g \times K \times NCV \times Q_{ref}}{Q_{H2O}}
\]

Equation 13. Daily gas consumption in summer mode

- \(Q_{gas,s}\) = daily gas energy consumption in summer mode for NCV in kWh
- \(Q_{ref}\) = energy delivered by load profile in kWh
- \(NCV\) = net calorific values (at 15 °C and 1013,25 mbar) in kWh/m³
- \(V_g\) = measured gas consumption in m³
- \(Q_{H2O}\) = energy recovered by the water
- \(K\) = gas pressure / temperature correction factor (see Equation 14)

\[
K = \frac{P_a + P_g}{1013.25 \times T_g + 273.15} \times 288.15
\]

Equation 14. Correction factor

- \(P_a\) = atmospheric pressure in mbar
- \(P_g\) = gas pressure in mbar
- \(T_g\) = gas temperature

Daily gas consumption in winter mode

Winter mode is the condition during which the combination boiler supplies energy for the production of domestic hot water and space heating.

The daily gas consumption in winter mode is equal to the gas consumption in summer mode for all (dedicated) water heaters and combination boilers which have a net input above 70 kW or a storage capacity above 500L.

For other combination boilers the gas consumption in winter mode is converted from summer (\(Q_{gas,s}\)) to winter mode (\(Q_{gas,w}\)) with the help of the useful efficiency of the space heating function at 70 °C (\(\eta_{CH-nom}\)) and the energy delivered of the load profile used in the tests (\(Q_{ref}\)).

\[
Q_{gas,w} = \frac{Q_{gas,s}}{1 + 0.5 \times (\eta_{CH-nom} \times \frac{Q_{gas,s}}{Q_{ref}}) - 1}
\]

Equation 15. Daily gas consumption in winter mode

- \(Q_{gas,w}\) = daily gas energy consumption in winter mode in kWh and for NCV
- \(Q_{gas,s}\) = daily gas energy consumption in summer mode in kWh and for NCV
- \(\eta_{CH-nom}\) = useful efficiency at nominal input rate and average temperature of 70 °C for space heating in %
- \(Q_{ref}\) = energy delivered by load profile in kWh

When a combination boiler switches from space heating to domestic hot water mode and back to space heating the standby losses usually generated from the domestic hot water mode are not lost but are instead used in the space heating mode. That means
combination heaters have lower domestic hot water heat losses in winter mode than in summer mode.

**Weighted daily gas consumption**
The daily gas consumption in summer and winter mode can be weighted by the number of days in each mode (respectively $D_s$ and $D_w$) so an average gas consumption can be obtained.

$$Q_{\text{gas,p}} = Q_{\text{gas,w}} \frac{D_w}{D_w + D_s} \cdot Q_{\text{gas,s}} \frac{D_s}{D_w \cdot D_s}$$

\[\text{Equation 16. Weighted daily gas consumption in kWh and for NCV}\]

- $Q_{\text{gas,p}}$ = weighted daily gas energy consumption in kWh and for NCV
- $Q_{\text{gas,w}}$ = daily gas energy consumption in winter mode for NCV in kWh
- $Q_{\text{gas,s}}$ = daily gas energy consumption in summer mode for NCV in kWh
- $D_w$ = number of days in winter mode [200 days, is 6.6 months]
- $D_s$ = number of days in summer mode [165 days, is 5.4 months]

**Annual Fuel Consumption**
The annual fuel consumption is the total fuel consumption of the appliance. This energy consumption will depend on the amount of days the product works in summer ($D_s$) and winter ($D_w$) mode. The same corrections for smart controls and ambient temperature apply as for the calculation of the water heating efficiency. Furthermore, it is assumed that the net load of an appliance is 60% of the tapping pattern.

$$AFC = 0.6 \times (D_w + D_s) \times \left[ Q_{\text{fuel}} \times (1 - SCF \times \text{smart}) + Q_{\text{cor}} \right] \times \frac{3.6}{1000}$$

\[\text{Equation 17. Annual fuel Consumption}\]

- $AFC$ = factor correcting for annual net load
- $D_w$ = number of days in winter mode [200]
- $D_s$ = number of days in summer mode [165]
- $Q_{\text{fuel}}$ = daily fuel energy consumption over the load profile in kWh
- $Q_{\text{cor}}$ = ambient correction term (only for load profiles XS to XL) in kWh
- $SCF$ = smart control factor (see Equation 11)
- $\text{smart} = $ smart control coefficient, which is 0 without smart control and 1 with

Ecodesign Boilers, Task 1, Final | July 2019 | VHK for European Commission 234
**Daily electricity consumption**

The electricity consumption of all auxiliaries is measured during the same time period as the gas measurements. This measured electricity will be corrected by the efficiency of the heat transfer to the water.

\[
E_{elececo} = E_{elecmes} \times \frac{Q_{ref}}{Q_{H2O}}
\]

Equation 18. Daily electricity consumption

- \(E_{elececo}\) = electricity consumption over the load profile in kWh
- \(E_{elecmes}\) = measured electricity consumption in kWh
- \(Q_{ref}\) = energy delivered by load profile in kWh
- \(Q_{H2O}\) = energy recovered by the water in kWh

**Annual Electricity Consumption**

The input \(E_{elececo}\) can then be used to calculate the total annual electricity consumption:

\[
AEC = 0.6 \times (D_w + D_S) \times \left[ E_{elececo} \times (1 - SCF \times \text{smart}) + \frac{E_{elececo}}{Q_{gas,p}} \times \frac{Q_{cor}}{CC} \right]
\]

Equation 19. Annual Electricity Consumption

- 0.6 = factor correcting for annual net load
- \(D_w\) = number of days in winter mode [200]
- \(D_S\) = number of days in summer mode [165]
- \(E_{elececo}\) = corrected electricity consumption in kWh
- \(Q_{gas,p}\) = weighted daily gas energy consumption for NCV in kWh
- \(SCF\) = smart control factor
- \(Q_{cor}\) = ambient correction term (only for load profiles XS to XL) in kWh
- \(CC\) = conversion coefficient of 2.5

**Standby energy consumption**

The standby energy consumption will be calculated over a 24h period with two exceptions:

- Appliances without a control cycle may be tested for a 1h period.
- Appliances with repeated control cycles may be measured during multiple control cycles as soon as the appliance operates in a regular manner.

The measured gas consumption in standby mode is corrected for the time of the test and the correction factor \(K\) (see Equation 14). The measured electricity consumption in standby mode is corrected for the time duration of the test.

**Energy in draw offs of useful water**

The total useful heat produced (recovered) by the heater per tapping profile is the sum of the heat produced per draw-off. The energy content in one draw off is calculated from the total volume of water, which is the product of the time and flow rate, the temperature rise during the tapping and the specific heat of water.
\[ Q_{H_2O} = c_w \sum_{i=1}^{n} \int_0^{t_i} D_i \cdot \Delta T_i(t) \, dt \]

- \( Q_{H_2O} \) = energy recovered by the water in load profile in kWh
- \( c_w \) = specific heat capacity of water (1,163*10^3 kWh/l*K)
- \( D_i \) = water rate delivered at the tap in l/min
- \( \Delta T_i(t) \) = instantaneous temperature rise during the tapping in K
- \( n \) = number of draw-offs
- \( t_i \) = tapping time in minutes

The useful energy content of the draw offs shall match the energy content required for the tapping profiles as specified in the Regulations (within +/- 2% of the individual tapping or +/- 2% for the overall tapping cycle).

### 4.11.3 EN 13203-3:2010 - Gas-solar combi

Solar supported gas-fired domestic appliances producing hot water - Appliances not exceeding 70 kW heat input and 500 litres water storage capacity - Part 3: Assessment of energy consumption

Supersedes: EN 13203-3:2007 draft

This European Standard is applicable to solar supported gas-fired appliances producing domestic hot water. It applies to a system marketed as single unit or a system fully specified by a manufacturer that:

- has a gas heat input not exceeding 70 kW; and
- has a hot water storage capacity not exceeding 500 l; and
- is equipped with at least one solar collector; and
- is, with regard to the solar hydraulic circuit, considered as a forced circulation system (definition according to EN ISO 9488:1999).

The appliances covered by this European Standard are described in Annex C of the standard.

The EN 13203-3 sets out a method for assessing the energy performance of a solar supported appliance. It defines daily tapping cycles for each domestic hot water use, kitchen, shower, bath and a combination of these, together with corresponding test procedures including information about the available solar radiation. It enables the energy performances of different gas-fired appliances to be compared and matched to the needs of the user.

The content of EN 13203-3 as far as relevant for establishing the water heating efficiency of combination heaters is aligned with EN 13203-2.

### 4.11.4 EN 13203-4:2016 - Micro CHP combi

Gas-fired domestic appliances producing hot water - Part 4: Assessment of energy consumption of gas combined heat and power appliances (mCHP) producing hot water and electricity

Supersedes: EN 13203-4:2015 draft

EN 13203-4 is applicable to gas-fired mCHP appliances producing domestic hot water and electricity. The electricity is generated in a process linked to the production of useful
heat. It applies to mCHP appliances marketed as single unit or as a package fully specified by a manufacturer that have

- a gas heat input not exceeding 70 kW;
- an electrical output not exceeding 50 kW and
- a hot water storage capacity not exceeding 500 l.

EN 13203-4:2016 sets out a method for assessing the energy performance of gas fired mCHP appliances. It defines a number of daily tapping cycles for each domestic hot water use, kitchen, shower, bath and a combination of these, together with corresponding test procedures, enabling the energy performances of different gas-fired appliances to be compared and matched to the needs of the user. When the mCHP generator does not supply domestic hot water in the summer period, the present standard is not applicable.

The content of EN 13203-3 as far as relevant for establishing the water heating efficiency of combination heaters is aligned with EN 13203-2.

Scope
This standard applies to gas-fired mCHP appliances that produce both hot water and electricity. In the scope are appliances that have:

- A heat input not exceeding 70 kW;
- An electrical input not exceeding 50 kW;
- A hot water storage capacity not exceeding 500L;

This standard is part of the EN13203 series in which EN13203-1 presents basic information and calculations concerning the production of domestic hot water. Other documents in this series each specify test procedures for specific appliances.

This standard does not apply if the mCHP does not produce hot water in the summer period.

General test conditions
The appliance is installed in a test room that is well-ventilated, draft free (air speed below 0,5 m/s) and that can protect the appliance from solar radiation and radiation. The ambient temperature will be 20 °C with a maximum average variation over the test period of ±1 K. The cold-water temperature will be 10 °C with a maximum average variation over the test period of ±2 K. The cold-water temperature will be 10 °C.

Combination gas boilers shall only be tested in summer mode, meaning that only the hot water function will be evaluated. The test will be consulted with the appliance in the setting as defined in the technical instruction.

Load profiles
During the testing of the water heating efficiency, either the maximum load profile or one load profile below maximum shall be used. The load profiles equal those that are defined in CR 814/2013, ranging from 3XS to 4XL. In this standard, tapping profiles for XXS and XS are excluded. Furthermore, the same principles concerning tapping profiles during the testing apply as described for EN 13203-2:2015.
Calculation energy efficiency

Water heating energy efficiency
The calculations on the water heating efficiency are equal to those of EN 13203-2:2015

Energy consumption

Daily gas consumption in summer mode
The measurements and calculations on the daily gas consumption in summer mode are equal to those of EN 13203-2:2015.

Daily gas consumption in winter mode
The measurements and calculations on the daily gas consumption in winter mode are equal to those of EN 13203-2:2015.

Weighted daily gas consumption
The measurements and calculations on the weighted daily gas consumption are equal to those of EN 13203-2:2015.

Annual Fuel Consumption
The measurements and calculations on the Annual Fuel Consumption in are equal to those of EN 13203-2:2015.

Electricity generation and delivery
The standard describes the calculation of electricity production split up in electricity generation and electricity delivery. Electricity generation is the output of the microCHP generator ($E_{CHP,p}$). The electricity delivered is the electricity that is supplied to the mains ($E_{delivered,p}$). This is the generated electricity minus the electricity consumed by the auxiliaries ($E_{Auxiliaries}$) of the mCHP itself.

$$E_{Auxiliary} = E_{CHP,p} - E_{delivered,p}$$

Calculation of the daily produced and delivered electrical energy in summer mode
The calculations for the electricity production ($E_{production}$) and electricity delivery ($E_{delivered}$) are the same, only difference is the point of measurement in the test setup.
Both measurements will take place simultaneously with the tests on gas consumption. If the electricity consumption of the auxiliaries, such as fan, pump etc. are known, the delivered energy can be calculated from measuring the produced energy and vice versa.

The daily electricity consumption is calculated as the measured electrical energy corrected by the ratio of the delivered energy by the tapping cycle and the measured energy delivered to the water.

$$E_{\text{delivered}} = \frac{E_{\text{delivered,24}} \times Q_{\text{ref}}}{Q_{\text{H}_2\text{O}}}$$

$$E_{\text{CHP}} = \frac{E_{\text{CHP,24}} \times Q_{\text{ref}}}{Q_{\text{H}_2\text{O}}}$$

**Figure 27. Test points electrical measurements**

- $E_{\text{delivered}}$ = daily delivered electrical energy in summer mode in kWh
- $E_{\text{CHP}}$ = daily produced energy in summer mode during the 24h test in kWh
- $E_{\text{delivered,24}}$ = measured electrical energy in summer mode during the 24h test in kWh
- $E_{\text{CHP,24}}$ = measured energy in summer mode during the 24h test in kWh
- $Q_{\text{ref}}$ = energy delivered by load profile in kWh
- $Q_{\text{H}_2\text{O}}$ = energy recovered by the water in kWh

**Equation 21. Daily electricity produced and delivered in summer mode**
Calculation of the daily produced and delivered electrical energy in winter mode

The daily delivery of electricity in winter mode can be calculated by converting the delivery in summer mode by the factor that represents the ratio in gas consumption in summer and winter mode.

\[
E_{\text{delivered},W} = E_{\text{delivered},S} \times \frac{Q_{\text{gas},W}}{Q_{\text{gas},S}} \\
E_{\text{CHP},W} = E_{\text{CHP},S} \times \frac{Q_{\text{gas},W}}{Q_{\text{gas},S}}
\]

Equation 22. Daily electricity produced and delivered in winter mode

| \(E_{\text{delivered},S}\) | daily delivered electrical energy in summer mode in kWh |
| \(E_{\text{CHP},W}\) | daily produced energy in winter mode during the 24h test in kWh |
| \(E_{\text{delivered},W}\) | daily delivered electrical energy in winter mode in kWh |
| \(E_{\text{CHP},S}\) | daily produced energy in summer mode during the 24h test in kWh |
| \(Q_{\text{gas},S}\) | gas consumption in summer mode using NCV in kWh |
| \(Q_{\text{gas},W}\) | gas consumption in winter mode using NCV in kWh |

Weighted produced and electricity consumption

The daily electricity consumption in summer and winter mode can be weighted by the number of days in each mode (respectively \(D_s\) and \(D_w\)) so an average electricity consumption is obtained.

\[
E_{\text{delivered},p} = E_{\text{delivered},W} \times \frac{D_w}{D_w + D_s} \times E_{\text{delivered},S} \times \frac{D_s}{D_w + D_s} \\
E_{\text{CHP},p} = E_{\text{CHP},W} \times \frac{D_w}{D_w + D_s} \times E_{\text{CHP},S} \times \frac{D_s}{D_w + D_s}
\]

Equation 23. Weighted daily electricity produced and delivered

| \(E_{\text{delivered},p}\) | weighted daily delivered electrical energy in summer mode in kWh |
| \(E_{\text{CHP},p}\) | weighted daily produced energy in winter mode during the 24h test in kWh |
| \(E_{\text{delivered},S}\) | daily delivered electrical energy in summer mode in kWh |
| \(E_{\text{CHP},s}\) | daily produced energy in summer mode during the 24h test in kWh |
| \(E_{\text{delivered},W}\) | daily delivered electrical energy in winter mode in kWh |
| \(E_{\text{CHP},W}\) | daily produced energy in winter mode during the 24h test in kWh |
| \(D_w\) | number of days in winter mode = 200 |
| \(D_s\) | number of days in summer mode = 165 |
Annual Electricity Delivery

For the purposes of Ecodesign the annual electricity delivery should be calculated. This is the sum of the weighted daily electricity consumption corrected for the electricity delivery. Furthermore, corrections are added for smart control or the size of the load profile.

\[
AED = 0.6 \times (D_W + D_S) \times [E_{\text{delivered, p}} \times (1 - \text{SCF} \times \text{smart}) + \frac{E_{\text{auxiliary}}}{Q_{\text{gas,p}}}] + \frac{Q_{\text{cor}}}{CC}
\]

Equation 24. Annual Electricity Delivery

- \(E_{\text{delivered, p}}\) = weighted daily delivered electrical energy in kWh
- \(E_{\text{auxiliary}}\) = daily auxiliary electricity consumption in kWh
- \(Q_{\text{cor}}\) = ambient correction term (only for load profiles XS to XL) in kWh (see Equation 12)
- \(SCF\) = smart control factor (see Equation 11)
- \(CC = \) smart control coefficient, which is 0 without smart control and 1 with
- \(D_W = \) number of days in winter mode [200]
- \(D_S = \) number of days in summer mode [165]

Standby mode

All measurements in on mode are also conducted in standby mode. The standby energy consumption will be calculated over a 24h period with two exceptions:

- Appliances without a control cycle may be tested for a 1h period.
- Appliances with repeated control cycles may be measured during multiple control cycles as soon as the appliance operates in a regular manner.

To obtain the results on annual standby consumption, the same calculations (using the same equation) are conducted as for on-mode consumption, only with a different measurement input.

Heat recovery

The measurements and calculations on heat recovery are equal to those of EN 13203-2:2015.

4.11.5 EN 13203-5:2015 - Electric heat pump combined with gas fired appliance

Gas-fired domestic appliances producing hot water - Part 5: Assessment of energy consumption of gas fired appliances combined with electrical heat pump

CEN/TC 109/WG 4

This European Standard is applicable to gas-fired appliances producing domestic hot water. It applies to both instantaneous and storage gas-fired appliances combined with electrical heat pump.

It applies to a package marketed as single unit or fully specified by the manufacturer that have:

- a heat input not exceeding 400 kW; and
• a hot water storage tank capacity (if any) not exceeding 2000 l.

EN 13203-5 sets out a method for assessing the energy performance of gas fired appliances combined with heat pump with electrically driven compressor according to EN 16147. The standard does not apply to gas boilers with recovery systems using combustion products as heat source for the electrical heat pump. When the electrical heat pump does not work for domestic hot water production in the summer period, the present standard is not applicable for energy performances assessing, EN 13203-2 should be used.

The content of EN 13203-5 as far as relevant for establishing the water heating efficiency of combination heaters is aligned with EN 13203-2.

Test conditions
The cold water inlet temperature is 10ºC +/-2K, the ambient temperature is 20º +/-2K, and the heat source temperatures at the outdoor heat exchanger are as stated in the relevant regulations with the following exceptions: Ambient temperatures are 20ºC +/-3K for indoor installations and 7ºC+/-3K for outdoor installations, a heat source temperature for direct evaporation has been provided at 4º+/-0.5K. This standard is not aligned with EN 12309-7 for sorption heat pumps which also provided temperatures for solar assisted systems and sorption heat pumps with ground source loop.

The test is performed in 'summer mode', which means that only domestic hot water is produced, the device is not used for space heating.

Energy efficiency and consumption
The standard describes procedures for establishing of:

1) Water heating energy efficiency, including consideration of:
   a) smart control
   b) ambient correction term Qcor, as prescribed by Delegated Regulation (EU) No 812/2013 and Regulation (EU) No 814/2013. The space and combination heater regulations 811/2013 and 813/2013 do not prescribe the ambient correction term Qcor.

2) Annual fuel consumption (AFC);

3) Annual electricity consumption (AEC);

4) Mixed water at 40 ºC (V40) for storage water heaters;

The standard does not mention the limits in available exhaust air (as stated in table 6 of 813/2013 etc.).

4.11.6 prEN 13203-6:2015 - Sorption heat pump combi
Gas-fired domestic appliance producing hot water - Part 6: Assessment of energy consumption of ad-sorption and ab-sorption heat pumps

CEN/TC 109/WG4
This European Standard is applicable to gas-fired appliances producing domestic hot water. It applies to sorption heat pumps connected to or including a domestic hot water storage tank. It applies to a package marketed as single unit or fully specified that have:
- a single gas burner for the heat pump and/or an additional gas burner for a peak load appliance;
- a gas heat input not exceeding 70 kW;
- a hot water storage tank capacity not exceeding 500 l.

The content of EN 13203-3 as far as relevant for establishing the water heating efficiency of combination heaters is aligned with EN 13203-2.

When the sorption heat pump cycle does not operate for domestic hot water production in the summer mode, the present standard is not applicable for energy performance assessment, EN 13203-2 should be used instead.

4.11.7 prEN 13203-7:2017 - PFHRD

Gas-fired domestic appliance producing hot water - Part 7: Assessment of energy consumption of combination boilers equipped with a passive flue heat recovery device (PFHRD)

CEN/TC 109/WG 4 and a PFHRD ad-hoc working group

Passive flue heat recovery devices (PFHRDs) have been placed on the market both as an external product (to be combined with an existing or new installation) or integrated in a product. The PFHRD recovers the heat from flue gases and pre-heats incoming cold sanitary water, which is then heated up by the heat generator of the water heater to the appropriate temperature level.

A PFHRD can be a relatively straightforward heat exchanger or can be equipped with some form of thermal storage which allows a temporal displacement of heat recovery. Heat recovered from central heating operation can then (minus heat losses) be transferred to incoming cold water for water heating at a later stage. A boiler with a PFHRD that has no form of integrated thermal storage functions as an instantaneous water heater.

The performance of a PFHRD is determined by the type of boiler (determining the temperature, moisture and flow rate of flue gases), the size/geometry of the heat exchanger of the PFHRD and the heat transfer efficiency, and the standby heat loss of the boiler and the PFHRD. The combustion fan must be capable to overcome the additional resistance introduced by the PFHRD (including that of the flue duct). The degree of integration also affects the possibility of thermal bridges with other parts of the combination boiler.

CEN/TC 109/WG 4 is working on standard EN 13203-7 which covers the functioning and performance of a passive flue heat recovery device integrated into or supplied with a combination boiler. This WG has produced a draft document (May 2018) presenting a proposal for performance testing of PFHRD. The draft is not a final standard.

The scope of the standard is limited to PFHRDs in gas-fired condensing combination boilers and limited to PFHRD for which a point can be identified at which the temperature increase of the incoming cold water over the PFHRD can be determined.

There are two possibilities: either the PFHRD can be recognised as a component (separate heat exchanger) and the temperature increase can relatively easily be measured at a point before the DHW enters the main heat exchanger, or the two heat exchangers are integrated for which the manufacturer has to identify a point where the temperature increase is to be measured.
The test requires that there is no significant heat transfer (thermal bridge) from central heating operation to the PFHRD. This is tested by feeding the space heating circuit of the combination heater with hot water (+/-70°C) for over an hour and then measure the heat contained in the PFHRD device. If the product does not exceed the limit values for thermal transfer, a test can be conducted to determine the water heating efficiency.

The contribution of the PFHRD is either determined using a short test method or a 24 hr test. The short test method involves measuring the energy contained in the PFHRD with two measurements. In the first measurement (Test1) the boiler is switched on for 30 minutes and in the second test (Test 2) for 15 minutes, at 30% load by a low temperature space heating regime (43/37°C). After both tests, firstly 2 litres are tapped (while measuring the water temperature) and subsequently water is tapped until inlet and outlet temperature have equalised. These tests yield the parameters for energy savings on the various tappings in a tapping pattern:

Test 1 : $Q_{\text{tapped, small}},1$ and $Q_{\text{tapped, large}},1$

Test 2 : $Q_{\text{tapped, small}},2$ and $Q_{\text{tapped, large}},2$

The indirect contribution is calculated on the basis of the heat content of the PFHRD and the number of smaller/larger tappings in the declared tapping profile.

The 24h test involves a 24h tapping profile test, with the DHW function deactivated, and only the space heating burner active (at 30% load, at 43/37°C supply/return) in the intervals between tappings. The duration of the tappings is calculated assuming a fixed temperature increase of 45 K. Doing so only the heat transferred to DHW coming from space heating operation is counted.

The energy stored (in kWh/24h) by the PFHRD over 24 hrs is calculated as the water heating efficiency with PFHRD engaged multiplied by the indirect contribution of the PFHRD.

The daily gas consumption (as required by Ecodesign and labelling regulations) is calculated using a weighting of the daily summer consumption (165/365=45%) and daily winter consumption (200/365 = 55%).

The flue gas temperature is an important parameter. The UK Ecuity study\textsuperscript{183}, assuming a household requiring 12000 kWh\textsuperscript{184} annually of gas for space heating and 2000 kWh for DHW (is 1270 m\textsuperscript{3}/a natural gas for space heating and 212 m\textsuperscript{3} for DHW at 34 MJ/m\textsuperscript{3} NCV) reported savings of 9% on water heating without thermal store and 31% if equipped with thermal store. According another UK PFHRD study the flue gas temperature assumed for the savings calculation is 55°C, suggesting a system supply temperature some degrees below this, well beyond those proposed in the EN standard. Also, the Aktion Brennwert-Check study by the German Verbraucherzentrale\textsuperscript{185} points towards higher temperatures in many real-life situations which is beneficial for PFHRD, but indicates lower space heating efficiencies than assumed by the Transitional Method.

\textsuperscript{183} Reliable Recovery–benefits of stored passive flue gas heat recovery for UK homes .., Ecuity, July 2017


\textsuperscript{185} https://www.verbraucherzentrale-energieberatung.de/assets/downloads/studien/Aktion_Brennwertcheck_Langfassung_Juli_2011.pdf
Status EN 13203-7

Although a prEN 13203-7 is already in place, the New Working Item Proposal (NWIP) that was submitted second half of 2018 was not accepted. Germany rejected the NWI mainly because of hygienic issues.

It was recently decided to launch a new Committee Internal Balloting (CIB) on the creation of an active WI on prEN 13203-7. The closing date is 31st March 2019 under reference DEC 2019-01.

The comments received from Germany on this working document addressed mainly hygienic aspects in relation to proliferation of legionella growth, asking for clauses that describe periodic disinfection (heating to above 70ºC), clauses that describe construction requirements (suitable materials, double wall between flue-gas and potable water).


- Monitoring the following parameters: lead and Legionella. The latter has been found by the WHO to cause the highest health burden of all waterborne pathogens in the Union. In addition, it is also recommended by the European Centre for Disease Prevention and Control to apply regular checks and appropriate control measures to man-made water systems as a means to prevent cases of Legionnaires’ disease at tourist accommodation sites, hospitals, long-term healthcare facilities or other settings where sizeable populations at higher risk may be exposed.
- On the basis of the risk assessment and monitoring, Member States can then take measures, such as training of plumbers, information and advice to house owners, appropriate treatment techniques in cooperation with water suppliers, etc. In addition, this Article partly addresses aspects covered in former Article 10 (products in contact with drinking water) and ensures consistency with Regulation (EU) No 305/2011 under which standards for construction products in contact with drinking water are to be established.

In that context, some countries refer to a specific water volume (e.g. < 3 litre) below which no additional measures regarding Legionella prevention are not required, amongst others based on tests that have been done, indicating that additional pipe lengths (up to 15 m), having a biofilm contaminated by Legionella, fed by clean hot water, do not influence the Legionella-concentration in the water at the taps.

In any event, it is up to the member states to deal with this aspect. The measures that are needed may very per country. PFHRD is not the first nor the only product that holds a certain risk for Legionella, meaning that solutions in all member states are already in place to deal with such risks.

---

In the light of the energy saving potential that PFHRD’s represent (around 25-30% of all hot tap water energy consumed by condensing combination boilers!), it might be more appropriate to just add a section in the EN13203-7 standard, referring to the fact that – in case a member state has identified that a certain type of PFHRD (different PFHRD designs may represent different risks) holds a the risk of legionella and needs some kind of anti-legionella provision, the manufacturer offering the PFHRD with condensing combination boiler, complies with such national requirements.

4.11.8 EN 303-6:2000 - Oil combi

Heating boilers - Part 6: Heating boilers with forced draught burners - Specific requirements for the domestic hot water operation of combination boilers with atomizing oil burners of nominal heat input not exceeding 70 kW

Specifies the supplementary requirements and tests for the construction, safety, rational use of energy, fitness for purpose, classification and marking related to the domestic hot water operation of oil-fired combination boilers of nominal heat output not exceeding 70 kW. The domestic hot water is produced on either the instantaneous or storage principle. The domestic hot water production is integrated or coupled, the whole being marketed as a single unit.

Supersedes: EN 303-6:1997 draft

4.11.9 EN 16147:2017 – Electric heat pumps providing DHW

Scope

This standard applies to air/water, brine/water, water/water and direct exchange/water heat pump water heaters and heat pump combination heaters which are driven by an electric compressor. Also, the appliance either needs to be connected to a hot water storage tank or include one. The standard focuses on testing methods, rating of performance and efficiency calculations for the domestic hot water production only. Testing methods for the simultaneous use of space heating and water heating are not described in this standard.

Load profiles

To calculate the electricity consumption of the water heater a set of load profiles is declared. Each load profile represents a tapping pattern which relates to a certain daily water consumption and heat load. The load profiles are copied from CR 814/2013.

General test conditions

Outdoor heat exchanger air source heat pumps are installed in a test room that is draft free (air speed below 1,5 m/s) to prevent the resistance at the in- and outlet orifices of the test appliances. Also, the appliance should be protected from solar radiation and radiation from other heat generators.

Heat pumps are installed according to the instructions of the manufacturer. Accessories will not be installed.

The different input parameters for relevant Ecodesign calculations are measured during test procedures split up in phases.
Table 47. Test phases

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Stabilisation</td>
</tr>
<tr>
<td>B</td>
<td>Filling and storage volume</td>
</tr>
<tr>
<td>C</td>
<td>Filling and heating up period</td>
</tr>
<tr>
<td>D</td>
<td>Standby power input</td>
</tr>
<tr>
<td>E</td>
<td>Water draw-offs</td>
</tr>
<tr>
<td>F</td>
<td>Mixed water at 40 °C</td>
</tr>
</tbody>
</table>

Energy efficiency

Water heating efficiency

The calculations for the water heating efficiency are equal to those of EN50193-1:2016.

Coefficient of performance

The COP\textsubscript{DWH} is the ratio of the useful energy content (Q\textsubscript{LP}) and the total electrical energy consumption (W\textsubscript{EL-LP}) during the whole load profile.

\[
COP_{DWH} = \frac{Q_{LP}}{W_{EL-LP}}
\]

Equation 25. Coefficient of Performance

| COP\textsubscript{DWH} = coefficient of performance of dedicated water heaters | W\textsubscript{EL-LP} = total electrical energy consumption during the whole load profile in kWh |
| Q\textsubscript{LP} = total useful energy content during the whole load profile in kWh |

When the COP\textsubscript{DWH} is determined according to the test conditions as specified in the standard, average climate conditions for outdoor units and with the maximum load profile, the COP equals the SCOP\textsubscript{DWH}.

Storage volume

The calculations for the water heating efficiency are equal to those of EN 50440:2015.

Energy consumption

Useful energy

The test methodology for measuring the useful energy consumption is mostly equal to that of EN50440:2015. The equation for one water draw-off is described differently in this standard than in EN50440:2015.

\[
Q_{HP-tap} = \frac{1}{60 * 1000 * 3600} \int_0^{t_{tap}} c_p * \rho(T) * f(t) * (\theta_{WH}(t) - \theta_{WC}(t)) dt
\]

Equation 26. Useful energy content per draw-off heat pumps
Draw-offs with a peak temperature ($T_p$) of 55 °C often need extra heating power from an additional electric heater ($Q_{EL-tap}$).

\[
Q_{EL-tap} = \frac{1}{60 \times 1000 \times 3600} \int_0^{t_{tap}} c_p \cdot \rho(T) \cdot f(t) \cdot (\theta_{WH}(t) + (T_p - 10)) \cdot (\theta_{WC}(t)) \cdot dt
\]

Equation 27. Peak temperature draw-offs

\[Q_{EL-tap} = \text{additional electric energy in kWh} \quad T_p = \text{peak temperature °C}\]

The total tapping energy over the load profile is the sum of the energy content of all tapping's and peak temperature draw-offs.

\[
Q_{LP} = \sum_{i=1}^{n_{tap}} Q_{HP-tap_i} + Q_{EL-LP}
\]

Equation 28. Total useful energy

\[Q_{EL-LP} = \sum_{i=1}^{n_{tap}} Q_{EL-tap_i}\]

$T_p = \text{peak temperature °C}$

### Daily electricity consumption

The daily electrical energy consumption is the ratio of the reference and useful energy for the considered load profile. This is multiplied with the total electrical energy consumption in the same load profile.

\[
Q_{elec} = \frac{Q_{ref}}{Q_{LP}} \cdot W_{EL-LP}
\]

Equation 29. Daily electricity consumption heat pumps

\[Q_{elec} = \text{daily electricity energy consumption over the load profile in kWh} \quad Q_{LP} = \text{total energy content of all draw-offs in kWh} \quad Q_{ref} = \text{energy delivered by load profile in kWh} \quad W_{EL-LP} = \text{total electricity consumption}\]

The total electricity consumption ($W_{EL-LP}$) is calculated from the measured energy consumption ($W_{EL-M-LP}$) with some corrections applied. The corrections involve the pump/fan corrections, the heat loss over 24h, additional electrical input ($Q_{EL-LP}$) and the off-peak electrical energy input ($W_{EL-off}$) when applicable.
\[
W_{EL-LP} = W_{EL-M-LP} - W_{EL-Corr} + (24 - t_{TTC}) \cdot P_{es} + Q_{EL-LP} + W_{EL}
\]

**Annual Electricity Consumption**

The calculations for the Annual Electricity Consumption are equal to those of EN50440:2015.

**Mixed water at 40 °C and reference hot water temperature**

For this test a continuous water draw-off is started until the temperature of the hot water falls below 40 °C. The hot water flow rate should be set to the maximum flow rate of the referenced load profile. The water temperature at the outlet over the time duration of the test is used to calculate the reference hot water temperature (which is the average hot water temperature).

\[
\theta'_{WH} = \frac{1}{T_{40}} \int_{0}^{T_{40}} \theta_{WH}(t) \cdot dt
\]

**Smart Control Factor**

The calculations for the Smart Control Factor are equal to those of EN50440:2015.
Standby power input

The stand-by power (Stage D) is calculated over a period of minimal 48 hours or at least 6 on-off cycles of the appliance. In this period, no water draw-offs take place. The standby power consumption is calculated from the energy consumption and the duration of the last on/off cycle.

\[
P_{es} = \frac{W_{es-HP}}{t_{es}} * 3600
\]

Equation 33. Standby power input

\(P_{es}\) = standby power input in kW

\(t_{es}\) = duration of the last on-off cycle of the heat pump in s

\(W_{es-HP}\) = energy consumption of the last on/off cycle in kWh

Off peak products

Off peak products are tested in Stage E of the performance test. The power supply to the unit will be switched off prior to the testing and will be reactivated 16 hours later. Then within 8 hours the compressor will be switched off again due to the thermostat sensing the temperature. The power consumption of the auxiliaries shall be included in the total power consumption.

\[
W_{EL-OFF} = 16 * P_s
\]

Equation 34. Off peak energy consumption

\(W_{EL-OFF}\) = energy consumption for off-peak in kWh

\(P_s\) = measured average power consumption

16 = off-peak time in h

Power input corrections to apply for fans and heat pumps

Since heat pumps allow a difference of external static pressure, only a share of the electricity consumption of the fan motor should be included in the power absorbed by the heat pump. The relevant equation is related to whether the fan is either integrated in the heat pump.

\[
W_{EL-Corr} = \frac{1}{3600 * 1000} \int_0^{t_d} V_{air}(t) * \frac{\Delta p_e}{\eta} \, dt
\]

Equation 35. Energy consumption corrections for integrated fan

\(\eta\) = fan efficiency according to EN 14511-3

\(\Delta p_e\) = measured internal static pressure difference in Pa

\(V_{air}\) = nominal air volume flow rate m³/s

\(t_d\) = test phase duration

\[
W_{EL-Corr} = \frac{1}{3600 * 1000} \int_0^{t_d} V_{air}(t) * \frac{\Delta p_e}{\eta} \, dt
\]

Equation 36. Energy consumption corrections for separate fan

\(\Delta p_e\) = measured external static pressure difference in Pa

\(V_{air}\) = nominal air volume flow rate m³/s
For the power absorbed by liquid pumps the same rules apply, but then the liquid measured volume flow rate ($\dot{V}_{\text{fluid}}$) will be replace $\dot{V}_{\text{air}}$.

**Discussion**

According FAQ 57 of the 2018 Guidelines the peak temperature (Tp) during a tapping shall be calculated as a mean value over the water draw-offs with a minimum value as specified in the tapping cycles. The FAQ 57 continues to state that "In cases where the peak temperature is not reached, additional the product cannot be declared under this tapping profile and needs to be tested under another tapping profile".

This means that water heaters, including heat pump water heaters, must achieve at minimum 55ºC peak temperature in load profile S and larger.

The present standard for DHW HPs EN 16147 is based on the 2015 Guidelines, which provided a different answer to the same question:

40. **In the load profiles S-XXL for water heaters, there is a parameter Tp, ‘peak temperature’, that should be achieved during tapping. The definition of Tp is as follows: “peak temperature” (Tp ) means the minimum water temperature, expressed in degrees Celsius, to be achieved during water draw-off, as specified in Annex III, Table 1”. For how long should Tp be achieved during tapping? Should it be during the whole tapping, or is it enough with a few seconds?**

Peak temperature (T_p) means the minimum water temperature, expressed in degrees Celsius, to be achieved during water draw-off, as specified in Annex III, table 1. The peak temperature T_p shall be calculated as a mean value over the water draw-offs with a minimum value as specified in the tapping cycles.

In cases where the peak temperature is not reached, the relevant standards need to correct the energy consumption of the water heater by assuming an additional electricity consumption in order to reach this temperature.

DHW HPs available on the market today may have been tested at storage temperatures that do not result in 55ºC mean water temperature at outlet. Manufacturers may have used the requirements in the French RT2012 which ask for a hot water temperature of at least 52.5ºC, resulting in a storage temperature set point of 55ºC but not higher...

Considering the 2018 Guidelines retesting of DHW HPs at higher storage temperatures (to achieve minimum 55 ºC at outlet) may be needed. Depending on design the unit can achieve such temperatures on their own, or make use of an immersion heater (controlled by the product). If so required, the test institute can add an immersion heater in the tank to raise storage temperatures so that 55ºC is achieved during tapping. This will result in somewhat higher standing losses and a lower COP.

If the product fails to achieve the 55ºC during tapping, a smaller load profile has to be selected according the 2018 Guidelines, but as the Regulation 814/2013 maximises the storage volumes for smaller load profiles (max. 36 l for load profile S) this is not always possible. This situation is not yet resolved. It could be that such products cannot be placed on the market as "combination or water heater".
4.11.9.1 Climate dependent brine temperatures

The TC 113/WG10 is currently (summer 2018) discussing, together with TC 113/WG 7, the introduction of climate dependent brine temperatures, similar to outdoor temperatures. After careful analysis of brine temperatures in various locations across the EU, for both vertical (borehole) and horizontal (slinky coil) ground collectors, average temperatures for the three climate zones have been suggested.

Table 48. Suggested brine temperatures for three climate conditions

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Average brine temperature</th>
<th>Proposed value (rounded and/or harmonised with current conditions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>6.19 ºC</td>
<td>5 ºC</td>
</tr>
<tr>
<td>Warmer</td>
<td>8.97 ºC</td>
<td>10 ºC</td>
</tr>
<tr>
<td>Colder</td>
<td>1.88 ºC</td>
<td>0 ºC (present standard rating condition)</td>
</tr>
</tbody>
</table>

The WGs will decide in 2019 on amending this standard and related standards (like EN 14825).

4.11.10 EN 12897:2016 Hot water storage tanks

Water supply - Specification for indirectly heated unvented (closed) storage water heaters

By CEN/TC 164/WG 10

This European Standard specifies the constructional and performance requirements and methods of test for indirectly heated, unvented (closed) storage water heaters of up to 2000 l volume suitable for connection to a water supply at a pressure between 0,05 MPa and 1,0 MPa (0,5 bar and 10 bar), and fitted with control and safety devices designed to prevent the temperature of the stored drinking water from reaching 95 ºC.

Whilst storage water heaters intended primarily for direct heating are not covered by this standard, it does allow the provision of electric heating elements for auxiliary use.

The standard was first published in 2006 and in 2016 a revised version was published to more closely align the standing heat loss test with the latest (current) technical requirements of the Commission. In addition, the option to heat the cylinder by external means was removed since it introduced too many difficulties to measure variables.

Recent independent testing of a standard “test” cylinder to EN12897:2016 revealed a good repeatability between different test rigs at different times. At the moment there are no current plans to further revise EN12897:2016 as it is believed to meet the requirements of the Commission.

The test requires the cylinder to be heated for at minimum 85% of the hot water content. Actual volume is established by weighing the cylinder empty and full. Heat exchangers can be kept empty. The rated storage volume is within a percentage of the actual volume (-2/+5% for storage volume less than or equal to 100 l, to -5/+10% for storage volume between 500 and 2000 l). The hot water volume equals the V40 capacity.

The standing heat loss can be determined using either its Annex B method, the EN 60379:2004, Clause 14 or EN 15332:2007, Clause 5.4. The Annex B method in EN 12897:2016 describes a test comprising kWh readings after 24 hr intervals (next thermal
switch off point). If the successive readings do not differ by more than 3% the tank is considered thermally stabilised and the measurement period to determine standing losses can commence. The standing losses are corrected for the actual time required and actual temperatures maintained (standing losses are normalised to 24 hr and 45ºK temperature difference and expressed in W for energy labelling purposes).

4.11.10.1 Discussion storage tanks

Many stakeholders found the mentioning of four standards in the TM2014wh for assessment of standing losses confusing need and requested more clarity as regards which standard to use.

EN 15332 and EN 12897 are converging as regards the establishing of standing heat losses. The latest draft EN 12897 is currently the more complete standard of the two. EN 12977-3 and -4 are specific standards to be used for assessment of solar storage tanks and calculations of solar contributions. The standard is intended to establish modelling parameters, designed for assessment of performance of solar systems, and exceeds its purpose in Ecodesign/labelling.

Some stakeholders mention the need to consider the effect of multiple connections on standing losses of a tank. In general, tanks with multiple connections enable the use of multiple heat sources, most often using renewable energy (as heat pump and/or solar device). Having multiple connections however can increase standing losses. Stakeholders have asked to consider a 'bonus' or otherwise correction of standing losses so that tanks with multiple connections are not penalised with a worse label performance.

4.12 Emissions

4.12.1 CR 1404: NO_x measurement

Standards containing clauses related to establishing NO_x emissions (concentration as mg/kWh heat input, GCV) are generally based CEN CR 1404 which is a general document describing methods for establishing NOC emissions of appliances.

The Ecodesign Regulation for space heaters 813/2013 prescribes maximum emission limit values per fuel type and technology.
Table 49. NO\textsubscript{x} emission limit values in 813/2013

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>Space/combination heater type</th>
<th>Combustion type</th>
<th>Limit value</th>
</tr>
</thead>
<tbody>
<tr>
<td>gaseous fuels</td>
<td>boilers</td>
<td>(n.a.)</td>
<td>56 mg/kWh</td>
</tr>
<tr>
<td></td>
<td>cogeneration</td>
<td>external (e.g. Stirling engine)</td>
<td>70 mg/kWh</td>
</tr>
<tr>
<td></td>
<td>heat pump</td>
<td>external (e.g. sorption)</td>
<td>70 mg/kWh</td>
</tr>
<tr>
<td></td>
<td>cogeneration</td>
<td>internal</td>
<td>240 mg/kWh</td>
</tr>
<tr>
<td></td>
<td>heat pump</td>
<td>(e.g. Otto cycle gas engine)</td>
<td>240 mg/kWh</td>
</tr>
</tbody>
</table>

| liquid fuels | boilers | (n.a.) | 120 mg/kWh |
| cogeneration | external (e.g. Stirling engine) | 120 mg/kWh |
| heat pump | external (e.g. sorption) | 120 mg/kWh |
| cogeneration | internal | 420 mg/kWh |
| heat pump | (e.g. Otto cycle gas engine) | 420 mg/kWh |

For gaseous fuels the 813/2013 does not correct for the gas family used in the test, which may mean that all gaseous fuel heaters, regardless of test gas (first, second or third family gases) have to meet the indicated limit value.

The establishment of NO\textsubscript{x} emissions of gaseous fuel boilers is described in standard EN 15502-1 which does allow a correction of class limits according gas family. This correction does not seem to apply when establishing the Ecodesign emission value. This may mean however that third gas family heaters (using propane, butane) may not meet the emission limit value and have been tested using second family gases.

This is probably not the intention of the Ecodesign regulation, and it would make sense to have limit values that differentiate per gas family.

**Liquid fuels**

Low-sulphur heating oil or kerosene usually has a nitrogen content of 50 mg/kg, although the actual value can vary according the crude oil and processing employed, and may be available in a range of 50-200 mg/MJ, in exceptional cases up to 400 mg/MJ.

In the 2007 preparatory study an NO\textsubscript{x} limit value of 20 ppm was proposed (from 42 ppm for average boilers). No distinction was made between gas and oil-fired heaters. That study assumed the following conversions: 1 ppm (at 3% O\textsubscript{2}) = 1.83 mg/kWh = 0.508 mg/MJ = 0.508 ng/J. 20 ppm is thus 36.6 mg/kWh (at 3% O\textsubscript{2}), 42 ppm is 77 mg/kWh.

The TM2014sh refers to EN 267:2009+A1:2011 and requires a correction taking into account a nitrogen content of a reference fuel of 140 mg/kg (11.8 mg/kWh NCV). Apparently, this used to be the nitrogen content of kerosene as this fuel oil is exempted from this correction. The correction is a reduction of nitrogen emission (in mg/kWh) by 20% of the difference in measured NO\textsubscript{x} content and reference NO\textsubscript{x} content (in mg/kg).
\[
NO_{X(EN\ 267)} \left( \frac{mg}{kWh} \right) = NO_{Xref} \left( \frac{mg}{kWh} \right) - (N_{meas} - N_{ref}) \times 0.2
\]

If \(M_{meas}\) is 200 mg/kg and \(N_{ref}\) is 140 mg/kg the correction is \(-(200-140)\times0.2 = -12\) [mg/kWh]

If \(M_{meas}\) is 50 mg/kg and \(N_{ref}\) is 140 mg/kg the correction is \(-(50-140)\times0.2 = +18\) [mg/kWh]

The emissions of a low nitrogen fuel oil should thus be raised by 18 mg/kWh (15% of the limit value) before assessment against the limit value.

The calculated emission value (in mg/kg) in the present EN 267:2017 is the measured emission (in mg/kg), corrected for \(O_2\) (or \(CO_2\)) content and includes a correction based in the nitrogen content of the fuel. This correction is not in reference to a standard fuel with 140mg/kg nitrogen content but in reference to zero (0) mg/kg nitrogen in the fuel.

\[
Q_{NO_x[En267]} = Q_{NO_x} - 0.2 \times f_{N_2, fuel}
\]

where:
- \(Q_{NOx(EN267)}\) is the value of \(NO_x\) (most likely in mg/kWh NCV) corrected to the reference conditions of nitrogen of the fuel oil chosen at 0 mg/kg;
- \(Q_{NOx}\) is the determined value of \(NO_x\) according to B.3 (most likely in mg/kWh NCV);
- \(f_{N_2, fuel}\) is the value of the nitrogen content of the fuel oil measured in mg/kg.

If \(f_{N_2, fuel}\) is 140 mg/kg the correction is \(-0.2\times140 = -28\) [mg/kWh]

If \(f_{N_2, fuel}\) is 50 mg/kg the correction is \(-0.2\times50 = -10\) [mg/kWh]

According this standard the emissions of a low nitrogen fuel are reduced by 10 mg/kWh before assessment against the limit value.

It thus appears that the emission limits were established in 2013 on emission values assuming a reference nitrogen content of 140 mg/kg (as deducted from calculation in TM2014sh) whereas the present standard results in emission values assuming zero nitrogen content of the fuel, thus making it easier to meet the emission limit value.

However, it is unclear if the \(Q_{NOx}\) according to B.3 refers to clause B.3 which is a correction for the influence of combustion air temperature and humidity, or equation (B.3) which is the primary conversion from \(NOx\) measured in flue gases (ml/m3) to emission in mg/kWh (NCV). The last option is more likely.

Furthermore, the value is, for the purposes of 813/2013, converted to GCV (0.94 default factor, EN 267).
Table 50. Emissions of atomizing burners

<table>
<thead>
<tr>
<th>Emissions of atomizing burners</th>
<th>Average</th>
<th>Modern technology</th>
<th>Best available technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen oxides, mg/MJ (1)</td>
<td>29-50</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>mg/kWh (1 kWh = 3.6 MJ)</td>
<td>~100-180</td>
<td>~108</td>
<td>~61</td>
</tr>
<tr>
<td>mg/kWh, corrected for 140 mg/kg</td>
<td>~70 - 150</td>
<td>~ 80</td>
<td>~ 33</td>
</tr>
<tr>
<td>Carbon monoxide, mg/MJ (NCV)</td>
<td>7-76</td>
<td>7</td>
<td>1.4</td>
</tr>
<tr>
<td>Unburnt hydrocarbons, mg/MJ (NCV)</td>
<td>1.4</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
<tr>
<td>PM10, mg/MJ (NCV)</td>
<td>0.05 – 1.2</td>
<td>&lt; 0.3</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>Sulphur oxides, mg/MJ (NCV) (2)</td>
<td>70</td>
<td>70</td>
<td>70</td>
</tr>
</tbody>
</table>

(1) Nitrogen content of reference fuel = 140 mg/kg
(2) Depends in sulphur content of fuel, here 0.15 mass %

4.13 Electric power consumption

4.13.1 Electric power consumption / EN 15456:2008

Heating boilers - Electrical power consumption for heat generators - System boundaries – Measurements

CEN/TC 57/WG 9

(not in Round Robin test 2018-2019)

This European Standard applies to heating boilers (e.g. with forced-draught burners (unit)) and burners equipped with a fan including all components specified by the manufacturer to be required for the designed boiler operation. This European Standard also applies to heating boilers sold without burners. This European Standard covers the required definitions, the system boundaries, the measurements for the determination of the electrical power consumption and, where applicable, the water side resistance in order to establish the electric auxiliary energy for:

- Oil-fired forced-draught burners in accordance with EN 267;
- Automatic forced-draught burners for gaseous fuels in accordance with EN 676;
- Flued oil stoves with vaporizing burners in accordance with EN 1;
- Heating boilers sold without burners for:
  - Oil-fired forced-draught burners in accordance with EN 303-1 [6], EN 303-2 [7] and EN 304;
  - Condensing boilers for liquid fuels in accordance with EN 15034;
  - Room sealed boilers for fuel oil in accordance with EN 15035;

---

4.14 Sound power

The sound power of heat pump boilers is regulated in Regulation (EU) No 813/2013 and the sound power must be indicated on the label in accordance with Delegated Regulation (EU) No 811/2013.


This Standard specifies test methods for airborne noise emissions from heat generators in a test laboratory or at the place of installation. The test methods described in this European Standard, however, may be used for measuring the airborne noise emissions of the appliances and functions listed below. This European Standard applies to following appliances regardless of their heat output and the fuel used:

- wall-mounted and floor-standing heating appliances;
- forced-draught burners;
- boilers/forced-draught burner units;
- boilers with freely allocated forced-draught burners; — pellet burners.

According to this Standard the manufacturer is allowed to choose an appropriate category of testing for the measured appliance. This Standard does not apply to:

- appliances used exclusively for heating drinking-water;
- function of heating drinking-water in so-called combined water-heaters;
- heat generators which work with air as the heat transfer medium;
- electrical heating appliances;
- structure-borne noise;
- sound transmission along the flue gas path.

4.14.2 Electric heat pumps: EN 12102-1:2017

Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors - Determination of the sound power level - Part 1: Air conditioners, liquid chilling packages, heat pumps for space heating and cooling, dehumidifiers and process chillers

The former standard EN 12102:2013 is harmonised (OJ C 092 of 09/03/2018) for use with Commission Regulation (EU) n° 206/2012 with regard to Ecodesign requirements for air conditioners and comfort fans and Commission Delegated Regulation (EU) n° 626/2011 with regard to energy labelling of air conditioners.

EN 12102:2013 is now split up into a part 1 for space heating/cooling (air conditioning) titled EN 12102-1:2017 titled: "Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors - Determination of the sound power level - Part 1: Air conditioners, liquid chilling packages, heat pumps for
space heating and cooling, dehumidifiers and process chillers" and a part 2 for heat pump water heaters titled (draft) prEN 12102-2:2017 titled: "Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors - Determination of the sound power level - Part 2: Heat pump water heaters". The standard states that for ErP and labelling purposes the measurements shall be Class A (related to tolerances of measurement).

The part 1 standard gives the method to establish the sound power of heat pumps and thus refers to Regulation (EU) No 813/2013 which states in Annex III, item 4.(a): "For establishing the rated coefficient of performance COP rated or rated primary energy ratio PER rated, the sound power level or emissions of nitrogen oxides, the operating conditions shall be the standard rating conditions set out in Table 3 and the same declared capacity for heating shall be used".

The standard rating conditions in Table 3 refer to an outdoor temperature of +7ºC and an indoor heat exchanger inlet/outlet temperature of 47/55ºC for a 'standard' heat pump or 30/35ºC for a low-temperature heat pump. The capacity to be used in the measurement is not defined and probably refers to the capacity at +7ºC as required in the product information in Annex II, item 5.(a), Table 2 for the 'average' season.

The frequency range of interest is (100 – 10 000) Hz for one-third octave bands and (125 – 8 000) Hz for octave bands analysis.

The standard says that units shall be tested in standard operating conditions, which for heat pumps are defined in Table 3 of 811/2013. However, the regulation adds that the 'same declared capacity' shall be used, and for certain heat pumps (non-inverter types) this is identical to the rated capacity, for which the reference design conditions apply.

For inverter (variable speed) type heat pumps Annex A (normative) 'Specific measurement for variable speed units' describes in clause A.4 additional requirements applying to Ecodesign and Energy labelling regulations:

- that the sound power level of variable speed units for compliance with Ecodesign or Energy labelling regulations shall be determined at the rating conditions of EN 14511-2, for the corresponding temperature application. The settings of the unit shall be such that the resulting capacity is the same as the declared capacity at a bin temperature of 7 ºC for average climate according to EN 14825.
- The two capacities shall not differ by more than 5 %. If the settings are such that this is not possible, then the operating conditions and/or settings of the unit within its boundary limits shall be such that at least the capacity and the leaving water temperature requirements are fulfilled.

Most manufacturers interpret this to mean that the sound power of a variable speed unit is assessed at +7ºC outdoor and a capacity of 35% of nominal capacity. Even though this annex is intended to provide clarity, it can still be confusing for manufacturers producing heat pumps with variable speed (capacity) and variable outlet water temperature as it does not solve the ambiguity as to which water flow rate and actual inlet/outlet temperatures are to be used. Either one fixes inlet/outlet at 30/35ºC (as in EN 14511-2) but then has to give exact settings for achieving the capacity as declared for point "C" in EN 14825. Or, one uses the test for capacity (including variable outlet temperatures) in point "C" for determining the sound power as well, which renders the reference to EN 14511-2 confusing as it is not needed.
For fixed speed air-source heat pumps, the capacity of the unit at standard rating conditions (7ºC outdoor temperature) is not necessarily the declared heating capacity at part load condition C (also 7ºC outdoor temperature, but at part load) because of the variable outlet water temperature, nor the reference design condition. CETIAT has proposed several options to explore. A revision of Annex A is being discussed by CEN/TC 113/WG 9 to solve the issue.

Stakeholders have mentioned that there is a vast discrepancy between the claim of the harmonized standard EN 12102 and the practical implementation of that standard. In principle, EN 12102:2013 requires class 1 noise measurements ("precision"- or "laboratory"-class) for accordance with the conformity requirements of Regulations (EC) Nos. 811...814/2013. Among all international noise measurement standards, this is the only one, where the common "engineering"-class (class 2) standards do not suffice. The stakeholders ask the Commission to mandate CEN/TC 211 (acoustics) instead of CEN/TC 113 (heat pumps and air conditioning units) for a full revision of standard EN 12102:2013. The harmonisation of both prEN 12102:2017 Parts 1 and 2 will not change this situation.

Furthermore, certain certification bodies (that issue voluntary certificates of performance of heat pumps) have indicated they establish the sound power of products using EN 14511 conditions (+7 outdoor temperature and 'highest setting') to enable a better comparison with sound power by air-conditioners (for air-conditioners the sound power applies to Tdesign at 35ºC outdoor) and to ensure historic consistency (compare with much older tests).

As sound emitted by heat pumps is under increased scrutiny of several stakeholders (local authorities, end-users, consumer organisations, etc.) the standard for sound measurement has received increasing attention in the last couple of years. An overview of the problems in sound power measurement of heat pumps by M. Mondot (CETIAT) is posted on the project website.

In Chapter 5 a discussion is added which lays down possible routes to clarify sound power measurement and making it more meaningful to all stakeholders, included end-users (and their neighbours).

4.14.3 FprEN 12102-2:2018

Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors — Determination of the sound power level — Part 2: Heat pump water heaters

EN 12102-2 covers testing of sound pressure at a specific setting of the heat pumps, targeting noise emissions at night time. This night mode and night testing of heat pumps is defined in the standard EN 12102-2.

Manufacturers can voluntarily share this information with their customers. In Germany a website "Schallrechner" (http://www.waermepumpe.de/schallrechner/) from BWP, the German Heat Pump Association allows making calculations of sound pressure. The site helps to estimate the noise emissions of air/water heat pumps on adjacent properties or to determine the necessary distance to install the heat pump. It is useful information for installers, planners and/or builders in noise-sensitive areas.

Another online noise calculation is:
http://www.dimplex.de/en/professional/online-planner/noise-calculation.html
4.15 Heating controls

4.15.1 EN 15232-1:2017


For Modules M10-4,5,6,7,8,9,10

NEN-EN 15232-1 specifies a structured list of control, building automation and technical building management functions which contribute to the energy performance of buildings; functions have been categorized and structured according to building disciplines and so called Building automation and control (BAC); - a method to define minimum requirements or any specification regarding the control, building automation and technical building management functions contributing to energy efficiency of a building to be implemented in building of different complexities; - a factor based method to get a first estimation of the effect of these functions on typical buildings types and use profiles; - detailed methods to assess the effect of these functions on a given building. Table 1 shows the relative position of this standard within the set of EPB standards in the context of the modular structure as set out in EN ISO 52000-1.


**Discussion**

BACS, in some form or other, are present in all buildings. Very simple BACS, such as basic thermostats and light switches, have been incorporated in buildings for many decades. Within these standard functions are grouped according to their Technical Building System service domain (1-heating, 2-domestic hot water, 3-cooling, 4-ventilation and air conditioning, 5-lighting, 6-shading/blinds, 7-technical home/building management). This results in a total of 45 functions whereby any one function can have from as little as 3 control parameters up to well above 10.

The EN 15232-1:2017 provides a categorisation by function provided and also defines BACS energy performance classes that range from D (less efficient) to A (more efficient) and that are an expression of the degree of sophistication that the BACS functionality provides. An example is provided below.

Table 51. Classification of heat generation functions according EN 15232-1:2017

<table>
<thead>
<tr>
<th>Function</th>
<th>Definition of classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat generator control (combustion and district heating)</td>
<td>Non-residential</td>
</tr>
<tr>
<td>0.1 Constant temperature control</td>
<td>x x x</td>
</tr>
<tr>
<td>1. Variable temperature control depending on outdoor temperature</td>
<td>x x</td>
</tr>
<tr>
<td>2. Variable temperature control depending on the load</td>
<td>x x</td>
</tr>
<tr>
<td>Heat generator control (heat pump, outdoor unit)</td>
<td></td>
</tr>
<tr>
<td>0.1 On/off control of heat generator</td>
<td>x x x</td>
</tr>
<tr>
<td>1. Multi-stage control of heat generator capacity depending on the load or demand (e.g. on/off of several compressors)</td>
<td>x x x</td>
</tr>
<tr>
<td>2. Variable control of heat generator capacity depending on the load or demand (e.g. hot gas bypass, inverter frequency control)</td>
<td>x x x x</td>
</tr>
</tbody>
</table>

Smart grid features for smart appliances and DHW storage tanks are already covered by the ongoing Ecodesign study on smart appliances.

The BACs scoping study [https://ecodesignbacs.eu] suggested to derive a factor that expresses the difference in primary energy consumption of a building equipped with the specific BACS, relative to a building equipped with class C BACS.

This study also proposed to focus the full preparatory study on the main 24 (energy-related) functions of BACS (as opposed to the 45 functions identified in the EN 15232-1:2017).

Among the generic policy measures which could be applied to realise energy savings through BACS are (limited to Ecodesign & labelling, excluding EPBD and EED, etc.):

- product level measures, such as:
  - Ecodesign: minimum performance limits (e.g. control accuracy), minimum compatibility requirements, information requirements;
  - Labelling: product energy labelling;
- system level measures, such as:
Labelling: a system label similar to an installer label for heating systems

Ecodesign (or EPBD): minimum installed system energy performance/functionality requirements or minimum performance and compatibility requirements for products installed within TBS systems.

The scoping study states: "... energy savings potentials arise from the specification of high functionality BACS systems as per the BACS classes in EN 15232-1:2017 for the building as a whole. It has been estimated that moving from the current spectrum of BACS to universal class A BACS can save approximately 22% of total EU building energy consumption. However, this transition to class A BACS is not happening automatically and the establishment of Ecodesign information requirements on products with EN 15232 functions can make it far more transparent and simpler for buildings as a whole to move to EN 15232 BACS class A levels. In principle, products which are only compatible with the lower EN 15232 BACS class D or C levels could then either be directly prohibited via [Ecodesign] minimum functionality requirements or indirectly phased out by building codes and the influence of the energy performance certificate."

The EN 15232-1:2017 standard on BACS (Building Automation & Control Systems) covers a much wider scope than just heating controls; besides heating emission control is included cooling emission control, ventilation control, room air temperature control (for all-air systems) and monitoring, scheduling and operation. The BACS scoping study suggest investigating in a full preparatory study the establishing of Ecodesign and labelling requirements for BACS functions, related to functionality and accuracy. This could include the self-consumption of BACS as well. The scoping study mentions the need to reassess the efficiency bonuses as identified in TM2014sh for heating controls.

The present regulation applies a default reduction of seasonal efficiency of 3% points because of non-ideal heating control of a heat generator alone (correction F(1)). By combining the space/combination heater with a heating control, like a thermostat of a specific kind, the 3% reduction of efficiency can be recuperated (partly or even exceeding the original value). The heating controls and bonuses are as follows:

Table 52. Definition of temperature control classes, transitional method.

<table>
<thead>
<tr>
<th>Definition of temperature controls classes (TM2014sh)</th>
<th>in short</th>
<th>Contribution to ηs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I - On/off Room Thermostat: A room thermostat that controls the on/off operation of a heater. Performance parameters, including switching differential and room temperature control accuracy are determined by the thermostat's mechanical construction.</td>
<td>on/off room</td>
<td>1%</td>
</tr>
<tr>
<td>Class II - Weather compensator control, for use with modulating heaters: A heater flow temperature control that varies the set point of the flow temperature of water leaving the heater dependent upon prevailing outside temperature and selected weather compensation curve. Control is achieved by modulating the output of the heater.</td>
<td>modulating weather</td>
<td>2%</td>
</tr>
<tr>
<td>Class III - Weather compensator control, for use with on/off output heaters: A heater flow temperature control that varies the set point of the flow temperature of water leaving the heater dependent upon prevailing outside temperature and selected weather compensation curve. Heater flow</td>
<td>on/off weather</td>
<td>1.5%</td>
</tr>
<tr>
<td>Class</td>
<td>Description</td>
<td>Control Strategy</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>IV</td>
<td>TPI room thermostat, for use with on/off output heaters: An electronic room thermostat that controls both thermostat cycle rate and in-cycle on/off ratio of the heater proportional to room temperature. TPI control strategy reduces mean water temperature, improves room temperature control accuracy and enhances system efficiency.</td>
<td>on/off proportional room</td>
</tr>
<tr>
<td>V</td>
<td>Modulating room thermostat, for use with modulating heaters: An electronic room thermostat that varies the flow temperature of the water leaving the heater dependent upon measured room temperature deviation from room thermostat set point. Control is achieved by modulating the output of the heater.</td>
<td>Modulating room</td>
</tr>
<tr>
<td>VI</td>
<td>Weather compensator and room sensor, for use with modulating heaters: A heater flow temperature control that varies the flow temperature of water leaving the heater dependent upon prevailing outside temperature and selected weather compensation curve. A room temperature sensor monitors room temperature and adjusts the compensation curve parallel displacement to improve room comfort. Control is achieved by modulating the output of the heater.</td>
<td>modulating weather + room sensing</td>
</tr>
<tr>
<td>VII</td>
<td>Weather compensator and room sensor, for use with on/off output heaters: A heater flow temperature control that varies the flow temperature of water leaving the heater dependent upon prevailing outside temperature and selected weather compensation curve. A room temperature sensor monitors room temperature and adjusts the compensation curve parallel displacement to improve room comfort. Heater flow temperature is varied by controlling the on/off operation of the heater.</td>
<td>on/off weather + room sensing</td>
</tr>
<tr>
<td>VIII</td>
<td>Multi-sensor room temperature control, for use with modulating heaters: An electronic control, equipped with 3 or more room sensors that varies the flow temperature of the water leaving the heater dependent upon the aggregated measured room temperature deviation from room sensor set points. Control is achieved by modulating the output of the heater.</td>
<td>Modulating multi-room</td>
</tr>
</tbody>
</table>

There is currently no indication on how the current correction factors of TM2014sh compare to possible corrections as calculated/proposed under EN 15232-1:2017, although stakeholders are working on such a comparison.
4.16 Measurement uncertainties and verification tolerances

Reproducibility of measurements is an important issue in this context. LABTQ\(^{188}\) has performed multiple round-robin tests of gas appliances and gas boilers in particular. The results show that the measurement uncertainty for the useful efficiency (at full load or part load) is +/-2%. The uncertainty for the seasonal efficiency (which includes auxiliary energy consumption in various power modes) was increased to +/- 2.5%. As LABTQ applies rigorous procedures to improve reproducibility it is believed these values reflect the current "best-in-class" as regards measurement uncertainties. These values can be compared to the current "ECOTest" round robin test (see section below). The association is promoting third party certification to ensure minimum Ecodesign requirements are met and energy labelling is providing reliable information.

4.16.1 ECOTest - "Round robin" test of measurement uncertainties

On 19 July 2017 CEN issued a call for tender for the execution of supporting co-normative work to support the implementation of the requirements regarding the verification of the declared parameters for the application of labelling delegated regulations and Ecodesign regulations of space and water heaters - (EU) No 811/12/13/14 2013 under the Standardization Requests M/534 (Water heaters) and M/535 (Space heaters), for which a Specific Agreement N° CEN/534-535/2015-14 'Water and Space Heater Ecodesign' was signed between the European Commission and EFTA and CEN. This project is now referred to as "Ecotest".

The scope of the project is to provide for the technologies covered under the mandates M/534 (water heaters) and M/535 (space heaters), for the parameters regulated under these mandates, a verification of the declared parameters for the application of labelling delegated regulations and Ecodesign regulations of space and water heaters - (EU) No 811/12/13/14 2013. (See Annex II Short summary of objectives M/534 and M/535).

The mandates state 'Each harmonised standard shall include a verification procedure that can be used to verify the declared parameters in particular for market surveillance purposes.' Such procedure shall:

1) identify the sources of variability to be considered for market surveillance purposes;
2) provide values for measurement uncertainties for the purposes of the verification procedure for the measured parameters taking into account the different sources of variability to be considered when a specific product is taken from the market and measured for market surveillance purposes;
3) indicate if, in order to reduce the impact of variability to the system, specific criteria should be met by laboratories involved in the verification of the declared data (e.g. quality management system, qualification system, personnel training)'

The general objective of the project under this call is:

4) to provide for each parameter measured for the application of (EU) Regulation(s) 811, 812, 813 and 814 of 2013 and each appliance a value of the inter-laboratory

---

\(^{188}\) See also Task 2 of the study: LABTQ (www.labtq.eu) is an association of European laboratories aiming to enhance the accuracy of efficiency and emission measurements by or on behalf of its members in the field of energy using appliances, qualifying independent laboratories respecting an enhanced level of accuracy (requiring ISO 17025 accreditation) and communication of common positions to relevant third parties.
reproducibility obtained with the test procedures of the corresponding standard developed;
5) to propose improvements of the procedures from the standards;
6) to evaluate the value of inter-laboratory reproducibility with the improved procedures;
7) to propose for all parameters and appliances tested a value of a reasonable tolerance that shall be used for the market surveillance.

An interim (progress) report is expected for 30 Sep 2018 and a final report for 16 June 2019. In more detail the final report for phase 1 (S+20,5 months) shall contain following elements:

A. An assessment (with Round Robin Tests) of the inter-laboratory reproducibility, repeatability and variability required by and for parameters to be used for the application of labelling delegated regulations and Ecodesign regulations of space and water heaters - (EU) No 811/12/13/14 2013 - by evaluating the standards implementing those regulations;

B. Comments to the relevant TC’s upon the practical application of the relevant standards in view of the above application (see Annex III Standards to be revised under Specific Agreement N° CEN/534-535/2015-14 "Water and Space Heater Ecodesign") and suggestions of improvements of the procedures that are expected to lead to better reproducibility when needed. The final report for phase 1 (see 3.3) will be the guidance for taking up the improvements into the standard Steering Group;

C. Comments on tolerances to be used for the market surveillance in the light of the results obtained, a presentation of the state of the art and suggestions.

Only laboratories accredited against ISO 17025 are eligible to participate (with possible exceptions for new technologies).
The standards involved are:

**Table 53. Overview of standards that are part of the round robin ECOtest**

<table>
<thead>
<tr>
<th>Revision/Amendment of Standards</th>
<th>Secretariat TC or TC WG</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEN CR 1404 (under revision as prCEN/TR 1404 rev)</td>
<td>AFG/BNG CEN/TC 238 WG 2</td>
</tr>
<tr>
<td>prEN 15502-1:2012+A1:2015 rev a)</td>
<td>NEN CEN/TC 109 WG 1</td>
</tr>
<tr>
<td>prEN 13203-2:2015 rev</td>
<td>AFG/BNG CEN/TC 109 WG 4</td>
</tr>
<tr>
<td>prEN 13203-4 rev</td>
<td>AFG/BNG CEN/TC 109 WG 4</td>
</tr>
<tr>
<td>prEN 13203-6 rev</td>
<td>AFG/BNG CEN/TC 109 WG 4</td>
</tr>
<tr>
<td>EN 50465:2015 rev</td>
<td>DKE CEN/CLC/JWG FCGA</td>
</tr>
<tr>
<td>EN 50465:2015</td>
<td></td>
</tr>
<tr>
<td>prEN 12309-2:2015 rev</td>
<td>UNI CEN/TC 299 WG 2</td>
</tr>
<tr>
<td>prEN 12309-3:2015 rev</td>
<td>UNI CEN/TC 299 WG 2</td>
</tr>
<tr>
<td>prEN 12309-4:2015 rev</td>
<td>UNI CEN/TC 299 WG 2</td>
</tr>
<tr>
<td>prEN 12309-6:2014 rev</td>
<td>UNI CEN/TC 299 WG 2</td>
</tr>
<tr>
<td>prEN 304 rev b)</td>
<td>DIN CEN/TC 57 WG 2</td>
</tr>
<tr>
<td>prEN 15034:2006 rev</td>
<td>DIN CEN/TC 57 WG 5</td>
</tr>
<tr>
<td>prEN 14511-2:2013 rev</td>
<td>UNM CEN/TC 113 WG 8</td>
</tr>
<tr>
<td>prEN 14511-3:2013 rev</td>
<td>UNM CEN/TC 113 WG 8</td>
</tr>
<tr>
<td>prEN 12102:2013 rev</td>
<td>UNM CEN/TC 113 WG 9</td>
</tr>
<tr>
<td>prEN 14825:2013 rev</td>
<td>NBN CEN/TC 113 WG 7</td>
</tr>
<tr>
<td>prEN 16147:2011 rev</td>
<td>DIN CEN/TC 113 WG 10</td>
</tr>
<tr>
<td>prEN 13203-5:2015 rev</td>
<td>AFG/BNG CEN/TC 109 WG 4</td>
</tr>
<tr>
<td>prEN 12975 (revision of prEN 12975-1:2006 d))</td>
<td>SNV CEN/TC 312 WG 1</td>
</tr>
<tr>
<td>prEN 12976-2:2006 rev</td>
<td>NEN CEN/TC 312 WG 2</td>
</tr>
<tr>
<td>prEN 12977-2 rev</td>
<td>DIN CEN/TC 312 WG 3</td>
</tr>
<tr>
<td>prEN 12977-3:2012 rev</td>
<td>DIN CEN/TC 312 WG 3</td>
</tr>
</tbody>
</table>

a) Only minor changes for EN 26:2015 and EN 89:2015 following changes made to EN 15502-1. Therefore not taken up separately.

b) EN 15456:2008 regarded as less relevant for this project

c) EN 15316-4-3:2007 and EN 62301:2005 regarded as not relevant for this project

d) EN12975-2 is not on this list as it was withdrawn some years ago and was replaced by EN ISO 9806:2014, which will not be harmonized under M/534
5 Issues Identified

5.1 Introduction
This chapter describes issues identified in the previous chapters on regulations and standards that are considered relevant for the review of the Regulations 811/2013 (labelling) and 813/2013 (Ecodesign) for space and combination heaters. Stakeholder comments have been included where available.

5.2 Issues related to regulatory text

5.2.1 Definitions
Certain definitions in the regulations need updating and/or further clarification. Examples are:

Definition of heat generator mentions combustion of fuels, Joule effect and capture of ambient heat. It is not clear whether fuel cells are covered by 'combustion'. Solar energy is, like capture of ambient energy, also a form of renewable energy that can be harvested by space/combination (or dedicated water) heaters and should be mentioned.

Stakeholder EHI suggested revised definitions of heat generators and housing in relation to the exemption of replacement parts from requirements. To this has to be added a definition of 'identical [part]' exemption

5.2.2 Scattered information requirements
Suppliers have to declare a lot of data for their products. Scattering the requirements over two regulations and, within one regulation, up to five (5) Annexes, with sometimes very subtle differences in requested data, is making fulfilling those requirements unnecessary complicated.

As an example, various information requirements for regular water heaters under 812/2013 require to declare/provide information as prescribed in:

- Annex IV - Product fiche;
- Annex V – Technical documentation
- Annex VI – 'Distance selling'
- Annex VII - Measurements
- plus various data that depends on whether the product is/contains fuel-fired, electric, 'smart', off-peak, etc.
5.3 Product specific issues

5.3.1 NOx, CO, PM and HC emissions

According to the regulation 813/2013 Article 7, the review should include an assessment of:

(b) on the basis of the measurement methods under development, the level of the Ecodesign requirements for emissions of carbon monoxide, hydrocarbons and particulate matter that may be introduced, and;

(c) the appropriateness of setting stricter Ecodesign requirements (...) for emissions of nitrogen oxides;

For this reason, the request for standardisation M/535 (C(2015)2626 final of 27.4.2015) requires the requested harmonised standard to cover the emissions of carbon monoxide, hydrocarbons and particulate matter, and the emission of nitrogen oxides. The sections below give an outline of how present standards cover these emissions.

5.3.1.1 NOx emissions

Oxides of nitrogen (NOx) formed in combustion processes are due either to thermal fixation of atmospheric nitrogen in the combustion air ("thermal NOx"), or to the conversion of chemically bound nitrogen in the fuel ("fuel NOx"). The first is relevant for gas-fired heaters, the second is relevant for oil-fired heaters apart from the fact that the current oil-fired boiler standards recalculate measured emissions back to values representative of fuel oil without nitrogen (practice since 2011). Four factors determine the formation of thermal NOx: (1) peak temperature, (2) fuel nitrogen concentration, (3) oxygen concentration, and (4) time of exposure at peak temperature.

Gas-fired equipment

The current status of establishing NOx emissions of gas boilers is in prEN 15502-1:2019, clause 8.13 (following text based on draft 2018 version). For modulating boilers the emissions are measured at 70%, 60%, 40% and 20% of nominal (100%) heat input. The values for these 4 test conditions are weighted by 0.15, 0.25, 0.30 and 0.30 respectively to arrive at a NOx ponderation value, possibly corrected for deviations of combustion air for temperature (20ºC) and humidity (10 g H2O/kg air) and, for Ecodesign, a correction to GCV of the fuel. For range rated boilers other capacities and weighing apply.

For modulating boilers, the return temperature is prescribed and follows an equation dependent on heat input: T_return = 0.4*Qinput + 20. At 100% input this corresponds to 60ºC, and for the 70% to 20% range this is 48ºC to 28ºC, which is well into condensing territory. The supply temperature is a variable determined by the heat input at constant water flow rate and return temperature. The weighted heat input is 44% of nominal, and the weighted return temperature is 37.4%. EN 15502-1 sets no emission limits but specifies that the measured value and declared NOx class should match.

For combination boilers the NOx emission values are currently assessed using the above method which relates to space heating. The regulations are not specific in whether NOx emissions for water heating need to be declared as well.

Comparing combination heater NOx emissions (based on space heating temperature regimes) with that of dedicated gas water heaters is not appropriate. Dedicated water heaters are tested with an inlet temperature of 10ºC and an outlet temperature of 40ºC,
at 70% and 50% of nominal capacity and at minimum capacity, weighted with 0.10, 0.45 and 0.45 respectively (according EN 26 and EN 89). As the temperatures, capacities and weighing are very different, the outcomes of such tests cannot be compared.

The current status of establishing NOx emissions of Gas sorption heat pumps is in FprEN 12309-2:2014, (draft version amended 2017) clause 7.3.12 which applies a similar test procedure with similar heat inputs and weighing factors as for modulating gas boilers EN 1550201. The supply temperature however is different, here 45ºC (and variable at part loads), and the return temperature follows a slightly revised equation: \( T_{\text{return}} = 0.15 \times Q_{\text{input}} + 20 \), leading to 35ºC return temperature in nominal load.

For the range 70% to 20% the return temperatures vary from 31ºC to 20ºC reflecting the anticipated low temperature heating systems the gas heat pumps are presumed to be used typically. The supply temperature at part loads is determined by the required heat input, a constant water flow rate and the prescribed return temperature. The tests are run at thermal equilibrium.

Constant water flow rates at lower capacities (heat inputs) result in smaller return/supply temperature differences.

Establishing NOx emissions of Endothermic heat pumps, e.g. gas or oil-fired engine heat pumps, is described in prEN 16905-2:2018, clause 7.11.3. Although the same partial heat inputs and weighting as for (modulating) gas boilers and sorption heat pumps is defined, these are only used to establish an equivalent engine rpm. At this equivalent engine rpm a supply temperature of 55ºC is required and a return temperature of 47ºC. Engine heat recovery is defined for an inlet/outlet temperature of 60/65ºC.

The outdoor conditions are the 'standard rating conditions' (10/7ºC for inlet/outlet water HPs, 0/-3ºC for inlet/outlet of brine HPs, 7/6 for dry/wet bulb outdoor air HPs and 20/12 dry/wet bulb for exhaust air HPs). If desired other temperature regimes can be tested as well (return supply at 30/35ºC for low temperature applications).

EN 16905-2 specifies that the product shall not exceed 240 mg/kWh fuel input (GCV), in line with the regulations.

The current status of establishing NOx emissions of Gas cogeneration products is in EN 50465:2018, with NOx covered by Clause 7.8. The part loads and supply/return temperatures applied depend on the CHP set-up and whether it comprises a supplementary heater. Three Methods are defined:

<table>
<thead>
<tr>
<th>Method</th>
<th>Part load (% of nominal heat input)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Method A: product follows heat demand instantaneously</td>
<td>0.082</td>
</tr>
<tr>
<td>Method B: if heat storage and multiple heat generators</td>
<td>0.15</td>
</tr>
<tr>
<td>Method C: for heat storage and single heat generator</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Method A is applied if the product comprises a supplementary heater, the tests are performed for the combination, where 100 % CHP + 100 % Sup is the nominal heat output and part loads are % of nominal. If the unit is follows heat demand instantaneously there are many part loads defined, which allow a better measurement of
emissions for the transient between CHP and CHP+sup operation. The return temperatures for the NOx test at part loads follows a heating curve according \( T_r = 0.2 \times Q + 20 \), in °C, where in nominal load the supply/return temperature is 60/40 °C for condensing appliances and 80/60 °C for non-condensing. The supply temperature follows from applying a fixed water flow rate and the reduced heat input. Which part loads and weighing are applied is determined by the type of product and control method, as per below.

Method B is applied for the supplementary boiler only and is combined with CHP emissions according Method A and requires weighing with utilisation factor \( F_{chp} \) to arrive at a cascade or package emission.

Method C is applied if the CHP is the primary heater in a cascade (no supplementary heater incorporated) the tests are performed for 'CHP only' (100 % CHP + 0 % Sup) and prescribe a return temperature for condensing products at 30 °C and for non-condensing at 47 °C, with a flow rate as in nominal conditions, or according instructions if equipped with a variable speed pump, or adjusted to a delta T of 6 K. All measurements are at thermal equilibrium.

Measured NOx emissions of a 15 kW_elec gas engine cogeneration unit range are in the range of 190-230 mg/kWh (GCV) for full load (100% power output) to 150-170 mg/kWh (GCV) at part load (50% power output).

Based on EN 267:2009+A1:2011 for oil-fired boilers NOx tests are performed with fuels with low nitrogen content and the calculated emissions are corrected for the nitrogen content of the fuel. There is a revised version of the EN 267 on the way to be published (pending approval by HAS consultants on the Machinery Directive and the Pressure Equipment Directive). The new standard will include the correction of the nitrogen content as in the A1 from 2011 and it is this standard the transitional method should refer to. It would be good if the regulations state how to deal with nitrogen in the fuel and which procedure is the right one. The fuel is specified having a viscosity at the burner inlet of 1,6 mm²/s (cSt) up to 6 mm²/s (cSt) at 20 °C.

In EN 267:2017 NOx (for single stage burners) is to be measured (and the arithmetic average calculated) for 5 to 6 test points: Hp1, Hp2, Hp3, Hp6, point 4 and point 5 (as in Fig 3 of clause 4.7.3 referred to in clause 4.8.5.2). For single stage burners this means 10 test points and for modulating burners 12 test points: each of the above, for both min and max modulation. The supply/return temperatures are 80/60°C.

Only one emission value of a bio-oil-fired cogeneration product has been found. The NOx emissions of RME (rapeseed oil methyl ester), based on product brochures emissions, are 3211 mg/kWh (not known if GCV or NCV). The actual test conditions are not known. This is for a product which is not marketed by that company anymore.

5.3.1.2 Carbon monoxide

Carbon monoxide (CO) is a poisonous gas that can be created during combustion of fuels in conditions with insufficient oxygen supply. The technical committees working on that mandate have discussed the meaning of the request as the current (gas) boiler standard EN 15502-1 already has a maximum emission limit for carbon monoxide.

Gas boilers: The purpose of the minimum emission limits specified in Clause 8.12 of prEN 15502-1:2019 (dated 2019-05-08) is to ensure that under certain out-of-ordinary-
circumstances the boiler does not exceed a CO concentration (expressed for dry, air-free) of 0.10% (1000 ppm, for limit conditions\textsuperscript{189}) and 0.20% (2000 ppm, under special conditions\textsuperscript{189}) when the boiler reaches thermal equilibrium.

**Gas sorption heat pumps, Gas endothermic heat pumps** and **gas cogeneration products** are assessed using EN 12309-2, EN 16905-2 and EN 50465 respectively which all have defined limit concentrations for CO under 'limit' and 'special' test gas conditions of max. 1000 ppm (1233 mg/Nm\textsuperscript{3}) in 'limit' conditions and max. 2000 ppm (2467 mg/Nm\textsuperscript{3}) in 'special' conditions.

Measured carbon monoxide emissions of gas cogeneration (gas engine) is typically between 60-70 ppm at (full load) down to 20-40 ppm (50% part load).

**Oil boilers:** Based on EN 267:2009+A1:2011 for **oil fired boilers** CO tests are done at similar loads as for the NOx test (Hp1-3, 4 and 5). Although it is not explicitly stated the supply/return temperatures are presumably the same 80/60ºC. Clause 4.8.5 states that oil boilers should not emit more than 110 mg/kWh (presumably NCV). The best class is \(< 60 \text{ mg/kWh.}

**Discussion**
The emission limit values as introduced by various countries should, according to the WG1 dealing with this issue, be interpreted as values that -if met- confirm that the boiler operates as intended, and –if exceeded– are an indication that the boiler may not be operating as intended and requires a check / maintenance / servicing / etc. Therefore, in November 2018 the WG1 concluded that the request dealt with emissions during normal operation and not in out-of-ordinary operating conditions. The follow-up however is not (yet) documented: The latest draft standard prEN 15502-1 does not contain a CO measurement during 'normal' conditions.

The core question however is whether CO formation is an environmental problem or a safety issue. The current view, of legislators, manufacturers and installers is that it is a safety aspect, to be dealt with within the context of the Gas Appliance Directive (now: Regulation). This is also a conclusion that can be drawn from a report published by the Dutch Safety Board\textsuperscript{191} detailing the circumstances of several accidents involving deaths or near-deaths from carbon monoxide poisoning. The report concludes that more attention needs to be given to gas installations in order to become more "failsafe" and "foolproof".

When limiting ourselves to gas heaters only, the report describes *failsafe* as heaters that recognise faulty combustion conditions and respond adequately, for instance by entering a failure-mode when sensing out-of-range CO emission levels. The report also mentions that manufacturers do not always use possible failsafe mechanisms (1) as this drives prices upwards, and (2) could lead to more disruption of service.

Gas heaters also need to become more *Foolproof* to avoid e.g. setting of incorrect gas-air ratios which could lead to or increase CO formation. Apparently one-in-five installers

\textsuperscript{189} At maximum test pressure and/or higher than nominal heat input, assessed at 80/60ºC and – if condensing – 50/30ºC

\textsuperscript{189} At nominal or higher heat input, using the 'incomplete combustion limit gas', a special test gas

\textsuperscript{191} Koolmonoxide – Onderschat en onbegrepen gevaar, Onderzoeksraad voor de veiligheid, Den Haag, November 2015
change the gas-air settings but are currently not warned when these settings results on excessive CO formation.

The report recommends the responsible authorities to consider the risks related to failsafe and foolproof operation. The procedure would be that the national standards organisation introduces these elements when revising the relevant safety standards for gas products.

5.3.1.3 Particulate matter
Particulate matter (PM) refers to solid particles and liquid droplets suspended in air, in this context created by combustion of fuels. Particles that are detectable with the naked eye are also called dust, dirt, soot, or smoke. Smaller particles however are invisible to the naked eye. Particulate matter can be classified as:

PM10: diameter 10 micrometres and smaller;
PM2.5: diameter 2.5 micrometres and smaller.

Gas boilers can emit particles but not as many as for oil boilers. NOx however, also emitted by gas boilers is considered a pre-cursor for tropospheric ozone (O3) and fine particulate matter (PM2.5).

Gas boilers are tested in accordance with EN 15502-1, in which Clause 8.12.4 requires that soot deposition shall not occur, although yellow tipping (of the flame) is acceptable. The test conditions are the same 'special' conditions as for CO measurement.

Gas sorption heat pumps are assessed using EN 12309-2 which specifies that the products "shall not show soot deposition", during a test with a duration of 1 hr at nominal heat input using 'limit' and 'special' conditions, similar to gas boilers assessed using EN 15502-1.

There are no requirements regarding emissions of particulate matter, nor sooting, defined in EN 16905-2 for Gas endothermic heat pumps.

Cogeneration products are tested using a 'sooting' gas and after 1 hr of operation (presumably nominal load) no sooting shall be observed, although 'yellow tipping' is acceptable (EN 50465).

Oil boilers
It is generally recognized that the exhaust aerosol concentration measured depends on both the sampling technique and the instrument used. The smoke number is a test for soot formation (soot being a mass of impure carbon particles resulting from the incomplete combustion of hydrocarbons). The Filter Smoke Number (FSN) 0 is assigned to clean filter paper and the "completely" black paper is assigned the value FSN 10. Unfortunately, there is no easy conversion between smoke number values and PM emissions (as PM is more than smoke particles).

In accordance with EN 267:2017, clause 4.8.3, oil boilers shall not exceed the smoke number 1 for single stage burners at all heat inputs and for multi-stage and modulating burners, except at minimum fuel rate where the smoke number shall be < 2.

The regulation in Germany - 1. BImSchV up to 20 MW – also refers to EN 267 and the smoke number has to be less than or equal 1 at full load. At the test conditions in the standard at min load the smoke number requirement is less or equal 2.
A study of the University of Stuttgart about PMs\textsuperscript{192} shows that the particle emissions of large boilers are reducing following cleaner liquid fuels and combustion and the move to gaseous fuels. For PM, VOC and CO the measured values were often that small they were within the measurement accuracy (< 1 mg/kWh). The study writers concluded that further strengthening of measures is not necessary.

5.3.1.4 Hydrocarbon emissions

Gas space/combination heaters

None of the gas heater standards (gas boilers: EN 15502-1, gas sorption heat pumps: EN 12309-2, gas endothermic heat pumps: EN 16905-2 and gas cogeneration products: EN 50465) contains a clause covering specifically hydrocarbon emissions.

There are requirements that aim to ensure that emissions of hydrocarbons other than in the combustion circuit during operation will not occur as these pose an immediate safety risk. This aspect is covered in clause related to soundness of the (gas) circuits and connections. The standards do not prescribe limit values, but technical means to achieve the objective which is appliance safety.

Obviously, the emission of hydrocarbons (unburnt fuel) has an impact on efficiency measured. It is possible that during cycling (start-up, operation, turn off) some unburnt gas escapes. But as the current (boiler) standard establishes the efficiency during at 30% modulation (part load) and 100% modulation (full load) most, if not all boilers, can operate in steady state conditions and cycling (and hydrocarbon emissions during transient operation) is not included.

Stakeholders have pointed out that in particular gas engine products (as in endothermic heat pumps or cogeneration devices) may emit significant levels of unburned hydrocarbons, which due to their high GWP- can increase the overall GWP emissions per unit of heat provided. However, due to the lack of measurement methods and a requirement to provide such information, no hydrocarbon emissions levels have been identified in product brochures, websites and literature. The information that is available in LCA literature is difficult to interpret as it does not specify the test conditions and other relevant parameters. Manufacturers of such devices have been asked to provide more data.

Oil boilers

For oil boilers, in accordance with EN 267:2017 Clause 4.8.4, the proportion of unburned hydrocarbons in the combustion gas shall not exceed 10 ml/m3 except during the first 20 s after release of the fuel (for a fuel having a viscosity at the burner inlet of 1,6 mm2/s (cSt) up to 6 mm2/s (cSt) at 20 °C).

Unburned hydrocarbons are formed in the phase the flame is created and there is currently no desire of experts to change the method.

\textsuperscript{192} Dr.-Ing. Michael Struschka et al; Untersuchungen der Feinstaubemissionen von Heizkesseln für Heizöl EL, Erdgas und Holzpellets bei Volllast und beim Betrieb mit Wärmebedarfsprofilen; Institut für Verfahrenstechnik und Dampfkesselwesen, Universität Stuttgart, commissioned by Instituts für wirtschaftliche Oelheizung e. V. (IWO); 7 August 2009.
Recommendation
The proposal in Task 6, to test at more part load conditions, especially lower part loads because of correction of DHW oversizing, cycling emissions may be included in efficiency at such part loads. The recommendation to the Commission is to discuss this aspect in dedicated technical committees to be set-up after finalisation of this report.

5.3.1.5 Overview
The following table presents an overview of emissions by various gas space/combination heaters.

Table 54. Overview of emissions

<table>
<thead>
<tr>
<th>Heater</th>
<th>NOx</th>
<th>CO</th>
<th>PM / soot</th>
<th>HC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Load</td>
<td>Load</td>
<td>Seasonal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ppm</td>
<td>mg/kWh</td>
<td>ppm/mg/kWh GCV</td>
<td></td>
</tr>
<tr>
<td>15-35 kWh</td>
<td>min: 10-16 mg/kWh: 22-42</td>
<td>min: 4-11</td>
<td>min: 5-11</td>
<td></td>
</tr>
<tr>
<td>modulation ratio 3.6-5.0</td>
<td></td>
<td></td>
<td></td>
<td>[n.a.] [n.a.]</td>
</tr>
<tr>
<td>80/60 regime</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas engine 15 kW (cogeneration)</td>
<td>full: 73 ppm: 64</td>
<td>full: 204 full: 64 min: 30</td>
<td>[n.a.]</td>
<td></td>
</tr>
<tr>
<td>min is 50% power output</td>
<td>min: 62</td>
<td>NCV min: 159</td>
<td>min: 30</td>
<td></td>
</tr>
<tr>
<td>Gas sorption heat pump</td>
<td>25 (25 ppm: 64</td>
<td>32 (14 36</td>
<td>[n.a.]</td>
<td></td>
</tr>
<tr>
<td>kWth)</td>
<td>kWth)</td>
<td>ppm: 64</td>
<td>kWth)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>32 (14</td>
<td>[n.a.]</td>
<td></td>
<td>[n.a.]</td>
</tr>
<tr>
<td></td>
<td>kWth)</td>
<td>[n.a.]</td>
<td></td>
<td>[n.a.]</td>
</tr>
</tbody>
</table>

The lack of actual emissions values shows there is a need for more information on performance and emission of space (and water) heaters using (liquid) fuels predominantly produced from biomass.

5.3.2 Liquid fuel-fired boilers
Multiple Member States have begun taking steps to phase-out liquid-fuel fired boilers by banning their use in new builds and actively promoting alternative technologies.

5.3.3 Gas-fired boilers
NOx emissions
Regulation 813/2013 presents one single NOx limit value for boilers using gaseous fuels, but NOx emissions vary according the type of test gas used (second family G20, G25 or third family G30, G31). In Task 6 it is suggested to have emission limits per gas family.

Water heating performance of combination-boilers
The standard EN 13203-2 applies weighting factors related to summer and winter operation, whereas this is not in accordance with point 4 of the TM2014wh, which reads: "In case of combination water heaters, no weighing factors taking into account differences between summer and winter mode shall be considered for the measurement/calculation of Q_{elec} and Q_{fuel}".
The issue of weighing summer and winter mode efficiencies also appears in standards for other combination heaters based upon EN 13203-2.

**C4 and C8 boilers in shared chimneys**

In Regulation 813/2013 the minimum efficiency of B1 type boilers was lowered to allow this non-condensing boiler design on the market for replacement of individually owned boilers connected to a shared chimney.

As it happens a similar situation exists for individually owned boilers in a shared combustion air/flue gas exhaust system (LAS = Luft Abgas System). These boilers are of the type C4 and C8 and are in use in many European apartment buildings. If a single boiler connected to such a LAS fails, there are no longer 'one-on-one' replacement boilers available: Available are condensing boilers (which are not suited for the LAS) or B1 type boilers (which are less safe to operate).

Proven alternatives are:

- renovation of chimney and replacement of all non-condensing boilers by condensing ones: This is costly and requires consent of individual home-owners with functional boilers.

Alternatives that are not yet 'proven' but may be worthwhile investigating:

- install a condensing boiler with an individual (small diameter) flue exhaust in the existing LAS. Combustion air can be supplied from the facade.
- check with the manufacturer of the existing and replacement boiler whether the products can run at negative pressure in the chimney. If this is allowed, line the existing flue pipe with a condensate-proof liner (add condensate removal facility at bottom), fit the flue pipe with a flue gas extraction fan at the top (to ensure sufficient negative pressure), install a condensing boiler as replacement, connected to existing air supply/lined flue gas exhaust. Eventually the boiler can be set to run at elevated supply/return temperatures (although this is certainly not ideal and can cause frequent on/off cycling of emitter capacity is limited or heat demand is low)

**5.3.4 Hybrid boilers (fuel-electric)**

Although the first EN standard for hybrids dates back to 2014, covering the combination of a gas fired absorption heat pump with a gas condensing boiler, the more recent draft EN 14825 of 2017 has attracted more attention as this one combines an electric heat pump with a fuel boiler.

The draft EN 14825 describes two methods: The first method is based on a separate assessment/test of the heat pump and the boiler. It has a limited number of test points, but is otherwise quite simplistic in its approach. The second method treats the hybrid as a black-box, and just registers the ingoing energy and the outgoing heat and constructs a COP from that. The resulting SCOPon is more accurate.

Nonetheless, CEN/TC109/WG1 responsible for boiler standard EN 15502-1 developed (currently in a joint working group with CEN/TC113/WG7) a new approach, based on three zones of operation: The first zone is the pure electric heat pump mode, the second zone is where the heat pump and boiler work in tandem, and the third zone is where the heat pump has passed its operating limit and the boiler operates alone. These zones are defined by boiler on/off and heat pump on/off threshold temperatures. The method uses
these three zones to define representative test points. Combined with the required part load capacity, (variable) flow temperatures and delta T the seasonal efficiency can be based on some 5 test points, 2 of which will require use of a climate chamber.

The method is currently being tested, also as part of the ECOtest project, and the results will be available in 2019. A comparison of the TM2014sh calculation and the three test methods described is however not yet available.

5.3.5 Heat pumps

Standard rating conditions

The regulations 813/2013 and 811/2013 define the standard rating conditions for heat pumps. The current market situation calls for a revision of several of these standard rating conditions:

- Regulation 812/2013 (labelling of water heaters) has a category "indoor air 20(15)ºC which is not used (overlaps with exhaust air?). Stakeholders suggest rephrasing the category as "Non-heated space" (e.g. garage) with 15(12)ºC standard rating conditions. This change could apply to space heating as well;
- exhaust air heat pumps:
  - the standard rating condition for exhaust air HPs is dry/wet bulb temperature of 20(12)ºC (rh 38%). Stakeholders suggest 20(15)ºC (rh 59%). This condition could apply to space heating as well;
  - standard EN 16573 describes standard rating conditions for multiple variants of ventilation heat pumps, combining other air sources and multiple functions (space and water heating). There is yet no method to assess a seasonal performance of more complex products;
- brine heat pumps: Studies show that brine temperatures vary across European climates. Stakeholders suggest the following climate-dependent temperatures (instead of the current single value):
  - cold: 0/-3ºC;
  - average: 5/2ºC;
  - warm: 10/7ºC;
- Alternative heat sources: Heat pumps connected to (ultra-) low district heating systems or the return-loop of underfloor heating operate at different conditions than the current standard rating conditions. DX-systems (direct exchange, with refrigerant-filled soil collectors) also exist (although increasingly rare). Stakeholders suggest the addition of the following conditions in the legal documents:
  - 40/30ºC for low temperature district heating applications;
  - 25/22ºC for applications linked to the return circuit of hydronic (underfloor) heating systems;

For brine HPs, the difference between return and supply is fixed at 3ºC, but in reality this value is not fixed when producing DHW: during start-up the temperature difference may be higher and during end of charging the difference may be lower than 3K as less heat can be transferred to the water as the storage temperature rises.

Lowering district heating supply/return temperatures lowers the considerable losses of DH: In Copenhagen these losses can be 20% of the energy input. Tap water still needs to be supplied at minimal 55ºC and 'booster' heat pumps can be applied. https://hpc2017.org/wp-content/uploads/2017/06/07-Brian-Elemgaard.pdf
- DX bath temperature 4ºC;
- Heat pumps and solar energy: Heat pumps are placed on the market of which the evaporator makes use of solar energy (among others). These can be 'thermodynamic panels' (refrigerant is evaporated inside the panel), more conventional solar thermal collectors (to heat a brine solution, possibly combined with storage) and 'PVT panels', which combines solar thermal with photovoltaics and allows (in favourable circumstances) the heat pump to run on solar power. There is yet no standard to properly assess the performance of products using such technology.

**GHG limits for refrigerants**

The F-gas regulation limits the GHG emissions of all relevant refrigerants placed on the market in the EU, including those used in heat pumps, and provides for a market mechanism reducing the mass of refrigerants used. The Commission has concluded that the measure is effective.

Manufacturers state that further tightening of these measures, specifically for space/combination heat pumps, is not appropriate and could even negatively affect other performances, most notably noise (if less refrigerant may be used, then the air flow needs to increase resulting in more noise).

**Which capacity to use for \( P_{\text{rated}} \), \( \text{COP}_{\text{rated}} \), noise and \( \text{NO}_x \)**

Experts in CEN/TC 299 pointed out the possible confusion arising from establishing the rated heat output \( P_{\text{rated}} \) in **reference design conditions** (\(-10^\circ\text{C} \) outdoor, or 100% part load=full load) whereas the \( \text{COP}_{\text{rated}} / \text{PER}_{\text{rated}} \), noise and \( \text{NO}_x \) (for fuel fired HPs) are established in **standard rating conditions** (\(+7^\circ\text{C} \) outdoor, or 35% part load).

Besides the possible confusion (does 'rated' refer to a test at \(-10^\circ\text{C} \) or \(+7^\circ\text{C} \)?) the effect of testing noise at 35% part load does not provide the information on the noise emission that will likely cause the most problems in dense neighbourhoods (when the heat pumps runs at its highest capacity, probably at night).

**Peak temperature of tapping**

The regulations 813/2013 and 811/2013 require a peak temperature of tappings (in the S and larger load profiles) of 55ºC. According the FAQ2018 this must be understood as a minimum temperature.

In the DHW heat pump standard EN 16147:2017 this minimum temperature does not have to be reached during the tapping\(^{195}\). Although the difference in temperature of that specific tapping is corrected in the calculation, the 24-hour test can be conducted with a lower storage temperature (thus lower standing losses) than for products that apply a 65ºC storage temperature\(^{196}\).

---

\(^{195}\) This was allowed under the 2015 Guidelines.

\(^{196}\) The regulation 813/2013 and 811/2013 do not prescribe a minimum temperature of DHW storage tanks. Only in the TM2014wh, in the description of the assessment of the V40 value, a storage temperature of 65ºC is mentioned. In practice most standards for products containing DHW storage tanks prescribe a setpoint of 65ºC: Storage tank standards EN 12897 and EN 15332 both use 65ºC as setpoint, as does FprEN 13203-2:2018 (combi-boilers) and EN 89:2015 (for gas storage water heaters). EN 50440:2015 for electric storage water heaters refers to "out-of-the-box" settings (no minimum specified) but its international counterpart IEC 60379 (2018 draft) specifies a minimum 65º storage temperature.
**DHW heat pumps sold without storage**

As it happens heat pump heat generators are placed on the market without a storage tank. Currently there is no way to calculate the performance of such heat pump heat generators as they are not 'water heaters' (generally cannot be tested using a DHW load profile out of the box). These can be either:

1. heat pump heat generators that are intended to be combined with storage tanks before they are put into practice (these can be existing tanks, or tanks purchased from a different supplier);
2. or heat pump heat generators that are generally quite powerful and able to produce high temperature heat (e.g. CO₂ type heat pumps) and can be installed in systems with a large heat capacity without storage tanks (hotels, sports/wellness centres).

In the first situation the HP heat generator can be assessed using an equation similar to "Packages of heat pump and solar device" as published in the 2018 Guidelines under "Packages where not all information is available". Care should be taken that the calculation method does not result in unfair benefits compared to actual measurement of water heating performance of an integrated product.

In the second situation the heat pump heat generators often also meet the definition of space heating heat pumps and certain manufacturers choose to rate them as such, even if the rating is not appropriate for the intended use as water heater. Stakeholders suggest adding new standard rating conditions for heat generators sold without storage tanks, these being: A7 or B0 / W45-60 (return-supply) for both COP and Prated.

**Sorption heat pumps**

Sorption heat pumps are covered by EN 12309 series of standards and are so far without specific issues.

**Sound power measurement**

Sound power by heat pumps when providing space heating is caused mainly by the air flow (air-source units). Sound emitted by the compressor plays a role as well, but less than the fan. Certain other components may produce sounds during transient operation (valves that open or close, reversing a cycle, etc.) that can be considered annoying, but these sounds do not last long.

Several stakeholders have indicated that the current practice of measuring sound power of variable speed units at 35% capacity (part load at +7°C) is not representative of the sound power in situations where sound emitted is at its highest (this is when the capacity increases, at cold days, during the night).

Measurement of sound power at -10°C (or TOL), for average climate, would result in the heat pump running at maximum capacity, but this puts restraints on the test (sound power measurement in climatic chamber under freezing conditions). From a laboratory perspective, performing sound power level test at negative temperatures is not always possible. Also, when using the 'intensity technique', the operator is inside the climatic room during measurements, for a longer period (when compared to reverberant room measurement).

In principle the maximum compressor speed and fan speed (thus highest sound emitted) can be achieved at any outdoor condition. However, it may be that the settings or
controls of the heat pump prohibit the compressor/fan to run at their highest capacity at elevated temperatures. This is why reverting back to EN 14511-2 and -3 conditions is not a safe choice as the heat pump may not be operating at "full load" or highest capacity (highest fan and compressor speed) in these standard rating conditions. Test labs can find ways to sidestep such issues (e.g. by manipulating the outdoor sensor) or measuring the fan speed (or air flow rate) at design conditions (or TOL) and program the product to reproduce these speeds/flow rates at elevated temperatures, but this is not always possible. Using the same fan speed in each test is crucial for repeatability and reproducibility.

Furthermore, a solution needs to be found to deal with other 'settings' of a product (settings could relate to control algorithms that aim for higher energy efficiency, lower operational costs, lower noise, or higher comfort – such settings could result in differences in fan speed and compressor speed even in identical indoor/outdoor conditions).

A proposal to bring the sound power level measured closer to the maximum is:

- to ask the manufacturer to declare the compressor and fan speed, reached by the unit at Tbib (assumed to be maximum speed); and
- to perform the test at +7 °C, using the declared compressor and fan speed settings at Tbib, with the outlet water temperature equal to the outlet water temperature at Tbib as set out in EN14825.

In case the unit is not allowed to operate at 7 °C with maximum compressor and/or fan speed the manufacturer shall indicate the outlet water temperature to be set instead of the outlet water temperature of Tbib to perform the acoustic test. The test method should describe how to deal with fixed speed or staged capacity units as well. The setting of fan and compressor speeds however may introduce elements that are undesirable from circumvention perspective if this requires manufacturer intervention.

By applying this proposed methodology, even if the achieved capacity does not meet exactly the capacity declared at Tbib, the measured sound power level will be very close to that emitted by the heat pump at Tbib due to the compressor and fan speed settings.

Changing the test method for sound power also means that the thresholds need to be revised as it is unlikely that many heat pumps will be below the thresholds if the sound power level is measured at the maximum compressor and fan speed. That data is obviously not available at the moment.

If the threshold for sound power is revised this should take into account possible effects on energy efficiency and use of refrigerants as well.

Combination heat pumps will likely not emit more sound when producing DHW than producing space heat at max. fan/compressor speeds. This leaves sound power emitted by dedicated DHW heat pumps. These are assessed at +7°C when establishing water heating efficiency. It is expected that the sound emitted is less sensitive to ambient conditions as DHW heat pumps may run at maximum capacity (fan speed, compressor speed) also at +7°C. The duration may be different (more quickly heated up at +7°C than at -10°C).
**Tonality**

As Member States have started (or are starting) to regulate the sound pressure emitted by heat pumps, they may take into account the tonality of the sound. For example, The Netherlands intend to apply an extra 5 dB correction if tonality applies (with fixed threshold sound pressure). In order to calculate the presence of tonality it is required to know the sound power by third-octave bands, from 40 Hz (for the lowest octave) up to 10.000 Hz. EN 12102-1 already prescribes measurement of third-octave bands, except for the 40Hz band. If the product information requirements include this information, calculation of tonality is easier implemented.

**Maximum air flow rate for exhaust air heat pumps**

Regulations 811/2013, 812/2013, 813/2013 and 814/2013 prescribe the same maximum ventilation exhaust air available for ventilation air heat pumps when tested for a certain load profile.

A first observation, by ECOS-EEB, is that with an average air change rate of 0.5 times the volume of the dwelling per hour (in accordance with analysis by REHVA in 2012, see figure below), the M load profile aligns with a dwelling of approximately 130 m² up to 160 m² (the latter assuming the ventilation unit provides 80% of air change).

---

**Figure 29. Air change rates in Europe**

Assuming an average dwelling size of 90 m² the flow rate specified for the M profile (considered to be representative for 'average' dwellings) is at least 30% higher than the

---

197 Presence of tonality means that certain frequencies are more present than others. Tonal noise is generally more noticeable and more annoying than non-tonal noise of the same level. To take this into account, tonal noise can be penalised in assessments of noise impact, usually by adding 5 dB to the measured level (https://www.cirrusresearch.co.uk/blog/2012/03/tonal-noise-analysis-with-the-optimus-green-sound-level-meters/).

198 Nejc Brelih; Ventilation rates and IAQ in national regulations; presented at the AIVC conference Oct 12-13, 2011, Brussels, Belgium; REHVA Vol.49, issue 1, January 2012

199 ECOS-EEB mentions 96m², referring to Eurostat, but the EU Buildings database mentions 90m² (for 2014) [https://ec.europa.eu/energy/en/eu-buildings-database]
'average' air change rate. By linking the heat demand of all load profiles to floor areas, an estimation of air change rate and exhaust air available can be made.

In the review study for the ventilation products a reference net ventilation requirement per heated floor area of 1.3 m³/(h*m²) is mentioned, but to achieve a minimum indoor air quality the ventilation requirement in practice is higher.

Assuming a central exhaust ventilation system using demand control ventilation for VST 3 (acc. to EVIA Ventilation Performance Assessment Model) the approximate amount of air needed in m³/h varies with total floor area as shown below.

![Ventilation rate graph](image)

**Figure 30. Ventilation rate for minimum IAQ by total floor area**

Applying this relation to the total floor area linked to load profiles (based on 90 m² for 'M', extrapolated on basis of Qref) leads to the conclusion that about half of the ventilation rates are almost or more than twice as high as required for minimum indoor air quality, using central exhaust ventilation and simple controls.

---

200 https://www.ecoventilation-review.eu/documents.htm#a20190628
Table 55. Maximum exhaust air available

<table>
<thead>
<tr>
<th>DHW load profile</th>
<th>3XS</th>
<th>XXS</th>
<th>XS</th>
<th>S</th>
<th>M</th>
<th>L</th>
<th>XL</th>
<th>XXL</th>
<th>3XL</th>
<th>4XL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation / max.</td>
<td>0</td>
<td>128</td>
<td>159</td>
<td>190</td>
<td>870</td>
<td>1021</td>
<td>2943</td>
<td>8830</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ventilation exhaust</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>air available</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qref</td>
<td>0.345</td>
<td>2.1</td>
<td>2.1</td>
<td>5.845</td>
<td>11.655</td>
<td>19.07</td>
<td>24.53</td>
<td>46.76</td>
<td>93.52</td>
<td></td>
</tr>
<tr>
<td>Building total floor</td>
<td>5</td>
<td>32</td>
<td>32</td>
<td>90</td>
<td>179</td>
<td>294</td>
<td>378</td>
<td>720</td>
<td>1440</td>
<td></td>
</tr>
<tr>
<td>area (M set at 90 m²,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rest extrapolated)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculated ventilation</td>
<td>40</td>
<td>53</td>
<td>53</td>
<td>94</td>
<td>193</td>
<td>383</td>
<td>568</td>
<td>1714</td>
<td>6189</td>
<td></td>
</tr>
<tr>
<td>requirement for min. IAQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference to air</td>
<td>0%</td>
<td>206%</td>
<td>242%</td>
<td>169%</td>
<td>98%</td>
<td>227%</td>
<td>180%</td>
<td>172%</td>
<td>143%</td>
<td></td>
</tr>
<tr>
<td>available acc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>regulations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 31. Comparing Regulation air flow rate and air flow rate for min. IAQ

Of course, this is a simple approximation and in reality the link between a Qref in a load profile and a dwelling size will vary per dwelling or building. Also, ventilation air heat pumps may typically operate at flow rates lower than maximum allowed, putting these closer to what is required for good IAQ. And if a different pivotal floor area is chosen for ‘M’, the relative differences will reduce as well (if choosing > 100 m² for instance). Nonetheless, the above calls into question the apparent differences in maximum air available even if the Qref is identical (load profile XXS to S) and the incomprehensible relation between Qref and maximum ventilation rate.

In addition, many households do not even achieve the ventilation air flow rates recommended for good IAQ. This is reportedly one of the reasons the ventilation air heat pumps installed recently by a Dutch energy company did not save as much as anticipated: they were set up to ventilate according the Dutch Building Codes which was...
at higher rates than people were accustomed to\textsuperscript{201}. The result was that the heat demand grew (compared to a situation w/o ventilation heat pump) and savings were reduced.

A second observation is that there are no maximum ventilation rates for ventilation heat pumps for space heating. Neither in regulations, nor in test standards. Ventilation rates are indirectly restricted by the maximum indoor/outdoor sound power levels (for ventilation heat pumps, 'indoor' counts) but a rather quiet heat pump can still require more ventilation air than is advisable, effectively cooling down the building (as outdoor air is drawn in).

If it is agreed that the volume flow rate of ventilation air for space heating should be maximised, a possible way forward could be based on the Pdesign declared and an assumed net heat demand of the dwelling/building (kWhth/m\textsuperscript{2}).

For example: A 3.6 kW heat pump (Pdesign, at 45/55 \textdegree{}C) and 2066 equivalent full load hrs/yr gives 7438 kWh/yr annual heat demand, and when assuming a net heat demand of 75 kWh/y, the floor area is 100 m\textsuperscript{2}, and the ventilation rate 103 m\textsuperscript{3}/hr.

\subsection*{5.3.6 Cogeneration boilers}

The current standard for cogeneration products EN 50465:2015 deviates from the methods set out in the Commission Communication TM2014sh to calculate the seasonal space heating energy efficiency.

In particular the correction of electricity production results in 'space heating efficiencies' that exceed even the theoretical maximum space heating output for a given fuel input. There are alternative methods for correcting or converting the power production of cogeneration units into an (equivalent) space heating output.

The deviation related to the use of a factor \(F_{CHP}\) allows for a more realistic weighing of efficiencies and contributions of preferential and supplementary heaters. This resolves the current misalignment of efficiencies of integrated products and packaged products (comprising a preferential and supplementary heater).

The introduction of a factor 'b' in the calculation of correction factor \(F(2), F(3)\) and \(F(4)\) is intended to better reflect the expected share of the cogeneration heater in standby mode, given a certain modulation range of the product.

A stakeholder has suggested to base the scope of cogeneration covered not on its electric power output (now max 50 kW\textsubscript{electric}), but to align it with the maximum heat output for labelling of space heaters which is max 70 kW\textsubscript{thermal}. This is not supported by COGEN or experts as the alignment with other legislation, the EED in particular, is lost and the current threshold of 50 kW\textsubscript{electric} is not seen as a hindrance.

\textsuperscript{201} \url{https://www.installatieprofs.nl/nieuws/verwarming/overige-verwarming/besparingen-warmtewinner-vallen-tegen} The Eneco WarmteWinner requires a flow rate between 100-230 m\textsuperscript{3}/h. It has an average 1,5 kW heat output, COP 4.2 (air 20 \textdegree{}C, water supplied 45\textdegree{}C) and average power input of 300 W, max. power input 620 W and max. temperature water supplied 60 \textdegree{}C.
5.3.7 Solar devices

The Solar Industry in particular views the package label (and also the Product Fiche of a package) as an important instrument to illustrate to consumers the potential benefits resulting from the combined effect of several components of a space and water heating system, including solar thermal. In fact, for space /combination heaters the package label is the only regulatory tool that considers the contribution of solar thermal systems for total space heating efficiency.

Calculation of water heating and space heating efficiencies

The energy efficiency (of space- and/or water heating) of solar devices is covered under the current regulation as either:

- Solar water heater: This product comprises solar devices and a water heater (can be integrated or supplementary) and can supply DHW on demand. The water heating performance is based upon a solar device test (SOLICS or EN 12976-2:2017, for factory-made systems) or solar component testing (SOLCAL or better EN 15316-4-3:2017, for custom built systems) combined with a water heating efficiency of the non-solar water heater.
  - This product is covered by a water heating product label, and technical information;

- Solar device plus water heater: This is by definition a package (components placed on the market separately) and the performance can only be calculated using the package fiche approach.
  - This package must be accompanied by a package label and package fiche, plus product labels and product information of the components if applicable;

- Solar device plus space heater: This is by definition a package (no solar space heaters are defined in). The seasonal space heating efficiency is calculated using the method in the package fiche, based on the preferential heat generator efficiency, corrected by a contribution of the solar system.
  - This package must be accompanied by a package label and package fiche, plus product labels and product information of the components if applicable;
  - An alternative, simpler method to the package fiche calculation is presented by SHE in comments supplied (see section below)

Calculation of solar contribution in space heating package label

The present calculation of the solar contribution to space heating requires inputs related to collector size, (solar) storage tank volume, tank rating and collector efficiency, factors 'III' and 'IV' and a correction of 0.9. Note: The value '0.9' only applies to packages comprising a preferential boiler, for a cogeneration package the value is '0.7', and for heat pumps it is '0.45'. The origin of the value and the reason for the differences between packages could not be identified anymore.
The total package efficiency equation is:

$$\eta_{\text{pack, sol}} = \left( \frac{294}{11 * P_{\text{rated}}} * A_{\text{coll}} \right) + \left( \frac{115}{11 * P_{\text{rated}}} * V_{\text{sto}} \right) * 0.9 * \left( \frac{\eta_{\text{coll}}}{100} \right) * (\text{tank rating})$$

Solar Heat Europe has developed and tested a simpler alternative approach, using the following equation:

$$\eta_{\text{pack, sol}} = \frac{P_{\text{boiler,rated}}}{\eta_{\text{sh}}} - P_{\text{solar(\Delta T_{\text{col,amb}})}} * N_{\text{mod}} * \Delta t_{\text{int}}$$

Where:
- $\eta_{\text{pack, sol}} =$ Solar and backup heater efficiency (%) – see example below for calculations
- $P_{\text{boiler,rated}} =$ Rated (peak) heat power output of the backup space heater (kW) – in example below 24 or 12 kW
- $\eta_{\text{sh}} =$ space heater efficiency (%) – in example below 95%
- $P_{\text{solar(\Delta T_{\text{col,amb}})}} =$ Rated heat output of the collector module applied at $\Delta T_{\text{col,amb}}$ (from collector test data sheet) (kW) – in example below 0.8 kW
- $N_{\text{mod}} =$ Number of applied collector modules (#) – in example below: 5-15-30 m²
- $\Delta t_{\text{int}} =$ 0.25, the ratio of overlap of space heating load and simultaneous available solar irradiation (> 150 W/m²).

For a boiler rated 24 kW or 12 kW the package efficiency (preferential solar heat plus supplementary boiler) increases more when the combined collector output power approaches or even exceeds the rated boiler output (the example below has combined collector power from 17% to 200% of boiler rated output).

The proposed alternative assumes that storage volume is optimally sized ($m^3 = 50 * \text{collector area} / 1000$) and has no entries related to standing losses of tank (is included in overall factor $\Delta t_{\text{int}}$). The $\Delta t_{\text{int}}$ has been established for the average climate. Other $\Delta t_{\text{int}}$ factors have to be established for colder and warmer climates.

It is noted that a more accurate, scientifically proven, method is only possible if the package fiche is based on an annual heat load (kWh) of the dwelling/building. This is currently not the case and is not expected to be the case in near future.
Abrecht method

Solar systems may be used for DHW only, or for both space heating and DHW. If used for both, ISH argues that most consumers are not interested in distinguishing between water and space heating efficiency but how efficient the system is as a whole. Moreover, with most of the combi-systems which supply heat for DHW and space heating from one single storage tank it is also technically not really possible to split it up.

In addition, for combination heater packages the solar heat is based on the full collector area for both functions (whereas in reality only a varying share of the solar heat collected will be used for either space hating or DHW).

Solar expert Abrecht has proposed a method that combines both functions (combination heating) in a single method. For more details – see the comment\textsuperscript{202} and calculation tool\textsuperscript{203} posted on the review study websites.

---

\textsuperscript{203} https://www.ecoboiler-review.eu/downloads/SHI 2018-02 ErP Review - Calculation tool Solar packages V.1.0.xlsx
**mIO method**

An alternative method "mIO" produces more representative results but is more complex and requires more inputs (such as length and diameter of piping). For more details – see the comments posted on the review study websites.

**Correction of calculation of solar water heater efficiency**

CETIAT states that the calculation in figure 1 of 812/2013 is not correct.

First, figure 1, calculation of solar contribution (as correction upon water heating efficiency):

Solar contribution

\[
\text{From liche of solar device}
\]

\[
(1.1 \times \eta' - 10\%) \times \eta' - \eta = \frac{2.5 \times Q_{aux}}{Q_{non\text{-sol}}}
\]

In more recognisable terms this is:

\[
(1.1 \times \eta_{\text{DHW}} - 0.1) \times \left(\frac{366 \times 0.6 \times Q_{\text{ref}}}{Q_{\text{non\text{-sol}}}}\right) - \left(\frac{2.5 \times Q_{aux}}{366 \times 0.6 \times Q_{\text{ref}}}\right) - \eta_{\text{DHW}}
\]

A breakdown of the calculation results in:

- 1.1*\eta_{\text{DHW}} -10% is the efficiency of the non-solar water heater, first corrected by 1.1 and then by -0.1 so that WH at lower efficiencies get a malus and WH at higher efficiencies get a bonus, with the tipping point at an efficiency of exact 100%.
- 366*0.6*Q_{\text{ref}} is the annual DHW demand (Q_{\text{ref}} is the daily hot water demand according the tapping profile, in kWh/day, 0.6 is a factor that corrects this demand to more realistic values, and 366 converts this into annual values, in kWh/a). Divided by Q_{\text{non\text{-sol}}} (annual demand to be fulfilled by the non-solar water heater) the result is the share of non-solar demand of the annual DHW demand.
- 2.5*Q_{aux} / annual DHW demand is the annual electricity consumption, converted to primary energy with factor 2.5, then divided by the annual DHW demand which results in a share of primary energy.

The expert states that the calculation of the contribution should be changed to this:

\[
\frac{(366 \times 0.6 \times Q_{\text{ref}})}{Q_{\text{non\text{-sol}}} \left\{\left[\frac{1.1 \times \eta_{\text{DHW}} - 0.1}{1.1 \times \eta_{\text{DHW}} - 0.1} + (2.5 \times Q_{aux})\right]\right\}} - \eta_{\text{DHW}}
\]

Or in more easily understandable terms:
The result is a simple output/input ratio, or efficiency.

The figure below shows that the leger calculation results in a more realistic correction, without unexplainable variations per Qref (calculations by VHK, using an implementation of SOLCAL by Solar-Experience GmbH).

Figure 33. Contribution of solar device to water heating efficiency, for smaller and larger system

The calculation is based in an 'Average' climate, assuming a typical flat plate collector (of 4 or 16 m²), a 300 L storage and 70% efficiency of the water heater. The proposed correction is less beneficial for some tapping patterns (L and XXL).

**Distribution losses added to heat demand to be met by solar devices**

In regulation 812/2013 the water heating demand in all solar calculations (both SOLCAL and SOLICS, in accordance with TM2014wh) includes distribution losses of the solar collector loop of 1.09 kWh per day (fixed value). This results in a higher Qₙonsol as these losses as a result need to be covered by the non-solar water heater. The overall efficiency however is calculated assuming a demand without distribution losses. This introduces a difference with calculations of efficiencies of other water heaters that do not include distribution losses in the assessment of energy inputs. This leads to a systematic difference of 19% in tapping profile M, 9% for L and 6% for XL.
Thermosiphon solar water heaters

Solar Heat Europe argues that users of thermosiphon solar water heaters adapt their behaviour to the characteristics of solar water heating and that this should be taken into account in the calculation of the performance for instance through a compensation of 10%, similar to the smart control factor.

Ecodesign requirements for solar water heaters are based on 'average' climate only

Water heating

The Ecodesign regulation 814/2013 for water heaters requires the water heating energy efficiency of the (factory-made) solar water heater to be assessed for the 'average' climate only. However, most solar water heater products (these being thermosiphon systems mainly, the rest are packages) available in the EU are typically not used in an 'average' climate but in a 'warmer' climate. As a result, the Ecodesign requirements based on the 'average' climate are relatively strict and do not bear value for the main markets of these types of solar water heaters.

The labelling regulation 812/813 for water heaters also requires the efficiency class of solar water heaters to be determined using the 'average' climate. The product label does allow showing the 'annual electricity (or fuel) consumption' for three climates, but this quantitative data alone does not give an easy interpretable value. This approach also applies to heat pumps.

Additionally, the package label for packages including solar devices can show the efficiency class for the 'average' climate only. Advertisements including price or energy information and promotional material shall also display the efficiency class under the average climate.

The package fiche can show the water heating energy efficiency for all three climates, but the method is not based on the actual climates in Athens and Helsinki, but is a simple correction of the value for the 'average' climate. Thus, the only climate data included in the labelling regulation is for the 'average' climate.

Space heating

The Ecodesign regulation 813/2013 for space heaters does not include a requirement for the minimum efficiency of space heaters with solar devices. Solar devices are only considered in the labelling regulation 811/2013 for space (and combination) heaters and then again only for the average climate (similar as for water heating energy efficiency). In the package fiche for heat pumps there is a possibility to calculate efficiencies for other climates, but this only takes into account the change in heat pump performance (outdoor temperature bins available for three climates) but not a change in the output of the solar devices.

None of the space/water heating labels discussed presents the efficiencies of products (or packages) for all three climate conditions. The room air conditioner label of regulation 626/2011 is an example of an energy label that does present the efficiencies (plus output, SCOP, consumption) in three climates.
Technically it is not complex to add additional climate conditions for solar devices in the regulatory text: Monthly and average reference outside air temperatures and solar irradiation can be based upon publicly available datasets (like Meteonorm) and standard EN 12976-2:2017 has already done the work for the 'colder' climate available; the 'warmer' climate of 'Athens' (reference year) can be added as per above.

**Retrofit labels?**

Solar systems are particularly suited to enhance the performance of existing heating systems. Solar Heat Europe proposes the installer is allowed/given the opportunity to calculate a package performance of a solar system combined with a pre-existing heat generator and/or storage tank (the principle could be applied to other configurations of heaters as well).

This requires a method to assign a (water/space) heating efficiency to an already existing boiler and/or storage tank (e.g. default values based on age and type).

**Simplified calculation for solar contribution**

The current method for calculating the solar contribution of solar devices to space/water heating efficiency requires knowledge of specific solar performance characteristics (should be known from product fiche, but in practice not so simple apparently) and a not-so-straightforward calculation.

Solar Heat Europe proposes, as one of multiple solutions, a simpler approach in which the seasonal efficiency of the package is simply boosted with a number of % points.
depending on the collector area and the climate. The % improvement represents the solar fraction of the heat demand.

Table 56. Package improvement for simplified solar calculation

<table>
<thead>
<tr>
<th>Collector area (Acol)</th>
<th>Package improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cold – Average climate</td>
</tr>
<tr>
<td>&lt; 10m²</td>
<td>+15%</td>
</tr>
<tr>
<td>10 &lt; Acol &lt; 20m²</td>
<td>+30%</td>
</tr>
<tr>
<td>≥ 20 m²</td>
<td>+45%</td>
</tr>
</tbody>
</table>

5.3.8 Buffer tanks

Buffer tanks, or system buffers that store system water (e.g. to limit cycling in case the available system capacity is too small, or to collect/store solar energy), are covered by 811/2018: They are 'hot water storage tanks' and if sold as part of a package containing a solar device information on efficiency class, standing loss and storage volume must be stated. The storage temperature to be used for the assessment is not stated in the regulation 811/2013 (only indirectly in TM2014wh).

When buffer tanks are combined with DHW production (via an internal coil or external plate heat exchanger) the storage temperature is close to 80ºC in practice. Most standards however prescribe a minimum storage temperature of 65ºC which underestimates the actual losses.

5.3.9 PFHRD

According to the Energy Label regulation (EU) No. 811/2013, the appropriateness of including passive flue heat recovery devices in the scope of this Regulation shall be reviewed. At the moment, also because no test standard was in place to measure the indirect contribution of space heating\textsuperscript{204}, the PFHRD is mentioned but cannot indirectly contribute to the seasonal boiler efficiency in the current calculation method.

There is now a draft EN standard for assessment of PFHRD performance 13203-7 (May 2018, for NWIP and CEN enquiry), describing a method to be applied to integrated PFHRDs. No information on recovery rates or savings from PFHRDs using this draft standard is yet available. For "add-on" (retrofit) PFHRDs there is no agreed method yet.

The draft standard assumes supply/return temperatures (the heat source for PFHRDs) of 43/37ºC which corresponds to fairly good condensing operation of the space heaters. In practice, the supply/return temperatures will often be higher and thus the space heating contribution to PFHRD is certainly not overestimated (see also Task 4). Higher flue gas temperatures allow more energy to be extracted from flue gases, at the expense of less efficient heating operation.

\textsuperscript{204} Currently being elaborated by TC109-WG4.
There is yet no consensus on how to treat the hygienic safety aspect of pre-heating water. Traditionally thermal stores containing DHW are periodically heated to 60ºC or above (the possibility to sanitise at 70ºC) to kill off (most) bacteria, but in certain countries less stringent rules apply to limited volumes (e.g. max 3 litres). The rules for the hygienic aspect of PFHRD are not harmonised.

In a 2016 report for the British government, Delta and Enertek have evaluated the PFHRD for possible inclusion in British energy policy. They found that a PFHRD with storage can save 31% on hot water energy consumption of a gas condensing combi-boiler. This is as much as the contribution of an average solar thermal installation (sic!). Without the storage facility, the PFHRD saves 9%.

As mentioned in paragraph 3.5.27, the PFHRD is one of the 4 possible additional energy efficiency measures in the mandatory UK Boiler Plus requirements. Furthermore, several manufacturers offer PFHRD either integrated or —for specific boiler-models— as add-on.

These are all indicators that PFHRDs are mature enough to have their place in the boiler regulations, but details need to be elaborated.

### 5.3.10 Temperature controls

EHPA says that the addition of temperature controls brings a lot of administrative burden with very little effect on overall efficiency, and that it can therefore be ignored/removed from the label calculation.

EU.BAC claims the package label distorts the market as installers do not apply it, and prefer the controls to be removed from the package calculations.

### 5.4 Cross-category issues

#### 5.4.1 Maximum load profile for labelling or Ecodesign (2XL vs. 3XL/4XL)

The Ecodesign regulations for combination heaters (and water heaters) require the declared load profile for a product to be the maximum load profile or the load profile one below the maximum load profile. The Ecodesign scope is limited to 400 kW heat output, a 2000 l tank and load profiles extend to class 4XL. The labelling regulation scope is limited to max. 70 kWh heat output, 500 l tank and load profile of maximum XXL (2XL).

Problems arise if a combination heater (or water heater) is covered under the labelling scope (e.g. < 70 kW heat output) but can meet a load profile larger than 2XL. Such products need to be assessed with the 2XL profile for labelling purposes and the largest load profile (e.g. 4XL) for Ecodesign purposes. This means:

---


206 The largest tapping (energy-wise) in load profile 4XL is 24.08 kWh at 40ºC, at 21:30. For an instantaneous heater this represents a power draw of 200 kW at 40ºC and 96 l/min (Tcold 10ºC). A storage heater rated at 70 kW heat output could theoretically produce this same tapping energy content in 20 min. If the tank temperature is 60ºC a volume of 414 l would suffice. In practical terms, a 70 kW heater has enough time to replenish/recharge this tank in the period between tappings.
Manufacturers need to assess their water heater twice: for Ecodesign (according to 3XL or 4XL) and for energy labelling (according to 2XL);

Manufacturers have to give different product information for the same water heater pursuant to Ecodesign and energy labelling, which cannot be compared;

The energy labelling Regulation discriminates against such water heaters: their efficiency may be lower with a 2XL profile than a 4XL profile;

Such water heaters (meeting the 3XL or 4XL load profile) are primarily for commercial purposes, for which the energy label is not intended.

Furthermore, the combination of thresholds at max. 70 kW for the heater and max. 500 l for the storage tank limit is not realistic. 70 kW DHW heaters can supply heat to tanks much larger than 500 l. Tank sizes also tend to be larger if combined with solar heating (to buffer heat over longer period).

Regarding the upper limit of the scope for Ecodesign, the amount of energy that can be withdrawn from a 400 kW combination or water heater, combined with appropriate storage tanks at appropriate storage temperatures, is much larger than represented by the largest load profile 4XL. Some stakeholders argue that even larger load profiles should be made available to such large (>200 kW) combination or water heaters.

### 5.4.2 Minimum storage temperature

The regulation 813/2013 and 811/2013 do not prescribe a minimum temperature of DHW storage tanks. Only in the TM2014wh, in the description of the assessment of the V40 value, a storage temperature of 65 °C is mentioned.

In practice most standards for products containing DHW storage tanks prescribe a set point of 65 °C: Storage tank standards EN 12897 and EN 15332 both use 65 °C as set point, as does FprEN 13203-2:2018 (combi-boilers) and EN 89:2015 (for gas storage water heaters). EN 50440:2015 for electric storage water heaters refers to "out-of-the-box" settings (no minimum specified) but its international counterpart IEC 60379 (2018 draft) specifies a minimum 65° storage temperature.

In the DHW heat pump standard EN 16147 the storage tank temperature is not defined (settings out-of-the-box). In most cases the storage tank temperature of DHW heat pumps does not exceed 55 °C when heated with the heat pump. The storage tanks can often be heated to 60-65 °C periodically if so required by local law, using an immersion heater, but this is not the standard condition for the assessment of water heating performance (this may be different for CO₂ heat pumps).

### 5.4.3 Product and package label

The opinions of stakeholders regarding the use and effectiveness of the package label are largely in agreement: Most state that installers rarely use this possibility and that the package label is mainly used by manufacturers to show the higher rating of the package of heater, temperature control, heat pump and/or solar device.

**EHI**

Heater manufacturers and National Associations have invested heavily in training installers on the Energy Label, including for water heaters.

Manufacturers do use the package label, which helps to promote renewable heating systems and efficient controls; but installers do not always do it as some claim that the...
calculation is too difficult (or unclear), there is no incentive from market surveillance and some do not find it a sufficient business incentive.

EHI prefers not to have the actual efficiency (numerical value) on the Energy Label for all heaters as it would risk misleading consumers. The Energy Label should also be made as simple and understandable as possible.

For the same reasons, EHI has doubts about the added value of adding information about the seasonal energy efficiency in the other climate zones on the Energy Label. This information is already in the product fiche and it is up to the manufacturers to choose to communicate on it or not. This information will also not be available for heat pumps that do not work in colder climates.

EHI proposes that manufacturers of products the indoor noise of which is below a threshold should be awarded a 'waiver' to avoid unnecessary tests.

**EHPA**
The EHPA has no conclusive opinions on the package label. As regards the product label EHPA would like to see a low-temperature combination heat pump label. EHPA is not in favour of putting the performance of the heat pump under other climates on the label. EHPA is not in favour of a rescaling of labels (at least, not in the short term).

**Netherlands**
The Netherlands states that, based upon EEPLIANT experience, manufacturers of packages in general provide a correct package label whereas for other market actors (installers) compliance is low. Nevertheless, the Netherlands is in favour of the continued use of the package label. Improvements in use and compliance should be realized through consumer information, training of installers and market surveillance.

**Germany UBA/BAM**
The German UBA/BAM states that the package label is the only measure that is able to show the benefits of solar collectors and hybrid space heaters. Both are important technologies which should continue to be supported by the (package) label or by another appropriate way. The package label gives installers freedom to choose components from different manufacturers. Just 2.5 years after entering into force, it would be too early to suspend the package label.

UBA/BAM agrees that the package label enters the market very slowly. Consumers don’t know it or may struggle to understand it (in comparison to the product label). Installers don’t use it because they find it too complicated (although manufacturers and wholesale organisations provide tools) and because consumers don’t ask for it. In consequence, the market is still non-transparent. Proper market surveillance is at least very difficult or even impossible. In Germany it isn’t used for funding programmes because it is considered as too complex and not useful to promote solar thermal collectors directly.

At the moment, it seems more useful to improve the package label. UBA/BAM sees the following possibilities:

- What public relations or other measures would be useful for better promotion of the package label (as well as of the product labels)?
- What are the users’ expectations and information needs when purchasing a (package) space heater?
• Should the package label be simplified?

• Should the package label be extended? A few applications are not covered like:
  - water heating with a cogeneration space heater,
  - water heaters and combi heaters with external storage,
  - packages for operation at low temperature,
  - impact of storages: both losses and benefits (efficiency gains through continuous operation of on/off space heaters),
  - retrofit of existing space heaters.

• Does it make sense to make the package label more flexible and more accurate by issuing it for actual installation of solar thermal packages (i.e. roof orientation)? Installers may know all relevant information.

• The fiches to calculate the package efficiency class may be too difficult to use. Should they be converted into a general calculation method in an EN standard? Are easy tools missing?

• Does it make sense to attach the package label to the (preferred) space heater after installation?

• Should controls be removed from the package label and integrated into the product label?

• How could the energy labelling database enhance package labels (for example if data are missing)? How does the database have to be designed that it supports issuing labels as well as possible?

**UIPI – International Union of Property Owners**

UIPI finds it necessary to add, on top of the product fiche and technical documentation included in the package of water heaters and/or boilers, additional documentation to explain in a simple, clear and non-technical language the different indicators of the energy labels and provide recommendations on how to efficiently operate the appliance.

**EU.BAC**

EU.BAC thinks the installer label is not being recognized and used in the market. On the other hand, the product label is used widely. EU.BAC claims that therefore the objective of avoiding market distortion is not met. In addition, EU.BAC wants both the definitions of temperature control classes and the scores attributed to them to be reviewed to ensure they are clear, up to date and robust.

EU.BAC proposes to amend the space heater labelling regulation by removing the temperature controls from its scope and leave these to the outcome of the preparatory study for Lot 38 (Building Automation and Control Systems).

If this option cannot be met, then one of the following options should be met:

• ensure that there is increased market surveillance at point of installation to drive installers to comply – however, in practice dealers cannot be “forced” to apply the dealer label …OR;

• simplify the approach for installers – however, despite efforts to support application of dealer label, market take-up of support tools is minimal.

**Groupe Atlantic**

Group Atlantic doubts the effectiveness of energy labels for such technical products and considers the recommendations of engineering companies, consultants and installers to
be much more efficient. Groupe Atlantic wants the energy label to be as simple and understandable as possible and advocates a revision of the existing package label.

The package label should be kept but transformed into an extended product label which would allow the manufacturers to publish only one label for a product (instead of two as of today). For instance, most of the heat pumps sold on the market are delivered systematically with an outdoor temperature sensor which obliges the group to publish two labels.

RISE- Sweden
RISE has shared a list of comments and recommendations, the most relevant ones shown below:

- the actual seasonal efficiency (value) should be visible on the label and indicated for all climates the product is considered fit for purpose.
- the low-temperature combination heater should be covered by a product label.
- the package label should remain, but its application should be simplified as manufacturers find the package label difficult to use.
- label classes should be rescaled, with A starting at higher efficiencies and having more resolution in beyond A classes.
- manufacturer of products of which the indoor noise level is below a certain threshold should be allowed a 'waiver' to avoid unnecessary tests.
- the test temperatures in EN 14825 should not be based on fixed outlet temperatures as most heat pumps now apply a variable flow rate. Instead a mean temperature should be applied.

SHI – Solar Heat Initiative
The SHI finds that the benefits of solar devices are 'hidden' in the package label that is created for another heat generator. SHI proposes to market solar devices, in particular collectors, as renewable heat generators in their own right, and advocates the SOLERGY collector performance label.

SHI also finds that solar devices should be considered preferential heaters, in accordance with FAQ 56 (in FAQ2018)\(^\text{207}\).

The current package label calculation can be made simpler and more robust, especially to show the benefits of solar devices combined with space and/or water heating devices.

Solar Heat Europe (ESTIF)
Based upon the results of the LabelPack A+ project SHE recommends rethinking the overall labelling concept in order to increase enforcement. This would include overhauling the efficiency categories, the design of the label and its calculation methods. More specifically SHE recommends:

- Include expected energy consumption on the label;
- Review scale of energy efficiency classes system;

\(^{207}\) 37. What is the definition of preferential heater? A preferential heater is a heater that generates heat in cases where the heat demand is lower than or equal to its rated output. In general, a preferential heater is a heater which is to be switched on first (usually because it gives the best efficiency). Only if the heat demand exceeds the output of the preferential heater, the supplementary heater is switched on.
- Include performance under other climates;
- Allow labelling of package with existing boilers (showing efficiency of current boiler and efficiency of improved package);
- Better connection between energy labelling and EPBD.

### 5.4.4 Primary energy factor - PEF

**Stakeholder responses**

Stakeholders have been asked which PEF they would propose for Ecodesign/labelling of heaters. The responses ranged from PEF =2.0 (JRAIA, Mitsubishi, EPEE and EHPA) to PEF=3.0, based on a marginal displacement mix (joint statement by Bioenergy Europe, COGEN Europe, EFIEES, EGEC, EHP and Solar Heat Europe/ESTIF\(^\text{208}\)).

Eurelectric/the electrification alliance supports the PEF as proposed in the revised Energy Efficiency Directive (= 2.1)\(^\text{209}\).

Stakeholders that argue that a marginal PEF should be considered mention as reasons:

1. The lowering of the PEF is partially a result from the increased share of solar energy in electricity production (on annual basis), but heat demand is generally higher during periods of lower solar electricity generation (night-time, winter). A PEF that takes into account seasonal variations is more applicable.
2. Where the use of space/comboination/water heaters leads to a change in electricity demand, the generation mix used to follow the change in demand is likely not represented by the average electricity mix, as this average mix includes renewable electricity generation on the basis of priority dispatch (as electricity from renewables have the lowest variable costs, they are prioritised). Instead it is argued that a change in demand is primarily met by (or displaces) electricity generated by dispatchable technologies that can easily change their output in response to changes in demand, resulting in a lower share of renewables\(^\text{210}\). This marginal PEF is closer to 2.8 (excluding nuclear generation) to 3.1 (including nuclear generation) on the basis of the net calorific value of fuels.

Germany expects the PEF to decrease and suggests to switch to specific energy requirement or SER (energy IN/useful heat OUT), the reciprocal of the efficiency (useful OUT/energy IN) as the efficiency metric limits the possible range of values to be covered (if more efficient, SER is closer to zero, if SER becomes negative the unit is saving energy elsewhere).

**Status of PEF discussion**

The current revision of the EED includes an update of the PEF, taking into account the rising share of renewables in electricity generation. The most recent available document

---

\(^{208}\) In that statement the joint parties prefer a PEF (or CC) that takes into account seasonal and marginal approach and is based on GCV (not NCV as currently).


is the 2\textsuperscript{nd} reading of the European Parliament, suggesting a default PEF = 2.1 (Annex IV, footnote 3) \textsuperscript{211}. 

The current PEF = 2.5 is present in the regulations (as "conversion coefficient CC=2.5") in supporting documents (transitional methods) and present in equations in many technical EN standards of many product groups, so that these standards can be used for presumption of conformity with the relevant regulations. A change of the PEF in the regulatory text will therefore have a "ripple-effect" extending to many EN standards (which need harmonising anew).

5.4.5 Definitions

Definitions for the following parameters need to be clarified:

- Heat generators: Similar to renewable energy extracted by heat pumps, solar energy should be considered a form of (preferential) heat generation. Non-renewable space heaters are used to complement the output of a solar system;
- A stakeholder questioned whether the scope is sufficiently technology neutral, as there are more ways than Joule heating to convert electric power into useful heat (magnetic induction elements?) and suggested a more generic definition: "Conversion of gas/oil/electricity to useful heat for space/water heating". A change like this requires a check on unwanted inclusion of technologies.
- A definition for 'preferential heater' is missing.
- The use of 'preferential' and 'supplementary' in the package fiches is not logical in certain fiches: Figure 1 (for boilers) presents a "supplementary heat pump", which according the definition should generate heat in case the heat demand is greater than the rated heat output of the preferential (fuel) boiler. In practice it is the other way around as the fuel boiler supplements the (electric) heat pump (as in fiche figure 3 & 4).
- The relation between the rated heat output of preferential and supplementary heater(s) and Prated should be clarified: Prated can refer to the preferential boiler (e.g. for fuel boilers), but also to the combination of both preferential and supplementary heat generators (e.g. for heat pumps Prated = Pdesign, which includes a possibly fictional supplementary heater sup(Tj) with its own rated heat output).
- The definitions and values for correction factors of temperature controls as applied in the calculation of the efficiency of a package are not present in the regulation.
- The rated volume of a storage tank does not explicitly state this is the DHW volume (and does not include heat exchanger volume) or how system volume (in case of DHW buffer tanks) is considered.

Annex IV, footnote 3: "Member States may apply a default coefficient of 2.1 or use the discretion to define a different coefficient provided that they can justify it ".

Ecodesign Boilers, Task 1, Final | July 2019 | VHK for European Commission 298
5.5 Conformity assessment

This section first describes the background of third-party conformity assessment of fuel boilers in regulation 813/2013. It is followed by a section on the modules and procedures prescribed for conformity assessment and the risk assessment that is the basis for such procedures, followed by a section describing stakeholder opinions on the matter, and section that discusses different aspects of conformity assessment. The last section provides a summary and conclusion.

5.5.1 Introduction to "third-party verification"

The implementing measure for space/combination heaters 813/2013 currently prescribes two different conformity assessment procedures for space heaters: Module B+C/D/E or "third party verification" for fossil fuel fired (combination) boilers; and Module A, internal production control, or "self-declaration" for the 'other' space/combination heaters, such as electric heat pumps. The reason for two different conformity assessment procedures in 813/2013 is the combination of a legacy requirement from the 92/42/EEC Boiler efficiency Directive (BED) requiring third party verification for fuel fired space heaters (Module B+C/D/E, as described in the BED), and the default conformity assessment procedure under Ecodesign 2009/125/EC which is the current 'Module A'.

The 92/42/EEC BED introduced harmonised energy efficiency limits for fuel boilers, to harmonise the different limits imposed by Member States following Directive 78/170/EEC.

Until then, boiler tests were performed by national private and voluntary test houses but with the adoption of the BED they lost their privilege, as tests could be performed all over Europe, by whichever Notified Body. A sudden rise in number of Notified Bodies occurred, which led to a market "shake out": An erosion of price and quality of testing, with only the strongest bodies surviving.

The BED required an 'EC type examination' (Module B), followed by a Module C/D/E, combined with an 'EC declaration of conformity' (by the manufacturer) as fuel boilers were already required to undergo the same procedures following the Gas Appliance Directive (GAD) 90/396/EEC (29 June 1990)\(^{212}\). Article 7.2 of 92/42/EEC states: "For boilers burning gaseous fuels, the procedures for assessing the conformity of their efficiency shall be those used to assess conformity to the safety requirements laid down in Directive 90/396/EEC on the approximation of the laws of the Member States relating to appliances burning gaseous fuels". By requiring the same GAD procedure for the BED, the additional administrative burden for manufacturers (administrative, costs) was reduced.

The GAD 90/396/EEC did not yet mention the modules referred to in BED, as these modules were introduced by Council Decision 90/683/EEC issued a few months later (13 December 1990) than the GAD. The BED of 1992 of course could refer to these modules (Module B etc.). The Modules were expanded upon/updated in Council Decision 93/465/EEC of 22 July 1993.

\(^{212}\) The GAD 90/396/EEC (codified as 2009/142/EC and recast as Regulation (EU) 2016/426) introduced CE marking and mandatory third-party verification for gas boilers to assess gas appliance safety. The GAD also introduced Notified Bodies identified by Member States that may perform the assessment.
In 2005, the then Ecodesign Directive 2005/32/EC did not repeal the BED (which would have left boilers unregulated) but amended the BED by changing it into an implementing measure under 2005/32/EC (Article 21). Directive 78/170/EEC (national efficiency requirements of boilers) was repealed (Article 22) but the provisions in the BED were kept despite attempts of stakeholders to make the requirements more stringent (in 1996, 2001, and also in 2006). These attempts probably failed as market parties preferred the status quo as it allowed continued sales of (low cost) conventional boilers and putting condensing boilers on the market with the help of subsidies (effectively postponing competition on price of condensing technologies). The recitals of 2005/32/EC also mentioned possible withdrawal of the poorly functioning star-rating scheme of the BED.

In 2008 the Decision 768/2008 further clarified/structured the modules introduced by 90/683 and here it became apparent that the BED Module C is now referred to as 'Module C2' (involves "product checks... at random intervals"). Module D/E stayed largely the same.

In 2009 the recast of the Ecodesign Directive 2009/125/EC mentioned (in recital 37) the possibility to repeal the BED (as an implementing measure under 2009/125/EC) but it wasn’t until regulation 813/2013 that this finally happened, except for two articles regulating the conformity assessment procedures for fuel boilers.

The reasons for keeping the BED conformity assessment procedures were not explained in recitals of 813/2013, although the issue was extensively discussed between stakeholders and the Commission. A possible reason to keep the third-party procedures for fuel boilers in 2013 may have been that the conformity assessment procedures involving 3rd parties were thought to result in higher conformity of products and less risk of ‘free-riders’ entering the market. Another reason may have been that industries over the years had invested in accredited labs to perform in-house conformity testing, and that a complete repeal of these procedures would diminish the benefits of owning such accredited labs, which would be undesirable to the industries as such labs are expensive to own/run.

A reason for not applying Module B etc. to 'other' heaters (not fuel boilers) may have been that this procedure did not already apply to such heaters at that moment and their introduction was considered unjustified and/or disproportionate.

Earlier drafts of 813/2013 proposed other conformity assessment procedures for boilers such as 'full quality assurance' according module H or 'EC-type examination in combination with conformity to type' in accordance with modules B and F. Ultimately the solution was to keep the Module B+C2/D/E for fuel boilers and Module A for 'other' heaters.

5.5.2 Conformity assessment modules and risk

The review article 7 in 813/2013 (and 814/2013 for water heaters) asks for "an assessment of appropriateness of third-party verification". The below section shows that only Module A does not involve Notified Bodies at any point. Other modules require assessment by either Notified Bodies or an accredited in-house body (aihb).
Modules for conformity assessment
The following modules for conformity assessment exist under 768/2008/EC:

1. Module A is a self-declaration without involvement of NB. Other modules introduce verification by NB or aihb doing tests for each product (A1) or at intervals decided by the testing body (A2).
2. Module B is the type examination by a notified body, resulting (if positive) in an EC type examination certificate to the applicant.
3. Module C requires a prior EC-type examination certificate by a NB (Module B). The sub variant Module C1 or C2 introduce verification of type by NB or aihb for each product (C1) or at intervals decided by testing body (C2).
4. Module D also requires Module B (a prior EC-type examination certificate by a NB) and assessment by the NB of the quality system (QS) of the manufacturer for production, product inspection and testing of products by surveillance including audits. Module D1 does without the prior EC-type examination, but product tests may still be part of the audits.
5. Module E is similar to Module D as it requires Module B (a prior EC-type examination certificate by a NB) and assessment of the quality system (QS) of the manufacturer. A difference to D is that in Module E the QS does not involve production (only product inspection and testing of products). Module E1 does without the prior EC-type examination, but tests may be part of the audits.
6. Module F (like C, D and E) requires a Module B type examination certificate and requires a NB to verify the conformity to type (for each product or interval decided by body). Module F1 does without the prior EC-type examination. The NB may still perform tests to verify the conformity to type (for each product or interval decided by body).
7. Module G is rather similar to F1 (no prior type examination), but here the NB carries out "appropriate tests" (more flexibility on testing schedule).
8. Module H is similar to Module D1 and E1 as it does not require a prior EC-type examination certificate by a NB. However, the quality system (QS) to be assessed is much larger as it covers design, manufacturing and final product inspection and testing of products, and tests may be part of the audits. Module H1 includes a design examination. Like Module H tests may be part of the audits.

As certain modules are designed to be applied in combination, the total number of conformity assessment procedures is reduced to 15. These are the procedures:

---

213 CERTIF 2009-04, Introduction to conformity assessment and conformity assessment procedures of the new legal framework (as laid down in decision 768/2008 of the new legal framework) SOGS N 594 EN, 17-3-2009
Table 57. Conformity assessment procedures

<table>
<thead>
<tr>
<th>A - Internal production control</th>
<th>Who does verification?</th>
<th>Product checks?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 - Internal production control plus supervised product checks</td>
<td>NB or aihb</td>
<td>each</td>
</tr>
<tr>
<td>A2 - Internal production control plus supervised product checks at random intervals</td>
<td>NB or aihb</td>
<td>(random) interval</td>
</tr>
<tr>
<td>B+C - EC-type examination (B) followed by Conformity to EC-type based on internal production control (C)</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td>B+C1 - EC-type examination (B) followed by Conformity to EC-type based on internal production control plus supervised product testing (C1)</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td>B+C2 - EC-type examination (B) followed by Conformity to EC-type based on internal production control plus supervised product checks at random intervals (C2)</td>
<td>NB or aihb</td>
<td>each</td>
</tr>
<tr>
<td>B+D - EC-type examination (B) followed by Conformity to EC-type based on quality assurance of the production process (D)</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td>D1 - Quality assurance of the production process. As D1 requires from the manufacturer to draw up the technical documentation of the product design, the examination of the product design is carried out in the framework of D1. Therefore D1 does not need to be preceded by B.</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td>B+E - EC-type examination (B) followed by Conformity to EC-type based on product quality assurance (E)</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td>E1 - Quality assurance of final product inspection and testing. As E1 requires from the manufacturer to draw up the technical documentation of the product design, the examination of the product design is carried out in the framework of E1. Therefore E1 does not need to be preceded by B (similar to D/D1).</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td>B+F - EC-type examination (B) followed by Conformity to EC-type based on product verification (F)</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td>F1 - Conformity based on product verification. As F1 requires from the manufacturer to draw up the technical documentation of the product design, the examination of the product design is carried out in the framework of F1. Therefore F1 does not need to be preceded by B (similar to D/D1, E/E1).</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td>G - Conformity based on unit verification</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td>H - Conformity based on full quality assurance</td>
<td>NB</td>
<td></td>
</tr>
<tr>
<td>H1 - Conformity based on full quality assurance plus design examination</td>
<td>NB</td>
<td></td>
</tr>
</tbody>
</table>

**Risk and conformity assessment modules in existing measures**

The conformity assessment procedures and the modules they consist of are designed to fit an enormous variety of manufacturing processes, ranging from making medicines, to food production, to construction products, consumer products, industrial products, etc. and take into account the different risks (of not meeting essential requirements) involved. The risk assessment for various pieces of legislation has resulted in the following conformity assessment procedures (examples):

- The Gas Appliance Regulation (GAR) 2016/426/EU prescribes (in article 14) the (current) Module B+C2 (random interval checks), B+D (quality assurance production, no mandatory product checks), B+E (quality assurance product, no mandatory product checks) or B+F (product verification, mandatory product checks). For smaller series/low quantities Module G (unit verification, mandatory product checks) may be applied. All GAR procedures require involvement of Notified Bodies.
- The Pressure Equipment Directive (PED) 2014/68/EU prescribes procedures that depend on risks (e.g. related to pressure and volume contained):
Except for the lowest risk category all PED procedures require involvement of Notified Body in the production phase, or production and design phase.

- The Machinery Directive (MD) 2006/42/EC requires a conformity assessment procedure depending on risks involved. Machinery considered to pose limited risks can follow Module A (Annex VIII of 2006/42/EC). Machinery with higher risks can follow either Module A (if harmonised standards are applied), Module B (Annex IX of 2006/42/EC) plus Module C (Annex VIII, point 3) or Module H (Annex X of 2006/42/EC). Two out of three MD procedures require assessment by Notified Bodies. The one procedure without involvement of Notified Bodies is only allowed if harmonised methods are available that describe allowed safety measures.

- The Low Voltage Directive (LVD) 2014/35/EU requires conformity assessment according Module A and requires no involvement of Notified Bodies.

The above-mentioned Directives and Regulation aim to ensure a sufficient level of safety of products by minimisation or avoidance of risks that are very direct and immediate (resulting in personal injury and/or damage or loss of persons and goods due to unsafe products).

However, the risks relevant for the Ecodesign Directive and its implementing regulations are different to the risks of 'safety' legislation: These risks are not as direct, but their combined effect (of heaters and other sources together, over sufficient time) on society is probably more profound than that of risks associated with unsafe equipment: Climate change is threatening the planet, security of energy supply is of paramount importance for the EU, air pollution is causing numerous premature deaths, etc..

There is an economic dimension: How much money can be saved on the consumer’s energy bill from more efficient boilers? How much more circumvention would take place, and how much less credible do measures become, with lenient rather than stringent compliance checks and procedures? What do the measures cost and are governments willing, given the budgetary restrictions, to spend that money?

There is the matter of the level playing field for competition, e.g. how to protect a compliant EU industry from incompliant imports without an effective market surveillance? Likewise, if –as is the case for several product categories—countries in other continents require costly test procedures and long delays before imported products can be traded, why should the EU not do the same? Within the GATT that is possible for environmental legislation.  

---

214 https://www.wto.org/english/tratop_e/envir_e/envt_rules_exceptions_e.htm
5.5.3 Stakeholder positions

Stakeholders have been asked to present their view on third-party conformity assessment. The following presents an overview of positions received before the 2\textsuperscript{nd} stakeholder meeting and after this meeting: In case no additional comments were received after this 2\textsuperscript{nd} stakeholder meeting, the position was kept as in the draft report. New comments received are included below, indicated with an asterisk *.

5.5.3.1 Manufacturer associations and individual companies

EHI* (European Heating Industry) is in favour of TPCA but also specifies several specific conditions in order to guarantee a level-playing field:

- the choice of modules as described in Annex II to Decision No 768/2008/EC, except module A, shall be free;
- an appropriate transition period shall be set;
- the TPCA should be applied to a unit of a new model before placing such unit on the EU market;
- the link with the other third-party conformity assessment procedures applying to these different product groups should be analysed (e.g. from the Gas Appliances Regulation (EU) 2016/426 or the Pressure Equipment Directive 2014/68/EU);
- the mCHP calculation method should be clarified.

EHI does not consider the extension of third-party conformity assessment procedure to water heating energy efficiency values because the additional testing procedure costs would outweigh the expected benefits.

Eurovent states that “voluntary and mandatory third-party verification and certification do not replace market surveillance. However, Eurovent hold that proven certified and verified product information can provide a support to market surveillance activities – in particular where this information can be publicly accessed and results from accredited testing processes.

Third party certification does come at a cost. There is a return on investment to manufacturers in many ways. It allows manufacturers to compare their laboratories or calculation with the data obtained in independent ISO 17025 accredited laboratories and thus increases the reliability and accuracy of data. It allows to build up customer confidence in the product data that are published by manufacturers and in various instances it can be uses to show compliance with national requirements or as input to national Energy Performance of Building calculations.

The recognition of the Eurovent Certita Certification voluntary certification schemes outside Europe has proven to be beneficial to many manufacturers who otherwise would have been obliged to submit to other voluntary certification schemes to gain access to markets. An underestimated fact is the actual competition between voluntary certification schemes from America, Australia, China, India to get acceptance in other markets. European voluntary third-party schemes are often referred to when European architects and engineers design or oversee projects abroad.

It may be useful to look at the manner other nations look at foreign trade barriers and how they view the Regulation 765/2008 and Decision 2008, for example the 2016 report under the President Obama.
It can be noted that in America the Department of Energy (DoE) and the Environmental Protection Agency (EPA) refer to the products that comply with the voluntary third-party certification schemes run by the association AHRI. AHRI submits certification reports and compliance statements to EPA and DoE on behalf of the certification scheme participants, in compliance with the DoE reporting requirements. This type of data reporting to DoE is a benefit to the participants in the AHRI certification schemes because it helps to reduce the regulatory burdens as the manufacturers do not have to take on this reporting themselves. It is an approach that possibly could be considered when analysing the pro and cons of voluntary and mandatory third-party certification with respect to the costs involved for industry, consumers and authorities.

Marcogaz* (Technical Association of the European Natural Gas Industry) is in favour of TPCA as it enables a fair competition and a level playing field and provides customers with information they can trust when choosing products.

EPEE* representing the interests of HVAC suppliers in Europe requires a thorough impact assessment in case TPCA is pursued. The impact assessment should identify the products covered by TPCA, which modules shall be used, as well as the time for the market to adapt. The introduction of TPCA should be assessed on a case by case basis, considering the particularities of each product category (mass produced products, customised products), production volumes of equipment, etc. The relevant modules should be specified, and to further support market surveillance authorities and product compliance, these modules should involve product tests at some point. To avoid barriers to market both EU-based and non-EU-based notified bodies should be allowed to perform (oversee) the required tests.

EPEE emphasises that TPCA cannot replace market surveillance and should never be assumed to be a replacement for MSAs activities which are the only way to ensure a level playing field on the market.

EPEE emphasises that if the status quo is maintained the shortcomings of the current situation as regards market surveillance need to be addressed, also in the light of the forthcoming Market Surveillance Regulation.

EPEE also states that "if TPCA is introduced, it should be mandatory for Member States to recognise the TPCA results within their national EPB and subsidy programmes as otherwise, manufacturers could end up with the obligation of applying both, TPCA and private certification programmes" but this requirement conflicts with present rules regarding subsidiarity and proportionality.

JRAIA* is not in favour of TCPA nor directly against, but says that market surveillance based on Regulation (EU) No. 765/2008 is not functioning correctly. JRAIA considers that challenges in market surveillance should be discussed further before considering the options for third party certification and mentions the use of voluntary certification schemes in Japan.

EHPA (heat pump suppliers) is aware of the extreme importance of the topic of third-party certification and is currently in the process of working to develop a common definition within the industry of third-party certification as well as to identify the pros/cons and the impact of the inclusion of mandatory third-party certification on consumers and industries.
**APPLIA** (Home Appliance Europe) is opposed to TPCA and prefers the present situation (using Module A) as a mandatory assessment would incur costs without benefits to consumers.

**Individual manufacturers**

**Daikin** (heat pump manufacturer) is in favour of third-party conformity assessment under the conditions that a free choice of modules is allowed, a reasonable transition period is implemented and a delay in going to market is avoided. By thoroughly assessing the potential impact, they find that the benefits to outweigh the concerns, if above-mentioned conditions are met.

Daikin expects third party conformity assessment (TPCA) will (1) reduce free riders in the market and enhance trust in data declarations. (2) more robust and comparable data will be better accepted on other platforms (EPBD calculations, support schemes). (3) a TPCA in Lot 1 for all product groups creates a level playing field and (4) TPCA can support market surveillance authorities.

Risks that have been mentioned for TPCA include (1) the potential increase in compliance costs, (2) the impact on SMEs and (3) the availability of test laboratories and Notified Bodies. Daikin expects, after an initial raise of costs, these to level out, that the choice of modules reduces impacts and costs for SME's, a transition period is required to establish the required testing capacity.

In addition, Daikin thinks it is necessary to allow inter-competition testing or mutual verification as this leads to increased credibility of data.

**NIBE** (heat pump manufacturer) is also in favour of extending the mandatory third-party conformity assessment to heat pumps and combination heat pumps. The current situation of different national certification schemes (required for subsidies) is burdensome. Schemes are reluctant to accept self-declared performance data. Third-party verification would remove such barriers and could help to create trust.

If implemented, manufacturers should be allowed to select the module that suits their specific situation best, and a suitable transitional period should be allowed.

**Mitsubishi Electric** (heat pump manufacturer) supports the self-certification system (i.e. keeping status quo) for electric heat pumps.

**Panasonic** (heat pump manufacturer) also supports the status quo and emphasises the role of market surveillance. Panasonic adds that a 'level playing field' between fuel boilers and heat pumps does not exist (differences in requirements, in efficiency classes, test procedures, and differences in market challenges) and will not be created through TPCA. Neither will TPCA ensure that national authorities recognise the ErP data and forfeit other, voluntary, certification schemes for subsidy schemes etc.

**Stiebel Eltron** is not in favour of TPCA and says the SME position is overlooked: TPCA would be costly, burdensome and harming heat pump development. Furthermore, without TPCA the market would be better able to absorb changes in test methods.

**Various German heat pump manufacturers**

A joint position paper by 14 German heat pump manufacturers (Bartl, Heliotherm, iDM, Kermi, Ochsner, Proxon, Remko, Solvis, Stiebel Eltron, Tecalor, Thermia, Waterkotte, Weider and Wolf, available on the study website) mentions that “according to the signatories of this letter, compulsory "third-party certification" for heat pumps would
entail a significant financial and temporal burden on manufacturers and increase the cost of heat pumps as a product. Small and medium-sized enterprises (SMEs) would be significantly disadvantaged compared to large manufacturers and their innovative capacity hindered. Compulsory "third-party certification" would significantly hinder the technical development and market penetration of heat pumps in Europe, and not least the EU’s Renewable Energy and Climate goals”.

No responses regarding TPCA have been received from:

- **SOLAR HEAT EUROPE / ESTIF** (solar devices)
- **Eurofuel** (oil-fired heating)
- **EBA** (biogas)
- **EUBIA** (biomass)
- **Orgalime** (manufacturers)
- **Europump** (pumps, circulators)
- **EVIA** (fans, including those incorporated into products)
- **GCP Europe** (installers)
- **AFECOR** (oil/gas combustion controls, valves, etc.)

### 5.5.3.2 Certification organisations

**Eurovent-Certification/CERTITA**

“In 1991 the association Eurovent started to develop certification schemes for various product groups. The certification activities are run independently from the association Eurovent by Eurovent Certita Certification according to ISO 17065 and for testing it relies on laboratories that are accredited according ISO 17025. Depending on the actual scheme certification can mean factory audits and the annual testing of randomly selected products. Eurovent Certita Certification currently manages 42 certification programmes, the Eurovent Certified Performance (ECP) mark and the French NF mark. Included are programmes for heat pumps.

Eurovent Certita Certification *is in favour of keeping the current rules, meaning third-party verification* for fuel boilers and self-declaration for products like heat pumps. It is the view of Eurovent Certita Certification that the voluntary certification is well accepted by the manufacturers. Manufacturers recognize voluntary third-party certification as an efficient quality control instrument at an acceptable cost. Manufacturers also use it as a tool to benchmark their own laboratories and by doing so can improve and speed up their product development programmes.

Because the wide array of products on the market, it may not be appropriate to impose mandatory verification as it could very much hurt manufacturers with limited production runs, who would be better off by self-declarations. In the case of series production run voluntary certification has a role because it can adapt relatively swiftly to changes in products and the market. Experience shows that the availability of competent

---

215 http://eurovent-certita-certification.com/
216 The original text said "certification".
certification bodies is limited and that when the mandatory verification of gas and fuel boilers was introduced this has led to a demise of competent certification bodies.

Eurovent Certita Certification does not expect that the continuation of self-declaration will reduce the demand for voluntary third-party certification. In their experience suppliers appreciate the quality control offered by voluntary third-party certification that adheres to ISO 17065 and ISO 17025.

Voluntary certification marks historically have a valuable brand recognition as it distinguishes certified from non-certified products. Certified products benefit from consumer confidence, especially where there is an understanding of the CE marking.

Eurovent Certita Certification expects that the energy labelling database introduced by Regulation 2017/1369 will increase the policing effect as performance data of all suppliers are then publicly available for scrutiny. Listing all products on the EU market would help voluntary certification bodies and market surveillance authorities to identify suspicious performance data. The database targets end-users which would increase visibility and provide for a better knowledge regarding efficient and non-efficient products.

Eurovent Certita Certification points out that third-party verification, voluntary or mandatory, cannot replace market surveillance. Certification can be a supporting tool because, and depending on the certification scheme, it can provide for confidence in the data declared. This may then help market surveillance in targeting products that may not be compliant with Regulations by focusing efforts and funding on those products.

Since Eurovent Certita Certification doesn't cover fuel or gas boilers, it has not provided position regarding these products. To be noted that ECC is a Notified Body pursuant to the Regulation No 305/2011 for chimneys (NB 2270, decision 95/467/EC).

**Solar Keymark**

Solar Keymark has not established an official position as regards third-party verification. As Solar Keymark is not a notified body it fears losing relevance in case of mandatory third-party certification. Solar Keymark does acknowledge the lack of market surveillance on space heating products, including solar devices. Solar Keymark holds a strong position as regards quality control of solar devices in the context of subsidies and other promotional schemes.

**Heat Pump Keymark**

Heat Pump Keymark, managing the Heat Pump Keymark certification scheme, has not established an official position as regards third-party verification.

**ASERCOM** (Association of European Refrigeration Component Manufacturers) states the use of TPCA will most likely not have any measurable impact on the efficiency of the product and it will not relieve market surveillance authorities from their responsibilities. It will create additional effort at manufacturers’ level, which especially in the HVACR industry, are already under a lot of challenges due to the F-gas regulation.

In addition, TPCA will very likely impact most negatively small and medium enterprises. SMEs are in many instances not having the adequate resources and their additional need of personnel/capacity for TPCA might seriously impact them.
ASERCOM is doubtful whether “TPCA would [increase] trust from consumers” but how does a consumer even know that certain products fall under TPCA? There is no evidence presented.

In any case there must be a thorough impact assessment to understand the impact of TPCA, on SMEs and in general, before any decision should be made and any proposal drafted.

VHK concludes that ASERCOM wants this assessment to spell out the available lab capacity for all products within scope and how Notified Bodies select labs to perform tests.

5.5.3.3 Testing laboratories

ECO-BEDAC* is in favour of TPCA believes that "considering the current situation, it is very necessary to establish this control in order to guarantee an equal criteria in the way how the tests are carried out, the way how the ErP values are calculated and declared in the data plate of appliances, and the way how a recurrent surveillance is done."

They believe it will reduce the strain on market surveillance as it is easier to check which products are circulating in the EU market and whether they are in conformity or not. Furthermore, ECO-BEDAC believes that TPCA will avoid "too cheap” low quality testing (the relative costs for maintaining an accredited high quality lab is higher for smaller manufacturers).

As regards electrical heat pumps and solar devices, mandatory third-party testing would be new, but already now many laboratories are performing voluntary third-party tests, because many manufacturers do not have the appropriate testing facilities and many others do third party testing just to be on the safe side. ECO-BEDAC does not expect the testing capacity to be problematic and adds this should not prevent the introduction of third-party certification.

Regarding costs ECO-BEDAC notes that maintaining an accredited laboratory at the same level as laboratories used by Notified Bodies is not cheap either. In many cases it is more cost effective to use a third party.

To ensure reproducibility ECO-BEDAC recommends labs used for TPCA to be accredited and participate regularly in intercomparing tests.

The modules should cover both design and production (B+C2/D/E/F or G)

VHK concludes from ECO-BEDAC comments that especially the DHW tests require close cooperation of testing body and standardisation groups as they are not easy to perform. Nonetheless also here TPCA can be introduced. The burden for parties involved can be reduced if for instance the mandatory tests are limited to the smallest and largest products in a range, and intermediate products are assessed using a simulation model. Notified Bodies could verify such an approach.

LABTQ (independent test institutes): No position received.
5.5.3.4 NGOs

ECOS-EEB (environmental organisations) support third party conformity assessment of heat pumps, of gas and oil boilers, and of other boilers.

Note: ECOS has published a discussion paper on circumvention, which is mentioned in the next section.

BEUC-ANEC* (consumers / in standardisation) is in favour of mandatory third-party conformity assessment, partly because of the high investment costs involved, partly because of the importance of the product group of heat pumps in particular in the upcoming energy transition.

REHVA* a non-profit organisation representing more than 120 000 HVAC engineers and energy experts, states that as heat pumps are becoming more and more mainstream technology reliable data of product performance is becoming more and more important as it is essential for correct design and dimensioning of heating systems. REHVA emphasises the importance of independently assessed data.

REHVA is not a clear supporter for one or more specific conformity assessment modules, but does not rule out the use of such modules either as it wishes all systems placed on the market to be scrutinised.

5.5.3.5 Member states and market surveillance authorities

The Netherlands: The Dutch representative sees third-party certification as "..useful because it provides a certification independent from the manufacturer. However, as with market surveillance, this independence can be endangered when the product cannot be installed and set-up independent from the manufacturer. Also, differences in interpretation of legislation and/or standards can lead to differences in test results between laboratories".

Germany (UBA/BAM) states that "..on the one hand, third-party testing would increase efforts for manufacturers (especially SMEs, with higher testing costs for heat pumps than for boilers). On the other hand, market surveillance authorities could be relieved from high cost of measurements and improve reliability of product data (e.g. uncertainties at noise measurements). However, a thorough political assessment is necessary. Therefore, we ask the study to investigate the pro’s and con’s carefully in order to revisit this issue in a consultation forum".

Denmark* strongly supports third party conformity assessment, also because most suppliers in Denmark already commit themselves to voluntary third part testing.

Belgium* also supports TPCA and in particular module B for the certification and C2 /D / E / F for the verification, for the entire scope of the regulation. Nevertheless, Belgium thinks that very small and medium-sized companies with low sales volumes should be able to modulate requirements according to modalities to be defined or similar modalities that exist in other Ecodesign regulations. Also, for custom made boilers module G is more appropriate. Belgium does present a precaution related to available lab capacity and cost impacts.
5.5.3.6 **Summary of positions of stakeholders**

Stakeholders preferring third-party conformity assessment for all space heaters mostly cite as reason the (expected) higher rate of compliance, avoidance of free-riding, and facilitating market surveillance. Member states are cautious for costs of third-party assessment and independence of tests if manufacturer involvement is required.

Stakeholders preferring the situation "as is" mention the (expected) increase in testing costs, possible time delays and less flexibility in bringing products to the market for products that are currently self-declared. This is particularly affecting SME-sized companies as these have less options/resources available for testing.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>TPCA for all ((^1))</th>
<th>'as is'</th>
<th>self-declaration for all</th>
<th>no clear position</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Industry associations</strong></td>
<td>EHI, Marcogaz</td>
<td>APPLIA</td>
<td></td>
<td>Eurovent, EPEE, JRAIA, EHPA</td>
</tr>
<tr>
<td><strong>Individual manufacturers</strong></td>
<td>Daikin, NIBE</td>
<td>Mitsubishi, Panasonic, Stiebel Eltron and other SME-sized (German) heat pump manufacturers</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Certification organisations</strong></td>
<td></td>
<td>Eurovent-Certita, ASERCOM</td>
<td></td>
<td>Solar Keymark, Heat Pump Keymark</td>
</tr>
<tr>
<td><strong>Notified bodies</strong></td>
<td>ECO BEDAC</td>
<td></td>
<td></td>
<td>LABTQ</td>
</tr>
<tr>
<td><strong>NGO's</strong></td>
<td>ECOS, BEUC-ANEC</td>
<td></td>
<td></td>
<td>REHVA</td>
</tr>
<tr>
<td><strong>Member States</strong></td>
<td>NL, DE, DK, BE</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(\(^1\)): Organisations supportive of TPCA in most cases add ‘disclaimers’ that lab capacity should be sufficient, costs and other impacts should be minimal or proportionate, etc.

5.5.4 **Discussion of relevant elements**

This section discusses various elements brought forward by stakeholders, and tried to bring in other sources than stakeholder opinions only.

5.5.4.1 **Compliance of products**

Probably the main question is whether third-party conformity assessment results in more/better compliant products. This study concludes, on the basis of other studies and projects described below, there is some evidence for this assumption.

An Ifia/CEOC study\(^2\) of 2015 showed that the compliance (of various household items and electronic goods) is higher under (voluntary) third-party certification and lower for self-declared products.

- Of the 319 samples of self-declared products in the EU, 77% were not-compliant with EU standards and regulations and 14% even showed safety-critical failures.
- Of the third-party certified products (EU sample n=139, USA sample n=185) only 0.7-1% showed safety-critical failures.

In the case of toys, since 2008 (when US imposed mandatory third-party certification) recalls decreased by 93% in the same time period, in Europe (with self-declared products), recalls increased by 56%.

This suggests that (voluntary) third-party certified products are more often compliant than self-declared products. However, the study draws no conclusions on the possible difference in compliance of products by manufacturers who are voluntarily willing to pay for external scrutiny (third-party certification, such as operated by Solar Keymark, NF Heat Pumps. etc.) and products submitted to mandatory external scrutiny (third-party conformity assessment, involving Notified Bodies). One may assume that manufacturers choosing voluntary certification are more inclined to make sure their products comply, as they voluntarily opt to pay for and be submitted to scrutiny to carry the certification mark on their products. The study does show that involvement of a third-party often increases compliance levels.

The European EEPLIANT 1 project showed that for lighting products (self-declared) the level of non-compliance with Ecodesign/labelling requirements is particularly high (overall >60% non-compliant, energy efficiency 20% non-compliant) whereas for imaging equipment, which are mostly also certified by Energy Star USA (a de-facto industry standard which requires assessment by EPA approved third-party test labs) non-compliance is lower at 11%. This, similar to the Iifa/CEOC study, suggests a higher compliance of products that are third-party certified. EEPLIANT did not quantify the savings lost due to non-compliance.

When EEPLIANT assessed technical documentation and performed tests of gas boilers (third-party verified) and heat pumps (self-declared) it found compliance of technical reporting was higher for third-party assessed products. But EEPLIANT1 also concluded that both product groups were compliant with the main Ecodesign criteria (which suggests no loss of savings for 'self-declared' products).

But perhaps the most surprising part is that a significant share of the technical documentation of fuel boilers that have undergone third-party testing by accredited Notified Bodies still contained errors. This is also visible in the boiler-check applied in the UK SAP procedure, that introduced maximum efficiency values even if the declared values are higher. Apparently, the involvement of a notified body is no guarantee for a faultless report. This also means that Market Surveillance should not assume a technical report of a third-party assessed product is correct, and third-party conformity assessment (using notified bodies) will still require market surveillance.

It is not known how many of the heat pump products tested within EEPLIANT1 had voluntary third-party certification, but the information from Eurovent Certita suggests that a significant share of heat pumps is third-party certified (voluntarily). Nonetheless errors in technical documentation occurred.

The EEPLIANT project is perhaps not a statistically representative survey, as only a limited number of products available on the market were assessed.

---

218 http://eepliant.eu/
Overall, the available information (Ifia/CEOC and EEPLIANT1) suggests that for product groups in general the involvement of 3rd parties (either voluntary certification or mandatory verification) results in more compliant products\textsuperscript{219}, but offers no guarantee for faultless documentation or declared values. Neither have energy savings from more compliant products been quantified. The role of voluntary certification is unclear, but it appears to have a similar effect on compliance as mandatory third-party verification as both fuel-fired heaters (mandatory third-party) and heat pumps (voluntary third-party) both meet minimum energy efficiency requirements. Differences are mostly related to errors in technical documentation.

### 5.5.4.2 Circumvention

Certain stakeholders consider mandatory type approval (by 3rd parties) as a means to reduce (wilful) circumvention of requirements. Circumvention is basically "false and misleading information being provided to regulators and consumers when measurements are undertaken in a test procedure" or, as the ANTiCSS project\textsuperscript{220} puts it:

"Circumvention” describes the act of deliberately, artfully or deceptively bypassing the requirements in the applicable EU Ecodesign and / or labelling legislation in an illegal way.

It is important to distinguish circumvention clearly from other acts leading to non-compliance of a product (e.g. label not displayed correctly at point of sale), as all products subject to “circumvention” are non-compliant, but not vice versa. A distinctive feature is that circumvention is induced deliberately and that the act is artful and deceptive. Masking non-compliance is a key indicator for circumvention.

ANTiCSS describes several categories of suspicious behaviour which may point at or are considered as “circumvention”: hidden software or hardware, software or firmware updates, specific design / accessories for testing only, modified test samples, ignorance of legislation, ignorance of standard, wrong reference to legislation, deliberate misrepresentation.

The ECOS discussion paper on circumvention\textsuperscript{221} discusses many aspects relevant to addressing this problem and describes options for regulators, standardisation organisations and market surveillance authorities. The ECOS discussion document mentions that the involvement of a third-party can help to uncover suspect behaviour of appliances in a test, whereas for self-declared products, the \textit{mala fide} manufacturer may decide to take his chances with market surveillance (more precisely: the lack of it).

Certain test procedures require intervention by manufacturers to correctly set up the product or test equipment (e.g. as is currently the case in heat pump testing).

\textsuperscript{219} Compliant with main Ecodesign requirements.

\textsuperscript{220} https://www.anti-circumvention.eu/storage/app/media/uploaded-files/ANTiCSS_Definition_circumvention_Preliminary_Short.pdf

\textsuperscript{221} Jeremy Tait, Christoforos Spiliotopoulos; Approaches to address circumvention of Ecodesign and energy label requirements – an ECOS discussion paper
An accredited test institute, operating wholly independent from manufacturers, is probably better positioned to recognise attempts of *mala fide* manufacturers to influence test results in case of such dependencies.

*Diesel gate*\(^{222}\) however shows that involvement of 3\(^{rd}\) parties does not guarantee absence of circumvention, even if it is explicitly forbidden.

### 5.5.4.3 Free-riders

Multiple stakeholders state that third-party conformity assessment will reduce the presence of *free-riders*\(^{223}\) on the market. Possibly free-riders are easier identified if all manufacturers or authorised representatives need to lodge applications with a Notified Body. A check of presence of manufacturer/authorised representative in a list of clients for whom applications have been lodged with Notified Bodies would essentially allow identification of possible free-riders (model, manufacturer and Notified Body receiving the application need to be registered and allow consultation by authorities).

However, it all starts with an action from market surveillance authorities. *Bona fide* manufacturers, consumer organisations and other market ‘watch dogs’ can assist market surveillance in identifying potential free-riders. The ECOPLIANT project has resulted in guidelines that help MSA in these tasks, for instance by focusing on international cooperation.

Some conformity assessment modules allow easier administrative checks than other modules (for instance if Notified Bodies are involved which have to show authorities upon request the conclusions of their assessments).

### 5.5.4.4 Costs and administrative burden

Both manufacturers that self-declare or use third-party conformity assessment need to perform the required tests to show compliance, as both need to produce Technical Documentation, presenting test results of that product, upon request by MSA.

Depending on the conformity assessment module the tests can be performed in-house or by a un-accredited third-party test laboratory, whereas for third-party conformity assessments the test lab has to be an accredited notified body (or an in-house accredited lab, often with witness testing by expert from Notified Body) which raises the costs. Stakeholders are quite unanimous in stating that the administrative burden for manufacturers of products requiring third-party testing is higher than for those that have products requiring self-declaration. The manufacturer has to pay for the assessment by Notified Bodies.

In the event of third-party conformity assessment for all, the capacity of Notified Bodies will initially be limited and a risk for delays in testing and increase of prices can be expected. Manufacturers that self-declare have more options as in-house test labs and independent labs, including Notified Bodies, can be approached for testing and prices of


\(^{223}\) Free-riders are parties that place products on the market (or put them into service) that have not passed the appropriate conformity assessment procedures, and/or have not submitted correct information on the performance of the product and in doing so gain an unfair competitive advantage.
testing will be lower, freeing up resources for product development (innovation, redesign, improvement).

5.5.4.5 Time to market / capacity to innovate

Stakeholders generally agree that the introduction of third-party assessment will initially increase this "time to market" (the time between starting the development of new products and placing them on the market) as the need to receive type approval from Notified Bodies can introduce delays (a capacity problem which can be solved in due time) especially for SME-sized manufacturers that do not own accredited labs.

Furthermore it is expected that the extra costs will reduce the resources available for innovation and that the third-party conformity assessment procedure offers less flexibility in assessment of additional product variations / extra functions / product families / etc. which is again more relevant for SME-sized manufacturers (significant changes in design, may require EC-type examination of the revised design).

5.5.4.6 Lab capacity

If third-party verification would be introduced for all space heaters the lab capacity of Notified Bodies would surely need to increase to absorb the additional applications of especially heat pumps. Chances are that more labs will strive for accreditation to become a Notified Body, filling the capacity gap. As manufacturers/suppliers can shop within the EU for test labs, a competitive element is introduced. Based on historical experience (when boilers were made subject to third-party testing) this can lead to a "race-to-the-bottom" where prices of testing are very much dependent on the available test capacity on the market (more volatile, and probably higher than for self-declared products) and quality may suffer (if national accreditation bodies do not function properly).

Larger manufacturers could employ in-house accredited labs and witness testing but this route would not be available for smaller (SME-sized) companies that produce rather small series / lower quantities of heat pumps, solar devices, certain microgeneration types, as the market for these products allows this diversity in series-size to exist. These SME's will compete with other SME's for testing capacity at Notified Bodies. However, as seen with boilers, it is expected that conglomeration of manufacturers will occur.

Vice versa, if self-declaration would become the default conformity assessment procedure, the use of accredited labs would no longer be necessary. As fuel boilers would still require involvement of Notified Bodies for safety assessment, chances are that these would continue to have their products tested by Notified Bodies (or in-house accredited labs). Other heaters could rely on in-house (unaccredited) labs or third-party labs as today. The resulting change in required test capacity is probably less abrupt compared to changing to mandatory third-party conformity assessment as the existing routes can still be applied.

Experience of ASERCOM

ASERCOM has experience in a program for the private certification of condensing units in order to support the COMMISSION REGULATION (EU) 2015/1095 of 5 May 2015 with regard to Ecodesign requirements for condensing units. They qualified 4 labs (from 10 that were considered and approached) for the measuring of Condensing Unit MEPS, and only 2 of them have an accreditation for condensing units according to ISO 17025. The other 2 without accreditation is an independent lab an industry lab (not producing condensing units though). Each lab has a different capacity for
testing and there is actually only one lab that can test all types of condensing units covered by Ecodesign.

A test of a condensing units takes about one week. In general, the labs do test other HVACR products as well, so there is competition and our ASERCOM working group usually tries to “reserve” capacities by planning and informing the labs several months in advance. Whenever a lab had to upgrade their facilities in order to perform testing, especially concerning flammable refrigerants, the waiting time increases since the lab has to get the approval from the authorities on top of changing the infrastructure physically and possibly increasing their manpower accordingly.

The maximum capacity of a lab depends on both the technical infrastructure of the lab as well as the personnel capacity of the lab.

5.5.4.7 Subsidies/grants requiring certification or other sources

National or local authorities may require third-party certification of products in order for them to be eligible for subsidies or grants, but in other cases the mandatory Ecodesign information is accepted as well. A complete overview is difficult to establish as this is regulated at national or even local level, and the role of third-party certification is not always easy to distinguish. Some examples of proof required for subsidies/grants/tax reliefs are:

- In Germany BAFA subsidies for solar devices require the products to be certified with Solar Keymark, produced by an ISO 17025 accredited assessment body.\(^{224}\)
- In France a tax relief is available for renovations in which (a.o.) solar devices are applied (CSTBat, Solar Keymark, or equivalent mark required) or heat pumps (no certification required, and as minimum required efficiency is expressed in primary energy, it is assumed that Ecodesign technical information suffices). The scheme also covers mCHP, water heaters, and other heating equipment.\(^{225}\)
- In Italy the Conto Termico supports (a.o.) heat pumps and solar devices. Solar devices have to be certified according Solar Keymark. Heat pumps have to have a minimum COP, as established by EN 14511, so here Ecodesign information would suffice.\(^{226}\)
- In Spain solar thermal devices are eligible for funding if tested according European standards and the manufacturing process is ISO 9001 certified. Solar Keymark is not directly accepted as test reports have to be scrutinised by AENOR.\(^{227}\)

In The Netherlands the ISDE subsidies (heat pumps, solar, cogeneration, biomass) are based upon Ecodesign/labelling information.

In the UK the list of Energy Saving Trust (EST) endorsed products are verified by EST itself.

---


\(^{225}\) https://www.ademe.fr/particuliers-eco-citoyens/financer-projet/renovation/dossier/credit-dimpot/conditions-beneficier-credit-dimpot-transition-energetique-2018


In Denmark the *Varmepumpelisten* shows performance data of heat pumps as supplied by accredited labs. Only products present on that list are eligible for subsidies (e.g. in case of replacing an oil boiler with an electric heat pump). The list is also referred to by manufacturers active in other (Nordic) countries.

In Belgium/Walloon region various efficient heating products receive grants of €200 for installing a condensing boiler (!), €750 for a DHW heat pump, €1500 for a combined space heating and DHW heat pump and €1500 for a solar thermal system. Gas boilers require just the technical documentation, heat pumps must show a certificate of performance issued by an ISO 17025 accredited organisation, for solar devices the technical information suffices, but installation has to be done by a registered and qualified installer.

More country reports are available at:

- [https://www.iea.org/policiesandmeasures/renewableenergy/](https://www.iea.org/policiesandmeasures/renewableenergy/)
- [https://www.euroobserver.org/euroobserver-policy-files-for-all-eu-28-member-states/](https://www.euroobserver.org/euroobserver-policy-files-for-all-eu-28-member-states/)

Third-party certification is thus still very relevant for space heaters in particular those applying renewable energy (solar thermal devices, heat pumps) because of the relation to incentive schemes (subsidies, tax reliefs, etc.).

According information from Eurovent Certita Certification at least 67% of heat pump models placed on the EU market are third-party certified (this can mean that one model of a family of products has been tested, and the other family models have been screened). The relatively high level of compliance of heat pumps is likely the result of third-party certification required for subsidies/tax relief/etc. and is possibly not representative for performance of all self-declared products.

### 5.5.5 Summary

Even if many industry associations have not yet presented / cannot reach their final positions, the preceding sections have shown that none of the stakeholders asked for self-declaration for all products. The choice is therefore between: the situation as is; or applying third-party conformity assessment to all heaters covered.

The stakeholders in favour for third-party assessment procedures for all heaters, believe it raises the compliance of products with requirements, reduces the tasks/workload of Market Surveillance Authorities, and reduces chances for free-riders.

Stakeholders opposed to third-party testing for all products fear that the limited testing capacity will raise testing costs and longer time-to-market and reduce flexibility to operate.

Almost all parties agree that changing the current conformity assessment procedures to "third-party conformity assessment for all" will bring profound changes to the existing market in multiple ways: A need for more (capacity of) Notified Bodies will emerge, the

---


(initially) limited testing capacity will increase testing costs and time for testing, but some also state that after time the increase in number of Notified Bodies to choose from will reduce testing costs and time. Independent labs currently involved in third-party certification may apply to become an official Notified Body to increase available test capacity. Extra costs for heat pump manufacturers may be limited if the use of NB's means that separate third-party certification can be foregone.

Arguments pro third-party conformity assessment:

- An independent accredited lab is not under any commercial pressure to have favourable test results and is bound to neutral assessment of the product’s performances;
- Type examination can detect possible non-conformity before the product is placed on the market;
- Accredited labs can produce reliable test results because of their experience, quality equipment and inter-laboratory testing;
- Third-party conformity assessment may be as expensive, or slightly less expensive, than third-party certification (Note: this will depend on the selected module);
- A registration of applications lodged with Notified Bodies could allow free-riders to be recognised by an administrative check (if all products need to be verified by Notified Bodies);
- If there is a significant increase in sales of heat pumps this could result in a reduction of subsidies and tax reliefs that require third-party certification. This would remove an incentive for manufacturers to apply for certification and this could make the market more vulnerable to free-riders, raising the need for third-party conformity assessment;

Arguments contra third-party conformity assessment:

- Third-party conformity assessment is more expensive than self-declaration;
- the mandatory use of Notified Bodies results in limited testing capacity available, higher time-to-market and less flexibility in bringing to the market (slightly) changed designs;
- The efforts required to address a change in conformity assessment procedures may be better applied to improving the current imperfections of the market (simplification of installation and cost reductions of heat pumps, better integration with other heat generators e.g. solar devices, general product improvement);
- SME-sized companies may be disproportionately disadvantaged as they have lesser options to meet certain conformity assessment modules procedures (supply a specimen for EC-type examination, operate a Quality System, operate an accredited in-house body, etc.)
- Manufacturers of heating products have indicated the importance of a level playing field, and testing costs / time is an element of that. Testing costs of heat pumps are currently two- or three-fold the testing costs for fuel boilers. The differences in purchase costs are however also much higher for heat pumps than for (gaseous) fuel boilers. It is doubtful whether increased testing costs for non-fuel heating products will reduce the existing difference in purchase prices and level the playing field;

Conditions for success for third-party conformity assessment:

- Sufficient test capacity needs to be realised before the assessment procedures are changed -> this requires careful timing of the change;
• The mandatory third-party conformity assessment should replace the voluntary third-party certification (otherwise double costs for suppliers) -> this requires careful cooperation with (national/regional) authorities that operate subsidy/tax relief schemes. An alternative source of income needs to be found for these certification schemes to remain viable (become a Notified Body, etc.)

• Market Surveillance must award higher priority to verification of products, so that free-riders and non-compliant products are identified and removed from the market.

If third-party conformity assessment is introduced, a selection must be made as regards which modules are allowed for conformity assessment.

Modules requiring a check of each individual product (Module A1, C1, F/F1) are considered not proportionate or justified, as this is even more restrictive than the current scheme for safety of gas appliances.

Currently Module A1 and A2 do not require the Notified Body to inform the authorities of the results of the inspection or checks.

All Modules requiring EC-type examination (B+.. and H1) require the Notified Body to keep record of EC Type certificates issued (and refused, withdrawn, suspended or otherwise restricted).

All Modules that involve a Quality System assessment (D, D1, E, E1, H) require the Notified Body to inform authorities of quality system approvals issued or withdrawn, refused, suspended or otherwise restricted.

Module F, F1 and G require the Notified Body to issue a certificate of conformity (CoC), which in principle should allow an administrative assessment.

The table below shows the different conformity assessment procedures and highlights the presence of an EC-Type examination (green cell) or the mandatory check of each product / representative batch (red cell).
<table>
<thead>
<tr>
<th>Conformity assessment procedure (based on modules applied)</th>
<th>NB assessment covers</th>
<th>Administrative assessment by MSA possible?</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: self-assessment</td>
<td>[n.a.]</td>
<td>no</td>
</tr>
<tr>
<td>A1: self-assessment + check of each product by NB/aihb</td>
<td>each product</td>
<td>no</td>
</tr>
<tr>
<td>A2: self-assessment + interval check of product by NB/aihb</td>
<td>interval</td>
<td>no</td>
</tr>
<tr>
<td>B+C: EC-Type examination + self-declaration</td>
<td>NB/aihb</td>
<td>EC-type</td>
</tr>
<tr>
<td>B+C1: EC-Type examination + check of each product by NB/aihb</td>
<td>each product</td>
<td>EC-type</td>
</tr>
<tr>
<td>B+C2: EC-Type examination + interval check of product by NB/aihb</td>
<td>interval</td>
<td>EC-type</td>
</tr>
<tr>
<td>B+D</td>
<td>NB/aihb</td>
<td>production + product</td>
</tr>
<tr>
<td>D1</td>
<td>product</td>
<td>QS</td>
</tr>
<tr>
<td>B+E</td>
<td>NB/aihb</td>
<td>EC-type + QS</td>
</tr>
<tr>
<td>E1</td>
<td>product</td>
<td>QS</td>
</tr>
<tr>
<td>B+F: EC-type examination + verification to EC-type by NB, for each product on statistical basis</td>
<td>NB/aihb</td>
<td>EC-type + Certificate of conformity</td>
</tr>
<tr>
<td>F1: self-assessment + verification by NB, for each product or on statistical basis</td>
<td>each product or sample</td>
<td>Certificate of conformity</td>
</tr>
<tr>
<td>G: self-assessment + verification by NB (appropriate examinations and tests)</td>
<td>appropriate examination / test</td>
<td>Certificate of conformity</td>
</tr>
<tr>
<td>H: full quality assurance</td>
<td>design + production + product</td>
<td>QS</td>
</tr>
<tr>
<td>H1: full quality assurance + design examination</td>
<td>design + production + product</td>
<td>EC-design</td>
</tr>
</tbody>
</table>

The options open to conformity assessment can then be grouped according:

1. mandatory EC-type examination (1st column)
2. no EC-type examination but involvement of notified body for assessment of quality assurance and/or product tests (production phase);
3. no EC-type examination, no involvement of notified body (3rd column);
4. product check of ‘each’ product (more strict than current GAR procedures).
Table 61. Grouping of conformity assessment procedures

<table>
<thead>
<tr>
<th>Conformity assessment procedures (between brackets: possible MSA administrative check)</th>
<th>With EC type examination with production checks (random interval or to be decided)</th>
<th>Without EC type examination with production checks (random interval or to be decided by NB)</th>
<th>Without EC type examination no production checks</th>
<th>Requires product check of ‘each’ product</th>
</tr>
</thead>
<tbody>
<tr>
<td>B+C (EC-type)</td>
<td>A2 (no)</td>
<td>A (no)</td>
<td>A1 (no)</td>
<td>B+C1 (EC-type)</td>
</tr>
<tr>
<td>B+C2 (EC-type)</td>
<td>D1 (QS)</td>
<td></td>
<td></td>
<td>B+F (EC-type + CoC)</td>
</tr>
<tr>
<td>B+D (EC-type+QS)</td>
<td>E1 (QS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B+E (EC-type+QS)</td>
<td>G (CoC)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H1 (EC-design)</td>
<td>H (QS)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A possible administrative check by MSA is indicated between brackets (to verify with legal experts).

5.6 ECOTest - "Round robin" test of measurement uncertainties

On 19 July 2017 CEN issued a call for tender for the execution of supporting co-normative work to support the implementation of the requirements regarding the verification of the declared parameters for the application of (Delegated) Regulations (EU) No 811/2013, 812/2013, 813/2013 and 814/2013 under the requests for standardization M/534 (Water heaters) and M/535 (Space heaters) for which a Specific Agreement Nº CEN/534-535/2015-14 ‘Water and Space Heater Ecodesign’ was signed between the European Commission and EFTA and CEN. This project is now referred to as "ECOtest".

The scope of the project is to provide for the technologies covered under the requests for standardization M/534 (water heaters) and M/535 (space heaters), for the parameters regulated under these mandates, a verification of the declared parameters for the application of (Delegated) Regulations (EU) No 811/2013, 812/2013, 813/2013 and 814/2013.

The requests for standardization state ‘Each harmonised standard shall include a verification procedure that can be used to verify the declared parameters in particular for market surveillance purposes.’ Such procedure shall:

- identify the sources of variability to be considered for market surveillance purposes;
- provide values for measurement uncertainties for the purposes of the verification procedure for the measured parameters taking into account the different sources of variability to be considered when a specific product is taken from the market and measured for market surveillance purposes;
- indicate if, in order to reduce the impact of variability to the system, specific criteria should be met by laboratories involved in the verification of the declared data (e.g. quality management system, qualification system, personnel training).

The general objective of the project under this call is:

- to provide for the application of (Delegated) Regulation (EU) No 811/2013, 812/2013, 813/2013 and 814/2013 for each parameter measured and each appliance
a value of the inter-laboratory reproducibility obtained with the test procedures of the corresponding standard developed;

- to propose improvements of the procedures from the standards;
- to evaluate the value of inter-laboratory reproducibility with the improved procedures;
- to propose for all parameters and appliances tested a value of a reasonable tolerance that shall be used for the market surveillance.

An interim (progress) report is expected for 30 Sep 2018 and a final report for 16 June 2019. In more detail the final report for phase 1 (S+20,5 months) shall contain following elements:

D. An assessment (with Round Robin Tests) of the inter-laboratory reproducibility, repeatability and variability required by and for parameters to be used for the (Delegated) Regulation (EU) No 811/2013, 812/2013, 813/2013 and 814/2013 by evaluating the standards implementing those regulations;

E. Comments to the relevant TCs upon the practical application of the relevant standards in view of the above application (see Annex III Standards to be revised under Specific Agreement N° CEN/534-535/2015-14 “Water and Space Heater Ecodesign”) and suggestions of improvements of the procedures that are expected to lead to better reproducibility when needed. The final report for phase 1 (see 3.3) will be the guidance for taking up the improvements into the standard Steering Group;

F. Comments on tolerances to be used for the market surveillance in the light of the results obtained, a presentation of the state of the art and suggestions.

Only laboratories accredited against ISO 17025 are eligible to participate (with possible exceptions for new technologies).
The standards involved are:

**Table 62. Overview of standards that are part of the round robin ECOtest**

<table>
<thead>
<tr>
<th>Revision/Amendment of Standards c)</th>
<th>Secretariat TC or TC WG</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEN CR 1404 (under revision as prCEN/TR 1404 rev)</td>
<td>AFG/BNG CEN/TC 238 WG 2</td>
</tr>
<tr>
<td>prEN 15502-1:2012+A1:2015 rev a)</td>
<td>NEN CEN/TC 109 WG 1</td>
</tr>
<tr>
<td>prEN 13203-2:2015 rev</td>
<td>AFG/BNG CEN/TC 109 WG 4</td>
</tr>
<tr>
<td>prEN 13203-4 rev</td>
<td>AFG/BNG CEN/TC 109 WG 4</td>
</tr>
<tr>
<td>prEN 13203-6 rev</td>
<td>AFG/BNG CEN/TC 109 WG 4</td>
</tr>
<tr>
<td>EN 50465:2015 rev</td>
<td>DKE CEN/CLC/JWG FCGA</td>
</tr>
<tr>
<td>prEN 12309-2:2015 rev</td>
<td>UNI CEN/TC 299 WG 2</td>
</tr>
<tr>
<td>prEN 12309-3:2015 rev</td>
<td>UNI CEN/TC 299 WG 2</td>
</tr>
<tr>
<td>prEN 12309-4:2015 rev</td>
<td>UNI CEN/TC 299 WG 2</td>
</tr>
<tr>
<td>prEN 12309-6:2014 rev</td>
<td>UNI CEN/TC 299 WG 2</td>
</tr>
<tr>
<td>prEN 304 rev b)</td>
<td>DIN CEN/TC 57 WG 2</td>
</tr>
<tr>
<td>prEN 15034:2006 rev</td>
<td>DIN CEN/TC 57 WG 5</td>
</tr>
<tr>
<td>prEN 14511-2:2013 rev</td>
<td>UNM CEN/TC 113 WG 8</td>
</tr>
<tr>
<td>prEN 14511-3:2013 rev</td>
<td>UNM CEN/TC 113 WG 8</td>
</tr>
<tr>
<td>prEN 12102:2013 rev</td>
<td>UNM CEN/TC 113 WG 9</td>
</tr>
<tr>
<td>prEN 14825:2013 rev</td>
<td>NBN CEN/TC 113 WG 7</td>
</tr>
<tr>
<td>prEN 16147:2011 rev</td>
<td>DIN CEN/TC 113 WG 10</td>
</tr>
<tr>
<td>prEN 13203-5:2015 rev</td>
<td>AFG/BNG CEN/TC 109 WG 4</td>
</tr>
<tr>
<td>prEN 12975 (revision of prEN 12975-1:2006 d))</td>
<td>SNV CEN/TC 312 WG 1</td>
</tr>
<tr>
<td>prEN 12976-2:2006 rev</td>
<td>NEN CEN/TC 312 WG 2</td>
</tr>
<tr>
<td>prEN 12977-2 rev</td>
<td>DIN CEN/TC 312 WG 3</td>
</tr>
<tr>
<td>prEN 12977-3:2012 rev</td>
<td>DIN CEN/TC 312 WG 3</td>
</tr>
</tbody>
</table>

**a)** Only minor changes for EN 26:2015 and EN 89:2015 following changes made to EN 15502-1. Therefore not taken up separately.

**b)** EN 15456:2008 regarded as less relevant for this project

**c)** EN 15316-4:3:2007 and EN 62301:2005 regarded as not relevant for this project

**d)** EN12975-2 is not on this list as it was withdrawn some years ago and was replaced by EN ISO 9806:2014, which will not be harmonized under M/534

**Interim results**

Interim results from extensive round-robin tests in the ECOtest project suggest that the verification tolerances can often –depending on the product category— be considerably
reduced. Presentations during the November 2018 Steering Group meeting suggest that verification tolerances for space heating efficiency of gas/oil fired boilers could be reduced from the current 8% to 2%. For efficiency of gas-fired instantaneous water heating values of 3% are mentioned. For storage water heating 4% would be feasible. Confirmation, explanation and results for other products (solar, heat pumps, cogeneration, etc.) can be expected around April 2019.
APPENDIX I – SOLICS, SOLCAL AND OTHER METHODS TO CALCULATE THE SOLAR CONTRIBUTION TO WATER HEATING (COMBINATION HEATERS)

Solar heating, introduction to calculations

Scope and definitions
Regulation (EU) No 813/2013 (Ecodesign of space heaters) does not cover solar products. It is aimed at space heaters, including those in a package with solar devices, but no requirements apply to solar devices.

Delegated Regulation (EU) No 811/2013 for labelling of space/combination heaters does cover solar devices, either as solar devices sold separately (for which a product fiche has to be supplied, Annex IV, point 4) and/or as part of a package (for which a space heater package label, product fiche and technical documentation has to be established/supplied). The package label for space or combination heaters with solar devices shall be based on information from the product fiche of the solar devices (collector size, tank volume, collector efficiency and tank rating).

Contrary to the water heater regulations, the measurement and calculation required for calculating the contribution to space heating is limited to two collector parameters (area and efficiency) and two tank parameters (volume and label class).

The calculation of the solar contribution to the water heating performance –and this covers combination heaters as well is however quite different and requires establishing $Q_{nonsol}$ (the part of the heat demand that cannot be met by solar heat) and $Q_{aux}$ (the auxiliary electricity input by the solar system). $Q_{nonsol}$ and $Q_{aux}$ can be established for custom built systems using collector parameters (zero loss efficiency, $a_1$, $a_2$ AIM and are) and the SOLCAL method described in the Transitional Method for water heaters (and updated in EN 15316-4-3:2017) and for factory-built systems the SOLICS method (updated in EN 12976-2:2017). These procedures are described below.

TM2014wh describes the applicable standards and allowed tolerances on parameters and continues under point 4.8 the calculation for solar water heaters and solar-only systems, testing and calculation methods. Point (4.8.a) describes assumptions and calculations for solar collector testing, the SOLCAL method is described under point (b) and finally the SOLICS method under point (c).

The following sections describe the calculations applied in the SOLCAL or SOLICS method. Equations and assumptions defined in TM2014wh are presented in dark-orange text. Equations or assumptions defined by 812 and 814/2013 are presented in blue text.
**SOLCAL method**

The SOLCAL method is based on the EN 15316-4-3 standard and the f-chart modelling approach. The method requires input parameters:

- solar collector: Asol (aperture or reference area), zero-loss efficiency (\(\eta_0\)), a1, a2 and IAM, in accordance with EN ISO 9806. The TM2014wh point 4.8(a) requires that the IAM is established from a test at 50\(^\circ\) incidence angle to the collector.;
- solar hot water storage tank: nominal volume (Vnom), non-solar storage volume (Vbu) and the specific standing losses (psbsol), in accordance with various standards, notably EN 12897, EN 15333, or EN 12977-3;
- the power consumption of the collector pump (solstandby) and controls, necessary to calculate the auxiliary electricity consumption \(Q_{aux}\).

SOLCAL is a monthly method. The monthly non-solar heat contribution \(Q_{nonsol_{tm}}\) is the monthly demand for heat (\(Lw_{htm}\)) of which the monthly solar contribution (\(LsolW_{tm}\)) is subtracted, and the monthly standing losses of the solar part of the storage tank are added (0.732*Psbsol*Vbu/Vnom*(60-Ta)).

\[
Q_{nonsol_{tm}} = Lw_{htm} - LsolW_{tm} + ( 0.732 \times Psbsol \times \frac{V_{bu}}{V_{nom}} \times (60 - T_a) )
\]

0.732 is a factor that takes into account the monthly hours (30.5 days*24 hrs) and the conversion from W to kW (/1000)

\(Lw_{htm}\) is the monthly water heating demand

\[
Lw_{htm} = 30.5 \times 0.6 \times (Q_{ref} + 1.09)
\]

Where:

- 30.5 is the average number of days per month
- 0.6 is a factor to calculate the average heat demand on the basis of the load profile
- \(Q_{ref}\) is the daily water heating demand as established per load profile (from XXS to 4XL)
- 1.09 is a factor that adds distribution losses to the daily water heating demand

\(LsolW_{tm}\) is the monthly heat captured by the solar devices:

\[
LsolW_{tm} = LsolW1_{tm} - Qbuf_{tm}
\]

The minimum value of \(LsolW_{tm}\) is 0 and the maximum value is \(Lw_{htm}\). This means that one cannot put more energy in the solar storage tank, than is extracted as useful energy (\(Lw_{htm}\)). In other words, the storage tank losses are always considered to be met by a back-up heater, even in the summer months. See also the section 'Discussion'.

Where:

\[
LsolW1_{tm} = Lw_{htm} \times \left(1.029 Y_{tm} - 0.065 X_{tm} - 0.245 Y_{tm}^2 + 0.0018 X_{tm}^2 + 0.0215 Y_{tm}^3\right)
\]
\[ Q_{buf_{tm}} = 0.732 \times P_{bsol} \times \left( \frac{V_{nom} - V_{bu}}{V_{nom}} \right) \times \left( 10 + \frac{50 LsolW_{1_{tm}}}{Lwh_{tm}} - T_a \right) \]

Where:

\[ X_{tm} = A_{sol} \left( a_1 + 40 \times a_2 + \frac{6 + 0.3 \times A_{sol}}{A_{sol}} \right) \times \left( 1 - \frac{\eta_0 \times a_1}{100} \right) \times (T_{ref_{tm}} - T_{out_{tm}}) \times ccap \times \frac{0.732}{Lwh_{tm}} \]

\[ Y_{tm} = A_{sol} \times IAM \times \eta_0 \times \left( 1 - \frac{\eta_0 \times a_1}{100} \right) \times Q_{sol_{tm}} \times \frac{0.732}{Lwh_{tm}} \]

\( Y_{tm} \) is the monthly ratio between absorbed energy and the heating demand.

Note 1: \( 6 + 0.3A_{sol} \) is the heat loss through the collector loop \( (WK^{-1}m^{-2}) \)
Note 2: \( 100A_{sol} \) is the heat capacity of the heat exchanger \( (W/K^{-1}m^{-2}) \)
Note 3: The minimum value of \( X_{tm} \) is 0 and the maximum is 18
Note 4: The minimum value of \( Y_{tm} \) is 0 and the maximum is 3

\[ T_{ref_{tm}} = 58.8 + 3.86 \times T_{cold} - 1.32 \times T_{out_{tm}} \]

\[ ccap = \left( 75 \times \frac{A_{sol}}{V_{sol}} \right)^{0.25} \]

\( T_{out_{tm}} \) is the average daytime temperature in °C for average, colder and warmer climate conditions (see tables).

\( T_{cold} \) is the cold-water temperature, by default 10°C.

\( Q_{sol_{tm}} \) is the average global irradiance in W/m² for average, colder and warmer climate conditions (see tables).

The annual non-solar heat contribution (in kWh/a) is calculated as:

\[ Q_{nonsol} = \sum (Q_{nonsol_{tm}}) \]

Discussion:

\( LsolW_{tm} < Lwh_{tm} \)

Experts of CEN TC 312 have argued that the limitation of the maximum delivered solar heat \( LsolW_{tm} \) to maximum the (monthly) hot water demand \( Lwh_{tm} \) is not realistic. Especially in summer months the contribution of modern solar devices can be sufficient to cover the hot water demand AND the storage losses. The current method means that in summer months a backup heater \( (Q_{nonsol}) \) is required to cover storage losses and \( Q_{nonsol} \) can never be zero. In practice this means that, particularly with the small load profiles M and L, the storage loss of the back-up part is relatively high. So, except for highly efficient collectors virtually no \( (M\text{-profile}) \) or only minor improvements of the water heating energy efficiency e.g. to A + \( (L\text{-profile}) \) are possible.

The error can be corrected by adding the storage losses to the load to be covered by solar heat.
**Ytm ≤ 3**

The parameter Y is limited to maximum 3 in accordance with the f-chart method which forms the basis of the SOLCAL method. However, modern collectors can have much lower heat loss values than in the seventies, when the f-chart method was developed, and the maximum value of 3 for $Y_{tm}$ is outdated. The limitation of $Y_{tm}$ distorts in particular solar fractions that can be obtained by highly efficient collectors.

The error can be corrected by removing the maximum of $Y_{tm}$.

**Correction of solar storage losses in LsolW1**

The f-chart method includes, in the determination of $LsolW1_{tm}$, storage losses. In order to avoid double counting the equation can be corrected by a factor 1.08 (can be called $f_{app}$).

The overall method can be made more transparent by adding equations for intermediate parameters, such as indicating the storage losses ($Lbu_{tm}$) and the solar fraction ($f_{tmp,m}$).

The water heating energy efficiency is then calculated according the type of backup heater (equations are provided by EN 15316-4:2017, Annex F) and whether it is a product or package (equations in regulations). The remaining elements needed for these calculations are the water heater energy efficiency in conventional mode ($\eta_{wh,nonsol}$) and, if applicable, the power and fuel consumption ($Q_{elec}$ and $Q_{fuel}$).

**Effects of improved SOLCAL, SOLICS**

The SOLCAL method in its current implementation in TM2014sh has a maximum Y-factor is '3' which limits the effect of modern high-performance collectors. Furthermore, the TM2014sh SOLCAL implementation does not allow the heat losses of the storage tank to be met by solar heat (which means there is always 'back-up energy' required, even in summer months, where solar inputs may exceed hot water demand).

The corrections introduced by the most recent EN 15316-4-3 result in lower values for $Q_{nonsol}$ (the remaining heat to be supplied by a non-solar heat generator): For a typical flat plat glazed collector of 4 m² in the average climate, the $Q_{nonsol}$ is 7-38% lower for the improved method (for XXL to M profile). This can result in a shift of multiple label classes, in particular in the lower (M-) profiles. The differences get more pronounced if the collector area, and the solar fraction, increases.

<table>
<thead>
<tr>
<th>$Q_{nonsol}$ for typical flat plate, 4 m²</th>
<th>Climate</th>
<th>M</th>
<th>L</th>
<th>XL</th>
<th>XXL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOLCAL original</td>
<td>Average</td>
<td>843.0658</td>
<td>2318.538</td>
<td>1661.934</td>
<td>3628.313</td>
</tr>
<tr>
<td></td>
<td>Warmer</td>
<td>648.4657</td>
<td>1742.025</td>
<td>1156.539</td>
<td>2788.439</td>
</tr>
<tr>
<td></td>
<td>Colder</td>
<td>1066.197</td>
<td>2644.025</td>
<td>3384.195</td>
<td>4124.365</td>
</tr>
<tr>
<td>SOLCAL improved</td>
<td>Average</td>
<td>525.0926</td>
<td>2066.326</td>
<td>1416.211</td>
<td>3390.857</td>
</tr>
<tr>
<td></td>
<td>Warmer</td>
<td>263.6417</td>
<td>1422.898</td>
<td>856.6074</td>
<td>2445.234</td>
</tr>
<tr>
<td></td>
<td>Colder</td>
<td>820.8177</td>
<td>2441.105</td>
<td>3189.544</td>
<td>3937.983</td>
</tr>
<tr>
<td>difference</td>
<td>Average</td>
<td>-38%</td>
<td>-11%</td>
<td>-15%</td>
<td>-7%</td>
</tr>
<tr>
<td></td>
<td>Warmer</td>
<td>-59%</td>
<td>-18%</td>
<td>-26%</td>
<td>-12%</td>
</tr>
<tr>
<td></td>
<td>Colder</td>
<td>-23%</td>
<td>-8%</td>
<td>-6%</td>
<td>-5%</td>
</tr>
</tbody>
</table>

Typical glazed collector, 4m², $\eta_0=0.76$, $a_1=3.33$, $a_2=0.010$, IAM=0.94, $V_{nom}=300$ l, $V_{bu}=100$ l, psbsol=1.87 W/K, average climate, solpump=36W, solstandby=3 W.

Calculations by software from Solar-Experience GmbH
**SOLICS method**

The SOLICS method is based on the ISO 9459-5 standard and requires testing of the system as a whole, but with any heat generator disabled. The test results in values for parameters that feed into a modelling approach for establishing the annual performance.

As the TM2014wh prescribes an hourly method, the heat demand (the 24 h tapping pattern that results in $Q_{ref}$) has to be expressed in hourly values, and the monthly climate data supplied in table 2 and 3 of Regulation (No) 814/2013 and table 4 and 5 of Delegated Regulation (No) 812/2013 have to be expressed in hourly values.

The result of the modelling is the calculation of the solar contribution $Q_L$ to the overall heat demand. The calculation of the non-solar heat contribution $Q_{nonsol}$ is then calculated differently for solar-only systems and solar water heaters in accordance with TM2014wh:

for solar-only systems (in EN 12976-2:2017 called a "pre-heater system") $Q_{nonsol}$ is:

$$Q_{nonsol} = 0.6 \times 366 \times (Q_{ref} + 1.09) - Q_L$$

and for a solar water heater $Q_{nonsol}$ is:

$$Q_{nonsol} = Q_{aux, net}$$

The water heating energy efficiency is then calculated according the type of backup heater (equations provided by EN 12976-2:2017, Clause 5.9.3.5.) and whether it is a product or package (equations in regulations). The elements needed for these calculations are the water heater energy efficiency in conventional mode ($\eta_{wh,nonsol}$) and, if applicable, the power and fuel consumption ($Q_{elec}$ and $Q_{fuel}$).

**Water heater energy efficiency $\eta_{wh,nonsol}$**

Both EN 12976-2:2017 and EN 15316-4-3:2017 describe the calculation of $\eta_{wh,nonsol}$ and $Q_{elec}$, $Q_{fuel}$ for the following types of products/packages:

1) with integrated fuel fired heater

$$\eta_{wh,nonsol} = \frac{\eta_{wh,tot} \times (Q_{ref} + U S \times f_{aux} \times \Delta T \times 0.024)}{Q_{ref}}$$

$Q_{elec} = \text{as tested}$

$$Q_{fuel} = \frac{Q_{ref}}{\eta_{wh,nonsol}}$$

$\eta_{wh,nonsol}$ is maximized at 1 (100%)

In this case, with an integrated fuel fired heater, the SOLICS method includes calculation of both solar and backup storage losses. To avoid double counting of these losses, the water heater efficiency (tested inclusive of storage losses) is corrected by a factor based on the size of the storage losses ($US*f_{aux}\Delta T*0.024$) compared to the size of the reference water heating demand $Q_{ref}$.

2) with integrated electrical resistance heater

$$\eta_{wh,nonsol} = 40\%$$
\[ Q_{\text{elec}} = Q_{\text{ref}} \]
\[ Q_{\text{fuel}} = 0 \] (zero by default)

For factory-made products (mostly thermosiphon) using the SOLICS method (or the latest EN 12976-2:2017 in accordance with ISO 9459-5 (DST method)) the heat loss of the solar storage is included in the SOLICS calculation. The backup storage losses are however not included.

As the \( \eta_{\text{wh, nonsol}} \) is set to 40% by default, the backup storage losses are NOT included in the calculation of \( \eta_{\text{wh, nonsol}} \) and are therefore considered in the equation for \( Q_{\text{tot}} \) as presented in Regulations 812/2013 (Annex IV, item 3.b) and 814/2013 (Annex VIII, item 3.b) by reducing the \( \eta_{\text{wh, nonsol}} \) by 10% percentage points.

For custom-built products tested as components (collector and tank tested separately) and with the solar water heater energy efficiency determined using the SOLCAL method (or the latest EN 15316-4-3:2017) the backup storage losses must be included in the SOLCAL calculation in case these are not included in the determination of \( \eta_{\text{wh, nonsol}} \). The consideration of storage losses is found in equation [32] in EN 15316-4-3:2017 and the determination of the solar contribution (equation [39] in EN 15316-4-3:2017).

3) with **external** boiler-type auxiliary (backup) heater

\[ \eta_{\text{wh, nonsol}} = 0.95 \times \frac{Q_{\text{ref}}}{Q_{\text{fuel}} + CC \times Q_{\text{elec}} + Q_{\text{corr}}} \]
\[ Q_{\text{elec}} = Q_{\text{elec,on}} + Q_{\text{elec, sb}} = (24 - t_{\text{on}}) \times PSB + t_{\text{on}} \times el_{\text{max}} \]
\[ Q_{\text{fuel}} = \left( Q_{\text{ref}} + \left( 24 \times \frac{Q_{\text{ref}}}{P_{k}} \times P_{\text{stab}} \times \frac{100}{\eta_{k}} \right) \right) \]
\[ t_{\text{on}} = \left( Q_{\text{ref}} + \left( 24 \times \frac{Q_{\text{ref}}}{P_{k}} \times P_{\text{stab}} \times \frac{1}{P_{k}} \right) \right) \]

This is a system with a heating-only boiler as supplementary heater. If \( \eta_{\text{wh, nonsol}} \) is not available from water heater tests (logical for heating only boilers), the efficiency is based on elementary parameters and efficiencies at nominal load (point P4). The calculation above is in line with Guidelines 2018 where it is deemed relevant for packages of water heater and solar device where not all information is available.

This method makes simplifications: First, the smart control factor does not apply in this context. Second: Both relevant standards EN 12976-2:2017 for SOLICS, and EN 15316-4-3 for SOLCAL and the Guidelines 2018, mention that "the tank losses are set to 0 (zero) as they are already considered in the [SOLCAL or SOLICS] method". It is assumed the solar storage tank losses are meant (Qbutfm). The backup storage tank losses are considered to be covered by Pstby only if a storage tank is integrated, as this covers the heat loss of the (space) heater when not providing heat. This does require a correction on the basis of the solar fraction (or backup fraction, depending what is calculated) of the storage tank. If the space heating only boiler makes use of the solar storage boiler, then Pstby does not cover backup storage losses and these have to be considered somewhere.
The factor 0.95 is essentially a safeguard in order not to create an incentive driving the market towards calculation instead of measurements and to ensure that adequate information is provided to consumers (Guidelines 2018).

4) with external heat pump type auxiliary heater

\[ \eta_{\text{wh,nonsol}} = 0.95 \times f \times \frac{\text{COP}_H}{\text{CC}} \times \frac{Q_{\text{ref}}}{Q_{\text{ref}} + S \times 24h} \]

\[ f = \text{depends on HP heat source and climate (if outside air) and ranges from 0.844 to 1.059} \]

The calculation above is in line with Guidelines2018 where it is deemed relevant for packages of water heater and solar device where not all information is available. This method makes a series of simplifications:

- The total energy demand is provided by charging the tank at 60ºC, in consequence, this method does not apply to low-temperature heat pumps;
- At least 0.25 m² of heat exchanger surface are used per kW of thermal capacity;
- The storage losses are pre-determined by standard measurement at a storage temperature of 65ºC;
- The smart factor is not taken into consideration;
- The approach is suitable for heat pumps with electrically driven compressors.

In this case it is assumed a backup storage tank is present and its losses are covered by the heat loss factor S*24h in the equation above.

The "solar preheat" products (as in EN 12976-2) assume an external auxiliary heater, the storage loss of which (if any) is not included in the SOLICS method. This backup storage loss has to be considered in the determination of the water heater energy efficiency \( \eta_{\text{wh,nonsol}} \) of the external water heater.

**Product level: Solar water heater efficiency**

The product level solar water heater energy efficiency only applies to products placed on the market as one unit. This is usually the case for factory-made thermosiphon systems, but in theory also configurations of components placed on the market as one unit (one model to be assembled on site) could apply.

The solar water heater efficiency \( \eta_{\text{wh}} \) is determined as follows (point 3(b) of Annex IV of 814/2013, or 3(b) of Annex VIII of 812/2013):

\[ \eta_{\text{wh}} = \frac{0.6 \times 366 \times Q_{\text{ref}}}{Q_{\text{tota}}} \]

where: \( Q_{\text{tota}} = \frac{Q_{\text{nonsol}}}{1.1 \times \eta_{\text{wh,nonsol}} - 0.1} + Q_{\text{aux}} \times 2.5 \)

Where:

- \( Q_{\text{ref}} \) stems from regulation 812/2013 (also covered in 814/2013), \( Q_{\text{nonsol}} \) stems from either EN 12976-2:2017 (Qaux,net, for solar-plus-supplementary only) or EN 15316-4-3:2017, Table F.7, the summation of the monthly solar contributions.
- $\eta_{wh, nonsol}$ is the water heating energy efficiency for the respective tapping pattern (load profile). For most thermosiphon systems an immersion electric resistance heater (Joule-effect) applies heat generator and the $\eta_{wh, nonsol}$ is by default 40% and the backup storage losses are considered through the 10% deduction in $Q_{tota}$. If the product includes an integrated heater for which no default values apply, then this heater has to be tested in accordance with the appropriate test standard (for combi boilers EN 13203-2, etc.).

The auxiliary electricity consumption $Q_{aux}$ is calculated assuming 2000 hours of pump runtime. The equation is presented in the TM2014wh:

$$Q_{aux} = \frac{2000 \cdot solpump + 24 \cdot 365 \cdot solstandby}{1000}$$

The heating efficiency classes run from G-class: <27 to A+++ class: ≥ 163 for load profile M.

For solar water heaters the efficiency has to be established for all three climate conditions.

**Package level: Efficiency of water heater and solar device**

The efficiency of a package of a water heater and solar device is calculated slightly different to that of a solar water heater (Fig. 1 of 812/2013).

The equation below is based on Figure 1 of 814/2013 (combining calculations ❶ and ❷) and shows the water heating energy efficiency of the package under average $\eta_{wh, sol, average}$ where the subscript ('wh, sol') refers to the heat source and ('average') to the climate condition.

$$\eta_{wh, sol, average} = (1.1 \cdot \eta_{wh, nonsol} - 10\%) \cdot \frac{220 \cdot Q_{ref}}{Q_{nonsol}} - 2.5 \cdot \frac{Q_{aux}}{220 \cdot Q_{ref}}$$

For packages the efficiency has to be established for the average climate condition, and the scores for 'warmer' and 'colder' climates are calculated as a correction of -20% or +40% of the solar contribution on the overall package efficiency:

"Colder": $\eta_{wh, sol, colder} = \eta_{wh, nonsol} - 0.2 \cdot \eta_{wh, sol, average}$

"Warmer": $\eta_{wh, sol, warmer} = \eta_{wh, nonsol} + 0.4 \cdot \eta_{wh, sol, average}$

The source for the values of parameters $Q_{nonsol}$, $Q_{aux}$ and $\eta_{wh, nonsol}$ is the same as for the product level calculation. It is however more likely that EN 15316-4-3:2016 is used (SOLCAL, for components based custom-built systems) and less likely that EN 12976-2:2017 (SOLICS) is used (more appropriate for factory-made systems).

**Space heating and solar devices**

All the above applies to solar heating in the context of water heating. However, solar heating can also contribute to space heating, depending on availability of solar heat, system set-up and demand. Although the current regulations do not consider solar heat as a heat generator technology like heat pumps, solar heat can make a viable contribution to domestic heat demands.
The current solar market is not showing signs of strong growth or revival, which leads to conclude that the package label (for solar) does not work as intended (aside from other effects, such as diminishing subsidies, etc.).

There are articles\(^{230}\) that show that due to outdated or incomplete calculation methods in SOLCAL, the performance (label class) of solar water heater products is not as high as it should be.

And for space heating, the effect of solar devices on overall (package) space heater efficiency is calculated using very simplistic equations.

Solar systems are more and more part of integral heating systems placed on the market as one unit, or components to be added to existing heating systems.

Changes proposed:

1. Recognition of solar heat as heat generator technology, similar to heat pumps (the fact that heat pumps rely on supplementary heating in the form of a back-up heater, hasn't excluded them from getting recognised as heat generator technology). The same basic principle, heat from ambient when required supplemented by another heat generator using a different 'fuel', can be applied to solar technology.
2. As solar heat is easy to combine with existing installations, a self-standing energy label for solar collectors could be helpful, similar to labels for storage tanks (and circulation pumps).
3. The term 'collector aperture area' (A sol) shall be replaced by 'collector reference area' (A sol) throughout the document. The definitions (70) CDR 811; (33) CDR 812 and (30) CDR 814 shall be changed to: 'collector reference area' (A sol) means the maximum projected area through which un-concentrated solar radiation enters the collector (aperture area as in EN 12975-2 or gross area as in EN ISO 9806:2013). Related terms (collector efficiency, incidence angle modifier, a1, a2 etc.) shall consistently relate to the same collector reference area.
4. The term 'collector efficiency' (\(\eta_{col}\)) shall be replaced by 'collector annual efficiency' (\(\eta_{a}\)) throughout the document. An appropriate definition of the performance of a collector is the calculated annual collector output per m² gross area at a reference location for average climate (Solar Keymark Certificate page 2) divided by the annual irradiation sum (all values taken from Solar Keymark Certificate page 2). For space and water heating the output data for a temperature level of 50 °C are suitable.
5. Replace the icon for solar devices (below, left) by a more appropriate one (below, right). The current symbol is used for PV applications.

6. Introduce the label class for warmer climate for solar water heaters on the label, change the assessment of S and M profile so that there is not so a huge change from S to M and extend the rating to A+++. 

The label for solar water heaters is almost exclusively applied to so-called thermosiphon systems installed in the Mediterranean region. The number of such solar water heaters in regions with medium or colder climates can be neglected. It is obvious that an assessment of performance and labelling for the average climate confuses consumers because the label based on an average climate is much worse than for the warmer climate where it is usually applied. It is not desirable to have a (thermosiphon) system that typically supplies more than 75% of the useful heat by solar heat, can be rated at best as A+. Furthermore, the difference to electric heaters is small for the consumer’s eye, especially for the S and M profiles: An electric S-size heater can reach A (ηwh >38%) and an M-size solar system can reach A (ηwh > 65%) whereas the solar system provides has a 75% solar heat contribution and the electric heater has none.

One stakeholder has issued a proposal for a method to assess the performance of a solar system supplying both water heating and space heating (“Combined performance”)

**Discussion solar thermal**

Delegated Regulation (EU) No 811/2013 applies as definitions (Art. 2 and Annex I):

(13) ‘solar device’ means a **solar-only system** (def. 14), a **solar collector** (def. 15), a **solar hot water storage tank** (def. 17) or a pump in the collector loop, which are placed on the market separately;

(14) ‘solar-only system’ means a device that is equipped with one or more solar collectors and solar hot water storage tanks and possibly pumps in the collector loop and other parts, which is placed on the market as one unit and is not equipped with any heat generator except possibly one or more back-up immersion heaters;

(15) ‘solar collector’ means a device designed to absorb global solar irradiance and to transfer the heat energy so produced to a fluid passing through it;

(17) ‘solar hot water storage tank’ means a hot water storage tank storing heat energy produced by one or more solar collectors;

(16) ‘hot water storage tank’ means a vessel for storing hot water for water and/or space heating purposes, including any additives, which is not equipped with any heat generator except possibly one or more back-up immersion heaters;
(18) ‘back-up immersion heater’ means a Joule effect electric resistance heater that is part of a hot water storage tank and generates heat only when the external heat source is disrupted (including during maintenance periods) or out of order, or that is part of a solar hot water storage tank and provides heat when the solar heat source is not sufficient to satisfy required comfort levels;

(74) ‘auxiliary electricity consumption’ (Q aux ), for the purpose of Figure 5 in Annex IV referred to as ‘auxiliary electricity’, means the annual electricity consumption of a solar-only system that is due to the pump power consumption and the standby power consumption, expressed in kWh in terms of final energy;

(75) ‘pump power consumption’ (solpump) means the rated electrical power consumption of the pump in the collector loop of a solar-only system, expressed in W;

(76) ‘standby power consumption’ (solstandby) means the rated electrical power consumption of a solar-only system when the pump and the heat generator are inactive, expressed in W;

Definitions 74 to 76 in Annex I suggest that Qaux, solpump and solstandby can only be established for solar-only systems (collector, tank and possibly pumps, that are placed on the market ‘as one unit’). The limitation to solar-only systems solves the potential problem of establishing Qnon-sol for solar devices placed separately on the market (this is problematic as Qnon-sol can only be established if both collector information and tank information is available)

The definition of solar device covers solar-only systems, collectors, tanks, possibly pumps placed on the market separately, but the calculation of package efficiency (product fiche, Annex IV) appears to be limited to configurations based on solar-only systems. Whether this is intentional is not known.

According the current regulations a solar device, excluding the 'solar-only system', is not a space heater or water heater, as these comprise a heat generator by default. The solar-only system can be a space or water heater as it may comprise a 'back-up immersion heater' which is a heat generator. A solar collector, solar hot water storage tank or a pump are solar devices but no heaters.

This means that solar devices are either a 'single' product (like the factory made solar devices intended to be installed on rooftops as a single package, often with exposed outdoor tanks) or a set of 'components' (collectors, tank, pump, control) which are separate products but offered together.

Solar devices are, presently, not considered to be space heaters as space heaters have to include a heat generator and the definition of a heat generator does not include solar irradiance as energy source (the definition of heat generator in 813/2013 does include ambient heat from air, water or ground or waste heat). Solar can only be considered as part of a package (811/2013).
Solar heat and heat generators

The Directive 2009/28/EC defines ‘energy from renewable sources’ as: energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases. In the current space/combi heater (and water heater) regulations, solar heat is however not mentioned as possible heat source for heat generators, whereas hydro-/aero-/geothermal energy is 'mentioned' as heat source for heat pumps.

Stakeholders argue that solar heat is a renewable heat source (energy carrier) in its own right (like aerothermal, geothermal or hydrothermal energy used by heat pumps) and should be given preference over energy carriers that result in net CO₂ emissions (like fuels and grid electricity). The fact that solar heat is often not sufficient to cover a (building) heat load, has not been a hindrance for heat pumps to be included as 'heat generators' that may also need back-up heating (a method to include back-up energy is described in EN 14825).

In Regulation (EU) No 814/2013 (Ecodesign of water heaters) there is a definition for a 'solar water heater' (Article 2.(12), a subset of water heaters) for which test conditions are defined (separate testing if possible) and a calculation that relies on identification of the annual non-solar heat contribution (Qnonsol) and the non-solar water heater efficiency. In Delegated Regulation (EU) No 812/2013 (labelling water heaters) this definition is placed in Annex I (2). The package may also include solar devices.

The level of detail required for the inclusion of solar thermal devices in the space heating seasonal efficiency for packages is limited to the product fiche for packages which requires as solar inputs:

- collector size;
- tank volume;
- collector efficiency;
- tank rating (based on standby heat loss);
- 'III'' the value of the mathematical expression: \( 294 = (11 \cdot P_{\text{rated}}) \), whereby \( P_{\text{rated}} \) is related to the preferential space/ combination heater;
- 'IV'' the value of the mathematical expression \( 115 = (11 \cdot P_{\text{rated}}) \), whereby \( P_{\text{rated}} \) is related to the preferential space/combination heater;

Combination heaters that comprise solar devices (as package) shall be assessed on the basis of the non-solar water heating efficiency, and then corrected for the addition of a solar device. The size of the solar device is not a primary input parameter and is indirectly reflected in the size of Qnonsol (the remaining heat demand to be completed by the non-solar device).

---

231 OJ L140/16-62, 5-6-2009
The water heating efficiency of combination heaters [and water heaters (according Delegated Regulation (EU) No 812/2013)] that include solar devices are calculated in consideration of the following parameters:

\[ \text{Solar contribution from fiche of solar device} \]

\[ (1.1 \times I - 10\%) \times II \times III \times I = \]

Where:

'I': the value of the water heating energy efficiency of the combination heater, expressed in %;

'II': the value of the mathematical expression \((220 \cdot Q_{\text{ref}}) / Q_{\text{nonsol}}\), where \(Q_{\text{ref}}\) is taken from Table 15 in Annex VII and \(Q_{\text{nonsol}}\) from the product fiche of the solar device for the declared load profile M, L, XL or XXL of the combination heater;

'III': the value of the mathematical expression \((Q_{\text{aux}} \cdot 2.5) / (220 \cdot Q_{\text{ref}})\), expressed in %, where \(Q_{\text{aux}}\) is taken from the product fiche of the solar device and \(Q_{\text{ref}}\) from Table 15 in Annex VII for the declared load profile M, L, XL or XXL.

The values for \(Q_{\text{nonsol}}\) and \(Q_{\text{aux}}\) are to be taken from the fiche of the solar device and only in relation to water heating performances. The calculation of these parameters is described in the Transitional Methods for water heaters TM2014wh where for \(Q_{\text{nonsol}}\) both the SOLCAL and the SOLICS method are allowed (no difference in methods for \(Q_{\text{aux}}\)).

According to experts the SOLCAL method for custom-built (component) systems as described in TM2014wh contains errors. These have been corrected in the latest version of EN 15316-4-3: 2017 (Method 2 implementation for Ecodesign and Energy labelling in Annex F - informative). Still the method is prone to errors and experts are developing a simpler to use method (method 3 of EN 15316-4-3 is a candidate).

The SOLICS method for factory-made systems is actually referring to ISO 9459-5:2007 that uses the DST method (dynamic fitting algorithm and simulation model as in Annex A). As the ISO 9459-5 is an hourly method and the regulations (Delegated Regulation (EU) No 811/2013 to Regulation (EU) No 814/2013) present ambient conditions on a monthly basis, and a load profile with multiple tapping’s per hour, some adjustments to an hourly method were necessary. EN 12976-2 has an annex with adjusted (hourly) reference conditions.

A stakeholder asked to make clear what types of solar collectors are covered and which are not. The market recognises three types: glazed flat panel, evacuated tube and unglazed collectors. The latter type is mainly used for pool heating.
Figure 35. Collector efficiency

At higher T differences, the unglazed collectors lose much energy and efficiency drops. Furthermore, they are much more susceptible to wind conditions.

As there is no technical reason to differentiate by collector type the regulation can remain technology-neutral. The same calculation method as for glazed collectors applies, based on zero loss collector efficiency, a1, a2 and IAM or ISO 9459XXX measurement (SOLICS).

Also related to solar systems is that certain definitions have been made obsolete because of changes in applicable standards (such as "aperture area" to be replaced by "reference area").

**Online solar thermal calculation.**

Various sites allow online calculation of solar contribution, with certain boundary conditions.

http://valentin.de/calculation/thermal/start/de

---

**Appendix II – Modules**

**Modules of Decision 768/2008/EC**

Several options exist for conformity assessment, both with and without third party involvement, as defined by Decision 768/2008/EC. The figure below outlines the modules and combination of modules that can be required for the manufacturer to obtain CE marking of their product.

---

**Module A – Internal production control**
- Covers both design and production
- The manufacturer ensures conformity of the products to the legislative requirements
- The manufacturer affixes required conformity marking (CE mark)

**Module A1 – Internal production control + supervised product testing**
- Covers both design and production
- Module A + tests on specific aspects of the product carried out by an accredited in-house body or notified body
- Possible to require the use of an accredited third party where this is felt necessary

**Module A2 – Internal production control + supervised product checks at random intervals**
- Covers both design and production
- Module A + product checks at random intervals carried out by an accredited in-house

---

*: NB does product check(s)

*: NB approves quality system for product

#: NB approves quality system for whole production
- body or notified body
- Possible to require the use of an accredited third party where this is felt necessary

**Module B – EU-type examination**
- Covers design and is always followed by other modules
- The manufacturer submits technical documentation, supporting evidence for the adequacy of the technical design solution and a specimen (if required) of the product
- to a Notified Body
- The Notified Body examines the technical design and/or the specimen of a type and
- verifies and attests that it meets the legislative requirements
- The Notified Body issues an EU-type examination certificate
- The EU-type examination can be carried out in three ways:
  - Production type
  - Combination of production type and design type
  - Design type

The three ways to carry out type examination allows for flexibility by including the options of examining only the technical documentation and/or critical parts of the specimen. This concept is designed to provide sufficient flexibility and to recognise relevant practice where the examination of the complete specimen “representative of the production envisaged” is either not economically viable or not necessary.

**Module C – Conformity to type**
- Covers production and follows module B
- The manufacturer ensures conformity of the products to the approved EU-type

**Module C1 – Conformity to type + supervised product testing**
- Covers production and follows module B
- Module C + tests on specific aspects of the product carried out by an accredited in-house body or notified body
- Possible to require the use of an accredited third party where this is felt necessary

**Module C2 – Conformity to type + supervised product checks at random intervals**
- Covers production and follows module B
- C + product checks at random intervals carried out by an accredited in-house body or notified body
- Possible to require the use of an accredited third party where this is felt necessary

**Module D – Conformity to EU-type based on quality assurance of the production process**
- Covers production and follows module B
- The manufacturer operates and approved quality system for production, final inspection and testing (E.g. EN ISO 9001)
- The manufacturer declares conformity with the EU-type
- The manufacturer affixes required conformity marking (CE mark)
- The notified body carries out surveillance and approves the quality system
Module E – Conformity to EU-type based on product quality assurance
- Covers production and follows module B
- The manufacturer operates and approved quality system final inspection and testing (e.g. EN ISO 9001)
- The manufacturer declares conformity with the EU-type
- The manufacturer affixes required conformity marking (CE mark)
- The notified body carries out surveillance and approves the quality system

The idea behind module E is similar to the one under module D: both are based on a quality system and follow module B. Their difference is that the quality system under module E aims to ensure the quality of the final product, while the quality system under module D (and D1 too) aims to ensure the quality of the whole production process (that includes the manufacturing part and the test of final product). E is thus similar to module D without the provisions relating to the manufacturing process.

Module F – Conformity to EU-type based on product verification
- Covers production and follows module B
- The manufacturer declares conformity with the EU-type
- The manufacturer affixes required conformity marking (CE mark)
- The Notified Body carries out product examinations (testing of every product or statistical checks) in order to control product conformity to EU-type
- The Notified Body issues a certificate of conformity
- Note: Module F is like C2 but the notified body carries out more systematic product checks

Module D1 – Quality assurance of the production process
- Covers both design and production
- Used like D without module B
- The manufacturer operates and approved quality system for production, final inspection and testing (E.g. EN ISO 9001)
- The manufacturer declares conformity with the legislative requirements
- The manufacturer affixes required conformity marking (CE mark)
- The notified body carries out surveillance and approves the quality system

Module E1 – Quality assurance of final product inspection and testing
- Covers both design and production
- Used like E without module B
- The manufacturer operates and approved quality system final inspection and testing (E.g. EN ISO 9001)
- The manufacturer declares conformity with the legislative requirements
- The manufacturer affixes required conformity marking (CE mark)
- The notified body carries out surveillance and approves the quality system

Module F1 – Conformity based on product verification
- Covers both design and production
- Used like F without module B
- The manufacturer ensures compliance of the manufactured products to the legislative requirements.
- The manufacturer affixes required conformity marking (CE mark)
- The Notified Body carries out product examinations (testing of every product or statistical checks) in order to control product conformity to EU-type
- The Notified Body issues a certificate of conformity
- Note: Module F1 is like A2 but the notified body carries out more detailed product checks

Module G – Conformity based on unit verification
- Covers both design and production
- The manufacturer submits technical documentation and product
- The manufacturer declares conformity with legislative requirements
- The manufacturer affixes required conformity marking (CE mark)
- The notified body verifies every individual product in order to ensure conformity to legislative requirements
- The Notified Body issues a certificate of conformity

Module H – Conformity based on full quality assurance
- Covers both design and production
- The manufacturer operates a full quality assurance system for design (EN ISO 9001) in order to ensure conformity to legislative requirements
- The manufacturer submits technical documentation
- The Notified Body carries out surveillance of the quality system

Module H1 – Conformity based on full quality assurance + design examination
- Covers both design and production
- The manufacturer operates a full quality assurance system for design (EN ISO 9001) in order to ensure conformity to legislative requirements
- The manufacturer submits technical documentation
- The Notified Body carries out surveillance of the quality system
- The Notified Body verifies conformity of the product design
- The Notified Body issues an EU-design examination certificate
- Note: Module H1 in comparison to module H provides in addition that the notified body carries out a more detailed examination of the product design

Risk of not achieving energy savings
In the 'ECO' calculation in Ecodesign Impact Accounting 2017 for year 2010, approximately 18% of total energy consumption of products covered under Ecodesign and labelling is non-electric central heating boilers and 3% is by solid fuel heaters, together 21% of the total energy consumed. The other 79% of total energy consumption is by products for which manufacturers can use self-declaration. In 2030 this share in energy consumption of non-electric central heating boilers is expected to drop to 8% in 2030, and for solid fuel space heaters a slight increase to 4%, leaving

233 Solid fuel boilers and solid fuel local space heaters are also under third-party conformity assessment, see also https://www.3rdpartysolidfuel.eu/
234 Ecodesign Impact Accounting, Status Report, by VHK, 22 Dec 2017 (NRGECO, p.63 and NRGSAVE, p.70)
some 89% of energy consumption falling under a self-declaration regime (the figures for central heating products will be revisited in Task 7 of this review study).

When looking at energy saved only, the picture is different and non-electric central heating boilers are responsible for some 20-28% of general (annual) savings in the period 2010-2030. Solid fuel heaters are 1% of the total energy saved.

Table 64. Primary energy consumption and savings according to EIA 2017

<table>
<thead>
<tr>
<th>Product group</th>
<th>ECO primary energy (TWh/a primary)</th>
<th>SAVED primary energy (TWh/a primary)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
<td>2020</td>
</tr>
<tr>
<td>non-electric CH boilers</td>
<td>1957</td>
<td>1154</td>
</tr>
<tr>
<td>% of total</td>
<td>18%</td>
<td>12%</td>
</tr>
<tr>
<td>solid fuel heaters (boilers + LSH)</td>
<td>320</td>
<td>334</td>
</tr>
<tr>
<td>% of total</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>electric CH boilers + aux (1st est.)</td>
<td>308</td>
<td>286</td>
</tr>
<tr>
<td>% of total</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>total of water heating</td>
<td>1217</td>
<td>1034</td>
</tr>
<tr>
<td>% of total</td>
<td>11%</td>
<td>11%</td>
</tr>
<tr>
<td>total of central air heating &amp; cooling</td>
<td>671</td>
<td>664</td>
</tr>
<tr>
<td>% of total</td>
<td>6%</td>
<td>7%</td>
</tr>
<tr>
<td>total of electric motors</td>
<td>1837</td>
<td>2019</td>
</tr>
<tr>
<td>% of total</td>
<td>17%</td>
<td>21%</td>
</tr>
<tr>
<td>all other groups</td>
<td>4981</td>
<td>4570</td>
</tr>
<tr>
<td>% of total</td>
<td>45%</td>
<td>47%</td>
</tr>
<tr>
<td>General total</td>
<td>10971</td>
<td>9727</td>
</tr>
<tr>
<td>% of total</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>of which third-party conf. assessed</td>
<td>21%</td>
<td>15%</td>
</tr>
</tbody>
</table>

Source: EIA 2017

(1): ECO is the calculation of energy consumption assuming existing and announced measures apply.

(2): This value includes ‘negative’ savings from heat pumps, caused by the increase of sales (and growth of stock) outpacing the savings realised in the stock of heat pumps through more efficient products.

Note: The EIA data above (energy) for central heating boilers (non-electric and other) is primarily based upon the Impact Assessment concluded in 2013. The Ecodesign Impact Accounting will be updated by data coming from the present review study.
responsible for the remaining $1271 \text{TWh}_{\text{prim}}$ savings, with water heaters alone being responsible for $251 \text{TWh}_{\text{prim}}$ or 20% of the savings for self-declared products.

But the EIA overview does not provide evidence regarding the cause-effect relation between savings and the conformity assessment procedure applied, and one cannot claim that third-party assessment for other heaters or water heaters reduces the risk of not meeting energy saving objectives. Vice versa, one cannot claim that third-party did not play a role in realising energy savings, because the single largest share of savings is realised by third-party assessed products and there is a possibility that removal of third-party assessment could reduce these savings.
ANNEX III – TESTING COSTS

Electric heat pumps – seasonal space heating energy efficiency
Testing costs of heat pumps for seasonal space heating efficiency and other parameters (EN 14511 series plus EN 14825) vary according to test laboratory involved, size (capacity) of heat pump, type of heat pump, number of test points, additional tests, etc.

An overview of test costs for certification by Eurovent Certita Certification, also applicable to NF mark, is available from Certita\textsuperscript{235}. These tests are performed by accredited laboratories, and the testing costs are harmonised within the certification program partners. The price list 2018 shows that admission costs are starting from approximately 3000 euro, which is more than doubled if a factory visit is included. Costs for the tests themselves start from approximately 3000 euro for a single test condition, with additional test points for approximately 2000 euro per point.

Acoustic tests are over 3500 euro per test/product. The tests for low power consumption (standby, off mode, crankcase mode) vary between 190 euro per test, or 1820 euro per test if the thermal point is included.

A complete test, suitable for Ecodesign/labelling purposes with 4 to 6 test points, costs probably over 10 000 euro, possibly up to 15 000 euro per test/product.

Electric heat pumps – water heating energy efficiency
A typical test for a DHW heat pump (air-to-water) is close to 12 500 euro per tested product, with each additional test (other outdoor temperature or other tapping pattern) costing some 7300 euro extra\textsuperscript{236}.

A typical test for certification requires on average 8 days. Tests performed during development of models, and to be used for ErP declarations can be lengthier (16 days) with unknown costs (commercially sensitive data).

Fuel boilers
Testing costs for gas boilers (tests performed by Notified Bodies) also depend on capacity of boiler and are on average 2500 – 3000 per tested product.

A single DHW test for gas boilers is probably similar in costs as an extra tapping test for DHW heat pumps, some 7000 – 7500 euro.

A total combination boiler test is then some 10 000 euro per tested product.

MicroCHP
Test costs for micro-CHP products have not been identified but will exceed those of gas boilers because of additional electric power/efficiency measurement, and the possibility of testing of preferential and supplementary heat generators. However, there are no

\textsuperscript{235} http://www.certita.fr/sites/default/files/tarifs/s01d03_tarifs_nf414_2018_v2.pdf

\textsuperscript{236} Personal information L.Meljac.
temperature dependent test conditions as for heat pumps. It is estimated that test costs are between those for gas boilers and heat pumps, e.g. 6000 – 7000 euro per tested product for seasonal space heating efficiency alone.

Additional DHW testing is probably some 7000 – 7500 extra.

**ESWH**

The Norwegian authorities stated that tests related to market surveillance of ESWHs are approximately 4300 euro.
ANNEX IV – SPACE HEATING EFFICIENCY OF CHP

Following the 2nd stakeholder meeting BDR Thermea and COGEN Europe disapproved of the removal of text/figures in the first draft report related to calculation of cogeneration space heating efficiency. As the calculations are not disputed it is re-inserted in this Annex.

In FprEN_50465:2014+A1:2017 the useful efficiencies $\eta_{\text{CHP100+Sup}0}$ and $\eta_{\text{CHP100+Sup}100}$ are calculated on the basis of an equivalent efficiency that incorporates a correction for the electric power output. The factor F(5) of the TM2014sh is not included as F(5) in the EN 50465 as the correction for electricity production is introduced at a previous level.

JTC17 proposes to put only the space heat output in the numerator and correct the energy required for that heat output in the denominator by subtracting the primary energy used for electricity production by a separate (reference) system. The secretary’s note in the foreword of EN 50465 refers to relevant harmonized Life Cycle Assessment standards ISO 14040 and ISO 14044.

The basic equation in EN 50465 is:

$$\eta_s = \frac{Q_{\text{total out}} - Q_{\text{electricity out}}}{Q_{\text{prim in total}} - Q_{\text{prim in for electricity}}} = \frac{Q_{\text{heat out}}}{Q_{\text{prim in total}} - Q_{\text{prim in for electricity}}} = \frac{\eta_{\text{thermal}}}{1 - 2.5 \times \eta_{\text{electrical}}}. $$

JTC17 says this equation aligns equal savings (on primary energy) into an equal efficiency and is aligned with the Energy Efficiency Directive 2012/27/EU as solving the equivalent heating efficiency (PES = 0) from the PES equation in 2012/27/EU with $1/\text{RefE} \eta = \text{CC} = 2.5$ gives: $\eta_{\text{equivalent}} = \eta_{\text{thermal}} / (1 - 2.5 \times \eta_{\text{electrical}})$.

The calculation in the table below compares the energy input and heat/electricity output of a cogeneration device with a heat pump combined with separate electricity production producing a similar heat/electricity output. The efficiencies according TM2014sh and EN 50465 are indicated.

<table>
<thead>
<tr>
<th>Cogeneration</th>
<th>Energy OUT</th>
<th>Electric heat pump</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Prim. = Final)</td>
<td>← Conversion</td>
</tr>
<tr>
<td>22857 kWh_fuel</td>
<td>70% thermal</td>
<td>16000 kWh_heat</td>
</tr>
<tr>
<td></td>
<td>20% electric</td>
<td>4571 kWh_elec</td>
</tr>
<tr>
<td>22857 kWh-fuel</td>
<td>70%/1-2.5*20% = 140%</td>
<td>Efficiencies</td>
</tr>
</tbody>
</table>

The graphics below show a similar argument for correcting the electricity production at the energy input side.
Power plant: $\eta_{\text{electricity}} = 20/50 = 40\%$

Figure 36. Power plant efficiency

Heat pump (COP = 4): $\eta_{\text{HP}} = 80/50 = 160\%$ (primary energy)

Figure 37. Heat pump efficiency

Cogeneration: $\eta_{\text{thermal}} = 80/100 = 80\%$, $\eta_{\text{electric}} = 20/100 = 20\%$

Figure 38. Cogeneration heater efficiency

Cogeneration + Heat pump (COP = 4): $\eta_{\text{overall}} = 160/100 = 160\%$ (primary energy)

Figure 39. Cogeneration heater + heat pump efficiency ("virtual gas heat pump")

In the above figure "Cogeneration heater + heat pump efficiency" 50% of heat is supplied by a heat pump (at $\eta=160\%$) and 50% by cogeneration. The overall efficiency is 160% (160 out, 100 in). This means the other 50% of heat must be supplied by cogeneration of 160%, calculated as $\eta_{s,\text{CHP}} = \eta_{\text{thermal}} / (1-(2.5*\eta_{\text{electric}}))$. 
However, this approach would result in a calculation error if the electric efficiency is exactly 40% (the denominator would result in zero, resulting in a #DIV/0 error), and values near 40% would become extremely high or even negative if beyond 40%.

FprEN 50465:2014 defines the space heating efficiency by subtracting the avoided reference heat input from electricity production by a reference system from the CHP heat input.

With supplementary heater: $\eta_{eq,CHP+Sup} = \left(\frac{\eta_{Hs,CHP100+Sup100}}{100-\eta_{Hs,el,CHP100+Sup100}}\right) \times 100\%$

Without supplementary heater: $\eta_{eq,CHP} = \left(\frac{\eta_{Hs,CHP100+Sup}}{100-\eta_{Hs,el,CHP100+Sup}}\right) \times 100\%$

Therefore, Annex EE of EN 50465 prescribes a linear approximation for electrical efficiencies beyond 30% ($\eta_{Hs,el} > 75/CC$, or equal to/larger than 75% of the reference PEF 2.5 = 40%).

For cogeneration with supplementary heater:

$$\eta_{eq,CHP+Sup} = 4 \left( \eta_{Hs,CHP100+Sup100} - \frac{75}{CC} \right) + 16 \times (CC \times \eta_{Hs,CHP100+Sup100} - 100) \times (\eta_{Hs,CHP100+Sup100} - \frac{75}{CC})$$

For cogeneration without supplementary heater:

$$\eta_{eq,CHP} = 4 \left( \eta_{Hs,CHP100+Sup0} - \frac{75}{CC} \right) + 16 \times (CC \times \eta_{Hs,CHP100+Sup0} - 100) \times (\eta_{Hs,CHP100+Sup0} - \frac{75}{CC})$$

Where:

- CC = the conversion coefficient or primary energy factor (PEF), currently 2.5;
- $\eta_{Hs,CHP100+Sup100}$ = the equivalent heating efficiency in the test point (100 % CHP + 100 % Sup) in % [Hs];
- $\eta_{Hs,CHP100+Sup0}$ = the equivalent heating efficiency in the test point (100 % CHP + 0 % Sup) in % [Hs];

The linear approximation can be avoided if the relevant parameter is not defined as efficiency (output/input), but the reciprocal value calculated as a specific energy consumption (input/output). The EN 50465 has elaborated this approach in its Annex K, which presents:

$$SEC_{CHP} = \left(\frac{100}{\eta_{Hs,th,CHP100+Sup0}} - \frac{CC \times \eta_{Hs,el,CHP100+Sup0}}{\eta_{Hs,th,CHP100+Sup0}}\right) \times 100\%$$

$$SEC_{CHP+Sup} = \left(\frac{100}{\eta_{Hs,th,CHP100+Sup100}} - \frac{CC \times \eta_{Hs,el,CHP100+Sup100}}{\eta_{Hs,th,CHP100+Sup100}}\right) \times 100\%$$

The seasonal specific energy consumption in active mode $SEC_{son}$ is then calculated as:

$$SEC_{son} = F_{CHP} \times SEC_{CHP} + (1 - F_{CHP}) \times SEC_{CHP+Sup}$$

Where:

- $F_{CHP}$ = a weighing factor representing the CHP working without supplementary heater.
In the EN 50465 the $F_{\text{CHP}}$ is dependent on the ratio of the respective powers of the CHP heater and the supplementary heater:

Table 66. Weighing factor $F_{\text{CHP}}$

<table>
<thead>
<tr>
<th>$P_{\text{CHP}} / P_{\text{CHP+Sup}}$</th>
<th>Cogeneration appliance without hot water storage tank</th>
<th>Cogeneration appliance without hot water storage tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (only listed for interpolation purpose)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.1 (e.g. 1 kW CHP + 10 kW supp. heater)</td>
<td>0.30</td>
<td>0.37</td>
</tr>
<tr>
<td>0.2</td>
<td>0.55</td>
<td>0.70</td>
</tr>
<tr>
<td>0.3</td>
<td>0.75</td>
<td>0.85</td>
</tr>
<tr>
<td>0.4</td>
<td>0.85</td>
<td>0.94</td>
</tr>
<tr>
<td>0.5</td>
<td>0.95</td>
<td>0.98</td>
</tr>
<tr>
<td>0.6</td>
<td>0.98</td>
<td>1.00</td>
</tr>
<tr>
<td>$\geq 0.7$</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Intermediate values are calculated by linear interpolation between two adjacent values.

For range rated units $P_{\text{CHP+sup}}$ represents the arithmetic mean of the maximum and minimum nominal heat output of the cogeneration appliance.
**ANNEX V – REFERENCES**

**GENERAL EU LEGISLATION**


**SPECIFIC EU LEGISLATION and similar**


Standards under M535 (Boilers mandate)

EN 267:2017, Forced draught burners for liquid fuels, CEN/TC 47.

EN 304:2017 (WI=00057039), Heating boilers - Test code for heating boilers for atomizing oil burners, CEN/TC 57/WG 2.


prEN 12102-1 (WI=00113073)*, Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling - Measurement of airborne noise - Determination of the sound power level - Part 1: Air conditioners, liquid chilling packages, heat pumps for space heating and cooling, CEN/TC 113/ WG 9.

prEN 12102-2 (WI=00113080)*, Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors - Determination of the sound power level - Part 2: Heat pump water heaters, CEN/TC 113/ WG 9.

FprEN 15316-4-1(WI=00228051), Energy performance of buildings - Method for calculation of system energy requirements and system efficiencies - Part 4-1: Space heating and DHW generation systems, combustion systems (boilers, biomass), Module M3-B-1, MB-E-1, CEN/TC 228/WG 4.


EN 12976-1:2016 (WI=00312036), Thermal solar systems and components - Factory made systems - Part 1: General requirements, 06/10/2016(FvD), CEN/TC 312/WG2.

EN 12976-2:2016 (WI=00312035), Thermal solar systems and components - Factory made systems - Part 2: Test methods, 06/10/2016(FvD), CEN/TC 312/WG2.

EN 50465:2015 (WI 21817), Gas appliances - Combined heat and power appliance of nominal heat input inferior or equal to 70 kW, CEN-CLC JTC 17 (former FCGA).

prEN 62282-3-400, prEN 62282 Part 3-400: Gas appliances - Combined heat and power 170 appliances of nominal heat input inferior or equal to 70 kW, CEN-CLC JTC 17 (former FCGA).

Other relevant Standards under M535


prEN 303-6 (WI=00057038), Heating boilers - Part 6: Heating boilers with forced draught burners - Specific requirements for the domestic hot water operation and energy performance of water heaters and combination boilers with atomizing oil burners not exceeding 70 kW, CEN/TC 57/WG 8.


EN 50465:2015, Gas appliances - Combined heat and power appliance of nominal heat input inferior or equal to 70 kW, CEN-CLC/FCGA.

EN 12309-1:2014, Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 1: Terms and definitions, CEN/TC 299/WG 2.


Standards under M534 (Water heater mandate)


EN 50440:2015, Efficiency of domestic electrical storage water heaters and testing methods., CLC/TC59x/WG4.


Other relevant standards under M534


Other relevant standards under M543


EN 12102-1:2017, Air conditioners, liquid chilling packages, heat pumps, process chillers and dehumidifiers with electrically driven compressors - Determination of the sound power level - Part 1: Air conditioners, liquid chilling packages, heat pumps for space heating and cooling, dehumidifiers and process chillers, CEN/TC 113/WG9.


Standards under M543 (Material resources)


Building system level standards (for EPB)

EN15459-1, Economic evaluation procedure for energy systems in buildings.
EN15378-1, Inspection of boilers, heating systems and DHW.
EN15378-3, Measured energy performance.
EN12831-1, Design heat load: space heating.
EN12831-3, Design heat load: water heating.
EN15316-1, General and Energy performance expression.
EN15316-2, Space emission systems (heating and cooling).
EN15316-3, Space distribution systems (DHW, heating and cooling).
EN15316-4-1, Space heating generation systems, combustion systems (boilers, biomass).
EN15316-4-2/AC:2017, Space heating generation systems, heat pump systems.
EN15316-4-3, Thermal and PV solar systems.
EN15316-4-4, Building-integrated cogeneration systems.
EN15316-4-5, District heating and cooling.
EN15316-4-8, Space heating generation systems, air heating and overhead radiant heating systems, including stoves (local).
EN15316-5, Space heating and DHW storage systems (not cooling).

Other references and links

[https://core.ac.uk/download/pdf/132420836.pdf]
Analysis of the trade in Guarantees Origin, Economic analysis for Energy Norway, OE-report 2017-58, Oslo Economics, 16 January 2018
Article 3 of Directive 2009/125/EC specifies that "Member States shall ...ensure that products covered by implementing measures may be placed on the market and/or put into service only if they comply with those measures and bear the CE marking in accordance with Article 5." Article 5 states that a CE marking shall be affixed before the products is placed on the market and/or put into service.
http://www.estif.org/solarkeymarknew/ Nov. 2018
BRG European HVAC Newsletter November 2018
BRG HVAC Newsletter 2018.
CALCM-02—SAP-2016-SEASONAL-EFFICIENCY-VALUES-FOR-BOILERS—ALL-FUELS---DRAFT8
Celic, C., Heating Market in Turkey, Opportunities and Perspectives, presentation DOSIDER 2017.
https://www.bdh-koeln.de/fileadmin/user_upload/ish/ish2017/vortraege_15_maerz/1_ish2017_heating_market_turkey_celic.pdf
CERTIF 2009–04, Introduction to conformity assessment and conformity assessment procedures of the new legal framework (as laid down in decision 768/2008 of the new legal framework) SOGS N 594 EN, 17-3-2009
Comment by EHI, 5 December 2017
Czech Convergence Programme (Nov. 2005)
Dr Satya Prasad Mavuri, Field Behaviour of Inverter Air Conditioners Effect on Seasonal Performance, International Journal of Application or Innovation in Engineering & Management (IJAEM), Volume 4, Issue 8, August 2015
Ecodesign and Energy Labelling regulations refer to the use of harmonised standards but do not exclude the use of other standards to prove compliance.
Ecodesign Impact Accounting, Status Report, by VHK, 22 Dec 2017 (NRGECO, p.63 and NRGSAVE, p.70)
Ecofys (2016) EU Pathways to a Decarbonised Building Sector, pp. 18-20.


https://gallery.mailchimp.com/4f2cf878a38d152a781d97560/files/cf00f99e-7c78-408f-9a56-150f00ecc38/20180515_EU_Displacement_Mix_002_.pdf


Fatalities related to fires, explosions and asphyxia (MarcoGaz 2013 EGAS C Report – Statistics 2011, on European Gas Safety Part C: Gas Installations)

Figure 24 of "Non-economic barriers to large-scale market uptake of fuel cell based micro-CHP technology", Final report 28/08/2017.

For boilers with a range rating device the efficiency is measured at the maximum heat input and the arithmetic mean of the maximum and minimum heat input.


Gesetzentwurf der Bundesregierung, Entwurf eines Ersten Gesetzes zur Änderung des Energieverbrauchskennzeichnungsgesetzes, Germany, 2015.

Health and Safety Executive, Legionnaires’ disease Part 2: The control of legionella bacteria in hot and cold water systems (www.hse.gov.uk/pubns/priced/hsg274part2.pdf)


household-electrical-appliances-water-heater-gas-fired-heating-and-hot-water-combi-boilers/
http://ec.europa.eu/DocsRoom/documents/18027/
http://ec.europa.eu/DocsRoom/documents/18027/
http://ec.europa.eu/DocsRoom/documents/18027/
http://ec.europa.eu/DocsRoom/documents/18027/
http://ec.europa.eu/DocsRoom/documents/26525
http://ec.europa.eu/environment/industry/stationary/mcp.htm citation
http://ec.europa.eu/environment/waste/rohs_eee/pdf/faq.pdf - in particular FAQ 7.1 is instructive
http://eepiant.eu/
http://enefield.eu/category/about/

Personal communication with U. Fritzshe, 13-11-2017. In EN 12976-2:2017, clause 5.9.3.5 dealing with Calculation of the water heater efficiency of the auxiliary heater, Qref was mistakenly replaced by Qnonsol in every equation and table starting with table 4. Starting with clause 5.9.3.6 Contribution of the auxiliary heater, the nomenclature is again right. As etawh,nonsol for an integrated electrical heater is given with fixed 40%, this mistake is not relevant for thermosiphon systems with electrical auxiliary heater.

Personal information L. Meljac.

plus some 22 other ‘programmes’ such as Comfort Air Conditioners, Air Handling Units, etc. Eurovent Certita also adds various other appliance / equipment categories, including solid fuel fired, gas-fired, solar driven and thermostatic radiator valves. These products are outside the scope of this study.

Presentation: Energy Efficiency Compliant Products 2014 (EEPLIANT 2014) FINAL CONFERENCE 20 June 2017 Brussels

Projektne podloge za zidne uredaje atmo/turboTEC plus i pro - 092007 - Pridræavamo pravo izmjene or 0020029203_01 BE 022007.


Reliable Recovery—benefits of stored passive flue gas heat recovery for UK homes , Ecuity, July 2017


Review of Regulation 206/2012 and 626/2011 Air conditioners and comfort fans Task 7 report SCENARIOS Final version Date: May 2018


Solid fuel boilers and solid fuel local space heaters are also under third-party conformity assessment, see also https://www.3rdpartysolidfuel.eu/

Stockholm Environment Institute, 28 May, 2015.

TEST REPORT #59, for the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Low-GWP Alternative Refrigerants Evaluation Program (Low-GWP AREP), January 18, 2016

The GAD 90/396/EEC (codified as 2009/142/EC and recast as Regulation (EU) 2016/426) introduced CE marking and mandatory third-party verification for gas boilers to assess gas appliance safety. The GAD also introduced Notified Bodies identified by Member States that may perform the assessment.

The SHARES tool: http://ec.europa.eu/eurostat/web/energy/data/shares


Ullmann’s Energy: Resources, Processes, Products, John Wiley & Sons, 1 jun. 2017

Waiide, P. et al, Policy Opportunities for More Efficient Residential Water Heating, CLASP study, final report November 2015. Values are presumably on GCV

www.clasp.ngo


Xiaochen Yang, Supply of domestic hot Water at comfortable temperatures by low-temperature district heating without risk of Legionella, PhD Thesis Department of Civil Engineering 2016 (DTU Civil Engineering Report R-346)