

CH boilers and combination boilers

Ecodesign and Energy Label



Review Study

Task 1

Scope – Policies & Standards

DRAFT INTERIM REPORT (Part 1)

Review study of Commission Regulation (EU) No. 813/2013 [Ecodesign] and Commission Delegated Regulation No. (EU) No. 811/2013 (Energy Label)

Prepared by

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Cover: Gas-fired central heating boiler [picture VHK 2016-'17].

IMPORTANT NOTICE: To avoid confusion with the many other space heaters that have been regulated through Ecodesign since 2013, the reports of this study use the term '**boiler**' or '**central heating boiler**' (DE. Heizkessel, FR. Chaudière, IT. Caldaia, NL. Verwarmingsketel) to mean a gas/oil/heat pump/electric resistance central space heater for hydronic emitter systems. This is a provisional working title; a final proposal for naming will be made by the policy makers in due time.

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GLOSSARY

mCHP = micro combined heat and power device

RISE = Research Institutes of Sweden

NLF = New Legislative Framework

[To expand]

EXECUTIVE SUMMARY

This is the draft Task 1 report of the preparatory review study on the Ecodesign Commission Regulation (EU) No. 813/2013 and Energy Label Commission Delegated Regulation (EU) No. 811/2013 for water based space and combination heaters.

Task 1 not only describes the scope of the study, and the policies and test standards that apply to the products within the scope, 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.

[TBD after the stakeholder meeting]

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1 INTRODUCTION

This is the draft Task 1 report of the preparatory review study on the Ecodesign Commission Regulation (EU) No. 813/2013 and Energy Label Commission Delegated Regulation (EU) No. 811/2013 for central heating boilers.

The complete preparatory review study follows the general structure laid down in the Methodology for Ecodesign of Energy-related Products (MEErP) of 2011¹ 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;.**

¹ <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 developend (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

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, to 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 first Ecodesign and Energy Labelling requirements applied as of September 2015 and certain stakeholders (even if involved in the preparatory works that started in 2006²) have only recently started to realise the full impact of the regulation(s) on their businesses as the final rules were published in 2013, the transitional methods in 2014 and FAQ/explanations in 2015.

² The preparatory study for the current regulations started in January 2006, using market data from 2004. Already from the start of that process it was clear that the new measures would entail an increased or exclusive use of condensing boilers. From February 2010 the outlines of the current regulations were known and in 2013 the regulations entered into force. So one could say that industry –involved in consultations from the very start-- had almost ten years to prepare for, with progressive certainty, the measures that applied as of in September 2015.

2 SCOPE OF THE 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 Study scope

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.

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).

Local space heaters (room heaters) and solid fuel fired boilers are excluded as these are covered by different 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. Fuel driven heat pump space/combination heaters that are;
3. Cogeneration space/combination heaters;
4. Electric boiler space/combination heaters;
5. Electric heat pump space/combination heaters;

6. including combinations of the above, with/without controls, solar thermal devices, storage tanks

Boilers

Throughout this report reference may be 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 EU Categorisation

Water based space heaters are categorised in the Eurostat PRODCOM/Europroms database using CN8 product code 25.22.12.00, and the COMEXT database for trade, using HS codes 84031010 (cast iron boilers) and 84031090 (non cast-iron boilers), PRODCOM categorisation. 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 type. Already in 2004, when there were still separate categories for gas-fired, oil-fired and 'other' types these data-sets were almost empty, except for a few countries.

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.

Water- and ground source heat pumps, usually intended for water-based central heating, are categorised in Eurostat PRODCOM prccode 2851380 'Heat pumps other than air conditioning machines of HS 8415'.

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.

First is described generic EU legislation with relevance to space/combination heaters followed by product specific legislation such as the Boiler Efficiency Directive, the ecodesign Regulations and the labelling (delegated) regulations.

The section includes a description of measures at Member States and extra EU level.

Test standards are described in chapter 4.

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

Generic	Labelling 1369/2017	Ecodesign 2009/125/EC	RoHS(2)	REACH	WEEE(2)	F-gas	LVD	PED	GAD / GAR	other (CPR, EMC, etc.)	EPBD, EED & RES Drinking Water, Packaging
	Space/combi heaters 811/2013	Space/combi heaters 813/2013	substance bans		EOL treatment	safety & environ ment (substanc es)	primarily safety			energy, environment (incl. substances)	
Specific for space/combi heaters	Water heaters 812/2013	Water heaters 814/2013									
	M/534 water heaters M/535 space/combi heaters		M/545 "circular economy" standards currently developed by CEN-CLC/TC10/WG1..6		(various mandates)						
	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 efficiency³, environmental performance, safety and/or functionality.

Where these policies or measures prescribe essential requirements, the actual meaning is then translated into technical (test) standards according which products have to be tested in order to carry the CE marking and move freely within the internal market.

The Ecodesign Directive and Energy Labelling Regulation are different in the sense that these are framework directives/regulations that do not prescribe the essential requirements but instead depend on product specific implementing measures to do this.

³ 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.

For space/combi heaters this is Delegated Regulation (EU) 811/2013 (energy labelling) and Regulation (EU) 813/2013 (ecodesign).

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 ⁴.

Like the old Directive, amended by Commission Delegated Regulation (EU) No 518/2014 with regard to labelling of energy-related products on the internet⁵, 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 and .

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:

- Suppliers 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.
- 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 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)..

For manufacturers of space and combination heaters currently covered by Delegated Regulation (EU) 812/2013 and 814/2013 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.

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 used or sold in the EU. It does not apply to transport used to carry people or goods.

⁴ OJ L 198, 28.7.2017, p. 1-23

⁵ OJ L 239, 6.9.2013, p. 162.

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 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 EED- Energy Efficiency Directive 2012/27/EU

The 2012 Energy Efficiency Directive⁶ 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 EED repeals Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on promotion of cogeneration (except for its Article 4(1-4) regarding energy performance requirements and system requirements set by Member States). This EED contains specific provisions for cogeneration and presents a scheme to identify high-efficiency cogeneration.

The primary energy savings provided by cogeneration production defined in accordance with Annex I must be calculated on the basis of the following equation:

⁶ OJ L 315, 14.11.2012, p. 1-56

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

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.

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. The revised EED is not yet published (status Aug 2017).

It also included a proposal to revise the default European primary energy factor (PEF) of electricity which is used in the calculation of seasonal efficiencies of electric products under ecodesign and labelling. In addition, the EED review proposal give 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 is breaking down.

The revised EED is not yet published as it is still in the first reading of the EU decision-making process and should be finalised by 2018 (status November 2017).

3.2.4 EPBD – Energy performance of buildings Directive 2010/31/EU

The Directive 2010/31/EU⁷ 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 units⁸ and for the main envelope elements, This requirement applies both to buildings and existing buildings undergoing major renovation⁹.

⁷ OJ L 153, 18.6.2010, p.13-35

⁸ A section, floor or apartment within a building which is designed or altered to be used separately

⁹ 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

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 "very limited impact"¹⁰

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 is about 0.5% per year and the rate at which existing buildings undergo a major renovation is about 1% per year.¹¹ 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 and double glazing) account for 85% of the renovation market.¹² 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.

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".

¹⁰ <https://www.epbd-ca.eu/ca-outcomes/2011-2015>

https://ec.europa.eu/energy/sites/ener/files/documents/20160314_EPBD_Review_Stakeholders_event_14_March_final.pdf

¹¹ Ecofys (2016) EU Pathways to a Decarbonised Building Sector, pp. 18-20.

¹² European Parliament DG for Internal Policies Policy Department A (2016) Boosting Building Renovation: What potential and value for Europe?, p. 20, retrieved from: [http://www.europarl.europa.eu/RegData/etudes/STUD/2016/587326/IPOL_STU\(2016\)587326_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2016/587326/IPOL_STU(2016)587326_EN.pdf)

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' (Schornsteinfeger¹³) 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.

On 30 November 2016 the European Commission proposed a revision of the EPBD. The revised EPBD is not yet published as it is still in the first reading of the EU decision-making process and should be finalised by 2018 (status Nov 2017).

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 more¹⁴:

- 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.

¹³ 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.

¹⁴ <http://www.euractiv.com/section/energy/news/revision-of-eu-buildings-law-offers-chance-for-multiple-benefits-wins/>

More on building regulations in Member States is provided in section 3.5 of this Task 1.

3.2.5 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.

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 is 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 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 energy from heat pumps, and only heat pumps the seasonal performance factor SPF (equal to SCOPnet) of which exceeds $1.15 \cdot (1/\eta)$ shall be taken into account, whereby η is 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. For a PEF of 2.5 this means the SPF shall exceed 2.875 (based on electricity in, heat out).

The Commission published the Communication 2013/114/EU laying down default values to calculate the energy from heat pumps. The Communication presents default values for the full load equivalent hours (H_{HE}) and SPF per type of heat pump and climate condition.

3.2.6 RoHS – 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/EU¹⁵ (RoHS 2) which clarified certain terms, introduced new definitions and introduced a wider scope of products (open

¹⁵ OJ L 174, 1.4.2011, p.88-110

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.

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.

Based on the explanations offered in the FAQ for the RoHS(2)¹⁶ it is understood that space/combi heaters and water heaters are within the scope of RoHS from 2019.

3.2.7 REACH – 1907/2006/EC

Regulation (EC) No 1907/2006 establishes the 'REACH' (Registration, Evaluation, Authorisation and Restriction of Chemicals) system¹⁷. 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:

- supplying a safety data sheet;

¹⁶ http://ec.europa.eu/environment/waste/rohs_eee/pdf/faq.pdf - in particular FAQ 7.1 is instructive

¹⁷ Regulation (EC) No 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending .., OJ L396, p.1, 30.12.2006.

- 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).

Under REACH there are 22 substances on the authorisation list¹⁸ per May 2013. The REACH candidate list¹⁹ of Substances of Very High Concern (SVHC) for authorisation currently contains 174 substances (Dec 2014).

3.2.8 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.

Considering the FAQ document for the WEEE²⁰ of 2014 explains that 'Dependent on electric currents or electromagnetic fields in order to work properly' means that the equipment needs electric currents or electromagnetic fields (e.g. not petrol or gas) to fulfil its basic function (i.e., when the electric current is off, the equipment cannot fulfil its basic function). 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 fulfil 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/combo 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/combo heaters are inside/outside the scope of the transposed WEEE²¹.

On 4 February 2013, the Commission requested through M/518 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 1. Standards for treatment of WEEE

¹⁸ Meaning that they cannot be placed on the market, unless a special derogation is approved for a specific application. See <http://echa.europa.eu/web/guest/addressing-chemicals-of-concern/authorisation/recommendation-for-inclusion-in-the-authorisation-list/authorisation-list>

¹⁹ Meaning that they have been identified as SVHC but have not yet reached their 'sunset date' (phase-out).

²⁰ <http://ec.europa.eu/environment/waste/weee/pdf/faq.pdf>

²¹ Comment by EHI, 5 December 2017

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

3.2.9 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, including heat pump water heaters by Commission Decision 2007/742/EC which attracted a few applicants. In 2014 Commission Decision 2014/314/EU introduced criteria for water heaters but these have not resulted in applicants for the label.

In May 2016, the JRC-IPTS recommended to the EU Ecolabelling Board to withdraw the EU Ecolabel criteria for heat pumps and to consider including air-based heat pumps products in the scope during the possible revision of the EU Ecolabel criteria for water-based heaters. In June 2017, the JRC-IPTS recommended to withdraw the EU Ecolabel for water-based heaters to the EU Ecolabelling Board. On the basis of these assessment results, the European Commission decided not to prolong nor revise the EU Ecolabel criteria for these product groups.

3.2.10 F-gas 517/2014/EU

The original F-gas Regulation 842/2006 is replaced by the Regulation 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.
- 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/manufacture 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.

With a charge of 4 kg of R410a at 2088 kg CO₂ eq./kg a heat pump system equals 8352 kg CO₂ eq. A quantity of 100 tonne annual CO₂ eq. equals just 12 products/year. The minimum threshold for the quota system is easily exceeded by manufacturers/importers. Especially suppliers of refrigerants (for new equipment or maintenance) will be 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 R407²².

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 modern low GWP blends in products.

Possible alternative refrigerants are lowGWP 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 HFOs²³. Study Task 4 (Technologies) will describe products that apply low GWP refrigerants.

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.

²² http://r744.com/articles/7888/french_hvacandr_sector_mulls_future_challenges_at_sifa?utm_source=mailchimp&utm_medium=email&utm_campaign=Bi-weekly%20Newsletter

²³ TEST REPORT #59, for the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Low-GWP Alternative Refrigerants Evaluation Program (Low-GWP AREP), January 18, 2016

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 2017²⁴.

3.2.11 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.

Directive 2009/142/EC of the European Parliament and of the Council of 30 November 2009²⁵ relating to appliances burning gaseous fuels, harmonised the Single Market as regards boiler safety. This Directive was a codification of the former Council Directive 90/396/EEC of 29 June 1990 on the approximation of the laws of the Member States relating to appliances burning gaseous fuels and its amendments.

The former GAD was a CE marking Directive that only referred to essential requirements. 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 GAD states that these standards, harmonised at Community level, are drawn up by private bodies and must remain non-mandatory texts.

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.

The new GAR 2016/426/EU modifies and updates rules set out in earlier legislation (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 normal²⁶ 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.

²⁴ <http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=578>

²⁵ OJ L 330, 16.12.2009, p. 10-27

²⁶ 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".

3.2.12 LVD – 2014/35/EU

Directive 2014/35/EU is a CE marking Directive of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits. It repeals Directive 2006/95/EC with effect from 20 April 2016.

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/combo 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 2017²⁷).

3.2.13 EMC – 2014/30/EU

Directive 2014/30/EU²⁸ is a CE marking Directive of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (recast). It repeals Directive 2004/108/EC.

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 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/combo 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.

3.2.14 PED – 2014/68/EU

The Pressure Equipment Directive 2014/68/EC²⁹ 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.

²⁷ <http://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-5291384>

²⁸ OJ L 96, 29.3.2014, p.79-106

²⁹ OJ L 189, 27.6.2014, p.164-259

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 $TS > 110\text{ }^{\circ}\text{C}$.

3.2.15 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 lays down both compulsory and voluntary 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.

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.

3.2.16 CPD – 89/106/EEC & CPR 305/2011/EU

The Construction Products Directive 89/106/EEC of 1989 has been replaced by the Construction products Regulation (CPR) 305/2011/EU. 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 2017³⁰).

1.1.1 PD – Packaging Directive – (EU) 2015/720 (amending Directive 94/62/EC)

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 sourced or sector. It 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 relative for 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.

1.1.2 DWD – Drinking Water Directive – 98/83/EC & Revised technical annexes – (EU) No. 2015/1787 (amending 98/83/EC)

The Drinking Water Directive 98/83/EC of 3 November 1998 concerns the quality of water intended for human consumption. The Directive 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.

³⁰ https://ec.europa.eu/growth/sectors/construction/product-regulation/review_en

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

New Approach

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 and does not pre-judge the choice of technical solutions to achieve these levels. Today, the so called New Approach directives cover 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 legislation³¹.

New Legislative Framework

In 2008 the New Legislative Framework (NLF) was adopted to improve the Internal Market for goods and strengthen the conditions for placing a wide range of products on the EU Market. The NLF is a package of measures that aim to improve market surveillance and boost the quality of conformity assessments. It also clarifies the use of CE marking and creates 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

2. Regulation (EC) 765/2008 setting out the requirements for accreditation and the market surveillance of products;

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.

³¹ http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_type=251&lang=en&item_id=4372

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 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 Directive 2009/125/EC, Article 8.2 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 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 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 notified³² to the European Commission and lists of Notified Bodies can be searched on the NANDO web site of the European Commission³³. 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.

So far, only fossil fuel boilers covered under 92/42/EEC have to be certified by a Notified Body for a Module B 'EC Type-examination' (the so-called mandatory 3rd party compliance verification).

There are currently 46 Notified Bodies registered on the NANDO pages under the 92/42/EEC Boiler Efficiency Directive³⁴. Some 2/3 of these bodies are located in seven

³² 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.

³³ http://ec.europa.eu/growth/tools-databases/nando/index.cfm?fuseaction=directive.notifiedbody&dir_id=11

³⁴ http://ec.europa.eu/growth/tools-databases/nando/index.cfm?fuseaction=directive.notifiedbody&dir_id=11

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 max 2 notified Bodies, resulting in nine Member States without Notified Bodies.

Figure 2. Notified Bodies (for BED 94/42/EEC) per member state

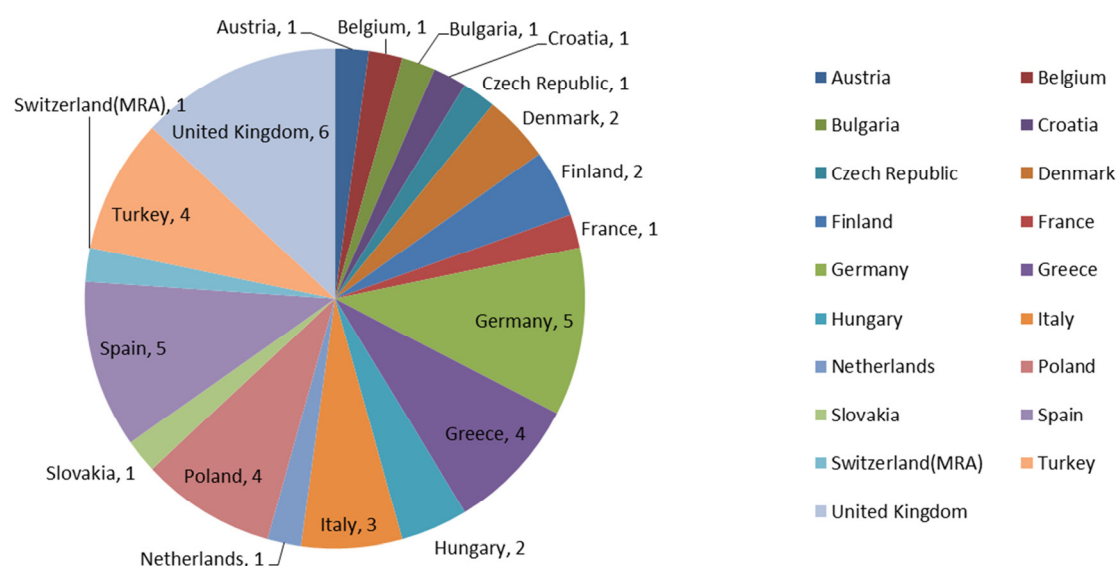


Table 2. Names and nr. of Notified Bodies (for BED 92/42/EEC)

Nr.	Name	Countries
NB 0036	TÜV SÜD Industrie Service GmbH	Germany
NB 0048	DANMARKS GASMATERIEL PRØVNING	Denmark
NB 0049	AFNOR CERTIFICATION SA	France
NB 0051	IMQ ISTITUTO ITALIANO DEL MARCHIO DI QUALITÀ S.P.A.	Italy
NB 0053	TÜV SÜD ATISAE, S.A.U.	Spain
NB 0063	Kiwa Nederland B.V.	Netherlands
NB 0085	DVGW CERT GmbH	Germany
NB 0086	BSI	United Kingdom
NB 0087	GL Industrial Services UK Ltd	United Kingdom
NB 0099	AENOR INTERNACIONAL	Spain
NB 0120	SGS United Kingdom Limited	United Kingdom
NB 0359	INTERTEK TESTING; CERTIFICATION LTD	United Kingdom
NB 0370	LGAI TECHNOLOGICAL CENTER, S. A./Applus	Spain
NB 0408	TÜV AUSTRIA SERVICES GMBH	Austria
NB 0424	INSPECTA TARKASTUS OY	Finland
NB 0461	TECHNIGAS	Belgium
NB 0476	KIWA CERMET ITALIA S.P.A.	Italy
NB 0480	BSRIA LTD.	United Kingdom
NB 0541	LABORATORIO DE TERMOTECNIA DE LA ESCUELA TECNICA SUPERIOR DE INGENIEROS INDUSTRIALES DE MADRID	Spain
NB 0542	LABORATORIO DEL CENTRO DE INVESTIGACION Y DESARROLLO DE RESPOL BUTANO S.A.	Spain
NB 0558	KIWA LTD T/A KIWA GASTEC	United Kingdom
NB 0598	SGS FIMKO OY	Finland
NB 0617	NATIONAL TECHNICAL UNIVERSITY OF ATHENS, LABORATORY OF STEAM BOILERS AND THERMAL PLANTS	Greece

NB 0618	HELLENIC REGISTER OF SHIPPING	Greece
NB 0626	Universität Stuttgart Institut für Gebäudeenergetik	Germany
NB 0909	Gas- und Wärme-Institut Essen e. V. -> Module C only	Germany
NB 1008	TÜV Rheinland InterCert Muszaki Felügyeleti és Tanúsító Korlátolt Felelősségű Társaság	Hungary
NB 1009	MBVTI Műszaki Biztonsági Vizsgáló és Tanúsító Intézet Kft.	Hungary
NB 1015	STROJIRENSKY ZKUSEBNI USTAV s.p.	Czech Republic
NB 1255	SCHWEIZ. VEREIN DES GAS- UND WASSERFACHES (SVGW)	Switzerland(MRA)
NB 1299	Technicky skusobny ustav Piestany s.p.	Slovakia
NB 1312	CERTIGAZ (since 4 December 2017)	France
NB 1433	URZAD DOZORU TECHNICZNEGO	Poland
NB 1450	INSTYTUT NAFTY I GAZU-PANSTWOWY INSTYTUT BADAWCZY	Poland
NB 1451	INSTYTUT TECHNOLOGII ELEKTRONOWEJ ODDZIAŁ PREDOM	Poland
NB 1452	INSTYTUT ENERGETYKI	Poland
NB 1506	DANSK GASTEKNIISK CENTER A/S	Denmark
NB 1617	QMSCERT AUDITS-INSPECTIONS-CERTIFICATIONS LTD. (Q-CERT LTD.)	Greece
NB 1783	TURKISH STANDARDS INSTITUTION (TSE)	Turkey
NB 1837	"ITEM CONSULT" Ltd. - Departament "Conformity Assessment"	Bulgaria
NB 1936	TUV Rheinland Italia SRL	Italy
NB 2159	S&Q Mart Kalite Güvenlik Sanayi ve Ticaret A. Ş.	Turkey
NB 2195	Szutest Uygunluk Değerlendirme A.Ş.	Turkey
NB 2456	TÜV Rheinland Energy GmbH	Germany
NB 2464	TÜV Croatia d.o.o.	Croatia
NB 2671	Nova Certifications Single Member Ltd -> Module C only	Greece
NB 2674	Standard Sertifikasyon Muayene Laboratuvar ve Eğitim Hizmetleri Anonim Şirketi	Turkey

The Notified Bodies carry out an Module B - EC Type examination of boilers. Two Notified bodies cannot carry out Module B, but only Module C. The modules 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 of the envisaged production a “type” 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.

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".

The other space/combination heaters (outside the scope of 92/42/EEC, but in the scope of 813/2013) do not require mandatory 3rd party certification and the Declaration of Conformity is a self-declaration.

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.

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

The other Modules (Aa, D, E, F, G and H) are currently not relevant for space/combi heaters, insofar these cover ecodesign and or labelling requirements.

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.

The list is of NBs is continuously updated: By Aug 2017 some 22 NBs had been removed from the list as the registration as NB has expired and/or withdrawn.

Table 3. Notified bodies 9for 92/42/EEC) withdrawn

#	Name of NB withdrawn/expired	Countries
NB 0068	Mit International Testing S.r.l.	Italy
NB 0032	TÜV NORD CERT GMBH & CO. KG	Germany
NB 0119	CALOR GAS APPLIANCE TESTING LABORATORY CALOR GAS LIMITED	United Kingdom
NB 0302	ANCCP Certification Agency Srl	Italy
NB 0407	ISTITUTO GIORDANO S.P.A.	Italy
NB 0645	PRÜFSTELLE FÜR ENERGIETECHNISCHE EINRICHTUNGEN DER TÜV RHEINLAND SICHERHEIT UND UMWELTSCHUTZ GMBHINSTITUT FÜR UMWELTSCHUTZ UND ENERGIETECHNIK	Germany
NB 0705	FLAM GAS LABORATORIES SRL	Italy
NB 1256	EIDG. MATERIALPRÜFUNGS- UND FORSCHUNGSANSTALT EMPA, PRÜFSTELLE FEUERUNGEN	Switzerland (MRA)
NB 2091	Stazione Sperimentale per i Combustibili	Italy
NB 2107	NOVA CERTIFICATION LTD	Greece
NB 0035	TÜV Rheinland Industrie Service GmbH	Germany
NB 0045	TÜV NORD SYSTEMS GMBH & CO. KG	Germany
NB 0196	DIN CERTCO GESELLSCHAFT FÜR KONFORMITÄTBEWERTUNG MBH	Germany
NB 0365	ELOT - HELLENIC ORGANIZATION FOR STANDARDIZATION	Greece
NB 0402	RISE Research Institutes of Sweden AB	Sweden
NB 0654	TUV HELLAS S.A.	Greece

NB 0694	KIWA ITALIA S.P.A.	Italy
NB 0727	C3T S.A.	Greece
NB 1004	Fraunhofer-Institut für Bauphysik IBP	Germany
NB 1621	Lithuanian Energy Institute Laboratory of Heat-Equipment Research and Testing	Lithuania
NB 1785	TÜRK LOYDU UYGUNLUK DEĞERLENDİRME HİZMETLERİ A.Ş.	Turkey
NB 1798	S.C. ISCIR CERT S.R.L.	Romania

3.4 Specific EU policies and measures

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

The regulation of energy efficiency of boilers (using liquid or gaseous fossil fuels) in the EU (EEC) already started in 1978 through Council Directive 78/170/EEC of 13 February 1978 *"on the performance of heat generators for space heating and the production of hot water in new or existing non-industrial buildings and on the insulation of heat and domestic hot-water distribution in new non-industrial buildings"* (amended by Council Directive 82/885/EEC of 10 December 1982). This Directive required Member States to set minimum efficiency levels. As Member States rarely chose identical levels, the requirements differed from state to state, resulting in technical barriers to trade.

Council Directive 92/42/EEC of 21 May 1992 on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels³⁵, addressed these barriers by introducing mandatory horizontal minimum energy efficiency requirements for hot water boilers from 4 to 400 kW in the EU (EEC), presumption of conformity to be shown 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, D or E.

Amendments to Directive 92/42/EEC (and multiple other CE marking Directives) have been introduced through Council Directive 93/68/EEC³⁶ of July 1993 in order to align terminology and clear up elements regarding the affixing of the CE marking, and by Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004³⁷

³⁵ OJ L 167 , 22.06.1992, p.17-28

³⁶ OJ L 220 , 30.08.1993, p.1-22

³⁷ OJ L 052 , 21.02.2004, p.50-60

on the promotion of cogeneration based on a useful heat demand in the internal energy market by specifically excluding cogeneration units from the scope of 92/42/EEC.

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 eco-design 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.

Directive 2008/28/EC of the European Parliament and of the Council of 11 March 2008 also amended Directive 92/42/EEC as regards the powers conferred to the Commission. This was a technical correction, concerning committee procedure only.

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.

3.4.2 Ecodesign Regulation (EU) 813/2013/EC

Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC with regard to eco-design requirements for space heaters and combination heaters³⁸ introduced new, updated minimum energy efficiency requirements for space and combination heaters.

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;

³⁸ 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 and 814/2013 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 4. Minimum seasonal energy efficiency requirements of Regulation (EU) 813/2013

Type	26 Sep 2015	26 Sep 2017	26 Sep 2018
	(% = seasonal space heating efficiency)		
Fuel boiler space heaters < 70 kW, except type B1 (<10 kW space heater / <30 kW combination heater)	86%		max. NOx
B1 boiler <10 kW if space heater / <30 kW if combination heater	75%		max. NOx

electric space/combination heater	30%	36%	
cogeneration space heaters	86%	100%	max. NOx
[Remark: no mentioning of cogeneration combination heaters]			
Heat pumps space/combination heaters, except low-temperature types	100%	110%	max. NOx
	max.sound power		
Low-temperature heat pumps space/combination heaters	110%	125%	max. NOx
	max. sound power		
Combination heaters water heating efficiency (varies per class XXS-3XL)	22%-32%	32% - 64%	
All	Product information		

The Regulation (EU) 813/2013 also introduced maximum emission limits for NOx.

Table 5. Maximum NOx emission values of Regulation (EU) 813/2013

Type	Combustion	Fuel	as of 26 September 2018
Emission limit value (mg/kWh GCV)			
Fuel boiler		gaseous	56
		liquid	120
cogeneration	external (e.g. Stirling engine)	gaseous	70
		liquid	120
	internal (e.g. engine)	gaseous	240
		liquid	420
Heat pump	external sorption)	gaseous	70
		liquid	120
	internal (e.g. engine)	gaseous	240
		liquid	420

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 6. Maximum sound power levels for heat pumps

Rated heat output	Per 26 Sep 2015
--------------------------	------------------------

	$\leq 6 \text{ kW}$		$> 6 \text{ kW}, \leq 12 \text{ kW}$		$> 12 \text{ kW}, \leq 30 \text{ kW}$		$> 30 \text{ kW}, \leq 70 \text{ kW}$	
Position	indoor	outdoor	indoor	outdoor	indoor	outdoor	indoor	outdoor
Sound power level (L_{WA}), dB	60	65	65	70	70	78	80	88

Information requirements apply as of 26 September 2015.

Annex III on Measurements and Calculations prescribed certain 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 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 3rd 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 2016/2282³⁹ 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 NOx

³⁹ OJ L 356, 20.12.2016, p.51-110.

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 NOx requirements.

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

Stakeholders have raised a lot of questions regarding the interpretation of the Regulation and in response the European Commission published guidelines in January 2015, revised in September 2015, which provide clarification in the form of *Frequently Asked Questions* (FAQs) relating to the Energy Labelling and Ecodesign Regulations (EU) No 811/2013, 812/2013, 813/2013, 814/2013. In April 2017, the European Commission circulated a proposal to revise the guidelines to include solid fuel boilers and clarify additional questions. Several stakeholders, including EHI and ESTIF, proposed comments to these proposed changes in 2017 (see the appropriate section). The European Commission is expected to publish the updated guidelines by end 2017.

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 device⁴⁰.

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

⁴⁰ OJ L 239, 6.9.2013, p. 1.

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 differs 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 7. Seasonal space heating energy efficiency classes of space/combination heaters, in %

Energy efficiency class	Space heating (except LT-heat pump)	LT heat pump
A+++	$\eta_s \geq 150$	$\eta_s \geq 175$
A++	$125 \leq \eta_s < 150$	$150 \leq \eta_s < 175$
A+	$98 \leq \eta_s < 125$	$123 \leq \eta_s < 150$
A	$90 \leq \eta_s < 98$	$115 \leq \eta_s < 123$
B	$82 \leq \eta_s < 90$	$107 \leq \eta_s < 115$
C	$75 \leq \eta_s < 82$	$100 \leq \eta_s < 107$
D	$36 \leq \eta_s < 75$	$61 \leq \eta_s < 100$
E	$34 \leq \eta_s < 36$	$59 \leq \eta_s < 61$
F	$30 \leq \eta_s < 34$	$55 \leq \eta_s < 59$
G	$\eta_s < 30$	$\eta_s < 55$

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, to 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 8. Water heating energy efficiency classes of combination heaters, in %

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

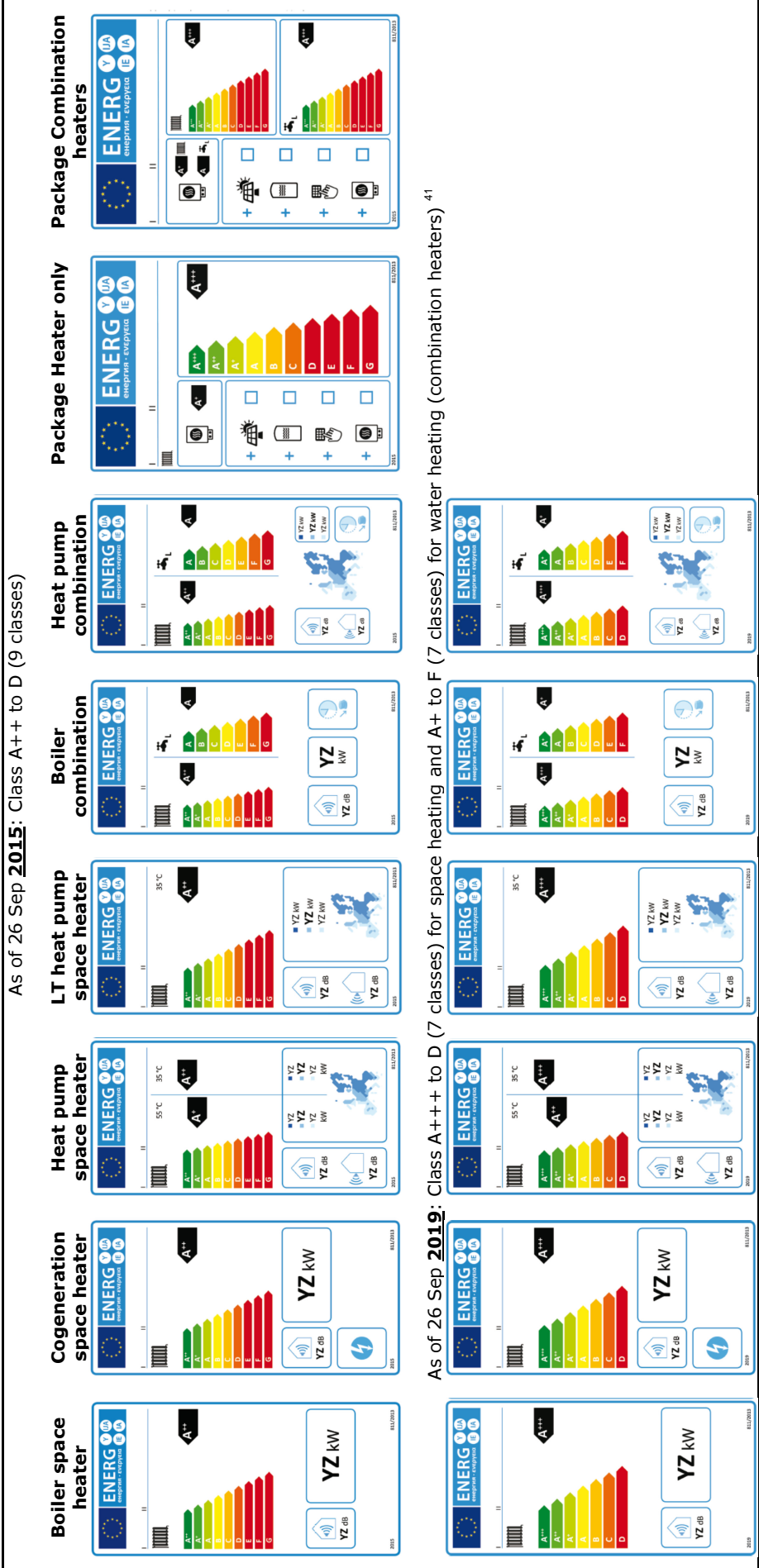
The energy efficiency classes of solar hot water storage tanks, if (part of) a solar device, are determined on the basis of its standing loss, as follows:

Table 9. Storage tank energy efficiency classes, if (part of) a solar device, in %

Standing loss S in Watts, with storage volume V in litres	
A+	$S < 5,5 + 3,16 \cdot V^{0,4}$
A	$5,5 + 3,16 \cdot V^{0,4} \leq S < 8,5 + 4,25 \cdot V^{0,4}$
B	$8,5 + 4,25 \cdot V^{0,4} \leq S < 12 + 5,93 \cdot V^{0,4}$
C	$12 + 5,93 \cdot V^{0,4} \leq S < 16,66 + 8,33 \cdot V^{0,4}$
D	$16,66 + 8,33 \cdot V^{0,4} \leq S < 21 + 10,33 \cdot V^{0,4}$
E	$21 + 10,33 \cdot V^{0,4} \leq S < 26 + 13,66 \cdot V^{0,4}$
F	$26 + 13,66 \cdot V^{0,4} \leq S < 31 + 16,66 \cdot V^{0,4}$
G	$S > 31 + 16,66 \cdot V^{0,4}$

The labels (design, size, format) are described in Annex III :

Figure 3. Energy labels for the various products in scope of Regulation (EU) No 811/2013



⁴¹ Unless the review of the Regulation 811/2013 proves otherwise

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:

Figure 4. Product fiche (package label) space/combination heater

Seasonal space heating energy efficiency of boiler		1	<input type="text"/> %																														
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 %		2																														
From fiche of temperature control	+ <input type="text"/> %																																
Supplementary boiler	Seasonal space heating energy efficiency (in %)		3																														
From fiche of boiler	$(\text{ } - \text{'I'}) \times 0,1 = \pm \text{ } \%$																																
Solar contribution	From fiche of solar device Collector size (in m ²) Tank volume (in m ³) Collector efficiency (in %)		4																														
	Tank rating A* = 0,95, A = 0,91, B = 0,86, C = 0,83, D-G = 0,81																																
	$(\text{'III'} \times \text{ } + \text{'IV'} \times \text{ }) \times 0,9 \times (\text{ } / 100) \times \text{ } = + \text{ } \%$																																
Supplementary heat pump	Seasonal space heating energy efficiency (in %)		5																														
From fiche of heat pump	$(\text{ } - \text{'I'}) \times \text{'II'} = + \text{ } \%$																																
Solar contribution AND Supplementary heat pump	Select smaller value $0,5 \times \text{ } \text{ OR } 0,5 \times \text{ } = - \text{ } \%$		6																														
Seasonal space heating energy efficiency of package		7	<input type="text"/> %																														
Seasonal space heating energy efficiency class of package																																	
<div style="border: 1px solid black; padding: 5px; text-align: center;"> <table border="0"> <tr> <td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td><td><input type="checkbox"/></td> </tr> <tr> <td>G</td><td>F</td><td>E</td><td>D</td><td>C</td><td>B</td><td>A</td><td>A*</td><td>A**</td><td>A***</td> </tr> <tr> <td>< 30 %</td><td>≥ 30 %</td><td>≥ 34 %</td><td>≥ 36 %</td><td>≥ 75 %</td><td>≥ 82 %</td><td>≥ 90 %</td><td>≥ 98 %</td><td>≥ 125 %</td><td>≥ 150 %</td> </tr> </table> </div>				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	G	F	E	D	C	B	A	A*	A**	A***	< 30 %	≥ 30 %	≥ 34 %	≥ 36 %	≥ 75 %	≥ 82 %	≥ 90 %	≥ 98 %	≥ 125 %	≥ 150 %
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>																								
G	F	E	D	C	B	A	A*	A**	A***																								
< 30 %	≥ 30 %	≥ 34 %	≥ 36 %	≥ 75 %	≥ 82 %	≥ 90 %	≥ 98 %	≥ 125 %	≥ 150 %																								
Boiler and supplementary heat pump installed with low temperature heat emitters at 35 °C?																																	
From fiche of heat pump	7	$\text{ } + (50 \times \text{'II'}) = \text{ } \%$																															

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 5. Product fiche (package label) Cogeneration package

Seasonal space heating energy efficiency of cogeneration space heater		①	<input type="text" value="I"/> %
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 %		②
From fiche of temperature control			+ <input type="text"/> %
Supplementary boiler	Seasonal space heating energy efficiency (in %)		③
From fiche of boiler	$(\text{III} - \text{I}) \times \text{II} =$		- <input type="text"/> %
Solar contribution			
From fiche of solar device	Collector size (in m ²) <input type="text"/>	Tank volume (in m ³) <input type="text"/>	Collector efficiency (in %) <input type="text"/>
			Tank rating A* = 0,95, A = 0,91, B = 0,86, C = 0,83, D-G = 0,81
$(\text{III} \times \text{I} + \text{IV} \times \text{II}) \times 0,7 \times (\text{V}/100) \times$			$\text{VI} = + \text{VII} \%$
Seasonal space heating energy efficiency of package			⑤
			<input type="text"/> %
Seasonal space heating energy efficiency class of package			
<div style="border: 1px solid black; padding: 5px; text-align: center;"> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 1px solid black; padding: 2px 5px;">G</div> <div style="border: 1px solid black; padding: 2px 5px;">F</div> <div style="border: 1px solid black; padding: 2px 5px;">E</div> <div style="border: 1px solid black; padding: 2px 5px;">D</div> <div style="border: 1px solid black; padding: 2px 5px;">C</div> <div style="border: 1px solid black; padding: 2px 5px;">B</div> <div style="border: 1px solid black; padding: 2px 5px;">A</div> <div style="border: 1px solid black; padding: 2px 5px;">A⁺</div> <div style="border: 1px solid black; padding: 2px 5px;">A⁺⁺</div> <div style="border: 1px solid black; padding: 2px 5px;">A⁺⁺⁺</div> </div> <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 5px;"> < 30 % ≥ 30 % ≥ 34 % ≥ 36 % ≥ 75 % ≥ 82 % ≥ 90 % ≥ 98 % ≥ 125 % ≥ 150 % </div> </div>			

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 6. Product fiche (package label) Heat pump package

Seasonal space heating energy efficiency of heat pump 1' %

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 %

2' %

Supplementary boiler
From fiche of boiler

Seasonal space heating energy efficiency (in %)

$$(\text{III} - \text{I}') \times \text{III}' = - \text{III}' \%$$

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

$$(\text{III}' \times \text{I} + \text{IV}' \times \text{II}) \times 0,45 \times (\text{III} / 100) \times \text{Tank rating} = + \text{III}' \%$$

Seasonal space heating energy efficiency of package under average climate 5' %

Seasonal space heating energy efficiency class of package under average climate

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
G	F	E	D	C	B	A	A⁺	A⁺⁺	A⁺⁺⁺
< 30 %	≥ 30 %	≥ 34 %	≥ 36 %	≥ 75 %	≥ 82 %	≥ 90 %	≥ 98 %	≥ 125 %	≥ 150 %

Seasonal space heating energy efficiency under colder and warmer climate conditions

Colder: 5' % - 'V' = % Warmer: 5' % + '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 7. Product fiche (package label) Low temperature heat pump package

Seasonal space heating energy efficiency of low temperature heat pump		<div>①</div> <div>'I'</div> %
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 %	<div>②</div> <div>+</div> <div></div> %
Supplementary boiler	Seasonal space heating energy efficiency (in %)	<div>③</div> <div>-</div> <div></div> %
From fiche of boiler	(<div></div> - 'I') × 'II' =	<div></div> %
Solar contribution	From fiche of solar device	<div>④</div> <div>+</div> <div></div> %
Collector size (in m ²)	Tank volume (in m ³)	Collector efficiency (in %)
Tank rating A* = 0,95, A = 0,91, B = 0,86, C = 0,83, D-G = 0,81		
('III' × <div></div> + 'IV' × <div></div>) × 0,45 × (<div></div> / 100) × <div></div> =		<div></div> %
Seasonal space heating energy efficiency of package under average climate		<div>⑤</div> <div></div> %
Seasonal space heating energy efficiency class of package under average climate		
<div> <div>□</div> <div>□</div> <div>□</div> <div>□</div> <div>□</div> <div>□</div> <div>□</div> <div>□</div> <div>□</div> <div>□</div> </div> <div> <div>G</div> <div>F</div> <div>E</div> <div>D</div> <div>C</div> <div>B</div> <div>A</div> <div>A⁺</div> <div>A⁺⁺</div> <div>A⁺⁺⁺</div> </div> <div> <div>< 55 %</div> <div>≥ 55 %</div> <div>≥ 59 %</div> <div>≥ 61 %</div> <div>≥ 100 %</div> <div>≥ 107 %</div> <div>≥ 115 %</div> <div>≥ 123 %</div> <div>≥ 150 %</div> <div>≥ 175 %</div> </div>		
Seasonal space heating energy efficiency under colder and warmer climate conditions		
Colder:	<div>⑤</div> <div></div> - 'V' =	<div></div> %
Warmer:	<div>⑤</div> <div></div> + 'VI' =	<div></div> %

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. Product fiche (package label) for any package with combination heaters

Water heating energy efficiency of combination heater ① %

Declared load profile: ☐

Solar contribution
From fiche of solar device

Auxiliary electricity

$(1,1 \times \text{'I'} - 10\%) \times \text{'II'} - \text{'III'} - \text{'I'} = + \text{②} \%$

Water heating energy efficiency of package under average climate ③ %

Water heating energy efficiency class of package under average climate

	G	F	E	D	C	B	A	A ⁺	A ⁺⁺	A ⁺⁺⁺
M	< 27 %	≥ 27 %	≥ 30 %	≥ 33 %	≥ 36 %	≥ 39 %	≥ 65 %	≥ 100 %	≥ 130 %	≥ 163 %
L	< 27 %	≥ 27 %	≥ 30 %	≥ 34 %	≥ 37 %	≥ 50 %	≥ 75 %	≥ 115 %	≥ 150 %	≥ 188 %
XL	< 27 %	≥ 27 %	≥ 30 %	≥ 35 %	≥ 38 %	≥ 55 %	≥ 80 %	≥ 123 %	≥ 160 %	≥ 200 %
XXL	< 28 %	≥ 28 %	≥ 32 %	≥ 36 %	≥ 40 %	≥ 60 %	≥ 85 %	≥ 131 %	≥ 170 %	≥ 213 %

Water heating energy efficiency under colder and warmer climate conditions

Colder: $\text{③} - 0,2 \times \text{②} = \text{ } \%$

Warmer: $\text{③} + 0,4 \times \text{②} = \text{ } \%$

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.

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 in 2016-2017 on the use of tolerances

In 2016 and 2017 two regulations were introduced that repealed the existing Annexes of Regulations (E) No 811/2013 and 813/2013 on Verification procedures for market surveillance purposes: Regulation 2016/2282/EU for ecodesign and Delegated Regulation 2017/254/EU 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 circumvention devices and 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) ⁴² 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.

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, just, etc.) and the time elapsed between measurements. Most test standards give guidance on acceptable values/ranges for measurement equipment, calibration and test conditions. These 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.

⁴² <http://ec.europa.eu/transparency/regdoc/rep/3/2016/EN/C-2016-7765-F1-EN-MAIN-PART-1.PDF>

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.

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

In addition to these two regulations the Commission published in 2014 a transitional method for space/combination heaters in the form of Commission Communication 2014/C-207/02⁴³ in the framework of the implementation of Commission Regulation (EU) No 813/2013 and of Commission Delegated Regulation (EU) No 811/2013.

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 **TM2014_{sh}**, to set it apart from the transitional methods for water heaters **TM2014_{wh}**

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 combination heaters and cogeneration space heaters, to be used for verification of product conformity by market surveillance authorities in absence of harmonised standards for space heaters.

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 10 Parameter table of Commission Communication 2014/C 207/02

Parameter to be verified	Reference to standard
Boiler space heaters and boiler combination heaters using gaseous fuel	
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)	EN 15502-1:2012
Useful efficiency η (at rated heat output for 80/60°C regime η_4, and 30% of rated heat output at 'low temperature regime' η_1)	
design types	
Standby heat loss P_{stby}	
Ignition burner power consumption P_{ign}	
NO_x emissions	

⁴³ OJ C 207, 3.7.2014, p. 2–21.

See: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2014.207.01.0002.01.ENG

Boiler space heaters and boiler combination heaters using liquid fuel

Test conditions EN 304:1992; A1:1998; A2:2003

Standby heat loss Pstby EN 304:2017 (announced)

Seasonal space heating energy efficiency in active mode η_{son} for standard/LT boilers

Seasonal space heating energy efficiency in active mode η_{son} for condensing boilers EN 303-2:2017 (announced)

Emission of nitrogen oxides NOx EN 267:2009+A1:2011

Electric boiler space heaters and electric boiler combination heaters

Seasonal space heating energy efficiency η_s Point 4 of the Communication

Cogeneration space heaters (microCHP)

Useful heat output at rated heat output FprEN 50465:2013

Useful efficiency at rated heat output

Electrical efficiency at rated heat output

Standby heat loss Pstby

Ignition burner power consumption Pign

Emission of nitrogen oxides NOX

Boiler space heaters, boiler combination heaters and cogeneration space heaters

Auxiliary electricity consumption at full load e_{lmax} , at part load e_{lmin} and in standby mode PSB EN 15456:2008: Heating boilers - Electrical power consumption for heat (for oil boilers?)

EN 15502:2012 for gas boilers.

FprEN 50465:2013 for cogeneration space heaters

Sound power level LWA EN 15036 - 1

Seasonal space heating energy efficiency η_s Point 4 of the Communication

Heat pump space heaters and heat pump combination heaters

for electric motor driven heat pumps and (gas) engine driven heat pumps EN 14825:2013

EERbin(Tj) and COPbin(Tj)

SCOP (electric) or SPER (engine driven)

(gas)engine heat pumps

In accordance with table 3 Annex III of Commission Regulation 813/2013 with Engine rpm equivalent (Erpm equivalent)

Emission of nitrogen oxides NOX

fuel sorption heat pumps

prEN 12309-4:2013

test conditions

fuel sorption heat pumps

prEN12309-6:2012

SPER

fuel sorption heat pumps	prEN 12309-2:2013
Emission of nitrogen oxides NOX	
Seasonal space heating energy efficiency η_s	Point 5 of the Communication
Sound power level (LWA)	EN 12102:2013
Other	
Temperature controls	Point 6 of the Communication
Water heating energy efficiency η_{wh} 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*:

- uncertainty of measurement (accuracy) is the precision of the instrument (or a sequence of instruments) compared to a value measured with highly-calibrated instruments;
- permissible deviation (average over test period) is the maximum allowed difference between a measured parameters, averaged over the test period, and a predefined value;
- 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 **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 **TM2014sh** deviates from the appropriate EN standard, now published as EN 50465:2015 in that the **TM2014sh** applies a different calculation to correct for electricity production that is not in conformity with the EED and applied correction factors for auxiliary power and standby heat losses that are not in relation to the coverage of the heat demand. The EN 50465 presents alternative calculation methods.

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 (A_{sol});
- collector efficiency: η_{col} (%);

- annual non-solar heat contribution: Q_{nonsol} (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, Q_{aux} (kWh/a in final energy = kWh_elec);

The calculation of the solar contribution Q_{nonsol} 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 method 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 methods to be used for storage 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
- 4) EN 60379:2004.

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 11. Differences in test standards for standing losses of storage tanks

Test aspect	EN 12897:2006	EN 15332:2008	EN 12977-3:2008	EN 60379:2004
-------------	---------------	---------------	-----------------	---------------

Scope	heated warm water storage tank up to 1000 l	warm water storage up to 1500 l	warm water store volume 50 to 3000 l	electric storage water heater
Installation	connections should be insulated	connections should be insulated	connections should be insulated	(no insulation connections required)
Test	immersion heater 3 kW, or external flow through heater 65°C +/- 2K 24 h stabilisation measurement uncertainty for energy <2%, multiple tests of 24 h may be required	electric immersion heater in lower third of tank hysteresis < 0.8 K start/end of test based on temperature control switching	heated by external heater (full heating possible) test sequence: conditioning – heating – standby – conditioning	energy supply measured over 48 h at minimum, start/end on basis of thermostat switch
Ambient conditions	20°C +/- 2K	20°C +/- 5K	20°C +/- 2K	20°C +/- 2K
Storage temperature	25 mm below outlet	according instructions or in upper third, minimum 65°C	not required	must be 65°C +/- 3K in upper part of tank
Other measurement values	(-)	(-)	inlet and outlet temperatures, every 10 s	(-)
Results	energy consumption for keeping temperature constant for 24 h	energy consumption for keeping temperature constant for 24 h	parametric approach for identification of thermal loss parameters	energy consumption for keeping temperature constant for 24 h
Uncertainty of temperature measurement	+/- 1K	+/- 0.1K	absolute temperatures: +/- 0.1K temperature difference +/- 0.05 K time step < 10 s	+/- 1K
Uncertainty of energy measurement	+/- 0.01 kWh	+/- 0.01 kWh	Volume flow: +/- 2.0 %	+/- 0.01 kWh
Result of a comparison test	2.44 kWh/24h =	2.25 kWh/24h =	2.60 kWh/24h =	[not tested]

of a 300 l tank	D	C	D	
Result of a comparison test of a 500 l tank	2.53 kWh/24h = C	2.71 kWh/24h = C	2.85 kWh/24h = D	[not tested]
Possible factors contributing to differences	No verification that start and end temperature are identical	Heated volume is not precisely defined	External loading / unloading introduces extra losses	[not tested]
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.

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 (20°C) 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 (20°C). 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 results 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 Request for standardisation M/535 and harmonisation

Before standards can be harmonised, there needs to be a request by the Commission to European standardisation organisations for (harmonised) standards⁴⁴. Therefore, in April 2015 the Commission published a standardisation request M/535⁴⁵ 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 2015⁴⁶.

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 Request for standardisation 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:

- 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).

⁴⁴ 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

⁴⁵<http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=555>

⁴⁶http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2014.207.01.0002.01.ENG

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.

At this moment (Oct 2017) some 9 draft standards have reached Secretary Enquiry level, these being:

- prEN45550 – Definitions
- prEN45551 – 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 Guidelines and FAQ (2015)

The regulations of 2013 and the Transitional Methods of 2014 still left certain 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 guidelines⁴⁷ 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 is expected to publish the updated guidelines by end 2017.

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 deal 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. Some of these FAQ are listed below as capita Selecta (this is not a complete overview):

FAQ 7: How to deal with hybrid products, combining multiple technologies in one casing, e.g. a heat pump integrating a fossil fuel heater?

According the Commission this would be a product and not a package and, if no specific standards are available, should be assessed in analogy with similar appliances (e.g. apply the method for a

⁴⁷ https://ec.europa.eu/energy/sites/ener/files/documents/GuidelinesSpaceWaterHeaters_FINAL.pdf

heat pump with a joule back-up heater, but replace the COP of the electric element by an appropriate efficiency of the fuel boiler). Currently hybrids are considered as heat pumps and therefore EN 14825 is applicable.

→ describe if/how hybrid products are considered in standards and whether it contributes to a level playing field

FAQ 8: How can cogeneration combination heaters be labelled? [Note: there are currently no specific requirements for cogeneration combination heaters, only space heaters are covered]

The Commission responds that in such cases (i.e. a cogeneration combination heater) the manufacturer has to provide appropriate labels, combining both cogeneration and water heating performance, and when assessing water heater performance the electricity generation should not be double counted (attributed to space heating when applicable).

→ this is to be revisited in the review study

FAQ 10: How to label a device declared 4XL under ecodesign 814/2014 if 812/2013 has XXL as maximum?

The Commission replies that the product has to be labelled in accordance with the load profiles stated in the legal text. Indeed the maximum water heating load profile is different for ecodesign and labelling, for both combination heaters and water heaters:

- Regulation (EU) No 813/2013 Ecodesign combination heaters – 3XS to 4XL
- Regulation (EU) No 811/2013: Labelling of combination heaters – 3XS to XXL ('2XL')
- Delegated Regulation (EU) No 814/2013: Ecodesign water heaters – 3XS to 4XL
- Delegated Regulation (EU) No 812/2014: Labelling of combination heaters – 3XS to XXL ('2XL')

→ Harmonise maximum water heating profiles across regulations.

FAQ 12: Can the sound power symbol be removed from the 'non-heat pump' water heaters/combination heaters?

The Commission replies that the label content/format shall be respected.

→ revise sound power requirements to only cover relevant equipment

FAQ 14: How to deal with a package of space heater, temp. control and solar device with tank > 500L?

Note: The water heater labelling scope (812/2013, article 1) is limited to tanks not exceeding 500 L storage volume. The water heater ecodesign scope (814/2013, article 1) is limited to storage tanks not exceeding 2000 L storage volume. The ecodesign and labelling regulations for space heater/combination heaters do not limit the scope through a maximum storage volume.

The Commission replies that packages .. with a volume larger than 500 L .. are in principle covered by the regulations.

→ harmonise the scope across regulations as regards maximum storage tank volume

FAQ 17: Certain combinations of heat pumps comprise indoor units that can be combined with several outdoor units, storage tanks and controls – permitting a multitude of

possible configurations, one of which to be selected by the installer based on local conditions. How should the options for this model range be labelled?

The Commission replies that 'one label must be supplied' and this could be the most common combination. Manufacturers may indicate where/how information of the performance of other products may be found.

→ The requirements specify that only 1 label must be in the box, but that the rest must be supplied online. Current wording indicates that it is optional ('may'). As regards the energy labelling database: current understanding is that all combinations will have to be entered.

FAQ 21: How to label combinations of more than two space heaters

The Commission replied that, assuming this is a so-called cascade of identical products, the fiche doesn't cover this configuration, but that product labels must be supplied and the supplier can calculate the expected performance and indicate this (but not as a package label).

→ whether the product fiches need to consider this situation needs to be discussed

FAQ 24: If the water heating performance of an exhaust air heat pump combination heater is declared for a give profile, must the same ventilation air flow rate be used for declaring the space heating mode?

The Commission replies this is not required: Different exhaust air ventilation rates can be used if the heat pump has been tested for them and if they apply to the different operation modes.

Note: the labelling and ecodesign regulations only specify ventilation rates in relation to water heating performance.

→ discuss a need for ventilation rates for space heaters

FAQ 34: The definition of a package in 811/2013 (Article 2(19-20) does not include a storage tank.

The Commission replies that the definition does not exclude a storage tank from the package.

→ make the definition of a package less ambiguous

FAQ 35: The product fiches of regulation 811/2013 and 812/2013 are slightly different. Can they be made the same?

The Commission replies that the supplier can construct a single fiche that meets the demand of both regulations.

→ harmonise the fiches as far as possible/required

FAQ 36: Can a burner and a boiler body be labelled?

The Commission replies that both burner and body are covered by the ecodesign regulation 813/2013 (and 814/2013 for water heaters) and that the manufacturer has to state the configurations used to declare compliance. For energy labelling 811/2013 (and 812/2013) the definition of heat generator does not include separate burners and boiler bodies.

→ do separate burners and boiler bodies need to be labelled as space heater as well?

FAQ 37: What is the definition of a preferential heater?

The Commission replies that a preferential heater is a heater that generates heat in cases where the heat demand is lower than or equal to its rated heat 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.

Note: This definition can be exploited if the 'preferential heater with higher efficiency is not responsible for fulfilling most of the heat demand, but a supplementary heater with lower efficiency is.

→ Does the preferential heater needs to be identified on the basis of sequence (first one turned on) or on the basis of operating hours (possibly weighted by heat output)? Furthermore, definitions of *preferential* heater and *supplementary* heater should be aligned. In Regulation 811/2013 Annex 4, the weighting factors for preferential heaters are only valid for bivalent parallel operation (= preferential heater remains working until lowest outdoor temperature), and not for bivalent alternative operation (= preferential heater switches off below a certain outdoor temperature and supplementary heater takes over completely), which gives essentially lower contribution/weighting factors.

Moreover the terms "supplementary heater" in Annex 4 Table 1 and "supplementary heat pump" in Annex 4 Figure 1 calculation step 5 do not comply with the definition of supplementary heater in Annex I (5): in this case the heat pump is used preferentially; the boiler is in contrary to the text not preferential, but supplementary.

Secondly, space/combination heaters that have a preferential and supplementary heat generator integrated are treated differently than a package comprising identical heaters, as the ration 0.15/0.85 is converted to a variable linked to heater output for packages.

→ integrated units and packages comprising preferential and supplementary heaters the preferential heater

FAQ 38: How to calculate the annual energy consumption of a fuel boiler?

The Commission replies that a calculation method has been developed by CEN/TC 109/WG1.

→ the method for calculating the annual energy consumption must be developed for fuel boilers and cogeneration space heaters as well

FAQ 40: How to calculate the peak temperature of a combination heater tapping pattern?

The Commission replies that the peak temperature is the mean value over the draw-off, with a minimum value as specified in the tapping cycles..

→ the definition of peak temperature needs further clarification

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 (screen shot).

Figure 9. Screen shot of energy label generator (eepf-labels)

3.5 Member State (+ EEA) policies and measures

With the ecodesign and labelling regulations in place since 2013, Member States were allowed, in accordance with article 8 of the Ecodesign regulation, the placing on the market and/or putting into service of heaters which comply with the national provisions in force when the Regulation was adopted regarding seasonal space heating energy efficiency, water heating energy efficiency and sound power level until 26 September 2015, and for nitrogen emissions until 26 September 2018.

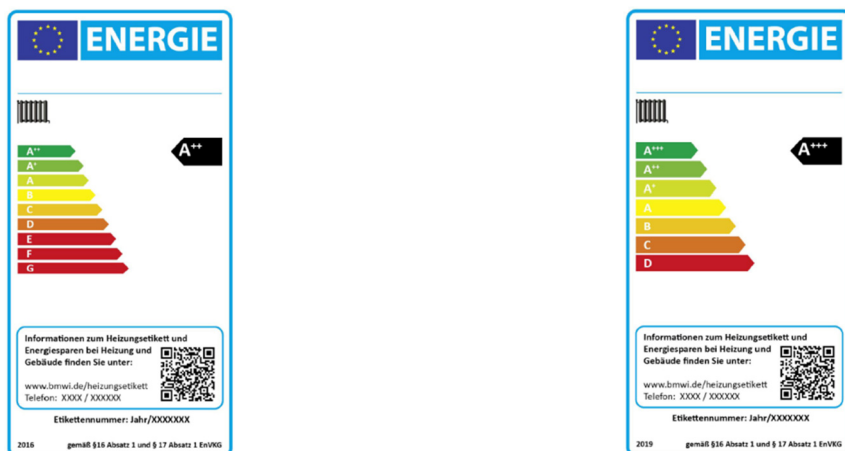
So today, the only heater specific requirements (for energy and sound) are the EU requirements. Still, Member States can exert through building energy performance regulation a great deal of influence on what kind of heating installations are allowed in new builds or large renovations. Furthermore the States can introduce rules for the decommissioning of boilers, as is the case in Germany.

3.5.1 Germany

According ENEC 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)⁴⁸. As of 1.1.2017 certified chimney sweepers are required to attach such labels (mandatory). The technical scope of the measure is identical to that of Regulation (EU) No 811/2013. The assessment and affixing of the label is free of charge but the inspector has to have access to the boiler.

Figure 10. ENEC labels for existing heaters



per 1.1.2016 (max. class A++)

per 26.9.2019 (max. class A+++)

The QR code on the label links to: 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.

The Nachrüstverpflichtung 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 heaters⁴⁹. Homeowners of small 1-2 family dwellings may be excluded from the Nachrüstpflicht, under certain conditions.

New buildings in Germany have to meet overall energy performance standards, laid down in the EnEV. These are based on a reference energy consumption of a (theoretical) building with the same geometry and functionality as the 'to be build' design. The heat losses may not be more than the reference losses as well. Until 2016 it was possible to meet slightly less demanding standards if for

⁴⁸ http://www.enev-online.com/news/15.08.19_bundesregierung_beschliesst_novelle_energieverbrauchskennzeichnungsgesetz.htm

⁴⁹ http://www.enev-online.com/enev_praxishilfen/151220_enev_alte_heizkessel_heizung_erneuern_altbau_bestand_baubestand_pflcht.htm#Alte_Heizkessel_nicht_mehr_betreiben_sondern_erneuern

instance the new building was equipped with installations making use of renewable energy (for example high efficiency biomass pellet boilers) but as of 2016 this is not allowed anymore. The 2016 EnEV introduced a reduction of the reference consumption of 25%, compared to the 2014 version.

3.5.2 France

The RT 2012 is the French implementation of the EPBD and is the main building code for new and refurbished buildings. RT 2012 is a comprehensive methodology, based on primary energy. The conversion factor from final (electric) energy to primary energy is 2.58⁵⁰. Regarding gas and fuel boilers this coefficient is 1.

The RT 2012 requires that detached houses get a minimum share of their energy demand from renewable sources. The calculation formula used in RT 2012 to assess the renewable energy coming from heat pumps differs from the formula of the European directive Renewable Energy Directive 2009/28/EC annex 7 (under revision). The RT 2012 equation leads to a smaller share of renewable energy coming from heat pumps as it converts final energy with a PEF of 2.58 while the European formula is in final energy.

Formula presented in Annex VII of 2009/28/EC:

$$E_{RES} = Q_{usable} * (1 - 1/SPF)$$

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 $SPF > 1,15 * 1/\eta$ shall be taken into account

SPF = the estimated average seasonal performance factor for those heat pumps;

η = 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

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 (90% for full load or 93% for part load).

Subsidies / incentives

Article 200 of the Code Général⁵¹ des Impôts establishes a tax reduction through which some 30% of the costs for energy refurbishment is returned for works of minimum € 8000 (single person) or € 16000 (couples) of worth (in 2019 the tax credit will probably be reformed to a premium of the same amount). According to Code général des impôts, Annex 4, Article 18⁵² the tax relief applies to

⁵⁰ In the EED 2012/27/EU this PEF is 2.5, as in regulations N°813/2013 and N°811/2013.

⁵¹ 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

⁵² <https://www.legifrance.gouv.fr/affichCodeArticle.do?idArticle=LEGIARTI000023374187&cidTexte=LEGITEXT000006069576>

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) and a water heating efficiency at class A or higher (for heat pump combination heaters the minimum efficiency values for water heating are even higher).

Refrigerants

Although the French heating and cooling industry is supportive of the F-Gas Regulation and the clear steps in the F-Gas phase-down by 2030 at EU level, the French government considers introducing a tax on HFCs. The French industries dealing with refrigerants are reluctant, according some sources because an HFC tax would counter French policy support to heat pumps and their contribution to the energy transition, according other sources because of the lack of trained installers with experience in using alternative refrigerants like ammonia, propane and CO₂⁵³.

3.5.3 The Netherlands

The Netherlands have energy efficiency requirements for new buildings and large renovations (EPC) since 1995, and which 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. The building regulations also state a minimum heat loss value for the building envelope: floor ≥ 3.5 m²K/W, facade ≥ 4.5 m²K/W and roof ≥ 6 m²K/W, and transparent elements (windows): average 1.65 W/m²K, maximum 2.2 W/m²K for an individual element.

The recently installed government proposed to abolish the plight for building authorities to require new buildings to be connected to the gas grid (exemptions in case of district heating or shared heating). This opens up a path for more full-electric buildings/districts using heat pumps and increased use of photo-voltaics.

Since 2014 buildings have to be energy labelled but the current implementation of the scheme is under scrutiny by the Commission as it does not require an independent inspection on site.

3.5.4 Sweden

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:

$$EP_{pet} = \frac{\sum_{i=1}^6 \left(\frac{E_{uppv,i}}{F_{geo}} + E_{kyl,i} + E_{tvv,i} + E_{f,i} \right) * PE_i}{A_{temp}}$$

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

⁵³

- 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 °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 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 (PET_{max}) 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.

The Swedish Building Regulations states a minimum ventilation air flow 0,35 l/(s*m²) for residential buildings. Insulation standards apply, resulting in an energy consumption for DHW and space heating expressed in (electric) kWh/(year *m²). A maximum is defined at 55 kWh/(year *m²) depending on the part of Sweden where one lives.

The value of 0.35 l/s*m² is adequate as nominal air exchange in a simple central exhaust ventilation system, but is considered to contribute to overventilation when compared to situations where the ventilation exchange is linked to presence, number and location of residents.

3.5.5 Norway (EEA)

Fossil fuels (for space and water heating) are no longer allowed in new and refurbished buildings that have to adhere to the building code TEK'17 (the building code for new buildings apply if more than 50% of the value of the building is refurbished). The prohibition to install fossil fuel heating systems for new dwellings started in 2010. 15th of June 2017 the government announced the prohibition to use fossil 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 end of 2017.

Important notice: the word "heating installation" in the Norwegian legislation covers both local space heaters, central heaters, heaters in ventilation systems and heating of sanitary water.

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 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 has 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 in to the utility/boiler room shall be at least of 1 meter with

Previous legislation

Previous legislation also had restrictions on use of direct electric resistance heating and water heating, due to ample surplus and the second lowest unsubsidized electricity prices in EU28+NO, 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. In addition it was a drive to simplify Building Codes.

Due to

- relative high product costs and in particular high installation cost for energy flexible heat generators and distribution systems based on a high cost level in Norway
- one of the lowest electricity costs in Europe
- a renewable status 98% of central hydroelectric and wind power production

the government introduced a simplified legislation that allows direct electrical resistance heating for smaller buildings.

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.

3.5.6 Indoor/outdoor sound power level

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.

Sound pressure is what we hear. It is a pressure disturbance at a specific point in the atmosphere whose intensity is influenced not only by the sound power of the source, but also by the surroundings and the distance from the source to the point at which the sound is heard.

Besides the sound power level as measured in a laboratory, more and more communities and Member States are introducing maximum outdoor sound power limits at the installation site.

Indoor sound is often regulated in national building codes. Most often values close to 30 dB are required for equipment that is installed close to or in habitable rooms.

Outdoor noise may become a bigger problem if more and 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.

Outdoor sound is often regulated (traffic). Certain member states (Austria, Germany, United Kingdom and Switzerland) have introduced maximum sound power limits for outdoor heat pumps.

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 provided⁵⁴. Maximum noise pressure levels vary per region, and limits may apply to the property border or the facade of the neighbouring property.

In Germany the 32. BImSchV regulates permitted outdoor noise and reverts to the "Technische Anleitung Lärm" (TA Lärm). This guideline sets maximum noise (pressure) 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 Wärmepumpe (BWP) e.V. has published a guideline to establish / calculate indicative noise levels⁵⁵.

In the UK the installation of an air source heat pump does not require prior permission if the requirements of MCS 20 (see below) are met⁵⁶: MCS20 means the maximum sound pressure one metre external to the centre point of any door or window to a habitable room of a neighbouring property as measured perpendicular to the plane of the door or window is maximum 42 dB(A)⁵⁷. 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 is considering a maximum sound power level of 35 dB for neighbouring homes. For an average heat pump in a dense area this means a reduction of 9 to 14dB(a) is needed. The easiest way is to apply a sound canopy or enclosure⁵⁸.

The outdoor unit produces some 54 to 62 dB(A), measured at 1 m distance. Each extra meter distance reduces the sound pressure by approximately 6 dB. So, if an outdoor unit produces 62

⁵⁴ http://www.umweltbundesamt.at/fileadmin/site/umwelthemen/laerm/forum_schall/downloads/Informationsblatt_Luftwaermepumpen_2013.pdf

⁵⁵ https://www.waermepumpe.de/uploads/tx_bcpagflip/BWP_LF_Schall_final.pdf

⁵⁶ https://www.planningportal.co.uk/info/200130/common_projects/27/heat_pumps/2

⁵⁷ MCS 20 Planning Standards, by the Department of Energy and Climate Change (DECC), United Kingdom, 2008

⁵⁸ <https://stillewarmtepomp.nl/>

dB(A) at 1 m and a neighbouring home at 3 m distance requires maximum 35 dB(A), an additional reduction of 15 dB(A) is required: $(62 \text{ dB(A)} - (2 \times 6 \text{ dB(A)})) = 50 \text{ dB} - 35 \text{ dB(A)} = 15 \text{ dB(A)}$.

Companies have started to respond with aftermarket sound canopies or 'extra silent' air-source heat pumps.

3.6 Extra EU policies and measures

3.6.1 USA

The USA have introduced a minimum energy efficiency of boilers based on the annual fuel utilization efficiency (AFUE) ratings. 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. The minimums are:

- 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 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 upon – 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, and then⁵⁹:

SUBCHAPTER D—ENERGY CONSERVATION PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS:

⁵⁹ <https://energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/52residentialwaterheatingequipment.htm>

Appendix E to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Water Heaters

Appendix N to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers

PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

Subpart E—Commercial Packaged Boilers

§431.81 Purpose and scope.

§431.82 Definitions concerning commercial packaged boilers.

Test Procedures

§431.85 Materials incorporated by reference.

§431.86 Uniform test method for the measurement of energy efficiency of commercial packaged boilers.

Energy Efficiency Standards

§431.87 Energy conservation standards and their effective dates.

Appendix A to Subpart E of Part 431— Uniform Test Method for the Measurement of Thermal Efficiency and Combustion Efficiency of Commercial Packaged Boilers

Subpart G—Commercial Water Heaters, Hot Water Supply Boilers and Unfired Hot Water Storage Tanks

§431.101 Purpose and scope.

§431.102 Definitions concerning commercial water heaters, hot water supply boilers, unfired hot water storage tanks, and commercial heat pump water heaters.

Test Procedures

§431.105 Materials incorporated by reference.

§431.106 Uniform test method for the measurement of energy efficiency of commercial water heating equipment.

Energy Conservation Standards

§431.110 Energy conservation standards and their effective dates.

Appendix A to Subpart G of Part 431—Uniform Test Method for the Measurement of Thermal Efficiency and Standby Loss of Gas-Fired and Oil-Fired Storage Water Heaters and Storage-Type Instantaneous Water Heaters

Appendix B to Subpart G of Part 431—Uniform Test Method for the Measurement of Standby Loss of Electric Storage Water Heaters and Storage-Type Instantaneous Water Heaters

Appendix C to Subpart G of Part 431—Uniform Test Method for the Measurement of Thermal Efficiency and Standby Loss of Gas-Fired and Oil-Fired Instantaneous Water Heaters and Hot Water Supply Boilers (Other Than Storage-Type Instantaneous Water Heaters)

Appendix D to Subpart G of Part 431—Uniform Test Method for the Measurement of Standby Loss of Electric Instantaneous Water Heaters (Other Than Storage-Type Instantaneous Water Heaters)

Appendix E to Subpart G of Part 431—Uniform Test Method for the Measurement of Energy Efficiency of Commercial Heat Pump Water Heaters

Refrigerants

The EPA issued the Significant New Alternatives Policy (SNAP)⁶⁰ Rule which 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, CO2 (R744) and ammonia (R717). The current rule affects mostly supermarket refrigeration, but extending the scope to other refrigerant equipment is possible.

Currently, the Environmental Protection Agency 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.

3.6.2 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 framework⁶¹ 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 program⁶².

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 are not regulated nor is regulation being developed.

3.6.3 Canada

Canada has implemented the following rules for space/combi heaters⁶³:

- 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, 0°C entering water) to 3.6 (open system, 10°C 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 20°C inlet water, ≥ 5 kW and ≤ 40 kW COP ≥ 4.2 with 20°C inlet water. Test standard: CAN/CSA-C13256-1.

⁶⁰ <http://www.epa.gov/ozone/snap/regulations.html>

⁶¹ <http://www.energyrating.gov.au/products/space-heating-and-cooling>

⁶² Gas space heaters – performance testing & energy labelling, E3 Equipment Energy Efficiency Research Report, May 2015 Reissued September 2015 incorporating amendments

⁶³ <http://www.nrcan.gc.ca/energy/regulations-codes-standards/6861>

- large air conditioners, heat pumps and condensing units: COP at 8.3°C 3.2 to 3.3 depending on capacity, and at -8.3°C 2.05 to 2.25 depending on capacity;
- oil-fired boilers: minimum AFUE 84%

Water heaters:

- gas water heaters: Energy factor of $\geq 0.675 - 0.00039 V_r$;
- oil-fired water heaters: Energy factor of $\geq 0.68 - 0.0005 V_r$;
- electric water heaters: maximum allowable standby loss.

Table 12. Canada - Electric water heater maximum standby loss

PRODUCT CLASS	MAXIMUM ALLOWABLE STANDBY LOSS September 2004 (W)
Bottom inlet *	
50 to 270 litres (11 to 59 Imperial gallons)	40 + (0.20V)
270 to 454 litres (60 to 100 Imperial gallons)--> > 270 to 454 litres (60 to 100 Imperial gallons)	(0.472V) – 33.5
Top inlet	
50 to 270 litres (11 to 59 Imperial gallons)	35 + (0.20V)
270 to 454 litres (60 to 100 Imperial gallons)--> > 270 to 454 litres (60 to 100 Imperial gallons)	(0.472V) – 38.5
Where V = rated storage capacity in litres	
W = Watts	
* = supply pipe external to tank and connection near the bottom. Standby Loss as defined in the CSA test procedure.	

The energy efficiency and other information has to be reported to Natural Resources Canada and be entered into searchable product list⁶⁴.

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.

3.7 Voluntary Labelling and Certification schemes

In Europe and abroad there are several independent, voluntary certification schemes that enhance the trust in the performances claimed by the manufacturer/supplier.

⁶⁴ <http://oee.nrcan.gc.ca/pml-lmp/index.cfm?action=app.welcome-bienvenue>

3.7.1 NF Heat Pumps

The NF Heat Pump is a label covering electric or gas HPs, intended for space or pool heating and possibly for domestic hot water production (dual-mode), individual or collective.

The NF Mark certifies the energy performances and sound power level of the products in accordance with the applicable European standards. In addition it guarantees compliance with the efficiency and sound level thresholds required by Regulation (EU) No 813/2013.

Some several hundred heat pumps have been awarded the NF label⁶⁵.

3.7.2 Netherlands: GaskeurHR, CW and SV

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% l_hv) 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 extended by an additional label Gaskeur HR_{ww} which signifies a minimum energy efficiency of 61% (higher heating value) and tighter limits for waiting times.

The Gaskeur SV label means the NO_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.

3.7.3 Solar keymark

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).

3.7.4 EHPA Quality Label

The EHPA Quality Label is a label 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.

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

⁶⁵ <http://www.certita.fr/en/certita-mark/nf-heat-pumps>

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.

3.7.5 Heat pump Keymark

The Heat Pump KEYMARK⁶⁶ is a voluntary, independent, European certification mark (ISO type 5 certification) for all heat pumps, air/air heat pumps (covered under Lot 10), combination heat pumps and hot water heaters (as covered by Ecodesign, EU Regulation 813/2013 and 814/2013):

- Heat pumps covered by Lot 1 and Lot2;
 - 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;

⁶⁶ <http://www.heatpumpkeymark.com/>

- 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. It has been developed by the heat pump industry in 2015 and now owned by CEN. 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.

It currently has some 11 certificate holders, comprising 101 products.

3.7.6 Eurovent certification (incl. Eurovent CERTITA)

Eurovent Certification certifies the performance ratings of air-conditioning and refrigeration products according to European and international standards.

The objective is to build up customer confidence by levelling the competitive playing field for all manufacturers and by increasing the integrity and accuracy of the industrial performance ratings.

The Certification 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 Certification certifies:

1. European HP (Euro-HP)

2. Liquid Chilling Packages and Heat Pumps (LCP-HP)

(plus some 22 other 'programmes' such as Comfort Air Conditioners, Air Handling Units, etc.)

Eurovent CERTITA adds various other appliance / equipment categories, including solid fuel fired, gas-fired, solar driven and thermostatic radiator valves.

The Euro-HP programme⁶⁷ applies 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

⁶⁷ http://www.eurovent-certification.com/en/Certification_Programmes/Programme_Descriptions.php?lg=en&rub=03&srub=01&select_prog=Euro-HP

- 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 \dot{Q}_h [kW]
- Electrical Power input P_e [kW]
- Coefficient of performance COP
- Sound power level L_w [dB(A)]
- Minimum continuous operation Load Ratio $LR_{contmin}$ [%]
- COP at $LR_{contmin}$
- Performance correction coefficient at $LR_{contmin}$ $C_{pLRcontmin}$
- Seasonal Coefficient of Performance SCOP
- Seasonal efficiency η_s

+ 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.

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.

3.7.7 USA Energy Label

The **US Energy Star levels are 85%** for non-condensing and **95% for condensing boilers**.

See also section 3.6.1.

4 TEST STANDARDS

This Chapter present 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 *Standards harmonised for Regulation (EU) No 811/2013 and Regulation (EU) No 813/2013*

There are no references of harmonised standards which have been published in the Official Journal of the European Union for⁶⁸:

- 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);
- Local space heaters (Regulation (EU) 2015/1185, Regulation (EU) 2015/1186, Regulation (EU) 2015/1188);
- 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).

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 2014/C 110/01 of 11 April 2014 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 12102:2013 - 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 14825:2013 - 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;

⁶⁸ https://ec.europa.eu/growth/single-market/european-standards/harmonised-standards/ecodesign_en

- 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.

4.1.2 Transitional Methods for space/combination heaters/packages

There are transitional methods of measurement presented in the Commission communication in the framework of the implementation of Commission Regulation (EU) No 813/2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters and of Commission Delegated Regulation (EU) No 811/2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to 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 - (2014/C 207/02)** - *Publication of titles and references of transitional methods of measurement and calculation for the implementation of Regulation (EU) No 813/2013, and in particular Annexes III and IV thereof, and for the implementation of Regulation (EU) No 811/2013, and in particular Annexes VII and VIII thereof - Official Journal C 207, 3.7.2014, p. 2-21*

See section 3.4.5. for details.

4.1.3 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/535⁶⁹ 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 811/2013⁷⁰.

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

Supersedes: EN 15502-1:2012/ A1:2014

⁶⁹<http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=555>

⁷⁰http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2014.207.01.0002.01.ENG

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 (η_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 losses from the test rig are added. The volume of the gas consumption is measured and multiplied with the net calorific value of the gas.

$\eta_u = \frac{4,186 * m * (t_2 - t_1) + D_p}{10^3 * V_{r(10)} * H_i}$		Equation 1. Useful efficiency
η_u = useful efficiency in %		$V_{r(10)}$ = gas consumption corrected to 15°C and 1.013,25 mbar in m ³
m = mass collected water during test in kg		
H_i = net calorific value (inferior, or lower heating value) of the gas in MJ/m ³		D_p = heat losses from test rig in KJ

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 input⁷¹ 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

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 $\pm 2 \%$.

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, η_{100} is the useful efficiency at full load and η_{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:

$\eta_{son} = 0,85 * \eta_1 + 0,15 * \eta_4$	Equation 3. Seasonal space heating efficiency in active mode
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⁷¹ 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.

$\eta_1 = \eta_{30} * \frac{H_i}{H_s}$		$\eta_4 = \eta_{100} * \frac{H_i}{H_s}$
η_{son} = seasonal space heating efficiency in %		$V_{vr(10)}$ = gas consumption corrected to 15°C and 1.013,25 mbar in m ³
m = mass collected water during test in kg		
H_t = net calorific value of the gas in MJ/m ³		D_p = heat losses in KJ

This η_{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:

$\eta_s = \eta_{son} - \sum F(i)$		Equation 4. Corrected seasonal space heating efficiency
η_s = corrected seasonal space heating efficiency in %		F_i = correction factors
η_{son} = seasonal space heating efficiency in %		

With:

Temperature controls	$F(1) = 3$
Auxiliary electricity power	$F(2) = 2,5 * \frac{0,15 * el_{max} + 0,85 * el_{min} + 1,3 * P_{SB}}{0,15 * P_4 + 0,85 * P_1} * 100$
Standby heat losses	$F(3) = 0,5 * \frac{P_{stby}}{P_4} * 100$
Ignition burner power consumption (continuous pilot flame)	$F(4) = 1,3 * \frac{P_{ign}}{P_4} * 100$

For boilers with a nominal heat output > 70 kW and ≤ 400 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.

If the pump is not integrated in the boiler or neither supplied nor specified by the manufacturer, the measurement cannot be conducted simultaneously with the efficiency test. In that situation the pump energy is calculated.

$P_{hyd} = Q_{max} * (h_i + 2,5) * 2,73$ $P_{HE100,pump} = 2,21 * (P_{hyd} + 55) * (1 - e^{-0,39 * P_{hyd}})$		Equation 5. Electric power input to the pump
P_{hyd} = hydraulic pump output at rated input (100%) in Watt		h_i = internal resistance of the heating boiler in m
$P_{HE100,Pump}$ = hydraulic pump output at rated input in Watt		Q_{max} = maximum pump feed in m ³ /h rated input (100%)

Boilers without a pump can also be assessed according to EN 15456.

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.

$CO = (CO)_M * \frac{(CO_2)_N}{(CO_2)_M}$		Equation 6. Corrected seasonal space heating efficiency
CO = the carbon monoxide concentration of the dry air-free combustion products in %		(CO ₂) _N = maximum carbon dioxide concentration of the dry, air-free combustion products in %

(CO)M = the measured concentrations in the samples taken during the combustion test, both expressed in %;

(CO₂)M = the measured concentrations in the samples taken during the combustion test, both expressed in %.

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 NO_x measurements need to be corrected.

$NO_{x,0} = NO_{x,m} + \frac{0,02NO_x - 0,34}{1 - 0,02(h_m)} * (h_m - 10) + 0,85 * (20 - T)$		Equation 7. Nitrogen oxides measured
NO _{x,m} = NO _x measured at h _m and T _m in mg/kWh (within the range of 50-300 mg/kWh)		T _m = temperature during test in °C (within the range of 15-25°C)
H _m = humidity during test in g/kg (within the range of 5-15 g/kg)		NO _{x,0} = corrected NO _x value in mg/kWh

Also the measured NO_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 8. Weighting of NO _x concentrations
NO _{x,pond} = weighted NO _x value in mg/kWh		NO _{x,mes(x)} = NO _x 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_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 [ok]

CEN/TC 109/WG 2

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 [ok]

CEN/TC 109/WG 2

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 297:1994/A2:1996

EN 297:1994/A5:1998

EN 297:1994/A3:1997

EN 677:1998

EN 297:1994/A6:2003

EN 297:1994/A4:2004

EN 15417:2006

EN 297:1994/A2:1996/C1:2006

EN 15502-2-2:2012 draft

4.2.4 EN 303-3:1998 / A2:2004

The European Standard EN 303 includes six 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

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 13836:2006 - REVOKED

Gas fired central heating boilers - Type B boilers of nominal heat input exceeding 300 kW, but not exceeding 1 000 kW.

This standard is revoked/withdrawn.

4.2.6 EN 676/+A2:2008

Forced draught burners for gaseous fuels

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.

This European Standard does not deal with hazards due to specific applications.

This European Standard is not applicable to forced draught gas burners which are manufactured before the date of its publication as EN.

This European Standard does not apply to burners specifically designed for use in industrial processes carried out on industrial premises.

This European Standard deals also with the additional requirements for the burners in the scope with pressurised parts and /or firing pressurised bodies, see Annex K.

This European Standard deals also with forced draught burners intended to be used with biogene gaseous fuels, mixtures with line-conveyed gas and special gaseous fuels.

This European Standard deals also with burners equipped to increase the total appliance efficiency; see Annex M.

A revised standard has been published on 1-12-2016 (EN 676:2016)

4.2.7 CEN/TR 1749 - Classification according air supply and evacuation

CEN/TR 1749 provides a general scheme for the classification of gas appliances according to combustion air supply and evacuation of combustion products. The scheme applies to gas appliances intended to be installed indoors or in a partially protected place external to a building. Gas appliances (can be boilers, but also baking ovens, gas cookers, furnaces, etc.) are categorised as per the categorisation table below.

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, ..."

Figure 11. Classification according CEN/TR 1749

gas appliance type	flue system	combustion air supply	down-draught diverter	type of air supply and flue gas discharge	fan location	combustion air circulation or increased tightness ¹⁾ yes = x	CO ₂ -stop = AS FGS ²⁾ = BS	former national designation	national installation requirements according to DVGW Codes of Practice
a ₁ a ₂	b	c	d	e	f	g	h	i	j
A	A ₁	no		flue gas discharge and combustion air supply via installation room	1	without		AS	cf. TRGI '86 / 96, para 5.4: gas appliances with "AS" additional marking (CO ₂ stop device) do not meet the installation requirements for Germany
	A ₂				2	downstream of burn./h.s.		AS	
	A ₃				3	upstream of burner			
B	B ₁₁	room air dependent	1	connection to flue system, shared flue system (negative pressure), combustion air supply via installation room	1	without		BS	cf. TRGI '86 / 96
	B ₁₂				2	downstream of h.s.		BS	at present not covered by German installation rules
	B ₁₃				3	upstream of burner		BS	possible with "fan-assisted burner" like B ₁₁
	B ₁₄				4	downstream of ddt. div.			not specifically covered by German installation rules (pgr. G 626, G 660)
	B ₂₁			connection to flue system, shared flue system (negative / positive pressure), combustion air supply via installation room	1	without			at present not covered by German installation rules
	B ₂₂				2	downstream of h.s.		B	cf. TRGI '86 / 96,
	B ₂₃				3	upstream of burner		B with burner with fan	special ventilation conditions with flue outlet under pressure
	B ₃₂			3	connection to flue system, shared flue system (negative pressure), combustion air supply in external tube via installation room	2	downstream of h.s.	D _{3.1}	cf. G 637 / I and
	B ₃₃					3	upstream of burner	D _{3.1}	TRGI '86 / 96
	C ₁₁	yes	no	1	air supply and flue gas discharge through external wall in an area of equal pressure	1	without	C ₁	cf. TRGI '86 / 96
	C ₁₂					2	downstream of h.s.	C _{3.3}	cf. TRGI '86 / 96
	C ₁₃					3	upstream of burner	C _{3.3}	
	C ₂₁			2	connection to AFS ³⁾ , (single flue), shared flue system	1	without	C ₂	only existing appliances according to G 627
	C ₂₂					2	downstream of h.s.		not permitted under building regulations
	C ₂₃					3	upstream of burner		
	C ₃₁			3	air supply and flue gas discharge above roof in an area of equal pressure	1	without		at present not covered by German installation rules
	C ₃₂					2	downstream of h.s.	C _{3.2}	cf. TRGI '86 / 96
	C ₃₃					3	upstream of burner	C _{3.2}	
	C ₄₁			4	connection to AFS, (bain flue), shared flue system	1	without		at present not covered by German installation rules
	C ₄₂					2	downstream of h.s.	C _{3.1}	cf. TRGI '86 / 96
	C ₄₃					3	upstream of burner	C _{3.1}	
C	C ₅₁	room air independent	no	5	air supply and flue gas discharge from / to atmosphere in areas of different pressure	1	without		at present not covered by German installation rules
	C ₅₂					2	downstream of h.s.		only in combination with a jointly approved flue system
	C ₅₃					3	upstream of burner		
	C ₆₁			6	air / flue connection to separately tested and supplied air / flue tubes	1	without		at present not covered by German installation rules
	C ₆₂					2	downstream of h.s.		only possible with clearly defined interface and e.g. flue system approved by the building inspectorate
	C ₆₃					3	upstream of burner		
	C ₇₁		yes (in the attic)	7	flue gas discharge above roof, combustion air supply via attic	1	without		at present not covered by German installation rules
	C ₇₂					2	downstream of h.s.		
	C ₇₃					3	upstream of burner		
	C ₈₂		no	connection to flue system, shared flue system, combustion air supply through separate air duct	2	downstream of h.s.	X	D _{3.2}	cf. G 637 / I and TRGI '86 / 96
						upstream of burner	X	D _{3.2}	

¹⁾ appliances without "x" require special installation room ventilation

²⁾ FGS = flue gas sensor

³⁾ AFS = combined air flue system

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

Supersedes: EN 303-1:1999/ A1:2002

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

CEN/TC 57/WG 5

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 303-2:1998/A1:2003

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 (announced) , the limit values are stated.

4.3.3 EN 304: 2017 (announced)

Heating boilers - Test code for heating boilers for atomizing oil burners

CEN/TC 57/WG 2

Supersedes: EN 304:1992/A2:2002

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 $60 \pm 1^\circ\text{C}$ and $80 \pm 2^\circ\text{C}$. The test room temperature is set at $20 \pm 5^\circ\text{C}$. 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 method appears 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 13. Return temperatures of condensing boilers, low temperature boilers and other heaters (standard boilers)

Return temperatures (at heater inlet)	According 813/2013, ANNEX II Ecodesign requirements, Table 1 Information requirements for boiler space heaters., (**)	prEN 304: rev 2015	
		'1' Time-dependent	'2' Load-dependent
Condensing boiler	30°C	30°C	30°C
Low temperature boiler	37°C	37°C	40°C
Other heater (for EN 304 "standard boiler")	50°C	47°C	50°C

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.

$P_{stby} = P_m * \frac{30^{1.25}}{T - T_A}$		Equation 9. Standby heat loss
Pstby = standby heat loss, corrected to standard conditions		Pm = 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 according EN 15456.

Emission values of NOx and CO

The emission values of NOx and CO are determined by means of methods and instruments as described in EN 267. The calculation of NOx 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 mm²/s (cSt) up to 6 mm²/s (cSt) at 20 °C; and higher boiling petroleum based first raffinates (viscosity greater than 6 mm²/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

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 Other boilers

Solid fuel

4.4.1 EN 303-5:2012

Heating boilers - Part 5: Special heating boilers for solid fuels, hand and automatically stoked, nominal heat output of up to 300 kW - Terminology, requirements, testing and marking

Supersedes: EN 303-5:1999 and EN 303-5:2010 draft

By CEN TC 57

EN 303-5 applies to heating boilers, including safety devices, up to a nominal heat output of 500 kW which are designed for the burning of solid fuels only and are operated according to the instructions of the boiler manufacturer. These boilers may burn either fossil fuels, biogenic fuels or other fuels such as peat, as specified for their use by the boiler manufacturer, in accordance with the requirements of this European Standard.

The standard covers only boilers that include burners as a unit. The standard applies to the combination of a boiler body with a solid fuel burner according to EN 15270 as a unit only when the whole unit is tested in accordance with this European Standard. The boilers may operate under natural draught or forced draught. The stoking may work manually or automatically.

The standard deals with significant hazards, hazardous situations and events relevant to solid fuel boilers and contains requirements and test methods for safety, combustion quality, operating characteristics, marking and maintenance of heating boilers. It also covers all external equipment that influences the safety systems (e.g. back burning safety device, integral fuel hopper).

Solid fuel boilers in accordance with this European Standard are designed for central heating installations where the heat carrier is water and the maximum allowable temperature is 110 °C, and which can operate at a maximum allowable operating pressure of 6 bars.

For heating boilers with a built-in or attached water heater, EN 303-5 only applies to those parts of the water heater which are necessarily subject to the operating conditions of the heating boiler (heating part).

EN 303-5 does not apply to:

- heating boilers and other heating appliances which are also designed for the direct heating of the place of installation;
- cooking appliances;
- the design and construction of external fuel storage and transportation devices prior to the safety devices of the boiler;
- room sealed applications;
- condensing boilers.

An update of EN 303-5:2012 will be finalised soon: The enquiry stage started in November 2017, so that EN 303-5:2018 should be finalised in 2018.

4.5 Electric boilers (Joule-effect heaters)

[TBD]

4.6 Electric heat pumps

4.6.1 EN 14511 series

4.6.1.1 EN 14511-1:2013 - Part 1: Terms, definitions and classification

Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 1: Terms, definitions and classification

By CEN/TC 133 "Heat pumps and air conditioning units"

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.

There is a Fpr-version from 2017 for which the voting has been closed. Hence it will probably be published during 2018.

4.6.1.2 EN 14511-2:2013 - 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.

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 14. Standard rating conditions for heat pumps in EN 14511

Standard rating conditions	Outdoor heat exchanger		Indoor heat exchanger /					
			low temperature		medium temperature		high temperature	
	Inlet temperature °C (wet bulb)	Outlet °C	Inlet temp. °C	Outlet temp. °C	Inlet temp. °C	Outlet temp. °C	Inlet temp. °C	Outlet temp. °C
water-to-water,	10	7	30	35	40	45	47	55
brine-to-water	0	-3	30	35	40	45	47	55
outdoor air heat pump	7 (6)		30	35	40	45	47	55
exhaust air heat pump	20 (12)		30	35	40	45	47	55

The 'very high temperature'-type has standard rating condition inlet/outlet temperatures of 55-65°C.

4.6.1.3 EN 14511-3:2013 - 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.

4.6.1.4 EN 14511-4:2013 - Part 4: Operating requirements, marking and instructions

[TBD]

4.6.2 EN 14825:2016

There is a pr-version from 2017, and there will probably be another pr-version 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.

4.6.3 EN 16147:2017

[TBD]

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. These load profiles equal exactly those that are defined in 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 a test procedures split up in phases.

Table 15. Test phases

A	Stabilisation
B	Filling and storage volume
C	Filling and heating up period
D	Standby power input
E	Water draw-offs
F	Mixed water at 40°C

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_{DWH} is the ratio of the useful energy content (Q_{LP}) and the total electrical energy consumption (W_{EL-LP}) during the whole load profile.

$COP_{DWH} = \frac{Q_{LP}}{W_{EL-LP}}$		Equation 10. Coefficient Of Performance
COP_{DWH} = coefficient of performance of dedicated water heaters	W_{EL-LP} = total electrical energy consumption during the whole load profile in kWh	
Q_{LP} = total useful energy content during the whole load profile in kWh		

When the COP_{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 $SCOP_{DWH}$

Storage volume

The calculations for the water heating efficiency are equal to those of EN50440:2015 (see paragraph).

Energy consumption

Useful energy

The test methodology for measuring the useful energy consumption is mostly equal to that of EN50440:2015 (see paragraph **Error! Reference source not found.**). 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 11. Useful energy content per draw-off heat pumps
Q_{HP-tap} = energy content per hot water draw-off in kWh		
$\theta_{WH}(t) - \theta_{WC}(t)$ = temperature difference between the in- and outlet of hot storage water in K	$f_{(t)}$ = useful water flow rate in l/min t_{tap} = time duration of draw-off of useful water in s	
$\rho(T)$ = density of the hot water at the flow meter in kg	C_p = specific heat capacity in kJ/(kgK)	

Draw-offs with a peak temperature (T_p) of 55°C often need extra heating power from an additional electric heater (Q_{EL-tap}). For peak temperature draw-offs the formula of Equation 11 is adjusted to the calculation of Equation 12.

$Q_{EL-tap} = \frac{1}{60 * 1000 * 3600} \int_0^{t_{tap}} c_p * \rho(T) * f(t) * (\theta_{WH}(t) + (T_p - 10) * \theta_{WC}(t)) dt$		Equation 12. Peak temperature draw-offs
Q_{EL-tap} = additional electric energy in kWh	T_p = 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 13. Total useful energy
$Q_{EL-tLP} = \sum_{i=1}^{n_{tap}} Q_{EL-tap_i}$	T_p = 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.

$Q_{elec} = \frac{Q_{ref}}{Q_{LP}} * W_{EL-LP}$		Equation 14. Daily electricity consumption heat pumps
Q_{elec} = daily electricity energy consumption over the load profile in kWh		Q_{LP} = total energy content of all draw-offs in kWh
Q_{ref} = energy delivered by load profile in kWh		W_{EL-LP} = total electricity consumption (see Equation 15)

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 ($W_{EL-Corr}$), the heat loss over 24h, additional electrical input (Q_{EL-LP}) and the off-peak electrical energy input (W_{EL-off}) when applicable.

$W_{EL-LP} = W_{EL-M-LP} - W_{EL-Corr} + (24 - t_{TTC}) * P_{es} + Q_{EL-LP} + W_{EL}$		Equation 15. Total measured electricity consumption heat pumps
W_{EL-LP} = total measured electricity consumption in kWh		$W_{EL-Corr}$ = correction due to electricity consumption of the fan/liquid pump in kWh
$W_{EL-M-LP}$ = total measured electricity consumption in kWh		W_{EL-off} = energy consumption for off-peak in kWh
t_{TTC} = load profile time/duration in h		P_{es} = standby power input
Q_{EL-LP} = additional electrical input in kWh		

Annual Electricity Consumption

The calculations for the Annual Electricity Consumption are equal to those of EN50440:2015 (see paragraph **Error! Reference source not found.**).

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).

$\theta'_{WH} = \frac{1}{t_{40}} \int_0^{t_{40}} \theta_{WH}(t) * dt$		Equation 16. Reference hot water temperature
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θ'_{WH} = reference hot water temperature in °C	$\theta_{WH}(t)$ = outgoing hot water temperature in °C
T_{40} = time from start draw-off until θ_{WH} is smaller than 40°C	

With the in- and output temperature difference and measured flow rate the water volume can be calculated.

$V_{40} = \frac{1}{(40 - 10) * 60} \int_0^{t_{40}} f_{max}(t) * [\theta_{WH}(t) - \theta_{WC}(t)] dt$		Equation 17. Mixed water volume at 40°C
V_{40} = maximum volume of mixed water at 40°C in L	$\theta_{WH}(t) - \theta_{WC}(t)$ = temperature difference between the in- and outlet of hot storage water in K	
$f_{max}(t)$ = flow rate of hot water during draw-off in l/min		

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 18. 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 19. 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	
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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 (Equation 20) or not (Equation 21).

$W_{EL-Corr} = \frac{1}{3600 * 1000} * \int_0^{t_d} \frac{V_{air}(t) * \Delta p_e}{\eta} dt$		Equation 20. Energy consumption corrections for integrated fan
η = fan efficiency according to EN 14511-3	Δp_i = measured internal static pressure difference in Pa	
V_{air} = nominal air volume flow rate m ³ /s	t_d = test phase duration	
$W_{EL-Corr} = \frac{1}{3600 * 1000} * \int_0^{t_d} \frac{V_{air}(t) * \Delta p_i}{\eta} dt$		Equation 21. Energy consumption corrections for separate fan
Δp_e = measured external static pressure difference in Pa	V_{air} = nominal air volume flow rate m ³ /s	

For the power absorbed by liquid pumps the same rules apply, but then the liquid measured volume flow rate (\dot{V}_{fluid}) will be replace \dot{V}_{air} . Again, for integrated pumps the calculation follows Equation 20, while for separate products Equation 21 applies.

4.6.4 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 Technical Committee CEN/TC 156 "Ventilation for buildings",

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 mount 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.

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

A multifunctional ventilation unit provides ventilation for single dwelling as a leading function. This means, that all additional functions:

- hydronic heating/air heating;
- hydronic cooling/air cooling;
- hot water production;

shall be operating only when ventilation is operating.

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 (fresh air and removed air).

Additional tests shall be performed according to the declaration of manufacturer. No further correction needed

- 2) The air volume flows for ventilation (fresh air and/or removed 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.

4.6.5 EN 12900:2013

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.

4.7 Sorption heat pump (gas-fired)

4.7.1 EN 12309 series

The standard for sorption appliances is EN 12309 series, written and maintained by CEN TC 299/WG 2⁷². 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 16. EN 12309 series of standards

EN 12309-1:2014 (WI=00299013) Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 1: Terms and definitions	2014-12-17
EN 12309-2:2015 (WI=00299019) Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 2: Safety	2015-05-20
EN 12309-2:2015/ AC:2015 (WI=00299C01) Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 2: Safety	2015-12-02
EN 12309-3:2014 (WI=00299018) Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 3: Test conditions	2014-12-17
EN 12309-4:2014 (WI=00299014) Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 4: Test methods	2014-12-17
EN 12309-5:2014 (WI=00299015) Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 5: Requirements	2014-12-17
EN 12309-6:2014 (WI=00299016) Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 6: Calculation of seasonal performances	2014-12-17
EN 12309-7:2014 (WI=00299017) Gas-fired sorption appliances for heating and/or cooling with a net heat input	2014-12-17

⁷² <https://standards.cen.eu/dyn/www/f?p=CENWEB:6:0::NO::>

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).

4.7.2 EN 12309-1: 2014 - Terms and definitions

[TBD]

4.7.3 FprEN 12309-2: 2014 - 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 (a.o.) the measurement and calculation of NOx emissions.

NOx Emissions

Clause 6.14 of prEN 12309-2:2013 (E) presents the NOx classes, with NOx concentration of flue gasses expressed as mg/kWh (NCV) and related to dry, air free products of combustion.

Table 17. NOx emissions classes

Class	Concentration in mg/kWh
1	260
2	200
3	150
4	100
5	70

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 H₂O/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_x emissions. For on/off appliances the NO_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_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 31° to 29°C, 26°C and 23°C respectively.

$$NO_{x,m} = NO_{x,m} * \frac{0,02 NO_{x,m} - 0,34}{1 - 0,02(h_m - 10)} * (h_m - 10) + 0,85 * (20 - T_m)$$

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 18. NO_x weighing factors

Partial heat input Q _{pi} as a % of Q _n		70	60	40	20 if applicable
Weighting factor	F_{pi}	0.15	0.25	0.30	0.30
Return water temperature		31	29	26	23

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 GUE_h.

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).

4.7.4 EN 12309-3: 2015 - Test conditions

Full title: 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 15° to 30°C) and for outdoor installations (when cooling 25°C to 35°C and heating 0°C to 7°C).

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 15-30°C for water/brine-to-water appliances for indoor installations and 0-7°C 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 19. EN 12309-3:2012 Standard rating conditions, heating mode

Type of appliance	Outdoor heat exchanger	Indoor heat exchanger
Outdoor air	Inlet dry/wet bulb temperature °C	Inlet/outlet temperature °C
low temperature	7 / 6	* / 35
medium temperature	7 / 6	* / 45
high temperature	7 / 6	* / 55
very high temperature	7 / 6	* / 65
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	Inlet/outlet temperature °C	Inlet/outlet temperature °C
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 (ΔT_{\max}) calculated using the following formula:

$$\Delta T_{\max} = 7 + \left(\frac{T_{out} - 35}{30} \right) * 10$$

For $T_{out} = 35$, ΔT_{\max} is 7 and corresponding T_{inlet} is 28 or higher. For $T_{max} = 55$, ΔT_{\max} is 13.7 and corresponding T_{inlet} is 41.3 or higher.

In case this condition is not respected, the flow rate shall be increased till when the ΔT is equal to ΔT_{\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 ΔT is equal to ΔT_{\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 ΔT equal to ΔT_{\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 allows a variable inlet temperature as long as ΔT_{\max} is not exceeded. It may be that the required inlet temperature is reached, but this is not prescribed.

4.7.5 EN 12309-4:2015 - Test methods

Full title: 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 ΔT . For a

delta T of 7°C the uncertainty is 3.6%. The gas input is to be determined with an overall uncertainty of 2%⁷³.

4.7.6 EN 12309-5:2015 - Requirements

[TBD]

4.7.7 EN 12309-6:2012 - Calculation of seasonal performances

[TBD]

4.7.8 EN 12309-7:2012 - Specific provisions for hybrid heating appliances

[TBD]

4.7.9 EN 12309-8 - Environmental aspects

[TBD]

4.7.10 EN 12309-9 - Domestic hot water

[TBD]

4.7.11 prEN 12309-10 - Requirements, conditions and methods

[TBD]

4.7.12 prEN 12309-11 - Seasonal performance (incl. hybrid devices)

[TBD]

4.8 Micro CHP

Standards related to micro CHP are developed by the CEN/CENELEC Joint Working Group FCGA (Fuel Cell Gas Appliances, which refers to the origin of the standard) which also covers microCHP from combustion engines, both internal combustion (gas engine) driven or external combustion (Stirling engine) driven.

4.8.1 EN 50465:2015

Full title: "Fuel Cell Gas Appliances" Gas appliances - Combined heat and power appliance of nominal heat input inferior or equal to 70 kW"

By CEN-CLC/JWG/FCGA

EN 50465 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 °C during normal operation, - where the maximum operating pressure in the - heating water circuit does not exceed 6 bar, - 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

⁷³ Both uncertainties combined results in a possible tolerance of GUEh of min -5.5% to max 5.7%.

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.

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 P_{chp} and $P_{chp}+P_{sup}$ 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:

$$Q_{HE} = \frac{H_{eh} * P_{design}}{\frac{\eta_s}{100\%}} * \frac{3.6}{1000}$$

Where:

- H_{eh} = 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 $P_{th,n}$ 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).

4.8.2 Discussion microCHP

The EN 50465:2015 was published on 1-2-2015. On several aspects it deviates from the Transitional Methods of April 2014. These differences are related to the calculation of seasonal efficiency, and in particular the correction factor F5 that applies to cogeneration.

The standard also proposes different approaches to calculation of correction factors F2, F3 and F4 related to auxiliary power, standby heat loss and pilot flame, respectively.

Apart from the differences in approach for calculating the seasonal efficiency, the standard also suggests to apply a different weighting ratio than 85/15 for cogeneration power and supplementary power, as the ratio affects the performance calculated for integrated products versus packages.

Seasonal energy efficiency and correction factor $F(5)$

The **TM2014sh** states the seasonal efficiency (of cogeneration heaters) in active mode η_{son} is calculated as:

$$\eta_s = \eta_{son} - \sum F(i)$$

Where:

η_{son} = the seasonal efficiency in active mode, in %

$F(i)$ = corrections $F(1)$ to $F(5)$, if applicable, expressed in %

For cogeneration space heaters not equipped with supplementary heaters:

$$\eta_{son} = \eta_{CHP100+Sup0}$$

The active mode efficiency is thus the useful efficiency (thermal efficiency) with no supplementary heater enabled.

For cogeneration space heaters equipped with supplementary heaters:

$$\eta_{son} = 0.85 * \eta_{CHP100+Sup0} + 0.15 * \eta_{CHP100+Sup100}$$

The active mode efficiency is thus the useful efficiency (thermal efficiency) with no supplementary heater enabled multiplied by 0.85, plus the useful efficiency (thermal efficiency) with the supplementary heater enabled multiplied by 0.15. The active mode efficiency is thus more heavily influenced by the mode with no supplementary heater enabled.

The correction factors $F(i)$ relate to:

- $F(1)$: correction factor for temperature controls: reduces the η_{son} by 3%;
- $F(2)$: correction factor for auxiliary electricity consumption: reduces the η_{son} depending on the value for el_{max} and P_{SB} .

No supplementary heater: $F(2) = \frac{2.5 * (el_{max} + 1.3 * P_{SB})}{P_{CHP100+Sup0}}$

With supplementary heater: $F(2) = \frac{2.5 * (0.15 * el_{max} + 0.85 * el_{min} + 1.3 * P_{SB})}{(0.15 * P_{CHP100+Sup100} + 0.85 * P_{CHP100+Sup0})}$

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: $F(3) = \frac{0.5 * P_{stby}}{P_{CHP100+Sup0}}$

With supplementary heater: $F(3) = \frac{0.5 * P_{stby}}{P_{CHP100+Sup100}}$

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: $F(4) = \frac{1.3 * P_{ign}}{P_{CHP100+Sup0}}$

With supplementary heater: $F(4) = \frac{1.3 * P_{ign}}{P_{CHP100+Sup100}}$

- F(5): correction factor for electricity generation:

No supplementary heater: $F(5) = -2.5 * \eta_{el,CHP100+Sup0}$

With supplementary heater: $F(5) = -2.5 * (0.85 * \eta_{el,CHP100+Sup100} + 0.15 * \eta_{el,CHP100+Sup0})$

This is following the text in Annex VII, point 3(a) of Regulation (EU) No 811/2013 (Energy Labelling of space heaters) and Annex III, point 3. of Regulation (EU) No 813/2013 (Ecodesign of space heaters): *the Seasonal space heating energy efficiency.. of cogeneration space heaters ... shall be calculated as the seasonal space heating energy efficiency in active mode η_{sonr} , corrected by contributions accounting for temperature controls, auxiliary electricity consumption, standby heat loss, ignition burner power consumption (if applicable) and, for cogeneration space heaters, corrected by adding the electrical efficiency multiplied by a conversion coefficient CC of 2,5.*

In the **TM2014sh** this is interpreted as mathematically adding instead of joining or putting in. Temporarily ignoring factor F(1) to F(4) the **TM2014sh** approach results in the (simplified) equation for seasonal efficiency η_s as:

$$\eta_s = \eta_{son} + 2.5 * \eta_{el,CHP100+Sup0} = \eta_{thermal} + 2.5 * \eta_{electrical} = \frac{Q_{heat\ out}}{Q_{prim\ in\ total}} + \frac{Q_{prim\ in\ for\ electricity}}{Q_{prim\ in\ total}} = \frac{Q_{heat\ out} + Q_{prim\ in\ for\ electricity}}{Q_{prim\ in\ total}}$$

The equation includes a correction factor F(5) of the thermal efficiency by summing this efficiency with the "efficiency" of the electricity generation, expressed in primary energy (avoided energy). The **TM2014sh** method thus puts both space heat output ($Q_{heat\ out}$) and primary energy input for electricity generation ($Q_{prim\ for\ electricity}$) in the denominator (electricity production expressed as equivalent thermal output) and the device primary energy input as the denominator. The savings are related to the overall combined production of heat and electricity.

In EN 50465 the useful efficiencies $\eta_{CHP100+Sup0}$ and $\eta_{CHP100+Sup100}$ 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.

The FCGA proposes to put only the space heat output as the numerator (as the energy input for a given heat output is the basis for comparing all space/combination heaters) and only the energy required for that heat output is put in the denominator through correcting the total energy input for the simultaneous electricity production, by subtracting the equivalent thermal input for that electricity generation. 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:

$$\eta_s = \frac{Q_{total\ out} - Q_{electricity\ out}}{Q_{prim\ in\ total} - Q_{prim\ in\ for\ electricity}} = \frac{Q_{heat\ out}}{Q_{prim\ in\ total} - Q_{prim\ in\ for\ electricity}} = \frac{\eta_{thermal}}{1 - 2.5 * \eta_{electrical}}$$

The FCGA claims 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 $1/RefE\eta = CC = 2.5$ gives: $\eta_{equivalent} = \eta_{thermal} / (1 - 2.5 * \eta_{electrical})$. The approach in EN 50465 is in line with this.

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.

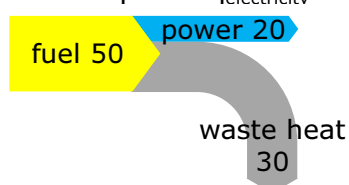
Table 20. Comparing cogeneration and heat pump for output, input and efficiencies

Cogeneration		Energy OUT	Electric heat pump			
Energy IN → (Prim. = Final)	Conversion →		← Conversion	← Final Energy IN	← Conversion	← Prim. Energy IN
22857 kWh_fuel	70% thermal	→ 16000 kWh_heat ←	SCOP 350%	4571 kWh_elec	40%	11429 kWh_fuel
	20% electric	→ 4571 kWh_elec ←	elec. 40%	←	←	11429 kWh_fuel
22857 kWh-fuel						22857 kWh-fuel
TM2014sh 70%+(2.5*20%) = 120%		Efficiencies	350%/2.5 = 140%			
EN 50465 70%/(1-2.5*20%) = 140%						

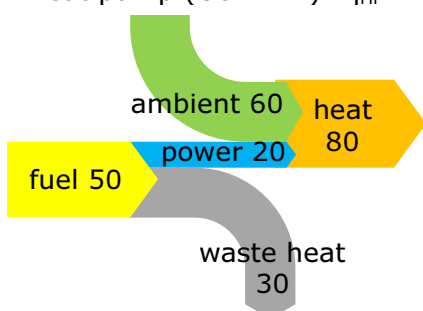
The graphics below show a similar argument for correcting the electricity production at the energy input side.

Figure 12. Power plant efficiency

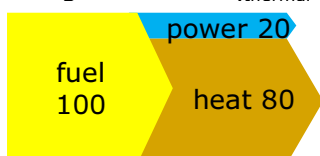
Power plant: $\eta_{\text{electricity}} = 20/50 = 40\%$

**Figure 13. Heat pump efficiency**

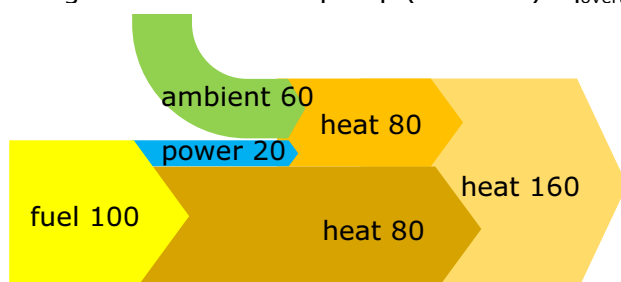
Heat pump (COP = 4): $\eta_{\text{HP}} = 80/50 = 160\%$ (primary energy)

**Figure 14. Cogeneration heater efficiency**

Cogeneration: $\eta_{\text{thermal}} = 80/100 = 80\%$, $\eta_{\text{electric}} = 20/100 = 20\%$

**Figure 15. Cogeneration heater + heat pump efficiency**

Cogeneration + Heat pump (COP = 4): $\eta_{\text{overall}} = 160/100 = 160\%$ (primary energy)



In the above figure "Cogeneration heater + heat pump efficiency" 50% of heat is supplied by a heat pump (η 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 $\eta_{s,CHP} = \eta_{thermal} / (1 - (2.5 * \eta_{electric}))$.

However, the EN 50465 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%.

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:

$$\eta_{eq,CHP+Sup} = 4 \left(\eta_{Hs,CHP100+Sup100} - \frac{75}{CC} \right) + 16 * (CC * \eta_{Hs,CHP100+Sup100} - 100) * \left(\eta_{Hs,CHP100+Sup100} - \frac{75}{CC} \right)$$

For cogeneration without supplementary heater:

$$\eta_{eq,CHP} = 4 \left(\eta_{Hs,CHP100+Sup0} - \frac{75}{CC} \right) + 16 * (CC * \eta_{Hs,CHP100+Sup0} - 100) * \left(\eta_{Hs,CHP100+Sup0} - \frac{75}{CC} \right)$$

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:

$$SEC_{CHP} = \left(\frac{100}{\eta_{Hs,th,CHP100+Sup0}} - \frac{CC * \eta_{Hs,el,CHP100+Sup0}}{\eta_{Hs,th,CHP100+Sup0}} \right) * 100\%$$

$$SEC_{CHP+Sup} = \left(\frac{100}{\eta_{Hs,th,CHP100+Sup100}} - \frac{CC * \eta_{Hs,el,CHP100+Sup100}}{\eta_{Hs,th,CHP100+Sup100}} \right) * 100\%$$

The seasonal specific energy consumption in active mode SEC_{son} is then calculated as:

$$SEC_{son} = F_{CHP} * SEC_{CHP} + (1 - F_{CHP}) * SEC_{CHP+Sup}$$

Where:

F_{CHP} = a weighing factor representing the CHP working without supplementary heater.

In the EN 50465 the F_{CHP} is dependent on the ratio of the respective powers of the CHP heater and the supplementary heater:

Table 21. Weighing factor F_{CHP}

$P_{CHP} / P_{CHP+Sup}$	Cogeneration appliance without hot water storage tank	Cogeneration appliance without hot water storage tank
0 (only listed for interpolation purpose)	0	0
0.1 (e.g. 1 kW CHP + 10 kW supp. heater)	0.30	0.37
0.2	0.55	0.70
0.3	0.75	0.85
0.4	0.85	0.94
0.5	0.95	0.98
0.6	0.98	1.00
≥ 0.7	1.00	1.00

Intermediate values are calculated by linear interpolation between two adjacent values.

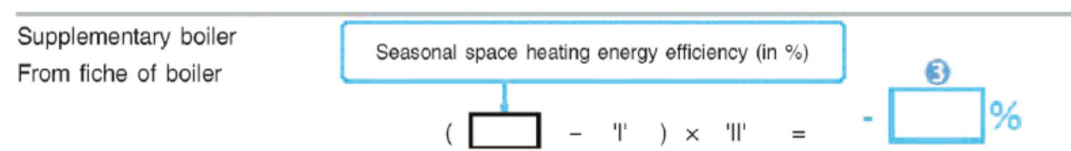
For range rated units $P_{chp+sup}$ represents the arithmetic mean of the maximum and minimum nominal heat output of the cogeneration appliance

The 0.85/0.15 ratio and F_{CHP}

Regulation (EU) No 813/2013 defines the seasonal efficiency in active mode for fuel boilers as the weighted average of the useful efficiencies at rated load and part load (Annex I, Definition 11) and for cogeneration heaters as a weighted average of the useful efficiency at rated heat output with supplementary heater disabled, and the useful efficiency at rated heat output with supplementary heater enabled, expressed in %.

In the **TM2014sh** the weighing between operation with and without supplementary heater is set at 0.15/0.85: the smaller CHP is counted for 0.85 and the supplementary heater for 0.15 in the calculation of the seasonal efficiency. This ratio is applied in calculation of F(2) auxiliary electricity consumption and F(5) seasonal efficiency. It is not considered in the calculation of F(3) standby heat loss and F(4) ignition burner power consumption.

If however the above product is offered as a package of a separate CHP and supplementary unit, 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).

Figure 16. Part of figure 2 of Annex IV of Delegated Regulation (EU) No 811/2013

The factor 'II' is determined by the ratio of $P_{rated}/(P_{rated}+P_{sup})$ and whether a hot water storage tank is present or not. For the above example, factor II which corrects the supplementary heater efficiency, is $(2/20 - 0.1 =) 0.7$.

Figure 17. Part of table 6 of Annex IV of Delegated Regulation (EU) No 811/2013

For the purposes of Figures 2 to 4 of this Annex, weighting of preferential cogeneration space heater, heat pump space heater, heat pump combination heater or low-temperature heat pump and supplementary heater (*)

$Prated / (Prated + P_{sup})^{(**)}$	II, package without hot water storage tank	II, package with hot water storage tank
0	1,00	1,00
0,1	0,70	0,63
0,2	0,45	0,30
0,3	0,25	0,15
0,4	0,15	0,06
0,5	0,05	0,02
0,6	0,02	0
$\geq 0,7$	0	0

(*) The intermediate values are calculated by linear interpolation between the two adjacent values.

(**) $Prated$ is related to the preferential space heater or combination heater.

This means that the calculation of the efficiency of cogeneration 'packages' (as covered by the Energy Labelling regulation for packages) is different than the calculation of the efficiency of cogeneration products that have an integrated supplementary heater (as covered by the Energy Labelling Directive and the Ecodesign Directive for cogeneration space heaters).

Table 22. Comparing the calculation of product performance for integrated and packaged products

Comparison integrated or packaged product					
Integrated product	CHP100 + Sup0	CHP100 + Sup100	Packaged product	CHP100 + Sup0	Supplementary
Power (heat output, kW)	0.6	23	Power (heat output, kW)	0.6	(see below)
eta_CHP (heat, %)	39.3%	86.6%	eta_CHP (heat, %)	39.3%	
eta_son (TM2014sh,%) = $0.85 * \text{eta_CHP100+Sup0} + 0.15 * \text{eta_CHP100+Sup100}$	46.4%		eta_son (TM2014sh,%) = eta_CHP100+Sup0	39.3%	
eta_el (electricity, %)	41.4%	2.5%	eta_el (electricity, %)	41.4%	
F(5),% = $-2.5 * (0.85 * \text{eta_el,CHP100+Sup0} + 0.15 * \text{eta_el,CHP100+Sup100})$	-88.9%		F(5),% = $-2.5 * \text{eta_el,CHP100+Sup0}$	-103.5%	
eta_seasonal (%) = $\text{eta_son} - F(5)$	135.3%		eta_seasonal (%) of preferential heater = $\text{eta_son} - F(5) = 'I'$ (%)	142.8%	
supplementary heater -->			Psup (kW) (= $\text{PCHP100+Sup100} - \text{PCHP100+Sup0}$)	22.4	

		eta_seasonal of Sup (%)	86.6%
		(Prated/Prated+Psup) (-)	0.03
		'= 'II' (-)	0.92
Integrated product efficiency	153.3%	Packaged efficiency (%)	91.0%

Although in the above example the CHP heat generator may operate (almost) continuously, a small CHP heat generator cannot be expected to fulfil an 85% share of the overall annual heat demand. In analogy to the bin-method applied in heat pump calculations: the share of the total heat demand that can be fulfilled by a part load ≤ 0.6 kW at a P_{design} of 23 kW in an average climate is approximately 6%.

In EN 50465 the fixed ratio of 0.85/0.15 from the **TM2014sh** is replaced by a 'variable' ratio based on the relative size of the supplementary heater – see

Table 21. Weighing factor F_{CHP} , so that performances of separate and packaged products are treated similarly.

The above issue goes beyond cogeneration appliances and affects all packages such as those with heat pumps and boilers or two different types of boilers. The same remark is therefore copied to the section 4.3.8. regarding the Guidelines, after FAQ 37.

Variable F(2)

EN 50465 includes establishment of el_{max} , el_{min} and P_{SB} excluding the circulator (similar to EN 15502-1).

Variable b in F(3) and F(4)

According **TM2014sh** the correction factor for the standby heat loss F(3) is calculated using a factor 0.5. The EN 60465 has replaced the fixed value of '0.5' by a variable 'b':

$$F(3) = b * \frac{P_{stby}}{P_{CHP+Sup}} * 100\%$$

Where:

$$b = 0.5 * \frac{P_{min}}{P_{CHP+Sup}}$$

The reasoning is that at smaller P_{min} it can be expected the unit is operating more continuously and has lower standby hours.

If P_{min} is 6 kW and $P_{CHP+Sup}$ is 24 then the factor 'b' is 0.125.

If however P_{min} is 15 kW and $P_{CHP+Sup}$ is 15 then the factor is 0.5

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'.

$$F(4) = 0.5 * b * \frac{Q_{pilot}}{P_{CHP+Sup}} * 100\%$$

Where Q_{pilot} is the permanent ignition burner heat input determined (according to 7.6.5 of EN 50465, expressed in kW).

Specific energy consumption instead of efficiency

The FCGA describes in the EN 50465:2015, Annex K, a revised basis for energy 'efficiency'. Efficiency is currently defined as *useful output* divided by *unit of input*. 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 is the reciprocal value: *required input* divided by *unit of output*. For the same car this is 7 l per 100 km.

The *specific energy consumption* is 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 $30/60 * 10 \text{ km/l} + 30/60 * 30 \text{ km/l} = 20 \text{ km/l}$ (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 15 km/l 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 equations for cogeneration without supplementary heaters can be rewritten as:

$$SEC_{CHP} = \left(\frac{100}{\eta_{Hs,th,CHP100+Sup_0}} - \frac{CC * \eta_{Hs,el,CHP100+Sup_0}}{\eta_{Hs,th,CHP100+Sup_0}} \right) * 100\%$$

And for cogeneration with supplementary heaters it is:

$$SEC_{CHP+Sup} = \left(\frac{100}{\eta_{Hs,th,CHP100+Sup_100}} - \frac{CC * \eta_{Hs,el,CHP100+Sup_100}}{\eta_{Hs,th,CHP100+Sup_100}} \right) * 100\%$$

The *specific seasonal space heating consumption* is then calculated as:

$$SEC_s = F_{CHP} * SEC_{CHP} + (1 - F_{CHP}) * SEC_{CHP+Sup}$$

with F_{CHP} as defined in the labelling regulation (variable per ratio Prated and Prated+Psupplementary). A similar exercise needs to be done for all the other products groups if one wants to compare values.

4.9 Solar thermal

Solar systems – factory made or custom built

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);
- are sized for a single family, with a total area typically < 4 m2;
- also 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;
- 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.

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 withdrawn 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.

Table 23. Difference factory made and custom built solar devices

Factory Made Solar Heating Systems (EN 12976-1 and EN 12976-2)	Custom Built Solar Heating Systems (EN 12977-1, EN 12977-2 and EN 12977-3)
Integrated collector storage systems for domestic hot water preparation	Forced-circulation systems for hot water preparation and/or space heating, assembled using components and configurations described in an assortment file (mostly small systems)
Thermosiphon systems for domestic hot water preparation	
Forced-circulation systems as batch product with fixed configuration for domestic hot water preparation	Uniquely designed and assembled systems for hot water preparation and/or space heating (mostly large systems)

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).

For water heaters this means a 'package' label of solar water heaters and/or packages with solar devices (Annex III of Delegated Regulation (EU) No 812/2013), a product fiche (Annex IV of Delegated Regulation (EU) No 812/2013), technical documentation (Annex V of Delegated Regulation (EU) No 812/2013) and the water heating efficiency (Annex VI of Delegated Regulation (EU) No 812/2013) must be provided.

The descriptions of standards below starts with standards for factory-made systems (EN 12976 series), followed by standards for custom built systems (EN ISO 9806 and EN 12977 series).

4.9.1 EN 12976-1:2017

Full title: Thermal solar systems and components - **Factory made systems** - Part 1: General requirements

By CEN/TC 312 "Thermal solar systems and components"

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).

4.9.2 EN 12976-2:2017

Full title: Thermal solar systems and components - **Factory made systems** - Part 2: Test methods

By CEN/TC 312 "Thermal solar systems and components"

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 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).

This standard is to one be used when following the so-called SOLICS method, however the January 2017 published version contains some errors related to Q_{nonsol} and Q_{ref} :

In clause 5.9.3.5 Calculation of the water heating efficiency of the auxiliary heater, from Table 4, Q_{ref} is erroneously replaced by Q_{nonsol} . The correct version should replace Q_{nonsol} by Q_{ref} in Table 4 - Daily heat demand for load profiles, and subsequent equations:

The correct equation is: $Q_{\text{fuel}} = \frac{Q_{\text{ref}}}{\eta_{\text{wh,nonsol}}}$

And $Q_{\text{elec}} = Q_{\text{ref}}$, where Q_{ref} is the daily heat demand according to Table 4.

The 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.

In clause 5.9.3.4 Calculation of the parasitic energy, the electrical parasitic energy is calculated, measured according ISO 9459-5 (DST). It is understood this is the Q_{aux} as referred to in the TM2015wh. 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 often do not comprise a pump or a controller. EN 12976-2 allows calculation of parasitic energy (= Q_{aux}) 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).

The Transitional Methods refers to the SOLICS method (described in EN 12976-2) and the methods applied in ISO 9459-5. However, the regulations on which the Transitional Methods is based prescribes an assessment based on monthly irradiance and temperature levels (for the three climate considered) whereas ISO 9459-5 is an hourly method. Therefore EN 12976-2 provides for data to be used for the hourly method (Annex B.4 Additional set of reference conditions for annual performance calculations, Table B.8, referring to Meteonorm datasets for Strasbourg and Helsinki⁷⁴), which are at the same time still consistent with the monthly data required by the regulations.

Similarly, the regulations require assessment based on the tapping patterns, which may include several tapping's 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 Additional set of reference conditions for annual performance calculations, Table B.5), useable in an hourly context, that result in the same hot water withdrawal as the original tapping patterns.

4.9.3 EN 12975-1:2013

Full 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,

⁷⁴ Athens is already the test reference year

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 Sep 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 EN 12975-2 results translate to ISO 9806:2013 and ISO 9806:2017 (soon to be published).

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 24. Overview of ISO 9806 versions, in relation to EN 12975-2

	ISO9806:2017	ISO9806:2013	EN12975-2:2006
Internal pressure tests for fluid channels	Clause 6	Clause 6	Clause 5.2
Air leakage rate test (air heating collectors only)	Clause 7	Clause 7	--
Rupture or collapse test (air heating collectors only)	Clause 8	Clause 8	--
Standard Stagnation Temperature	Clause 9	Clause 10a	Annex Ca
Exposure and half-exposure test	Clause 10	Clause 11b	Clause 5.4c
External thermal shock	Clause 11	Clause 12b	Clause 5.5c
Internal thermal shock test	Clause 12	Clause 13b	Clause 5.6c
Rain penetration test	Clause 13	Clause 14	Clause 5.7
Freeze resistance test	Clause 14	Clause 15d	Clause 5.8d
Mechanical load test with positive or negative pressure	Clause 15	Clause 16	Clause 5.9
Impact resistance test	Clause 16	Clause 17	Clause 5.10
Thermal Performance Incidence angle modifier	Clause 19-26	Clause 20-27e	Clause 6e

Heat capacity cp

Pressure drop	Clause 27	Clause 28	Clause 6.2.8
Final inspection	Clause 17	Clause 18	Clause 5.11

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 describe a.o. the Collector aperture area, Zero loss efficiency, First order coefficient, Second order coefficient and Incidence angle modifier.

4.9.4 EN 12975-2:2006 - withdrawn

Full title: Thermal solar systems and components - Solar collectors - Part 2: Test methods

EN12975-2 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.

The (revoked) standard covered Reliability testing of liquid heating collectors (Clause 5), thermal performance testing (Clause 6) and normative annexes on schematics (Annex A), test report sheets (Annex B), stagnation temperature (Annex C), performance test report for glazed (Annex D) and unglazed collectors (Annex E), modelling of coefficients (Annex F), measurement of thermal capacity (Annex G) and informative annexes in collector model comparison (Annex H), properties of water (Annex I), test report for quasi dynamic test (Annex J), guidelines for uncertainty (Annex K) and determination of pressure drop (Annex L).

4.9.5 EN ISO 9806:2013 (soon :2017)

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 12975-2:2006

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).

4.9.6 EN 12977-1:2012

Part 1 is titled: Thermal solar systems and components - Custom built systems - Part 1: General requirements for solar water heaters and combi systems.

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).

4.9.7 EN 12977-2:2012

Part 2 is titled: Thermal solar systems and components - Custom built systems - Part 2: Test methods for solar water heaters and combi systems

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).

4.9.8 EN 12977-3:2012

Part 3 is titled: Thermal solar systems and components - Custom built systems - Part 3: Performance test methods for solar water heater stores

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).

4.9.9 EN 12977-4:2012

Thermal solar systems and components - Custom built systems - Part 4: Performance test methods for solar combustors

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 combustors 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).

4.9.10 EN 12977-5:2012

Thermal solar systems and components - Custom built systems - Part 5: Performance test methods for control equipment

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.

4.9.11 Discussion solar thermal

A solar device is not necessarily a space heater or water heater as defined in the regulations, as these comprise a heat generator by default.

In Regulation (EU) No 813/2013 (ecodesign space heaters) the definition of a space heater does not include solar devices. This is the same in Delegated Regulation (EU) No 811/2013 (labelling of space heaters) but the definition of a package does include a solar device.

in Regulation (EU) No 814/2013 (ecodesign 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 in identification of the annual non-solar heat contribution (Q_{nonsol}) 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.

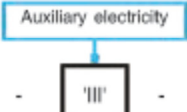
The level of detail required for the inclusion of solar thermal devices in the **space heating** seasonal efficiency is limited to:

- collector size;
- tank volume;
- collector efficiency;
- tank rating (based on standby heat loss);
- 'III' the value of the mathematical expression: $294 = (11 \cdot Prated)$, whereby $Prated$ is related to the preferential space/ combination heater;
- 'IV' the value of the mathematical expression $115 = (11 \cdot Prated)$, whereby $Prated$ 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 Q_{nonsol} (the remaining heat demand to be completed by the non-solar device).

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:

Solar contribution
From fiche of solar device

$$(1,1 \times 'I' - 10\%) \times 'II' - \boxed{'III'} = + \boxed{2} \%$$


Where:

'I': the value of the water heating energy efficiency of the combination heater, expressed in %;

'II': the value of the mathematical expression $(220 \cdot Q_{ref}) / Q_{nonsol}$, where Q_{ref} is taken from Table 15 in Annex VII and Q_{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 $(Q_{aux} \cdot 2,5) / (220 \cdot Q_{ref})$, expressed in %, where Q_{aux} is taken from the product fiche of the solar device and Q_{ref} from Table 15 in Annex VII for the declared load profile M, L, XL or XXL.

The values for Q_{nonsol} and Q_{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_{nonsol} both the SOLCAL and the SOLICS method are allowed (no difference in methods for Q_{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: 2015 (method 2 in Annex F). Still the method is prone to errors and experts are developing a more simple to use method (method 3 of EN 15316-4-3 is a candidate).

The gross aperture and IAM are named differently in EN ISO 9806. A correct relation is now established by the current draft of EN 12975-1 which uses regulation names and refers to ISO 9806 for establishment of several parameters

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 were necessary. EN 12976-2 has an annex with adjusted reference conditions.

4.10 Buildings / System level

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 ESO's 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 and published in 2017.

Table 25. Building system level standards

prEN15459-1	Economic evaluation procedure for energy systems in buildings
prEN15378-1	Inspection of boilers, heating systems and DHW
prEN15378-3	Measured energy performance
prEN12831-1	Design heat load: space heating
prEN12831-3	Design heat load: water heating
prEN15316-1	General and Energy performance expression
prEN15316-2	Space emission systems (heating and cooling)
prEN15316-3	Space distribution systems (DHW, heating and cooling)
prEN15316-4-1	Space heating generation systems, combustion systems (boilers, biomass)
prEN15316-4-2	Space heating generation systems, heat pump systems
prEN15316-4-3	Thermal and PV solar systems
prEN15316-4-4	building-integrated cogeneration systems
prEN15316-4-5	district heating and cooling
prEN15316-4-8	Space heating generation systems, air heating and overhead radiant heating including stoves (local)
prEN15316-5	Space heating and DHW storage systems (not cooling)

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 methods 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 15316-4-3:2017

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). 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 and EN 12977-3 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. These three last calculation methods do not take into account: electrical storage; PV/thermal photovoltaic systems. Primary energy savings and CO2 savings, which can be achieved by photovoltaic systems compared to other systems, are calculated according to EN ISO 52000-1.

4.10.2 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. 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.

4.11 Combination boilers / Water heating efficiency

EN 13203-1:2015 applies to gas-fired instantaneous or storage water heaters and has no relevance for space/combo heaters.

4.11.1 Gas combi / EN 13203-2:2015

Gas-fired domestic appliances producing hot water - Part 2: Assessment of energy consumption

Supersedes: EN 13203-2:2006 and EN 13203-2:2014 draft

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; water-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 13203-1 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} , $E_{elececo}$ and corrections) and the heat demand Q_{ref} (see [Equation 22](#)).

$\eta_{wh} = \frac{Q_{ref}}{(Q_{fuel} + CC * E_{elececo}) * (1 - SCF * smart) + Q_{cor}} * 100$		Equation 22. Water heating efficiency
η_{wh} = water heating efficiency in %		CC = conversion coefficient of 2,5
Q_{fuel} = daily fuel energy consumption over the load profile in kWh		$E_{elececo}$ = 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 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 23](#) $\geq 0,07$.

$SCF = 1 - \frac{Q_{fuel,week,smart} + CC * Q_{elec,week,smart}}{Q_{fuel,week} + CC * Q_{elec,week}}$		Equation 23. Smart Control Factor
$Q_{fuel,week,smart}$ = fuel energy consumption in smart mode in kWh		$Q_{fuel,week}$ = fuel energy consumption without smart mode in kWh
$Q_{elec,week,smart}$ = electric energy consumption in smart mode in kWh		$Q_{elec,week}$ = 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 22](#).

$Q_{cor} = -0,23 * (Q_{fuel} * (1 - SCF * smart) - Q_{ref})$		Equation 24. Ambient correction term
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Daily gas consumption in summer 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:

$Q_{gas,s} = \frac{V_g * K * NCV * Q_{ref}}{Q_{H_2O}}$		Equation 25. 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/m ³		V_g = measured gas consumption in m ³
Q_{H_2O} = energy recovered by the water (see 0)		K = correction factor (see Equation 26)
$K = \frac{p_a + p_g}{1013,25} * \frac{288,15}{T_g + 273,15}$		Equation 26. Correction factor
P_a = atmospheric pressure in mbar		T_g = gas temperature
P_g =gas pressure in mbar		

Daily gas consumption in winter mode

The daily gas consumption in winter mode is equal to the gas consumption in summer mode for all 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 (η_{CH-nom}) and the energy delivered of the load profile used in the tests (Q_{ref}).

$Q_{gas,w} = \frac{Q_{gas,s}}{1 + 0,5 * \left(\frac{\eta_{CH-nom} * Q_{gas,s}}{Q_{ref}} \right) - 1}$		Equation 27. Daily gas consumption in winter mode
$Q_{gas,s}$ = daily gas energy consumption in summer mode in kWh and for NCV		η_{CH-nom} = useful efficiency ate nominal input rate and average temperature of 70°C for space heating in %
$Q_{gas,w}$ = daily gas energy consumption in winter mode in kWh and for NCV		Q_{ref} = energy delivered by load profile in kWh

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.

$Q_{gas,p} = Q_{gas,w} * \frac{D_w}{D_w + D_s} * Q_{gas,s} * \frac{D_s}{D_w * D_s}$		Equation 28. Weighted daily gas consumption
$Q_{gas,p}$ = weighted daily gas energy consumption in kWh and for NCV		D_w = number of days in winter mode [200]
$Q_{gas,s}$ = daily gas energy consumption in summer mode for NCV in kWh		D_s = number of days in summer mode [165]
$Q_{gas,w}$ = daily gas energy consumption in winter mode for NCV in kWh		

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.

$AFC = 0,6 * (D_w + D_s) * [Q_{fuel} * (1 - SCF * smart) + Q_{cor}] * \frac{3,6}{1000}$		Equation 29. Annual fuel Consumption
0,6 = factor correcting for annual net load		smart = smart control coefficient, which is 0 without smart control and 1 with
D_w = number of days in winter mode [200]		Q_{fuel} = daily fuel energy consumption over the load profile in kWh
D_s = number of days in summer mode [165]		Q_{cor} = ambient correction term (only for load profiles XS to XL) in kWh
SCF = smart control factor (see Equation 23)		

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.

$E_{elececo} = E_{elecme} * \frac{Q_{ref}}{Q_{H_2O}}$		Equation 30. Daily electricity consumption
$E_{elececo}$ = electricity consumption over the load profile in kWh		Q_{ref} = energy delivered by load profile in kWh

$E_{elecmes}$ = measured electricity consumption in kWh	Q_{H_2O} = energy recovered by the water in kWh
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Annual Electricity Consumption

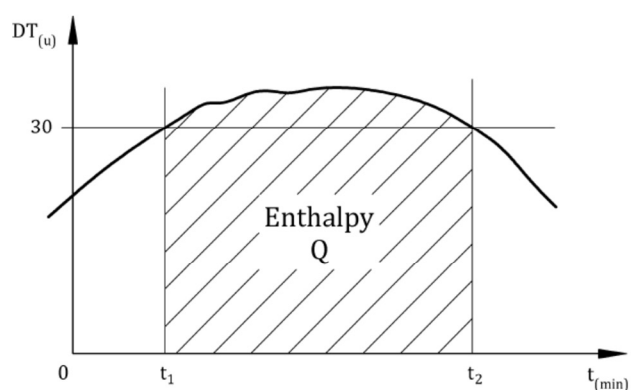
The input $E_{elececo}$ can then be used to calculate the total annual electricity consumption:

$AEC = 0,6 * (D_w + D_s) * [E_{elececo} * (1 - SCF * smart) + \frac{E_{elececo}}{Q_{gas,p}} * \frac{Q_{cor}}{CC}]$		Equation 31. Annual Electricity Consumption
0,6 = factor correcting for annual net load	smart = smart control coefficient, which is 0 without smart control and 1 with. (See Equation 23)	
D_w = number of days in winter mode [200]	$E_{elececo}$ = corrected electricity consumption in kWh	
D_s = number of days in summer mode [165]	$Q_{gas,p}$ = 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		

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:

$V_{40} = \frac{\int_{t_1}^{t_2} \Delta T_d(t) * D_d(t) * dt}{30}$		Equation 32. 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		

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 26). The measured electricity consumption in standby mode is corrected for the time duration of the test.

Heat recovery

The total useful heat recovered is the sum of the heat recovered per draw-off. The energy content retrieved from one draw of equals 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.

$Q_{H_2O} = c_w \sum_{i=1}^n \int_0^{t_i} D_i * \Delta T_i(t) dt$		Equation 33. Heat recovery
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)
n = number of draw-offs		t_i = tapping time in minutes
D_i = water rate delivered at the tap in l/min		$\Delta T_i(t)$ = instantaneous temperature rise during the tapping in K

4.11.2 Gas-solar combi / EN 13203-3:2010

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 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 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.

4.11.3 Micro CHP combi / EN 13203-4:2016

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

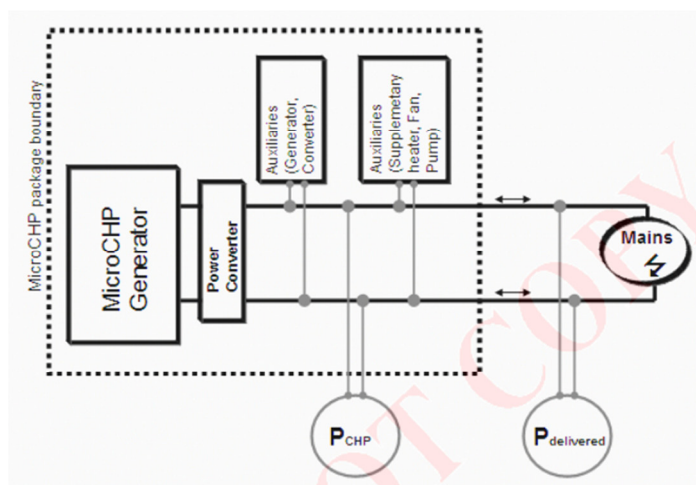
The standard describes the calculation of electricity production split up in electricity generation and electricity delivery. Electricity generation is the output of the microCHP generator ($E_{CHP,p}$). The electricity delivered is the electricity that is supplied to the mains ($E_{delivered,p}$). This 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 ($E_{\text{production}}$) and electricity delivery ($E_{\text{delivered}}$) are the same, only difference is the point of measurement in the test setup.

Figure 18. Test points electrical measurements



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.

$E_{\text{delivered}} = \frac{E_{\text{delivered},24} * Q_{\text{ref}}}{Q_{\text{H}_2\text{O}}}$ $E_{\text{CHP}} = \frac{E_{\text{CHP},24} * Q_{\text{ref}}}{Q_{\text{H}_2\text{O}}}$		Equation 34. Daily electricity produced and delivered in summer mode
$E_{\text{delivered}}$ = daily delivered electrical energy in summer mode in kWh		E_{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_{ref} = energy delivered by load profile in kWh		$Q_{\text{H}_2\text{O}}$ = energy recovered by the water in kWh

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.

$E_{delivered,W} = E_{delivered,S} * \frac{Q_{gas,W}}{Q_{gas,S}}$ $E_{CHP,W} = E_{CHP,S} * \frac{Q_{gas,W}}{Q_{gas,S}}$		Equation 35. Daily electricity produced and delivered in winter mode
$E_{delivered,S}$ = daily delivered electrical energy in summer mode in kWh		$E_{CHP,W}$ = daily produced energy in winter mode during the 24h test in kWh
$E_{delivered,W}$ = daily delivered electrical energy in winter mode in kWh		$E_{CHP,S}$ = daily produced energy in summer mode during the 24h test in kWh
$Q_{gas,S}$ = gas consumption in summer mode using NCV in kWh		$Q_{gas,W}$ = 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.

$E_{delivered,p} = E_{delivered,w} * \frac{D_w}{D_w + D_S} * E_{delivered,s} * \frac{D_S}{D_w * D_S}$ $E_{CHP,p} = E_{CHP,w} * \frac{D_w}{D_w + D_S} * E_{CHP,s} * \frac{D_S}{D_w * D_S}$		Equation 36. Weighted daily electricity produced and delivered
$E_{delivered,p}$ = weighted daily delivered electrical energy in summer mode in kWh		$E_{CHP,p}$ = weighted daily produced energy in winter mode during the 24h test in kWh
$E_{delivered,S}$ = daily delivered electrical energy in summer mode in kWh		$E_{CHP,S}$ = daily produced energy in summer mode during the 24h test in kWh
$E_{delivered,W}$ = daily delivered electrical energy in winter mode in kWh		$E_{CHP,W}$ = 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.

$AED = 0,6 * (D_W + D_S) * [E_{delivered,p} * (1 - SCF * smart) + \frac{E_{auxiliary}}{Q_{gas,p}} * \frac{Q_{cor}}{CC}$		Equation 37. Annual Electricity Delivery
--	--	--

$E_{\text{delivered,p}}$ = weighted daily delivered electrical energy in kWh	D_W = number of days in winter mode [200]
$E_{\text{auxiliary}}$ = daily auxiliary electricity consumption in kWh	D_S = number of days in summer mode [165]
Q_{cor} = ambient correction term (only for load profiles XS to XL) in kWh (see Equation 24)	SCF = smart control factor (see Equation 23)
	smart = smart control coefficient, which is 0 without smart control and 1 with

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.

4.11.4 Electric heat pump combined with gas fired appliance / EN 13203-5 :2015

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 10°C +/-2K, the ambient temperature is 20° +/-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 20°C +/-3K for indoor installations and

7°C+/-3K for outdoor installations, a heat source temperature for direct evaporation has been provided at 4°C+/-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 Q_{cor} , 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 Q_{cor} .
- 2) Annual fuel consumption (AFC);
- 3) Annual electricity consumption (AEC);
- 4) Mixed water at 40°C (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.).

4.11.5 Sorption heat pump combi / prEN 13203-6:2015 draft

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

4.11.6 Oil combi / EN 303-6:2000 [TBD]

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

4.11.7 EN 12897 Hot water storage tanks

The standard was first published in 2006 than 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 retesting of a standard "test" cylinder to EN12897:2016 has 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

4.11.8 Passive flue heat recovery device / prEN 13203-7:2017 draft

Gas-fired domestic appliance producing hot water - Part 7: Passive flue heat recovery devices

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 the product. The PFHRD recovers the heat from flue gases and transfers this to incoming cold water, which is then heated up by the heat generator of the water heater to the appropriate temperature level. A PFHRD without any form of integrated thermal storage only functions with fuel water heaters for the time the burner is on during warm water extraction.

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. For instance: heat recovered from central heating operation can then (minus heat losses) be transferred to incoming cold water for water heating at a later stage.

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** a combination boiler. This WG has produced a draft document (June 2017) presenting a proposal for performance testing of PFHRD. The draft is not a final standard.

The scope of the standard is limited to PFHRDs for combination heaters 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 and that do not have a significant thermal bridge between the PFHRD and the central heating circuit. It appears the point is that heat from circulating central heating water shall not heat up the water flowing through the PFHRD. The maximum permitted thermal bridge energy varies according the load profile (established for M to 4XL).

The draft standard then describes two possible set-ups for determining PFHRD performance: a 24 h test or a short test.

The 24 h test is performed on the basis of the tapping patterns identified in the Regulations. The shorter test method prescribes a test for determining the heat recovery from heating operation, and the heat recovery of heating operation whereby the PFHRD was not completely charged. These values are weighted in accordance with the number and size of tapping's, represented by a simplified tapping pattern.

No test standard yet exists for **external** PFHRDs.

4.12 Emissions

4.12.1 CR 1404: NO_x measurement

Product specific standards should contain clauses related to establishing NO_x emissions (concentration as mg/kWh heat input, GCV).

Most of these standards propose a method similar to or are based upon CEN CR 1404 which is a general document describing methods for establishing NO_x emissions of appliances.

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;
- Heating boilers - Heating boilers with forced-draught burners - Nominal heat output not exceeding 10 MW and maximum operating temperature of 110 °C in accordance with EN 14394;
- Pellet burners for small heating boilers in accordance with EN 15270.

NOTE: All measurements for boilers are carried out in the heating mode only. For hot water production this mode is also relevant.

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.

4.14.1 Gas boilers: EN 15036-1

[TBD]

4.14.2 Electric heat pumps: EN 12102:2013

This standard EN 12102:2013 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.

There is a Fpr-version for EN12102-1 from 2017 for which the voting has been closed. Hence it will probably be published during 2018.

4.15 Measurement uncertainties and verification tolerances

Reproducibility of measurements is an important issue in this context. LABTQ⁷⁵ 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.

4.15.1 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 (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 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 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

⁷⁵ 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.

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:

- 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 (Delegated) Regulation (EU) No 811/2013, 812/2013, 813/2013 and 814/2013 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 under 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 26. Overview of standards that are part of the round robin ECotest

Revision/Amendment of Standards c)	Secretariat TC or TC WG
CEN CR 1404 (under revision as prCEN/TR 1404 rev)	AFG/BNG CEN/TC 238 WG 2
prEN 15502-1:2012+A1:2015 rev a)	NEN CEN/TC 109 WG 1
prEN 13203-2:2015 rev	AFG/BNG CEN/TC 109 WG 4
prEN 13203-4 rev	AFG/BNG CEN/TC 109 WG 4
prEN 13203-6 rev	AFG/BNG CEN/TC 109 WG 4
EN 50465:2015 rev	DKE CEN/CLC/JWG FCGA
prEN 12309-2:2015 rev	UNI CEN/TC 299 WG 2
prEN 12309-3:2015 rev	UNI CEN/TC 299 WG 2
prEN 12309-4:2015 rev	UNI CEN/TC 299 WG 2
prEN 12309-6:2014 rev	UNI CEN/TC 299 WG 2
prEN 304 rev b)	DIN CEN/TC 57 WG 2
prEN 15034:2006 rev	DIN CEN/TC 57 WG 5
prEN 14511-2:2013 rev	UNM CEN/TC 113 WG 8
prEN 14511-3:2013 rev	UNM CEN/TC 113 WG 8
prEN 12102:2013 rev	UNM CEN/TC 113 WG 9
prEN 14825:2013 rev	NBN CEN/TC 113 WG 7
prEN 16147:2011 rev	DIN CEN/TC 113 WG 10
prEN 13203-5:2015 rev	AFG/BNG CEN/TC 109 WG 4
prEN 12975 (revision of prEN 12975-1:2006 d))	SNV CEN/TC 312 WG 1
prEN 12976-2:2006 rev	NEN CEN/TC 312 WG 2
prEN 12977-2 rev	DIN CEN/TC 312 WG 3
prEN 12977-3:2012 rev	DIN CEN/TC 312 WG 3

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 EVALUATION AND OUTLOOK

5.1 Consultation / opinion sought

Issues for which further information or opinion from stakeholders is requested:

1. Section 3.5: The EPBD has an indirect influence on the space heaters that are allowed to be installed in new and renovated buildings. We are looking for an overview, ideally per **Member State**, of EPBD **requirements** (or values used in the calculation required for EPBD) that determine or influence the type and performance of the heaters allowed for use in buildings as well as information on financial incentives regarding boiler efficiency in Member States.
2. Section 3.6: Which **third countries** (extra EU/EEA) have requirements on space heaters that need to be considered in this review? The study team has looked into / will look into requirements applicable in the USA, Canada, Japan, China. But which other extra EU countries need to be looked at as well?
3. Section 3.3 on CE marking and **3rd party certification**: Does the risk of not meeting ecodesign and/or labelling requirements require mandatory 3rd party certification (Module B assessment) of space/combi heaters? If so, should other space heaters then also become 3rd party certified? If not, should the mandatory 3rd party certification be lifted for fuel boilers? Note: this applies to energy efficiency (and possibly emissions and noise) only. Certification of safety is a different matter.
4. The current draft report does not state much on **market surveillance**. We intend to improve on this on the basis of stakeholders' experiences / opinions.
5. Section 3.4.3. and 3.4.8 – **the package label**: The review should assess the appropriateness of the 'package label' (product fiche of packages). Please send us your opinion on this: Has the package label been effective? (in placing on the market more heating systems with efficiencies that exceed that of a single product) Should the package label be maintained / kept as is, be improved, or be abolished? and why?

5.2 Certification (3rd party or self)

The Gas Appliance Directive (GAD) 90/396/EEC introduced CE marking and mandatory 3rd party certification to assess gas appliance safety. The GAD also introduced Notified Bodies identified by Member States that may perform the assessment. This meant that national test houses lost their prerogative, as tests could be done all over Europe and presumption of conformity applied.

The GAD led to a sudden rise in number of notified bodies, which led to a market "shake out": An erosion of price and quality occurred, and only the strongest survived. There are now some 5 Notified Bodies.

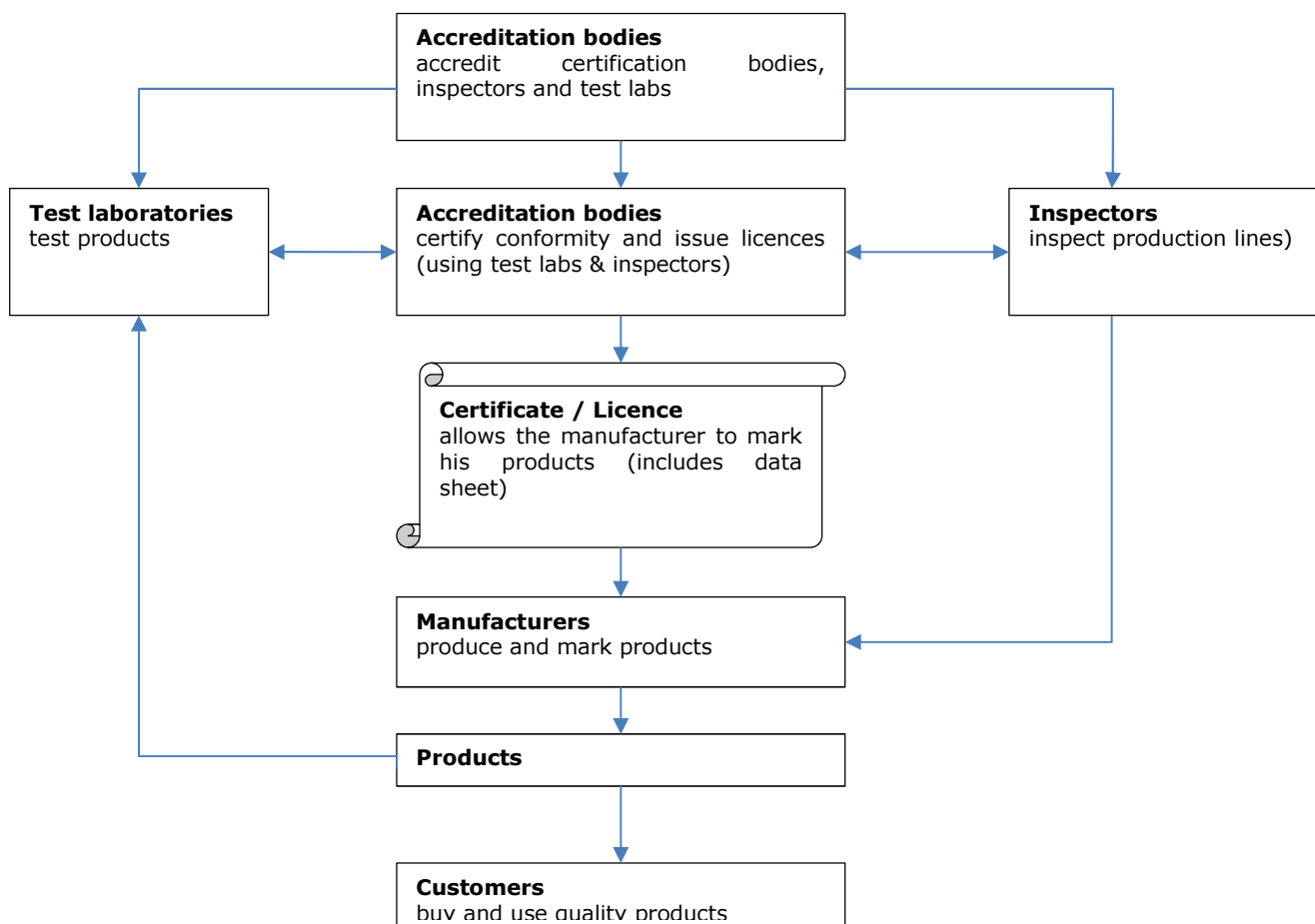
BED 92/42/EEC became an implementing Directive under the Ecodesign Directive in 2002, but this was mainly an administrative alignment and the BED did not change technically. Its requirements remained in force, despite some attempts to make the requirements more stringent (attempts in 1996, 2001, 2006). The 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).

In 2008 the Commission described the modules for CE marking in Directive 2008/xx/xx and larger companies (conglomerations) started to certify their own test houses (for instance in accordance with ISO 17025). This opened up the possibility to do witness testing at the manufacturers' premises, with an authorised representative of the Notified Body present. All product testing for conformity of the major manufacturers now happens as in-house test. Smaller manufacturers

without their own certified test facilities now have to resort to the few independent test houses (like TUV, DGW, CETIAT, KIWA see NANDO). This raises the bar for testing and increases costs relative to those companies who own an in-house facility.

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

Figure 19. Structure of EU certification and accreditation



Directive 2008/765 introduced criteria for conformity assessment which notified bodies have to meet. Furthermore, if no relevant product tests have been performed for 5 years, the test house could lose that accreditation.

As stated in the sections describing the applicable regulations and (some of its) history, the Boiler Efficiency Directive 92/42/EEC was never repealed as a whole and sections of it still apply today through Regulation 813/2013.

Major boiler companies (conglomerations) with their in-house test facilities have an advantage over smaller companies who must rely on independent test houses.

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 (in case manufacturer A has no own laboratory equipped for verification testing).

For products that are currently self-declared under (Delegated) Regulations (EU) No 811/2013 to 814/2013, these are mainly electric heat pumps, the questions arises which kind of certification is required. The current trend appears to be that the major manufacturers aim for a similar strategy

as the boiler manufacturers: in-house testing to become the norm. This would again reduce the market for independent test houses and could raise the bar for smaller manufacturers.

The Ecodesign Directive allows to prescribe, in implementing regulations, a different module for certification than the self-declaration currently employed (for newly regulated products) "*Where duly justified and proportionate to the risk*".

Without prejudice to Task 7 which describes recommended options for the legislator, and without prejudice for any requirements following the GAR, it can be concluded that the Commission has three main options:

- 1) Keep the status quo: Boilers remain third party certified and other heaters are self-certified;
- 2) Make 3rd party certification mandatory for all equipment covered.
- 3) Remove 3rd party certification from the boilers and allow self-certification for all equipment.

The consequences for each option are [to be discussed]

5.2.1 Stakeholder positions

[This section presents stakeholder positions regarding 3rd party certification as known to the authors – we invite all stakeholders to provide their positions/comments to us – see contact details at project website www.ecoboiler-review.eu]

Eurovent-Certification/CERTITA

Eurovent-Certification/CERTITA, the organisation managing the Eurovent-certification system, is in favour of keeping the current rules, meaning 3rd party certification for fuel boilers and self-declaration for electric products like heat pumps. They expect that the energy labelling database will increase the self-policing effect as performance data of all suppliers are then available for scrutiny.

Eurovent-Certification/CERTITA does not expect that the continuation of self-declaration of heaters will reduce the demand for voluntary third party certification: In their experience suppliers appreciate the quality control offered by Eurovent-Certification/CERTITA.

Solar Keymark

Solar Keymark has not established an official position as regards 3rd party certification. As Solar Keymark is not a notified body it fears losing relevance in case of mandatory 3rd 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.

[We are looking for positions/contributions regarding 3rd party certification of the following organisations – please add yourself if you're not listed]

Eurovent

Eurovent, as association representing the interests of mainly HVAC suppliers in Europe, has not established an official position as regards 3rd party certification or not.

EPEE

EPEE, also representing the interests of HVAC suppliers in Europe, has not established an official position as regards 3rd party certification or not.

Heat Pump Keymark

Heat Pump Keymark, managing the Heat Pump Keymark certification scheme, has not established an official position as regards 3rd party certification or not.

EHI (European Heating Industry)

LABTQ (notified bodies heating equipment)

Eurofuel (oil-fired heating)

Marcogaz (gas-fired heating)

EHPA (heat pump suppliers)

EBA (biogas)

EUBIA (biomass)

ESTIF (solar devices)

COGEN (cogeneration, micro-CHP)

BEUC/ANEC (consumers / in standardisation)

ECOS (environmental organisations)

Orgalime (manufacturers)

Europump (pumps, circulators)

EVIA (fans)

REHVA HVAC (engineers)

GCP Europe (installers)

AFECOR (controls)

5.3 Opinions - Market surveillance / experiences

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.

5.4 Opinions - Package label

Groupe Atlantic

"We doubt very much about the efficiency of the energy labels for such technical products for which the recommendations of engineering companies, consultants and installers are much more efficient. So we think that one should make the energy label as simple and understandable as possible. For that reason, we advocate for a revision of the existing package label status. We agree to keep it, but to transform it on 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 us to publish two labels."

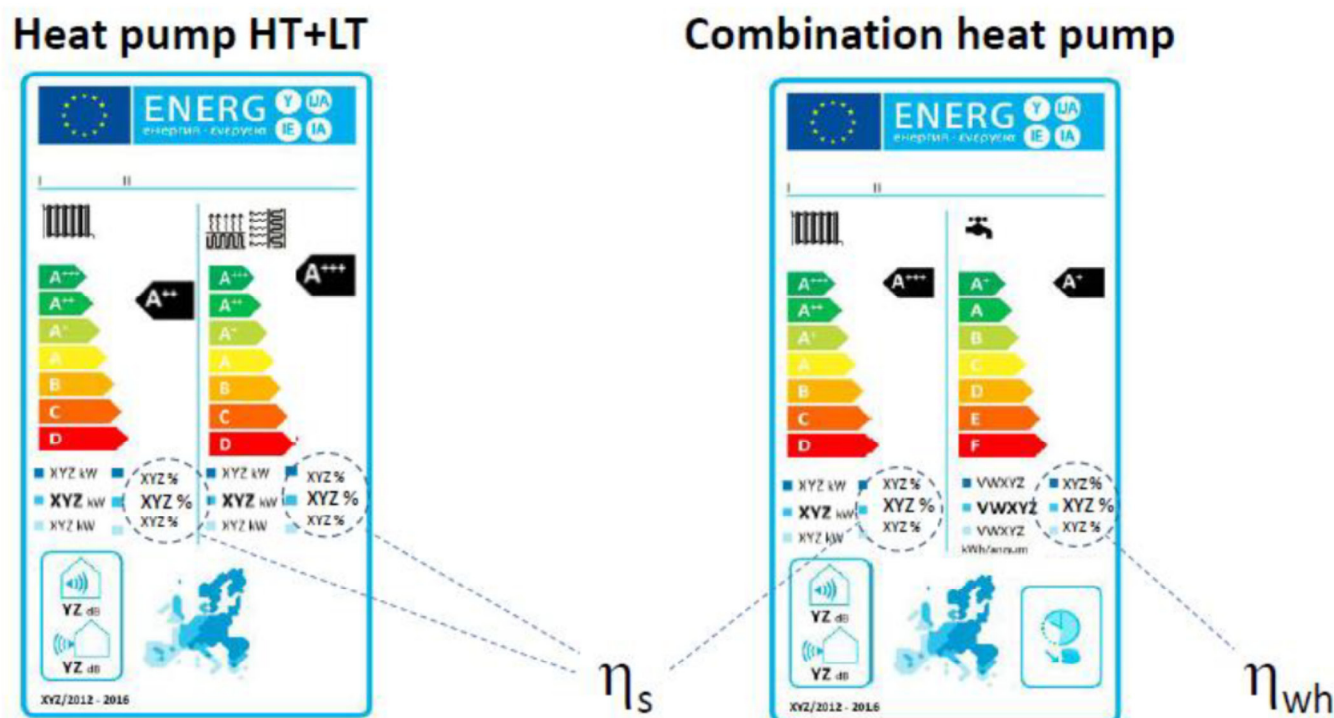
RISE- Sweden

RISE prefers to have the actual efficiency (numerical value) on the label as well, as now the distinction between the best and worst product in the same class (can be 25% !) is not visible.

And prefers to have performance indicated on label for all climates – now only the average climate is required, but differences in efficiencies for colder climates may relate to a good defrost function – this is not sufficiently visible in the average climate performance.

As the information is present anyway, it is a waste if it's not shown on the label as well.

Figure 20. Example of labels with information for all climates shown on label (Source: RISE, Sweden)

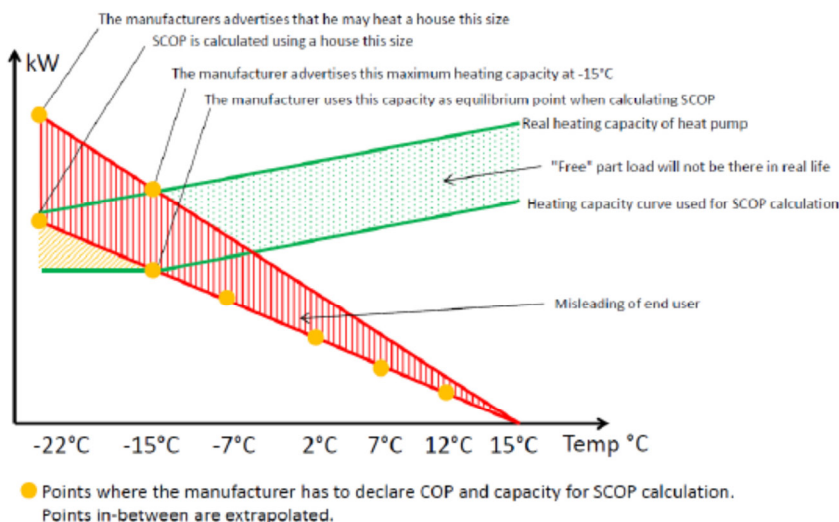


RISE prefers a rescaling of labels, with A starting at higher efficiencies and having more resolution in beyond A classes.

RISE prefers to have a label for a low-temperature heat pump combination heater (the present label only exists for medium temperature heat pump combination heaters). The product can be developed, but the medium-temperature ecodesign requirement is a problem.

Figure 21. The effect of labelling at lower Pdesign

This happens when you calculate SCOP on a smaller house using the same heat pump



A heat pump in part load is more efficient than a heat pump at full load

RISE agrees with the intentions of the package label, but has found that manufacturers found the package label difficult to use.

RISE presented a list of errors in the calculation tool for package labels, based on an analysis of the calculation tool for package labels on the EU Commission website⁷⁶:

Figure 22. Webpage with location of package calculation tool

The screenshot shows the European Commission website page for 'Space and water heaters'. The page includes a navigation bar with 'Commission and its priorities' and 'Policies, information and services'. The main content area has a blue header with 'European Commission > Energy > Topics > Energy Efficiency > Energy efficient products > Energy'. Below this is a navigation menu with 'HOME', 'TOPICS', 'DATA & ANALYSIS', 'CONSULTATIONS', 'NEWS', 'EVENTS', 'FUNDING', 'STUDIES', 'PUBLICATIONS', and 'ABOUT US'. The main content area is titled 'Space and water heaters' and includes an illustration of a water heater. The 'Energy Labels' section describes the energy efficiency classes for space and water heaters. The 'Ecodesign' section describes the mandatory requirements for heater manufacturers. The 'Related documents' section includes a link to 'Space heaters and water heaters: energy label templates'. A yellow circle highlights the link to 'Tool for calculating the energy efficiency of packages of space, water and combination heaters' in the 'Ecodesign' section.

⁷⁶ <https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficient-products/heaters>

The analysis was performed in 2016 by SP Technical Research Institute of Sweden on behalf of the Swedish Energy Agency and presented in the EEpliant work package 6 meeting in Brussels 01/03/2017.

RISE comments are:

Main errors

- 1) Tool not adapted for packages with low-temperature heat pumps
 - a) The calculation tool for package labels is not adapted for packages with low temperature heat pumps. The energy label class calculated by the tool is based on table 1 in the commission's regulation 811/2013, which is used for boilers and medium temperature heat pumps. For low temperature heat pumps, other limits on seasonal space heating efficiency apply. This results in the wrong energy efficiency class on the energy label calculated and shown in the tool.
- 2) It is not possible to choose a package with two heat pumps in the calculation tool
 - a) If one chooses a heat pump or cogeneration heater as the primary heater on the input data sheets, one cannot choose a supplementary heat pump, just a supplementary boiler. The definition of a package, however, is "a package offered to the end-user containing one or more combination heaters combined with one or more temperature controls, and/or one or more solar devices"
- 3) Water heating load profile not updated on energy label
 - a) The letter indicating the water heating load profile (M, L, XL...) on the energy label produced by the calculation tool is not updated when the load profile is changed on the input sheet and the calculations are run again. The energy label shown in the calculation tool always depicts load profile L, no matter what is chosen on the input data sheet.
- 4) A hot water storage tank is always used in the calculation of the solar contribution
 - a) When calculating the solar contribution to the seasonal energy efficiency according to the formula in figure 1-4 in annex IV in the commission's regulation 811/2013, a hot water storage tank has to be included in order to get a solar contribution that is not zero. This is the case because all the factors are multiplied with the tank rating.
However, in the calculation tool it is possible not to choose a hot water storage tank. But even without a storage tank, the program will calculate using the tank rating that was pre-chosen earlier, which gives the wrong result.
- 5) One can create "packages" that consist of just a primary heater and a supplementary heater
 - a) In the calculation tool it is possible to create an energy label for a package that consists of just a primary and a supplementary heater. This combination is not defined as a package according to the regulations. It should not be possible to choose a supplementary heater before one has chosen a solar device or temperature control

Minor errors:

- 1) Different terms for rated heat output in the calculation tool
 - a) In the calculation tool different terms for the rated heat output are used. For Combination Heaters "Rated heat output of preferential heater (Prated)" is used, while for Space Heaters "Heat Output (Prated)" is used. One term should be used throughout the tool.
- 2) Illogical order of hot water storage tank and solar device
 - a) One has to have a solar device in order to fill out data on a hot water storage tank in the calculation tool. If "No" is chosen for the solar device the cells for the hot water storage tank are greyed out and cannot be filled in. However, the cells for the hot water storage tank come before those for the solar device on the input data sheet. The logical order would be to present the solar device before the hot water storage tank, so the users do not have to go back up again when filling in the form.

- 3) Information on hot water storage tank in the calculation tool can easily be misunderstood
 - a) This is mainly a problem for the combination heaters. On the input data sheet one has to fill out data on the hot water storage tank that is assumed to be linked to the solar device. This could easily be misunderstood and users might fill out data on the hot water tank that is included in the combination heater. This should be clarified, for example by putting the cells for the hot water storage tank directly below those for the solar device, because both are components of the solar heating system.
- 4) Different terms for rated heat output for supplementary heat pump
 - a) In the calculation tool the rated heat output for the supplementary heat pump is different for Combination Heaters and Space Heaters. For Combination Heaters the abbreviation P_{sup}, Boiler, is used, while for space Heaters P_{sup}, Heat Pump is used. The same abbreviation should be used in both cases.
- 5) No official file for calculating Q_{nonsol}
 - a) It would help installers greatly if there was an official document to calculate Q_{nonsol}. Especially for smaller installer firms it is very hard to do these calculations solely based on regulations and standards.
- 6) Restrictions on how many package components the tool can handle
 - a) The definition of a package is: "a package offered to the end-user containing one or more combination heaters combined with one or more temperature controls, and/or one or more solar devices". The package calculation tool can handle one primary heater in combination with one supplementary heater as well as one solar device and one temperature control. According to the definition multiple heaters, controls and solar devices are allowed.

RISE's opinion on noise

There should be a relief regarding declaring sound values for "very silent" products, like indoor units of heat pumps containing only a tank, a circulation pump, a heat exchanger and some control equipment. It should not be necessary to perform costly sound measurements for a product, if it can be guaranteed that the sound power is below a certain value.

E.g. the indoor noise criterion should only apply for assemblies that have a heat generator using a vapour compression cycle (sorption products excluded) and/or a fan for forced air flow. Products containing none of the above should be allowed a waiver (this then also applies to products comprising a tank, circulation pump, heat exchanger and electronic controls).

RISE's opinion on heat pump inlet/outlet temperatures in standards

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 working with revisions of EN14825, 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.

COMMENTS CONSIDERED

- Veerle Beelaerts, 27-11-2017 (European Commission)
- Caroline Haglund Stignor, 4-12-2017 (RISE)
- Jerome Martel, 4-12-2017 and Erwan Fontbonne, 1-12-2017 (Groupe-Atlantic)
- Olga Milanin (Federal Ministry for Economic Affairs and Energy, Germany), 27-11-2017 and before
- EHI, 5-12-2017
- Laurent Van Thournout, 5-12-2017 (Daikin Europe)
- Martyn Griffiths, 22-11-2017 (CEN TC 164/WG10)
- Kirsti Hind Fagerlund, 20-11-2017 (Norwegian Water Resources and Energy Directorate)
- Wolfgang Hormel, 16-11-2017 and 13-11-2017