29/11/2022, Brussels

Obstacles posed by heat pump standards to ecodesign regulations and how to solve them

Summary

ECOS is active in several groups developing standards for heating appliances placed on the EU market.

We have identified significant issues in test and air pollutant measurements for heat pumps, among other appliances, as well as a misalignment between relevant standards and regulations.

The following document describes various opportunities to improve standards and mitigate inherent issues related to the implementation of the upcoming revision of ecodesign and energy labelling regulations. This paper offers a starting point for an exchange with DG ENER and VHK consultants.

ECOS - Environmental Coalition on Standards
Rue d'Edimbourg 26 · 1050 Brussels · Belgium
T +32 2 894 46 68 · info@ecostandard.org · ww.ecostandard.org

Contents

ECOS - Environmental Coalition on Standards
Rue d'Edimbourg 26 · 1050 Brussels · Belgium
T +32 2 894 46 68 · info@ecostandard.org · ww.ecostandard.org

Introduction

ECOS is an international NGO with a network of members and experts advocating for environmentally friendly technical standards and policies. We ensure the environmental voice is heard when they are developed and drive change by providing expertise to policymakers and industry players, leading to the implementation of strong environmental principles.

ECOS is regularly involved with experts in various European standardisation technical committees and working groups on heating appliances, and advocates for the highest environmental ambition in the sector.

Unfortunately, various issues emerged from these standardisation working groups that could undermine the role of the standards vis-à-vis the implementation of related ecodesign and energy labelling regulations.

Heat pumps rely mostly on electricity and renewable energy sources (such as air, water or ground) as inputs to run the compressor and the pump in its thermodynamic cycle and deliver heat via a secondary circuit[1]. As reversible appliances, they can be used for both heating and cooling purposes.

The relevant standards as the main subjects of the document are listed below:

- *EN 14825* – Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling
- *EN 14511-2* – Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors - Part 2: Test conditions
- *EN 16147* – Heat pumps with electrically driven compressors - Testing, performance rating and requirements for marking of domestic hot water units
- *EN 13203* – Gas-fired domestic appliances producing hot water

Furthermore, we mention several times throughout the text the link with regulations, specifically regarding the following:

- *EC 2013/813* – Ecodesign regulation for space heaters
- *EC 2013/814* – Ecodesign regulation for water heaters and storage tanks
- *EC 2013/811* – Energy labelling regulation for space heaters
- *EC 2013/812* – Energy labelling regulation for water heaters and storage tanks

The document thoroughly presents and describes the issues that standards could pose to the implementation of ecodesign and energy labelling regulations from a technical perspective. Then, we list several ECOS proposals to improve quality and reliability in both specific product-related standards and horizontal challenges in common for all working groups and their links with regulations.

[1] The secondary circuit is referring to the system heating the house, such as floor and/or radiator heating

1. Heat pump standards

1.1. Mean temperature approach (EN 14825 / EN 14511-2)

EN 14825 sets out test conditions and calculation methods for determining Seasonal Coefficient Of Performance (SCOP), which is the main efficiency indicator for heat pumps on an annual basis. It allows comparison between heating appliances.

In the standard, all the tables refer to a water-based indoor heat exchanger, setting the flow temperature of the secondary circuit.

The issue derives from EN 14511-2, which determines the appliance's flow rate at standard rating conditions (7°C). Currently, this standard allows manufacturers to choose the capacity, via the compressor settings, and the flow rate consecutively (to be used in the abovementioned EN 14825 tables). However, this is not necessarily the maximum capacity of the heat pump at this condition and, most importantly, the test laboratory cannot verify the chosen capacity, as it solely follows the instruction of the manufacturer.

When the declared capacity is low, the secondary flow rate will be low too, resulting in a higher temperature difference over the secondary system. This is favourable for the heat pump efficiency during testing, giving a better result than in real-condition operations. However, the combination of low flow and high-temperature difference reduces the heating power offered to the secondary system, leading to **good-performing products in the testing conditions but poor performance in real operations**. This results in low comfort levels for the consumer and higher energy bills.

Unfortunately, the subject is no longer being discussed in the standardisation working group, partly due to the revision of the ecodesign regulation for space heaters, based on the present flow temperature method. Hence, if we do not correct this issue in the regulation, because of its legal act nature, the wrong methodology will remain valid at least until the next revision, making the standard irreversible.

Both the capacity offered to the heating system, and the temperature level should guarantee a levelled playing field for comparison between heat pumps and other heating technologies.

We suggest one of the following options to be modified in the current standards:

- Tables in standard EN 14825 should clearly define the required average temperature between the flow and return temperatures. Today, this parameter is not verified during the test.
- Ensuring that the maximum capacity of the heat pump is selected at the standard rating condition in standard EN 14511-2

It is evident that the regulation draft should support this mean temperature approach to ensure the standards will be modified appropriately.

1.2. Non-heated space and indoor air as a heat source for heat pump water heaters (EN 16147)

Currently, standard EN 16147[2] describes test conditions for heat pumps in both non-heated space and indoor air as heat sources. This standard includes doubtingly more favourable test parameters compared to setting the conditions as ambient air. Below we address the issues for both non-heated space and indoor air for further observations.

1.2.1. Non-heated space

In wintertime, the non-heated space temperature can only be higher than the ambient temperature if the space is indirectly heated. Unfortunately, this is currently not the case in the standard. For example, a garage is a non-heated space, adjacent to a house. In real operation, the house is warm thanks to heating appliances and works as a heat source for the garage. Hence, the final efficiency for the consumer in the non-heated space depends on the walls' insulation values [3] and the garage's size[4].

Therefore, **non-heated space should be treated as external environment space** rather than relying on heating appliances installed elsewhere.

Moreover, there is also an impact by the region where the appliance is installed (cold, average, or warm climate). Currently, there are no limitations at all on such a matter.

We recommend the following potential improvements to the standard, building on the same test conditions:

- Region dependency should include the proportion of the heat source in the efficiency quotation (such as 25/50/75%).
- Specify a minimum non-heated space volume, depending on the tank's volume.

1.2.2. Indoor air

In winter, indoor air is heated, potentially by a fossil fuel appliance. The hot water heat pump will cool indoor air, using indoor air itself as the source. In summer, cooling this air can be beneficial, but it is arguable whether this cooling effect synchronises with the need for cooling and whether these benefits compensate the extra additional heating cost during wintertime.

The standard allows the indoor air unit without any limitations in capacities and volumes. The standard can also be applied in colder climates. Our position is to limit indoor air unit installations.

During the calculation of the Coefficient of Performance (COP), relevant in all the related standards, including a percentage of the energy source, would ensure that the unit is not 100% renewable, as it is currently mentioned. This could align the test to real case application without additional cost.

---

[2] Specifically, in paragraph 6.5.2, table 4.
[3] These coefficients are referring to the interfaces between the house and the garage and between the garage and the ambient.
[4] Because losses in the heating appliances in the house occur and, because the space of the garage is much smaller than external environment which is potentially infinite.

The draft of the revised regulations limits the electrical input and the tank volume for indoor air heaters. In addition to this limit, a region dependency could be added to the efficiency formula, as a percentage amount.

We recommend the following potential improvements while applying the same test conditions (20°C):

- Region dependency should include the proportion of the source energy into the efficiency quotation (such as 25/50/75%).
- Specify a minimum indoor space volume, depending on the tank's volume.

1.3. V40 test for heat pump and gas storage water heaters

The V40 test for water heaters measures how many litres of water are used by the heater before reaching 40°C operating temperature.

At first, EN 16417 and EN 13203 standards struggled with the V40 test for storage units with a capacity sufficiently high to reach an infinite V40 value for heat pumps and gas storage water heaters. This has been solved in revisions of the standards. The resulting test method is as close to real life situation as reasonably possible, and the resulting V40 value is close to what consumers experience.

Unfortunately, the draft for revised ecodesign regulations for water heaters and water storage tanks (2013/814)[5] will not reflect real operation as accurately. The proposal specifies that the heat generator needs to be switched off at thermostat cut off, leading to a wrong outcome for appliances with a high output. Furthermore, the outcome will be misleading for consumers since the comparison amongst different technologies is lost (electrical water heater V40 against a storage gas boiler V40, for example).

Therefore, we recommend keeping the heater on during the test, in combination with offered solutions in revised standards EN 16147.

1.4. 24h load profile and its test duration for heat pump and other water heaters (EN 16147)

1.4.1. Load profile

The load profile for a heating appliance is the representation of the electrical load variation over time, usually in an hours-scale.

Some implicit requirements in the ecodesign regulation for water heaters and hot water storage tanks (EC 2013/814) are not verified in the current standards (EN 16147). The load profile is currently declared by the manufacturer. However, a verification of such load profile as the maximum available load profile by the appliance is not in place, hampering the reliability of such declaration and potentially leading to an interest of the manufacturer to downgrade it. This may also apply to electrical and gas storage water heaters.

Verifying the load profile is the solution to cope with this gap. Acceptable alternatives could be:

[5] Specifically in Annex III 3(k).

- Require a theoretical explanation or simulation, with verification in case of doubt;
- Introduce the test as a verification procedure in Annex IV of Ecodesign regulation (EC 2013/814), encouraging authorities to make a verification.

1.4.2. Test duration

The current test is performed in one day. However, every appliance should be capable of realising the **same load profile over multiple days**. With a longer test duration, the possibility of ending (and automatically passing) the test could be introduced, in case of:

- A thermostat cut-off has occurred before the start of the first tapping.
- No thermostat cut-off has occurred, and the test continues until the next peak temperature.

Hence, we recommend that a new test be aligned with a multiple-day duration by (partly) testing the next day, thus having at least a 1.5-day duration.

In CEN/TC 113/WG 10, there are ongoing discussions to continue testing on the second day, aiming to avoid extremely long testing time. However, the debate revolves around stopping the test at the first thermostat cut-off, meaning that the peak temperature may not be verified.

2. Horizontal aspects

2.1. Improve coherence between the Ecodesign Directive and the Energy Performance of Buildings Directive (EPBD)

Various space and water heater-related standards underpin requirements from ecodesign and energy labelling regulations, the Low Voltage Directive and other product legislations. Test methods to determine heating appliances' energy efficiency and performance are included in the harmonised standards, and such values are also used in EPBD-related and various EU national standards.

However, additional testing is required to establish the performance and efficiency of heat pump appliances responsible for heating, hot water provision and sometimes ventilation in buildings. Knowing that product efficiencies are also used in EPBD standards, it could turn beneficial with very little effort to **modify the test methods and conditions**. This would optimise product efficiencies and performance values for the purposes of the EPBD.

As an example, in EN 14825, the test conditions could be modified to allow the creation of a matrix for climate zone and temperature applications. In case of insufficient data, numerical interpolation can be done for all zones and temperature applications.

In the EU, the newly built environment market is the main sector for heat pumps, especially those buildings complying with the EPBD. The number of product tests may therefore increase but, on the other hand, the total number of tests for any heat pump installed in a new building will be reduced.

Technical Committee CEN/TC 228 – Heating systems and water-based cooling systems in buildings – has already presented a proposal to committee CEN/TC 113 – Heat pumps and air conditioning units. A

one-time effort in standards could significantly **reduce expensive tests for heat pumps**. At the same time, it would help reach appropriate efficiency for the final application and be more valuable for end-users.

2.2. Peak temperature and fictitious heater

Standard EN 16149[6] states that the peak temperature (55°C) of a heat pump cannot always be reached, and it specifies that the gap will be filled by an electrical heater. However, there is no verification on whether the unknown electrical heater can deliver the additional energy needed to achieve the peak temperature, and do so with 100% efficiency on electricity.

Although not explicitly mentioned, the revised regulation (EU 2013/814) requires measuring inclusive backup heaters (e.g., when 55°C cannot be realised, 52°C is acceptable in combination with 2% efficiency penalty). The value of this penalty was discussed in CEN/TC 113/WG 10, but some members considered the penalty too low.

As the default value, the penalty should be conservative (in reality, possibly smaller). Still, a **new incentive** should be created: we should reward heat pumps that achieve peak temperature, incentivising manufacturers to improve heat pumps. This would allow shifting from a penalty- to a reward-based approach. It would enable a more levelled playing field between technologies, especially for heating appliances realising the desired peak temperature.

2.3. Exhaust air as heat source and ventilation requirements

Provided that the main requirement for waste reduction is preserved, exhaust air can be considered waste heat for its application as waste-to-energy.

The draft of the revised regulation for water and space heating is an excellent step in that direction. Building insulation is improving, hopefully until the passive house level. In this context, ventilation becomes the largest source of heat loss.

We also see a trend in ventilation becoming more and more important, because of clean indoor air requisites. This is relevant for heat pump installation[7]. Currently, the ventilation rate calculation takes average values into account, but is not aligned with real use cases. Therefore, the ventilation volume should be computed considering relevant ventilation criteria, such as CO_2 and humidity.

We recommend that **CO_2/humidity measurement be done for a minimum number of rooms in a dwelling, such as the kitchen, living room, and bedrooms,** creating a ventilation flow that guarantees clean indoor air conditions. This would prevent overventilation. If the heat pump needs a higher flow, excess air should be taken from the external ambient.

In the Netherlands, such heat pumps are already on the market. This application should be deployed all over the EU, driven by regulations and standards.

[6] In Paragraph 7.9.1.
[7] Ventilation should be set up according to relevant requirement, and not according to the heat pump installed.

2.4. Crankcase heater test point (EN 14825)

The crankcase heater is an electrical component installed in the compressor of the heat pump, whose goal is to prevent refrigerant migration and condensation as well as mixing with the oil present in the crankcase. The test point, in EN 14825, has been changed from B (2°C) to D (12°C).

We recommend **moving the test point back to B**, as it is a more appropriate temperature, resulting in a more realistic contribution of the crankcase heater energy to the SCOP.

2.5. NO_x measurement for multifamily gas heaters

The draft revisions of EU 2013/813 and EU 2013/814 give NO_x limits for the different gases, but standards for space and water heaters require only NO_x testing for natural gas, even in case of multifamily appliances. This does not prove that the appliances running on other gases (e.g. propane or butane) will meet the regulation limits.

Therefore, we recommend introducing **tests for all gas categories** in the regulations, to prove that all the limits of the regulations are met. The reference to current gas heater-related standards, in Annex IIIa of the regulations, may induce working groups to consider the existing test method as law, which is not the case yet.

2.6. NO_x measurement for combination boilers

Combination boilers generate heat and hot water within households, serving both space and water heating purposes. Considering annual working time, the current operation trend describes a declining working time for space heating mode (part load) and an increasing working time for water heating mode (full load), and it is expected to increase further with hybrid applications.

Nonetheless, the water heating mode for NO_x measurement is not checked at all: manufacturers only need to pay attention to the NO_x emission in space heating mode.

Therefore, we suggest the heating mode be part of NOx emission measurements with weighing factors (between water and space operations) representing the average use as reflected in the real usage. By doing so, the manufacturer can no longer ignore NO_x emissions in water heating mode.

2.7. Material efficiency

We support the development of vertical material efficiency standards for any heating appliances where necessary, as we are active in related working groups. At both product and component levels, the durability and reliability of appliances are essential for sustainable heating appliances. However. assessing lifetime and repairability upfront is hard to estimate with weak assumptions.

Real operational data related, but not limited to, the installation and dismissal of heating appliances can improve the reliability of the assessments of the appliance lifetime over the years. Manufacturers already register the installation date when the appliance starts operation. If a recycling company/installer also registers the end of life/recycling date, a valuable **database will gradually be built up with accurate**

durability data. A little effort gives highly tangible information to consumers and industry to implement circular economy measures.

In the case of product and component reliabilities, manufacturers keep track of spare parts within the guarantee period. This could be extended to the full durability period. Again, a database will be built up over the years with a focus on reliability.

Contacts:

Jan Tichelaar, jan@three-t.nl

Marco Grippa, marco.grippa@ecostandard.org