EU ECOLABEL FOR HYDRONIC HEATERS

EEB, INFORSE and BEUC comments to draft criteria (May 2013)

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Summary

The EU Commission has developed a proposal of criteria for the EU Ecolabel for hydronic heaters. The background information on this process, including the latest version of the criteria and the technical report, can be found in the Website of the Joint Research Centre of the European Commission[i].

In this paper, the European Environmental Bureau (EEB), the European Consumer Organisation (BEUC) and the International Network for Sustainable Energy (INFORSE), show his disagreement with the ambition level proposed for the energy efficiency of heat pumps, as most ground source heat pumps and a large part of the air source heat pumps available on the market will be able to comply with the criterion on energy efficiency. In addition, NGOs call for the use of low-GWP refrigerants (below 150), since the global warming potential (GWP) of the refrigerant is the other main environmental aspect of heat pumps.

1. General considerations

EEB, BEUC and INFORSE welcome the proposal for an Ecolabel for this product group. We see this as an opportunity for Ecolabel to go beyond the Ecodesign requirements and energy labelling information, setting higher requirements and making it possible to reward other criteria, such as low-GWP refrigerants. It is important that Ecolabelled products are clearly better than the average products that meet mandatory Ecodesign requirements, and we acknowledge that the proposal set requirements well above this for most hydronic heating products covered.

However, we consider that for the heat pumps this is not the case, as most ground source heat pumps and a large part of the air source heat pumps currently on the market will be able to get an Ecolabel. We suggest to limit the EU Ecolabel to the best ground source heat pumps and only the very best air source heat pumps filled with a low-GWP refrigerant. This can be regulated with a lower TEWI value, i.e. replacing the proposed limit of 150 with 130 or lower. Although we show feasibility of this proposal through some examples of heat pumps that can comply with a lower value, we emphasise that further analysis should be carried out to set a more transparent and consistent limit. We call on the European Commission to apply the Ecodesign calculation methodology and undertake a small survey of efficient air-source heat pumps and determine the appropriate TEWI limit from that survey.

EEB, BEUC and INFORSE call for use of low-GWP refrigerants (below 150), since the global warming potential (GWP) of the refrigerant is one of the two main environmental impacts of heat pumps. We provide references to studies showing that heat pumps using refrigerants with low GWP can have at least equal efficiency, typically higher, than heat pumps with normal GWP refrigerants. We also show that the cost implications of that option are minimal.

2. Comments to the specific criteria

Criterion 1. Energy efficiency.

We support that the energy efficiency requirements are set sufficiently high, so that only renewable-assisted equipment and micro-CHP can be awarded the EU Ecolabel, while a lower efficiency is allowed for biomass boilers.

EEB, BEUC and INFORSE would like to reiterate that there is currently an important loop hole in the efficiency calculation for heat pumps, as according to the Ecodesign methodology it is important to specify that the efficiency calculation should be for normal-temperature heat pumps, not for low-temperature heat pumps. In Ecodesign regulation, the requirement for seasonal space-heating energy efficiency for low-temperature heat pumps is 115% (tier 1 requirements) while for normal-temperature heat pumps it is 100%[ii]. To clarify that in the EU Ecolabel proposal, we suggest to include that for heat pumps that can only operate as low-temperature heat pumps, the seasonal space-heating energy efficiency value, calculated according to the Ecodesign methodology, should be subtracted 15% to make them equal with normal-temperature heat pumps. This is not the case with the current draft of May 2013, as we understand it.

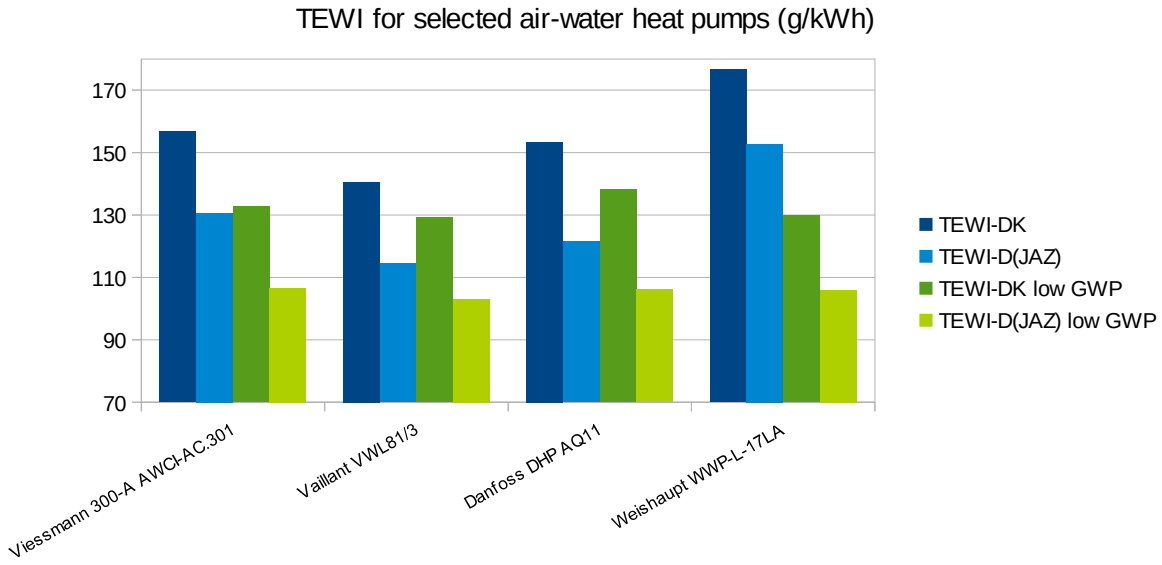
Criterion 2. TEWI value

EEB, BEUC and INFORSE call for the European Commission and Member States to set the maximum TEWI value (in g CO2-equivalent/kWh delivered heat) to a level where many of the ground source heat pumps will be able to get an EU Ecolabel, while only the best of the less efficient air source heat pumps can be awarded the EU Flower, and only with the additional requirement that they are filled with a low-GWP refrigerant. Today there are refrigerants on the market with GWP around 150 that are plug-in replacement for the refrigerants normally used for heat pumps with GWP in the range of 1500 – 4000. This will require a lower TEWI value of 130 or lower, not the 150 proposed in the draft.

In addition, we would like to stress that while TEWI value is based on energy efficiency calculated with the new Ecodesign methodology, hardly any data are currently available for heat pumps based on this new calculation system. As a result that the calculation of the TEWI value is uncertain and we find it hard to estimate the precise TEWI limit value to allow only the best air source heat pumps with low GWP-refrigerants.

As the Ecodesign measure for hydraunic heaters is adopted, it is possible to calculate the energy efficiency of heat pumps with Ecodesign methodology. We call on the European Commission to undertake a small market survey of efficient air-source heat pumps and determine an appropriate TEWI limit value from that survey. We consider that the appropriate limit value can be expected to be in the range of 107 – 133 to allow only the best air source heat pumps filled with low-GWP refrigerants. We propose to set the limit to 130, using the newly standardised energy efficiency measurements and calculations according to EN14825. This solution is supported by the conclusions of the below examples.

Using a seasonal efficiency calculated by the Danish Technological Institute, the TEWI value of the best **air source heat pump** for which we have data from both Denmark and Germany, filled with a low-GWP refrigerant (GWP = 160) will be 129 (the model is currently on the market with a refrigerant with GWP=1610, but the refrigerant can be changed). Using a German method to calculate the seasonal efficiency, the same heat pump will have a TEWI value of 103. The Danish method is known to be conservative while the German method is known to be optimistic. The following graph provides the TEWI values for air-water heat pumps with Danish and German efficiency tests and with present and low-GWP refrigerants.



Graph: TEWI values for four air-water heat pumps on Danish and German market, with TEWI values for each heat pump calculated in four ways:

2. with Danish seasonal efficiency factor (”normeffektfaktor”) for radiator use from Danish Technological Institute (published by Danish Energy Agency) as Seasonal Performance Factor (SPF), and current refrigerant
3. with German seasonal efficiency factor (“Jahresarbeitszahlen”) from JAZ Rechner(online) from Bundesverband Värmepumpe e.V for SPF with a heat design temperature (Normaussentemperatur) of -10'C, forward temperature 55'C, and monovalent use of the heat pump, and current refrigerant.
4. With Danish seasonal efficiency factor as above, but with change of the refrigerant to a low GWP refrigerant with GWP = 150
5. With German seasonal efficiency factor as above, but with change of the refrigerant to a low GWP refrigerant with GWP = 150

The conditions for calculation of the TEWI are the same specified in the draft Ecolabel criteria proposal: GHG emissions of electricity 384 g CO2/kWh, lifetime 15 years, annual refrigerant loss during operation 3.5%, loss at end of life 35%, and annual full load operating hours of 2000.

The data for the 4 heat pumps are:

Heat pump	Refrigerant	DK “Norm-effektfaktor”	D. Jahres-arbeitszahl	Refrigerant charge (kg)	Heating capacity (kW)
Viessmann 300-A AWCI-AC.301	R407 C, GWP=1610	2,95	3,69	5,1	9

Vaillant VWL81/3 C	R407 C, GWP=1610	3,00	3,77	2,2	8,1
Danfoss DHP AQ11	R407 C, GWP=1610	2,81	3,66	5	14,1
Weishaupt WWP-L-17LA	R404A, GWP=3922	3,00	3,69	8,2	19,3

The graph shows that with current use of refrigerant, three of the four air-water heat pumps can be expected to meet the TEWI requirement of 150. A TEWI limit of 130 may be achieved by one air-water heat pump under the current conditions for calculation. However, if the refrigerant is changed to a low-GWP heat pump with GWP = or < 150, all heat pumps are expected to meet the requirement of 130.

For **ground-source (ground-water) heat pumps** that typically have SPF 10% higher than air source heat pumps, and TEWI values around 10 points lower, many of them will meet a TEWI requirement of 130 also with existing refrigerants.

EEB, BEUC and INFORSE would like to stress that setting stricter limits than a TEWI of 150 seem feasible. We therefore disagree with the conclusion of the technical report stating that “setting a more restrictive TEWI limit (than 150) would not lead to pushing the market to best environmental performance”. On the contrary, we consider that setting the TEWI limit to 150 will not make a push towards more energy-efficient heat pumps nor to low-refrigerant heat pumps.

NGOs would like to stress that the proposed TEWI value of 150 for heat pumps will result in little difference between the efficiency of Ecolabelled heat pumps and the Ecodesign minimum-efficiency in the second tier of the Ecodesign of hydraunic heater (expected in 2017), as shown in the table below. Then all heat pumps with low greenhouse warming potential (GWP) will have TEWI values below 150, making them eligible for ecolabels, while also many heat pumps with the most popular refrigerent today (R407c) will have TEWI values below 150.

For calculation of the TEWI value, it is important to specify that for low-temperature heat pumps, the seasonal efficiency tested with a forward temperature of 35°C should be reduced by15% to set them on equal level with normal temperature heat pumps tested with a forward temperature of 55°C. Lack of this requirement will create a loophole for inefficient heat pumps.

If this loophole is not addressed, most low temperature heat pumps will have TEWI values that will make them eligible for the EU Ecolabel in the first Ecodesign tier (expected 2015) and all in the second tier.

With the proposed TEWI value of 150, many A+ labelled heat pumps will have TEWI values that will make them eligible for the EU Ecolabel. A+ is the lowest permitted class for heat pumps, when Ecodesign and energy labelling requirements will enter into force (expected in 2015).

In the table below the TEWI values for heat pumps with seasonal efficiencies on the lower limits of coming Ecodesign requirements and within Energy Label classes are shown.

	GWP 150	R407c (GWP 1610)
Ecodesign 2015	155	174
Ecodesign 2017	141	160
Ecodesign lowT 2015	135	154
Ecodesign lowT 2017	125	143
A+	125- 159	143- 177
A++	104-125	122-143
A+++	Below 104	Below 122
A LowT	127 - 135	145 - 154
A+ LowT lowes eff = high TEWI	127	145

Left column for heat pumps with low-GWP refrigerent (GWP = 150) and right column with normal refrigerent (R407c). The yellow fields are heat pumps not meeting the proposed Ecolabel criteria of TEWI= 150, green fields are heat pumps meeting the Ecolabel criteria of TEWI = 130 proposed by NGOs. Values for low temperature heat pumps are not adjusted for their lower capability (i.e. with the loophole described above)

Criterion 3. Refrigerant

EEB, BEUC and INFORSE call on the European Commission and Member

States to reduce the maximal GWP to 150. Since the global warming potential (GWP) of the refrigerant is one of the two main environmental impacts of heat pumps, the criterion addressing refrigerants directly is important. The figure of 150 (which is consistent with the limit in the "F-gas" Directive) still allows some HFCs, such as R152a and R161, and new fluorocarbon blends from some refrigerant manufacturers, rather than allowing only natural refrigerants.

We strongly disagree with the analysis of the background report that refrigerants with low GWP (<150) lead to lower energy efficiency. Heat pumps using refrigerants below 150 GWP can have at least equal efficiency, typically higher, than heat pumps with normal GWP refrigerants. Extensive articles and papers[iii], as well as manufacturers' experience[iv], show that hydro-carbons, such as propane (R290) give the same or better efficiency of refrigerant in heat pumps than HFC's (such as R407C or R22).

The European heat pump industry has raised the concern that the use of hydrocarbons as refrigerants add to the costs of installations because of their flammability. However, we disagree with this statement as experience shows that the use of heat pumps with low-GWP have only minor extra costs, once the development costs are covered. However, these potential extra costs may also be offset by lower material costs such as less copper and cheaper refrigerant. In particular, for a reversible air-to-air unit using a flammable refrigerant, the additional materials/parts cost is about 1% of the unit cost. However, when using R290, the total cost is lower because the refrigerant and oil is cheaper and copper tubes are smaller so the total material cost of the R290 unit is overall a few percent less[v]. For a water heating heat pump the situation is a little different because a ventilated enclosure may be needed (if the system is located indoors). In this case, the material cost for flammability may increase by up to about 5%. Nevertheless, amongst the other lower GWP alternatives, the flammability is "lower" and therefore the safety requirements are less severe and as such the cost implications would be less than with R290.

In terms of (flammability) safety, use of the ATEX and Machinery Directives should be followed, using EN 1127-1 for the risk assessment. The practical design should follow EN 378 and EN 60335-2-40 (which allows up to 5 kg of R290, ~10 kg of R1234yf - equivalent to about 10 kg of R407C). These safety requirements for heat pumps are robust, have existed for many years, and should apply to all refrigerants. As far as R290 is concerned, heat pumps using this refrigerant are widely used and all have an excellent safety record.

In addition, there is a significant penetration market of other refrigerants than hydrocarbons or ammonia that can meet the low-GWP requirement and that have minimal flammability, including HFC blends[vi].

Criterion 4. Nitrogen oxide (NOx) emission limits

EEB, BEUC and INFORSE consider that the limit for oil fired CHP engines is not challenging (380 mg/kWh energy input). While we acknowledge that the technology produces this level of emissions, catalysers can be used to reduce

them. We call for use of catalysers by which lower emission levels can be achieved, e.g. 300 mg/kWh.

We welcome the limit of 36 mg/kWh for gas boilers, as this value is feasible.

Regarding the limits proposed for solid fuel heaters, NOx emissions from biomass are mainly due to the fuel. By selecting good quality fuel with low NOx content, the limits proposed can be met.

Criteria 6. Organic gaseous components (OGC) and 7. Particulate matters (PM)

The limits proposed are stricter than the proposed Ecodesign limits, and on the limit of what is achievable:

Flue gas at 10% O_2	New Ecodesign proposal*	Ecolabel proposal	Best on DK market**
OGC	10	7	0/0/7
PM	20	15	10/12/16

* Ecodesign proposals in Interservice Consultation May 2013.
** The data for the best boiler on the Danish market are based on data from Danish Technological Institute for full load operation. The first value is for automatic pellet boilers, the second for automatic woodchip boilers, and the third for hand-fed wood-log boilers. The data are for three distinct boilers, other boilers have lower PM but higher OGC values. Part-load operation gives higher emissions. A 0-value means in practice a value below detection-level.

From the comparison in the above table it is clear that the proposed limit will restrict Ecolabelled wood boilers to the very best and will probably exclude hand-fed boilers. We can agree to that, as this will make Ecolabelled boilers outstanding in low emissions.

In addition, it has to be specified if the emission criteria are only for full-load operations or also for part-load operations. For part-load operations, it will be hard to reach the limits for any currently available biomass boiler. In the Ecodesign proposal the requirements are for an average og 15% full load and 85% part load, except for boilers that cannot operate in part load, where it is for full load.

Criterion 12. Design for sustainability

We support the inclusion of this criterion and propose that it is made more specific by including indications of how much of a heating product should be serviceable, how long it should take to disassemble and replace parts that need service/replacement, etc.

We would like to refer to some of the work done by the EU Joint Research Centre (JRC) on durability[vii] and give more details requirements for reusability, recyclability, and recoverability as proposed for Televisions[viii].

We think some of this could be incorporated into this Ecolabel criteria.

We will also like to emphasize that the free take-back of products after use shall be within reasonable distance from consumers or point of sale.

Criterion 14. Information on the EU Ecolabel

We propose that only relevant information is on the Ecolabel. Thus, there is no need to stress "reduced air emissions" for electric heat pumps that do not have air emissions.

3. Other comments

In article 3.1, it is proposed to exclude heaters that combine direct and indirect heating. All boilers have a small fraction of indirect heating, so we propose to be more specific regarding the exclusion and set a fraction of maximal indirect heating. This could be set to around 20%.

END

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[i] http://susproc.jrc.ec.europa.eu/heating/stakeholders.html

[ii] In Ecodesign there is a distinction between normal temperature heat pumps that are tested with 55'C forward temperature (i.e. good for radiators) and low-temperature heat pumps that are tested with 35'C forward temperature (i.e. good for floor heating, but not good for radiators). There is a difference of Ecodesign minimum requirements for the two types of heat pumps: 100% minimum efficiency for normal-temperature heat pumps and 115% for low-temperature heat pumps. This is because if a normal temperature heat pump is tested as a low-temperature heat pump, it will have about 15% higher efficiency. The TEWI calculation is based on the energy efficiency calculated according to the Ecodesign methodology, but the EU Ecolabel proposal fails to specify this distinction between normal-temperature heat pumps or a low-temperature heat pumps.

[iii] Some examples of studies showing same or better efficiency of hydrocarbons, such as propane, than HFCs (such as R407C or R22):

- *Performance of heat pumps charged with R170/R290 mixture*. KANG D. G. / PARK K. J. / JUNG D. 3rd Conference on Thermophysical Properties and Transfer Processes of Refrigerants Proc., Boulder Conf., IIR/C. R. Conf. Boulder, IIF / 2009.06.23-26. This study shows for a R170/R290 mixture (hydro-carbons) a much higher performance for HCs than R22.

- *Optimized design of a heat exchanger for an air-to-water reversible heat pump working with propane (R290) as refrigerant: modelling analysis and experimental observations*. BLANCO CASTRO J. / URCHUEGUÍA J. F. / CORBERÁN J. M. / et al., Appl. therm. Eng. / 2005.10. This study shows that R290 has in this case has a much better performance than R407C

- *Effect of climatic conditions on the performance of an air-to-water reversible heat pump using R290 as refrigerant: seasonal system performances evaluation by means of experiments and modelling*. BLANCO CASTRO J. / ROMERO G. / URCHUEGUÍA J. F. / et al. 8th IEA Heat Pump Conference 2005: global advances in heat pump technology, applications, and markets. Conference proceedings [CD-ROM]. Proc. IEA Heat Pump Conf., Las Vegas, Nevada / 2005.05.30-06.02. This study shows good efficiency for R290 for air-conditioning and heat-pumping applications.

- JUNG D. S. / HAM Y. 8th IEA Heat Pump Conference 2005: global advances in heat pump technology, applications, and markets. Conference proceedings [CD-ROM]. Proc.

IEA Heat Pump Conf., Las Vegas, Nevada / 2005.05.30-06.02. This study shows that most mixtures offer better performance than R22.
- *Performance of CARE 50 as an R22 replacement in a domestic HPAC system* Firth, A., Carrington, G, , Proc. Int. Cong. Refrig., IIR, Sydney, 1999.
- *Hydrocarbons as alternative refrigerants for heat pumps initial operational experience*, Frehn, B. KI, Klima-Kalte-Heizung, Heidelberg, Germany, 1993.
- *Propane as refrigerant in a small heat pump. Safety consideration and performance comparisons*, Granryd, E., Tengblad, N., Nowacki, J.E. Proc. Natural Working Fluids Conf., IIR, Hanover, 1994.
- *Propane an alternative coolant for heat pumps*, Rodecker, A., Proc. Natural Working Fluids Workshop (HHP-AN22-1), Trondheim, 1995.
- *Performance of plate heat exchange and compressor in a domestic heat pump using propane*, Pelletier, O., Palm, B., Proc. Natural Working Fluids Conf., IIR, Aarhus, 1996.
- *Performance and heat transfer of hydrocarbon refrigerants and their mixtures in a heat pump system*, Kim, M. S, Chang, Y. S, Ro, S. T., Proc. Natural Working Fluids Conf., IIR, Aarhus, 1996
"Testing of a heat pump with propane as working fluid", Lystad,T., Proc. Natural Working Fluids Workshop (HHP-AN22-1), Trondheim, 1995.
"Evaluation of flammable refrigerants for use in a water-to-water residential heat pump", Choi, D. K., Domanski, P. A., Didion, D. A., Proc. Natural Working Fluids Conf., IIR, Aarhus, 1996.
Erfahrungen zum Einsatz von Propan in der warmepumpen-an-wendung", Korner, F., "FKW/IKET Seminar, Frankfurt, Germany, 1994.
"A study of a water-to-water heat pump using flammable refrigerant", Payne, W. V., Domanski, P. A., Muller, J., Proc. Natural Working Fluids Conf., IIR, Oslo, 1998.

[iv] There is a number of manufacturers marketing R290 Heat Pumps (e.g., Dimplex, Hautec, Airpac, Auer, Skyline Energy, Neura, etc). Hautec have R290 and R404A models – the R290 models have higher efficiency than R404A (http://www.hautec.co.uk/Hautec_Air_to_Water.pdf)

[v] *Cost analysis of producing split-type air conditioners using HC-290*. Proklima intenational. The scope of this article covers Air Conditioners, but according to the author the conclusions can apply to heat pumps. Also see: *Hydrocarbons as refrigerants in small heat pump and refrigeration systems – A review.* Bjorn Palm (Royal Institute of Technology, Department of Energy Technology, Division of Applied Thermodynamics and Refrigeration, Stockholm) In international journal of refrigeration 31 (2008) 552-563.

In addition, although a HP may use 5 kg of R407C, using R290 (directly) would only use 2 - 2.5 kg. However, much work has gone into developing low charge systems. For example, the following article describes such a heat pump using only 200 g R290 for 5 kW (or maybe 0.5 kg for 15 kW): Designing a heat pump for minimum charge of refrigerant. PALM B. / FERNANDO P. / ANDERSSON K. / et al. 8th IEA Heat Pump Conference 2005: global

[vi] Dr Daniel Colbourne, RinstR. Presentation (available upon request) at the European Parliament F-Gas Expert Haring on 27th of February: Lower-GWP alternative refrigerants for air conditioning sub-sectors.

[vii] Integration of resource efficiency and waste management criteria in European product policies – Second phase. Report n° 1. Analysis of Durability F. Ardente, F. Mathieux, J. Sanfélix Forner

[viii] See for instance regarding TV's:
http://www.eceee.org/Eco_design/products/televisions/Television%20Review%20proposal%20on%20end%20of%20life.pdf