Norwegian
Water Resources and
Energy Directorate

VHK
Project manager
Special review, Article 7. of eco-design regulation 814/2013

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Our date:
Our ref.: 160524/bes
File no.:
Your date: 24.05.2016
Your ref.:

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Input to the interim report on article 7 of regulation 814/2013

VHK has been assigned the task of evaluating the appropriateness of setting separate eco-design requirements for different water heaters. Task 1 in the mandate for the study is based on article 7 (2) and shall include an evaluation of the improvement/saving potential of adopting specific minimum requirements for products using different fuels.

It is NVE's view that the interim report does not answer this most central point of the assignment.

The answer to this question consists in our view of a study of each technology with an assessment of efficiency potential as a function of product and system cost in a life cycle perspective. The potential savings for alternative ambition levels should then be aggregated for EU 28 (+3).

In the Executive Summary of the original preparatory study, it is stated that at Least Life Cycle Cost (LLCC), the savings is close to 35 % from the base case while with BAT technology the savings can be more than 60 %. NVE cannot find that the preparatory study or the interim report have any discussion on what is an appropriate and ambitious requirement for each technology.

NVE has done our own assessment and found that setting separate requirements on gas products alone can result in a 30-60 TWh/year savings for EU 28 (based on the Impact assessment, market data in table 2, page 45). In addition, there will be savings from setting realistic but ambitious targets for direct electric, solar and heat pump water heaters.

NVE observes that most Regulations, including 813/2013 on space heating, with success, have set separate requirements on various technologies. NVE cannot see why this distinction is not followed also for water heaters. If there are any special reasons for why water heaters needs to be treated differently, the interim report on Article 7 must include a discussion where arguments are being brought forward.

NVE also believes that the interim report should discuss the load shifting capabilities of large water heaters linked to the preparatory study on Smart Appliances. It is NVE's view that thermal storage will play an important role in a future electrified and renewable society.

Task 2 of the interim report asks for an assessment of the impacts of the requirements. It is NVE's view that this assignment has not been answered so far in the interim rapport. However, during a good phone conference with Mr. Kemna on May 10th, many of our concerns and views were discussed and partially clarified.

For Norwegian consumers, fossil fuels are not an option for space or water heating. The Norwegian Government is preparing a ban on fossil fuel heating from 2020. Neither is natural gas an option since Norway has an insignificant gas infrastructure with very limited coverage.. For most Norwegian consumers, heat pumps and solar heating then becomes the only option to electric water heaters. The problem with this however, is the very low Norwegian winter temperature and a sun that does not pass above the horizon for 3-4 month in the northern part of the country.

Approximately 15 % of our population live in cold highland climate, often with average yearly temperatures below 0° C. An air to water heat pump for 55-60° hot water will then at BAT have a SCOP of 1.5 - 2 resulting in a clear negative LCC compared to direct electric water heating. See attachment, case 2 for data.

Geothermal heat pumps could have been a solution in Norway, but the high life cycle cost associated with a dedicated hot water geothermal heat pump blocks this option. As much as 79 % of the Norwegian households do not have a water based heat distribution system and will therefore not benefit from a geothermal heat pump unless substantial investments (> € 10.000) are spent on building infrastructure. Se attachment, case 1 for data.

Wood or pellets is not a solution for many buildings because they have no chimneys. Instead their need for heating is based on electricity. There are also growing concern on biomass heating in many city centers due to particle emissions.

Feedback on the interim report data:

The interim report presents a LCC for Norwegian hot water production on page 45. The results seem reasonable for a coastal climate and for the small 120 liter tanks. As discussed in our phone meeting we also need to present the cost for the approximately 15 % of our population that live in inland "artic climate" and it would be appropriate with two separate LCC graphs.

1. The presented LCC on page 45 must be updated to show actual investments for tanks of sizes XXL or above and not for a 120 liter water heater. To our knowledge, it is only hot water tanks below 300 liters where integrated heat pumps have become available. Norwegian water heater manufacturers explain this with the fact that a 400-1000 liter tank will be too large for doorways and ceiling heights with an integrated heat pump.

   NVE did a market survey in 2014 showing that the affordability (investments cost difference) was 4 -7 times higher for heat pump water heaters against electric stainless steel tank water heaters in the Norwegian market for the larger tanks*. Norway uses solely stainless steel tanks to achieve a 30 year lifetime with 70-80 degree water.

* Norwegian Non-paper dated December 2nd, 2014. The figures are updated in the table on next page with SCOP of 3 and with the current € to NOK exchange rate.

Replacement conventional water heater versus **heat pump water heater** in **costal** Norway	XXL (400 litres volume)	3XL (600 litres volume)	4XL (1000 litres volume)
Difference between cost over lifetime (air to water heat pump vs. electric water heater)	€ 10 053	€ 5 729	€ -26 744
Lifetime cost index (AWHP WH/ EL WH) (Best case costal HP with SCOP of 3)	1.32	1.12	0.74
Affordability (Investment costs difference)	696 %	525 %	417 %

The presented case on page 45 has an "Affordability" of approximately 250 % and is not representative for the larger tank volumes were our calculation gives between 417 % and 696 % cost difference.

2. A separate case should show the options for 15 % of our consumers living in "artic" inland climate with an SCOP of 1.5. Input data are given in the attached case 2.

3. At the bottom of page 45, the report states that solar contribution is 20% lower in Norway than in Belgium. This may be true for the southern part of Norway, e.g. Oslo, but not for areas north of the artic circle where the sun is missing 3-4 months of the year. Typical average yearly solar contribution in Norway's northern cities is 650 kWh/m2.

4. Tables 3-9: "Hot Water system efficiency". It would be important for transparency reasons to show how the percentages given in row 1 are established? Many of the values are puzzling – like the 38% efficiency of an air source heat pump (ASHP) in table 6 (page 22).

To sum up. It is NVE's view that VHK has not answered the most central point of the assignment which was to evaluate the appropriateness of setting separate eco-design requirements for different water heaters. There is no explanation for why separate eco-design requirements for different water heaters cannot be set as for various other products. The result of the interim report is as a result critical for Norway as many of the consumers live in cold highland climate zones that have no practical alternative to direct electric water heating.

Yours sincerely

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Attachment:

Case 1: LLC calculation for geothermal hot water heat pumps for XXL, 3XL and 4XL

Case 2: SCOP of Hot Water Air Heat Pump in cold inland climate in Norway

Case 1: LLC calculation for geothermal hot water heat pumps for XXL, 3XL and 4XL

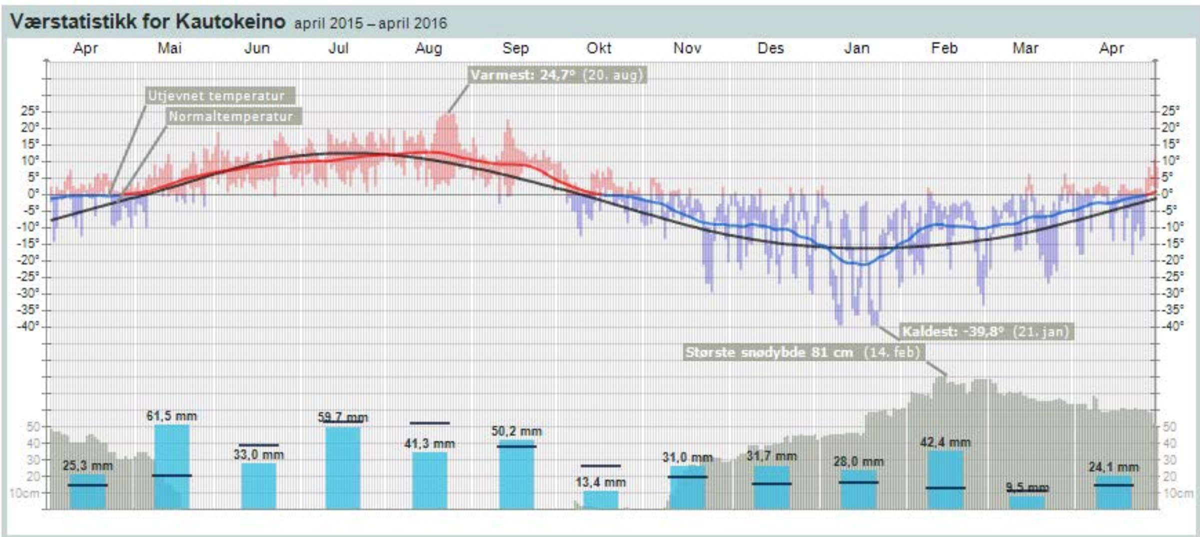
Approximately 15 % of Norway's population live in an inland "arctic" climate zone where air-to-water heat pumps perform below a SCOP of 2, resulting in negative lifetime cost from investments in air-to-water HP. These heat pumps normally have an operating range down to 0° and occasionally - 5° C. Consumers in towns like Kautokeino, with an average yearly temperature of -3° C, will obviously have a challenge. Drawing heat from inside the house is hardly an option with an electrically heated house.

Northern Norway has no sun 3-4 months of the winter so thermal sun heat is hardly an option.

Geothermal heat pumps then seem to be the only potential option to an electric water heater. The affordability is still a challenge but the negative LCC is the main reason why even this route is not a viable option.

Norway also has land areas with permafrost, like Svalbard. We see no option to the electric water heater for such artic areas.

Replacement conventional water heater versus **geothermal heat pump** water heater	XXL (400 liters)	3XL (600 liters)	4XL (1000 liters)
Difference between cost over lifetime	€ 28 394	€ 21 893	€ -10 120
Lifetime cost index	1,83	1,43	0,91*
Affordability (Investment costs difference)	537 %	395 %	291 %



Example: Temperature of the city of Kautokeino with an average yearly temperature of -3°C:

* We managed to achieve a positive LCC on the largest tanks* by designing a system with a small heat pump and double the tank volume to allow for a 10 hour re-heating time. The tank volume has already been increased by 50% to compensate for a storage temperature of 55° C instead of the normal 70° C of an electric water heater. There will obviously be many existing buildings that will have challenges with three tanks instead of one. Including the footprint of the heat pump one will need four times the space compared to an electric water heater.

Case 2: Hot Water Air Heat Pump in cold inland climate in Norway

The heat pump suppliers simulation model does not allow this configuration so the figure below is "forced" by setting the demand for space heating instead of hot water with a 55° C supply temperature.

The horizontal dotted line in the graph on the following page would represent a stable year round hot water demand and it is clear that for 40% of the year (vertical dotted line) there is practically no benefit from the heat pump (green area) while the "summer months can give a COP of ~3. This results in a theoretical SCOP of 1,7 (realistically 1,5) and a negative LCC result for the investment in an Air Heat Pump vs. direct electric water heating.

Replacement conventional water heater versus **heat pump** water heater in "**artic climate**"	XXL (400 liters)	3XL (600 liters)	4XL (1000 liters)
Difference between cost over lifetime (air to water heat pump vs. electric water heater)	€ 19 441*	€ 19 811*	€ 4 550*
Lifetime cost index (AWHP WH/ EL WH) (At worst case with SCOP of 1,5)	1,62	1,42	1,04
Affordability (Investment costs difference)	696 %	525 %	417 %

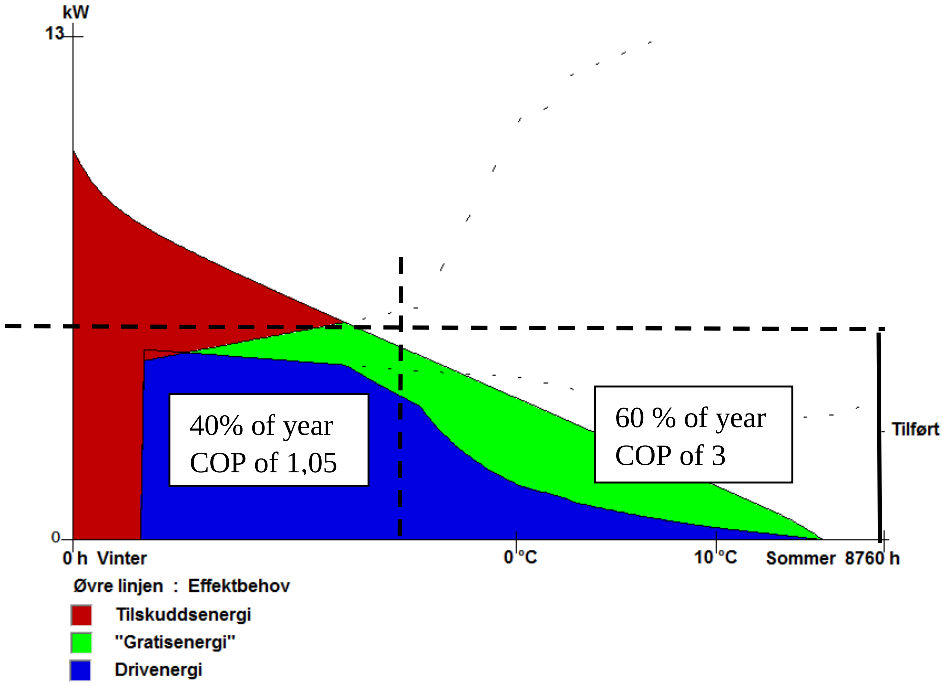
Investment and operations cost		**Prices in EUR incl VAT**		
Electric water heater	Lifetime	400 lit	600 lit	1000 lit
Electric storage water heater - Investment	30	2 366	3 334	5 834
El. storage w.heater - Installation costs		1 000	1 666	1 666
Air-to-water heat pump				
AW HP - Investment	15	9 111	9 973	11 334
AW HP - Installation cost		5 723	5 805	6 084
Water heater with coil - AW HP - Investment	30	3 500	5 250	6 734
Water heater coil -AW HP - Installation cost		2 750	3 334	3 750
Yearly maintenance (F-gas ++) AW HP		166	334	334
Replacement HP after 15 years, cost investment %		100 %	100 %	100 %
COP factor AW HP		1,5	1,5	1,5
Energy produced / delivered from tank		12 000	18 000	40 000

Replacement conventional water heater by heat pump water heater in Norway	**400 litres**	**600 litres**	**1000 litres**
Electricity price Norway [€/kWh]	0,097	0,097	0,097
Electric water heater			
Purchasing and installation costs [€]	3 366	5 000	7 500
Electricity consumtion [kWh/year]	12 000	18 000	40 000
Costs over lifetime (LCC [€], 30 years)	31 531	47 246	101 381
Air-to-water heat pump water heater			
Purchasing and installation costs	23 418	26 261	31 268
Electricity consumtion [kWh/year]	8 000	12 000	26 667
Costs over lifetime (LCC [€], 30 years)	50 971	67 057	105 931
Difference between cost over lifetime (HP-EL)	**19 441**	**19 811**	**4 550**
Lifetime cost index (AWHP / EL)	**1,62**	**1,42**	**1,04**
Affordability (investment costs)	**696 %**	**525 %**	**417 %**

* Market prices are collected from Norwegian vendors and importers of heat pumps in a NVE survey in June 2014.

NVE, Example 36000kWt/y, 9520 KAUTOKEINO

Heat pump: Alira LW 121A/SX 230v



Input data

Power demand heat net	kW	**12**
Of wich ventiallaion is	kW	**0**
Net energy demand	kWh/y	**36200**
Hot Water demand	kWh/y	**1**
HW. from VP max	%	**100**
Indoor temperatur	°C	**21**
Average outside temp	°C	**-2**
DUT (Dim. Outside t)	°C	**-37**
Supply at DUT	°C	**55**

Results (space heating)

From Heat Pump	kWh/y	**26110**
Supply power	kWh/y	**17780**
Supplementary el. from	°C	**-8,7**
Energy coverage	%	**72,1**
SCOP (totalt 1,30)		**1,47**
Savings (gros)	kWh/år	**8330**
Supplementary el.(100 %)	kWh/y	**10090**
Peak power	kW	**12**
Max power demnd.	kW	**12**

Heat source

OUTSIDE AIR

Energy saving	%	**23**