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Title: Heat pump market development in Europe

Availability and quality of market data is a proxy for the maturity level of an industry.

The European Heat Pump Association has compiled market data and sales statistics for the European Heat Pump market since 2005. Data from individual markets is available since the early 1990s. What was an industry action in the past has been taken to the government level with the implementation of the Directive on the promotion of use of renewable energy sources in (European Community 2009). Annex VII of the Directive gives a mandate to the Commission to establish guidelines on how Member States are to estimate the use of renewables by heat pumps. The guideline shall include the determination of total usable heat delivered (Q_{usable}) and the average seasonal performance factor (SPF) for the different heat pump categories. The commission complied with this precaution by publication of a full methodology and default values for the calculation of heat pumps.

The paper will briefly analyze the major development trends of the heat pump sector in up to 21 European markets starting in 2005.

Based on this data, it will in particular compare the current industry approach with the Commission guideline on how to determine renewables contribution by heat pumps into national energy statistics. It will outline differences of the approaches taken and analyze their impact on the results.

The analysis will reveal, that the calculation of the RES share from heat pumps is more complex than suggested by the Commission calculation method. The Commission approach is a good, yet rather general basis for calculating the RES share from hat pumps. Member States of the European Union can and should increase the recorded contribution by collecting more detailed data on the different heat pump categories and their performance. The heat pump industry should support this effort to ensure proper acknowledgement of the technologies benefit in European energy statistics.

Note: A full description of the European Heat pump market is available in print.

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European Heat Pump Market and Statistics

1 INTRODUCTION

EHPA records HP sales data and market information since 2003. The number of countries covered has reached 21 in 2013. Part of the data analysis is the calculation of contribution of heat pumps towards the European climate and energy targets.

In early 2013 the Commission issued Decision 2013/114/EU (European Union 2014) on the calculation of the renewable energy share from heat pumps. Applying this decision to existing heat pumps sales data has an effect both on the number of units to be counted and on their use of renewable energy.

2 DEVELOPMENT OF THE EUROPEAN HEAT PUMP MARKET

753 363 heat pumps were sold in 2012 (Nowak, Jaganjacova 2013). For 2013, the data collection is not complete, but assuming a stable market for all countries that have not yet reported data, and using the latest data where available reveals an estimated sales of 768 797. After a decline of 7% from 2011 to 2012, these numbers suggest a recovery of the European market in 2013 with a growth of 2% compared to 2012. When integrating data since 1989, the aggregated stock of the European market is close to 6.85 million units (see table 1 and figure 1).

Table 1: Heat pump sales in Europe 2005 - 2013 (Source: EHPA)

	sum EU-14	sum EU-21	cumulated total
2005	419 966		989 536
2006	548 353		1 537 888
2007	633 154		2 171 042
2008	798 054		2 969 096
2009	731 352		3 705 553
2010	717 191	805 215	4 510 768
2011	716 473	813 335	5 324 103
2012	677 622	753 363	6 077 466
2013e	688 022	768 797	6 846 263

Based on the 2012 data, the following trends can be observed:
Air is the dominant energy source for heat pumps. The majority of heat pumps sold are reversible air-air systems (59.3%) followed by air-water (16.2%) and ground-coupled units (geothermal energy | 14.1%), Exhaust air heat pumps are a small yet growing segment (1.9%). The biggest growth is recorded for sanitary hot water units with an increase of 25% from 2011 to 2012 and a share in total sales (2012) of 8.4% (see figure 2).

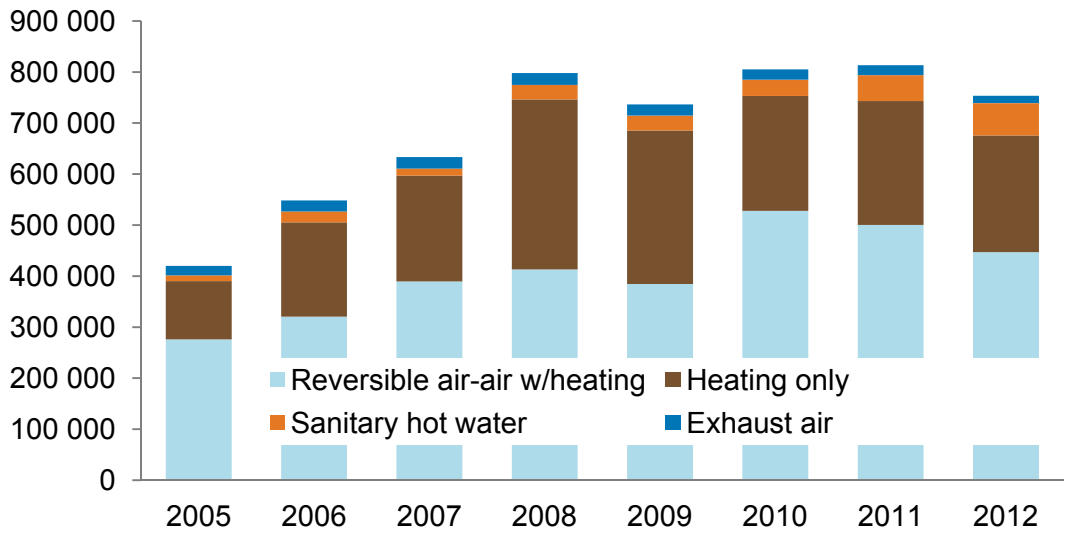

Figure 1: Development of heat pumps sales in Europe, 2005-2012 | by category
Countries covered: 2005-2008: 14; 2009: 19; 2010-2012: 21

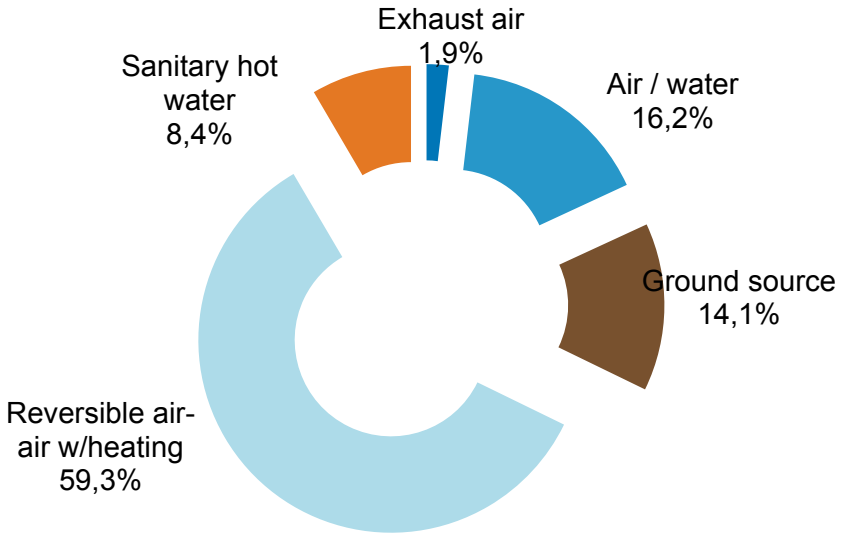

Figure 2: Heat pump sales in Europe 2012 | shares by type of heat pump

Expected advancements in technology will make the already easy to install units more efficient and compact, integrating most of the necessary components. As well, new products are introduced in the market providing efficient heat pump solutions for more and more demand scenarios, namely the **renovation segment and large building** solutions where a parallel demand for heating and cooling makes heat pumps particularly suitable. Air source units are cost-competitive in an investment and even more in an operations perspective. As such, they are preferred solutions for the performance and cost-aware consumer.

Sanitary hot water systems, which also use air as energy source, are the fastest growing sales segment. Their easy integration with existing heating system makes

them an "entry level heat pump". They enable the use of a minimum share of renewables (around 15%) as often requested by legislation.

The segment of **geothermal and hydrothermal installations** shows a split picture. The number of large installations for commercial buildings, buildings blocks and district heating is increasing with the latter often connected to bodies of water. The market for residential geothermal application sees a constant number of approx. 100 000 units. This is not expected to change unless cost of drilling can be reduced and the necessary administrative procedures to obtain a drilling permit are simplified.

Large heat pumps for commercial, industrial and district heating applications are getting more popular, yet not enough data exists for this important market segment.

The slight increase of the European market by 2% is spread unevenly across countries. In 2012 approx. half of the 21 observed markets grew, while the other half shrank. In 2013, 10 out of 13 markets that have reported data show positive growth, most of them stronger than reported from 2011 to 2012 (see figure 3).

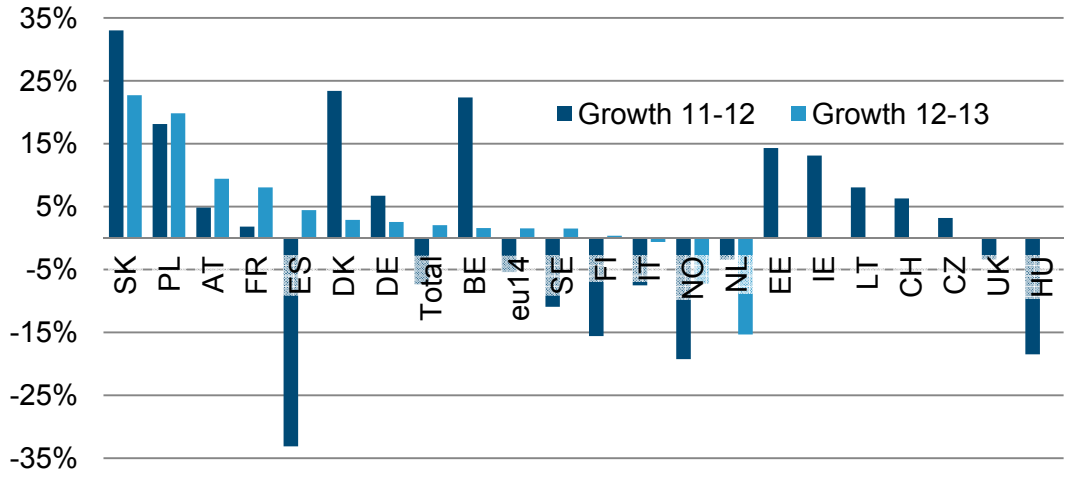

Figure 3: Growth rate of heat pumps sales in 21 European countries (in per cent) 2011-2012 and 2012-2013 (Source: EHPA)

The number of markets showing double double-digit growth has decreased from 2012 to 2013, but some of the big markets like Germany, France and Sweden have returned to the group of growth markets, thus the absolute increase of sales in the growth markets is bigger than the reduction in sales in the rest.
Looking at the available data for 2013 reveals that the Slovak Republic is leading the growth countries for a second time in a row followed by Poland, a market quickly becoming one of the major drivers of heat pump growth in Europe. In absolute terms, France is the growth leader with an additional 11 428 units, followed by Poland (+2 493) and Spain (+ 2 233).

With regards to the technologies benefits towards the EU's climate and energy targets, heat pumps continue to deliver the expected triple dividend in addition to providing local employment as well as security and affordability of energy supply. As the market is growing, a slightly higher contribution to the different targets can be expected from sales in 2013.

The 753 363 units sold in 2012 added nearly 5.7 MW of capacity to the market. They produced approx. 9.5 TWh of useful energy, and integrated 6.22 TWh of renewables in heating and cooling, at the same time avoiding 1.71 Mt of CO2-equivalent

emissions. An additional 4.61 TWh of primary energy was saved resulting in a reduced final energy demand of 8.19 TWh.

In order to produce the 2012 sales volume and to maintain the installed stock, a total of 41 062 man years were necessary. Obviously real employment related to the heat pump market is larger as not every employee works full-time on heat pumps only.

The numbers presented here are based on EHPA data and interpretation. The following paragraphs will compare this established industry approach with the official method introduced by the European Commission in the RES Directive and augmented by the recent Decision on how to calculate the RES contribution. (European Community 2009 and European Union 2014).

3 CALCULATING RES - APPLICATION OF THE METHOD AS PROPOSED BY THE COMMISSION'S DECISION

3.1 The Calculation of RES according to the Commission decision

The Commission decision 2013/114/EU (European Union 2014) provides a guideline on how to determine the RES contribution from heat pumps. Using the formula introduced in the RES Directive, detailed information is provided on how to calculate Q_{usable} and on the use of the 'seasonal performance factor' (SPF) as well as the heating hours (H_{HP}). Both parameters are provided per used/heat pump category and climate zone. The RES contribution is calculated based on final energy.

(1) $E_{RES} = Q_{usable} * (1 – 1/SPF)$
(2) $Q_{usable} = H_{HP} * P_{rated}$

Where:

- Q_{usable} = the estimated total usable heat delivered by heat pumps,
- H_{HP} = equivalent full load hours of operation,
- P_{rated} = capacity of heat pumps installed,
- SPF = the estimated average seasonal performance factor.

These formulas are then applied to all heat pump categories and the respective results are aggregated to finally yield the total renewable contribution from heat pumps (E_{RES}) per Member State of the European Union (MS).

The EHPA calculation has used the same formulas, yet instead of using default values, it applied industry data based on surveys and expert opinion for H_{HP} and SPF.

The total capacity of installed heat pumps (P_{rated}) is based on the number of units sold multiplied by a factor representing the capacity per unit. This parameter is not specified in the decision and thus, the same value is used for EHPA and for the comparison calculation.

3.2 Accounting for reversible air-air heat pumps

The Commission Decision gives special consideration to the case of air-air heat pumps to avoid an overestimation of their RES contribution. Depending on system design and the climate zone of installation, these units can vary greatly in their performance. More importantly, as most air-air units are reversible, they can also be used for cooling. In warm climates, they are often used for cooling only. The decision states: "reversible heat pumps in warmer climates are often installed with the purpose of cooling the indoor environment, [...]. This needs appropriate adjustment"

(European Union 2014, p.27). As the RES Directive only focuses on heating, cooling-only heat pumps must be excluded from the calculation.

In the Commission approach "appropriate adjustment" is achieved by a reduction of the H_{HP} value only, while all reported air-air units are counted.

The industry approach used by EHPA has taken a different approach. It leaves the H_{HP} value untouched and instead deducts the cooling-only air-air units from the number of units included in the calculation. This number was determined by a study on the Italian market deemed to be representative for the Mediterranean as well as by expert opinion. In markets, where the share of cooling-only air-air units could not be determined, air-air units were not included in the statistics and the calculation. Table 2 illustrates the two perspectives - with and without EHPA adjustment of reversible heat pumps - on sales data for countries affected by the adjustment.

Table 2 Comparison of 2012 sales numbers - EHPA adjusted vs. full inclusion of all units sold (source: EHPA)

	EHPA adjusted	Full inclusion	Full incl./Adjusted
ES	50 418	510 073	912%
IT	116 669	958 786	722%
PT	8 671	58 651	576%
BE	9 310	47 450	410%
NL	9 010	36 635	307%
FR	142 066	444 132	213%
SK	705	799	13%
HU	706	733	4%
Total	337.555	2.057.259	509%

Table 3 shows that both approaches reduce the risk of overestimation, yet the EHPA approach is leading to a much lower contribution. Following the Commission approach, leads to a 2012 heat pump market of 2.473.227 units.

Table 3 Adjusting share of reversible air/air systems: The EHPA method modifies the number of units counted, COM uses the H_{HP} factor

Climate zone	EHPA approach	Commission Decision
Cold	90%	100%
Average	rev not included	40%
Warm	9.5%	10%

The impact on these approaches on the RES contribution from heat pumps will be discussed in detail.

3.3 Parameter comparison

The Commission default values are deliberately conservative in order to trigger action on the Member State level. It is expected that Member States - once they realize that true efficiency of heat pumps is better than suggested by the Commission approach - take an effort to determine the average values of SPF and H_{HP} in their country. Once proposed to and agreed by the Commission, the new values can be used for calculation.

Comparing the **SPF values** in the EHPA approach with the Commission default values, shows a general reduction in the Commission's values with the difference being particularly large for the colder climate zone and for air source heat pumps (see figure 4).

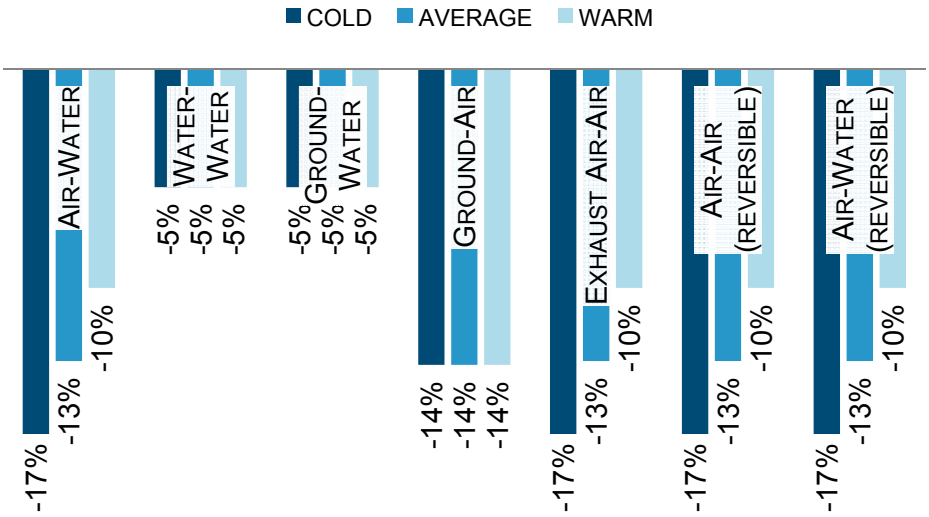

Figure 4: Difference between the SPF values used by EHPA and those suggested by the Commission | per technology and climate zone (source: EHPA)

Bearing in mind the positive impact towards improved heat pumps by legislation, in particular by the introduction of the Ecodesign requirements and the Energy label in 2014 the distance between default value and reality is expected to increase. Industry R&D in a growing market will further propel this development.

The comparison of the values applied for **operating hours (H_{HP})** shows a different picture. It becomes obvious how the Commission approach uses this parameter to adjust for the use of reversible air-air units for cooling (-88% in warm climate). As well, for all other categories but exhaust air, the applied value is consistently higher in warm and cold climates and lower in the average climate zone (see figure 5).

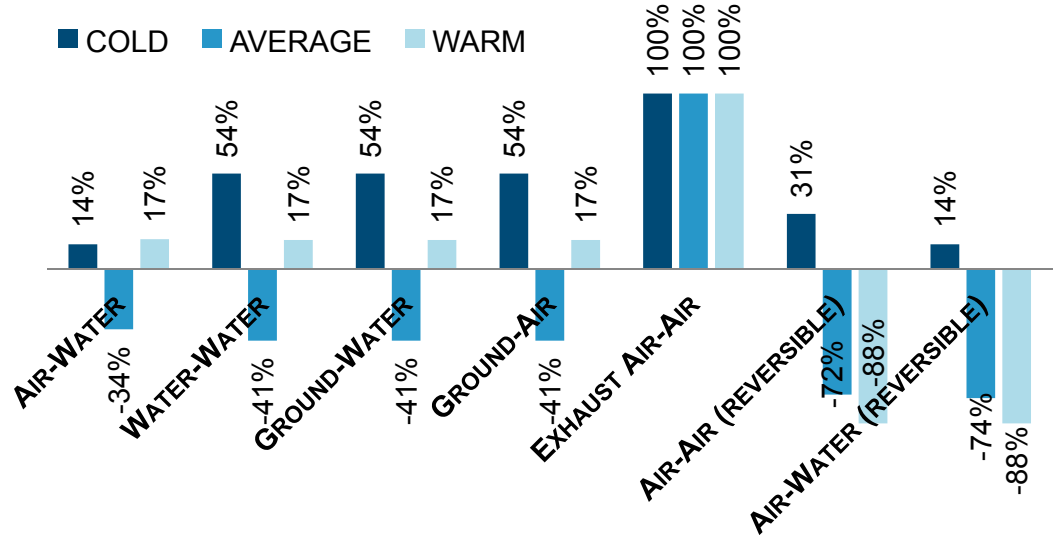

Figure 5: Difference (in per cent) of EHPA vs. Commission approach on the assumption of average H_{HP} values per climate zone (source: EHPA)

3.4 Effects on the RES contribution from heat pumps

Calculating the RES contribution from heat pumps using both approaches has a number of effects on the technologies contribution towards the use of renewables.

The approach suggested by the Commission increases the amount of RES by 31%. Additional contribution results from a strong increase in RES in the warm and average climate zones, and a reduced one for the cold climate zone. Figures 6 and 7 illustrate the impact on a per country basis.

The main effect of a higher energy contribution is caused by the integration of all hat pumps into the calculation. It is particularly strong for countries with average and warm climate. The additional number of heat pumps outweighs the reduced values for H_{HP} and SPF. As a result RES contributions from the Commission calculation are from 79% to 249% higher in comparison to EHPA calculations (see figure 7).

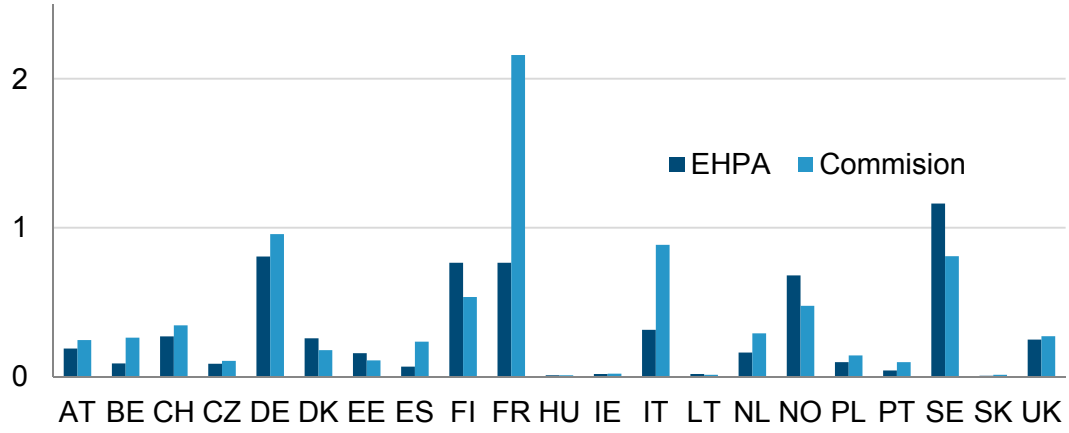

Figure 6: RES contribution in TWh from heat pumps installed in 2012 | per country (Source: EHPA)

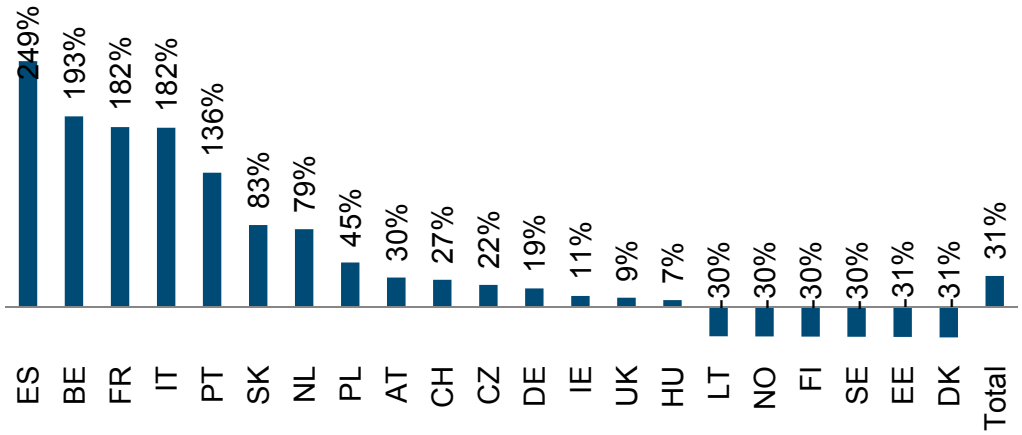

Figure 7: Change in RES contribution in 2012 (in %) resulting from the Commission approach compared to the EHPA | per country (Source: EHPA)

In Nordic countries, where reversible heat pumps are used predominantly for heating, the conservative SPF values as suggested by the Commission directly have a negative impact (-30%) on the calculated amount of RES.

Even though the Commission approach suggests a higher contribution towards the use of renewables by heat pumps, the aggregated values are still on the low side. **This is caused by a general lack of data on the performance and running hours, but also by a lack of data, particularly on large and very large heat pumps (**100kW to 1MW). These units have a different SPF and different operating hours than standard residential units. Industry estimates assume sales numbers of approx. 10 000 units per year with insufficient data on the total heating capacity provided and thus their contribution to RES and energy efficiency. Yet due to their capacity, a single installation might provide the same contribution than some hundred individual installations. The structure of this market segment as well as the current approach towards collecting statistical data on heat pumps leads to a systematic underestimation of the considerable contribution of large-scale heat pumps.

The same holds true for new solutions like hybrid heat pump systems which integrate several energy sources, both thermal and electric into a heat pump system The impact of those systems in terms of sales volume and RES is still small due to the early market stage. But it is foreseeable that this new range of heat pumps will grow and thus should be covered in heat pump statistics.

A last factor influencing the aggregated contribution of heat pumps towards renewables is the approach taken by Member States. A first assessment of their progress reports reveals differing results: some Member states calculation leads to a reported contribution largely exceeding both the Commission and the EHPA approach, others seem not to count the contribution of heat pumps at all (see figure 8). The difference needs further observation.

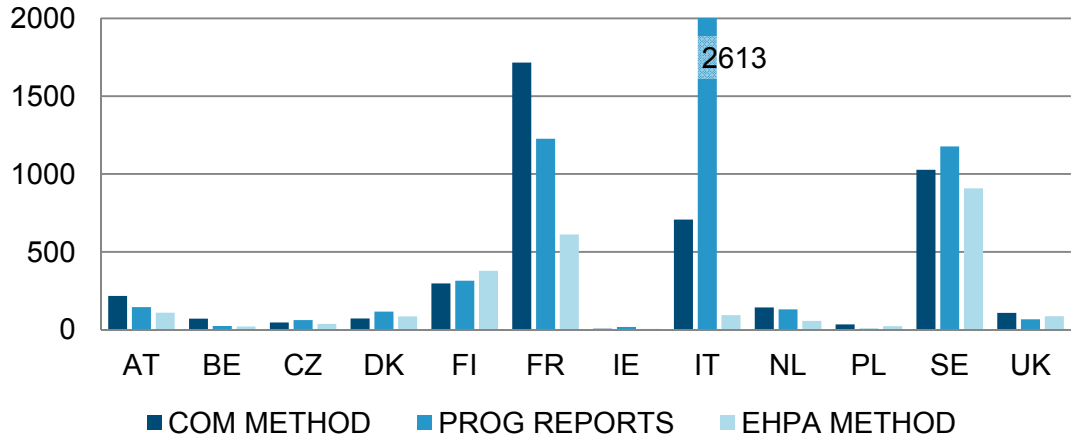

Figure 8: Comparison of RES contribution (in ktoe) of the heat pump stock in 2012: Commission vs. EHPA vs. MS | per country (Source: EHPA, Progress Reports according to Article 22 of the Renewable Energy Directive 2009/28/EC)

4 CONCLUSION

Heat pump markets have largely been stable over the last 4 years. Based on the EHPA calculation, the sales numbers are not sufficient to achieve the RES contribution from HP as anticipated by the Member States.

This picture actually changes when applying the Commission method. It results in a much larger contribution to the RES target from heat pumps and makes achieving

the targets very likely. This contribution will actually grow further, once Member States improve and report their performance data on heat pumps.

Analysing the progress reports by Member states reveals a split picture that makes a more detailed analysis necessary to understand the deviations from both the Commission and the industry approach. It should also lead to a critical discussion with Member States representatives to understand why some are not reporting any meaningful contribution of heat pumps to statistics, in spite of the existence of heat pump markets.

Independent of the approach taken the renewables contribution can be increased by better data, mainly addressing the following issues:

1. Conservative estimates for SPF and H_{HP}
2. Missing inclusion of big heat pumps

Action is necessary towards the provision of more accurate and detailed data on heat pump use and efficiency. Improved data is beneficial to industry and Member States alike. It will show the true value of heat pump technology and will help Member States to document the achievement of the national RES targets towards Europe's goal.

If this situation is not tackled, the contribution of heat pumps as an efficient technology using renewables is not reported correctly.

5 RESOURCES

Nowak, T.; Jaganjacova, S.; 2013: European Heat Pump market and statistics report 2013. Brussels

European Community (2009): Directive 2009/28/EC on the promotion of the use of energy from renewable sources. OJ L 140, p. 16-62 of 5.6.2009

European Union (2014) Commission Decision 2013/114/EU establishing the guidelines for Member States on calculating renewable energy from heat pumps. OJ L 62 p.27 - 35 of 6.3.2013:

European Community (2009): Directive 2009/125/EC establishing a framework for the setting of Ecodesign requirements for energy-related products. OJ L 285, p. 10–35 of 31.10.2009

European Community (2009): Directive 2009/28/EC Promotion of the use of energy from renewable sources. OJ l140 of 5.6.2009