Heat pumps – a renewable energy technology?

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"Are heat pumps using renewable energy?" was one of the questions most vigorously debated during the consultation on and preparation of the Directive on the promotion of the use of renewable energy sources (2009/28/EC). Positions, especially in the European Commission did only change very slowly towards acknowledging the full renewable potential from air, water and ground. Eventually, agreement was found between the negotiating parties to augment the definition of renewable sources by "aerothermal" and "hydrothermal" sources – to be used by heat pump technology. Article 2 states: 'energy from renewable sources' means energy from renewable non-fossil sources, namely wind, solar, **aerothermal**, **geothermal**, **hydrothermal** and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases. 'Aerothermal energy' means energy stored in the form of heat in the ambient air; 'geothermal energy' means energy stored in the form of heat beneath the surface of solid earth (geothermal energy was already part of existing renewables definition which included energy sources usable for the generation of electricity); 'hydrothermal energy' means energy stored in the form of heat in surface water.

This change in wording must be seen as a huge success of those lobbying for it and as a tremendous change in many decision-makers positions in the European Commission, the European Parliament and the Member States. It has also considerable consequences on the treatment of heat pump technology in European and national legislation. While sometimes it is still debated whether or not heat pumps use renewable energy, a reference to the RES Directive solves most disputes. Thus heat pumps will eventually find their way into all legislation related to the use of (renewable) energy, energy efficiency and GHG emission reduction.

Counting of renewables from heat pumps in statistics

The renewable share of heat pumps is determined based on final energy. **Figure 1** illustrates the ratio of auxiliary to renewable energy for an electric heat pump.

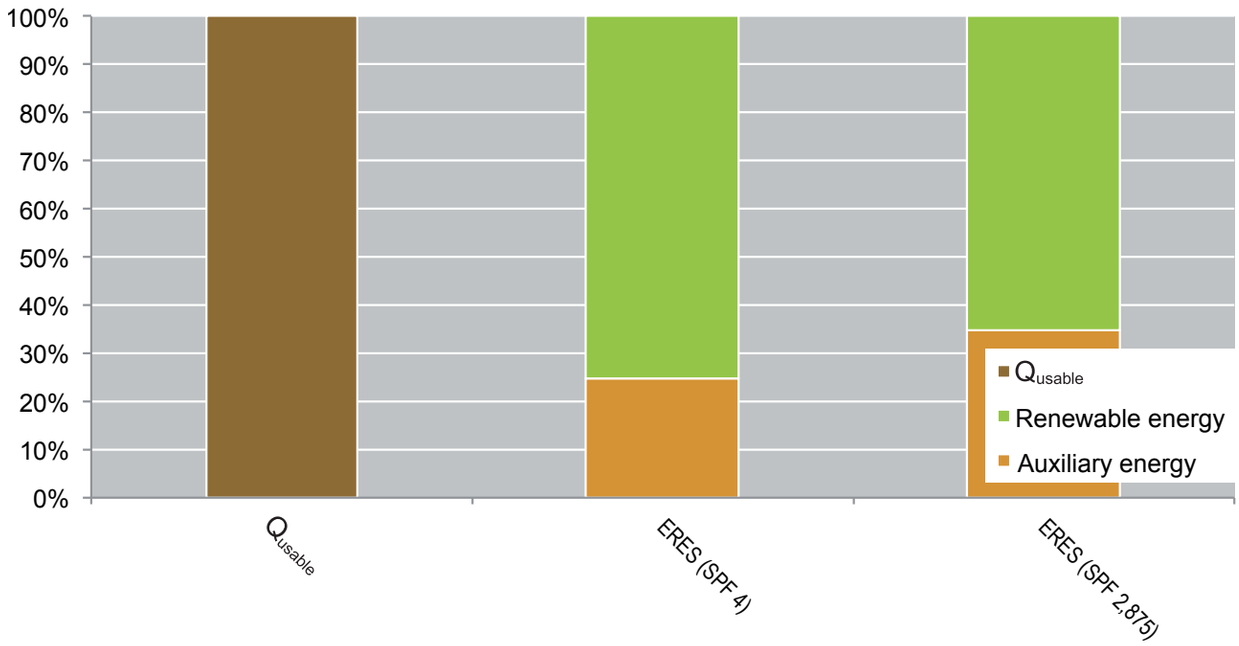

Figure 1. Renewable and auxiliary energy shares of heat pumps based on eta = 0,4. (Source: own)

Its calculation is described in Annex VII of the RES-Directive:

(1) $E_{RES}=Q_{usable} * (1-1/SPF)$
with Q_{usable} being the total usable heat delivered by the heat pump.

Q_{usable} is only counted for those heat pumps, which achieve 115% efficiency based on primary energy use.

(2) SPF > 1.15 * 1/eta
with eta being the ratio between total gross production of electricity and the primary energy consumption for electricity production.
Eta shall be determined by EUROSTAT as an **average value for Europe**.

Column 2 of **Figure 1** shows the renewable final energy contribution for a standard heat pump with an average SPF of 4 based on eta = 0,4. According to (1) heat pumps with an SPF of 4 provide 75% of renewable energy. Based on (2) heat pumps need to achieve a minimum SPF of 2,875 for their RES contribution to be counted. A heat pump with this SPF provides 64% of final renewable energy (see column 3). In terms of primary energy, this implies still 28% of renewable energy.

A greening electricity mix will effect the minimum SPF by an improvement of eta. The EUROSTAT calculation for 2007 data results in eta_{2007} = 43.8%. Electric heat pumps need to achieve a minimum seasonal efficiency (SPF) of 2,63 or better. According to preliminary discussion, the equivalent requirement for thermally driven heat pumps will be $\mathbf{eta_{thermal} = 1}$.

In addition to the calculation of eta, the European Commission needs to provide guidelines on how to estimate values for Q_{usable} and SPF values for different heat pump technologies and applications by the end of 2011 – the deadline was originally set for 1.1.2013 but was moved forward as these values are essential for calculating RES from heat pumps.

The described calculation will be used in EU energy statistics to determine each Member State's achieved share of renewable energy (via their National Renewable Energy Action Plan – NREAP) and the achievement of the 20% renewable target on the aggregated EU level.

RES contribution from heat pump sales – status quo and target

Member States are obliged to set trajectories on how to achieve their mandatory RES targets for 2020. This is done via their NREAPs. The evaluation of all plans shows a target contribution from heat pumps towards the 2020 use of final energy of 1 298 TWh (111 587 ktoe). Ambition among Member States is however not evenly spread. While the UK aims to cover 36% of its RES target by contributions from heat pumps, others like Portugal, Bulgaria, Estonia, Malta and Romania have not (yet) included the technology into their plans (see **Figure 2**).

The technologies proven yet unused potential may however turn into an advantage in the future if some of the foreseen measures to achieve the national renewables targets (as set in the NREAPs) fail. In this case, heat pump technology would be an easy alternative for Member States to still achieve their targets: it is available, reliable, efficient and cost per $kWh_{th\text{-}RES}$ is comparatively low.

Today's contribution of the heat pump stock can be determined from industry sales statistics. Based on EHPA data, a total of 2,64 mio. heat pumps were sold from 2005 to 2010 (the actual stock is higher, as significant heat pump markets existed before 2005 in at least Austria, France, Germany, Italy, Sweden and Switzerland).[1] The European Heat Pump Industry – represented by different associations – has worked with EUROSTAT on defining a feasible approach to include their RES contribution from heat pumps in EU energy statistics.

Using average values for SPF and Q_{usable} the total annual contribution of the heat pump stock is 27,37 TWh, saving 6,83 Mt of GHG emission annually [2]

When comparing both the contribution from the stock and the Member States' targets, an average approximate growth rate of 15% per year is necessary to achieve the cumulated target of the NREAPs. This pretty much reflects the growth rate observed over the past five years and can thus be understood as a business as usual scenario. Real growth can be expected to exceed 15% as markets are developing and this development will further be fuelled by heat pump recognition in institutional

1 Nowak, T.; Murphy, P.; Forsén, M. 2011: Outlook 2011 (data preview, final version forthcoming). Brussels

2 Nowak, T. 2011: Heat pumps in Europe – a "smart" future? IEA heat pump conference 2011. https://www.hpc2011web.org/.

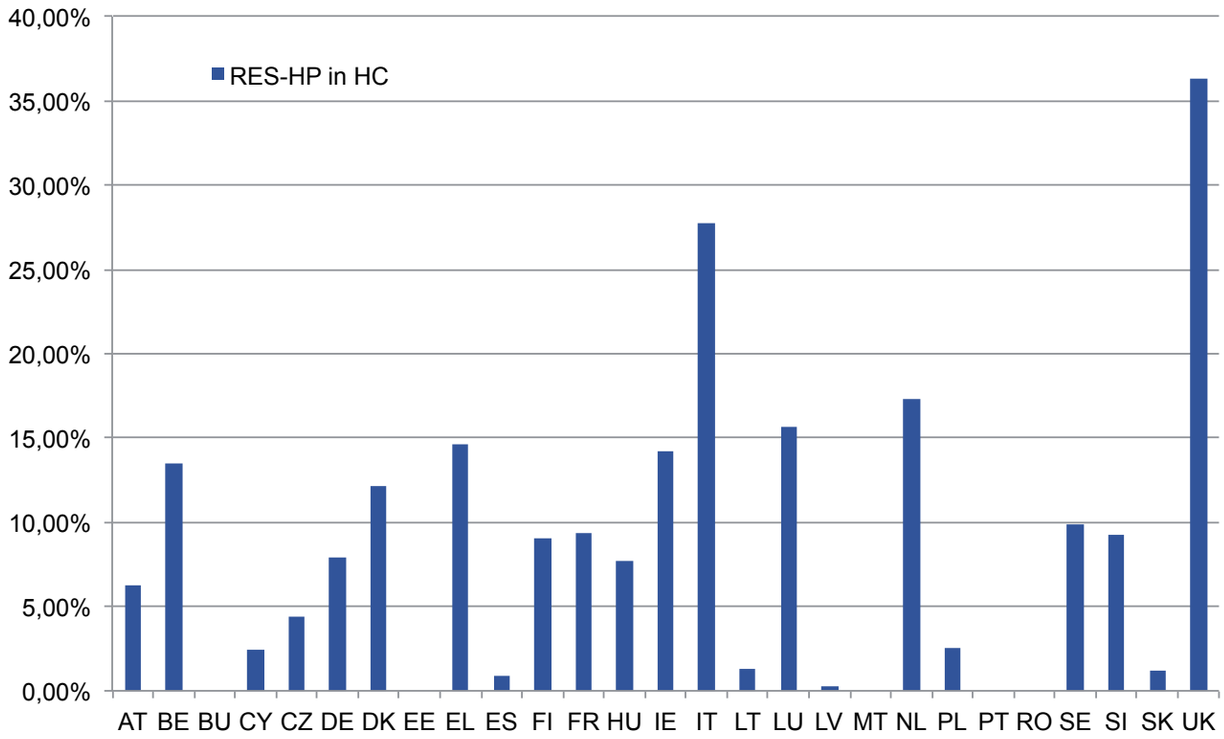

Figure 2. Contribution from heat pumps to achieve the designated RES share in heating and cooling. (Source: own, based on NREAPs and EREC 2011). EREC 2011: Mapping renewable energy pathways towards 2020, Brussels, download (6.5.2011) at http://www.repap2020.eu/fileadmin/user_upload/Roadmaps/ERECroadmap-V4_final.pdf

and financial support schemes as well by greater technology visibility in statistics.

In addition, the growing share of intermittent renewable sources from solar and wind requires peak shaving and storage options to better integrate them. Heat pumps are well equipped to provide demand side potential, thus helping indirectly to further increase the share of renewable sources in the energy mix. Smart grids and improved in-house controls will play an important role in balancing supply and demand towards a more sustainable energy supply.

Multiplier effects

A positive leverage effect exists between the amount of renewables used by heat pumps and its determining values – SPF and eta. The more efficient heat pumps become, the larger their RES contribution and their possible field of application. The more efficient the average EU power mix is, the better the efficiency of heat pumps primary energy use. As well, a better eta enlarges the number of heat pumps included in statistics, as the threshold value decreases. Both effects increase the amount of RES used by heat pumps.

A promising outlook

The basis for strong market growth is prepared. Heat pumps are reliable, efficient and affordable, and can add to comfort and building quality by providing heating, cooling and sanitary hot water. The industry is ready to deliver on these promises. Foreseeable developments in technology will result in even better technology and opening additional application fields for the technology, namely in the renovation sector, hybrid systems and large applications.

Government recognition of heat pump technology based on the minimum efficiency threshold as well as the upcoming energy label related to the implementing measures of the Ecodesign Directive will provide transparency and channel demand towards more efficient systems. From the RES perspective this means that the full amount of renewable energy used by heat pumps will be countable as contribution towards Member States' and the European Union's 2020 renewable energy targets.

Investment in heat pumps pays off over time – for individuals and governments alike. Now is the time to switch to higher gear to reap the benefits of these technologies.