ehi
association of the
European Heating Industry

Rolling out heat pumps

Barriers and how to overcome them

October 2021

ROLLING OUT HEAT PUMPS.
BARRIERS AND HOW TO OVERCOME THEM.

1. Key messages

- The climate urgency underlined in the 2021 climate change assessment of IPCC[1], the EU 2030 targets and EU climate neutrality by 2050 require unprecedented speed for decarbonizing the economy, including heating, meaning indoor comfort and access to hot water.

- The fit for 55[2] package represents a unique opportunity to set the right conditions for accelerating the replacement of the old and inefficient heating stock with more efficient, renewable-energy based heating solutions, such as heat pumps technologies.

- It is clear that heat pump technologies will play a key role in the pathway towards EU climate neutrality in 2050 and to achieving economy-wide emission reductions of at least 55% 2030 in the EU, as they are among the most efficient heating solutions, and can significantly contribute to the decarbonisation of buildings; as a result, the market share of heat pump technologies will have to grow significantly.

- The decarbonization of heating and the heat pump ramp-up must be compatible with the transition of the overall energy system and consider social impacts; Electrification of heating is a challenge for a stable and resilient energy system with affordable energy costs. By making use of existing energy infrastructures, the multi-vector approach[3] will optimise the investments in electricity grids; Besides, the building stock and the financial capabilities of EU citizens are extremely heterogeneous, making emissions from buildings very hard-to-abate, with high impacts on households - ensuring that nobody is left behind is key for success; hence a range of heating technologies and energy carriers is needed to support decarbonization of heating.

- Furthermore, there are additional challenges to the uptake of heat pump technologies, which will have to be overcome to support the roll out of heat pumps, these include challenges in the supply chain, standards/legislation and technology.

- The European heating industry proposes some solutions and recommendations to overcome these challenges, such as

    - Close collaborations with grid operators to ensure in-sync development on the product and the grid side;

    - EU-funding geared towards financing national subsidy and scrappage schemes as well as supporting investments for the uptake of efficient heating, including as heat pump technologies;

    - Ensuring integration of a training on heat pump technologies in programs of educational systems from early on to increase the number of upskilled installers;

    - Innovative solutions to minimize the physical constraints in installing heat pump technologies and reducing their sound.

1. https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/

2. the revisions and initiatives linked to the European Green Deal climate actions and in particular the climate target plan's 55 %

3. A multi-vector approach will ensure that the electricity grid does not need to be dimensioned to meet the heat demand during the 'Kalte Dunkelflaute', i.e. when the heat demand is high (cold days) and renewable electricity production is low (sunless, windless days)

2. Context

Heating serves an essential human need. Heat, meaning indoor comfort and access to hot water, supports the health and well-being of people, whether they are at home or at their workplace. Putting people at the centre of their innovation, the members of the European Heating Industry (EHI) are leading the energy transition in the heating sector. EHI members provide affordable, smart and efficient solutions to pave the way to decarbonised buildings in 2050. In doing so, they foster jobs in the European Union (EU), economic competitiveness and reduce energy system costs.

This paper focusses on hydronic appliances using heat pumps principles, hereafter referred to as heat pumps technologies.

Hydronic heating systems in a broad sense are installed in almost 130 million buildings across the EU[4], this makes them the most popular heating system in the EU. Hydronic heat pump technologies use hydronic heat emitters, such as existing radiators, but also convectors and surface heating (floor, ceiling, or walls) to heat buildings and can also be used for cooling and domestic hot water production.

With products using heat pump principles we refer to electric and thermally driven heat pumps and heat pumps combined with a boiler, in which case they are referred to as hybrid heat pumps; extracting heat from different sources, i.e. from outdoor air, a ground source, a water source or from waste heat. Each type and heat source has its own characteristics, so that the choice of one of the aforementioned products depends largely on the local environment and the building features. A detailed list of these characteristics, advantages and drawbacks for each type and heat source is to be found in Annex A.

Heat pump technologies represented 4 % of the installed stock in the 27 Member States of the EU (EU27) in 2019[5].

FIGURE 1 - Thermally driven heat pumps in commercial and residential areas.

4. EU27 + UK

5. EHI market data 2019

3. The role of heat pump technologies in today's climate policy context and building decarbonisation

The building sector accounts for 40% of the energy consumption[6] (and 36 % of the greenhouse gas emissions) in the EU, with heating representing the largest share of energy consumed. Indeed, in residential buildings, space and water heating account for 78%[7] of the final energy consumed and in industrial buildings, space and process heating account for 71%[8] of the final energy consumed. As such, in order to reach the European Green Deal's ambition to reduce greenhouse gas emissions by 55% by 2030 in comparison to 1990 and be climate-neutral by 2050, it is clear that the heating sector will sharply have to reduce their energy consumption and increase their use of decarbonized fuels in the next decades. The fit for 55 package represents a unique opportunity to set the right conditions and accelerate the replacement of the old and inefficient heating stock with more efficient, renewable-energy based heating solutions.

Today, around 61 million of the installed heating appliances in the EU are still energy inefficient. As such to decarbonise buildings and heating, the replacement of the installed old and inefficient heating appliances alongside the improvement of the thermal insulation of the building envelope will be key. It is important to note that the renovation of space heating and the domestic hot water systems appear overall to be the most efficient in comparison the building's insulation (with an average saving per dwelling 2 to 3 times higher)[9].

Heat pump technologies are among the most efficient heating solutions and can be installed in most building types. This makes them an attractive solution for the decarbonisation of buildings and heating. However, there will be no one-size-fits-all solution to decarbonise buildings and heating. This is because buildings are different across the EU, as are heating needs, due to different climates, purpose of use, energy infrastructure, availability of renewable energy resources at local level, individual preferences of the consumer or installers for use and economic resources. Hence, the optimal choice of space and water heating system will depend on specific local circumstances such as the availability of local renewable sources, the availability and feasibility of the energy infrastructures, the building's properties, technical building systems and their link with the energy system, national energy (pricing) policies. As such, heat pump technologies will be a key part of the solution but will not be the only solution.

Nonetheless, it is expected that the market share of heat pump will steeply grow in the path towards 2050[10,11]. Indeed, the EU scenarios towards 2050, foresee that the share of electrification of space heating in residential buildings would increase from around 4% in 2015 to around 12% in 2030 and around maximum 34% in 2050; in the services sector this would be from around 12% in 2015 to around 29% in 2030 and around maximum 51% in 2050[12]. Such a quick roll out of heat pumps will present some challenges.

FIGURE 2 - A hybrid heat pump.

6. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - a renovation wave for Europe - greening our buildings, creating jobs, improving lives. Brussels, 14.10.2020, com(2020) 662 final. (Renovation wave).

7. Source: Eurostat - Share of fuels in final energy consumption in the residential sector by type of end-use, 2018

8. Source: https://ec.europa.eu/energy/topics/energy-efficiency/heating-and-cooling_en

9. La rénovation énergétique des logements : bilan des travaux et des aides entre 2016 et 2019 | Données et études statistiques (developpement-durable.gouv.fr)

10. In-depth analysis in support of the Commission Communication Com(2018) 773 - A Clean Planet for all, A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy (In-depth analysis), figure 43, scenarios TECH1.5 and LIFE1.5

11. Commission staff working document impact assessment accompanying the document communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions stepping up europe's 2030 climate ambition investing in a climate-neutral future for the benefit of our people (Impact assessment for the 2030 climate target plan), derived from figure 55 and 56 in comparison to figure 42 of the in depth analysis.

12. In case all heating would be electrified by means of electric heat pumps based on the current electricity system, the total energy consumption would increase with about the total final consumption of electricity in France in 2018 (c.a. 450 TWh). Source: Decarbonising the heating sector, JRC technical report 2019, Figure 37, scenario E100All versus BSL .

4. Rolling out heat pumps: challenges, solutions and recommendations

Overcoming financial challenges

According to the review study for the Ecodesign regulation for space heater[13], heat pump technologies are the most efficient hydronic heating technology on the market today.

However, the upfront cost of heat pump technologies can make them economically unattractive for many consumers. This is because heat pump technologies are still at least 3 times more expensive than condensing gas boilers in terms of EU average purchase price[8].

In addition, there currently is a gap between electricity and gas prices. As an example, in the second half of 2020 in the EU, the average electricity price was 0.2134 EUR/kWh, in contrast the average gas price was 0.0698 EUR/kWh. This price difference largely reflects the Member States' political decision. Indeed, energy policy is a competence shared between the EU and its Members, but Member States are responsible for determining the structure of their mix and retain broad powers in terms of taxation of energy carriers and fuels. It is expected that the ETS will have an influence on the level of the energy prices in the future, making heat pump technologies more financially attractive for consumers compared to less energy-efficient appliances.

In the replacement market, these effects play a higher role than in the new built market. In the new built sector, the cost over the complete lifetime of heat pump technologies are not higher than alternative solutions, giving heat pump technologies an edge over competing solutions. As such, especially in the replacement market a lower purchase price and smaller price gap between electricity and gas prices would make heat pump technologies more beneficial.

At present, financial incentives or regulatory interventions can help in making the purchase and use of a heat pump technology more attractive and affordable. In addition to the above, policies that reward demand side response - meaning the fact that heat pumps can react to signals from the grid, while still delivering heat (e.g. by means of a heat storage system) - can reduce the pressure on the electricity grid via load shedding during peaks of demand.

National scrappage schemes targeting the replacement of old and inefficient heating systems, by taking into account the specificity of building types in each country, are also a good way to support households in the purchase of a heat pumps. They can be progressive and dedicate higher funding to low and middle-income households, helping fight and alleviate energy poverty.

In **Germany,** the subsidy program BEG supports the investment in heat pumps. Further, in individual buildings, the grid operator can apply lower electricity fees if he is entitled to turn off the product using the heat pump technology to a maximum 2 hours for three times a day during peak demand in the grid. The discount awarded by the operator can even reduce the variable cost of heating up to 20%[14].

To finance these national schemes, several funding options at EU-level are possible. With the flagship "renovate" and a minimum of 37% for climate investments and reforms, the Recovery and Resilience Facility is a great opportunity to support subsidy schemes for heat pump technologies and scrappage schemes. Further funding options at EU-level to support the investment and uptake of heat pump technologies include InvestEU, the European Investment Bank funding with its new energy lending policy, and the EU bulk procurement programme, targeting the upgrade of heating systems in public buildings. The sale of EU Emission trading system (ETS)[15] certificates can also provide Member States with the necessary funds to support the roll-out of heat pumps. On the private side, taxonomy will play a central role in channelling investments towards the projects supporting decarbonization. Therefore, it is crucial that all heat pump technologies are recognized as "sustainable activity" in this framework in order to attract private funding.

13. Space and combination heaters, ecodesign and energy labelling review study (Review study), task 5
14. Report "Good heating practices from Denmark and Germany"(2018) Forum energii
15. https://ec.europa.eu/clima/policies/ets_en

Overcoming challenges in the supply chain

Reinforcing the electricity grid

To be able to meet the incremental heating demand, but also to allow the planned growth of e-mobility and to reduce Europe's dependency on energy imports from outside the EU, it is clear that the electricity grid will need to be reinforced as acknowledged by grid operators[16].

Several projects are ongoing to develop a future proof, smart, secure and more resilient energy system ready to take on the 2050 challenges[17]. In addition, by making use of existing energy infrastructures, the multi-vector approach[18] will optimise the investments in the electricity grid. Additionally, to ensure that the roll out of electric heat pumps and the electricity grid go hand in hand, electricity transmission system operators, distributions system operators and smart grid operators will need to cooperate closely and tap into all sorts of potential flexibility sources, including heat pumps themselves but also other technologies (e.g. electric storage water heaters). It is our aim to set up a close collaboration with these actors to ensure that we work towards a common goal.

Decarbonising the gas grid

The use of the existing gas grids for the distribution of decarbonised gases such as bio-methane, e-methane or green hydrogen will allow for the optimisation of the investments in the electricity grid.

Gas driven heat pumps and hybrid heat pumps on the market today can already work with 100% bio-methane. In addition, the industry is developing products that can function with blends of hydrogen[19] and pure hydrogen or products that can be converted to work with pure hydrogen. As such, the heating industry will have products available that are compatible with a decarbonised gas grid.

Expanding the network of installers capable of working with heat pump technologies

Installing a heating system requires skills, training and a good understanding of the overall heating system needs. In Europe, the Renewable Energy Directive[20] (RED) requires installers to have a specific certification in order to install heat pump technologies; also current version of the F-gas Regulation[21] requires natural persons who install, service, repair, decommission split heat pump technologies with hydrofluorocarbons (HFCs), do leak checks or reclaim HFCs to be certified. Therefore, installers of heat pump technologies and other experts need to be trained specifically, e.g. in relation to refrigerants and dimensioning of the system, in order to handle heat pump technologies safely, ensure their optimal performance and prevent emissions.

However, this ability to work on heat pump technologies with synthetic and natural refrigerants will need to be extended to the current heating installer network, to be able to comply with the expected deployment of heat pump technologies throughout Europe. Currently, skilled labour is relatively low in some countries.

In **Germany** and in **Poland**, only 10% of installers are qualified to work with heat pump technologies. Similarly, in the UK, there are over 129.000 registered 'Gas Safe' installers but only 1921 registered installers of heat pump technologies.

In **France** already 25% of the installers are qualified to work with heat pump technologies and it is estimated that in the next ten years, 5000 jobs in the installation of new heat pumps will be created.

The roll out of heat pump technologies in the context of the Green Deal should translate into a need for more qualified installers and create significant job opportunities.

Therefore, policies should be geared towards training and upskilling enough installers to handle the Renovation Wave

16. Distribution system operators have estimated that between 375 and 425 billion euros will have to be invested in power distribution grids alone in the decade 2020-2030. EURELECTRIC, E-DSO Monitor Deloitte, Connecting the dots: Distribution grid investment to power the energy transition (January 2021), https://www.eurelectric.org/connecting-the-dots/

17. Some examples of EU Horizon 2020 funded projects: OneNet, BD4NRG, Interrface, CoordiNET, Crossbow, Eusysflex

18. A multi-vector approach will ensure that the electricity grid does not need to be dimensioned to meet the heat demand during the 'Kalte Dunkelflaute', i.e. when the heat demand is high (cold days) and renewable electricity production is low (sunless, windless days).

19. A variable share of hydrogen up to 20 % by volume

20. Directive 2018/2001/EU

21. Regulation (EU) No 517/2014

FIGURE 3 - More and upskilled installers are needed for heat pump growth in the market.

In **France**, the national heating association Uniclima serves on the Board of the organism which is accredited to deliver certification to installers for renewable installations, including heat pump technologies. Furthermore, the association supports actively the recognition of the training delivered by manufacturers in the scheme.

In addition, to facilitate the work of installers, manufacturers have been developing state-of-the-art connectivity technology, from factory mounted integrated man-machine interface, allowing easy and remote commissioning of units, up to online and voice control via applications, enhancing the end user efficient use and monitoring of heat pump technologies. These functions should be included in the training programs.

Finally, to ensure that young installers in training get acquainted with heat pump technologies from early on, educational systems should integrate training on heat pump technologies in their programs.

and support the penetration of heat pump technologies. The industry is committed to be part of this process.

Installer capacity Germany

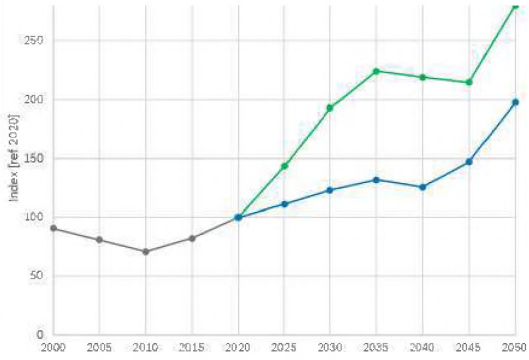

FIGURE 4 - Predictions of needed installers of heating appliances by 2030 in Germany, based on two higher electrification scenarios:
- Scenario 1 (lower line, in blue): to reach 3 million installed electric heat pumps requires +25% more installers than 2020 level (current installed stock of heat pumps in Germany: around 1 million);
- Scenario 2 (top line, in green): to reach 6 million installed electric heat pumps requires +100% more installers than 2020 level". (estimate Bosch TT)

Increasing periodic inspections of heat pump technologies

It was shown e.g. by Ademe that performance deterioration can occur in the absence of maintenance. Furthermore, in the absence of regular checks, malfunctions cannot be diagnosed early-on, potentially leading to energy losses and increasing the risk for consumers of having to replace their heat pump earlier than expected.

Measures facilitating appropriate maintenance include hydraulics, cleaning, doublecheck of control parameters and provide the user with advice for good use, possible improvements and possible need for replacement. Their consistent application helps to ensure that the heat pump stock remains efficient and robust. In practice, regular checks, implemented e.g. in France for heat output above 4 kW, or appropriate building automation and control functionalities support preventive maintenance and optimized performance of heat pump systems - as required under Articles 8 and 14 of the EPBD. New energy labelling for space and water heaters should support preventive maintenance functionalities, to facilitate national schemes implementing the EPBD.

FIGURE 5 - An example of an air to water heat pump.

Overcoming technological challenges

Reducing constraints due to the physical characteristics of heat pump technologies

Today, products based on the heat pump technology exist in different capacities to fit in all types of building. However, in some cases, these appliances can take up more space than a conventional heat generator such as a boiler, posing additional challenges for its installation.

Indeed, part of the heat pump or the complete unit, and, or pipework in case of a ground source heat pump, needs to be installed outside (or in a non-heated area inside the building). For some buildings, such an installation might not be possible due to space limitations.

Our industry is currently developing solutions to tackle this problem. For instance, in the Netherlands, a significant number of installations are with the outdoor unit placed on the rooftop. In the case of ground source heat pumps and depending on the drilling possibilities, the pipework can be laid vertically in boreholes rather than horizontally in trenches to adapt to limited garden space[22].

Moreover, great achievements have been made by component integration. All necessary installation devices (expansion vessel, pumps, safety valves, etc..) are included in the casing and do not need additional space. Further improvements are possible thanks to advanced system designs which make buffer tanks obsolete.

Reducing sound of heat pump technologies

When installing heat pump technologies, special acoustic parameters and often special acoustic planning

22. https://www.agreeneralternative.co.uk/how-much-space-do-you-need-for-a-heat-pump/

FIGURE 6 & 7 - Compared to horizontally laid pipeworks, vertically laid pipeworks require less garden space.

are needed at the place of installation. Indeed, the compressor of electrical heat pumps and some thermally driven heat pumps generates sound. In air to water heat pumps, the fan in the outdoor unit adds to the noise. This can be problematic in densely populated residential areas, where sound emissions are sometimes the subject of complaints.

FIGURE 8 - Hidden fans reduce the perception of the sound.

In recent years, manufacturers of heat pump technologies made huge progress in delivering solutions to reduce the sound of the heat pump's outdoor unit without affecting the energy efficiency of the appliance. Solutions include adding additional insulation material in the outdoor unit to reduce the sound, encapsulation of the compressor, multistage decoupling as well as dedicated outdoor units with new fan designs that ensure lower sound emissions.

Furthermore the heat pump technologies are optimized in terms of psychoacoustic i.e. noises that are perceived as especially annoying are reduced or completely banned. Finally, since the optical appearance also has an influence on noise perception, fans are covered and not visible anymore.

These innovations lead to more freedom in the choice of location for appliance, as the sound emission will not be detectable at places of interest, e.g. close to the neighbour's windows.

5. Policy recommendations

The "Fit for 55" package represents a unique opportunity to set the right conditions for accelerating the replacement of the old and inefficient heating stock with more efficient, renewable-energy based heating solutions, such as heat pump technologies.

To accelerate the replacement of old and inefficient installed heating appliances, including by a growing share of products based on the heat pump technology, the EHI recommends to:

- Further raise awareness by (re)introducing:
    - regular checks of heating appliances below 70 kW in the EPBD, unless appliances have self-predicting maintenance functionalities;
    - an EU wide energy label for the installed stock, to inform consumers about the (in)efficiency of their installed appliances and allow them to easily compare them with more performant solutions available on the market (such initiatives have already been implemented in some Member States, like Germany, and are currently being promoted by the H2020 project HARP);
    - scrappage schemes in the EPBD and/or other relevant EU legislation to support consumers financially in purchasing a new appliance (as already implemented in e.g. Germany, Italy);
    - an EU energy label for new appliances that is useful for end-users and investors in their purchasing decision, incentivising faster and deeper modernisation of their heating appliances according to their individual needs in support of the renovation wave and implementation of the Energy Performance of Buildings Directive.
- Support the replacement of old and inefficient heaters through the introduction of an annual replacement target of at least 6%/year in the EPBD, to be reflected across all relevant EU legislation;
- In case minimum energy performance standards for buildings (MEPS) were included in the EPBD, ensure they address the heating dimension of buildings and support/require the replacement of old and inefficient heating systems;
- Make sure that any new definition or requirement to be set for deep and staged-deep renovations includes and prioritises actions on heating systems, notably the installation of efficient technologies and the progressive switch to renewable and decarbonised energy sources.

In addition, to support the roll out of heat pump technologies in the coming years and building on the proposals made by the European Commission in the recently published package, the EHI believes that the co-legislators should:

- Ensure the proposed EU renewable energy target of 40% by 2030 in the RED as well as sectoral targets for renewables in buildings and in heating and cooling are coupled with adequate measures to support the uptake of efficient and renewable-based heating products;
- Keep the successful calculation of renewable energy (According to the RED, Annex VII) that can be captured via heat pump technologies and considered for renewable energy target and ensure that it is coherently applied in each Member State;
- Promote all types of heat pump technologies by explicitly acknowledging the different types of heat pump technologies in the different policies; allowing for the use of all renewable compatible appliances, including hybrid- and thermally-driven heat pumps, to achieve Member States' energy savings obligations; creating a product category for hybrids and adequate requirements for promoting all heat pump technologies in ecodesign and energy labelling; and granting Member States enough flexibility in determining the options to achieve minimum levels of renewables in buildings.

- Ensure that a diversity of refrigerants can be used in the different innovative heat pump applications in view of the ongoing review of the F-gas regulation and the per- and polyfluoroalkyl substances (PFAS) restriction in regulation on registration, evaluation, authorisation and restriction of chemicals[24] (REACH);

- Support the proposal to extend the EU Emission Trading System (ETS) to buildings, to accelerate the replacement of old and inefficient heating appliances with efficient and renewable compatible ones, including heat pumps; Within the EU ETS, earmark revenues to finance the replacement of old and inefficient heaters with efficient and renewable-compatible ones – including all kind of heat pumps. This would cut CO2 emissions, promote renewables and energy efficiency, which keeps under control energy expenses for households. In this sense, both the Modernisation and the Social Climate Fund should focus on the replacement of old and inefficient heaters;

- Promote low carbon and renewable energy sources via the energy taxation Directive;

- Review of the primary energy factor (PEF) in line with the schedule in the energy efficiency directive[25] (EED);

- Promote demand-side flexibility via smart grid enabled appliances, meaning appliances that can react to signals from third-party such as electric grid operators.

Finally, as financing will be a key element for the uptake of heat pumps, EHI recommends to:

- Make heat pump technologies more financially attractive for households by financing national subsidy and scrappage schemes via the Recovery and Resilience Facility;

- Support the investment in heat pump technologies via InvestEU and the European Investment Bank funding;

Support their uptake in public buildings with the EU bulk procurement programme.

FIGURE 9 - Electric air-to-water heat pump.

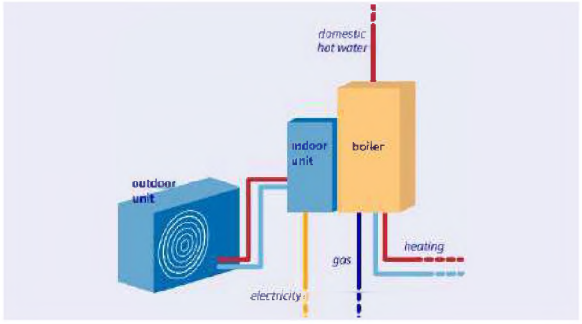

FIGURE 10 - Working principle of a hybrid heat pump.

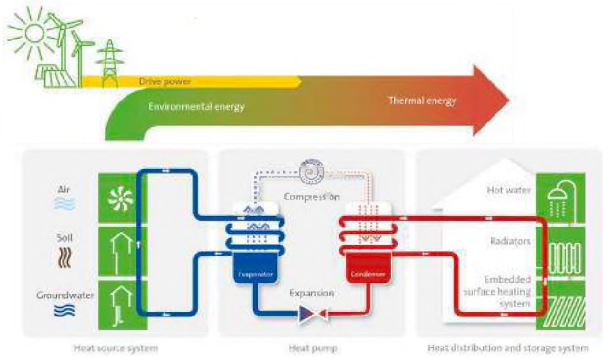

FIGURE 11 - Operating principle of an electric heat pump.

24. Regulation (EC) No 1907/2006

25. Directive 2012/27/EU amended by Directive 2018/2002

6. Annexes

Technical characteristics of heat pump technologies

A variety of heat pump types
Heat pumps can be either electric, thermally driven or coupled with a boiler, in which case they are referred to as hybrid heat pumps.

1) Electric heat pumps
Electric heat pumps use an electrically driven vapour compression cycle to transport heat by means of a refrigerant fluid from the source (i.e. air, ground water, waste heat) to the sink (i.. space heating or domestic hot water of the building).

2) Thermally driven heat pumps
Thermally driven heat pumps make use of the existing gas infrastructure and can already be used with renewable gases like biomethane or biopropane. Developments are ongoing to ensure they can work with hydrogen blends or pure hydrogen as well. There are several types of thermally driven heat pumps, including thermally driven compression heat pumps, adsorption and absorption heat pumps.

3) Hybrid heat pumps
Hybrid heat pumps combine an electric or thermally driven heat pump, a boiler and a smart control that switches between the two heat generators to ensure for example economical or ecological optimisation. They support the idea of sector coupling with the possibility to switch between different energy sources to alleviate stress on the electricity grid and to reduce extension cost for the infrastructure of the electricity grid. They provide flexibility and support resource adequacy in an integrated gas-electricity system. The gas condensing boilers in hybrid heat pumps on the market today can work with 100 % biomethane or e-methane and developments are ongoing to ensure they can work with hydrogen blends or pure hydrogen.

Heat sources used by heat pumps

Heat pump technologies can extract heat from different sources:

1) Air source
Air source pumps extract heat (thermal energy) from the outdoor (ambient), indoor or ventilation exhaust air, which is an abundantly available source.
The benefit of this type is that it can be installed in in a flexible way: for example next to the house or at the back of the garden. Furthermore, the investment costs are relatively low.

2) Ground source
Ground source or geothermal heat pumps extract heat from the ground by circulating water or brine or a refrigerant through pipes in the ground. The advantage of ground source heat pumps compared to outdoor air source heat pumps is that the energy extracted is more constant and not dependent on outdoor temperature. However, their applicability depends on the drilling possibilities of the site.

3) Water source
Water source heat pumps extract heat from rivers, lakes, the sea, or aquifers directly via an open loop. Compared to ground source, they can provide a higher source temperature level and a better efficiency.

4) Waste heat
Waste heat from industrial processes, any commercial application or even sewage can be used by heat pumps in closed or even open loops. It includes also exhaust air or waste heat from the cooling of machinery rooms. Waste heat offers a high source temperature level and a double benefit by simultaneous heating and cooling.

Heat pump technologies for many types of buildings

Today, there are products using heat pump technologies available for many types of building or markets.

1) Residential new built

Heat pump technologies reach their highest energy efficiency levels in new and well-insulated buildings, because they can work at low temperatures with low temperature radiators and/or underfloor or ceiling heating.

In particular, electric and thermally driven absorption heat pumps coupled with underfloor heating are an ideal solution for new buildings. In Europe, heat pump technologies have a market share in new single family houses of 50 % in average[26].

2) Residential replacement market

Heat pump solutions for the replacement market can be installed without any prior adaptation of the building envelope or heat emitters because these systems are capable of dealing with high system temperatures.

Hybrid heat pumps allow a staged renovation, i.e. to progressively add insulation. This reduces the energy demand on the one hand and on the other hand increases the efficiency. On top of that, the smart control that commands the switch between the electric heat pump and the boiler can be set to optimise energy efficiency or react to the availability of renewable electricity in the grid and price signals.

Also, thermally driven heat pumps are especially suited for existing buildings, since their thermodynamic cycle is less affected by the difference in temperature from sink (e.g. radiator) and source (e.g. air) of an existing building.

FIGURE 12 - An example of a thermally driven heat pump.

26. Estimated by EHI

27. In accordance with the Energy Performance of Buildings Directive 2010/31/EU amended by Directive 2018/844/EU

So-called high temperature electric heat pumps are an effective solution in less well insulated houses, they are increasingly available and able to fit in houses equipped with high temperature emitters.

3) Multi-family buildings

In multifamily buildings, heat pump technologies can be decentralised, meaning an individual product per apartment, or (semi-) centralised, meaning one (or few) product(s) per building.

Some multifamily buildings are already being equipped with heat pump technologies. The interest for it is gradually increasing, with the strengthening of requirements for new-built multifamily houses[27], and a range of dedicated heat pump technologies is already available in the market.

4) Commercial and industrial buildings

In commercial and industrial buildings, heat pump technologies are an excellent choice due to their capability of not only delivering heat and domestic hot water but as well cooling.
Here as well hybrid heat pumps can support to level the best choice of energy.

Thermally driven compression and absorption heat pumps are especially well suited for industrial and commercial buildings – such as hotels, hospitals or schools – and large housings to produce heating, cooling and domestic hot water.

Refrigerants

Refrigerants - F- gases and natural refrigerants - used in heat pump technologies are essential to their functioning. These gases are the working fluid of heat pumps that allow heat to be transferred from source to sink in a closed circuit.

Most heat pumps rely on hydrofluorocarbons (HFCs) to operate, conventionally these were refrigerant gases with a high global warming potential (GWP) but beneficial safety aspects. However, the heating industry has invested significantly in the development of new efficient and innovative technologies, which require the use of a diversity lower GWP refrigerants such as lower GWP HFCs contributing to the F-gases phase down according to the F-gas regulation (Regulation (EU) No 517/2014), hydrofluorolefines (HFOs) and alternative refrigerants (e.g. CO2, propane, ammoniac).

Thermally driven ab- or adsorption heat pumps use natural refrigerants (ammonia or water) and are therefore exempt from F-gas regulation since their ODP and GWP are equal to 0. However, in case of ammonia additional safety requirements apply.

FIGURE 13 - Indoor unit of an air-to-water heat pump.

FIGURE 14 - Underfloor heating.

Picture credits

Front cover: Ferroli S.p.A.

Figure 1: BDH-Federation of German Heating Industry

Figure 2: Viessmann

Figure 3: Daikin Europe

Figure 4: Bosch Thermotechnik

Figure 5: Viessmann

Figure 6 & 7: Daikin Europe

Figure 8: Bosch Thermotechnik

Figure 9: Viessmann

Figure 10: Hybrid Heating Europe

Figure 11: BDH-Federation of German Heating Industry

Figure 12: Ariston Group

Figure 13: Daikin Europe

Figure 14: BDH-Federation of German Heating Industry

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