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Making progress in the decade of heat pumps – status and trends of the European heat pump markets in 2022

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Abstract

European heat pump sales grew +38% in 2022. With 3.016 million units sold across Europe, this is a new sales. Assuming a life expectancy of approx. 20 years, the current European heating heat pump stock amounts to 16.97 million units, representing nearly 15% of the EUs building stock of 116 million residential buildings. The main influencing factors for market growth:

- Policy makers focus on heating: 10 years of energy and climate policy is now showing results in national markets.
- Heat pump technology delivers: the needs of new and existing residential and commercial buildings (temperatures up to 75°C) as well as industrial processes (providing between 140°C and 160°C) are met. Solutions are available to fuel the greening of district heating and cooling at temperatures of up to 95°C and capacities of between one and 35 MW.
- Homeowners have focused on upgrading their buildings to improve indoor environmental quality.

The paper explains the underlying market dynamics growth in Europe in 2022 including air-air, air-water, and ground-water heat pumps for heating as well as sanitary hot water heat pumps.

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Keywords: heat pumps; market development; sustainable energy system; decarbonisation; Europe; REPowerEU; Renewables; System integration, industrial strategy, heatpump accelerator

1. Background

Over the past decade, the importance of heat pumps has been hailed in the context of climate change. They have been mainly recognized for the highly efficient use of renewable energy and the related much lower emission of CO_2. While the policy framework has been adjusted over time with more ambitious targets for the use of renewable energy, energy efficiency and CO_2 emission reduction, the economic framework has been left untouched until recently [1]. The resulting mismatch between ambition and speed of conversion is observable in the slow transition speed from the use of fossil energy to more renewables as documented by the Eurostat SHARES tool [2]. The average increase of renewables used in heating and cooling has only been 0.6 percentage points for the decade until 2020, far below the target of 1.3 percentage points as set forth in the current European Renewable Energy Directive [3] or the targeted 2.5 percentage points [4] proposed in its future version.

From 2021 onwards, a new momentum was observable.

1. Increasingly recognizable effects of **global warming** made change urgently necessary, including a more ambitious focus on heating and cooling in legislation. Several European countries have started to discuss and/or to introduce measures that are giving an economic advantage to heat pumps over fossil based solutions.

2. Throughout the **COVID pandemic**, end users spent much more time in their homes and buildings, realizing the need for good indoor environmental quality.
3. The **war waged by Russia on Ukraine** has shaken the belief of "gas as a transition fuel" and has destroyed policy makers and end-users trust in Russia as a reliable partner for energy delivery. This recognition has materialized in conceptual papers like the IEA 10 point plan to reduce Europe's dependence on Russian gas [5] and powerful policy packages like "REPowerEU" [6]. Consequently, end-users are now asking for alternatives to their fossil based heating systems.

All three effects trigger additional demand at a level unexpected by industry and installers. The combination of this additional demand and supply shortages of components in a global value chain has led to bottlenecks across the heat pump sector. All three effects will mutually reinforce each other and stabilize the trend away from fossil heating and ensure the necessary exponential growth throughout this decade. Continued policy support both regarding targets and supporting their implementation on all levels is needed to overcome them and to accelerate and stabilise deployment.

2. Status of heat pump market development

The European Heat Pump market has seen positive, uninterrupted growth since 2012. From 2015 onwards double digit growth was observable and 2022 saw a new sales record of +38% (over +34% in 2021). In 2022 more than 3 million heating and hot water heat pumps were installed in the 21 countries covered by EHPA statistics (see figure 1) [7]. This lead to a stock of nearly 20 million units.

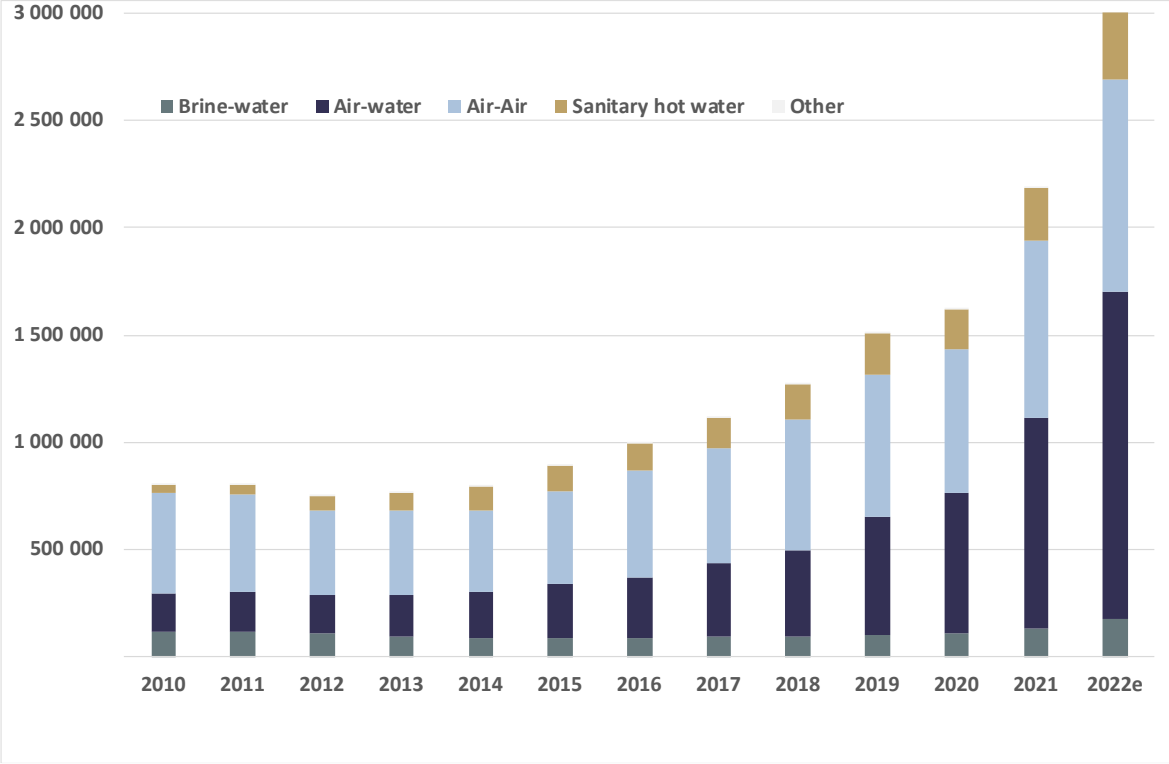

Fig. 1. 2022 heat pump sales in 21 European Countries.

The market was dominated by France (626k), Italy (517k), and Germany (282k). Together with Sweden (215k), Poland (203k), Finland (196k), Spain (185k), Norway (156k), and the Netherlands (125k), these countries form a group of nine markets, in which sales exceeded 100k units and which are jointly responsible for 83% of annual sales.

Figure 2 shows absolute and relative change of annual sales in 2022. Italy leads absolute change in sales with an increase of 134k (+37%) while Poland shows the biggest relative increase with doubling annual sales (+102%, + 99k). It is followed by Czech Republic (+99%), the Netherlands (+80%), Belgium (+66%) and Austria (+59%). Regarding year over year sales increase in absolut numbers the top 5 countries are Italy (+134k), Poland (+99k), Germany (+82k), France (+76k) and Finland (+67k).

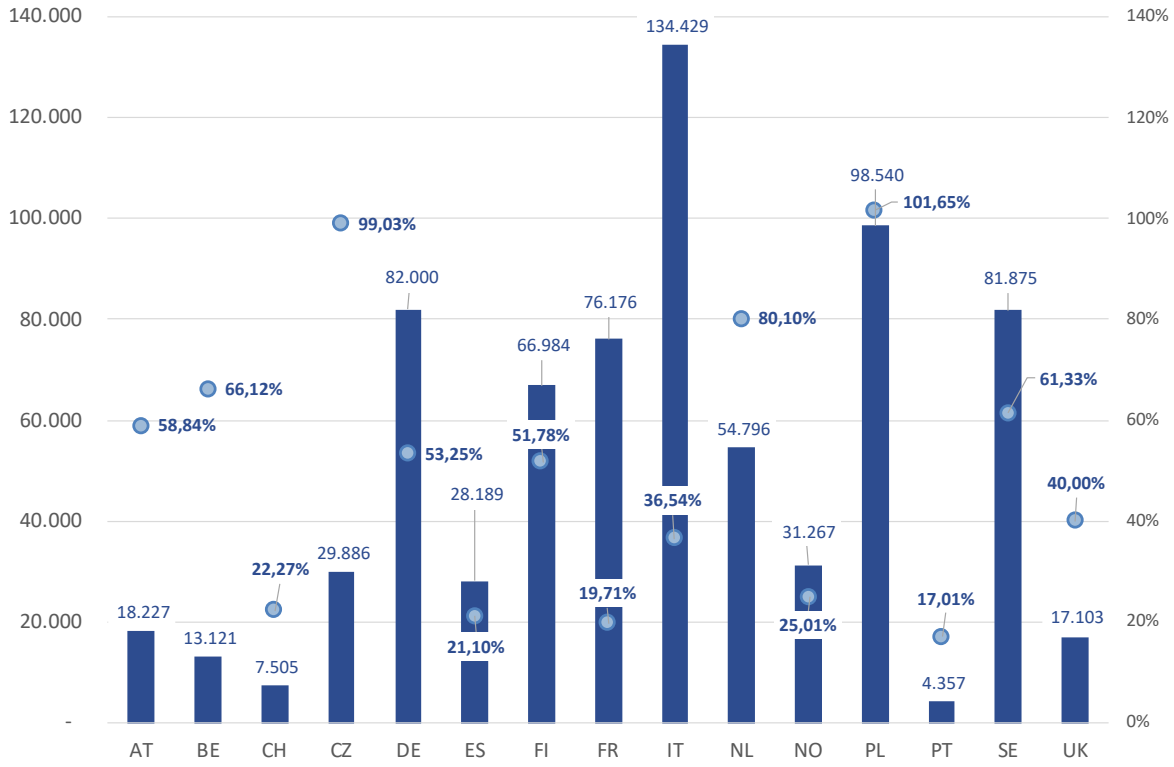

Fig. 2. Absolute and relative changes of 2022 sales compared to 2021 in 15 European Countries.

Growth is expected to continue as national legislation becomes more ambitious, partly as a result of local considerations (e.g., air quality in Poland), partly as a consequence of transposing European legislation. Germany aims at 500k heat pumps to be sold in 2025 supported by a new requirement of a 65% renewables share which is to be met by all heater installations (in new buildings and when replacing an existing heater) from 2024 onwards. Austria has already banned the installation of oil boilers in new buildings in 2020, and followed up with gas boilers in 2023. It aims to ban oil heating by 2035 and gas heating from 2040 onwards [8]. The Netherlands, after having declared the aim to become “gas free” in residential heating, is now mandating hybrid heat pumps as the minimum solution to be installed from 2026 [9]. Denmark has announced a shift of its remaining 400k gas boilers to district heating and individual heat pumps by 2028/2029 [10]. France has banned the installation of new oil boilers in all buildings and the installation of new gas boilers in new buildings from 2023 onwards. Ireland currently discusses the ban of fossil boilers with oil starting this year and gas following in as early as 2025. The European Commission is working on sharpening the regulation on Ecodesign for boilers in a way that would make the installation of fossil-only boilers impossible by 2029 [11]. These measures are fuelling a debate also in countries that have not yet agreed on a specific policy on the matter and their heat pump markets see a positive spill-over from more ambitious neighbours.

This strong increase in sales numbers in 2021 and 2022 is essential to decarbonise heating and to reduce local air pollution. The 2022 heat pump stock to the energy and climate targets is summarized in table 1 [12]. New units with a thermal capacity of 28.18 GW were installed producing approx. 33.95 TWh of useful energy and integrating 19.8 TWh of renewables in heating and cooling.

Table 1. Contribution of the heat pump stock and annual additions to Europe’s energy and climate targets.

	Installed stock end 2022	Addition in 2022
Thermal capacity	175.2 GW	28.2 GW
Useful energy produced	330.7 TWh	48.6 TWh
Renewable energy integrated	208.7 TWh	29.5 TWh
CO_2 emissions saved	53.5 Mt	7.6 Mt

Installing and maintaining these heat pumps is estimated at requiring a total of 162k full time equivalent of employment. Obviously real employment related to the heat pump market is larger, as not all employees work full-time on heat pumps only.

The total stock of heat pumps installed since 2003 amounts to 19.9 million units around 18 million of these being for heating purposes and about 1.9 million providing sanitary hot water. With a thermal capacity of 175.2 GW these heat pumps provided 330.7 TWh of useful energy, 208.7 TWh of which being renewable.

The average emission factor for electricity in Europe has declined from 500 g CO_2/kWh to a value as low as 229 g CO_2/kW in 2020 but has bounced back to 275 g CO_2/kW in 2021. Assuming a continuation of the downward trend, the emission value for 2030 is estimated at 115 g CO_2/kW [13]. The number of heat pumps sold in 2022 have reduced CO_2 emission by 7.6 Mt, arriving at a total annual savings of 53.5 Mt. With the greening of electricity, this number will increase further in the future.

The positive impact of heat pumps on the energy and climate targets is expected to continue, as the technology is not only the #1 heating technology in the new build segment of many national markets but is also making an inroad into the renovation sector. Improved technologies and new business models help their deployment and lead to an increase in demand. This will be further fuelled by the implementation of the "Clean energy for all Europeans", the fit-for-55 and REPowerEU-packages.

3. Legislative background: From EU Green Deal to REPowerEU

Europe's energy and climate policy has traditionally been shaped around:

- the promotion of the use of renewable energy, both in electricity and heating and cooling
- the support of energy efficiency measures in buildings and industry
- the introduction of minimum efficiency requirements for products through the Ecodesign directive and the related regulations on performance and labelling
- the reduction of CO_2 emissions through an emissions trading scheme and an effort sharing mechanism
- a re-design of the electricity grid.

Table 2 shows the increase of ambition on the EU level regarding the block's energy and climate targets. With each revision of the targets on renewable energy, energy efficiency and CO_2 emission reduction arose the need to review the underlying legislation on the EU and the Member State level.

Table 2. Energy and climate targets in the European Union

	Renewable energy	**Renewable energy in buildings**	**Energy efficiency**	**Reduction in CO_2 emissions**
Targets for 2020 [14]	20%		20%	20%
Targets for 2030 [15]	30%	49%	32.5% (9%)	40%
New targets for 2030	45% (EC), 40% (EP) [16]	49% (unchanged)	11.7% [17]	55% [18]
2050				Net zero **[19]**

Currently, the legislation on renewables, energy efficiency, CO_2 emission is undergoing its 3rd review round. New proposals related to heat pumps include:

1. a more ambitious Renewable energy Directive (see [17]) with
   - an increased renewables target for 2030,
   - a faster increase of the share of renewables used in heating (forthcoming Renewable Energy Directive), and
   - the recognition of cooling and waste heat, including in industry and district heating through large heat pumps.
2. the phase out of fossil heating in buildings (Energy Performance of Buildings Directive) [20].
3. a synchronised set of planning measures and assessments (National energy and climate plans, Comprehensive assessment, assessment of the potential from renewable sources, the use of waste heat and cold) (see the forthcoming Energy Efficiency Directive [16]).
4. the inclusion of heating and light commercial uses of fossil energy into the EU Emission Trading System (ETS2) [21].
5. a rebalancing of energy carrier taxation levels making the tax rate applied to electricity the lowest (Energy Taxation Directive [22]).

6. change of the accounting method of energy savings and ruling out the counting of savings from the installation of fossil boilers.

While this review was on its way, the war in Ukraine shattered the belief of gas being a bridge to a more sustainable heat supply and of Russia as a reliable trading partner for fossil gas. Both the International Energy Agency and the European Commission published communications on the need to remove Europe's dependency on Russian gas and both recognised that replacing gas boilers with heat pumps was a suitable approach. Each million of boilers replaced saves around 2 billion cubic meter of fossil gas imports. It hence required about 75 million additional heat pumps to completely remove the amount of gas imported from Russia in 2021 [23].

The European Commission followed up the **REPowerEU** communication **[24]** with a proposal for a sharpened legislation to accelerate the deployment of renewable energy **[25]**. For the first time, heat pump technology was mentioned in the top level communication. This was supported with specific targets on heat pumps, in particular:

1. the installation of 10 million additional hydronic heat pumps until 2026 and a total of 30 million additional units to be installed by 2030.
2. the recognition of renewable energy infrastructure as being of "overriding public interest". This recognition could then be used to justify simplification of administrative procedures.
3. taking additional measures to decarbonise the heat demand in industry, including through high capacity/high temperature heat pumps.
4. the need for additional 210 billion Euro investment identified as necessary to phase out the dependence on Russian gas. In parallel it was suggested to increase the share of renewables in final energy demand to 45% by 2030.

While these suggestions show a recognized need for higher ambition and action, they are not universally supported by neither the European Parliament nor by the Council. The European Heat Pump Industry assessed the proposals as appropriate and feasible but lacking clarity and detail. Achieving the growth numbers as proposed would require an action plan or a heat pump industrial strategy to ensure end-user trust in the technology, trigger and stabilise demand and increase capacity across all stages of the value chain. New technological solutions would have to be developed both for components and products, manufacturing sites would have to be build/redesigned, and experts would need to be trained on all levels. The latter including higher level education on the university level as well as a focus on mathematics, computer science, natural sciences and technology education in schools and a focus on the vocational training of installers, plumbers, or electricians.

4. A pandemic with an impact on home improvement

Regarding the need for a stabilised demand, the more inward focus of end-users on their own homes led to the realisation, that indoor environmental quality could be and should be improved. In consequence, the pandemic influenced demand for comfort and renewable solutions in electricity and thermal energy demand. And there is some evidence pointing to exactly that: When people were forced to stay home during the different lockdowns and home office obligations of the COVID pandemic, they began observing the shortcomings of their properties. With budget that would otherwise have been spent on hobbies, eating out or holidays now at the end user's disposal, they were channelled towards home upgrades. Focus areas were home offices, kitchens and living areas but also ventilation and heating systems. Why representative studies are sparse, (An evaluation of Discover Home Loans concluded that the interest in renovating increased dramatically during the pandemic [26].) anecdotal evidence from personal discussions with installers and other experts in the field support the assumption. An additional plausible explanation of increased demand is the aim to reduce the opearting cost of a building by investing in modern, efficient, and renewables-based power and heat generation solutions.

5. Using energy as a weapon has shattered the belief in gas as a transition fuel

The Russian invasion of Ukraine on 24th of February 2022 had an additional impact on the energy transition in heating. This war "using energy as a weapon" [27] is directly and heavily impacting energy users and may in the end have been the most decisive for the accelerated energy transition, in particular towards the use of renewables in heating [28]. The sudden and unexpected price increase for gas lead to higher cost for heating and – due to determination of the electricity price by merit order – electricity for most of Europe and lead end users to realise that supply security and affordability are at risk when relying on fossil energy. This realisation

has led to a double effect: several international and EU level communications describing the move away from (Russian) gas to the use of more renewables and the REPowerEU legislative package increasing existing energy and climate targets and introducing legislative measures and financing options to achieve them. The IEA 10 point plan to reduce Europe's dependence on Russian Gas lists 10 points to reduce demand of gas, two of which highlight the positive impact of a faster deployment and an increase in sales numbers of heat pump based solutions in residential and industrial applications. The REPowerEU plan aims at a similar target (see above) and identifies additional financing needs. This has a double impact on consumers: on top of their personal experience of the cost impact on energy resulting from the war, the need to shift our energy demand from fossil energy to renewables is re-enforce by the positive policy recognition and support systems that are (announced to be) put in place.

6. Concerted action still needed to fast-track heat pump deployment

Figure 3 shows the mutual support and boost for heat pump demand of three parallel developments. Where the continuous review, sharpening and increase of ambition of the different policy files has created a strong and continuous growth in demand, both the COVID pandemic and the war in Ukraine have added momentum on the end-user side.

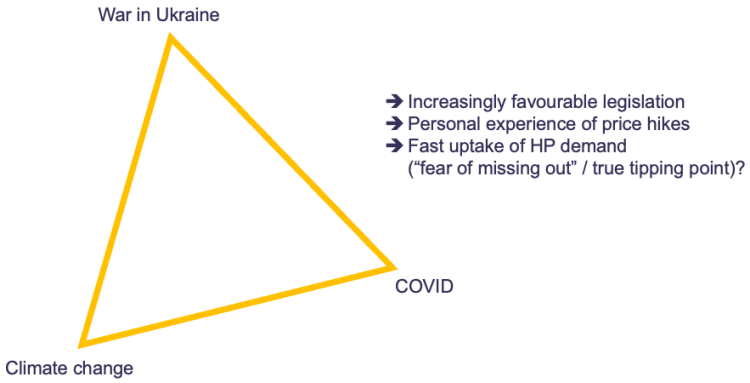

Fig 3: Mutually reenforcing impact on heat pump demand from policy, geopolitics, and pandemic.
Source: own.

The triple effect has steadied out demand not least through engaging hitherto reluctant end-users in considering heat pumps to ensure personal supply and affordability of heat and activating this target groups financing means. Demand must and likely will grow exponentially throughout this decade and while this is generally positive, it comes with a set of challenges that need to be overcome thorough enhancing energy and climate policy by a concerted heat pump industrial policy.

6.1. Are heat pumps becoming the dominant technology for heating in Europe?

Heat pump based heating can efficiently supply all residential and commercial buildings, both in new and renovation, single and multi-family application. Nearly 60% of all buildings are ready to be equipped and solely heated with heat pumps with the rest either having to undergo energetic renovation or be equipped with hybrid heat pumps, using two or more energy sources. As more than 75% of the European building stock are still heated by fossil energy, the necessary speed of change is far bigger than what can be currently observed.

Based on a previous assessment of around 116 million residential buildings in Europe and annual heater sales of around 7 million units, heat pumps now make up for a share of more than 35% in annual sales and about 15% in the stock of heating solutions. To achieve the target of 10 million additional hydronic heat pumps, as set forth by REPowerEU, exponential, double digit growth will be needed. Available data for 2022 shows that this target is within reach, and even the need for continued growth throughout this decade is within reach. Applying the necessary growth rates under REPowerEU also to air-to-air heat pumps, a category that is used for heating in Norway, Sweden, Denmark and Sweden, the Baltics as well as in the Mediterranean countries and that is responsible for about 33% of annual sales, heat pumps could provide 50% of Europe's building stock by 2030.

While the benefits of heat pumps for the energy and climate targets will undoubtedly lead to higher demand, the necessary growth is currently limited by supply shortages regarding components (fans, heat exchangers, pumps, semi-conductors and even tanks) and installation capacity. Related to this the need for a larger, skilled workforce, and the need for a competitive economic offering vs the incumbent fossil heating technology puts a limitation to the possibility of future growth. This needs to be overcome by concerted action.

6.2. A heat pump accelerator is needed to quadruple heat pump markets within this decade!

Europe has a strong position in heat pumps. It has a versatile landscape of research institutions and manufacturing sites and an established process of training and educating a skilled workforce. It should build on this strength to maintain this leadership in this new "industrial age" of renewables [29]. Industry has announced investments close to 5 billion Euro over the next three years [30]. For individual manufacturers, that means about a quadrupling of the 2021 production volume. It is the role of governments to back this growth by further shaping policy ambition and devising an industrial strategy along the whole value chain [31][32]. Making such policy continuity visible to developers and investors will allow them with the confidence needed to go ahead and even intensify their investments.

Hence it needs an all-hands-on-deck approach establishing a "heat pump industrial policy" that supports stakeholders on all stages of the heat pump value chain to implement and even enhance necessary investments to increase capacity. Such a heat pump accelerator will have to address the following points:

1. Maintain **trust** in the future importance of heat pump based solutions for the energy transition in Europe. Heat pumps need to be put forward in political communication on the European and national level. Their importance needs to be mentioned in high level speeches and used as an example of the low hanging fruits to reduce CO_2 emission quickly and significantly from heating and cooling. Heat pumps should be included in the overall energy and climate policy as well as in new, short term measures like EU net zero industry act [source]. Obstacles in component supply, administrative procedures and skilled workforce need to be addressed.
2. **Cost of the energy transition in heating**: The economic framework conditions need to be shaped towards making heat pump based solutions the economically most attractive alternative for private and commercial end-users, including those operating industrial plants and district energy networks. Regarding operation cost, this means improving the relative cost of electricity based heating and cooling solutions vs. their fossil counter parts. Negative external effects of the use of fossil energy need to be internalised, energy taxation needs to give an advantage to electricity and fossil fuel subsidies need to be stopped. Flexibility needs to be given a value, including through offering time-of-use tariffs and at least for the next years, investment cost support needs to be provided through subsidies and advantageous loan offering.
   The decision in favour of a heat pump is not only related to direct, but also to indirect cost. Uncertainty and doubt on the right technical solution, quality of offer and installation can be overcome by providing decision and process support through knowledge centres. This can go as far as providing complete support in form of one-stop-shops [33].
3. **Legal certainty** needs to be established for investors and end-users alike. Legislation should be established with a long term view making investments plannable and profitable. Administrative procedures should be simplified and revised to also allow the provision of new energy services ("heat-as-a-service") even beyond the individual lot. Similarly, the revision of current legislation such as on the use of refrigerants or Ecodesign should take the necessary accelerated deployment of heat pumps into consideration and simplify, not hinder, the path to this goal. Looking at the current review of the refrigerant regulation, the resulting new bans and phasedown trajectory will significantly shape the future of the heat pump industry. The proposed PFAS restriction proposal to the REACH regulation will limit available refrigerants for the industry. Clarity must be created as soon as possible [34][35].
4. In the foreseeable future, there will be a lack of **skilled workers** on several levels of the value chain. From architects, designers, and planners to factory workers to electric and heat pump installers. This needs to be addressed by policy makers through joint initiatives that recognize the importance of skills in the HVAC sector and aim at education and training as much as at re-skilling of existing employees. A focus on heat pump installations may allow a simplification of the extent of skills needed, for example by dropping those needed to install fossil based solutions.
5. Heat pump solutions require further **research and development** to develop residential, commercial, and industrial solutions for enhanced application areas, a reduced footprint, more compact solutions, and units that integrate thermal and energy through sector coupling. Such research can be supported

via different vehicles, Horizon Europe, and Life, but could also be positioned inside one or many Important Projects of Common European Interest (IPCEI).

In order to ensure the necessary growth rate is achieved and maintained, the heat pump accelerator or heat pump industrial policy must include a regular progress review to enable adjustment and modification of EU and national legislation.

7. Conclusion

The European heat pump industry has reached a level of maturity perfectly suited for exponential growth throughout this decade. In 2022 the heat pump share in annual boiler sales have reached about 30%. About 16% of all heating solutions installed in Europe are now heat pump based. Demand is triggered from both policy and individual end-user decisions in residential, commercial, and industrial applications. Growing demand encounters limitations in supply in capacity and skills across the value chain. As demand has increased rather surprisingly for many market players, friction between supply and demand is observable in factory construction, component, and heat pump manufacturing as well as installation. Ongoing investments are expected to overcome this friction over the course of the next 12 months.

The outlook for the heat pump sector is posivie, but more needs to be done in order to remove the use of fossil energy from heating in Europe. Accelerating its growth even further and stabilizing sales needs strong and visible support by governments including through establishing a European heat pump strategy that addresses and supports all parts of the value chain and coordinates the ambition of member states.

If this is established, heat pumps can become the #1 heating and cooling technology in Europe, meaningfully contributing to the continents energy and climate targets and removing its dependance on Russian gas, making renewable heat available and affordable for all. For the next winter and the winters to come.

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