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Decarbonisation of residential heating and cooling: The heat pump challenge

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European Foundation for the Improvement of Living and Working Conditions

When citing this research paper, please use the following wording:
Eurofound (2024), *Decarbonisation of residential heating and cooling: The heat pump challenge*, Eurofound research paper, Publications Office of the European Union, Luxembourg.

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Research project: Impact of change caused by the twin transition at sector level (construction)

Providers: Network of Eurofound Correspondents, see list in Annex 1

Acknowledgments: The authors would like to thank workshop participants and external experts who contributed valuable feedback to a draft version of this research paper in summer 2024 – Stéphane Quefelec (European Environment Agency), Silvia Rezessy and Philippe Riviere (European Commission DG-ENER), Mélanie Auvray and Milagros García (European Heat Pump Association) and Henriette Gleau (SGI Europe). Thanks also to the European Heat Pump Association for making available updated heat pump sales and stock data.

Luxembourg: Publications Office of the European Union, 2024

Print: ISBN 978-92-897-2438-8 doi:10.2806/7288203 TJ-01-24-005-EN-C
PDF: ISBN 978-92-897-2437-1 doi:10.2806/1095646 TJ-01-24-005-EN-N

This research paper and any associated materials are available online at https://eurofound.link/ef24051

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Contents

Executive summary

Introduction

The decarbonisation of residential heating is a critical component of the European Union's (EU) strategy to achieve carbon neutrality by 2050. This Eurofound research paper focuses on the installation of heat pumps in residential buildings, exploring their potential to enhance energy efficiency and reduce greenhouse gas emissions. Buildings account for over one-third of the EU's greenhouse gas emissions, making improvements in this sector essential for meeting climate targets.

Policy context

To meet the ambitious climate targets set by the EU, significant policy measures have been introduced.

- Fit-for-55 policy package: Accelerates the decarbonisation agenda across all sectors. This complex legislative and policy package will increase the penetration of renewables, drive energy efficiency and stimulate new financial tools. It also means that buildings emissions will be considered within the new Emissions Trading System from 2027.
- Renovation Wave initiative: Aims to double the rate of renovation of the EU's building stock and focuses on helping Member States to scale up renovation measures.
- RePower EU initiative: Seeks to double the number of heat pump installations between 2022 and 2026, targeting 50–60 million new installations by 2030, as a means of reducing EU dependence on imported gas.
- Energy Performance of Buildings Directive: Sets the framework for the gradual phasing out of fossil fuels in buildings and incentivises the installation of renewable alternatives, including heat pumps, while also improving the energy efficiency of buildings and addressing areas such as energy poverty.

Key findings

- Technology: Heat pumps are highly efficient, using renewable energy sources to transfer heat and provide both heating and cooling. The technology is well advanced and known across Europe, although greater awareness raising is required in emerging markets where heat pumps are less well known.
- Installation: Installing heat pumps is more complicated than installing the fossil-fuel equivalents that they will replace (e.g. gas boilers) and requires a broader range of skills and competencies. This makes installation relatively expensive. Making the installation process faster and more efficient may reduce costs and encourage greater take-up.
- Market trends: Europe was the fastest-growing market for heat pumps in 2022, but growth stalled in 2023 due to the normalisation of gas prices and uncertainty regarding policy and subsidies in some EU countries. While heat pump adoption is widespread in some countries (e.g. Finland, Sweden), it is considered new technology in others (e.g. Hungary) and there is limited market development.
- Labour market: Significant labour shortages exist: It is estimated that an additional 70,000 installers will be needed to meet the heat pump objectives set for 2030. Labour market shortages vary considerably across Europe, depending on the state of the wider construction market and availability of particular trades and crafts.
- Training and skills development: Many EU countries have adapted training curricula to include heat pump installation, but further efforts are needed to upskill the workforce and attract new entrants. There are many examples of public- and industry-led initiatives to enable upskilling. Gender balance within the heat pump sector is an issue, combined with an ageing population of installers.
- Subsidies and incentives: These vary widely across Europe, with substantial financial support available in some countries to encourage heat pump installation. Where there is already high penetration of heat pumps, supports tend to favour district heat solutions; other countries have packages of supports which can be combined depending on the type of heat pump and other measures undertaken (e.g. insulation, solar panels). Ensuring the stability of subsidies and supports has been highlighted as an issue by industry representatives.
- Energy pricing: The high cost of electricity compared to gas is a significant barrier to the adoption of heat pumps in many countries, and the financial return on investment can be perceived as too long due to low gas prices when compared with electricity prices.

Policy pointers

- Expand training programmes: Enhance vocational training and apprenticeships to develop the required skills for heat pump installation and maintenance. This requires public and private partnership and must be linked to the wider policy and subsidy framework. Small and medium-sized enterprises in particular need support to facilitate staff training.
- Standardise certification: Implement standardised training and certification programmes across the EU to ensure a consistent and high-quality installation workforce. This can also contribute to workforce mobility.
- Subsidise heat pump installation: Maintain and expand financial incentives for heat pump installation to offset initial costs and encourage adoption. The level of support should be stable over a sufficient period to support market development. Encourage the development of new business models that facilitate broader take-up. Examples include all-inclusive third-party installation and after-service packages and lease-based heating-as-a-service (HaaS) models.
- Address energy pricing: Implement measures to reduce the price differential between electricity and gas to make heat pumps more economically viable. This may involve electricity market reform more generally as well as taxes or other measures to reduce the electricity-to-gas price ratio to approximately 2.5 or less. At present, the monetary savings from the greater energy efficiency of appropriately installed heat pumps compared to fossil fuel-based heating systems are sometimes negated by relatively high electricity prices.
- Promote public awareness: Increase awareness of the benefits of heat pumps and available subsidies to drive consumer adoption. This is particularly critical in emerging and new markets.
- Support low-income households: Provide targeted support for low-income households to ensure equitable access to energy-efficient heating solutions, thereby expanding the take-up of heat pumps.
- Monitor progress: Establish robust monitoring and reporting mechanisms to track the progress made in achieving heat pump installation targets and adjust policies as needed.

The transition to heat pumps is essential for the decarbonisation of residential heating in the EU. While significant progress has been made, challenges remain, particularly in workforce development, subsidy and incentive packages and energy pricing. Continued policy support and targeted interventions will be crucial to overcoming these barriers and achieving climate targets.

Introduction

This Eurofound research paper explores one very practical example of a decarbonisation use case in the construction sector: the installation of heat pumps in residential buildings to improve energy efficiency and reduce greenhouse gas emissions. The aims of the research paper are to summarise how the EU heat pump rollout is proceeding at Member State level; to indicate which public supports have been successful in encouraging take-up; to map the labour market challenges of the rollout; and to draw some relevant policy pointers.

Energy consumption in buildings is responsible for over one-third of greenhouse gas emissions in the EU (36%). Increasing the energy efficiency of buildings will reduce the need for fossil fuels, which are currently the main source of thermal heating and cooling in most European homes.

Heat pumps use renewable energy sources (ambient/geothermal heat) to transfer useful heat or cold to internal spaces. They use electricity – an increasing share of which is generated from renewables – and are estimated to be between three and five times more energy efficient than gas boilers (IEA, 2022).

In addition to installing new, more energy-efficient heating equipment, retrofitting Europe's existing housing stock will be a necessary first step in reducing emissions. Europe's housing stock is old: three-quarters of it was built more than 30 years ago (BPIE, 2017) and predates current, stricter energy efficiency requirements. Heat pumps work most efficiently in well-insulated homes (Toleikyte et al, 2023).

To achieve the objective of a carbon-neutral building stock by 2050, the construction sector has a key role to play. The construction sector is the main sector where employment is projected to increase as a direct result of the implementation of Fit-for-55 policies (Eurofound, 2023a). Decarbonisation ultimately involves very material interventions in the way we live. It will be building firms and workers that retrofit and insulate existing homes, that build the new houses to desired efficiency standards and that construct and help install new renewable energy infrastructure.

In light of these demands, it is worrying to note that construction sector employment has been largely stagnant over the last decade and a half. There were 2.4 million fewer construction sector workers in the EU27 in 2023 compared with 2008. In that time, the sector's share of total EU27 employment fell from 8.4% to 6.8%, even as labour shortages are increasingly reported by sector representatives (Eurofound, 2021; Eurofound, 2023a; Eurofound, 2024a). According to International Energy Agency (IEA) estimates, REPower EU targets for heat pumps will require an increase in the number of trained heat pump installers from around 40,000 in 2019 to 110,000 by 2030 (IEA, 2022).

This raises the question of whether the EU has sufficient available labour to carry out the required improvements to Europe's building stock. Low unemployment and tighter labour markets mean that there are alternatives to the often physically arduous work of building labourers, posing a challenge for employers trying to hire. And even where basic job quality issues can be addressed and labour can be hired, the skill set required to install heat pumps is distinctive and will require significant (re)training even for those with related skill sets such as plumbers, electricians and ventilation or heating system installers.

Policy at EU and national level has mobilised to tackle these issues. The EU's accelerated schedule of decarbonisation outlined in the Fit-for-55 policy package envisages the inclusion of buildings in the new Emissions Trading System from 2027. This will impose a carbon price on fuels used to heat buildings based on their emissions. The target for the Renovation Wave initiative is a doubling of the rate of renovation of the EU's housing stock. One of the aims of the RePower EU initiative, designed to reduce the EU's reliance on Russian energy imports, is to double the number of new heat pump installations over the period 2022 to 2026, equivalent to 50–60 million new installations by 2030. In parallel, the revised Energy Performance of Buildings Directive will help to make the EU building stock less energy demanding (as building envelopes will be better insulated). It will also help to gradually phase out boilers powered by fossil fuels while incentivising the installation of more renewable alternatives, including heat pumps.

On the supply side, initiatives such as BUILD UP Skills as well as an array of existing funds (European Social Fund, NextGenerationEU) and planned funds (the Social Climate Fund in 2026) are intended to meet the human capital and training needs required to set the EU's building stock on the path to net zero.

Europe was the fastest growing market for heat pump sales globally in 2022 (IEA, 2023), up nearly 40% year on year. More recent indications are that the rate of growth declined markedly in 2023 (EHPA, 2023a). Reasons for this deceleration include the return of gas prices to more customary levels in 2023 and the scaling down of some generous installation subsidies at national level. A renewal of the effort to deploy more heat pumps between 2024 and the end of the decade will be one sign that the EU and its Member States are committed to the decarbonisation challenge in respect of its building stock.

This paper begins by setting out some useful context, including an outline of the basic technology behind heat pumps, the different types of heat pump and their share of the energy mix in residential energy consumption. Thereafter, the main body of the research paper summarises contributions from the Network of Eurofound Correspondents relating to policy targets or objectives at national level. These contributions cover heat pump rollout, evidence of progress and indications of labour market barriers to implementation (e.g. labour shortages, inadequate skills profiles). Where identified, the paper also sets out good practice examples of training and reconversion/reskilling incentives for building professionals and installers. A concluding section summarises the main findings and a series of policy pointers.

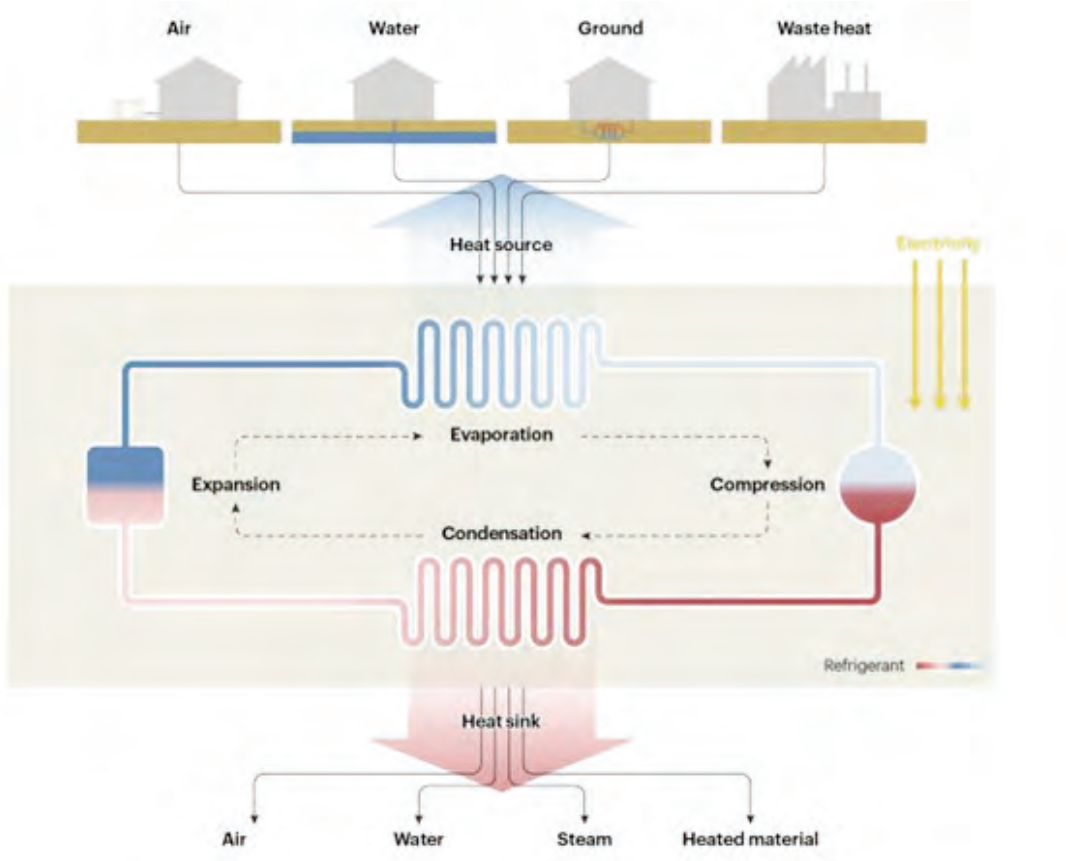
What are heat pumps?

Heat pumps are electricity-consuming heating (and cooling) devices that employ mechanisms similar to those used in refrigerators or air conditioners. The reason why heat pumps are so innovative compared with traditional heating technologies is that they can transfer existing heat rather than just generate it. This makes them more energy efficient than conventional heating systems, such as boilers or electric heaters.

Typical residential heat pumps consume one unit of electricity to deliver four units of heat output, which makes them three to five times more efficient than gas boilers (IEA, 2022). Within the context of the energy transition, heat pumps offer the dual advantage of being powered by a lower-emitting energy vector (i.e. electricity) and of having higher efficiency compared with conventional systems.

As Figure 1 shows, heat pumps are powered by electricity and consist of a compressor, two heat exchangers and an expansion valve. In a heat pump, a fluid, the refrigerant, undergoes a refrigeration cycle, enabling heat transfer from a cool space to a warm space. In the first stage, the refrigerant passes through a heat exchanger and evaporates. It is then conveyed to a compressor, where its boiling point is increased. A second heat exchanger allows the refrigerant, which is now a warm gas, to transfer heat to the room via a heat sink. Thanks to an expansion valve, the refrigerant is expanded, the temperature is reduced, and the refrigerant can go back to a liquid state and start the cycle again. In building applications, heat is distributed either through forced-air systems or hydronic systems like radiators or underfloor heating (IEA, 2022). Adopting the same mechanism in reverse, many heat pumps are able to provide space cooling during summer and heating during the winter.

Figure 1: How a heat pump works



Source: *IEA, 2022*

Overview of heat pump types

Heat pumps can capture heat from various sources, such as the surrounding air, the geothermal energy stored in the ground, or even nearby sources of water. The most common heat pump types are air source, water source and ground source. Air source heat pumps (ASHPs) use outdoor ambient air as a heat source. Specifically, they convert low-grade heat taken from ambient air to high-grade heat delivered to the heat sink. There is a distinction between two types of air source heat pumps: air-to-air and air-to-water heat pumps. Air-to-air pumps provide heat in the form of warm air, delivered through a fan to vents placed in the different rooms to be heated. Air-to-water pumps deliver heat to a water system, such as underfloor heating systems, radiators or fan coils. Among these applications, underfloor heating provides the maximum efficiency given the low intensity heat generated. Compared with air-to-air pumps, air-to-water systems offer the additional advantage of producing domestic hot water.

Water source heat pumps (WSHPs) use nearby bodies of water such as lakes, ponds, rivers or ground water as a source of heat. The water source provides low-grade heat, which is converted to high-grade heat by the heat pump. Water is a better heat source than air, since its temperature is warmer during winter, cooler during summer and overall more stable. This enables greater efficiency, leading to lower costs and emissions. However, installations are limited to sites where there are bodies of water nearby. In practice, only a small minority of EU heat pumps are water source pumps.

Both ground source heat pumps (GSHPs) and geothermal heat pumps use thermal energy that is naturally stored underground as a source and the terms are sometimes used interchangeably. Since ground temperature is more stable than air and reaches higher minimum values during winter, GSHPs are more efficient than ASHPs in locations characterised by severe winters while ASHPs operate better in moderate climates. Since GSHPs require the introduction of an additional underground heat exchanger with associated excavation, their installation is more expensive and requires significant outdoor space compared to ASHPs and WSHPs (Gaur et al, 2020).

Due to these different characteristics, various types of heat pumps are better adapted to operation in different countries. Countries such as France, Italy and Spain constitute the biggest markets for air-to-air heat pumps, while in countries such as Ireland air-to-water heat pumps are more common. Meanwhile, Germany and Sweden together account for half of all installed ground source heat pumps in Europe (Lyons et al, 2023).

Overall, while air source heat pumps may be less efficient than water source and ground source heat pumps, they allow for more flexible and less expensive installation, avoiding the installation of underground heat exchangers and the need for a connection with a water source, while still offering better efficiency and lower emissions than conventional boilers. As a result, air source heat pumps are the most common type, accounting for almost 85% of installations worldwide (IEA, 2023).

Trends in heat pump sales and installations

Eurostat data from 2021 show that households in the EU primarily use energy for heating their residences (space heating), accounting for 64.4% of total final energy consumption. If water heating is included (14.5%), around four-fifths (79%) of energy consumption in the residential sector is accounted for by space or water heating (Eurostat, 2021). By comparison, space cooling (e.g. air conditioning) accounts for only 0.5% of total final energy consumption and only above 10% in two Member States – Cyprus and Malta.

In 2021, Eurostat data indicated that natural gas accounted for the highest share of fuel consumption for space heating in the residential sector, accounting for 39.4% of total fuel consumption. The energy crisis triggered by Russia's invasion of Ukraine and the subsequent collapse in gas imports from Russia prompted the EU to intensify policy measures to accelerate the switch towards clean energy for heating. Heat pump technologies were among the targets of these policies. As a result, in 2022, there was significant growth in the heat pumps market throughout Europe (EHPA, 2023b). The stock of heat pumps installed in the EU surpassed 20 million units in 2022, though the distribution across Member States varies widely with approximately 87% of the European market volume concentrated in only 10 countries (EHPA, 2023b).

As already indicated, according to European Heat Pump Association (EHPA) estimates, the rate of growth stalled in 2023. The association recorded sales of 2.64 million heat pumps compared with 2.77 million in 2022 (EHPA, 2024a) in 15 Member States, which accounted for 9 out of 10 heat pumps installed in the EU27. Year-on-year declines were recorded in Austria, Denmark, Finland, France, Italy, Poland, Sweden and Switzerland. Although sales increased in countries such as Belgium, Germany, the Netherlands, Norway, Portugal and Spain, this rise was not sufficient to counterbalance the overall drop. Nonetheless, sales of heat pumps were over three times higher in 2023 compared to 2013 (EHPA, 2024b).

Looking at the sales of heat pumps per 1,000 households in 2023, northern countries record the highest values, with Finland (67.3 per thousand) and Norway (56.9) ranking at the top, followed by Sweden (45.1), Estonia (30.1) and Denmark (28.6). This reflects the relatively high installed base of (mainly ground source) heat pumps in the Nordic countries (EHPA, 2024b; see Figure 2). In Sweden, for example, more than half of single-family homes have a heat pump installed, while 95% of new builds are heated by heat pumps (Lyons et al, 2023).

Older heating systems installed in European buildings are currently replaced at a rate of 4% a year (EHI, 2023). At this rate, it would take over 20 years to substitute more than 58 million older and inefficient appliances. To meet EU energy efficiency targets, a faster replacement rate of at least 6% per year is needed according to the European Heating Industry (EHI, 2023).

Heat pump and renovation targets

Given that both building renovation and heat pump installation are primary drivers for decarbonisation within EU energy policy, it is interesting to consider the ambition and targets set for these areas across the EU Member States, while considering the challenges faced in developing a labour force that can deliver on these targets.

Evidence that the heat pump market is growing rapidly is clear from a range of European reports. The EHPA gathers market data from national members on heat pump sales. The latest report, providing data for 2022 and covering 21 European countries, indicates that heat pump sales grew by 39% in 2022 and 'the total stock of 20 million installed heat pumps is avoiding a record 52.5 megatonnes of CO_2 for Europe's buildings sector – around the annual emissions of Greece' (EHPA, 2023b). The market is dominated by air source heat pumps (air-to-air and air-to-water) and indications are that continued growth is possible as policymakers set more and more ambitious targets. Yet, as noted in the previous section, sales in 2023 have declined somewhat as gas prices fall and changes in policy and incentive emerge (Table 1).

In terms of targets for heat pump installation, considerable variation can be noted across Europe, in particular in relation to specific targets for heat pump installation for the residential sector. This is somewhat influenced by regional requirements and demands including climatic conditions, broader energy policy and linkages to residential retrofitting targets. The heat market in countries varies, depending on historical policy contexts. Broadly, it can be noted that Nordic countries have been early adopters of heat pump technology (Box 1).

Table 1: Heat pump sales, millions, 19 EU Member States

Year	Air-to-air	Air-to-water	Ground source	Other	Sanitary hot water [1]	Total
2020	0.65	0.65	0.10	0.00	0.20	1.60
2020	0.80	0.90	0.15	0.05	0.25	2.15
2020	0.95	1.50	0.15	0.05	0.35	3.00

Note: *The following countries are omitted from the summary figures: Bulgaria, Croatia, Cyprus, Greece, Latvia, Luxemburg, Malta and Slovenia.*
Source: *EHPA, 2023b*

Box 1: Expansion of heat pump market in Nordic countries

The heat pump market has traditionally been strong in Nordic countries such as Denmark, Finland, Norway and Sweden. Nordic heat pump 'leadership' is attributable in part to the high historic prevalence of oil heating in these countries and a strategic state response to periodic oil crises and oil price surges in the last century (Rosenow et al, 2022).

The Finland national contribution indicates that the number of installed heat pumps increased rapidly between 2000 and 2008. After that, the numbers remained fairly stable. According to the Finnish correspondent, a mix of policy instruments 'such as carbon taxation, government incentives, regulations, quality standards, consumer protection, for example through the creation of bodies to deal with complaints and offer redress, and information campaigns' has led to the success of heat pumps. Finland has been moving away from oil-heating at a fast pace since about 2000, through national climate and energy strategies, government policy and taxation.

In Norway, the government has forbidden the installation of heating systems based on fossil fuels since 2016 and the use of heating oil since 2020, resulting in a transition to electric heating systems. These facts have made heat pumps very appealing to Norwegian consumers, especially with rising electricity prices in recent years. The use of heat pumps in Norwegian households has grown from 4% in 2004 to 27% in 2012 and nearly 40% in 2022. The electricity share in households' energy use increased from 79% in 2012 to 85% in 2020. Because of greater energy efficiency, the average electricity consumption per household in 2022 was about 14,800 kWh (kilowatt hour), down from 16,400 kWh in 2020.

1 Heat pumps that just provide hot water at point of use.

In Denmark, nearly 200,000 heat pumps were installed in 2023, an eight-fold increase since 2011, with demand accelerating in recent years. Increasingly, the priority here, as in Sweden, remains to connect households to district heating networks.

The Swedish report highlights that the long-term growth of the heat pump market was originally given impetus by carbon taxes put in place in 1991 (SEI, 2017; SKVP, 2023). In 2023, there were around 1.5 million heat pumps in Sweden, of which approximately 500,000 were geothermal or ground source heat pumps. Incentives and targets are not set for installations but rather for making the current heat pumps more effective. The efficiency of small heat pumps has improved by an average of 1.5% per year since the 1970s. More generally, Swedish energy policy has developed such that it is directed as much at expanding district heating as at installing new heat pumps, which require more energy to operate. District heating is the preferred option for apartment buildings, while heat pumps are more common in single-family dwellings (Dzebo and Nykvist, 2017). Almost half of current households are currently heated with district heating, and a substantial proportion is heated with biofuel. Given the early adoption of heat pumps in Sweden, and the high penetration per 100 inhabitants, there is less of a need for a broad and ambitious policy for heat pump installation in Sweden than in other EU Member States. There is a broader vision for Sweden to become 'the world's first fossil-free welfare state' (SEI, 2020). This entails reducing climate impact while simultaneously enhancing welfare. In other words, the goal of achieving 'fossil freedom' is to be coupled with strong economic growth and improved quality of life for residents. The term 'welfare' encompasses various aspects of people's living conditions, including their personal finances, health, education, housing and culture. In this context, it also includes the notion of 'public welfare', meaning that everyone in society is entitled to a basic level of protection, security, support, housing, food, healthcare, education and culture (SEI, 2020).

In many countries, heat pump targets are connected to national renovation targets. Today, only 11% of the EU's existing building stock undergoes some level of renovation each year. However, only a small share of these renovation works address the energy performance of buildings. Across the EU, deep renovations that reduce energy consumption by at least 60% are carried out in only 0.2% of the building stock per year (BPIE, 2020). According to a European Commission staff working paper, 'at this pace, cutting carbon emissions from the building sector to net-zero would require centuries' (European Commission, 2020).

Many countries have set ambitious climate neutrality targets. These were set ahead of the EU 2050 target, and residential renovations/retrofits, new building construction and a shift to climate-friendly heating systems play a significant role in these targets. However, there are other countries where there is currently no evidence of either renovation targets or heat pump targets being specifically identified. In Austria, for example, a renovation rate increase to 3% has been set along with a significant growth in heat pump installations (46% of the heating market in 2022), to achieve the eventual installation of over 1.3 million heat pumps by 2040. There are over 4 million residences in Austria (Statistics Austria, undated). Ireland has a target of 400,000 heat pump installations in existing homes by 2030 (and a target of 500,000 existing buildings for renovation) from a total of 2.12 million permanent dwellings (CSO, 2022). Table 2 shows a sample of targets from a range of Member States.

Belgium has adopted a regional approach (across Brussels, Flanders and Wallonia), which defines heat pump targets as energy production targets (with Brussels aiming for 56.32 GWh, Flanders targeting 1,455 GWh and Wallonia setting a goal of 2,037 GWh, all for 2030) from air source and geothermal heat pumps. In its strategy to achieve net zero emissions, Romania is planning for a scenario where 25% of its heating/cooling demand will be provided by heat pumps (replacing biomass, coal, lignite or oil) by 2030. Hungary's National Energy Strategy envisions 100,000 heat pump installations by 2030. At a more general level, Lithuania's National Energy Independence Strategy underscores the integration of modern technologies, including heat pumps, to optimise central heating systems.

Growth in heat pump installation is significant. For example, Slovakia saw an 88% increase between 2021 and 2022 with 13,225 heat pumps being installed. While Poland saw heat pump sales quadruple between 2017 and 2022, they still only account for 2% of heat sources. According to projections, 3 million heat pumps will be needed to achieve Polish energy efficiency standards in buildings. With some exceptions, for example Denmark, national targets for heat pump installations remain ambitious and will require a rapid ramp-up of installation activity between now and 2030. In Germany, based on EHPA estimates, there will need to be a more than three-fold increase in installations over the period 2022–2030 to achieve the target of an installed base of 6 million heat pumps by 2030. In Ireland, a seven-fold increase (from 84,400 in 2022 to 600,000 in 2030) will be required.

Table 2: Sample of heat pump targets, selected Member States

Country	Type of heat pump referenced	2030 targets for number of heat pumps	Energy target (GWh), year	Comments
Belgium (Flanders)	All types	42,750 additional heat pumps (excluding air-to-air) per year from 2023; 50,000 additional air-to-air installations per year	1,455 GWh to be generated by heat pumps by 2030	Different regional targets
Czechia	Air-to-water heat pump, ground source-to-water heat pump		3,352 GWh to be generated by heat pumps by 2030	1.1% year-on-year increase in the share of renewable energy supply in the heating and cooling sector at the level of the average value in the period 2021–2030
Denmark	No data	80,000 heat pumps by 2030 (representing 20% of houses currently heated by gas)		District heating and heat pumps are typically grouped together as the sustainable alternative
Germany		500,000 heat pump installations annually by 2024		Installed base of 6 million by 2030 (BWP, 2023)
Greece	Air-to-water heat pumps		17% of residential buildings are expected to meet thermal needs with air-to-water heat pumps	
Hungary	No data	100,000 heat pumps		No specific support programme or subsidies currently declared
Ireland	Mainly air source heat pumps	400,000 heat pumps by 2030 in residential retrofits; 600,000 overall		
Lithuania	Air-to-water heat pump, air-to-air heat pump	50,000 units are to be replaced (20% with efficient biofuel boilers and 80% with heat pumps)		
Luxembourg	Geothermal heat pump, air-to-water heat pump, hybrid heat pump		1,036 GWh by 2030	
Netherlands	Hybrid heat pump (or fully electric heat pump)	1 million hybrid heat pumps installed in existing buildings by 2030		From 2026, hybrid heat pumps will be standard for heating homes
Romania	No data	No data	The share of heating and cooling generated by heat pumps will increase from 20% (10,769 GWh, 926 ktoe) (renewable energy supply) in 2025 to 35% (31,470 GWh, 2,706 ktoe) by 2050	Possible scenarios for heat pump installation in all buildings by 2050
Slovenia	No data	12,600 heat pumps (by 2026)		Target has been set and is supported with specific Climate Change Fund
Spain	No data		30,954 GWh (2,659 ktoe) energy supplied by heat pumps in 2030	

Notes: *GWh, Gigawatt hour; ktoe, kilotonne of oil equivalent.*
Source: *Contributions received from the Network of Eurofound Correspondents*

The scaling up of the volume of heat pump installations and the replacement of fossil fuel heating systems are supported by a range of funds and measures, including, in some countries, the prohibition of fossil fuel systems. In Slovenia, for example, the Slovenian Environmental Public Fund (Eco Fund) provided approximately €29 million in subsidies (amounting to 12,758 individual supports) in 2023. The supports come in the form of soft loans and/or grants. In Poland, supports include grants for heat pump installation under the Clean Air Programme (currently paused due to lack of funds) along with supports under programmes such as My Heat and My Electricity which provide subsidies also for heat pumps. Furthermore, at a regional level, various voivodeships (provinces) have programmes supporting the replacement of obsolete boilers with a variety of levels of support, depending on regional priorities and conditions. Ireland, Luxembourg and other countries have specific subsidies, depending on the type and size (in kWh) of heat pump being installed. Where heat pump installation is envisaged as part of a renovation package, different packages of supports are available. Recovery and resilience funds have been used in some countries. For example, in the case of Finland, subsidies for phasing out oil heating in low-rise housing was introduced as an answer to the government's target of phasing out fossil-based oil heating by the 2030s. Aid is directed at the installation of air-water heat pumps, ground heat pumps and district heating (Finnish Government, 2021).

In Sweden, where heating is dominated by district heating and there is already a high penetration of heat pumps, the focus has been on improving their efficiency (aiming for an annual increase in efficiency of 1.5%). As highlighted in Box 1, Sweden has historically had a strong heat pump market and has kept increasing the number of installations to a degree where manufacturers have difficulty in recruiting qualified installers to match demand. Heat pump production and innovation are thriving, with companies expanding sales internationally as well as serving the Swedish market. Electricity accounts for about 25% of residential heating in Sweden, with about half of the electricity-fuelled heating provided through heat pumps; the heat pump market grew by 61% in 2022.

Similarly, in Norway, heat pump growth continues (1.4 million heat pumps were sold between 1987 and 2020) and there are calls for more supports for heat pump installation. The installation of fossil fuel heating systems has also been banned in Norway since 2016 and the pace of heat pump installation remains high. In Finland, district heating solutions are extensively deployed. While heat pumps will play a major role in the decarbonisation of heating, they should not out-compete district heating or other solutions that are in place. This market growth can be contrasted with market development in Poland where a marked reduction in heat pump installation occurred in 2023 (from just over 200,000 in 2022 to approximately 125,000 in 2023) resulting in an oversupply of heat pumps in the market.

There is no clear trend in the types of heat pumps that are supported or included in targets at a European level. The chosen technology will depend, among other factors, on climatic conditions; heating/cooling demands that affect buildings and technical building systems; and cost effectiveness. Overall, there is evidence of an increased penetration of air source heat pumps. Some countries have specific supports for hybrid heat pumps. For example, the Netherlands has a target of 1 million hybrid heat pump installations in existing buildings by 2030. Population density and an extensive gas network within the Netherlands has influenced this policy decision; it compares with other countries, such as Ireland, which has a more dispersed population and extensive oil and solid fuel heating.

Countries in southern Europe, where cooling demands dominate, have specific requirements, for example, air-to-air heat pumps, which are reversible and can provide cooling in the summer. Furthermore, solar thermal and photovoltaic solutions dominate the market, given how effective these solutions are in assisting these countries to meet their national renewable energy supply targets.

Cyprus's National Energy and Climate Plan (NECP) indicates that heat pumps will contribute to 11.3% of all heating and cooling demands and they will cover almost all cooling demand in buildings. Croatia is also planning specific subsidies for heat pumps that use sea water for heating and cooling, as there is significant potential along the Adriatic coast. However, there are no specific targets for heat pump installations or fossil fuel-based boiler replacements. In Italy, heat pumps have been recognised as a strategic technology in the context of retrofitting and are forecast to increase renewable energy production from 2.8 million tonnes of oil equivalent to 6.7 million tonnes of oil equivalent by 2030. A range of tax incentives are available where existing winter air-conditioning systems are replaced with systems equipped with heat pumps.

The Danish Heat Pump Fund provides subsidies to those wishing to replace fossil fuel boilers and contributes to the Danish target of having an additional 80,000 heat pumps installed by 2030 (replacing gas fuel heating in 20% of 400,000 buildings connected to the gas grid). While fossil fuel boilers cannot be installed in new buildings (since 2013 in Denmark), gas boilers are still being installed in existing buildings.

Romanian energy and climate targets for 2050 demand a significant reduction in energy use in buildings (with a reduction of over 50% in energy demand), with the biggest drop occurring in the residential sector. Greece is aiming for a renovation rate of 1.7% in 2050 (increasing from 0.8% or 47,000 buildings in 2023).

In some countries, while heat pumps are expected to play an important role in the decarbonisation strategy, action plans and programmes are still under development. For example, Portugal will develop a national action plan to accelerate the adoption of heat pumps in buildings and in industry. Portugal has also placed a significant focus on addressing energy poverty in the context of its heat pump subsidies and supports (see the section 'Specific measures to address low income and energy poverty' for more details).

Reports from a number of countries indicate that current policies do not set specific targets for heat pump installation. Nonetheless, according to the Latvian national contribution, heat pump installation is broadly supported as an element of the country's overall renewable energy sources and energy efficiency plans. The contribution from Hungary highlights that targets have been set out in its renovation strategy for building upgrades (90% reduction in CO2 by 2050) but recent funding programmes did not specifically require the installation of heat pumps (gas-fuelled boilers were also eligible). Moreover, the implementation of revised requirements for new buildings under the recast Energy Performance of Buildings Directive was delayed until June 2024. Similarly, while targets for renewable energy production and energy efficiency through renovation are outlined in Bulgaria, no specific targets are set for heat pump installation. Of note, however, are specific measures at regional or municipal level: in Sofia, for example, there is a measure to replace solid fuel heating with environmentally friendly alternatives.

Data availability on the scale and quantity of heat pumps installed are also a concern. The Estonian contribution highlights differing data on the proportion of heating provided by heat pumps in residential buildings (between 25% and 34%) and some policies do not clearly disaggregate the anticipated proportion of heating expected to come from heat pumps in the future.

It is clear also that policies are emerging and changing rapidly across Europe and the impacts of these are not yet known. For example, in Germany, the new Buildings Energy Act (in force since 1 January 2024) stipulates that heating systems in new buildings need to use at least 65% renewable energy, thus creating demand for heat pumps (which are normally deemed to be renewable energy). While the choice of solution is left open to homeowners, heat pumps are seen as one potential solution. If heating systems installed before 2024 break down or cannot be repaired, homeowners have a three-year period in which to switch to a system that ensures compliance with the 65% rule. The government had set a target of installing 500,000 heat pumps per year by 2024, with the number of installations forecast to grow to 6 million by 2030.

Labour market supply

Setting ambitious targets for both renovation and heat pump deployment, supported by the relevant policy and intervention measures, such as subsidies, can create positive market conditions. However, an analysis of responses across the 27 EU Member States points to potential constraints due to labour and skills shortages. The picture is not entirely clear, however, due to the fact that data specifically focused on the heat pump market are lacking in many instances. At a European level, the EHPA estimates that there are 163,905 full-time equivalent (FTE) employees in the heat pump sector across Europe. Of these, 37% (or 61,000) are involved in the manufacture of heat pumps and 30% (or 49,000) are employed in the installation phase, with the remainder in components manufacturing and service or maintenance (EHPA, 2023b).

Table 3 outlines the responses from Member States on workforce estimates to meet heat pump targets and current labour shortages. Specific data on the heat pump market, and those directly employed in the installation of heat pumps, are lacking in many countries. This is due partly to the definitions of roles, the state of market development and evolving certification and regulatory systems.

It is important to consider the wider labour market context in construction when addressing labour market needs for the heat pump sector specifically. Contributions from Finland and Sweden mention a downturn in the construction sector. In Sweden, rising interest rates have resulted in a significant decline in the construction of new buildings. Investment in new housing has fallen from a high of SEK 321 billion (approx. €28.3 billion as at 24 September 2024) in 2022 to a preliminary forecast of SEK 197 billion (approx. €17.4 billion) in 2023, a drop of almost 40% in new construction. This has led to an increase in unemployment in the construction sector overall, which is likely to be temporary (Byggföretagen 2023). Such a slowdown in sector activity can of course assist renovation activity by freeing up labour; one of the lessons from many other countries with buoyant construction sector activity is that this can reduce the supply of labour for energy efficiency upgrades and renovations. The national contribution from Finland reflects on the ageing workforce in construction: a significant proportion of the workforce is due to retire, creating a need for younger workers in the occupation. While estimates indicate the need for about 2,000 new installers between 2020 and 2025 (Iltasanomat, 2020), the latest statistics on labour force availability and accessibility show an oversupply of installers in all three relevant International Standard Classification of Occupations (ISCO) codes (7124, 7126 and 7127).

It could be argued that this oversupply is caused by the current difficult economic situation in the construction sector, where large numbers of layoffs are occurring. A similar contraction in the construction sector is reported in the Luxembourg contribution. Recruitment in the sector began to slow down in 2020 and decreased sharply from 2023 onwards: employment declined by 2.7% year-on-year in the third quarter of 2023, a higher drop than during the financial crisis of 2007–2008. The Chamber of Commerce and the Federation of Artisans in Luxembourg fear the elimination of nearly 4,600 jobs in the construction sector.

The contribution from Croatia signals a significant shortage of workers in the construction sector. Due to the large number of unfilled jobs in the construction industry, employers hire foreign workers, who make up about one-third of the 115,000 employees in the industry. Latest estimates indicate that an additional 20,000–30,000 workers are needed in the Croatian construction sector in (Maric, 2023). Many interrelated reasons have been identified as influencing labour shortages but the most frequently noted are unfavourable working conditions and unsatisfactory wages.

Low or declining interest in vocational education and training (VET) is highlighted in the Danish contribution. Attracting young people to VET is a general challenge in Denmark. Despite attempts to attract more young people to choose VET following a reform of the system in 2014, there have not been any substantial increases: approximately 20% of the relevant cohort chose a VET course (in any area) in 2022 compared to a target of 25% (Dansk Industri, 2022). Details provided by the German contribution highlight the fact that the electrical and plumbing, heating and air conditioning trades alone lost over 18,000 skilled workers from each training year as the young workers started to work in other industries. The union therefore called on companies to improve working conditions as only this would retain and attract skilled labour to the sector and make it possible to achieve the target of installing 500,000 heat pumps annually (IG Metall, 2022). The German Energy Independence Council also estimates that labour shortages in the sector will continue to rise. To reduce future labour shortages in the relevant trades, it proposes to increase the share of skilled labour from abroad; to interest more women in such male-dominated professions; to provide better working conditions and pay; to increase the number of workers covered by collective agreement (to discourage workers from transferring to other sectors); and finally to recruit workers from other industries that are shutting down or

Table 3: Construction sector (NACE Section F) and heat pump employment indicators, 2023

Country	Number of workers in construction (thousands)	Number/share of construction sector workers currently working in heat pump installation	Estimated workforce needed to meet heat pump targets	Job vacancy levels/ rates in construction sector (%)
Austria	345.6	791 FTE[a]	n.a.	6.4
Belgium	329.3	2,645 certified heat pump installers (RESCert)	An estimated 2,700 additional heat pump installers are needed in the short term (VEKA)	5.4
Bulgaria	241.5	Limited data available; 120 trained heat pump specialists	n.a.	0.5
Croatia	117.4	n.a.	n.a.	1.9
Cyprus	38.0	9,357 (8,583 men, 774 women)	n.a.	2.0
Czechia	384.2	n.a.	n.a.	8.1
Denmark	186.2	20,023[b]	n.a.	2.4
Estonia	56.3	5,437[c]	n.a.	0.1
Finland	175.8	20,434	n.a.	1.6
France	1,791.0	n.a.	n.a.	4.0
Germany	2,690.8	n.a.	n.a.	6.4
Greece	162.1	n.a.	n.a.	2.6
Hungary	386.2	20,000–23,000 (including related tasks: planning, lead contractor, maintenance operator, repair staff)	Additional 5,000 estimated	1.6
Ireland	160.3	424 heat pump installers[d]	1,416 (mid-2020s) 1,739 (late 2020s)	0.7
Italy	1,493.7	n.a.	n.a.	3.2
Latvia	67.7	n.a.	n.a.	2.8
Lithuania	109.7	n.a.	n.a.	1.8
Luxembourg	15.4	n.a.	n.a.	1.0
Malta	19.1	n.a.	n.a.	3.0
Netherlands	418.6	500 (estimated)	3,000	6.8
Norway	227.8	67,381	4,200 in 2023[e]	3.5
Poland	1,285.0	2,000–3,000	200,000–300,000	1.6
Portugal	330.3	n.a.	n.a.	1.4
Romania	799.8	28 heat pump plumbers	n.a.	0.3
Slovakia	261.9	Approximately 2,900	Approximately 2,500 more heat pump installers will be needed by 2025[f]	0.4
Slovenia	66.3	6,150	n.a.	6.2
Spain	1,387.6	4.2%	150,000 more installers will be needed in 2030[g]	0.7
Sweden	313.4	22,388 HVAC technicians and others 3,854 cooling and heat pump technicians[h]	n.a.	1.7

Notes: *[a]BMK, 2023; [b]Includes all workers in the NACE Class 43.22, so it is safe to assume that not all are involved in heat pump installation (Danmarks Statistik, 2024); [c]Number of employees in NACE F43.2 ('Warming up business climate in Estonia', teatmik.ee (2024)); [d]Expert Group on Future Skills Needs; [e]The Confederation of Norwegian Enterprise (NHO) has estimated that a workforce of this number is needed in 2023 for its partner Nelfo's businesses. Nelfo is a trade association for electro, IT, electronic communications, system integrators and lift companies in Norway; [f]Slovak Association for Refrigeration and Air-Conditioning Technology (Slovenský zväz pre chladiarenskú a klimatizačnú techniku); [g]FEGECA, 2023; [h]SCB, 2021. HVAC, heating, ventilation and air conditioning; n.a., data not available.*
Sources: *Eurostat (lfsa_egan, column 1; jvs_a_rate_r2, column 4) and contributions received from the Network of Eurofound Correspondents (columns 2 and 3)*

are strongly affected by transformation (e.g. fossil fuel industries, combustion engine workers in the car manufacturing industry) (Fachrat Energieunabhängigkeit, 2023).

The Spanish contribution points to estimates by the National Confederation of Associations of Energy and Fluids Installation and Maintenance Companies (CONAIF) that 65% of installation and maintenance companies need staff to be able to provide the services they offer to customers, and almost all of them find it very difficult to find qualified workers. In fact, according to CONAIF, more than 10,000 available jobs are currently not filled, and there is little sign that this situation will change in the near future. The issue of an ageing workforce is also highlighted in the Spanish report with national figures from CONAIF demonstrating that the average age of heat pump installers is over 50 and that approximately 30% of current workers will retire in the next 10 years (Alonso, 2023). Other sector estimates suggest that about 150,000 more installers will be needed in Spain by 2030 (FEGECA, 2023).

The contribution from Romania highlights the dramatic growth in numbers required to deliver on ambitious national renovation strategies. To deliver on the renovation of 309,190 residential buildings, the government estimates that construction companies must increase their workforce by a factor of 5.8 (increasing the number of labourers who work on renovations from 14,782 in 2020 to 85,622 in 2030; increasing the number of engineers who work on renovations from 868 in 2020 to 5,065 in 2030). Government measures to address the labour shortage include increases to the minimum wage within the construction sector, tax incentives and measures to facilitate increased numbers of non-EU workers.

It is clear from the information provided that there are challenges in estimating the (direct and indirect) employment associated with heat pump installations. This is due to the fact that, in many countries, the installation is carried out by existing crafts (plumbers and electricians) who may work with multiple heating systems, and not exclusively on heat pump installation. Despite the variation in data available, the following trends are evident.

- The overall proportion of employees in the construction sector involved in heat pump installation is small. For example, it is estimated to be less than 1% in Austria, while the Spanish contribution indicates that 4.2% of the construction workforce of 1.4 million are involved in heat pump installation.
- Larger markets face significant labour shortages. For example, the German report identifies the need for an additional 60,000 fitters to facilitate the planned expansion of heat pumps by 2030, and 190,000 skilled workers to meet renovation targets.
- Even in strong markets such as Sweden, potential labour market barriers can be seen in the lack of qualified installers, leading to waiting times for heat pump installation. According to Per Jonasson, CEO of INCERT (an agency that deals with certification in refrigeration and heat pump technology), there is a need for another 1,000 certified installers to meet the needs of the market in this country (Byggnadsarbetaren, 2022; Energimyndigheten, 2020).
- In many countries, there is no specific data available on heat pump-specific roles as these roles tend to be incorporated into different crafts and trades, such as plumber, electrician or refrigeration and air-conditioning installer.
- There appears to be significant opportunities and openings for employment in the heat pump sector. In Finland, there are over 2,500 jobs available (2020 data) for roles related to the installation of refrigeration and air-conditioning equipment. Current estimates are that there are between 6,500 and 6,911 workers with special qualifications relevant to the heat pump sector.
- Employment demand in the construction sector remains strong in some countries (indicating overall competition for employees). Italy reported an 11% increase in demand for employees in the sector from 2019 to 2020 and from 2020 to 2021, followed by an increase of 21% from 2021 to 2022. This is attributable in large part to the Ecobonus and Superbonus schemes designed to increase energy efficiency in homes.

Few of the national contributions provide data regarding the percentage of female employees in the heat pump sector. It is unlikely, however, that the heat pump market would be expected to be any different to the broader construction sector where women are underrepresented. There is a concern across the construction sector in relation to the age of those currently involved in the sector. The Spanish contribution estimates that the average age of installers is over 50 and 30% will retire in the next 10 years. Both the gender balance and age factors are concerns across the construction sector in Europe (ELA, 2024, p. 59).

The EHPA estimates that Europe will need 500,000 qualified full-time workers by 2030 if EU targets are to be reached; this compares with the estimated 117,000 workers who were in the heat pump industry in 2022 (EHPA, 2023c). The Polish contribution indicates that it based its national estimates for the number of workers required in the heat pump sector as a proportion of EU needs, thus indicating a demand for between 50,000 and 80,000 workers.

A small number of countries have indicated that they have no significant concerns in terms of labour supply in the heat pump market. The contribution from Slovenia indicates that there are no specific labour shortages and a sufficient workforce is in place to meet the target of 13,000 new heat pump installations per year. Similarly, the report from the Netherlands indicates that there are no current concerns.

Labour shortages in the construction sector are also affected by the migration of workers across Europe, which depends on varying economic conditions. The national contribution from Croatia notes that some labour shortages are structural in nature and have been in existence for a long time and hence will not be solved in the immediate term. There is a pattern of workers from eastern Europe moving west to work in construction, with eastern European countries recruiting from beyond Europe (ELA, 2024, p. 64). However, with the incentives for heat pumps provided by a number of eastern and southern Member States and their heat pump markets still growing, the pull for the heat pump installers to move from east or south to west may decrease.

Skills development and training

The shift towards heat pump technology in domestic heating and cooling has underscored the need for a substantial increase in the skilled labour force within the construction sector. Estimates indicate a need for hundreds of thousands of additional trained workers across Europe to meet the demand for heat pump installations by 2030. This requirement has prompted various countries to initiate skills and training programmes, focusing on upskilling the existing workforce and attracting new entrants to the sector.

Overall, there is a positive trend across Europe, showing that existing training curricula have been adapted to include heat pump installation skills. Initiatives are in place to attract new workers and to retrain and upskill the current workforce, notably through apprenticeships in installation and building technology with a focus on heating technology. There is also a trend towards campaigns to increase the number of young people entering apprenticeships and crafts, for example in Ireland and Germany.

In many countries, apprenticeship programmes have evolved to include heat pump training for the relevant trades, such as plumbing. Alternatively, programmes include specific modules which cover heat pump installation as part of green energy technology modules, for example. The Danish contribution provides evidence of three specific VET programmes that address heat pumps, one in detail, 'Plumber Energy', with the others being broader in nature. The contribution notes that course content also needs to be continuously updated. The Norwegian national contribution highlights a specific cooling and heat pump technician VET programme, completed over four years, two of which involve training in a business/small or medium-sized enterprise (SME) in the sector.

Some concerns are noted in the Polish contribution: despite the availability of training that provides certification to those who complete it, enabling them to install heat pumps, there is no standardisation across the training programmes. The cost of completing such training is also high (a figure of €5,000 was noted), which is a barrier for many.

The importance of specific training for refrigerant and fluorinated greenhouse gas (f-gas) licences was also highlighted (see also EEA ETC/CM, 2023). F-gases, mainly hydrofluorocarbons, are used in the refrigerant cycle in heat pumps. If they leak or are not disposed of correctly at end of life, are significantly more harmful to the climate in terms of their global warming potential than carbon dioxide. There is legislation at EU level (Regulation (EU) No. 517/2014) to 'phase down' their use and to promote the transition to the use of more climate friendly 'natural' refrigerants such as propane (R290). This is one of the branches of specialised knowledge in which heat pump engineers will continue to need ongoing training and certification as the regulatory framework evolves.

There is evidence of the impact of EU-funded initiatives on skills notably under the Horizon 2020 and LIFE Clean Energy Transition programmes as part of the BUILD UP Skills initiative (European Commission, undated-a). The benefit of these initiatives is highlighted in the Bulgarian contribution, which references EnEffect (EnEffect, undated) as a partner in a number of projects including BUSLeague (BUSLeague, undated) and INSTRUCT (INSTRUCT, undated). These projects have both profiled skills demand and also piloted training on energy efficiency and renewable energy topics. However, these efforts are not yet mainstream and further resources are needed. Similarly, in Croatia, the CROSKILLS I and II projects have profiled training needs (in the wider sustainable building sector) and are developing curricula on key topics for lifelong learning provision (CRO Skills Reload, undated).

Similar initiatives exist in other countries. For example, Luxembourg has a heat pump installers lifelong learning programme. Reference has been made by some countries to the use of National Recovery and Resilience Funds for specific initiatives, for example the SOLAS Green Skills Action programme in Ireland. The contribution from Cyprus highlights the new Heat Pumps in Green Transition programme.

Belgium has established a certification system for reliable and high-quality green energy installers, with specific training programmes aimed at professional installers to encourage the installation of heat pumps (Box 2).

To address skills gaps, many countries have noted specific measures to support unemployed individuals to gain skills to enter sectors where there is a high demand for employees. The Estonian Unemployment Insurance Fund provides supports for people to attend specific training and courses on air conditioning, climate engineering and heating. This assistance is aimed at individuals seeking employment in occupations where there is high demand but they lack the required skills. Funding decisions, determining which training programmes receive support, are informed by research and by labour supply and demand forecasts in Estonia's economy. This is done by OSKA, which monitors the labour market and forecasts skills.

Contributions from Italy and Hungary note that there is a lack of formal training and that the majority of training is provided by manufacturers or suppliers. While the

quality is not considered to be an issue, there is no clear consistency or formal structure to the training and pathways for progression and career development are missing. Some countries, for example Romania, noted that technical expertise for the provision of training is lacking in the country due to the low presence of heat pumps in the market.

The challenge of attracting young people into the sector is again highlighted in the Spanish contribution. It provides data on the number of students engaged in specific VET-level heat pump training: the 7,414 students who completed these programmes represented approximately 1% of all VET students in Spain and is well below the target of 150,000 installers who need training. Industry-led training, however, continues to grow and is supported by specific state funds.

The low participation of women in training is also noted in Spain, and other countries, reflecting the general gender imbalance in the sector. According to the available data from Spain for 2021–2022, only 1.6% of students in these courses were women (1.4% in intermediate VET studies and 2.2% in higher VET studies). This low presence differs from the higher presence of women in general VET studies (approximately 43.6% of all VET students were women, with 42.2% in intermediate VET studies and 44.9% in higher VET studies) (Table 4).

This issue is also highlighted in the Slovakian contribution with the Slovak Association for Cooling, Air Conditioning and Heat Pumps underlining the participation of workers in the EU Women in Cooling competition as a means of highlighting the excellence of female workers and the opportunities for employment in the sector (Area, undated). This creates an opportunity to promote women working in the sector but also to attract new female workers.

There is evidence of collaboration between countries to address skills and capacity gaps. One interesting example is the cooperation between Greece and Germany whereby educators, trainers and companies in Greece are provided with training in solar cooling, ventilation, air conditioning and heat pumps by expert German partners. Furthermore, centralised training facilities have been developed and these can be used by multiple schools. This overcomes the barrier of all schools having to invest in heat pump technology.

Table 4: Participation of men and women in relevant VET programmes in Spain

Gender	Development of thermal and fluids installation projects	Maintenance of thermal and fluids installations	Total no. of heat pump-related VET studies	Total no. of VET students
Men	203	1,747	1,950	223,907
Women	8	35	43	182,534
Total	211	1,782	1,993	406,441

Notes: *The figures refer only to in-person students and do not include distance learning students.*
Source: *Spanish Ministry of Education, VET and Sports, 2023*

Box 2: Good practice examples in training

Germany has taken a proactive approach to updating the curricula of relevant craft programmes that are delivered through the vocational training system. All curricula were updated in 2016 and heat pumps are covered in modules such as renewable energy and environmental technology components. Furthermore, to address the upskilling of existing workers, a new incentivised training programme was launched in 2023. As part of this programme, companies are supported in sending their staff on heat pump training programmes; the aim is to train 17,500 workers and 3,000 consultants. If companies send their employees to a heat pump training course, 90% of their eligible expenses can be borne by the new funding programme (specific limits are in place). Similarly, coaching sessions on heat pump installation (i.e. on-the-job training by an expert) are also funded in the amount of 90% of the eligible expenses. A maximum of one coaching session per employee is funded with up to €500. Training sessions and coaching need to be taken with a licensed training or coaching provider. This state-funded training is also complemented by extensive training provided by heat pump associations, manufacturers and others in the market. The funding is available from 1 April 2023 until 30 September 2025 (Handwerksblatt.de, 2023).

The Netherlands is highlighted as having a well-structured approach to training and capacity building that is directly aligned with the country's Hybrid Heat Pump Action Plan. Techniek Nederland organises specific VET training for heat pump installers and there is close collaboration between the public and the private sector. A specific aim of the Heat Pump Action Plan is to contribute to the goal of reducing heat pump installation time (from 32 to 16 hours). Specific training centres are being developed at regional level (to facilitate access to training), and upskilling and reskilling courses are being developed. Central heating engineers are being retrained and new entrants are being trained. They can obtain a VET certificate in installing and commissioning hybrid heat pumps within six months (420 hours). There are also other training opportunities available through the Vakmanschapsprogramma Warmtepompen (Heat Pump Craftsmen's Programme).

The Flemish Region, the Walloon Region, and the Brussels-Capital Region have established a harmonised system aimed at training and certifying reliable and high-quality (green) installers. The regions aim to enhance the efficiency, safety and longevity of green energy systems such as solar panels, solar water heaters, and heat pumps by granting a 'certificate of competence' to installers. These certified professionals are known as RESCert installers. There is a specific certificate for heat pump installations. The course focuses on domestic heat pump installations and provides an insight into all aspects of preparation, implementation and operation of a heat pump system. The RESCert certificate is not only a quality guarantee, but also a tool to retrain professional installers so that they can install heat pumps properly. This training is aimed at professional installers of plumbing and central heating, as well as refrigeration technicians. The certificate is valid for seven years (or only 5 years in Brussels). In the last two years of validity, the installers can renew the certificate after undergoing a refresher training programme. This aims to update their knowledge in relation to recent changes in relevant legislation or new developments, for example. In 2022, heat pump courses were revised in consultation with the sector to make the training more appealing and practical for installers.

In the Flemish Region, there is an additional incentive (Flemish training leave) that supports upskilling. An employee in the private sector has the right to be absent from work to attend training, while still receiving their salary. They can do so for a maximum of 125 hours per academic year. To put this in context, the training needed to become a certified heat pump installer (RESCert) is 40 hours for existing professional installers of heating systems. To qualify for bonuses related to heat pump installation in Belgium, the installation needs to be carried out or validated by a RESCert-certified worker. This requirement serves as an incentive for workers to undergo the necessary training. Another aim of the RESCert is to give renewable energy/heat pump installers the opportunity to distinguish themselves from their competitors, but as of now, installers mostly follow the training because this is necessary for their clients to qualify for the bonus.

In Portugal, a new Energy Training Centre was established in 2023 to promote VET training and the recognition, validation and certification of skills in energy transition and climate action. In Ireland, a range of new Near Zero Energy Building (NZEB) centres of excellence have been opened and specific training programmes on heat pumps are offered by further education training providers. In addition, a mobile training rig, which is used to visit schools, companies and remote training locations, has been developed by Laois and Offaly Education and Training Board.

In Sweden, specific Certified Heat Pump Installer (CIN2) training is provided. The training consists of a two-week remote study course, which concludes with a two-day seminar and an exam. Currently, the course is administered in one location, the Härnösand vocational school, although more locations are expected to open. The course is validated by INCERT, which also keeps a record of companies whose employees have received the certification. As of 1 November 2023, 20 companies in Sweden were registered as having CIN2-certified employees (INCERT, 2023). This programme can only be accessed by those who have at least three years' experience in the heating, ventilation and air conditioning (HVAC) sector (and would already be a qualified HVAC technician).

New training programmes focused on heat pump installation and maintenance have been initiated in Italy and Lithuania, yet the reach and adequacy of these programmes vary. In Italy, training is offered predominantly by larger companies, while smaller businesses do not have the capacity to provide such training. The Lithuanian contribution showcases more structured training opportunities but acknowledged the need for broader skills development to support the green transition. The input from Hungary reported that curricula in the construction sector have generally been updated but lack a specific focus on heat pump technology, pointing to a potential gap in specialised training.

The importance of relevant statistics to inform training needs and the associated funding for such training has been highlighted in a number of countries. The Slovakian national contribution notes that heat pumps are grouped with sewage, air conditioning and heating devices in national statistics. This lack of clear data on people working in the heat pump sector, often driven by the nature of employment statistics, can result in the case for investment in training being hard to justify.

A number of EU and international initiatives are important to note. The EU-funded Heat Pumps for All (HP4All) project developed an initial heat pump competency framework, which considered the following core groupings (HP4All, undated).

- Installers – those requiring technical and customer-focused competencies. Typical positions include installer, maintainer and decommissioner.
- Chief installers – those with organisational and customer-focused competencies delivering organisational goals. Typical positions include team leader, project manager and technical specialist.
- Corporate – those requiring business and organisational competencies ensuring organisational growth. Typical positions include general manager, owner, director.

Three competency clusters (customer-orientated competencies, technical competencies and business/organisational competencies) were then defined. These covered a suite of 26 specific competencies that should be considered. The HP4All consortium noted that the competency framework can be developed further and could form the basis for planning and analysing skills needs in the heat pump sector across Europe. However, it also noted that it can be difficult to pinpoint the minimum competencies needed by heat pump designers and installers, as the building regulation, incentives and education systems are different for each region, which mitigates against standardisation at EU level (HP4All, undated).

The IEA report on the future of heat pumps (IEA, 2022) highlights the growing demand for installers. Focusing primarily on the technical skills required for design, sizing and installation, the report identifies key skills relevant to each occupation and differentiates between the skills relevant for each type of heat pump. The IEA indicates a need in Europe for approximately 150,000 heat pump installers and operations and maintenance workers by 2030 (up from approximately 50,000 in 2019). Given the constraints within the construction sector in general the IEA strongly recommends 'incorporating heat pumps into existing certifications for heating technicians, plumbers and electrical engineers, who have similar skills'. This would help reduce training requirements but would also have to be accompanied by incentives to upskill existing workers, develop new training programmes and encourage new workers into the sector.

Progress towards targets

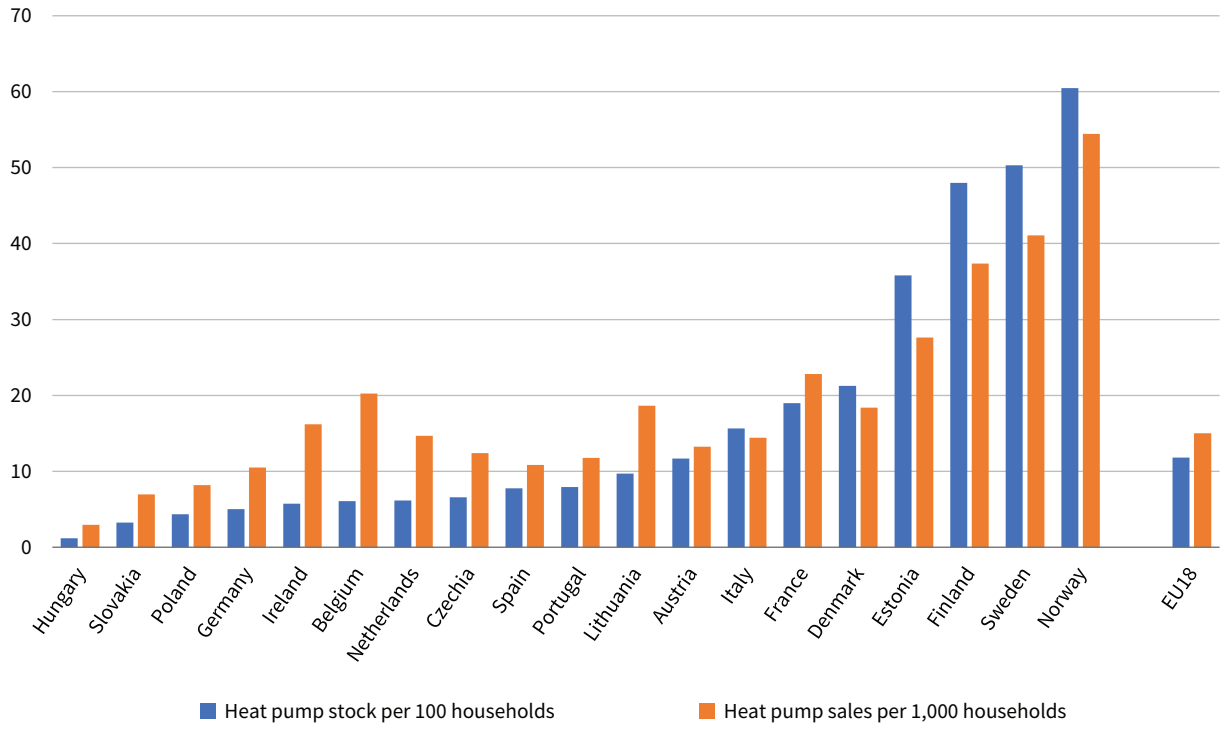
Growth of heat pump market

Heat pump sales across Europe have experienced significant growth in recent years. Driven by policy changes and energy security concerns, significant growth occurred between 2020 and 2022, but 2023 saw a decline in sales compared with 2022 (EHPA, 2023a). Figure 2 shows heat pumps sales and heat pump stocks for a selection of EU countries based on EHPA data. The leading position of the Nordic countries is highlighted – both sales and existing stock of heat pumps are much higher, particularly in Finland, Sweden and Norway. The majority of other countries within the sample recorded sales of between 10 and 25 per 1,000 houses in 2022 and have an installed base of less than 1 heat pump per 10 households.

Countries are at various stages in meeting their heat pump installation targets. The NECPs reflect the varied approaches that countries have taken in setting targets for heat pumps and retrofitting.[2] The assessment of progress in the context of the NECP is not always consistent. This may be because, in some cases, countries are outside of NECP requirements (e.g. Norway) or because the submission of plans (and their subsequent evaluation by the Commission) are delayed (e.g. Poland). In the case of Poland, no specific targets for heat pumps were included in the 2019 NECP, nor is there a specific target within the Polish Energy Policy to 2040 (PEP2040). While there are no specific targets, heat pumps are referenced generally in relation to contributing to general heating and cooling energy efficiency targets.

The progress made in achieving national targets for heat pump rollout paints a mixed picture. For example, the Italian contribution reports a significant uptake in heat pump installation, driven by fiscal incentives. The Lithuanian report focuses on replacing heating systems in homes that are not connected to central/district heating systems with more efficient renewable energy systems – including heat pumps. Data provided indicate that in 2021, 49,000 air source heat pumps were sold; however, a breakdown by area is not available.

Figure 2: Heat pump stock and heat pump annual sales, selected countries, 2023



Sources: *EHPA, 2024 for stock and sales data; Eurostat [lfst_hh] for household count in 2023 (authors' own elaboration)*

2 National Energy and Climate Plans were submitted to the European Commission in 2019 and revised drafts were due by 2023. The NECPs referred to in the national contributions were those published at the time the data were collected (January–March 2024). See https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en for a current listing.

The report notes that air-to-water heat pumps account for 80% of applications to the specific fund available for the replacement of heating systems. Hungary's lack of ambitious state programmes for residential heat pump adoption is seen as a barrier to reaching its targets, despite the national contribution acknowledging the potential to meet them ahead of time. Cyprus and Spain have ambitious plans but face challenges, as highlighted earlier, in relation to skilled labour availability and public awareness.

Greece is aiming to double the share of dwellings with heat pumps from 8% to 17% by 2030 and has a number of support programmes in place. Furthermore, it is tackling other market barriers such as the permission process for larger geothermal heat pump installations, which is considered slow and excessively bureaucratic. Such large-scale geothermal potential creates the opportunity to provide heating, cooling and domestic hot water in district heating systems. There are already 1,000 units installed in Greece (estimated 70 MW of heating and 72 MW of cooling), providing energy to central or district heating systems in areas such as Thessaloniki and East Attica.

Austria has seen a significant increase in the installation of renewable heating systems, particularly heat pumps, signalling a positive shift towards meeting its climate neutrality goal. The 'Get out of oil and gas' campaign played a particular role in this, with strong interest from individual homeowners in supports to switch to environmentally friendly heating or district heating. Belgium, particularly Flanders, already exceeded its 2030 heat pump capacity target in 2022, demonstrating significant progress. However, both countries acknowledge that a key component of the success in developing the market to date has been the efforts made to address skills and labour force shortages. Continuing challenges remain in these countries, despite the progress made to date.

The Italian national contribution showcases growth across all heat pump types up to 2022. The country had the highest growth rate in Europe in 2022 (ahead of Germany and France). The incentives provided through the Ecobonus and Superbonus schemes played a significant part in this growth. The trend towards the electrification of heat will see this growth continue. As in the Netherlands, there has been growth in hybrid installations (combined heat pump and condensing gas boiler).

In 2023, Germany's Federal Heat Pump Association (BWP) published its market analysis on heat pump installations, including an outlook on future market developments (BWP, 2023). In summary, the BWP holds that the federal government's 'ambitious targets' are achievable if the right market conditions and regulations are in place. This includes maintaining subsidies at a stable level to ensure market development, reducing electricity prices further (by reducing the VAT rate, for example) and adjusting supports to favour those with limited financial resources to install heat pumps themselves.

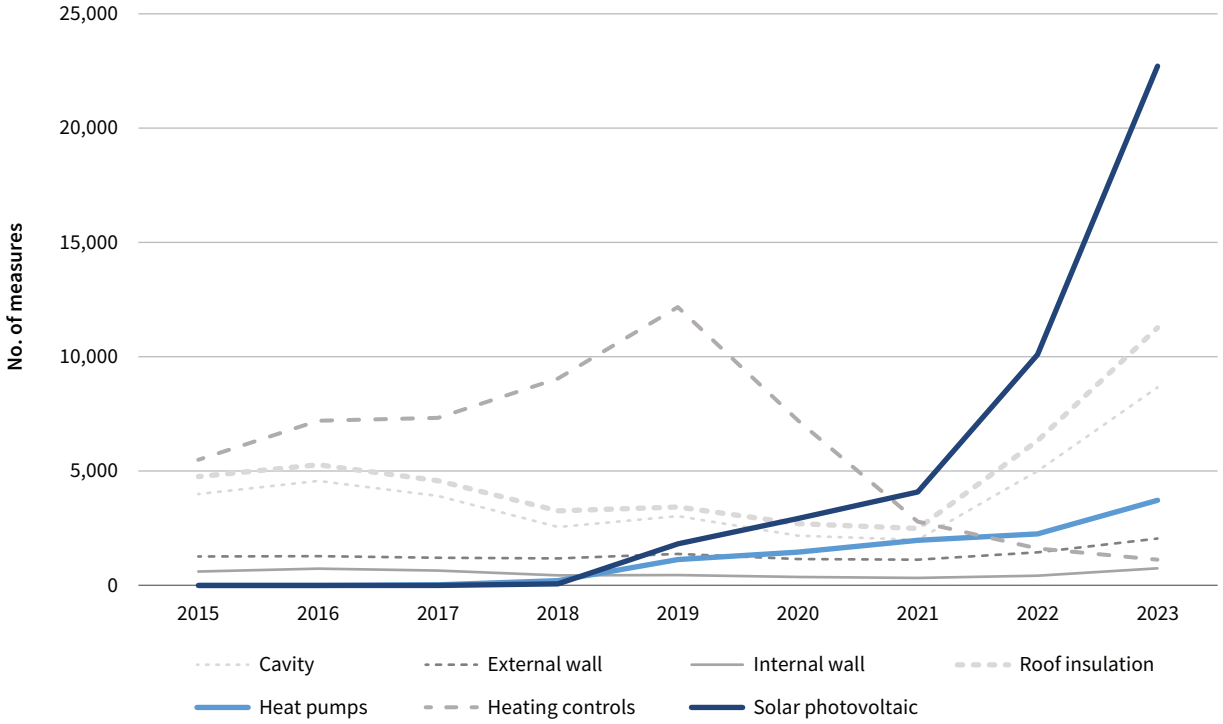
The BWP notes that the debate and discussion regarding the new laws and associated funding supports in 2023 contributed to a slowdown in the sale of heat pumps, as homeowners waited to consider the outcome of new policy and support measures. Uncertainty regarding policy commitments to decarbonisation – reflected in the deferral of the proposed phasing out of fossil fuel heaters, for example in Austria and Germany – is cited as one factor in the declining heat pump installation rate noted during 2023.

The Danish contribution notes a 640% increase in heat pump installation between 2011 and 2023, but notes some uncertainties regarding future projections. It should be noted that Denmark has one of the highest penetrations of renewables in the heating and cooling sector, having achieved a target of 60% of heating and cooling coming from renewables by 2022.

Taking a further example of Ireland, where annual data from relevant heat pump subsidy schemes (for retrofitted buildings) are available, the evidence of growth in the market is clear. Nevertheless, rapid growth is required if the target of 400,000 heat pumps in existing buildings is to be achieved by 2030. Over 11,000 heat pumps have been installed in existing homes in Ireland since 2019. While there was a 66% increase in heat pumps installed in 2023 compared to the previous year, the total installation figure of 3,769 was 66% of the target of 5,734 installations.

Figure 3 shows the changing profile of retrofit measures being undertaken in Ireland. Growth in heat pump installation began in 2019 but this has been overtaken by rapid growth in solar photovoltaics in recent years. This relates to the fact that the price of solar panels has been declining faster than the price of heat pumps and pay-back times are shorter as a result. From a sustainability perspective, a strong case can be made for householders installing both solar photovoltaics and a heat pump, as electricity generated by the former will help to run the heat pump.

Figure 3: Profile of retrofit measures in Ireland, 2015 to 2023



Source: *Authors' own elaboration, based on SEAI data, 2024a*

Variation in subsidies

There is significant variation in the range and type of subsidies available for the purchase and installation of heat pumps across Europe. Table 5 highlights the differences across a number of countries.

In some countries, there are no specific targets for number of heat pump installations but progress can be considered in the context of various funding initiatives and programmes. For example, in Portugal, while overall progress has been made in the distribution of subsidies on residential retrofit programmes, specific evaluation of heat pump incentives is lacking. An evaluation report (Palma et al, 2023) indicated that the Support Programme for More Sustainable Buildings 2023 distributed almost its entire budget: around €123 million distributed over 70,344 applications. This brought the total amount invested by citizens and the state to €190 million. Of the total number of eligible applications, 26.1% concern the installation of heat pumps (€51.3 million).

Evidence presented in the Netherlands contribution on the investment subsidy for renewable energy technologies is very positive, indicating a growth in the number of people availing themselves of grants for heat pumps. From 2021 to 2022, the number of applications for the investment subsidy for sustainable energy and energy saving (ISDE) for heat pump installation quadrupled, from 8,775 to 32,105 (Rijksdienst voor Ondernemend Nederland, 2024). To achieve the target of 1,000,000 heat pump installations by 2030, the industry will need to install 500 heat pumps per day in the Netherlands. Based on current trends, experts are confident that this will be achieved. An important provision in the Dutch Hybrid Heat Pump Action Plan, agreed between industry, construction interests and public authorities, is that there is a significant focus on installers, ensuring that the labour time required for the installation of hybrid heat pumps is reduced. With the right preparation and the efficient deployment of installers, a hybrid heat pump should be installed within one day. A subgoal is to reduce the average installation time for hybrid heat pumps from 32 hours to 16 hours. The reduction in the required installation time is important for scaling up the hybrid heat pump rollout, and this can be achieved through innovation and standardisation in product and chain processes. With the targeted installation time, the technician can install and commission both the gas boiler and the hybrid heat pump in one day. This will be greatly influenced by the ambition to reduce heat pump installation time, cut manufacturing costs and improve installers' skills. The Sustainable Installation Team Foundation (TDI500), a collaboration between 10 leaders in the heat pump installation industry, was formed to drive this ambition.[3]

3 See https://teamduurzaaminstalleren.nl/

Table 5: Examples of heat pump subsidies in selected Member States

Country	Heat pump-specific subsidy	Comment
Austria	Air-to-water heat pump: €16,000 Water-to-water or brine-to-water heat pump: €23,000	Additional new subsidies have been implemented. These include a €5,000 drilling bonus if a heat pump is installed. Through the combination of federal and regional state subsidies and tax benefits, it is expected that on average, three-quarters of the total investment costs will be covered by the subsidies
Czechia	Minimum financial support is CZK 60,000 (approx. €2,400) and maximum CZK 140,000 (approx. €5,600). Depending on the real energy savings, the owner can save up to 50% of the total eligible costs (depending on the type of heat pump)	The source of funding in the new programming period 2021–2027 is the NextGenerationEU Fund, through its National Recovery Plan. Eligible applicants are owners of family homes and apartment buildings (both natural and legal entities)
Denmark	Subsidy of up to DKK 27,000 (approx. €3,600) depending on the type of pump It is also possible to apply for a subsidy of up to DKK 25,000 (approx. €3,350) in cases where the household wishes to lease a heat pump rather than purchase it outright	The Heat Pump Fund will administer a total of approximately DKK 745.5 million (approx. €99.99 million) between 2023 and 2026
Finland	Subsidy of €4,000 when oil-based or gas-based heating is replaced by a geothermal heat pump, air-to-water heat pump or district heating	By February 2024, approximately 26,600 applications had been approved for replacing oil heating and 1,038 for replacing gas heating
Germany	If a fossil fuel heating system is replaced with a climate-friendly heating system, 30% of the costs can be funded	Applicants can receive an additional 20% of their costs if they replace old systems by the end of 2028 (the 'climate speed bonus'). A 5% efficiency bonus for heat pumps (only for heat pumps with natural refrigerants such as R290 propane, e.g. NovaAir or geothermal heat pumps) is also available. Private households with an annual taxable income of less than €40,000 can receive another bonus (to a maximum of 30% of their income) if they renovate their own home. All three bonuses can be combined and granted to one applicant. Total funding is limited to 70% of the costs for installing an energy- and eco-friendly heating system For single-family homes or for the first party in a multi-family home, investment costs can be subsidised up to a maximum of €30,000. For multi-family homes, the maximum eligible expenditure is increased by €15,000 each for the 2nd to 6th residential unit and by €8,000 each from the 7th residential unit. For example, an applicant can receive up to €31,500 for a new heat pump in an apartment building with two parties and up to €42,000 with three parties
Ireland	Subsidies vary depending on type of dwelling and heat pump type Air-to-water heat pump, ground source-to-water heat pump, exhaust air-to-water heat pump, water-to-water heat pump: €4,500 (apartment) or €6,500 (house) Air-to-air heat pump: €3,500	Technical assistance grant of €200 available for homes built before 2007. A heat pump bonus of €2,000 is available if work is done as part of a deep retrofit (typically a major renewal of an existing building, generating savings in energy and emissions that exceed 30–50%) through a one-stop shop. Supports are also available for upgrading central heating systems
Luxembourg	The following subsidies are available: €8,000 for geothermal heat pumps with a capacity of <= 10 kWth €5,000 for air-to-water heat pumps with a capacity of <= 10 kWth €500 per kWth for capacities > 10 kWth The same conditions apply to hybrid heat pumps	Aid is capped at 50% of the eligible actual costs, with a maximum amount of €12,000 that can be granted. Additionally, there is a 30% bonus for replacing a fossil fuel heating system (a gas, oil or electricity system that is more than 10 years old): 50% of the aid is for the actual costs of removing the oil tank (maximum €2,000) and 50% is for the actual costs of adapting the existing heat distribution system (e.g. radiators) (maximum €2,000)
Netherlands	Subsidies on the purchase of a (hybrid) heat pump have been increased to an average of 30% starting in 2022. In addition, financing through the National Heat Fund, with an interest rate of 0% for low and middle incomes, is available	Until 2030, the government has set aside €150 million per year to continue supporting homeowners in the purchase of a (hybrid) heat pump

Source: *Contributions received from the Network of Eurofound Correspondents*

Slovenia has seen a progressive increase in the number of subsidised heat pump installations, with financial incentives playing a significant role in this growth. The country's approach includes addressing energy poverty by subsidising energy renovations and boiler replacements, albeit with a focus on biomass boilers.

An evolving subsidy picture

One particular issue raised by many national contributions is the evolving policy situation and hence changes in subsidies or newly emerging subsidies. Furthermore, a number of countries are revising or developing support schemes in line with their NECPs and have no concrete data available yet.

Broadly speaking, where financial grants are in place, they cover between 20% and 40% of eligible costs. A number of respondents indicate that low levels of support are seen as a barrier by homeowners. In Germany, the new Federal Funding Scheme for Efficient Buildings (BEG), launched in early 2024, has a baseline of 30% support with bonuses if the replacement takes place before 2028; it also offers additional supports for low-income households. In Denmark, the Building Fund, which ran from 2020 to 2022, was very popular (the 2022 call for applications closed within two weeks due to the scale of applications). Data on a newer Heat Pump Fund in Denmark are not yet available. There is some commentary from TEKNIQ, the employer organisation for the technical sector, that it is not fit for purpose, as it does not sufficiently address those with the most substantial needs and those in areas where district heating will not be available.

In Spain, there has also been growth, supported by subsidies: sales of heat pumps increased from 47,500 in 2022 to 70,300 in 2023, but still only 5% of Spanish homes have heat pumps installed. The country places 17th in the EHPA ranking in terms of number of heat pumps per 1,000 homes. The market development potential is evident and the Spanish government has earmarked €1.32 billion for a subsidy programme for a range of renewable energy systems, including heat pumps. The funds will be administered through the autonomous communities and there may be variations in priorities and criteria aligned to the subsidies. These funds are there to support the Spanish NECP target of generating 2,659 ktoe of energy from heat pumps of by 2030 (up from 1,158 ktoe in 2022).

In countries where the market is yet to grow and is in a development phase, a lack of data is hindering an assessment of progress and understanding of market trends. In Romania, while various incentives and subsidy programmes have been in place (and are growing) – the Energy-Efficient House programme offers RON 70,000 (approx. €14,000) towards building renovation and heat pump installation, for example – there is a lack of data available on the effectiveness of these support programmes. This gap in the data is also reflected in the European Commission's review of the Romanian NECP, which cites a lack of data, a lack of targets and uncertainty around social, employment and other impacts. Croatia has also been requested to raise its level of ambition and include more detailed trajectories for the deployment of renewable energy technologies, including heat pumps. The country plans to use Recovery and Resilience Facility funding to support building renovation and heat pump installation. Where data is not available on market development that has been achieved through subsidies and supports, some countries were able to indicate market growth through heat pump import data. For example, the Latvian national contribution indicates a near doubling of imports from €7 million in 2020 to €13 million in 2023.

Experts in Hungary maintain that the 2030 target is not sufficiently ambitious (100,000 units by 2030) and that this will be achieved before then. This is in the absence of a government support programme, which presents a risk given the lack of incentives and the uncertainty in the market. These developing market challenges can be contrasted with Finland, which has the highest penetration of heat pumps per 1,000 households in the EU27. In Finland, growth was stable from 2008 to 2020; this was followed by 25% and 50% growth in 2021 and 2022, respectively.

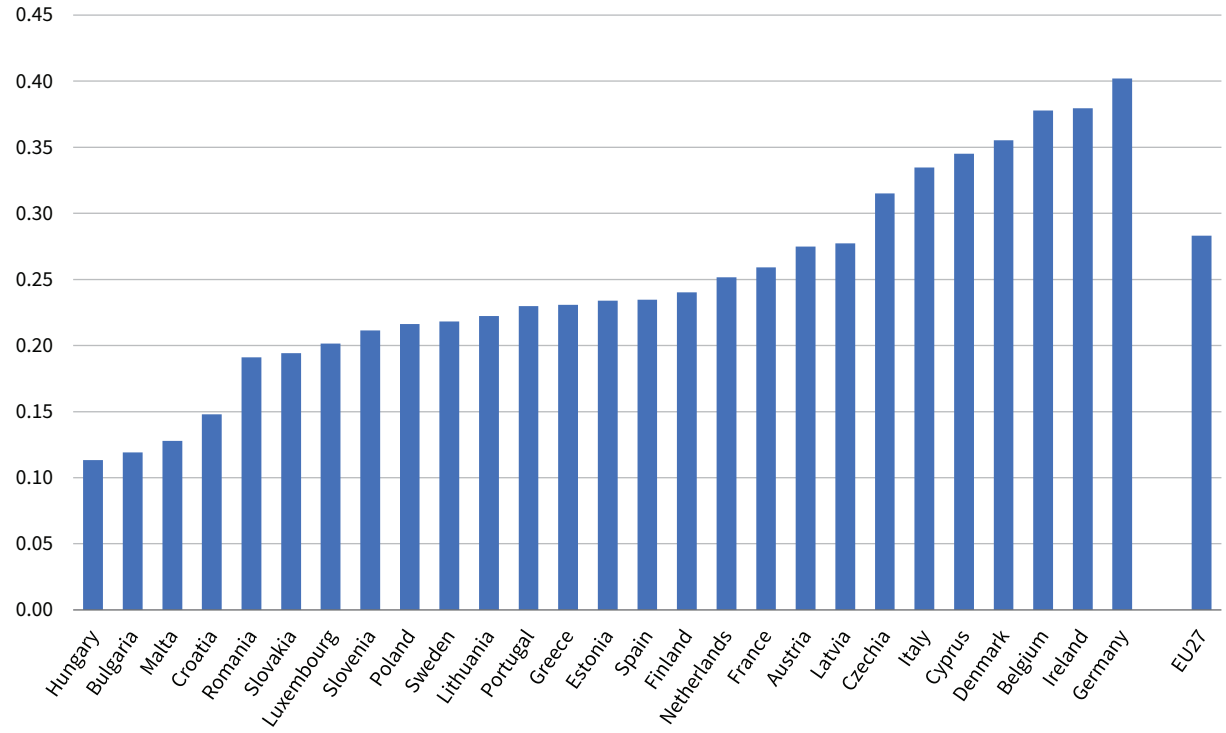
Palma et al (2023) published a report that aims to conduct an exploratory and critical analysis of the feasibility of decarbonising energy consumption in residential buildings in Portugal. According to this report, the Support Programme for More Sustainable Buildings 2023 distributed almost its entire budget, around €123 million over 70,344 applications. This brought the total amount invested by citizens and the state to €190 million. Of the total number of eligible applications, just over a quarter (26.1%) related to the installation of heat pumps (€51.3 million).

Electricity-to-gas price ratio challenge

In addition to the barriers presented by the lack of a trained workforce, concerns over the price differential between natural gas and electricity are raised in many national contributions. Electricity prices vary considerably across Europe (Figure 4) and in some countries the ratio of electricity to gas prices is 3 or 4 to 1 or greater, meaning that gas is three to four times cheaper than electricity (Figure 5).

As homeowners consider their options for moving away from fossil fuel-based heating systems, concerns over long-term energy bills due to high electricity prices is a deterrent. A ratio of 2:1 is regularly quoted as being ideal for mass heat pump deployment. Such a ratio,

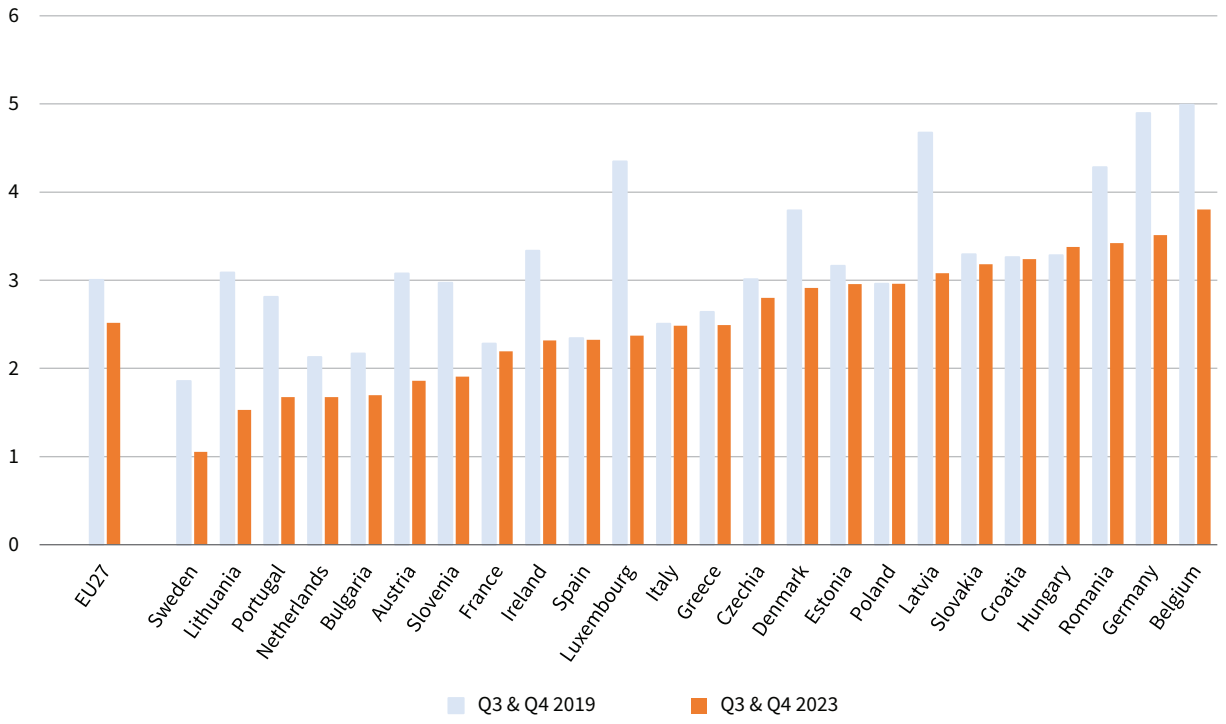
Figure 4: Average cost of electricity for domestic consumers, € per kWh, Q3 and Q4 2023



Notes: *Consumption bracket: 2,500-4,999 kWh. The above figures may or may not include adjustments for special heat pump tariffs that exist in some Member States.*
Source: *Eurostat [nrg_pc_204]*

given the superior energy efficiency of heat pumps (in a range of 3–4 times more efficient), would ensure that they are cheaper to operate than gas boilers. While the ratio has reduced in electricity's favour in recent years (Figure 5) in a majority of Member States, the economic case for choosing heat pumps over gas

Figure 5: Ratio of electricity to gas prices for household consumers, selected Member States, € per kWh, Q3 and Q4 2019 and Q3 and Q4 2023



Source: *Eurostat [nrg_pc_202] for gas: consumption from 20 to 199 gigajoules; [nrg_pc_204] for electricity: consumption bracket 2,500–4,999 kWh*

boilers from an operating cost basis remains marginal at best in around half of the Member States.

The existing high price differential reduces the potential financial savings that can be achieved by moving to a heat pump and decreases the return on investment for the installation of the heat pump. Payback and return on investment is the critical factor for end users, and an unfavourable electricity-to-gas price ratio therefore acts as a major barrier to market development. This is especially the case as heat pumps operate optimally in combination with a well-insulated building envelope and this will often require additional investment in insulation and other work.

The German contribution points to reports highlighting the fact that energy prices need to be kept at a level that favour heat pumps (BWP, 2023). To keep demand for heat pumps going, electricity prices need to be reduced further (for example, by lowering VAT). Federal subsidies (BEG) need to be kept stable as regards their financing and conditions terms. The BWP stressed that if the government wanted to reach the target of 6 million heat pumps by 2030, additional measures (apart from funding programmes) were needed and electricity prices should be lowered. Residential retail electricity prices are still subject to double the number of taxes, levies and surcharges than natural gas prices (BWP, 2024).

Similar sentiments are cited in the Slovakian contribution which emphasises that gas is three times cheaper than electricity in Slovakia. Although the number of heat pumps installed will increase, without subsidies, the financial return on their purchase is questionable. The Belgian contribution adds further evidence of this issue, noting that although heat pumps are much more efficient than fossil boilers, they struggle to compete due to the price differential between electricity and fossil fuels (electricity being about three times more expensive than gas) and the cost of installation. The average ratio between 2015 and 2023 in Flanders was 4.5. In 2021, Belgium had the highest ratio of all EU countries. Such a high price ratio renders it economically unviable for buildings to use a heat pump, irrespective of the level of insulation. A ratio of 1.8 would favour a heat pump over a gas boiler in the majority of homes, even those that are poorly insulated. In general, the breakeven point for the profitability of operating a modern heat pump occurs at electricity-to-gas price ratios lower than 2.5. Shifting taxes, levies and charges from electricity to gas could help to lower this ratio.

Conversely, the Netherlands contribution reports that the price for gas is relatively high and this is predicted to grow while the price of electricity is getting lower. This is reinforced by taxation changes, which are rising for gas and falling for electricity.

Specific measures to address low income and energy poverty

With over 1 in 10 EU27 households unable to keep their homes adequately warm in 2023 (Eurostat, [ilc_mdes01]), public policies to promote energy-efficient renovation are also a response to energy poverty, supporting the health and well-being of people and helping to reduce their energy bills.

The German contribution highlights the fact that state support and subsidies should be reviewed so that the federal funding programme is focused on homeowners with limited funds of their own. At the beginning of 2024, the BWP stated in a press release that heat pump sales had risen in Germany once more in 2023. However, sales had slowed noticeably in the second half of 2023 (BWP, 2023). The heated debate on the new law and funding conditions for heating systems had unsettled consumers in their decisions. Large upfront costs mean that only a certain section of society is in a position to undertake such an investment. In surveys conducted as part of the Slovakian Green Households programme, wealthier residents indicated that they would be interested in a subsidy but that it was not necessarily a determining factor for all, indicating that the subsidy was not a driving factor.

However, social inequalities persist in the adoption of heat pump technologies, largely due to high initial installation costs, even as subsidies aim to mitigate these barriers. Initiatives to extend funding to include low-income households (with higher funding rates) and a variety of residential situations have been introduced to ensure broader access to renewable heating solutions. Within Sweden, which has one of the lowest risks of energy poverty in Europe, there is also a debate generally about vulnerable Swedish households that cannot deal with rapid changes in electricity prices.

Where supports are in place to address energy poverty, uptake is not always as expected. For example, the Efficiency Voucher scheme in Portugal had a budget of between €138 million and €162 million and had capacity to award 100,000 vouchers but only 21,736 applications were submitted and 11,358 vouchers were awarded. Challenges with budget allocation, promotion and communication were identified. It was also noted that the programme only targeted homeowners, while many of those experiencing energy poverty may be in rental accommodation and thus unable to avail of such supports.

Research by Heinrich et al (2024) on German support programmes also noted that of the 653,000 projects funded under the federal subsidy for efficient buildings (BEG), the majority of recipients were generally in high-earning jobs, were highly qualified and were aged between 20 and 67. Similar trends were indicated for

home renovation programmes – indicating that such programmes were inaccessible to some sections of society and in particular low-income households.

In Ireland, there are specific schemes to support low-income households. Nearly half of 'one-stop shop' home upgrades are on social housing properties whose tenants are at risk of energy poverty. The number of fully funded home energy upgrades – an option only available to those receiving welfare benefits – increased in 2023, with nearly 5,900 homes upgraded (SEAI, 2024b). The wait times for fully funded home upgrades are much longer than for those not funded under the energy poverty programme, but the average wait time decreased in 2023 to 20 months.

A similar fully funded programme exists in Austria, while in Czechia a specific subsidy for boiler replacement is now focused on low-income households only. The subsidy covers the replacement of solid fuel boilers with more environmentally friendly solutions such as heat pumps. Applications can be submitted by people receiving an old-age pension, people with disabilities or households receiving a housing allowance. In comparison with the New Green Savings Programme, the subsidy is provided in advance and the applicant can receive up to 95% of the total eligible cost, up to a maximum amount of CZK 180,000 (approx. €7,200).

In Luxembourg, low-income households may benefit from additional assistance from municipalities and from the energy suppliers Enovos and SUDenergie.

Additionally, the Ministry of Housing and Spatial Planning has implemented a 'Topup social Klimabonus', which can result in a doubling of the amount received under the Klimabonus national grant scheme, depending on the income of the beneficiary household. However, this programme has since been discontinued as its budget was fully utilised.

The uptake of heat pumps also showed some variations at a regional level within countries (where data were available). In the Netherlands, regions with larger urban areas (for example, Randstad) have fewer heat pump installations, primarily due to existing district heat networks and a higher proportion of apartments and smaller homes. In other countries, rural regions appear to have lower growth in both retrofitting and heat pump installation due to lower income levels, poorer insulation levels within homes and lack of available finance. Other regional differences are evident in some support programmes where subsidies are aligned with targets to improve air pollution in particular regions. In Greece, for example, a specific sub-programme of the EXOIKONOMO 2024 programme provides extra supports in regions with air pollution problems, such as Thessaloniki, for the installation of a heat pump as long as a biomass boiler is removed simultaneously. In Germany, the greatest uptake was noted in Bavaria, Baden-Württemberg and North Rhine-Westphalia – densely populated and economically strong federal states when compared to eastern German states.

Faster rollout of heat pumps

The feasibility of reaching national targets for heat pump installation is contingent upon addressing the challenges that are identified and effectively leveraging the existing supports and incentives. The national questionnaire contributions suggest that while progress is being made, significant policy and initiative adaptations may be necessary to overcome labour market bottlenecks and supply chain constraints, and to ensure that the benefits of heat pump technology are accessible to all segments of the population, including low-income households.

Chief among the barriers across the majority of countries are labour and skills shortages. This is across the entire heat pump chain (from manufacturing and supply to installation and maintenance). While it has not been possible to fully quantify the labour market shortages (primarily due to a lack of consistent data), they clearly exist despite ongoing efforts to address skills shortages. In countries such as Austria, Germany and the Netherlands, the transition to renewable residential heating has been successful due to a close alignment between the defined targets for heat pump installation, effective implementation of subsidy programmes, legislative measures, and targeted skills development initiatives to support the rapid expansion of the heat pump market. If one or more of these components is not in place, market growth and development is challenging.

Addressing skills shortages, improving employment conditions in the construction sector, and increasing the supply of heat pumps are critical to achieving EU decarbonisation targets. Supply chain challenges have also been an issue in recent years. Post-COVID-19 shortages of raw materials (such as steel) and components (such as chips) presented challenges, but generally analysis would indicate that the supply chain of material needs is robust enough to meet market needs (Toleikyte et al, 2023). While heat pump manufacturers increased production capacity to meet market growth in 2022, the drop in sales in 2023 has prompted manufacturers to reduce production and in some cases lay off workers. For example, according to the European Restructuring Monitor, 300 job losses were announced at Vaillant plants in Germany in May 2024 (Eurofound, undated).

A summary of the challenges involved is presented below.

Technical barriers

- The current regulations need to be navigated by homeowners and building owners when considering renovation and heat pumps. Complying with standards and dealing with technical solutions for buildings in conservation areas or listed buildings can be challenging (and very relevant for many regions/cities) given the age of the EU building stock.
- Some current heat pump options require a considerable amount of technical space that will not be available in many apartments and even some houses.
- The design and set-up considerations of heat pumps are also critical. Correct sizing, design, installation and commissioning are required if the heat pump is to work effectively and efficiently.
- Another potential barrier to widespread heat pump adoption could be the capacity of the electrical grid to accommodate millions of new systems without risking blackouts. But energy companies and utilities say they are confident of being able to handle the added demand without threatening the stability of the grid.
- The dominance of the natural gas network – with ongoing investment in these networks in some countries – makes the market for heat pump development challenging.
- District heating and cooling networks play an important role in some countries and those regions without such networks may need more development in the heat pump market. Furthermore, the district heating network needs to be enhanced and developed in some areas.

Financial barriers

- The electricity-to-gas price ratio is highlighted in many national contributions and it will remain a barrier to adoption unless it is addressed in some countries. Electricity prices paid by households need to be lowered and the potential for reduction in associated taxes, levies and charges considered (when compared to the taxes, levies and charges imposed on natural gas or oil).
- Consumers often opt for the most economically advantageous choice when presented with a price list, regardless of any environmental advantages.

- While the rapid increase in gas prices between 2020 and 2022 contributed to market growth, the current trend of reducing gas prices can act as a disincentive for investing in energy-efficient technologies. The role of carbon taxes as a disincentive towards fossil fuel solutions is clearly evident in countries such as Sweden.
- The extension of the EU Emissions Trading Scheme (ETS) to cover buildings and transport is also likely to have a policy and market impact and this will need to be considered carefully at Member State level.
- In some cases, the energy transition requires significant investment that is not compatible with the financial capacity of households. Some segments of the population are more vulnerable and find it harder to adapt to new equipment and realities; they may also lack the financial capacity to make the necessary investment. Incentives and supports must be designed carefully in order to reach those who are socioeconomically disadvantaged and this must be accompanied by a robust communication campaign to engage and encourage people to avail of these supports.
- There are some regional variations in the take-up of heat pumps. Respondents indicate that this is driven primarily by density of population, but also by socioeconomic profile, for example rural versus urban. Consideration needs to be given to addressing such inequalities. Regional strategies highlight the importance of a tailored approach to building renovation and heat pump installation, acknowledging the unique challenges and opportunities within each region.

Legal barriers

- Dealing with rental properties and the landlord/tenant divide emerged as an issue in some countries and is linked to relevant incentives, legislation and other triggers that are required to address this housing segment.

Consumer acceptance of new technologies

- In those countries where the heat pump market is immature, such as Bulgaria, Hungary and Romania, there is often scepticism towards novel technologies, potentially influenced by their perceived unsuitability to the local climate, resulting in underperformance. Additionally, there is a prevailing lack of knowledge, understanding or confidence in undertaking renovation or energy efficiency measures where an existing functional heating system is in place.

Conclusions and policy pointers

Conclusions

While many countries have made significant strides towards their targets, challenges such as labour market shortages, skills development and supply chain issues remain critical hurdles to the rollout of heat pumps in the EU27. Ongoing activity in skills and training provision, including apprenticeships and certification programmes, is vital for supporting the transition. As countries continue to push towards their 2040 and 2050 decarbonisation goals, addressing these challenges will be crucial for their success.

This Eurofound research paper synthesises insights from across the EU27 and Norway on the transition towards decarbonised residential heating, focusing on the adoption of heat pump technologies. The transition reflects the EU's broader goals for energy efficiency, decarbonisation and increased use of renewable energy sources. The transition towards heat pump technology highlights a critical need for comprehensive strategies that encompass not only the setting of ambitious targets but also address the challenges of labour market readiness, skills development and supply chain robustness. While fiscal incentives have driven heat pump installation in some regions, a coherent approach involving training, certification and support for smaller businesses is crucial for the widespread adoption of heat pump technology and the achievement of decarbonisation goals in the residential heating sector.

Practically all countries face potential challenges in meeting labour demands for heat pump installation, in the electricity sector, in the manufacture of heat pumps and indeed in design and specification. While some countries rely on foreign labour to address shortages, concerns are looming over the ageing workforce and low enrolment in relevant vocational training.

This Eurofound research paper has explored the multifaceted efforts underway across Europe to decarbonise residential heating through the adoption of heat pump technology. Ensuring equitable access to technology and support mechanisms is another critical issue that needs resolution. Addressing such challenges is essential to achieve the ambitious decarbonisation targets set by European countries and will require coordinated action from governments, industry and educational institutions.

The range of initiatives in place across Europe provide valuable insights into the complexity of transitioning to renewable heating solutions and highlight the importance of a multifaceted approach involving policy support, skills development and market incentives.

The transition towards heat pump technology has highlighted several challenges in the labour market and supply chain. Key among these are shortages in the skilled labour necessary for the installation and maintenance of heat pumps and the logistical challenges in the supply chain that affect the availability and cost of heat pumps. These bottlenecks pose significant obstacles to meeting installation targets and necessitate targeted interventions to expand the skilled workforce and enhance supply chain resilience.

Based on the range of interventions, supports and initiatives across Member States, the following framework to ensure that the relevant EU and national policy objectives are met has been elaborated (Table 6).

Table 6: Heat pump deployment framework

Clear heat pump targets, embedded in policy. Targets should be easily understood and measurable. (For example, 1,000,000 hybrid heat pumps in the Netherlands; 400,000 heat pumps in existing buildings in Ireland)

Incentive	Regulation	Communication	Education
Minimum 30% subsidy/financial support for eligible costs associated with heat pump installation, with additional bonuses to stimulate innovation or integration	Ban on or phasing out of fossil fuel boilers	National/regional campaigns to promote alternatives to fossil fuels, e.g. 'Adieu Oil' in Austria	Updating craft and apprenticeship curricula
100% funding for low-income households or those in energy poverty	Where relevant, regulation complements the movement to district heating, e.g. Sweden	Homeowner advice centres established by regional energy agencies or equivalent	Comprehensive training programmes, co-designed with industry, addressing all levels and competencies. Training and upskilling coordinated between public sector education/training providers and industry
Stable and long-term subsidy environment	Certification of installers, e.g. RESCert in Belgium		Support SMEs to access training, e.g. supports to attend training in Germany
Aligned with deep retrofit targets	Building regulations favour heat pumps		Attract workers from other sectors that are transitioning

Electricity-to-gas price ratio addressed through tax and other measures

Investment in research and development by heat pump manufacturers and industry associations to cuts costs and reduce installation time and complexity

Decarbonisation of grid by increasing renewables and upgrading infrastructure to ensure a stable and secure power supply

Policy pointers

A series of recommendations or policy pointers have emerged from the analysis of the various country contributions, which could be considered by national and EU-level policymakers.

Addressing skills and labour shortages

Expand training programmes and certification

The EU and Member States should invest in expanding existing training programmes and establishing new ones focused on heat pump technology. This includes integrating heat pump installation into the certification programmes for electricians, plumbers and HVAC technicians. The HP4All project's heat pump competency framework, which outlines essential competencies for various roles, can be used as a model for developing these programmes.

Incentivise vocational training and apprenticeships

Provide financial incentives for individuals to enter vocational training and apprenticeship programmes in the construction and HVAC sectors. Subsidies or grants can be offered to cover tuition costs and provide stipends for apprentices to attract more young people into these fields.

Promote job opportunities in the sector

Governments and industry bodies should run awareness campaigns to highlight the career opportunities in the heat pump installation and maintenance sector. This can help attract new talent and address the current stagnation in construction sector employment.

Enhance working conditions

Improving working conditions in the heat pump and HVAC sector as the market develops and grows can make these jobs more attractive. This includes ensuring improved work practices (e.g. faster heat pump installation solutions), fair wages, safe working environments and opportunities for career progression including responding to new innovations in heat pump and HVAC technologies and systems.

Providing effective subsidies

Increase and stabilise financial incentives

Governments should enhance the financial incentives for heat pump installation, ensuring they are substantial enough to offset the higher upfront costs compared to traditional heating systems. These subsidies should be stable and predictable to encourage long-term investment by homeowners.

Target subsidies to low-income households

Special attention should be given to low-income households who might struggle with the upfront costs of heat pump installation. Programmes should offer higher subsidy rates or fully cover the installation costs for these households to ensure equitable access to energy-efficient technologies.

Encourage private sector investment

Introduce tax incentives and other financial benefits for private companies that invest in heat pump technology, including manufacturers and installation firms. This can stimulate market growth and technological innovation. This could extend to innovation in new business models including leasing-based and third-party ownership models where private intermediaries install and maintain ownership of heat pump systems charging users a fee based on consumption.

Subsidise training for heat pump designers and installers

Provide public supports to encourage take-up of training both for those with the relevant skill sets as well as unemployed or displaced workers. In addition to funding instruction and tuition, supports could also include compensation for downtime to participating employers.

Addressing energy prices and market dynamics

Implement carbon pricing and adjust energy taxes

Implement or increase carbon pricing on fossil fuels to make heat pumps more economically attractive. Adjust energy taxes, levies and charges to lower the cost of electricity used for heat pumps, thereby improving their operational cost efficiency compared to gas and oil heating.

Support market development

Support the development of a competitive market for heat pumps by reducing barriers to entry for new companies and supporting SMEs. This can include providing grants for research and development and easing regulatory requirements for market entry.

Promoting technological advances

Invest in research and development

Increase funding for research and development to improve heat pump technology, including sustainable refrigerants. Focus on efficiency, ease of installation, cost reduction and integration with renewable energy sources. Public-private partnerships can be instrumental in driving innovation in this field.

Encourage adoption of smart technologies

Promote the integration of heat pumps with smart grid technologies and home energy management systems. This can enhance the efficiency and reliability of heat pump systems, making them more appealing to consumers.

Pilot projects and demonstrations

Fund pilot projects and demonstration sites to showcase the benefits and practical applications of heat pumps in various types of residential buildings. These projects can serve as models for wider adoption and help build consumer confidence.

Enhancing consumer awareness and acceptance

Run public awareness campaigns

Governments and industry bodies should run extensive public awareness campaigns to educate consumers about the benefits of heat pumps, including their environmental impact, cost savings and reliability. Clear and accessible information can help overcome consumer scepticism and resistance to adopting new technologies.

Simplify the installation process

Simplify and streamline the regulatory and administrative processes related to heat pump installation. This includes providing clear guidelines, reducing bureaucratic hurdles and offering support services to guide homeowners through the installation process.

Foster community engagement

Engage with local communities and stakeholders to build support for heat pump projects. This can include working with local governments, community organisations and residents to develop tailored solutions that address specific local needs and conditions.

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Annexes

Annex 1: Network of Eurofound Correspondents

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Annex 2: Questionnaire to Network of Eurofound Correspondents

Implications for construction sector employment and skills of planned heat pump rollout

Targets and labour market supply/demand

- To what extent are heat pumps expected to play a role in the decarbonisation of heating in residential buildings in your country? Please cover the specific targets at national level[4] and their time frames in relation to the following questions:
  - Are there renovation targets?
  - Are there specific targets for heat pump installation?
  - Fossil fuel-based boiler replacement targets/programmes/incentives?
  - Provisions for phase-outs of fossil fuel-based boilers in newly built residential buildings?
- What are the construction sector estimates of the labour force requirements to achieve national heat pump installation targets – or if no such target is indicated refer to the RePower EU target of doubling the rate of heat pump installations in the period 2022–2027? Consider estimates by employers, professional associations or trade bodies, trade unions, relevant government bodies and/or policy evaluations.
- How do the estimates of labour force needed to achieve national heat pump installation targets compare to current construction sector levels of employment and job vacancy levels both in the construction sector (NACE F) as a whole as well as in the sub-category of construction workers currently working on heat pump installation and servicing? Fill in the table below indicating sources – figures can be shares (%) or headcount for 2023 or the most recent year for which data is available. Please specify.

Construction sector employment (number of workers in NACE F)	(Share of) construction sector workforce currently working in heat pump installation	Estimated workforce needs to meet heat pump targets	Labour shortages: job vacancy levels in construction sector

Skills and training

- Are existing training curricula for the indicated tradesperson jobs adapted or augmented to include the skills for heat pump installation? Consider initiatives by public employment services, professional associations, manufacturers or other relevant bodies.
- Are there any good practice examples of training/reconversion incentives/initiatives for experts/installers? Please distinguish initiatives to
  - attract new/young workers
  - re-train or upskill the current workforce in relevant construction sector specialisations.

Assessment

- What is the evidence of progress towards targets according to latest official monitoring reports (national NECP reports (European Commission, undated-b), or other available sources).
  - Please provide latest indications of progress in relation to targets (as percentage); if available, provide a breakdown of heat pump installation and/or stock by year
  - What is the level of take-up of subsidies for heat pump installation (or relevant accompanying measures)?
  - Are there any inequalities (e.g. by region, by social or income groups) in heat pump use, installation rates and the rates of take-up of support measures (subsidies)?

4 Please comment if there are subnational targets or measures.

- Please summarise existing evaluations, estimates or, if these are not available, construction sector expert opinions on:
  - the feasibility of national heat pump installations targets
  - the effectiveness of current incentives supporting heat pump rollout
  - actual or potential labour market barriers to their achievement
  - actual or potential other barriers to their achievement (e.g. supply chain problems – for pumps and for components, high price of electricity compared to gas)

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TJ-01-24-005-EN-N

This Eurofound research paper explores the decarbonisation of residential heating through the adoption of heat pumps, a key component in the EU's strategy to achieve carbon neutrality by 2050. Heat pumps offer a highly efficient alternative to traditional heating systems, leveraging renewable energy sources to significantly reduce greenhouse gas emissions. Despite rapid market growth in 2022, progress stalled in 2023 due to economic factors and reduced subsidies. The Eurofound research paper highlights critical challenges, including substantial labour shortages, variation in the policy framework at national level (including incentives and supports) across Europe, the high cost of electricity relative to gas and the need to address low income and energy poverty in policy responses. Policy pointers that emerge from the study focus on expanding vocational training; standardising certification or ensuring mutual recognition of relevant qualifications; maintaining and expanding subsidies; addressing energy pricing; and increasing public awareness and guidance. Ensuring equitable access for low-income households and robust progress monitoring are also emphasised. This comprehensive approach is necessary to accelerate the deployment of heat pumps and support the EU's ambitious climate goals.

The European Foundation for the Improvement of Living and Working Conditions (Eurofound) is a tripartite European Union Agency established in 1975. Its role is to provide knowledge in the area of social, employment and work-related policies according to Regulation (EU) 2019/127.

Publications Office
of the European Union

ISBN 978-92-897-2437-1
doi:10.2806/1095646