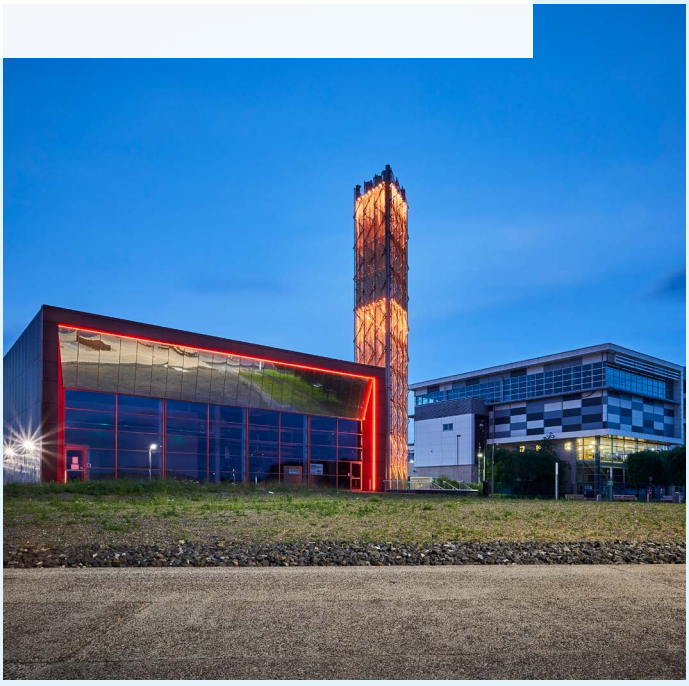
The perfect fit:

Shaping the Fit for 55 package to drive a climate-compatible heat pump market



Authors:

Regulatory Assistance Project

Dr. Richard Lowes (Lead author)
Dr. Jan Rosenow
Dominic Scott
Louise Sunderland
Samuel Thomas

Agora Energiewende

Andreas Graf

CLASP

Marie Baton

Steve Pantano

Global Buildings Performance Network

Peter Graham

MARCH 2022

Regulatory Assistance Project (RAP)®

Rue de la Science 23
B – 1040 Brussels
Belgium

Telephone: +32 2 789 3012

Email: info@raponline.org
raponline.org
linkedin.com/company/the-regulatory-assistance-project
twitter.com/regassistproj

Suggested citation:

Lowes, R. Rosenow, J., Scott, D., Sunderland, L., Thomas, S., Graf, A., Baton, M., Pantano, S., Graham, P. (2022). *The perfect fit: Shaping the Fit for 55 package to drive a climate-compatible heat pump market.* Regulatory Assistance Project, Agora Energiewende, CLASP, Global Buildings Performance Network.

Photo credit (clockwise, left to right):

Bob Beattie (@bobbt2417); Vital Energi; Jaap Burger (@burger_jaap);
Paul Barnfather (@paulbarnfather).

Acknowledgments

The authors would like to acknowledge and thank the following people who provided helpful insights into early drafts of this paper:

Megan Anderson, RAP

David Farnsworth, RAP

Ann McCabe, RAP

Davide Sabbadin, European Environmental Bureau

Pengfei Xie, RAP

Mélissa Zill, Ecos

Thomas Nowak, EHPA

We would like to thank The Crux Alliance for its support for this work.

Editorial assistance provided by Tim Simard.

Design by Noble Studio.

Responsibility for the information and views set out in this paper lies entirely with the authors.

List of figures

List of tables

Acronyms

COP: Coefficient of performance

EED: Energy Efficiency Directive

ESR: Effort sharing regulation

ETS: Emissions Trading Scheme

EU: European Union

MEPS: Minimum Energy Performance Standards

NZEB: Near zero energy building

RED: Renewable Energy Directive

SCOP: Seasonal coefficient of performance

Contents

Executive summary

As the energy system enters the next stage of the transition, climate targets are tightened and the requirement to reduce exposure to increasingly volatile gas imports grows, decarbonisation needs to enter homes and buildings. For Europe, and indeed other regions too, heat pumps are a critical sustainable heating technology which will significantly reduce primary energy demand.

This paper has been developed by a group of multi-institution buildings and heat decarbonisation experts. The authors have knowledge across the policy and regulatory landscape associated with heating and heat pumps in Europe. The rationale of the paper is to investigate the importance of heat pumps for Europe and to consider how European Union (EU) policy can support the deployment of heat pumps at required levels.

The transition to low-carbon heating will bring with it a number of co-benefits for the EU, including a reduced reliance on increasingly costly and fragile energy imports, the ability to maximize the use of ever-cheaper renewable electricity for heating, and more comfortable homes and buildings. EU energy policy needs to increase its focus on delivering low-carbon buildings, and within that the Fit for 55 package needs to explicitly recognize the value of heat pumps.

Policy to drive heat pump deployment

The primary policy focus of this analysis is on the EU's Fit for 55 package and how it could be improved to drive greater use of heat pumps. Based on best practice elsewhere, we also consider how Member States can support heat pump deployment in advance of potential EU-level reforms.

Overall, heat pumps of all sizes will be needed, with many of them installed at a building level. Larger heat pumps connected to another key low-carbon heat technology, district heating networks, will also be needed. In both cases, the rapid deployment of these heat pumps needs to take place alongside the deployment of measures which increase the fabric energy efficiency of buildings.

Heat pumps are relatively straightforward devices. Electricity – which can be generated from low-carbon sources – is used to efficiently collect heat from the environment and upgrade it to a temperature at which it can heat buildings and produce hot water. The components they use are identical to those in a fridge. Ambient heat from the air and ground is the most common source of environmental heat in heat pumps today, but heat pumps can also be used to extract heat from waste heat sources (e.g. industrial processes, data centres, sewer networks) and from water sources such as rivers, lakes and the sea.

Historically, EU energy policy has made only broad interventions into the heating market, with Member State requirements for renewable energy development under the Renewable Energy Directive being a key driver. Yet the EU's target of a reduction of 55% in greenhouse gas emissions by 2030 requires rapid progress across all sectors of the economy, including heating and cooling and buildings. The current Fit for 55 legislative proposals provide a valuable window of opportunity for heat-pump-supportive policy.

Reforming the Fit for 55 package

The Fit for 55 proposals are set to modify existing legislation which impacts the heating market, and some of the proposals appear beneficial for heat pump deployment and low-carbon heat planning more generally. However, the proposals could go further to support heat pumps, and there are also concerns that the proposals may be watered down, limiting their impact. The key heat pump issues we have identified with the package are summarized below:

- **Revisions to the EU Emissions Trading System (ETS) Directive** to develop an ETS 2 which would include transport and buildings could provide a strong boost for heat decarbonisation and heat pumps. Significant efforts, however, need to be made to ensure that carbon prices will not escalate to unacceptable levels if Member States do not directly support decarbonisation measures. Strengthening heating equipment and building energy efficiency requirements would significantly reduce this risk, while strengthening the effort-sharing regulation would ensure that Member States are held accountable to deliver. A cap on ETS 2 allowance prices and targeted recycling of revenues could also limit equity impacts.
- **Revisions to the Energy Taxation Directive** could support heat pump deployment by increasing the relative price of fossil fuels compared to electricity. The possibility, however, for Member States to exempt households where there are energy poverty concerns could stymie innovation, particularly if exemptions are applied loosely. Instead of removing environmental costs from energy prices, revenues can be used to offset costs for vulnerable groups and subsidize investments in clean technologies.
- Proposals in the **Recast Directive on Energy Efficiency** to disallow energy savings from fossil fuel boiler installations from counting towards Member States' energy savings obligations are well aligned with the goals of the Fit for 55 package and would shift support to heat pumps. The primary energy savings target, however, could go further, particularly in the context of current gas prices. Furthermore, safeguards need to be introduced so that district heat networks promoted under the directive cannot combust fossil fuels or unsustainable biomass, and choose heat pumps instead.
- Similarly, while the proposed revisions to the **Renewable Energy Directive** and stronger targets on heating could stimulate heat pump deployment, there is a concern that these modifications could inadvertently lead to the use of unsustainable bioenergy in heating. As such, caps on the level of biomass allowed under RED and targeted measures to support heat pumps – including a possible uplift for ambient heat – should be included.

- The requirements in the **proposed revision of the EPBD** for Member States to set out policies to phase out fossil fuels for heating and cooling by 2040 within their renovation plans are welcome. However, the EPBD proposals could go further so that minimum energy performance standards apply to more of the stock than just the least efficient buildings, and require more ambitious renovations. More efficient buildings can support the deployment of heat pumps and support more flexible electricity demand. Proposals for fossil fuel heating phaseouts in both new and existing buildings could also be brought in sooner.
- Finally, modifications to **energy labelling and ecodesign regulations** for heating appliances being reviewed in parallel to the Fit for 55 package must ensure that the energy labelling classes are immediately rescaled to clearly reflect the relative efficiencies of the types of equipment on the EU market. The lowest performance appliances must be rapidly phased out of the market. A progressive tiered tightening of the minimum energy efficiency standards could lead to an effective ban on fossil fuel heating appliances, something that is needed in this revision cycle in order to avoid appliance lock-in.

Member State policy reform

At the Member State level, various policy and regulatory options exist to drive the deployment of heat pumps. For countries which have been most successful, there appear to be two key ingredients.

Firstly, a clear strategy and policy stability is required to drive long-term investment and decision-making.

Secondly, a mix of different policy measures is needed which ensure that the journey towards heat pumps is simple, provides good consumer outcomes, and develops good jobs and skills. Such a policy mix should generally include the following elements:

- Pricing mechanisms to ensure heat pumps have lower total ownership costs (including running costs) than equivalent fossil fuel systems. Green heat needs to be cheaper than fossil fuel heat.
- Financial support for building owners to cover additional capital costs associated with first-time heat pump installs, as well as the associated building efficiency and heating system upgrades that may be needed to make buildings 'heat pump ready.'
- Regulatory measures such as appliance standards to drive eventual bans on fossil fuel heating.

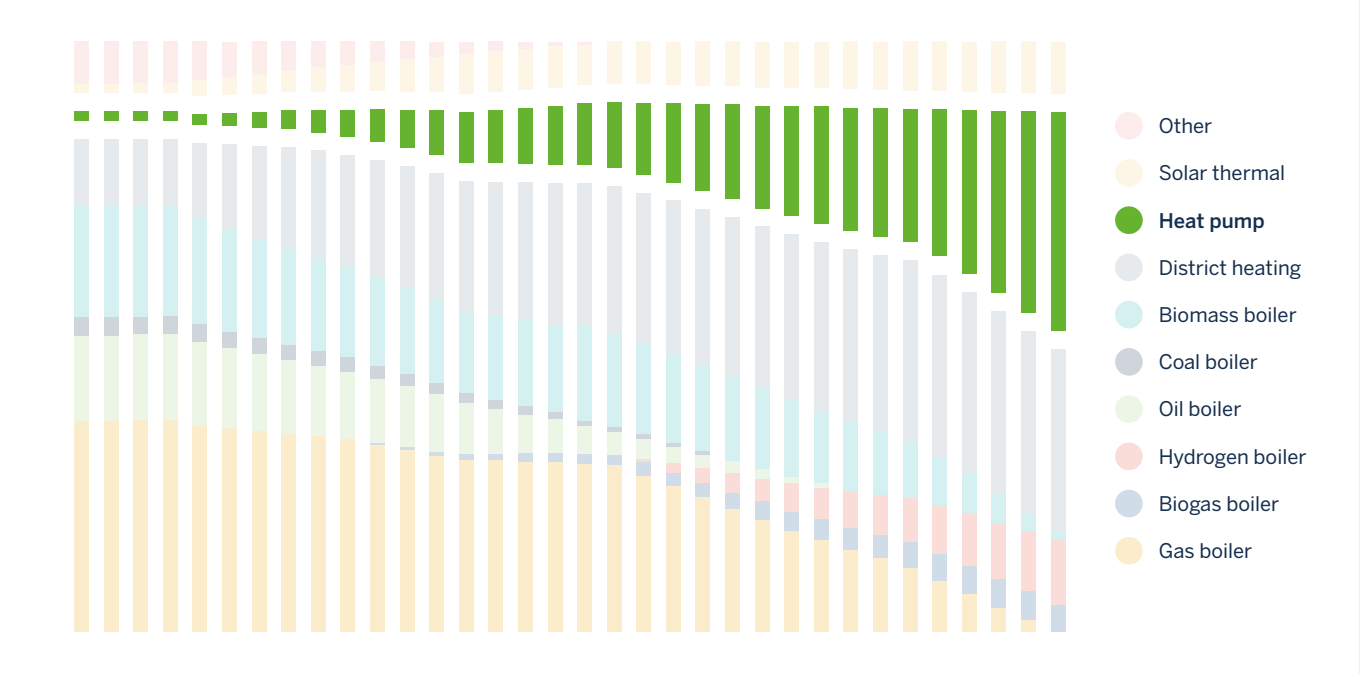
PART 1

Introduction

Nearly all major national, EU and global decarbonisation assessments see heat pumps as the key heating technology for transitioning heating to climate-neutrality by 2050, in particular in the residential and services sectors. To reach climate neutrality, the EU's long-term strategy projects that the share of electricity in heating demand in the residential sector should grow from around 25% to 40% by 2030 and to 50-70% by 2050, while in the services sector from the current 50% share, it should reach around 65% and 80% respectively.[1]

McKinsey estimates that heat pumps will need to achieve a 40% penetration in the space and water heating technology mix in their Net-Zero Europe scenario[2] (see Figure 1), and the European Commission's own analysis foresees a need for rapid growth in the use of heat pumps across multiple scenarios (Figure 2). With a global focus, the IEA's recent 'net zero report' projects that heat pumps will be the primary source of global heat production by 2050.[3] As well as decarbonising heating, heat pumps can also offer significant energy security benefits, reducing demand for gas, much of which is imported and which currently dominates the energy mix used for heating in the EU.

Figure 1. The rapidly expanding role of individual heat pumps in a decarbonising European heat mix (%)



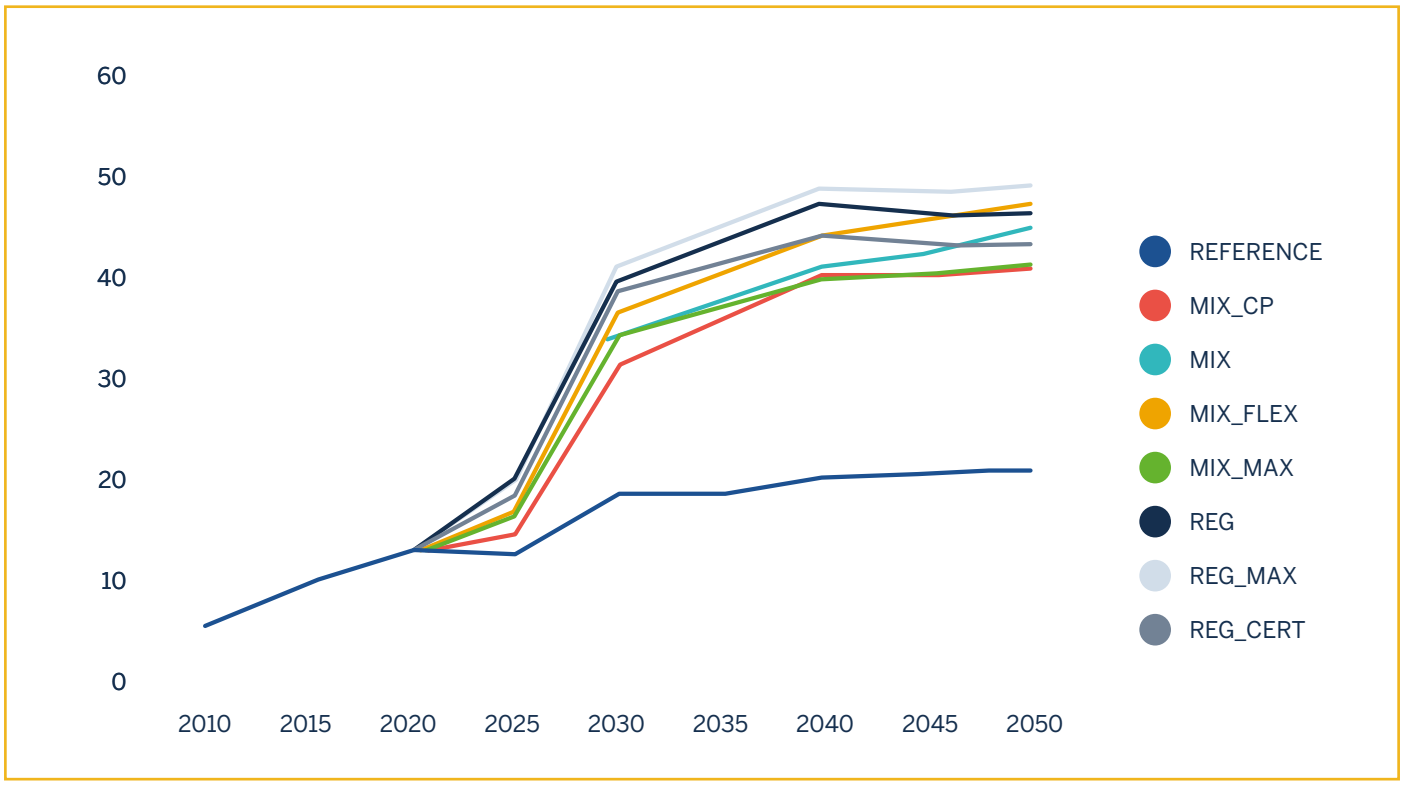
Source: McKinsey. (2020). *Net-Zero Europe – Decarbonisation pathways and socioeconomic implications.*

1 European Commission. (2020a). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions — Powering a climate-neutral economy: An EU Strategy for Energy System Integration.* https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2020:299:FIN

2 D'Aprile, P., Engel, H., van Gendt, G., Helmcke, S., Hieronimus, S., Naucler, T., et al. (2020). *Net-zero Europe: Decarbonisation pathways and socioeconomic implications*. McKinsey. https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability/our%20insights/how%20the%20european%20union%20could%20achieve%20net%20zero%20emissions%20at%20net%20zero%20cost/net-zero-europe-vf.pdf

3 IEA. (2021). *Net Zero by 2050 – A Roadmap for the Global Energy Sector*. https://www.iea.org/reports/net-zero-by-2050

Figure 2. Renewable energy from heat pumps grows rapidly across European Commission scenarios (Mtoe)



Source: European Commission. (2021). *Impact Assessment on the Proposal for a Directive of the European Parliament and of the Council on energy efficiency (recast).* Brussels, 14.7.2021 SWD (2021) 623 final PART 2/2

Put simply, heat pumps are a critical technology for decarbonising heating. But the path ahead is steep. As shown previously in Figure 2, the heat supplied by heat pumps will need to at least triple in the next decade if the EU is to meet its 2030 climate and energy targets.

While some EU countries have successfully deployed heat pumps at scale – it is estimated that nearly 15 million heat pumps have been installed in the EU as of 2020[4] – currently only 12% of renewable heating and cooling demand, or 2.5% of overall EU heating and cooling demand, is met by heat pumps.[5] Though growth has picked up in recent years, it is still limited to certain countries and not widespread. Much remains to be done for heat pumps to reach their full potential.

This paper will lay out why heat pumps are so important (section 2), the key factors shaping the competitiveness of heat pumps (section 3), assess the need for EU-level policy reform focusing on the Fit for 55 package (section 4), assess existing European heat pump strategies and policies at national level (section 5), and provide policy recommendations for the way forward at an EU and Member State level (section 6).

Heat pumps come in all sizes. A large water source heat pump feeding a heat network at Queens Quay, Glasgow, Scotland. Credit: Vital Energi and Rob Whitney's domestic air source heat pump.

4 European Heat Pump Association. (EHPA). (2021). *Market Data* [website]. https://www.ehpa.org/market-data/

5 Eionet Potral. (2020). *ETC/CME Report 7/2020: Renewable energy in Europe 2020 - Recent growth and knock-on effects.* https://www.eionet.europa.eu/etcs/etc-cme/products/etc-cme-reports/etc-cme-report-7-2020-renewable-energy-in-europe-2020-recent-growth-and-knock-on-effects

PART 2

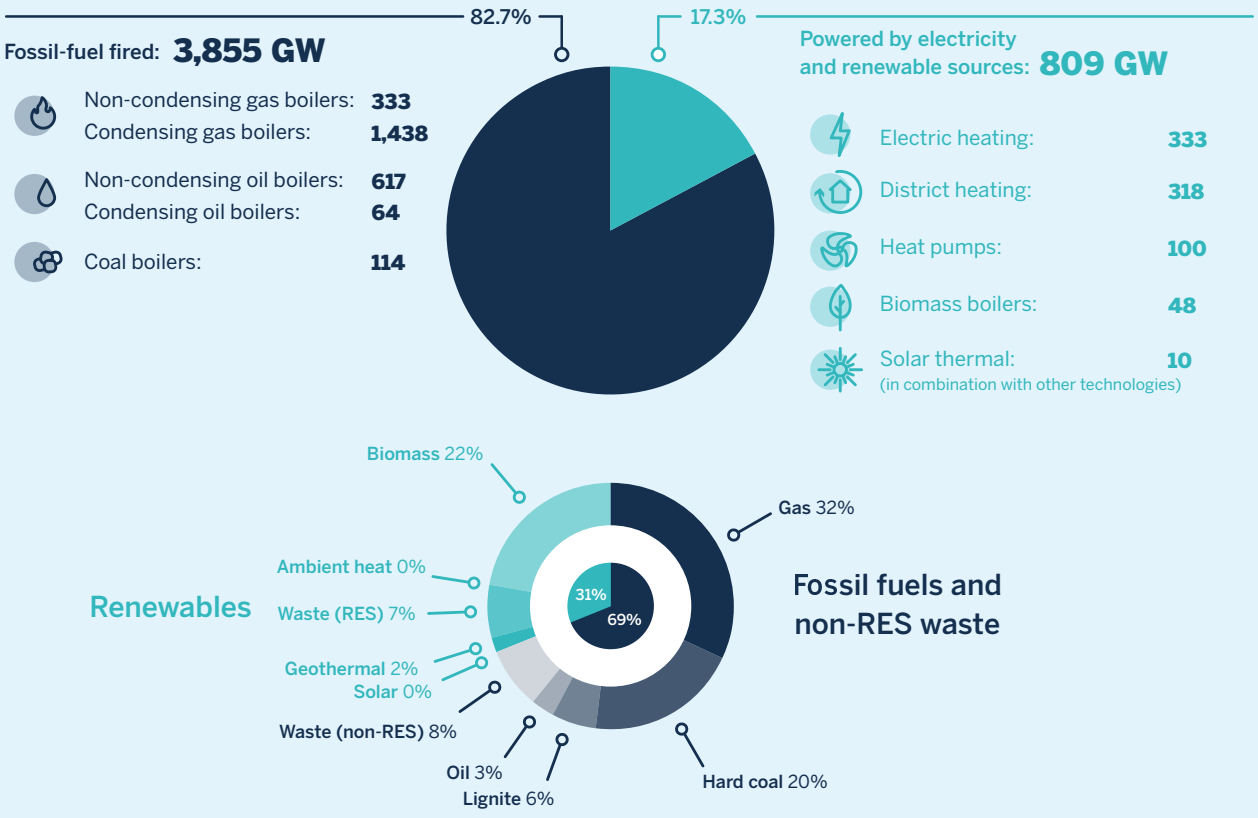
Why heat pumps are so important

Ambitious cuts in greenhouse gas emissions are required for the EU's energy and climate goals to be achieved. To meet the goal of reducing greenhouse gas emissions by at least 55% by 2030 (relative to 1990 levels), CO_2 emissions from buildings must fall by more than half relative to 2015 levels.[6] That means a massive increase in the energy saved through renovation and the replacement of tens of millions of fossil fuel heating systems, by sustainable and renewable alternatives.

Heat pumps are widely seen as the key solution to replace fossil fuel heating systems, either as direct replacements in individual buildings or as part of district heating systems.

As shown below in Figure 3, in 2017 83% of the installed capacity of space heating in the EU – some 129 million boilers – was estimated to be fossil-fuel fired (66% gas, 15% oil, 2% coal), more than half of which was also relatively inefficient (ranked in C or lower energy classes) and old (before 1992).[7] Similarly, more than half of the heat sold through heat networks in Europe still originates from fossil fuels,[8] and many older district heating systems remain old and inefficient, including as much as 80% of the systems in Poland.[9]

Figure 3. The installed capacity of space heating in the EU in 2017 (top) with a breakdown of district heating fuel use (below).



Source of overall heat mix: Zill, M. et al. (2020). *Five Years Left: How ecodesign and energy labelling can decabonise heating*. ECOS.
Source of heat network mix: From Fraunhofer et al. (2021). *Description of the heat supply sectors of individual EU Member States Space heating market summary 2017- European Union (EU-27)*, forthcoming.

6 European Commission. (2020b). *Commission Staff Working Document accompanying the proposals on the EU ETS Directive. Commission staff working document, impact assessment*. Part 2/4. https://ec.europa.eu/info/sites/default/files/revision-eu-ets_with-annex_en_0.pdf

7 Zill, M., Boye Olesen, G. & Toulouse, E. (2020). *Five Years Left: How ecodesign and energy labelling can decabonise heating*. ECOS. https://ecostandard.org/wp-content/uploads/2020/12/Five-Years-Left-How-ecodesign-and-energy-labelling-Coolproducts-report.pdf; Fraunhofer et al. (2021). *Description of the heat supply sectors of individual EU Member States Space heating market summary 2017- European Union (EU-27)*, forthcoming.

8 IEA. (2020). *District heat sales in Europe by fuel source, 2000-2019* [webpage]. https://www.iea.org/data-and-statistics/charts/district-heat-sales-in-europe-by-fuel-source-2000-2019

9 Macuk, R. (2019). *Heating in Poland – Edition 2019*. Forum Energii. https://forum-energii.eu/en/analizy/cieplownictwo-2019

With the goal of climate-neutrality necessitating the end of fossil-fuel heating in buildings by 2045, Europe requires a heating strategy aligned with this goal.[10] Beyond the need for decarbonisation, the EU also needs to reduce its reliance on imported and increasingly expensive fossil fuels, something which heat decarbonisation naturally drives.

Europe also has an unsustainable bioenergy problem. In many cases, bioenergy for heating and cooling is associated with significantly higher environmental costs (even more than fossil fuels), with implications for human health and biodiversity as well as questionable benefits from a climate perspective.[11] Yet today bioenergy represents by far the largest share of renewable heating and cooling in Europe (85% in 2019), and demand is still growing. Member State national energy and climate plans (NECPs) suggest that current policies could increase bioenergy use in heating and cooling by 11% by 2030.[12] In other words, without further guardrails, the EU's new climate targets could push demand for bioenergy in heating and cooling and electricity beyond sustainability limits.

A domestic air source heat pump. Image kindly provided by Jonathan Atkinson AKA @lowwintersun.

10 Buck, M. & Dusolt, A. (2021). *Preparing the necessary phase-out of fossil gas in Europe - Benchmarks and recommendations for the Fit for 55 package* [Presentation]. Agora Energiewende. https://www.agora-energiewende.de/en/publications/preparing-the-necessary-phase-out-of-fossil-gas-in-europe/

11 Material Economics. (2021). *EU biomass use in a net-zero economy: a course correction for EU biomass*. https://materialeconomics.com/latest-updates/eu-biomass-use

12 Smith, M., Kralli, A. & Lemoine, P. (2021). *Analysis on biomass in national energy and climate plans*. Trinomics. https://www.fern.org/publications-insight/analysis-on-biomass-in-national-energy-and-climate-plans-2326/

Heat pumps offer seven key energy system benefits:

01

Heat pumps can be fully decarbonised:
With the power sector decarbonising at a much faster pace than other sectors, heat pumps powered by low-carbon electricity can cost-effectively and sustainably act as a substitute for fossil fuels and bioenergy in heating as the EU transitions to a renewables-dominated power system. Already, with existing electricity mixes, ground source heat pumps have lower greenhouse gas emissions than gas boilers in all EU Member States, and air source heat pumps will reduce emissions in all but two Member States.[13]

02

Heat pumps are efficient:
By extracting some three to five units of useful heat from the environment for every unit of electricity used, the efficiency of heat pumps means they can substantially reduce fossil fuel consumption even when electricity generation is based on these fuels, allowing for a smaller, more resilient energy system

03

Heat pumps can reduce reliance on fossil fuel imports:
The efficiency of heat pumps also means that they can play an essential role in reducing reliance on increasingly volatile fossil fuel imports. Commission modelling shows that, together with improvements in the efficiency of building envelopes (e.g. through thermal insulation), heat pumps and other renewable heating technologies are expected to reduce gas consumption in buildings by more than 40% by 2030 (compared to 2015 levels) and contribute nearly two-thirds of the overall reduction in gas consumption over the same period.[14] At current fossil gas spot prices of around €100 per MWh these energy savings in the building sector would reduce fossil gas import costs by nearly €60 billion per year.

04

Heat pumps are cost-efficient for consumers:
Due to the energy and resource savings that heat pumps provide they can also achieve running costs similar to or better than fossil fuel heating bills. Recent research suggests that the majority of households will save money after installing a heat pump.[15]

13 EEB & Coolproducts. (2021). *Green heat for all*. https://www.coolproducts.eu/wp-content/uploads/2021/10/Green-heat-FS_v6.0indd.pdf.

14 European Commission. (2020c). *Impact assessment in support of the Commission communication Com(2020) 562 final: Stepping up Europe's 2030 climate ambition Investing in a climate-neutral future for the benefit of our people.* https://ec.europa.eu/clima/document/download/ec1acac9-10fe-4eeb-915f-cad388990e0f_en

15 Boye Olesen, G., Bo Madsen, H. & Campos, J. (2022). *The comfort zone: European users' perception of renewable heating performance*. EEB & CoolProducts. https://www.coolproducts.eu/wp-content/uploads/2022/02/EEB-Heat-Pump-Comfort-Audit-Report.pdf.

05

Heat pumps can play an important role in sustainable cooling:
Reversible heat pumps can serve as a useful technology for cooling as the same unit used for heating can be used to provide cooling at higher efficiency than a conventional air conditioner. With demand for air-conditioners expected to at least double by 2030, the use of heat pumps could prevent the installation of less efficient cooling appliances – and thus avoid both higher overall electricity consumption and higher peak electricity demand in summers.

06

Heat pumps can help to decarbonise heat networks:
Heat pumps come in various sizes, ranging from small household appliances to larger industrial-scale units. Where heat networks are viable, large industrial-scale heat pumps are expected to play a central role in providing low-carbon heating and cooling supplies to highly efficient, low-temperature heat networks.[16]

07

Heat pumps can help to decarbonise low-temperature industrial processes:
Heat pumps are well established in providing heating in industry for temperatures of up to 100°C, meaning there is enormous potential for heat pumps to be used to decarbonise many low-temperature industrial processes based on fossil fuels and bioenergy.

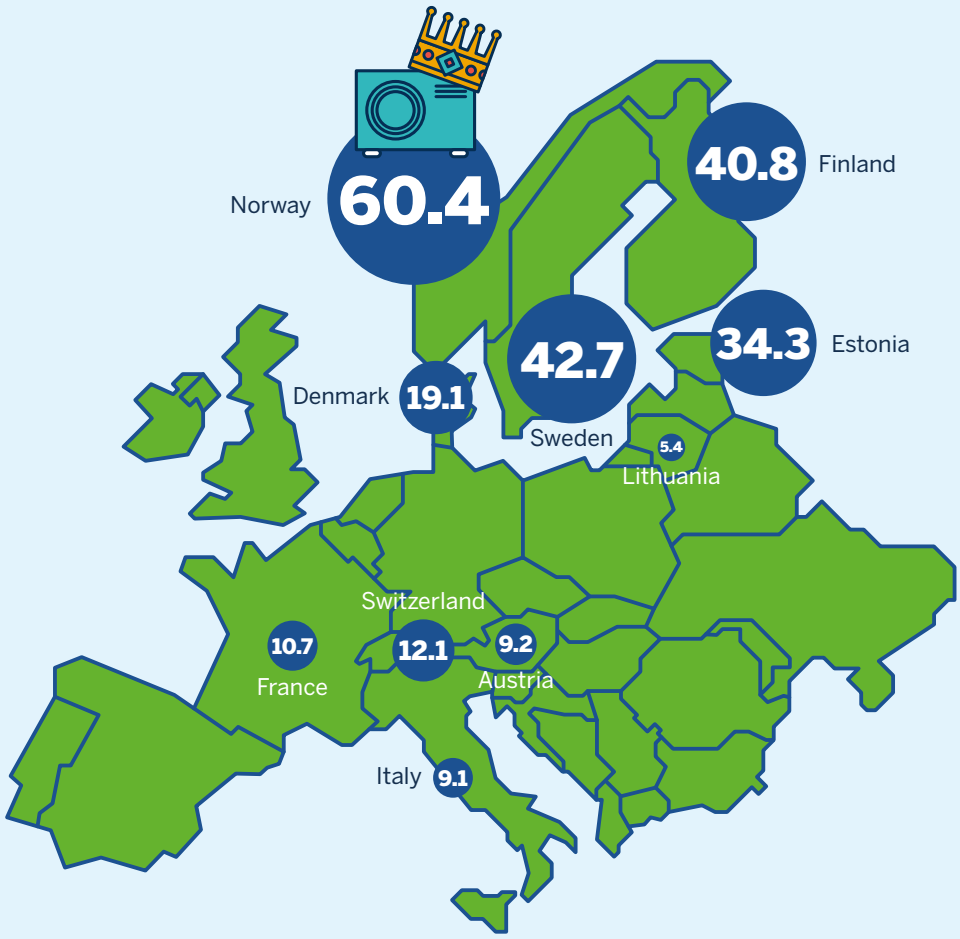
16 Smith et al., 2021.

PART 3

What holds back heat pump deployment and how to change it

International experience suggests that the most successful heat pump deployment strategies combine packages of policy and regulatory measures. Figure 4[17] below highlights the significant variation in the penetration of heat pumps in Europe, showing the top 10 countries in Europe by the proportion of heat pumps in buildings.

Figure 4. The top 10 European countries by the share of households with heat pumps installed (per 100 households)



Source: Based on New Statesman reporting of EHPA data: Nuttall, P. (2021). The UK home decarbonisation debate: heat pumps versus hydrogen. *The New Statesman.*

For the rapid increase in the number of heat pumps required in Europe, such a package will need to be highly tuned and responsive. First, this section considers the barriers that heat pumps face, focusing on the issues of competing infrastructure, economics and the existing policy environment. The chapter then considers what we can learn from past experiences about removing these barriers.

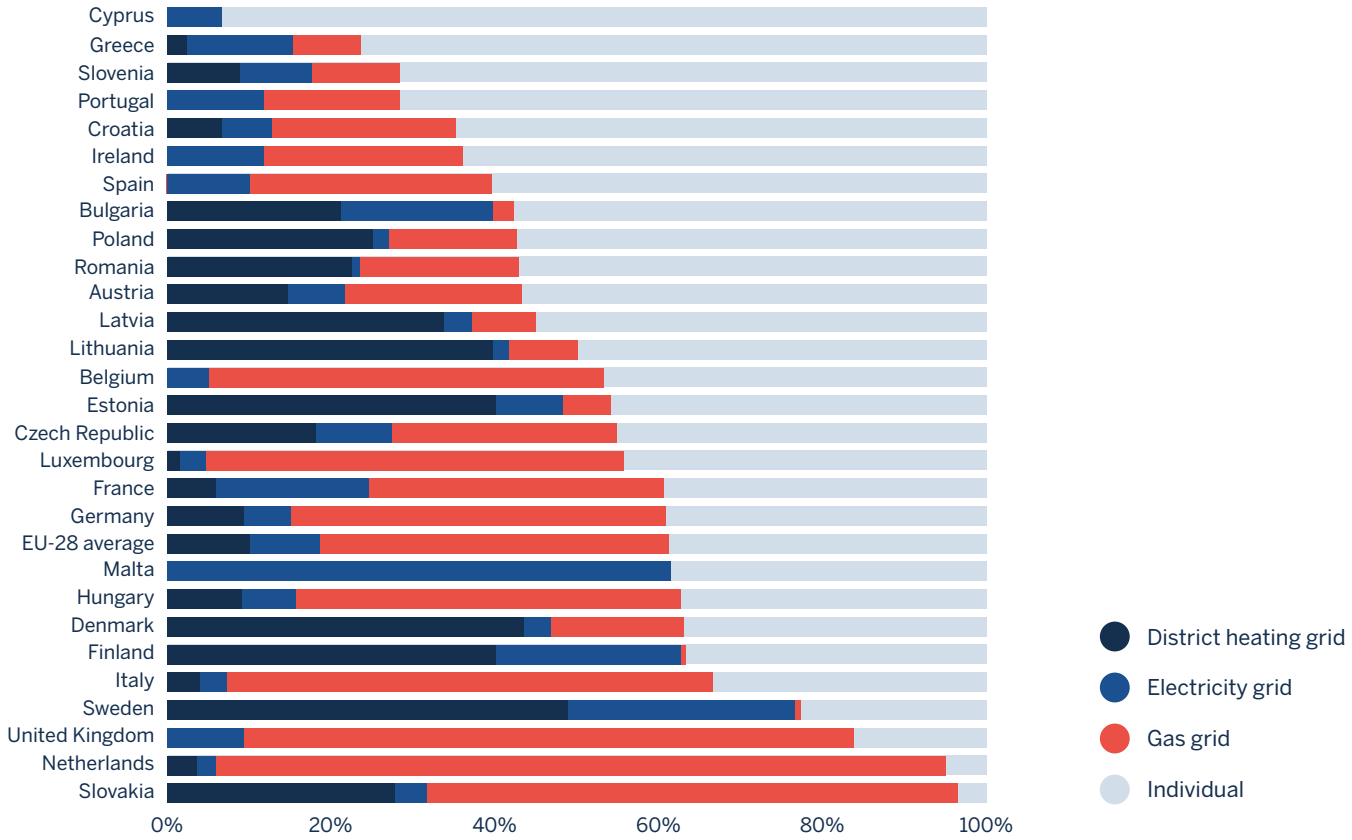
17 Nuttal, P. (2021). The UK home decarbonisation debate: heat pumps versus hydrogen. *The New Statesman*. https://www.newstatesman.com/energy-climate-tech/2021/10/the-uk-home-decarbonisation-debate-heat-pumps-versus-hydrogen

3.1 Incumbent heating infrastructure

A significant hurdle to heat pump deployment is often the infrastructures and systems in place which support the incumbent heating technology. These infrastructures may simply offer nothing to drive heat pumps, for example in the case of a gas grid, or they may actively lean markets away from heat pumps, for example where significant sunk costs have already been incurred, effectively perpetuating the incumbent technology.

Heating technology mixes vary significantly between and within European countries. Figure 5[18] shows the way heat is delivered across the (then) 28 EU Member States. In general, warmer countries in the south of Europe are more reliant on individual heating solutions (which include biomass, oil and coal) to meet their heating needs, and are less likely to use network infrastructure, such as electricity grids, heat networks and gas grids.

Figure 5. Share of residential heat consumption from individual heating or delivered via district heat networks, gas grids or electricity grids by Member State



Source: Bertelsen, N. & Vad Mathiesen, B. (2020). EU-28 Residential Heat Supply and Consumption: Historical Development and Status. *Energies.*

18 Bertelsen, N. & Vad Mathiesen, B. (2020). EU-28 Residential Heat Supply and Consumption: Historical Development and Status. *Energies 2020, 13*(8). https://www.mdpi.com/1996-1073/13/8/1894

The development of gas or heat distribution networks, because of their significant capital costs, is most likely to be in areas with a higher population density alongside higher heat demand. In more rural areas, the use of oil or electric heating is more likely. As is shown below in Table 1,[19] different types of heating come with different associated appliances and infrastructures. Connections to gas and heat networks come with an element of sunk costs, both within and outside of the building in question. Incumbent heating systems can also lead to an element of consumer familiarity, with relatively novel technologies such as heat pumps being viewed cautiously.

Table 1. Key heating technologies and their characteristics

Energy carrier	Heating oil	Fossil gas	Biomass	Lower carbon gas (H2 or biomethane)	Electricity	District Heating
Energy production	Refining of largely imported oil products	Extraction from onshore or offshore gas fields - largely abroad	Biomass production from forestry	Electricity for H2 production, biomass production for biogas	Electricity generation	Electricity for large heat pumps, waste heat, geothermal, solar thermal, biomass, coal and fossil gas
Appliance in building	Oil boiler	Gas boiler	Biomass boiler	Gas boiler	Heat pump or electric heater	Heat exchanger
Infrastructure	Individual transportation of oil	Gas network	Individual transportation of biomass	H2 or gas network	Electricity grid	Heat network

Source: Based on an idea from ECF: CE Delft, Climact and European Climate Foundation. (2020). *Zero Carbon Buildings 2050: Summary Report.*

The successful deployment of heat pumps will need to overcome any barriers that the existing infrastructure may pose. These barriers could be associated with costs (considered in the next section), the skills base (particularly around heating engineers), expectations of building owners, and new infrastructure requirements and regulations. If old infrastructure is to be stranded, wider heat strategy work should also consider how assets such as gas networks will be decommissioned – and how this should be funded.

3.2 The economics of heat pumps

While heat pumps are a key low-carbon heating option, when carbon prices are not included the costs associated with the purchase, installation and running of the heat pump may be higher than the incumbent heating technology. Another reason that heat pumps may appear more expensive is because incumbent technologies are likely to have benefitted from historic subsidy or regulatory support.

Policy makers looking to decabonise energy systems therefore need to ensure that incentives and markets rebalance energy economics towards heat pumps. There are two cost elements associated with heat pumps that need to be considered, capital costs and operating costs. Both are expanded on below.

19 CE Delft, Climact and European Climate Foundation. (2020). *Zero Carbon Buildings 2050: Summary Report*. https://europeanclimate.org/wp-content/uploads/2020/07/ecf--buildings-netzero-fullreport-v11-pages-lo.pdf

3.2.1 Capital costs

Capital costs include the costs for the heat pump itself, including its installation and any associated work such as internal pipework and emitter (underfloor heating or radiator) upgrades. These costs may include:

- The heat pump unit and its controller.
- A new hot water cylinder if needed (tank).
- Higher output radiators which run at lower flow temperatures.
- Pipework upgrades which may be required for lower flow temperatures.
- New circulation pumps.
- Drilling of boreholes, digging of trenches and laying of pipes for ground or water sourced systems.
- Electrical system upgrades.

It is important to bear in mind that the first-time switch to a heat pump from a boiler will be the most complex and most expensive because the system changes required for lower flow temperatures are only needed once. Subsequent heat pump unit replacements will cost less,[20] and not all heat pump installs will require all the additional costs listed above. For example, new heat pump models which use refrigerants with lower global warming potential can operate at higher temperatures, possibly negating the need for radiator upgrades.

However, while additional energy-efficiency measures are not always strictly necessary as heat pump systems and emitters (radiators and underfloor heating) can simply be scaled up, it is often cost-effective to carry out additional energy-efficiency work during or before a heat pump retrofit from the perspective of the building owner, the overall energy system or both. For example, the additional capital cost requirements of these efficiency investments may be compensated for by running cost savings, cost savings from a smaller sizing of the heat pump system, and/or lower grid investment and balancing needs.

3.2.2 Ongoing costs

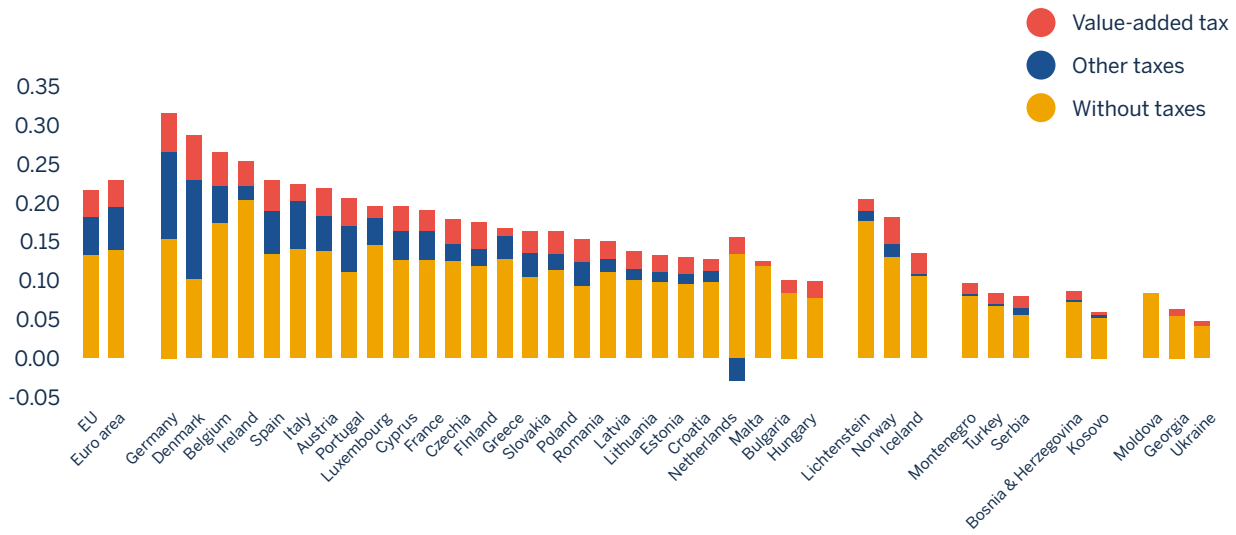
The operational costs of heat pumps are primarily associated with the cost of the electricity used to power them. These electricity usage costs are largely driven by two factors: the price of electricity, and the seasonal coefficient of performance (SCOP) of the heat pump system. Put differently, the operating expense cost of each kilowatt hour of heat from a heat pump is a function of the cost of electricity (€ per kilowatt hour electricity) divided by the SCOP. Ensuring that the heat pump operating costs (and therefore the related electricity price) compare favourably to the price of fossil fuels should be an important consideration for policymakers.

20 Once the heat pump reaches the end of its life, the replacement pump will require only a much simpler and cheaper installation. Initial heat pump retrofits are thus particularly capital-heavy, and that investment may be a barrier for households.

As is shown below in Figure 6,[21] the retail price of electricity varies significantly across Europe, driven by differences in wholesale market prices but also by tax and policy choices. While wholesale costs are more difficult to control, the application of taxes and levies on electricity bills can be modified and moved between government budgets and even into government spending to help support heat pump deployment. It's worth noting that the major wholesale gas market price increases which first happened in late 2021 will have impacted electricity prices and the relative consumer costs of fossil gas compared to electricity. Analysis by RAP has shown that, following the price rises, a satisfactorily performing heat pump will now be cheaper to run in the UK than a gas boiler.[22]

In addition, variable 'time of use' and 'smart' tariffs can reduce heat pump running costs through maximizing the use of lower-cost electricity.[23] Policymakers can support such smart pricing approaches to reduce heat pump running costs.

Figure 6. Household electricity costs across EU Member States for the first half of 2021 showing the impacts of taxes and levies (EUR per kWh)



Source: recreated from Eurostat. (2021). *File: Electricity prices for household consumers, first half 2021 v5.png* [website].

Minimum COPs for heat pumps in test settings are legislated for in product regulations under the eco-design directive,[24] and these can be increased over time as the technology further evolves. However, it should also be remembered that external temperatures will affect heat pump SCOPs. Lower ground or air temperatures in cooler countries will in general lead to lower SCOPs and therefore higher relative costs. Estimated seasonal performance of air source heat pumps in different European geographies is shown below in Figure 7.[25] The impact of this issue can be resolved in part through the requirement for higher levels of fabric efficiency in cooler countries, as is generally already the case.

21 Eurostat. (2021). *File:Electricity prices for household consumers, first half 2021 v5.png* [website]. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Electricity_prices_for_household_consumers,_first_half_2021_v5.png

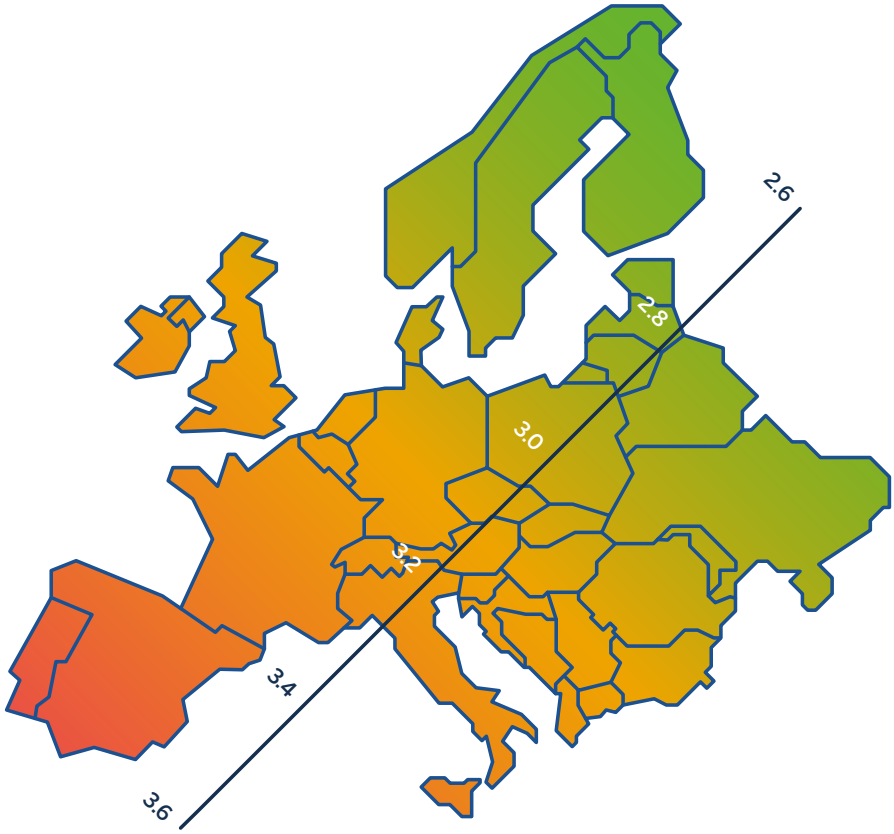
22 Regulatory Assistance Project. (2022). *Analysis: Running costs of heat pumps versus gas boilers.* https://www.raponline.org/wp-content/uploads/2022/02/Heat-pump-running-costs-v271.pdf

23 Rosenow, J. & Lowes, R. (2020). *Heating without the hot air: Principles for smart heat electrification*. Regulatory Assistance Project. https://www.raponline.org/knowledge-center/heating-without-hot-air-principles-smart-heat-electrification/

24 IEA. (2021). *Heat Pumps*. https://www.iea.org/reports/heat-pumps

25 Nouvel, R., Cotrado Sehgewlmeble, M. & Pietruschka, D. (2015). *European Mapping of Seasonal Performances of Air-source and Geothermal Heat Pumps for Residential Applications* [presentation at Conference: CISBAT 2015 At: Lausanne, Switzerland]. https://www.researchgate.net/publication/281745223_European_Mapping_of_Seasonal_Performances_of_Air-source_and_Geothermal_Heat_Pumps_for_Residential_Applications/download; Miara, M. (2021). How well do heat pumps really work in existing buildings? *Innovation 4E*. Fraunhofer. https://blog.innovation4e.de/en/2021/03/03/how-well-do-heat-pumps-really-work-in-existing-buildings/

Figure 7. Estimated seasonal air source heat pump COPs across Europe



Source: Estimated seasonal air source heat pump COPs in Europe based on: Nouvel, R, et al. (2015). *European Mapping of Seasonal Performances of Air-source and Geothermal Heat Pumps for Residential Applications*; and Miara, M. (2021). How well do heat pumps really work in existing buildings? *Innovation 4E.*

It is also worth noting that different types of heat pumps and differences in how they are installed can lead to variations in SCOP. For example, ground source heat pumps generally have higher SCOPs than air source heat pumps because the ground is normally warmer than the air on an annual basis.

The temperature of the hot water in the heating system also has a significant impact on COP, with lower flow temperatures leading to higher COPs. In general, higher COPs can be achieved through the use of underfloor heating, although large radiators can achieve similar results.

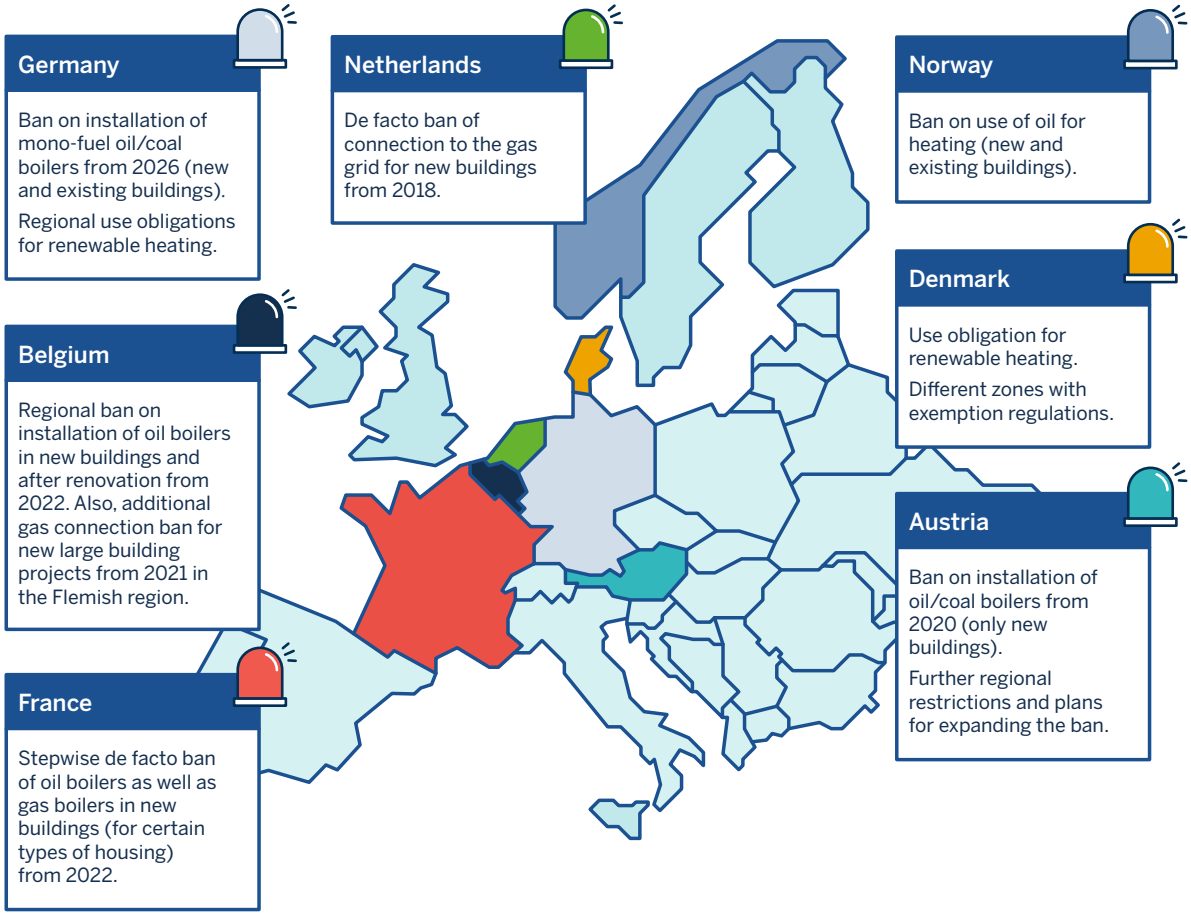
3.3 The existing policy environment

In nearly all European countries, regulations continue to allow the installation of replacement fossil-fuel heating systems in existing homes, and many still allow the installation of fossil-fuel heating in new homes. Furthermore, a number of Member States continue to subsidize and/or incentivize the installation of fossil-fuel heating, often through fuel poverty-focused schemes.

Where permitted, most householders and housing developers will continue to install fossil-fuel systems, because these tend to have lower capital costs than heat pump alternatives.

As is shown in Figure 8,[26] some Member States have imposed fossil-fuel heating bans for new buildings, but they are in a minority. For new buildings, the inclusion of heat pumps at the time of construction is more straightforward and more cost-effective than retrofitting them, as buildings and heating systems can be designed with low flow temperatures in mind from the outset. Fossil-fuel heating bans in new builds can also be relatively easy to achieve through building regulations and codes.

Figure 8. Fossil-fuel heating restrictions in EU Member States and Norway



Source: Based on Figure 4 from: Braungardt, S, et al. (2021). *Phase-out regulations for fossil fuel boilers at EU and national level.*

The more complex nature of low-carbon heating retrofits compared to bans in new builds means that policies for banning fossil-fuel appliance replacements are less common than new build fossil fuel bans. Bans on replacement oil systems are present in Norway, adopted in France and also under discussion in the UK. A full oil heating phase-out is planned in Finland by 2030.[27] Bans on gas heating are relatively novel but the UK is currently considering a gas boiler installation ban for the mid-2030s.

The relative lack of bans on new and replacement fossil-fuel heating systems is a key element maintaining fossil-fuel heating markets. Clearly these bans need to become more common, so that replacement systems will not lock in fossil-fuel heating and lead to stranded fossil fuel assets and potentially the breaching of carbon targets.

26 Braungardt, S., Keimeyer, F., Bürger, V., Tezak, B. & Klinski, S. (2021). *Phase-out regulations for fossil fuel boilers at EU and national level*. Öko-Institut e.V. https://www.oeko.de/fileadmin/oekodoc/Phase-out_fossil_heating.pdf

27 Vavre, J. & Zill, M. (2021). *Member States' ambition to phase out fossil-fuel heating – an analysis.* ECOS & Coolproducts. https://www.coolproducts.eu/wp-content/uploads/2021/07/ECOS-Coolproducts-Background-Briefing-MS-ambition-to-phase-out-fossil-fuel-heating.pdf

3.4 Learning from experience

The energy system models which highlight the importance of heat pumps tend to consider overall system costs, portraying cost-effectiveness at a 'macro' level. However, even if a high price of carbon were to be included across the entire economy of EU Member States (effectively replicating the findings of the models in the real world), it is not clear that this alone would drive heat pump deployment at the required levels.

What is needed is a package of policy and regulatory measures which takes into account the existing heat system, rebalances costs, and provides support to building owners and residents. In practice, a number of economic, technical, regulatory and socio-cultural factors at the 'micro' level determine whether heat pumps are competitive and deployable in a given situation.

Previous analysis by RAP considered a policy package which could be used to encourage heat pump deployment in the UK at a rate commensurate with the government's target of 600,000 installations annually by 2028.[28] This analysis (synthesized below in Figure 10[29]) considered heat pump deployment success stories, particularly in Nordic countries, and highlighted the need for a coordinated package of measures. Such a package should include:

01 Capital support to eliminate any potential upfront cost and access to capital issues where required.

02 Pricing policies, which result in lower ongoing heat pump running costs compared to incumbent fossil-fuel boiler running costs.

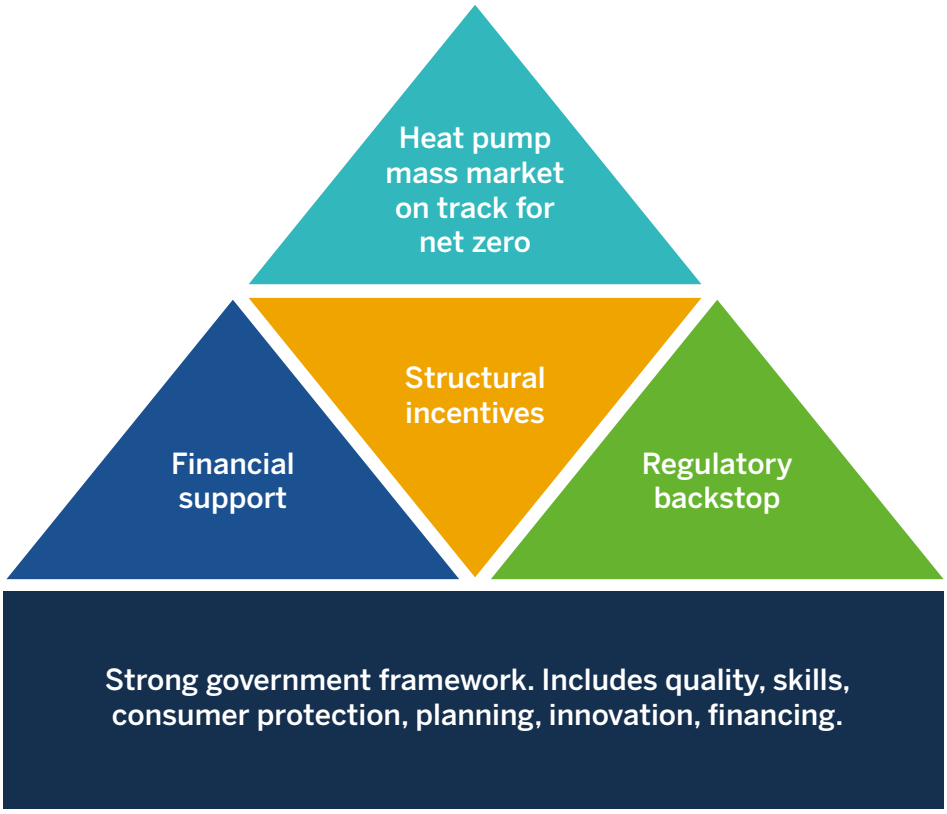
03 The use of regulations to drive purchasing behaviours.

04 A thorough governance framework to enable sustainable heat pump deployment through the development of softer social elements such as skills development and consumer protection.

28 Lowes, R., Rosenow, J. & Guertler, P. (2021). *Getting on track to net zero: A policy package for a heat pump mass market in the UK*. Regulatory Assistance Project. https://www.raponline.org/knowledge-center/getting-track-net-zero-policy-package-heat-pump-mass-market-uk/

29 Lowes, R. et al., 2021.

Figure 9. Key elements of a policy package to drive mass uptake of heat pumps



Source: Lowes, R. et al. (2021). *Getting on track to net zero: A policy package for a heat pump mass market in the UK.* Regulatory Assistance Project.

It is important to note that despite deployment success in the Nordic countries, growth in the deployment of heat pumps has also fluctuated over time as a result of policy changes. In order to achieve rapid and stable heat pump growth in line with decarbonisation goals, stable policy support without repeated stops and starts will be essential. Policy stability also has value because it can support investment not just in heat pumps but in the surrounding supply chains, which could otherwise be hindered by uncertainty.[30]

It appears that the key to Nordic heat pump success has been long-term strategies that employ combinations of policy measures. These measures include regulation and in some cases bans, pricing support often through carbon taxation, the use of product standards, and public engagement campaigns.

Outside of the Nordic countries, various measures have been employed to drive heat pump deployment. These include targets for renewable heat, capital support for building owners, carbon taxes, tax deductions for renovation works, new build standards, and low-interest loans. The perfect policy mix for heat pump deployment needs to include a combination of pricing, regulatory and subsidy measures; and it needs to be reactive to changing circumstances in order to avoid boom and bust cycles.

30 Lowes, R. (2021). *From laggard to leader: How the UK can capitalise on the heat pump opportunity*. Regulatory Assistance Project. https://www.raponline.org/blog/laggard-to-leader-uk-can-capitalise-heat-pump-opportunity/

PART 4

Making Fit for 55 package the perfect fit for heat pumps

The scale of change needed for the EU to meet its 2030 climate and energy targets is vast. But despite the centrality of heat pumps to European (and global) strategies for energy decarbonisation, policies and targets specifically looking to drive heat pump deployment have not been developed thus far at this level of governance.

However, EU policymakers are beginning to recognize the need for change, and the European Green Deal is giving momentum for a coordinated and concerted push to improve the enabling framework for heat pumps through EU legislation. Significant energy policy and regulatory reform is currently underway, linked to the Fit for 55 package and the European Green Deal. The current reforms provide a clear opportunity for developing policy to be shaped in a way that makes the package the perfect fit for heat pumps.

This chapter considers the three elements of heat pump support strategies mentioned previously: pricing and economics, financial support, and regulatory standards. Under each of these sub-headings, we consider how the European Commission's Fit for 55 proposals currently drive the uptake of heat pumps across EU Member States, and how this could be increased with further modification.

4.1 The importance of pricing

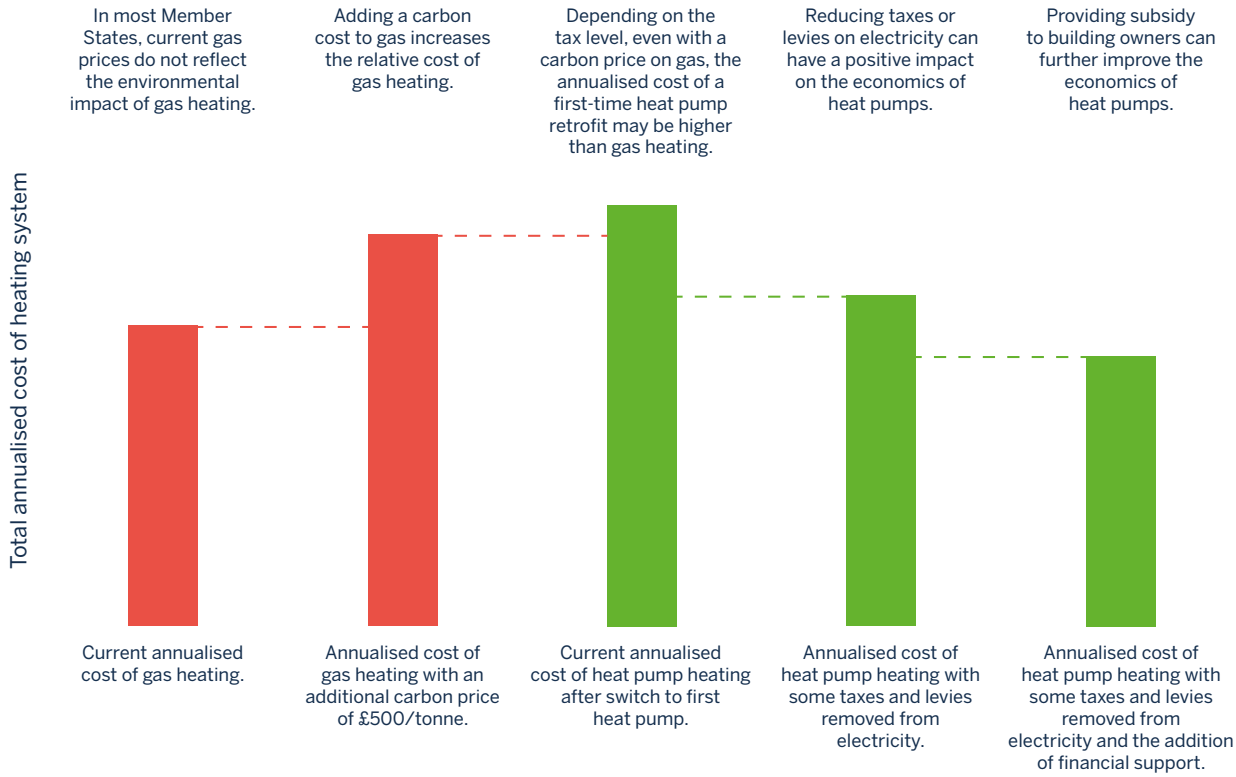
Policymakers should ensure that there is a clear financial incentive for building owners to invest in heat pumps. As described in Section 2.2, the levelized cost (or system cost) of heat pumps is made up of two elements: capital costs and running costs.

In general, heat pumps have higher upfront costs than fossil-fuel alternatives, and transition costs are particularly high for the first-time switch from a fossil-fuel system to a heat pump. As explained previously, the main running costs (associated with electricity used by the heat pump) will be determined by the cost of electricity, the COP of the heat pump, and the overall heat demand of the building.

Figure 10[31] below illustrates the impact that changes to pricing can have on the relative lifetime costs of heat pumps compared to gas heating. Increasing taxes on fossil fuels can reduce the cost differential, as can the removal of taxes and levies from electricity and the provision of subsidies to building owners. As was mentioned in section 2.2.1, in the context of pricing, it is important for policymakers to bear in mind that the first-time switch to a heat pump will be more costly than subsequent boiler replacements.

31 This example is illustrative and represents the fact that first-time heat pump retrofits are likely to cost more than gas heating across the EU. It includes a representation of appliance costs, but it should not be seen as quantitative because of geographical variations in energy pricing, heat demand and other factors.

Figure 10. Illustrative examples of the impact that pricing can have on the relative economics of heat pump retrofitting compared to gas boilers



Source: This example is purely illustrative and is intended to show the relative cost impacts of different policy measures on first-time heat pump retrofit costs compared to gas heating.

Because heat pumps are a cost-effective zero-carbon technology, putting a price on carbon emissions from heating fuels would shift overall market pricing away from fossil fuels towards heat pumps (depending on the price used). Policymakers, however, need to consider the response of consumers to potential carbon prices and ensure that:

01 Ongoing heat pump running costs are cheaper than fossil fuel alternatives, something that putting a carbon price on fuels should help to achieve; and

02 Capital is available to support building owners in upgrading their heating systems to heat pumps, including where necessary for improvements to the building envelopes and changes to hydronic systems to enable lower flow temperatures.

Elements of the Fit for 55 package could support shifting overall energy system prices towards heat pumps, but greater consideration of heat pumps in the revisions is needed. Revisions to the EU ETS and EU tax directive are considered in the following two sections.

4.1.1 Revision of the EU ETS directive

What are the current EU proposals?

Proposals for the revision of the ETS directive would deliver a second ETS ('ETS 2') covering direct emissions from fuels used in buildings and road transport, separate from the existing system ('ETS 1'), which already covers emissions from electricity production.[32] The ETS 2 proposals would:

- Regulate fuel suppliers (not end-users) to obtain allowances to cover the carbon dioxide emissions associated with their fuel sales;
- Begin in 2025, with a cap on emissions in effect from 2026;
- Set a cap with a trajectory that reduces annual emissions to 43% of 2005 levels by 2030;
- Auction all allowances (i.e. no free allocation);
- Frontload a proportion of allowances and set up a market stability reserve to help manage the risk of excessive price increases; and
- The European Commission proposes to capture 25% of the total revenues as EU 'own resources' to feed a new social climate fund, and requires Member States to use the remaining auction revenues for measures to support the decarbonisation of buildings and transport and, in part, address the social aspects of ETS 2.

How would these proposals affect heat pumps?

The proposals would put an EU-wide carbon price on fossil fuels used for heating in small heating installations, in the same way that ETS 1 already puts a carbon price on electricity and heat produced in large combustion plants (e.g. power plants, CHP, and heat-only installations). This price would go some way towards addressing the imbalance in costs between high-carbon and low-carbon heating fuels, internalizing a cost of carbon into all the heating fuel prices faced by end-users.

In combination with other price reforms (see Section 3.1.2 below), an increase in the price of fossil fuels relative to electricity would make heat pumps more attractive as an investment, as the payback period over which investment costs are recouped would be reduced. This means that some building owners may install heat pumps that otherwise would not have met their investment criteria.

Carbon pricing can also work in a complementary way with other policy measures. ETS auction revenues provide funding that can be used to compensate households in energy poverty affected by the carbon price and provide subsidies to offset the upfront costs of heat pumps and building retrofit

32 European Commission. (2021a). *Proposal for Directive of the European Parliament and of the Council amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union, Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and Regulation (EU) 2015/757*. https://ec.europa.eu/info/sites/default/files/revision-eu-ets_with-annex_en_0.pdf

measures. Because the ETS would lead to more balanced prices, the overall subsidy levels required to support heat pump deployment in line with the EU's energy and climate targets would also likely need to be lower for non-energy poor and low-income households, allowing public funds to go further. Similarly, if the economics of fuel switching improve, the introduction of regulation to ban fossil-fuel heating systems is likely to face less resistance.

What should the EU do to make the policy proposals better?

The emissions trajectory of the ETS 2 cap to 2030 is ambitious but aligned with climate requirements. Nevertheless, there is a high degree of uncertainty around the ability and willingness of Member States to make rapid emissions reductions in the buildings and road transport sectors. This imbalance creates a very real risk that the price of ETS 2 allowances will escalate to levels that would place unacceptable financial burdens on households if Member States fail to deliver adequate support policies. This risk is of particular concern for low-income building owners and households in private rental accommodation that are vulnerable to additional energy costs and least able to invest in low-carbon technologies to avoid the higher costs.

To mitigate this risk, the EU should ensure that sufficient emission reductions are delivered through complementary EU laws and Member State policy measures while ensuring that the social impacts of emissions trading are sufficiently taken into account. Strengthening requirements for Member States to make emissions reductions through the Effort Sharing Regulation, Energy Efficiency Directive (EED), and the Renewable Energy Directive (and indeed in transport-related laws) would reduce the demand for ETS 2 allowances, keeping carbon prices under control. Within the ETS directive itself, provision can be made to:

- Require ETS revenues to be spent on building decarbonisation measures, through the Social Climate Fund and the Modernization Fund, with a ring-fenced proportion to be spent on energy-poor households in the worst-performing buildings, while recognizing that ETS revenues would need to be supplemented by other funding to tackle heat decarbonisation among energy-poor households; and
- Introduce a price cap for the ETS 2 allowances, while recognizing that unanimity could be needed across Member States to agree both in principle and to the price cap trajectory.

What should Member States do now?

Member States could plan to use future ETS 1 and 2 revenues now to make energy efficiency and heat decarbonisation improvements to the worst-performing buildings in which energy-poor, vulnerable or low-income households live. Early action would enable some of the negative social impacts of ETS 2 to be avoided and help to kick-start the Renovation Wave. There is also nothing to stop progressive Member States from reforming their own energy prices to reflect carbon costs in advance of the 2025 ETS 2.

4.1.2 Revision of the Energy Taxation Directive

What are the current EU proposals?

Previous analysis by RAP has proposed the reform of the tax system so that it effectively supports carbon pricing.[33] The current Energy Taxation Directive (ETD) exists to ensure minimum tax levels across Member States on electricity and fuels when they are used for motor fuel, aviation or heating, in order to avoid competitive distortions and contribute to a low-carbon and energy-efficient economy.

The ETD, however, does not contribute to heat decarbonisation, as the minimum rates are low and relate to neither energy nor carbon content. Furthermore, Member States are free to increase any energy tax above the minimum levels prescribed by the ETD. In practice, many Member States have set tax rates, levies and surcharges in a way that effectively subsidizes fossil fuels by disproportionately burdening electricity consumption relative to other energy products, leaving taxes for fossil heating fuels at a relatively low rate.

The current proposals for revision of the ETD[34] aim to ensure that the energy content and environmental impact of fuels is reflected in taxation. The proposals would complement the ETS extension to heating and transport. Transitional rates on certain fuels and for certain groups (e.g. low income) would mean some tax increases come in from 2023 and higher rates would be reached by 2033. Under the proposals, electricity would always have the lowest rate, regardless of its use.

Fossil fuels and unsustainable biomass would both have higher rates owing to the associated environmental damages, albeit not at sufficient levels to correct existing imbalances. A proposed ranking rule would ensure that in each Member State, where energy tax levels are above the minimum, the ranking of fuels by environmental performance would be reflected in their respective tax rates.[35]

How would these proposals affect heat pumps?

Given the low minimum taxation levels proposed for fossil heating fuels and the possible exemptions, the likely effect of the Commission's ETD proposal on heat pump deployment could be limited compared to what can be achieved through stricter regulations and the ETS 2. Nonetheless, the changes could help to play a role in effectively rebalancing energy costs in favour of electricity use, shifting the economics of heating away from fossil fuels and biomass towards heat pumps. Twelve Member States, predominantly in Eastern Europe, would need to raise their taxation levels on fossil gas to the new minimum rate, while eight Member States would need to reduce their taxes on electricity (or raise taxes on heating fuels) in order to comply with the ranking rule.

33 Thomas, S., Sunderland, L. & Santini, M. (2021). *Pricing is just the icing: The role of carbon pricing in a comprehensive policy framework to decarbonise the EU buildings sector*. Regulatory Assistance Project. https://www.raponline.org/knowledge-center/pricing-just-icing-role-carbon-pricing-comprehensive-policy-framework-decarbonise-eu-buildings-sector/

34 European Commission. (2021b). *Proposal for a Council Directive restructuring the Union framework for the taxation of energy products and electricity (recast).* https://ec.europa.eu/info/sites/default/files/revision_of_the_energy_tax_directive_0.pdf

35 Gore, T. (2021). *The revision of the Energy Taxation Directive could underpin a fair and green tax reform in Europe*. Heinrich Boll Stiftung https://eu.boell.org/en/2021/09/13/revision-energy-taxation-directive-could-underpin-fair-and-green-tax-reform-europe

What should the EU do to make the policy proposals better?

As the Commission proposal to reform the ETD addresses the fiscal competence of Member States, it will most likely need to be approved through a unanimous vote. This legal and procedural hurdle means that it is unlikely to be significantly strengthened during the negotiation of the Fit for 55 package. The EU should accept the sound principles behind the Commission's proposals and avoid the temptation to weaken them or introduce further exemptions to suit national interests. Eventual changes should all contribute to levelling taxation across sectors.

What should Member States do now?

If the proposals become law they would not come into force until 2023; but because of the need for unanimous support around EU tax affairs, there is a risk that these proposals will not be enacted at all. In any case, Member States wishing to support heat pump deployment should ensure that their energy taxes, levies and surcharges support, as a bare minimum, cheaper running costs for heat pumps compared to fossil fuel and biomass heating. In many cases, the changes to tax rules and levies needed to rebalance costs towards electricity would be relatively simple policy modifications.

Voluntary higher national carbon tax rates, as have been introduced in countries like Sweden, Germany and France, could also shift the overall economics of energy systems from fossil-fuel heating towards heat pumps, in particular if they precede the introduction of ETS 2 and where they exceed or supplement the carbon prices achieved in the emissions trading system.

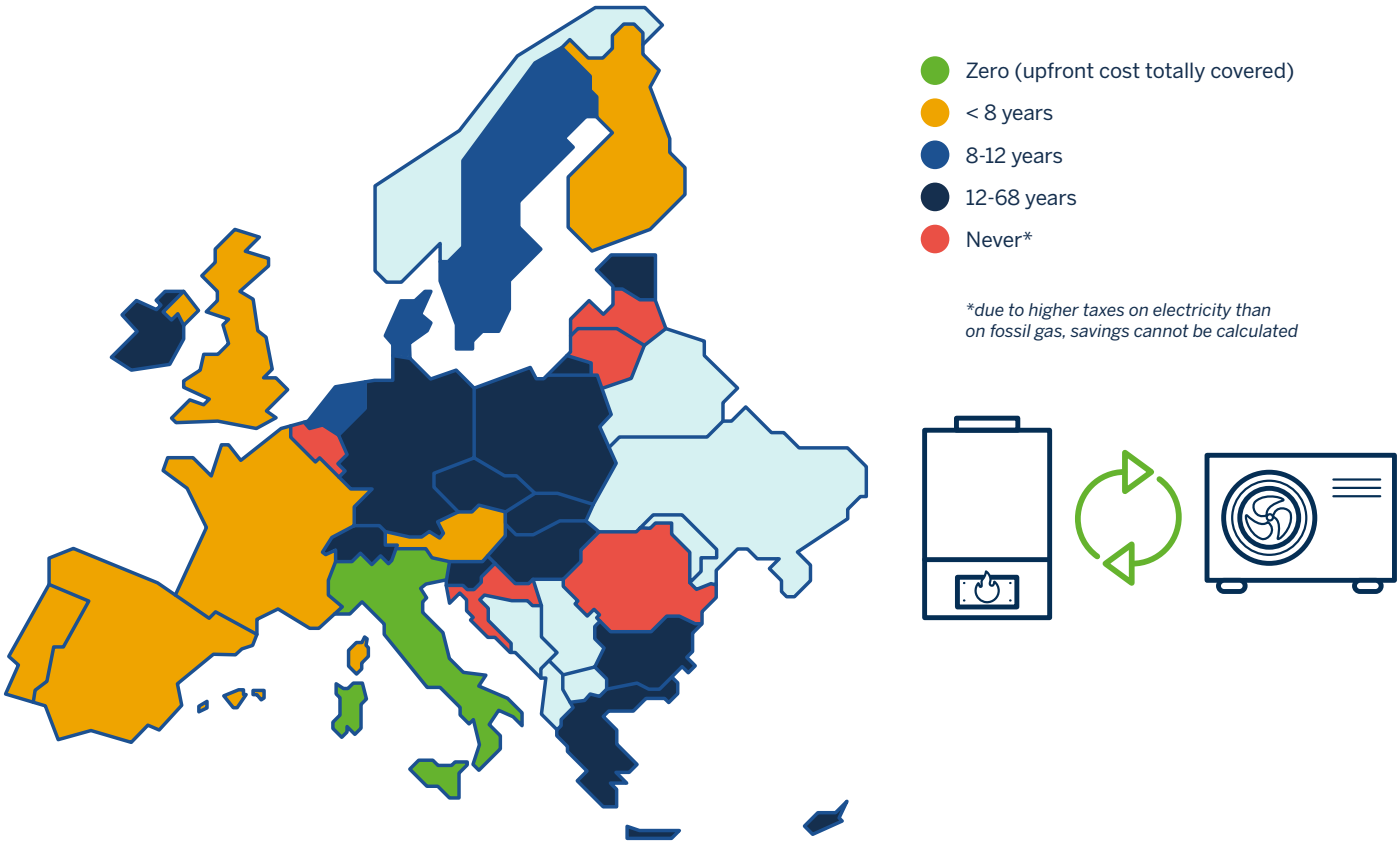
4.2 The need for subsidies, incentives and funding

In section 3.1 we considered how overall system pricing could support the deployment of heat pumps through the inclusion of buildings in the EU ETS and reform of the Energy Tax Directive. But even if system-wide pricing is adjusted to reflect currently externalized carbon costs and rebalance energy prices in favour of electrification, as we have explained in section 2.2.1, the additional upfront costs of heat pumps compared to fossil-fuel boilers lead to capital affordability concerns for some building owners.

For commercial building owners and landlords, additional capital costs associated with heat pumps may be able to be included in business turnover as a commercial cost. However, for owner-occupiers (i.e. those that own and live in their homes), these additional costs could be more difficult to finance, particularly for less affluent households. For households in the private and social rental sector (i.e. those renting a home owned by someone else), sufficient support and regulatory requirements must also be provided to ensure that landlords have sufficient incentive to make the necessary investments without the need to unduly increase rents, particularly for homes occupied by low-income households.

As such, for governments with major heat pump deployment plans, policy must also provide capital support for those who need it. This support could be in the form of grants, tax rebates or loans to building owners. Based on analysis by Coolproducts, Figure 11 below highlights existing policy support for renewable heating across Europe, and shows the current variation in offered subsidy and what that means for payback times when switching from gas to heat pumps and solar thermal. While short renewable heating paybacks are possible in countries with appropriate incentives and funding, limited financial support in others is limiting heat pump deployment.

Figure 11. Payback times for switching from gas to renewable heating considering current prices and financial incentives



Source: Based on analysis by Coolproducts. (2021). *Out of gas: EU is €70 billion away from making renewable heating affordable for all – New analysis.*

The development of energy service companies (sometimes referred to as ESCO models) could also provide heating as a service, whereby additional capital costs associated with heat pumps are spread over a number of years, avoiding the need for households themselves to provide capital. The suitability of such ESCO models will be dependent on household circumstances.

The following sub-sections consider how proposed changes to the Energy Efficiency Directive and the Renewable Energy Directive in the Fit for 55 package could be modified to support heat pump deployment. While these directives have a much broader scope than solely the provision of financial support for heat pumps, these financial issues are nonetheless key.

4.2.1 The recast Directive on Energy Efficiency

What are the current EU proposals?

The current proposals for the recast Energy Efficiency Directive (EED)[36,37] consist of a number of important elements. The recast EED:

- Introduces higher targets for reducing primary (39%) and final (36%) energy consumption by 2030, now binding at EU level in line with the Climate Target Plan, up from the current target of 32.5% for both primary and final consumption.
- Introduces an obligation for the public sector to reduce its energy consumption for public services and installations of public bodies by 1.7% per year, including efficiency measures in publicly owned district heating and cooling networks.
- Requires Member States to ensure the renovation of 3% of their public building stock larger than 250m2 per year to the Near Zero Energy Buildings (NZEB) standard, and broadens the scope of the existing obligation to include all public bodies at all administration levels and in all sectors of public bodies' activities (including healthcare, education and public housing), where the buildings are owned by public bodies.
- Requires Member States to ensure that contracting authorities and contracting entities concluding contracts above certain thresholds purchase only products, services and buildings with high energy-efficiency performance, strengthens public procurement provisions by requiring energy efficiency requirements to be taken into account, and removes conditionalities related to cost-effectiveness and technical and economic feasibility.
- Increases the annual energy savings rate under Article 7 (now Article 8) for 2024-2030 from 0.8% to 1.5% of final energy, and no longer counts energy savings from fossil fuel combustion technologies after January 2024.
- Requires Member States to undertake comprehensive heating and cooling assessments and encourage municipalities with more than 50,000 people to prepare local heating and cooling plans.
- Introduces a new definition of efficient district heating, which is gradually tightened to move away from fossil fuel-based systems towards renewables.
- Introduces an obligation for Member States to implement energy efficiency improvement measures as a priority among vulnerable customers, people affected by energy poverty, and people living in social housing.
- Reinforces provisions related to the availability of qualification, accreditation and certification schemes for energy services providers, energy auditors, energy managers and installers.

36 BC3 / IEEP (2022), Forthcoming.

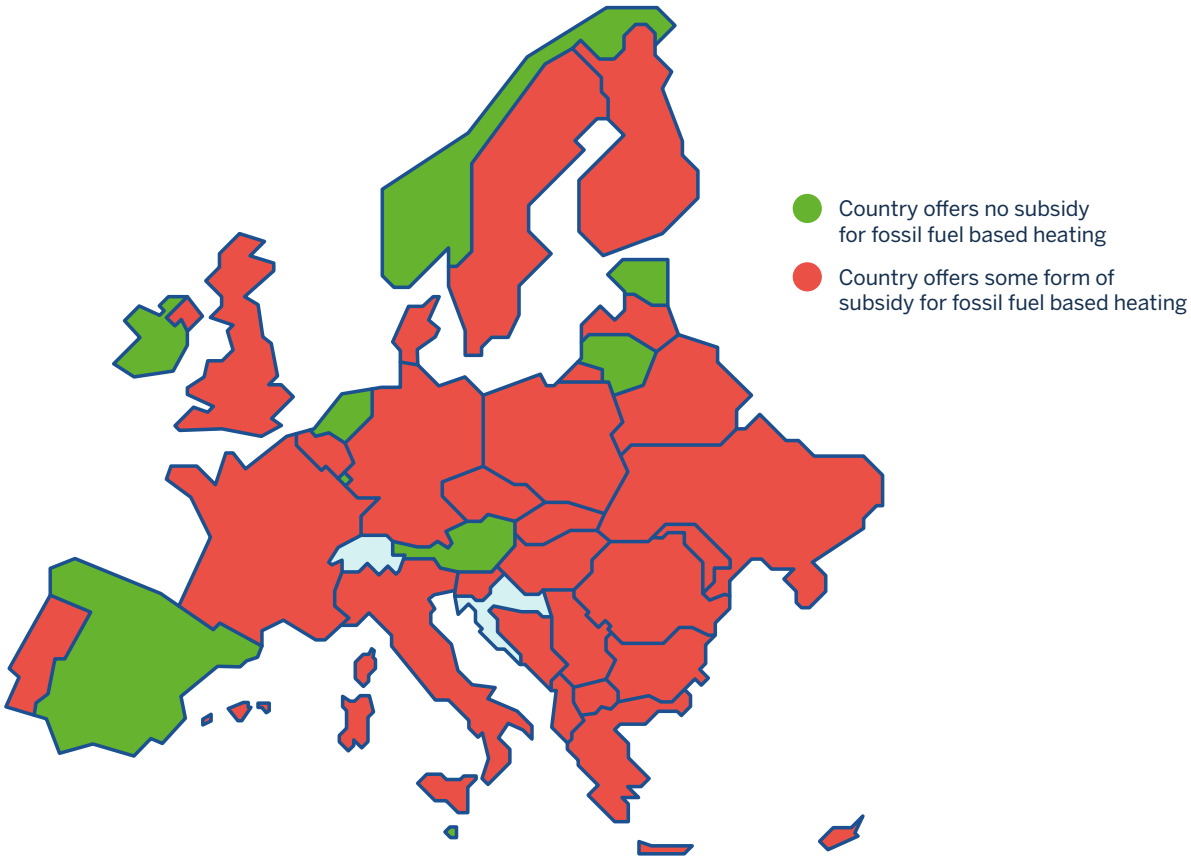
37 European Commission. (2021c). *Proposal for a Directive of the European Parliament and of the Council* ***on energy efficiency (recast)***. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0558

How would these proposals affect heat pumps?

The overall increase in ambition level, and specifically the higher mandatory energy savings rate under Article 8, will require Member States to ramp up existing measures and to introduce new policy measures to obtain higher energy savings. Because heat pumps reduce primary energy demand, they will be one of the technologies that can be deployed through programmes to deliver energy savings.

As is shown below in Figure 12, many Member States currently support the replacement of fossil fuel heating technologies with more efficient fossil fuel technologies, for example replacing old gas boilers with condensing gas boilers.[38] Under the new proposals Member States will no longer be able to count savings from these measures towards their energy saving targets set by the EED. This disallowance would in turn require Member States to refocus existing and new programmes on technologies that do not involve the combustion of fossil fuels, including heat pumps.

Figure 12. A number of European countries still offer subsidies for fossil fuel heating appliances



Source: Coolproducts. (2020). *Mapping Europe's subsidies for fossil fuel heating systems.*

The new definition of efficient district heating in the proposals means that the share of renewable energy used for providing district heating will have to increase. Table 2 below outlines the proposed milestones for the ever-increasing shares of renewable and waste heat in district heating.[39]

38 Coolproducts. (2020). *Mapping Europe's subsidies for fossil fuel heating systems*. https://www.coolproducts.eu/failing-rules/mapping-europes-subsidies-for-fossil-fuel-heating-systems/

39 European Commission, 2021c.

Table 2. Criteria for 'efficient heating and cooling system' as set out in proposed recast EED

	Share of low carbon heat
Until 31 December 2025	Option 1: >50% renewable energy or 50% waste heat Option 2: >75% cogenerated heat Option 3: >50% renewable and waste heat combined
From 1 January 2026	Option 1: >50% renewable energy or 50% waste heat Option 2: >80% cogenerated heat or at least a combination of such thermal energy going into the network where the share of renewable energy is at least 5% and the total share of renewable energy, waste heat or high-efficiency cogenerated heat is at least 50%
From 1 January 2035	>50% renewable energy and waste heat, where the share of renewable energy is at least 20%
From 1 January 2045	>75% renewable energy and waste heat, where the share of renewable energy is at least 40%
From 1 January 2050	Only renewable energy and waste heat, where the share of renewable energy is at least 60%

Source: European Commission. (2021c). *Proposal for a Directive of the European Parliament and of the Council on energy efficiency (recast).*

Subject to acceptance of the EED district heating proposals, it will become more attractive to deploy large-scale heat pumps as part of district heating systems as they would help to comply with the requirements for a rising share of renewable energy sources.

What should the EU do to make the policy proposals better?

Maintaining and potentially strengthening the energy-efficiency targets will be important in order for energy-efficient technologies such as heat pumps to be given increasing support by national policy makers. No longer counting savings from fossil fuel combustion technologies is another important element that, if kept, would steer Member States towards clean heating technologies rather than more fossil fuel-based heating systems.[40]

The current definition of efficient district heating is problematic as it allows maintaining and even expanding heat generation from fossil gas. The use of biomass even if unsustainable is not restricted under the current plans. An improved definition of district heating would ensure that gas and biomass use for district heating is limited.

40 Thomas, S. (2021). *Ensuring the EED energy savings obligation is Fit for 55*. Regulatory Assistance Project. https://www.raponline.org/knowledge-center/ensuring-the-eed-energy-savings-obligation-is-fit-for-55/

What should Member States do now?

Member States have an opportunity to revisit their policy portfolio in light of the proposals, but can also set more ambitious national climate goals. Phasing out public support for fossil-fuel heating systems in energy efficiency programmes and an early shift towards renewable heating systems and heat pumps would be an important reform. It would allow Member States to decabonise faster and ensure that clean heating technologies compliant with the 2050 target of climate neutrality are being deployed at the required rate. For Member States with existing and developing heat networks, regulations can be introduced now to ensure new networks use heat pumps from the outset and existing networks decabonise over time.

4.2.2 Proposed revisions to the Renewable Energy Directive

What are the current EU proposals?

The proposed revisions[41] include:

- A new binding target for the overall share of renewables in the
- EU energy mix to 40% by 2030,[42] with indicative national contributions of Member States.
- A new target for buildings of 49% renewables use by 2030.
- Various targets in the heating and cooling sector, including a binding contribution of renewables, renewable and waste shares in district heating and cooling, plus requirements for Member States to support access of renewables to district heating and cooling systems.
- A requirement to ensure that enough trained and qualified installers of renewable heating and cooling systems are available to deliver the EU's 2030 sub-target for renewables in heating and cooling, and that sufficient training programmes are made available to achieve this goal.
- A requirement for Member States to perform an environmental assessment of their renewable and waste heating and cooling potential.

41 European Commission. (2021d). *Proposal for a Directive of the European Parliament and of the Council amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652.* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0557

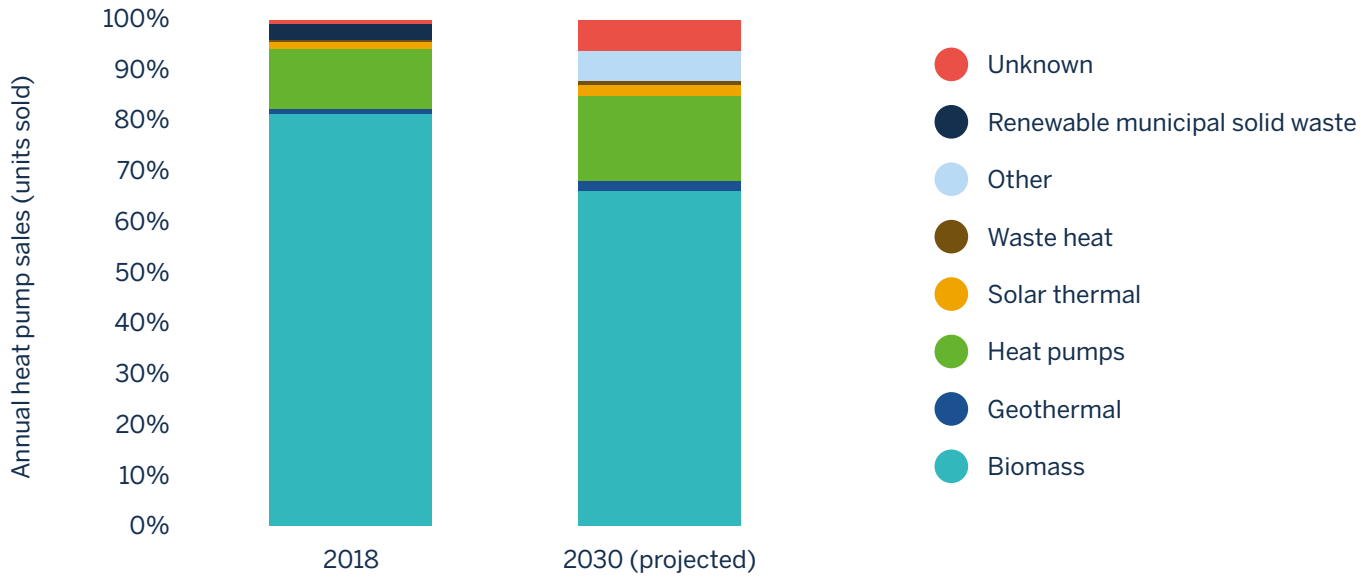
42 European Commission. (2021e). *Commission presents Renewable Energy Directive revision*. https://ec.europa.eu/info/news/commission-presents-renewable-energy-directive-revision-2021-jul-14_en

How would these proposals affect heat pumps?

Overall, these changes would drive increased support for heat pumps because heat which is extracted from the environment will count towards the overall 2030 renewable energy target. The proposed building-specific target, district heating requirements and the focus on the development of heating and cooling skills will also likely bolster the market. The requirement for heating and cooling resource assessments could also lead to more detailed area-based heat planning.

A major concern is that the combination of a more ambitious target and weak protective amendments against the deployment of harmful biomass will allow the lion's share of the required uptick in contribution of renewables to heat to be met by unsustainable biomass. This biomass would increase greenhouse gas emissions over the coming years and decades, damaging biodiversity and impinging on human health. Current projections for 2030 show that the majority of renewable heating and cooling is expected to be met through the use of biomass, but as is shown in Figure 13, the relative share of biomass in the heat mix is expected to reduce and the relative share of heat-pumped heat to significantly increase.[43]

Figure 13. Projected shares of non-fossil fuel heating technologies to meet EU renewable heating and cooling targets for 2030



Source: Toleikyte, A. & Carlsson, J. (2021). *Assessment of heating and cooling related chapters of the national energy and climate plans (NECPs).*

43 Toleikyte, A. & Carlsson, J. (2021). *Assessment of heating and cooling related chapters of the national energy and climate plans (NECPs)*. EUR 30595 EN, Publications Office of the European Union. ISBN 978-92-76-30234-6, doi:10.2760/27251, JRC124024. https://publications.jrc.ec.europa.eu/repository/handle/JRC124024

What should the EU do to make the policy proposals better?

Deployment of biomass heating represents a key risk to energy system decarbonisation which is best tackled head on.[44] We continue to urge revision of the Renewable Energy Directive (RED) to ensure it helps the EU to achieve its climate goals and does not damage biodiversity and human health. In particular, we propose three design features for a mandatory renewable heat target:

- Caps on the use of unsustainable bioenergy.
- Allowing the renewable portion of electricity to be counted towards the target: the current renewable heat accounting framework does not allow for this.
- In light of the potential absence of a tight cap on unsustainable bioenergy for heating, a multiplier for non-biomass renewable heat technologies (including heat pumps, geothermal and solar thermal) should be introduced. Such a multiplier would encourage Member States to put in place policy measures to support strategically important, non-bioenergy heating technologies.

Together, these requirements should ensure that unsustainable biomass is not deployed as a solution in place of more sustainable alternatives such as heat pumps and energy efficiency.

What should Member States do now?

Member States may wish to introduce their own targets for renewable heat and heat pump deployment in the interim period. These targets could include maximum levels of bioenergy which would count towards such a target. Heat pump-specific targets – such as the UK's 600,000 heat pumps per annum – can provide certainty to the industry and support investment, but such targets will need to be supported by a complete policy package which includes the development of installer skills.

With regards to heat pump deployment in district heating networks, Member States and cities can also actively introduce district heating-specific targets (e.g. number of low-temperature district heating networks or homes connected to district heating by 2030). Member States can also provide support for the development of new low-temperature district heating and cooling networks and the modernization of existing networks to support the integration of renewables using large heat pumps. Moreover, Member States can help promote and strengthen national and local heating and cooling planning by supporting the timely identification of the renewable and waste heat resource potentials and making the accompanying data easily accessible.

Member States with specific concerns over biomass deployment could look to guide future development of the RED to protect against risk of use of unsustainable bioenergies.

44 Scott, D., Rosenow, J. & Thomas, S. (2021). How the EU's Renewable Energy Directive risks destroying Europe's forests. *Euractiv*. https://www.euractiv.com/section/biomass/opinion/how-the-eus-renewable-energy-directive-risks-destroying-europes-forests/

4.3 Regulatory requirements for heat pumps

While pricing and subsidies are clearly important elements of the policy picture for heat pumps, other policy options, broadly categorized into 'regulatory' measures, can support heat pump deployment. The following sub-sections consider how the Fit for 55 package, and related policy measures, might drive heat pumps via regulation and how the package could be improved.

A multitude of potential regulatory measures, some of which are already in use around the world, can support heat pumps. Such measures include building standards, renovation standards, appliance performance standards, and bans on fossil-fuel appliances.

The following two sub-sections consider how building standards or codes might drive the uptake of heat pumps in retrofit situations and also in new builds. The final sub-section considers how product standards could also support heat-pumped heating systems.

4.3.1 Proposed revision of the EPBD for existing buildings

What are the current EU proposals?

The proposal for the recast of the Energy Performance of Buildings Directive (EPBD) (15th December 2021)[45] contains a number of relevant elements:

- The scope of the Directive is expanded to cover more explicitly the decarbonisation of buildings, not only energy performance.
- Member States must set out policies and measures to phase out fossil fuels in heating and cooling to complete the phaseout by 2040 within their National Building Renovation Plans.[46]
- Minimum energy performance standards[47] are introduced to improve the worst-performing buildings in classes F and G to class E by 2030 for non-domestic and 2033 for domestic buildings. Member States are further required to set out timelines for buildings to achieve higher performance levels in 2040 and 2050.
- Clarification is given that Member States may introduce policies to phase out the use of fossil fuels through requirements related to GHG emissions or types of fuels used in heating systems.
- Financial incentives for fossil fuel boilers are prohibited from 2027 or from 2030 for investments already committed before 2027.[48]

45 European Commission. (2021f). *Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings (recast)*. https://ec.europa.eu/energy/sites/default/files/proposal-recast-energy-performance-buildings-directive.pdf

46 European Commission. (2021g). *Annexes to the Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings (recast)*. https://ec.europa.eu/energy/sites/default/files/annex-proposal-recast-energy-performance-of-buildings-directive.pdf

47 Defined in the EPBD recast proposal as 'rules that require existing buildings to meet an energy performance requirement as part of a wide renovation plan for a building stock or at a trigger point on the market (sale or rent), in a period of time or by a specific date, thereby triggering renovation of existing buildings.'

48 Although this is in contradiction with the EED which states that subsidies should be phased out by 2024.

- Changes to assessment and information tools:
  - Introduction of Building Renovation Passports that set out an individual renovation pathway for the building.
  - Recommendations for building improvements contained in the Energy Performance Certificate (EPC) to include measures to reduce GHG emissions as well as improve energy performance.
  - Assessment of whether heating or air conditioning can be operated at a low temperature to be included both in EPC recommendations and in building system inspections required by the Directive.
- A new definition of deep renovation: before 2030 a renovation which transforms a building or unit to a nearly-zero energy building, and after 2030 a renovation which transforms a building or unit to a zero-emissions building.[49]

How would these proposals affect heat pumps?

The requirement for Member States to set out policies and measures to phase out fossil fuels in heating and cooling by 2040 is the most important of the new proposals, as it significantly strengthens the heat planning provisions in the rest of the European policy framework. These policies and measures would be a significant driver for heat pump deployment.

The minimum energy performance standards proposed require very poorly performing buildings to be renovated, but the proposal requires them to be brought up to only a relatively low level of performance. These standards alone, therefore, will not be likely to drive significant heat pump adoption. They will however drive improvement in efficiency and insulation levels of the worst-performing buildings. This is essential to put these buildings onto a pathway to efficient, full decarbonisation.

Together with the requirement for Member States to draw up a further trajectory of performance improvements and improved National Building Renovation Plan policies, measures and performance indicators for fully decarbonising the stock, these measures should contribute to driving demand reduction and therefore efficient decarbonisation. The changes to the information elements to require assessment of the readiness of heat emitters to run at lower temperatures are a useful precursor to heat pump installation.

49 As proposed in the EPBD a 'zero-emission building' means a building with a very high energy performance, as determined in accordance with Annex I, where the very low amount of energy still required is fully covered by energy from renewable sources generated on-site, from a renewable energy community within the meaning of Directive (EU) 2018/2001 [amended RED] or from a district heating and cooling system, in accordance with the requirements set out in Annex III.

What should the EU do to make the policy proposals better?

The requirement for Member States to introduce policies to phase out the use of fossil fuels in heating by 2040 should be strengthened. Currently this requirement exists only as a mandatory element of the National Building Renovation Plan (Annex 2). The phaseout of fossil fuels should be promoted to inclusion in the main Directive text.

The Directive should make better use of the opportunity to use MEPS to drive deeper renovations and heat decarbonisation in the 2020s and 2030s. The Directive should require that the F and G class buildings targeted in the existing proposal be improved to a higher standard of performance than the current proposal of EPC E. Buildings should be renovated to a minimum standard designed to ensure that they can be heated efficiently through low system flow temperatures and to enable heating to be scheduled flexibly to help heating loads to be electrified efficiently.[50] The Directive should also out a longer-term trajectory of minimum standards to address more than just the worst-performing stock.

The Directive should also give more explicit attention to support to enable new electrified loads to be made flexible, in particular by including demand-side electricity and heat storage and smart building automation measures in the building assessment and information tools mentioned above.

What should Member States do now?

Member States can set their own, more ambitious minimum energy performance standards to drive renovation and decabonised zero-emissions heat that are fully aligned with their 2030, 2040 and 2050 targets. These standards can be used to either define the complete pathway for buildings to decabonise or to improve energy-efficiency levels in advance of a fossil-fuel boiler phaseout so that building owners are afforded the opportunity to improve thermal conditions before switching heat source at boiler replacement.

Further still, Member States should set out fossil fuel heating phaseout dates. Such regulations should include not just an end date for the installation of replacement fossil-fuel heating systems but could also include backstop dates beyond which the use of fossil fuels in heating is disallowed.

4.3.2 Proposed revision of the EPBD for new buildings

Newly constructed buildings in the EU will not represent the majority of the building stock in 2050. However, unless they are constructed to performance standards that align with the EU's updated 2030 climate targets and climate-neutrality goal, they will lock in energy demand and associated emissions that will make it harder to achieve these goals. New buildings in Europe should not have to undergo a deep renovation between now and 2050 in order to bring the process of decarbonising the building stock back on track.[51]

50 Yule-Bennett, S. & Sunderland, L. (2022). *The Joy of flex: Embracing household demand-side flexibility as a system resource for Europe*. Regulatory Assistance Project. Forthcoming.

51 BPIE (Buildings Performance Institute Europe). (2021). *The make-or-break decade: Making the EPBD fit for 2030*. https://www.bpie.eu/publication/the-make-or-break-decade-making-the-epbd-fit-for-2030/

What are the current EU proposals?

The recast EPBD defines zero-emissions buildings as buildings with very low energy demand which is fully covered by energy from renewable sources where technically feasible. It would require all new public buildings to be zero-emissions by 2027 and all new buildings to be zero-emissions by 2030. Until then the current nearly-zero-energy requirements would apply. However, reviews of the engagement of the NZEB requirement in Member States shows a wide disparity in terms of both definitions and implementation.[52]

In general, neither the current definitions of nearly-zero-energy buildings, nor the rate of implementation, will support the EU in achieving its current 2030 targets.[53] Therefore, the proposed recast EPBD is designed to better support achieving the EU's new target of 55% GHG reduction by 2030, and climate neutrality by 2050.[54] It contains updated provisions for new buildings including:

- Moving from near-zero energy requirements to zero-emissions requirements for new buildings by 2030. As of 2027 new public buildings must be zero-emissions with all new buildings zero-emissions from 2030.
- Providing a new Annex III that establishes maximum thresholds for primary energy performance requirements for new zero-emissions buildings. New buildings must achieve net-zero on an annual basis with renewable energy from on-site or off-site sources, and defines zero-emissions buildings such that they are not permitted to generate GHG emissions on site.
- As of 2027 the whole of life-cycle global warming potential of new buildings with a floor area greater than 2000m2 must be calculated, with all new buildings required to comply from 2030.
- Provisions beyond energy performance that influence heating and cooling systems such as addressing healthy indoor climate, adaptation to climate change, and fire safety.
- Providing a clear legal basis for Member States to ban GHG-emitting heating technologies (Article 11).

52 European Commission. (2019). Comprehensive study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU: Final report. https://op.europa.eu/en/publication-detail/-/publication/97d6a4ca-5847-11ea-8b81-01aa75ed71a1/language-en/format-PDF/source-119528141

53 BPIE, 2021.

54 European Parliament. *Legislative Train Schedule: Revision of the Energy Performance of Buildings Directive* [website]. Accessed online 12/11/21. https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/file-revision-of-the-energy-performance-of-buildings-directive

How would these proposals affect heat pumps?

The move to mandate zero-emissions buildings will support building integrated renewable electricity, a phaseout of on-site use of fossil fuel for heating, and the electrification of new buildings from 2030. If the recast is adopted these provisions will support heat-pump integration for heating and cooling in the new construction market.

The proposed recast EPBD notes that several Member States are already including phaseout of fossil-fuel use in new buildings as key to their building decarbonisation strategies. Current policies for the phaseout of fossil-fuel buildings are included below in Table 3.[55]

Table 3. Current policy strategies for decarbonising new buildings in EU Member States

Country	New buildings policy
Austria	Since 2020 a ban on the installation of central heating boilers running on liquid or solid fossil fuels in new buildings. Further regulations are planned for the phaseout of fossil oil and gas boilers.
Belgium	In 2021 Flanders adopted a gas connection ban for large building projects. From 2022 a ban on fuel oil boiler installation for new buildings and major energy renovations in residential and non-residential buildings.
Denmark	Since 2013 installation of fossil oil and gas boilers has been banned in new buildings. The current Danish building regulation (2018) introduced a general obligation for renewable energy use for heating.
France	From 2022 will de-facto ban heating by fossil fuel in new buildings by adopting rules on carbon efficiency for new buildings with a maximum threshold for the CO2 emissions per square meter and year depending on the building type. This will effectively exclude systems relying only on fossil fuels.
Germany	New buildings are subject to obligations to use renewable energy. From 2026 the installation of mono-fuel fossil boilers will be banned.
Ireland	Plan to increase the stringency of building regulations to effectively ban oil boilers from 2022, gas boilers in new dwellings from 2025, and roll out heat pump technologies in the residential and services sectors.
Netherlands	Since 2018 connection of new buildings to the gas grid has been banned.
Norway	Since 2020 the use of mineral oil for heating of buildings has been prohibited in new and existing buildings.

Source: Braungardt et al, 2021; Department of Communications, Climate Action & Environment, Ireland. (2020). *National Energy & Climate Plan: 2021-2030.*

55 Braungardt et al., 2021; Department of Communications, Climate Action & Environment, Ireland. (2020). *National Energy & Climate Plan: 2021-2030*. https://ec.europa.eu/energy/sites/ener/files/documents/ie_final_necp_main_en.pdf

What should the EU do to make the policy proposals better?

We recognize three key reforms to the proposals which could support greater heat pump deployment and more rapid decarbonisation.

- To better align the recast EPBD with the 2050 Climate Neutrality goal for provisions concerning new buildings, the compliance dates for zero-emissions buildings should come earlier in time to avoid new buildings having to replace fossil fuel-based heating systems installed before 2050. The proposed compliance date of 2030 should be brought forward to 2025.
- The proposed revisions for new buildings do not put sufficient focus on reducing energy demand for heating. Annex III of the proposal defines limits for total annual primary energy use, but these could be further lowered to limit wider energy system impacts and to ease the integration of heat pumps.
- The proposal also includes a planned review of the cost-optimal methodology which could lead to more preferential conditions for heat pump deployment. A shift from cost-optimality to climate neutrality as a methodological basis for developing NZEB standards would reward zero-emission technologies.

What should Member States do now?

Recent analysis has shown that national NZEB standards are in many cases not aligned with the recommendations of the European Commission, which is a barrier to increased heat pump deployment.56 Member States who wish to move faster should upgrade their national new building standards in advance of the Fit for 55 package. Fossil-fuel heating bans can be introduced immediately, subject to supply chain and new building energy efficiency standards being progressively increased.

Furthermore, standards for new buildings can be strengthened to consider whole life-cycle emissions and 'beyond energy' performance considerations including climate adaptation and indoor environmental quality. Knowledge-sharing on the experience of EU Member States that have already begun regulating the phaseout of fossil fuel from new buildings should also be supported.

56 BPIE. (2021). *Nearly Zero: A review of EU Member State implementation of new build requirements.* https://www.bpie.eu/publication/nearly-zero-a-review-of-eu- member-state-implementation-of-new-build-requirements/

4.3.3 Performance standards for appliances

The current ecodesign and energy labelling regulations for space heaters have been up for review for three years. The European Commission shared draft revision proposals in July 2021. These proposals, based on a preparatory study[57] and further consultation,[58] were presented and discussed at a meeting in September 2021.[59]

Throughout 2022, the Commission will be leading an impact assessment, including stakeholder consultation. Finally, the draft regulations will undergo an internal Commission review (inter-service consultation) before they are submitted to the vote of Member States in Q2 or Q3 2023. New requirements would then enter into force no earlier than 2025.

What are the current EU proposals?

The proposed ecodesign regulations cover various space heating technologies up to 1 MW rating.[60] Only central heating equipment is covered, resistive heaters for local heating are not in scope. Heating equipment using solid fuel is also excluded from these regulations. The proposal for ecodesign includes requirements for seasonal space heating energy efficiency, water heating energy efficiency and sound power level, as well as requirements related to NOx emissions and material resource efficiency. Efficiency requirements are expressed in seasonal space heating energy efficiency. This efficiency indicator is calculated as a ratio between the space heating demand and the annual energy consumption required to meet this demand, divided by the EU average primary energy factor to represent the efficiency in terms of the use of primary energy to meet the heating demand.

Figure 14[61] illustrates the effect of the proposed rescaling on each heating technology in scope of the regulations. Class A is deliberately left empty as requested by the framework energy labelling regulation.

57 Ecoboiler-Review, European Union. (2019). *Impact Assessment / Consultation Space and Water Heaters— Documents pace/Combination Heaters 2017-2019*. https://www.ecoboiler-review.eu/Boilers2017-2019/documents-boilers-2017-2019.htm

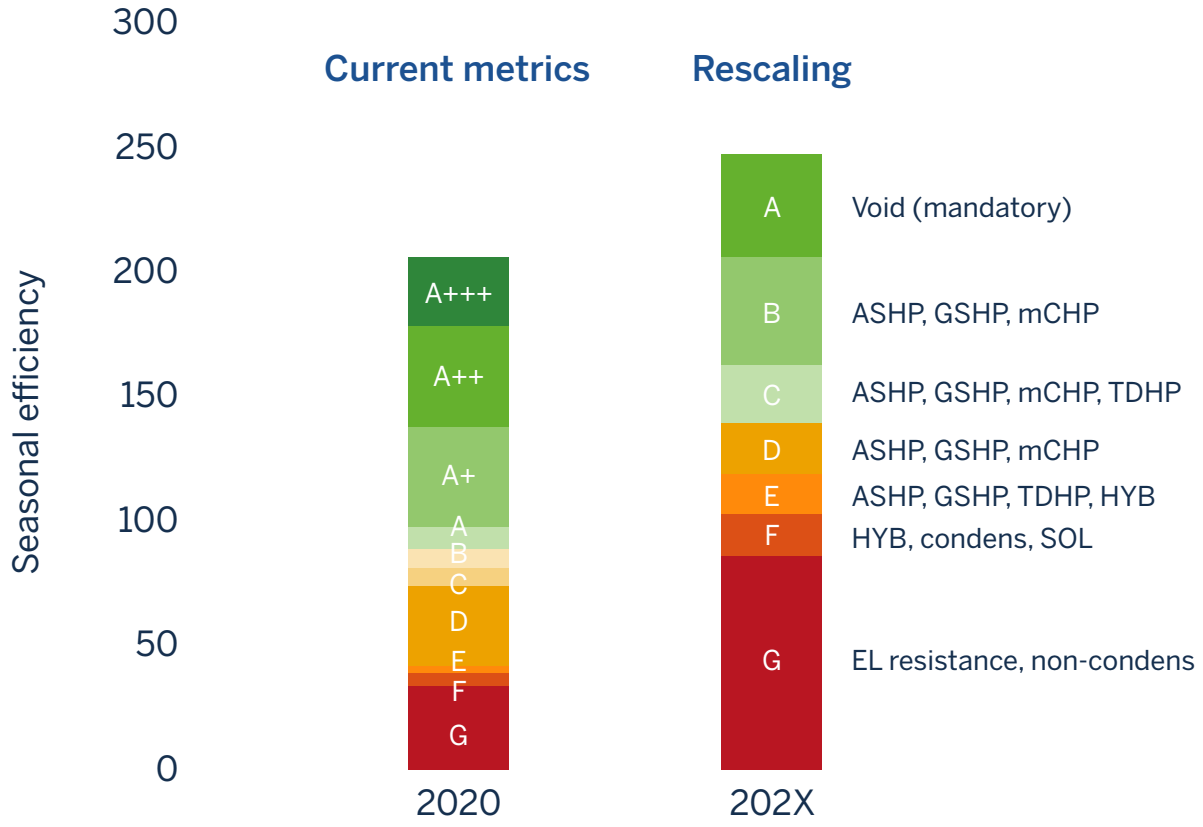
58 Ecoboiler-Review, European Union. (2019). *Impact Assessment / Consultation Space and Water Heaters— Documents*: https://www.ecoboiler-review.eu/documents.htm

59 Baton, M. (2021). *Review Energy Labelling: Hydronic space heaters and combination heaters* [Presentation before the Ecodesign and Energy Labelling Consultation Forum, 27 September 2021]. Slides available on request.

60 Gaseous and liquid fuel boilers (solid fuel boilers are covered by a different regulation), electric boilers, heat pumps, hybrid heaters (heat pump combined with fuel boiler) and cogeneration heaters

61 Slides presented by the consultants of the European Commission during the Consultation Forum of 27 January 2021.

Figure 14. The proposals for appliance rescaling by type of heating and seasonal efficiency alongside energy label ratings



	Full name	Minimum seasonal space heating energy efficiency
ASHP	Air source heat pump	155% for low temperature heat pump; 130% for medium temperature
GSHP	Ground source heat pump	
mCHP	(micro) Combined heat and power (Cogeneration space heater)	100%
TDHP	Thermally driven heat pump	115%
HYB	Hybrid space heater (heat pump + boiler combination)	110%
Condens	Condensing fuel boilers	88%; exemptions at 77%
Non-condens	Non-condensing fuel boilers	
SOL	Solar assisted boiler	N/A
EL resistance	Electric boiler (for central heating)	43%

Source: Slides presented by the consultants of the European Commission during the Consultation Forum of 27 January 2021.

How would these proposals affect heat pumps?

The ecodesign proposals in their current draft form would not significantly accelerate heat pump market penetration, as they keep inefficient fossil-fuel heating systems on the market with no intention to phase them out over time. Moreover, the promotion of 'hydrogen ready' boilers suggested by those drafts could be seen as a reason to maintain the status quo and keep installing gas boilers. In a letter addressed to NGOs on 19 November 2021, the European Commission seems to indicate a preference for leaving it to Member States to ban the sales of heating equipment that relies on fossil fuels.

Recent and potential future increases in the price of fossil fuels may however justify a reconsideration by the Commission of the proposed levels for ecodesign. Indeed the proposals are required to be based on an analysis of their economic impacts, and a significant change of the energy prices would modify the conclusion of the least life-cycle cost analysis.

As for the regulation of heat pumps themselves, the new regulations would increase the minimum seasonal space heating efficiency of heat pumps from 125% to 155% for low-temperature heat pumps and from 110% to 130% for medium-temperature heat pumps. Those represent very modest increases as they mainly reflect a change in the primary energy factor.

The proposed revised label would support the deployment of heat pumps by allowing a better comparison of the relative efficiencies of the available heating solutions and downgrading condensing gas boilers from an average A class to an average F class.

What should the EU do to make the policy proposals better?

The draft regulations do not provide a path for the EU to prohibit the sale of inefficient, carbon-intensive heating systems, something which may be required to drive the clean heating market at scale. The single most important improvement to support the uptake of heat pumps in the ecodesign proposal would be to include a minimum 110% minimum seasonal heating efficiency. This would lead to the phaseout of non-hybrid fossil-fuel boilers and would be a gamechanger for the market penetration of heat pumps and hybrid boilers. This could enter into force as early as 2025, or start with a less stringent level and set this level as a second tier that would apply a few years later.

The minimum efficiency standards for hybrid boilers are also not stringent enough to guarantee a sufficiently high contribution from heat pumps to the total heat output. The minimum requirements for this type of equipment should be more ambitious, with a minimum seasonal heating efficiency of 130% and/or a much higher (to be defined) contribution of the heat pump to the seasonal heating energy output.

Concerning the revised energy label, the EU should be consistent with its hydrogen strategy[62] and not promote hydrogen readiness in residential heating systems.

A mandatory load-based test procedure[63] should also help ensure that the actual efficiency in real life of heat pumps sold on the European market truly reflects the efficiency requirements set

62 European Commission. (2020d). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – A hydrogen strategy for a climate-neutral Europe*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0301

63 A load-based method effectively tests the equipment for a range of load levels to measure its behaviour and efficiency across a sample of operating conditions that will be met in real life, rather than extrapolating from a few test points defined by the manufacturer. It ensures a better representativeness and allows independent testing.

forth in the proposed new regulation. This objective may not be achieved by the current proposal, which presents a load-based test procedure but only an optional one, which wouldn't support a full adoption, and wouldn't allow a fair comparison of products.

Delaying the transition to a revised version of the label would hamper heat pump deployment, as the new label is expected to better promote the deployment of heat pumps. Concerning ecodesign, although a delay in the adoption would represent lost savings, a two-tiered approach may be possible, which would make the adoption of ambitious levels more likely.

What should Member States do now?

While product standards are adopted at the EU level and the European Commission has already prepared a draft proposal, Member States can still push for more ambitious ecodesign and energy labelling measures ahead of the European Commission's final proposal. Some Member States (Germany, France, Denmark, Austria and Sweden) have already expressed support for a higher ambition, and many others have remained silent for now. Ambitious Member States could thus seek to build a consortium to reassure the European Commission that a more stringent proposal would pass the vote of Member States.

Furthermore, the European Commission's proposal for the EPBD clarifies that national measures to restrict the installation of fossil-fuel boilers would be permissible, allowing Member States to go beyond the minimum performance requirements proposed by ecodesign regulations and building performance requirements under the EPBD. A report by the Öko-Institut clarifies that Member States could legally do that by targeting aspects not addressed by product regulations, such as GHG emissions of certain categories of equipment.[64]

Regardless of whether ambitious minimum energy performance requirements are adopted under ecodesign, Member States should thus introduce measures to ban the installation of fossil-fuel boilers by 2025. They should implement these measures at earlier dates than requested by the EPBD, as some are already doing, to accelerate the transition to decabonised heating solutions. Once the energy labelling regulation is adopted, Member States should also use it as the backbone of incentive policies, to support the deployment of the most efficient heating solutions.

64 Braungard et al., 2021.

PART 5

Existing European heat pump support strategies and policies

In light of the importance of heat pumps in meeting EU climate targets, multiple EU Member States have developed plans and programmes to support their deployment. This section takes a closer look at what some of the leading states are doing on heat decarbonisation, and aims to understand how strategies and policies have put them in these leading positions.

Specifically, we take a look at the four largest EU continental heat pump markets by sales[65] (France, Italy, Germany and Spain) as well as a number of Nordic EU countries (Sweden, Denmark and Finland) which have been particularly successful in deploying heat pumps, albeit for different reasons.

5.1 Pompes à chaleur: heat pumps in France

France saw the highest number of sales of heat pumps of any EU country in 2020. This high rate of adoption is likely in part due to the current French heat mix where around 60% of homes are connected to neither the gas grid nor district heat networks.[66] The absence of competing heating infrastructure and the prevalence of electric heating means that for many households, switching to heat pumps makes financial sense due to their clear efficiency advantage.

France also has a suite of policy measures to drive low-carbon technologies, including:

- **Targets:** France has a target for 38% of total heat consumption to come from renewables by 2030[67] and specific targets for the deployment of heat pumps.
- **Financial support:** Policies which financially support heat pumps in France include the 'MyPrimeRenov' system which was previously a tax credit but has since been reformed into a means-tested capital payment system;[68] this can be combined with the 'Eco-PTZ' zero-rate loans.[69] Further grants for heat pumps are also available under supplier-led fuel poverty schemes.[70]

65 Based on European Heat Pump Association sales data.

66 Bertelsen & Vad Mathiesen, 2020.

67 European Commission. (2020e). *Integrated National Energy and Climate Plan for France*. https://ec.europa.eu/energy/sites/default/files/documents/fr_final_necp_main_en.pdf

68 https://www.ecologie.gouv.fr/maprimerenov-0

69 Ministère de l'Économie, des Finances et de la Relance. (2022). *Qu'est-ce que l'éco-prêt à taux zéro (éco-PTZ)?*https://www.economie.gouv.fr/cedef/eco-pret-a-taux-zero

70 Ministère de la Transition Écologique. (2022a). *Coup de pouce "Chauffage" et "Isolation."* https://www.ecologie.gouv.fr/coup-pouce-chauffage-et-isolation

- **Pricing:** French energy bills contain a carbon tax element which does not cover electricity,[71] helping to balance energy prices in favour of electricity. French electricity retail prices (18p/kWh for 2020) were below the EU average whereas gas prices (8p/kWh for 2019) were higher than the average.[72] These price differentials imply a running cost benefit associated with switching from gas to electricity for heating. Domestic heating oil costs in France during 2020 were around €0.9/litre,[73] equating to a similar cost to gas per kWh.
- **Regulatory policies:** France has a goal of removing all oil heating by 2030, and central to this is the ban on the installation of fossil-fuel heating in new buildings[74] and the upcoming ban on replacement oil systems which has been delayed until July 2022.[75]

5.2 Pompa di calore: heat pumps in Italy

In 2020, Italy was the second biggest market for heat pumps in Europe, and the Italian National Energy and Climate Plan foresees the vast majority of growth in renewable heat to 2030 being met by heat pumps.[76] While currently roughly 60% of residential heat used in Italy comes from gas, over 35% of homes are not on the grid and have lower barriers to heat pump adoption.

Italy's main heat pump-specific policy has been in the form of financial support. Through the 'Conto Termico' or 'Thermal account' policy, the Italian government covers up to 65% of the capital cost of heat pump systems.[77] Moreover, a 'superbonus' tax deduction scheme was introduced as part of the Italian government's Covid-19 response package, which allows building owners to claim back up to 110% of building and heating renovation costs, including heat pumps.[78]

With regards to regulatory policies, the Italian government has no explicit plans for the phaseout of fossil fuels from heating in either new or existing buildings, despite growing calls[79] and some action on oil boilers at local government levels.[80]

71 Hanafi, O., Jousseaume, M., Menner, M., Reichert, G. & Schwind, S. (2019). *Carbon Pricing in France & Germany: Differences, Similarities and Perspectives*. CEPInput. https://www.cep.eu/fileadmin/user_upload/cep.eu/Studien/cepInput_Carbon_Pricing_in_France___Germany.pdf

72 European Commission. (2020f). *Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Energy prices and costs in Europe*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0951&from=EN

73 Ministère de la Transition Écologique. (2022b). *Prix des produits pétroliers*. https://www.ecologie.gouv.fr/prix-des-produits-petroliers

74 Connexion journalist. (2021). New-builds in France from mid-2021 must not have gas heating. *Connexion*. https://www.connexionfrance.com/Practical/Property/New-builds-in-France-from-mid-2021-must-not-have-gas-heating

75 Lacas, F. (2021). L'interdiction des chaudières au fioul reportée de six mois. *Batiactu*. https://www.batiactu.com/edito/interdiction-chaudieres-au-fioul-neuf-reportee-six-62018.php

76 European Commission. (2020g). *Integrated National Energy and Climate Plan—Italy*. https://ec.europa.eu/energy/sites/default/files/documents/it_final_necp_main_en.pdf

77 Gestore Servizi Energetici. *Conto Termico* [website]. https://www.gse.it/servizi-per-te/efficienza-energetica/conto-termico/conto-termico-per-la-pa

78 Lowes, R., Rosenow, J., Qadrdan, M. & Wu, J. (2020). Hot stuff: Research and policy principles for heat decarbonisation through smart electrification. *Energy Research & Social Science, Volume 70, December 2020, 101735*. https://www.sciencedirect.com/science/article/pii/S2214629620303108

79 Legambiente. (2021). *Recovery plan, stop ai finanziamenti alle caldaie fossili se la normativa non cambia*. https://www.legambiente.it/comunicati-stampa/recovery-plan-stop-ai-finanziamenti-alle-caldaie-fossili-se-la-normativa-non-cambia/

80 Milano Today. (2020). Milano, stop caldaie a gasolio anticipato ad autunno 2022: è ufficiale. *Milano Today*. https://www.milanotoday.it/attualita/caldaie-gasolio-stop-2022.html

5.3 Wärmepumpe: heat pumps in Germany

In 2019, only 3.4% of residential buildings had space heating and warm water supplied by heat pumps, while 49.3% were supplied by fossil gas.[81] But despite having a gas-dominated heating system, Germany has the third-largest heat pump market in Europe, in part due to the absolute size of the German market. Heat pump adoption is particularly successful in new construction, where the residential new-build market in 2020 saw 46% of homes using heat pumps.[82] But with more than 40% of homes being supplied by off-grid heating systems, including more than 30% by oil boilers, heat pumps are also in a strong position to replace older heating systems in single-family detached homes.

The largest barrier to heat pump adoption in Germany today is unfavourable economics due to the large imbalance in energy prices. The combination of high electricity prices (Germany currently has the highest in the EU) and fossil gas prices roughly at the EU average means that the electricity to gas price ratio rests well above four to one, competing with Belgium for the worst ratio in Europe.

To address this significant handicap and improve the investment framework for heat pumps, Germany is pursuing a number policy measures, including:

- **Targets:** While Germany does not have a technology-specific target for heat pump deployment, Germany's national climate law has ambitious sectoral targets for the building sector that have pushed the government to place a stronger focus on heat transition policies. The recent coalition agreement also includes a target to reach a share of 50% climate-neutral heating by 2030.
- **Pricing:** In 2021, Germany introduced a national emissions trading system for fossil transport and heating fuels. The new system increases the price of fossil heating fuels in fixed incremental steps from 2021 (€25/tCO2 = 0.5 ct/kWh fossil gas) to 2025 (€55/tCO2 = 1.1 ct/kWh fossil gas), before transitioning to a market-based carbon trading system from 2026. This carbon pricing mechanism raises revenues (€7.2 billion in 2021) which are reinvested into climate protection via Germany's Energy and Climate Fund, and helps to rebalance the price of fossil heating fuels and electricity. In parallel, Germany is also reforming its system of taxes, levies and surcharges for electricity to lower retail electricity prices.
- **Financial support:** The German government offers significant investment support for the installation of heat pumps via its 'Market Investment Programme'.[83] Under the programme, households are eligible for capital grants administered by the KfW bank that cover between 35% and 50% of the total investment costs, depending on whether an oil boiler is being replaced (+10%) and the household undergoes the renovation based on a building renovation passport (+5%).

81 BDEW. (2019). *Wie heizt Deutschland 2019: BDEW-Studie zum Heizungsmarkt*. https://www.bdew.de/energie/studie-wie-heizt-deutschland/

82 De Statis. (2021). *39% of the residential buildings constructed in 2020 are heated by natural gas* [press release]. https://www.destatis.de/EN/Press/2021/10/PE21_N060_61_44.html

83 Bank aus Verantwortung. (n.d.). *Wohngebäude – Kredit* [website]. https://www.kfw.de/inlandsfoerderung/Unternehmen/Wohnwirtschaft/F%C3%B6rderprodukte/Bundesf%C3%B6rderung-f%C3%BCr-effiziente-Geb%C3%A4ude-Wohngeb%C3%A4ude-Kredit-(261-262)/

- **Regulatory policies:** The installation of standalone oil boilers (i.e. 'mono-fuel' boilers not accompanied by heat pumps or solar thermal) is banned from 2026,[84] but hybrid oil heating systems coupled with renewables are still permissible from this date. By contrast, the recent coalition agreement outlines a plan to require all replacement heating systems to achieve 65% renewable energy levels by 2025.[85] While the details of this measure are unclear and must still be implemented, they would likely represent a significant strengthening compared to current provisions. Under Germany's Renewable Energies Heat Act, new buildings are also required to have at least 14% renewable heating and cooling as well as meet a certain primary energy standard, but in both cases it is left open with which (renewable) technologies these requirement are met.
- While fossil-fuel heating is not banned for new builds, the frequent use of heat pumps in new construction in part reflects the strict primary energy demand requirements set out in German building regulations,[86] as well as the amount of financial support given to buildings constructed to stricter energy-efficiency requirements. The recent coalition agreement proposes raising the minimum standard for new construction from Germany's 'Efficiency house 70' standard to the far stricter 'Efficiency house 40' standard from 1 January 2025. Moreover, special support for new construction is now restricted to buildings achieving at least the 'Efficiency house 40' standard from 1 February 2022.

5.4 Bomba de calor: heat pumps in Spain

In 2020, Spain was the fourth-largest heat pump market in Europe and Spain's Integrated National Climate and Energy Plan suggests a near six-fold increase in the number of heat pumps in Spain between 2020 and 2030.[87] Yet according to the Spanish Association for the Manufacturers of Air Conditioning Equipment, no specific heat pump support policies exist in Spain.[88]

One reason for the strong state of the heat pump market in Spain despite this minimal policy environment is likely to be because of the limited penetration of gas heating, meaning that in many instances the effective efficiency of heat pumps can drive down the costs of electric space and hot water heating. Relatively warm temperatures in many Spanish geographies may also mean that where households install cooling, these systems are also used to provide heating.

84 Vavre & Zill, 2021.

85 Koalitionsvertrag Zwischen, SPD, Bündnis 90/Die Grünen und FDP. (2021). *Mehr Fortschritt Wagen—Bündnis Für Freiheit, Gerechtigkeit und Nachhaltigkeit.* https://www.spd.de/fileadmin/Dokumente/Koalitionsvertrag/Koalitionsvertrag_2021-2025.pdf

86 Der Bundesverband Wärmepumpe. (2015). *Ratgeber Energieeinsparverordnung (EnEV).* https://www.waermepumpe.de/fileadmin/user_upload/waermepumpe/05_Presse/01_Pressemitteilungen/Ratgeber_EnEV.pdf

87 European Commission. (2020h). *Integrated National Energy and Climate Plan 2021-2030 – Spain*. https://ec.europa.eu/energy/sites/ener/files/documents/es_final_necp_main_en.pdf

88 Personal communication with AFEC.

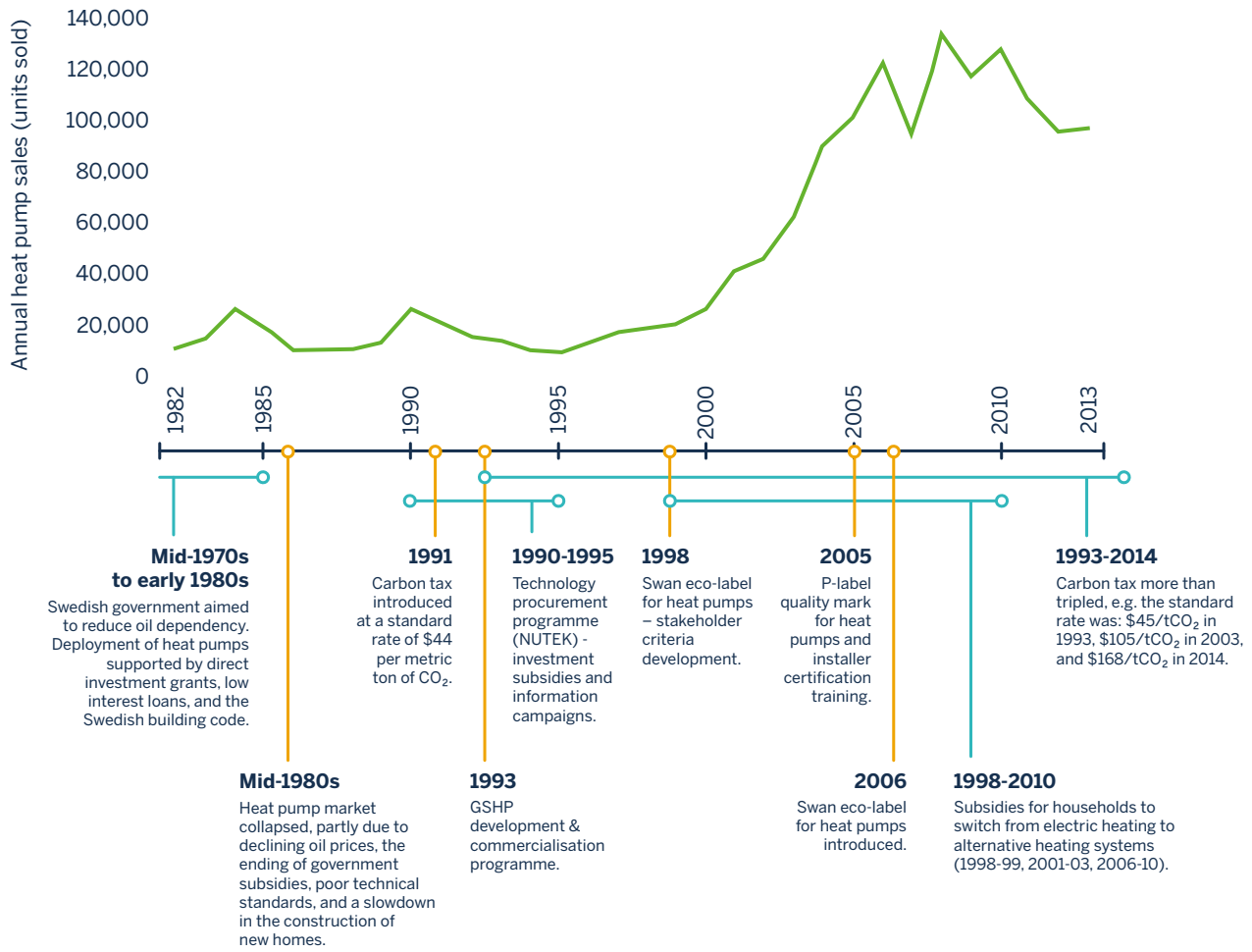
5.5 Varmepumpe and lämpöpumppu: heat pumps in Sweden and Finland

The Nordic EU Member States of Sweden and Finland represent a somewhat exceptional example of mass deployment of heat pumps. It is exceptional because mass penetration of heat pumps has already been achieved, but also because these countries never used fossil gas as a dominant heating technology.

Among the Nordic countries' heat pump success, Finland is perhaps the most successful with around a third of all homes now using heat pumps,[89] making it a world leader. A combination of different policy measures including grants, increased taxes on fossil fuels, ever-tightening buildings standards, and communication campaigns have underpinned this Finnish success story.

As is shown in Figure 15, Sweden also experienced a significant growth in heat pump deployment from the late 1990s. This growth was also supported by a combination of measures including labelling and standards, carbon pricing and direct subsidies for households.[90]

Figure 15. Sweden: heat pump support policies and market development, 1982-2013



Source recreated from: Hanna, R., et al. (2016). *UKERC Technology and Policy Assessment — Best practice in heat decarbonisation policy: A review of the international experience of policies to promote the uptake of low-carbon heat supply. UKERC.*

89 Sovacool, B. & Martiskainen, M. (2020). Hot transformations: Governing rapid and deep household heating transitions in China, Denmark, Finland and the United Kingdom. *Energy Policy, Volume 139, April 2020, 111330*. https://doi.org/10.1016/j.enpol.2020.111330

90 Hanna, R., Parrish, B., & Gross, R. (2016). *UKERC Technology and Policy Assessment — Best practice in heat decarbonisation policy: A review of the international experience of policies to promote the uptake of low-carbon heat supply.* UKERC. https://www.theccc.org.uk/wp-content/uploads/2017/01/UKERC-for-the-CCC-Best-practice-in-heat-decarbonisation-policy.pdf

PART 6

Conclusions and specific policy recommendations

The importance of heat pumps for decarbonising heating in the EU and indeed more widely cannot be understated. Heat pumps are central to many Member States' National Climate and Energy Plans and bring with them a variety of energy system benefits including gas import reductions, systemic efficiency and electricity system flexibility. They are expected to have a central role at a building level and in supplying district heat networks. Heat pumps are also increasingly being recognized as a key technology to reduce reliance on increasingly volatile fossil gas imports.

Heat pumps are a mature technology around the world, including in Europe, yet the required rapid and sustained growth in the number of heat pumps required to meet EU climate goals will only be delivered with thorough and coordinated policy support.

Such a support package would need to involve pricing reforms which ensure heat pumps are cheaper to own and operate than fossil-fuel systems, alongside investment support for households to cover any additional capital costs associated with first-time heat pump installations. Regulation would also be needed to ban the installation and eventually the operation of fossil-fuel heating systems. All of these measures need to be coordinated by a framework which also includes skills, consumer protection and the provision of finance.

The Fit for 55 legislative proposals provide an opportunity for the EU energy policy landscape to drive building decarbonisation and heat pump deployment in a coordinated manner and at the required speed. The authors of this report, a group of cross-institutional experts in the technologies and polices associated with heating, have shown that elements of the current proposals – such as new minimum energy performance standards for the EU's worst-performing buildings, planning requirements for phasing out fossil fuels by 2040 and the extension of the ETS to cover fossil heating fuels in buildings – could be transformative. But issues with the package remain. We suggest that to strengthen the package in order to more actively support heat pump deployment:

- The ETS 2 is a vital policy but it should be designed to reduce the risk of carbon prices escalating to unacceptable levels. This should primarily be achieved by ensuring it is dovetailed with other energy efficiency and policy measures and targeted revenue recycling, but could potentially also be accompanied by the introduction of an appropriate price cap.
- The revisions to the Energy Taxation Directive should strongly limit the exemption for fuel poverty and rather incentivize the deployment of energy-efficiency measures to drive both heat decarbonisation and fuel poverty reductions.

- The recast Directive on Energy Efficiency should go further on required primary energy demand reductions and ensure only truly sustainable heat networks are supported.
- The revisions to the Renewable Energy Directive need to ensure the use of biomass for heat is limited through caps.
- The proposed revisions in the Energy Performance of Buildings Directive should go further for all building types, not just to support heat pumps, but to support reductions in gas use and the overall energy transition.

The Fit for 55 package is not expected to become law until at least 2023, and most likely 2024. In the interim period Member States should encourage heat pump uptake in advance in preparation for the full implementation of the Fit for 55 proposals. As explained in the paper, the uptake of heat pumps depends on the availability of competing heat infrastructures, relative costs of electricity compared to fossil fuels, and the regulatory requirements currently in place.

To reach maximum deployment levels, a combined package of policy and regulatory measures will be required. Member States can also take steps to pre-empt the expected policy changes associated with the Fit for 55 package, drive early decarbonisation, and reduce the impacts of fossil fuel price rises. Specifically:

- Progress on energy efficiency will be needed in all Member States; taking early, targeted action on the worst-performing buildings and the homes of the vulnerable and energy-poor would directly drive decarbonisation and make some headway on ETS 2 requirements.
- While fossil gas prices may already have reduced gas/electricity cost differentials, there is nothing to stop Member States from reforming prices to support electrification.
- Member State-level heat pump targets may have value in providing foresight to heating market actors and encouraging investment in supply chains and skills.
- Bio-energy caps for heating could be introduced to reduce biodiversity risks and also to drive greater levels of heat pump uptake.
- Member States deploying heat networks should ensure that low-carbon heat sources, including heat pumps, are used from the outset.
- Energy-efficiency policies should be reformed to eliminate support offered to fossil-fuel heating systems.
- Member States can set their own minimum energy performance standards to increase energy efficiency, or define a complete buildings pathway which includes heat pumps.

While Member States can press ahead, heat pumps are a decarbonisation and energy security necessity across the EU. The Fit for 55 package provides an important window of opportunity to ensure that this system-critical technology is appropriately supported across the Union.

Regulatory Assistance Project (RAP)®

Rue de la Science 23
B – 1040 Brussels
Belgium

+32 2 789 3012
info@raponline.org
raponline.org