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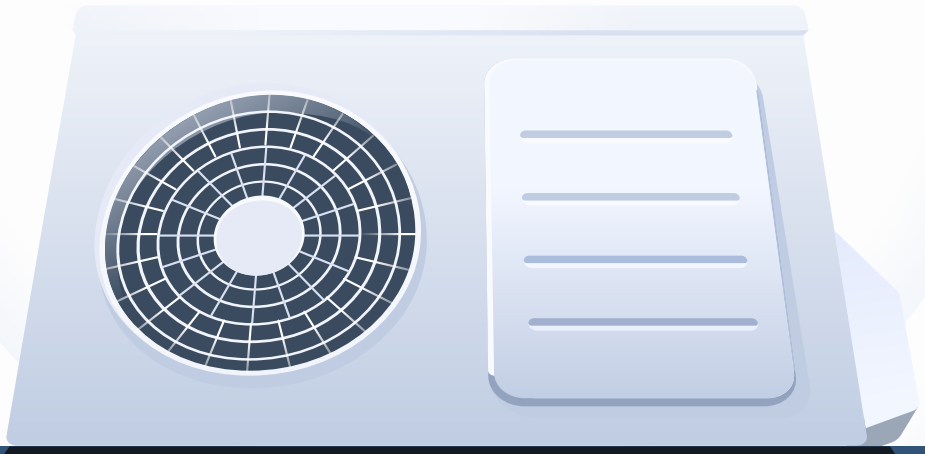
HEAT PUMP



REPORT

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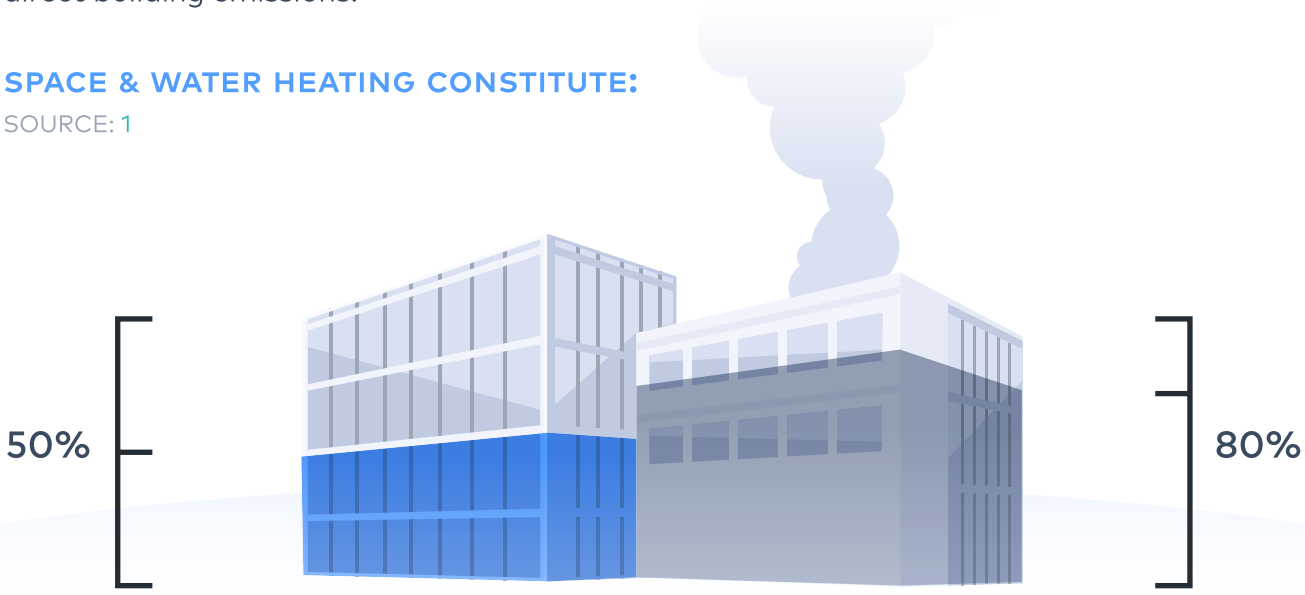
Unleash the full power of heat pumps

The need to decarbonize heating

The energy transition won't happen without decarbonizing heating. Through direct and indirect means, heating emitted over 4 gigatons of carbon emissions in 2021, which equates to 10% of global energy-related CO2 emissions.[1] Global energy demand for space and water heating also accounts for half of energy consumption in buildings, but emits 80% of direct building emissions.[1]

SPACE & WATER HEATING CONSTITUTE:

SOURCE: 1



Although in the past, questions have been raised as to which heating source will cover heating demand in a sustainable manner - biomass, biogas, hydrogen – it is fairly unanimous that heat pumps have emerged as primary means of decarbonizing space and water heating in buildings.

Why? Electrifying the heating sector allows heating to be powered by clean electricity. As a second step, combining heat pumps with smart energy management systems transforms them into a flexible asset – in this way, their consumption and storage can be controlled and entire energy systems become more balanced. As such, mobility, heating and electricity can be better integrated and managed, and building out intermittent renewables becomes easier and more cost-efficient.

Companies, governments, and think tanks are realizing and now leveraging their huge potential. In fact, in the IEA's Announced Pledges Scenario, heat pumps contribute almost half of global reductions in fossil fuel use for heating in buildings in 2030.[1] And the emissions reductions increase as renewable electricity generation steadily increases over time.

In the net zero emissions scenario, the number of heat pumps installed worldwide nearly triples by 2030, and doubles again to cover over half of global heating needs by 2050.[1] In the EU, reaching the new goal set by the RePowerEU directive of 30 million new heat pump units between 2022 and 2030 would result in a reduction of 15% of Russian imports today.[1] An important lever to reduce reliance on Russian gas given current geopolitical events.

Volatile gas prices increase the need to protect consumers with sustainable solutions

NATURAL GAS PRICES IN 2021-2022

SOURCE: 2

In late August 2022, after Russia announced it would shut down the Nord Stream 1 pipeline for repairs, gas prices at the Dutch TTF trading point, the European benchmark, reached €339 per megawatt hour (mWh). This was 140% higher than the week before and an 848% increase on prices in August 2021, where they sat at around €40/MWh.[2] As a result, end users' gas bills are rising exponentially, living standards have dropped, energy companies that were forced to buy and sell energy at a loss are being bailed out – such as Uniper in Germany and Bulb in the UK – and governments are also feeling the heat.

Over one-sixth of global natural gas demand is for heating in buildings – in the European Union, this number is one-third.[1] Current geopolitical events in Europe are now making reliance on fossil fuels riskier than ever. With CO_2 prices and continued questions over supply their prices are likely set to increase. As the market matures, heat pumps now offer benefits for all players.

Benefits

Consumers	decreasing total cost of ownership for heat pumps compared to rising costs for gas boilers. Optimizing heat pumps increases savings e.g. combining with PV or ToU tariffs
Energy providers	providing cost-efficient solutions with fewer dependencies and lower volatility in terms of price and supply
Real estate companies & Property developers	gain a true competitive advantage for having affordable energy in buildings
Government	a more sustainable energy system with fewer fossil fuel dependencies and lower overall system costs

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Why heat pumps are the future of heating (and cooling)

Heat pumps don't produce heat themselves, but extract it from an external source, making them highly efficient. Many heat pumps are also able to provide cooling by reversing the process and extracting heat from the warm indoor air. Essentially, they can be an all-round sustainable and smart heating, cooling and hot water solution.

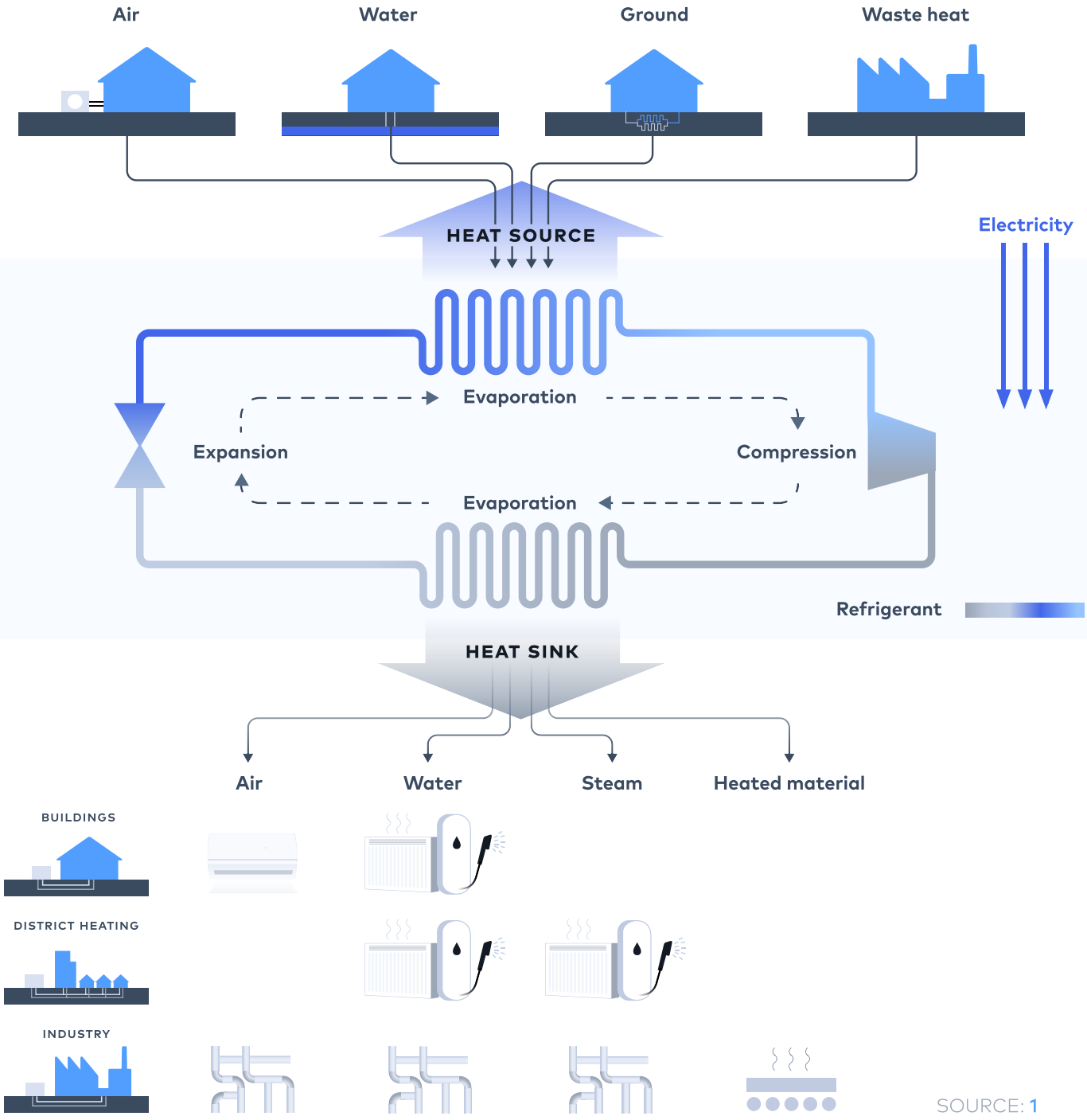
Heat is sourced from either

The ground: Geothermal heat pumps
Underground water: Groundwater heat pumps
Outside air: Aerothermal heat pumps

The heat sink, where the heat is used, is either

Water: Radiators or floor/wall heating
Air: Air conditioners, fan coil units or ducted systems

Regardless of the heat origin or the heat sink, the working principle behind all heat pumps is almost the same.



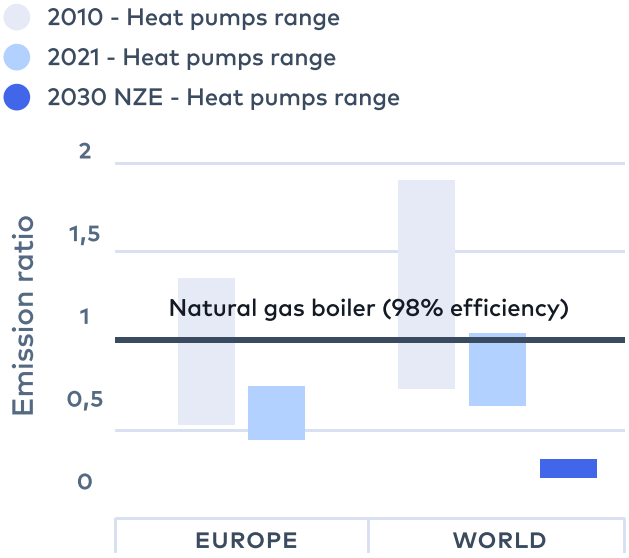
SOURCE: 1

Are heat pumps really more sustainable than gas boilers?

Heat pumps currently available on the market are three-to-five times more energy efficient than natural gas boilers. Heat pumps help decrease natural gas demand by more than 80 billion cubic meters (BCM), and heating oil demand by 1 thousand barrels per day (mb/d), while allowing coal use to fall to negligible levels. On the flip side, heat pumps contribute to just 9% of the increase in electricity demand by 2030, adding only modestly to system-wide peak loads in the winter.[1]

With today's refrigerants, heat pumps still reduce greenhouse gas emissions by at least 20% compared with a gas boiler, even when running on emissions-intensive electricity. This reduction can be as large as 80% in countries with cleaner electricity.[1]

RELATIVE CO2 EMISSIONS OF AIR-SOURCE HEAT PUMPS ALREADY BELOW THE MOST EFFICIENT GAS BOILERS – EXPECTED TO DROP FURTHER IN THE NET ZERO SCENARIO

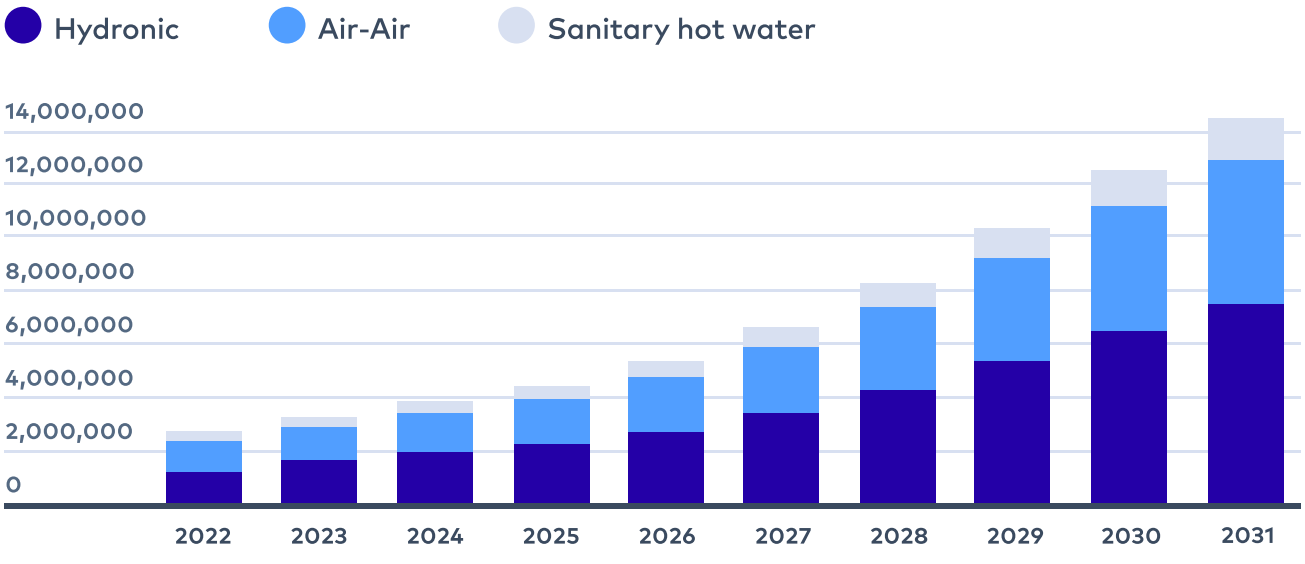


SOURCE: 3

Regulation & ambitions

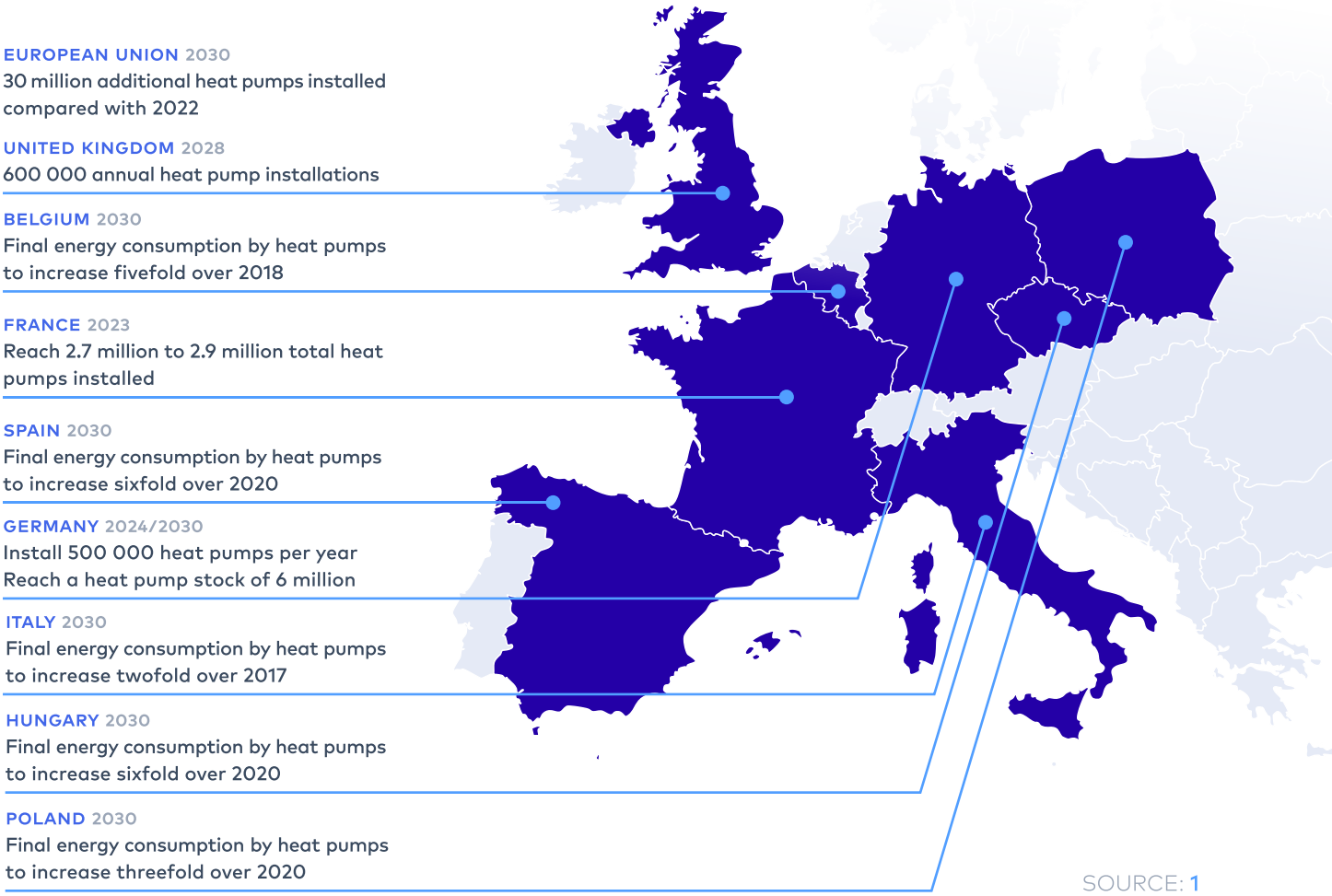
According to the Regulatory Assistance Project, by 2025, two-thirds of Russian gas can be replaced by clean energy technologies – with energy efficiency, renewable energy (primarily wind and solar power) and electrification being the key levers.[4] The new RePowerEU directive, which is focused on rapidly reducing our reliance on Russian gas, has increased EU-wide goals for increases in the number of heat pumps in the coming years. Specific country goals are also following suit.

REPOWEREU AMBITION: DOUBLE DIGIT GROWTH FOR THE REST OF THIS DECADE



SOURCE: 5

ESTIMATED SALES BASED ON REPowerEU



SOURCE: 1

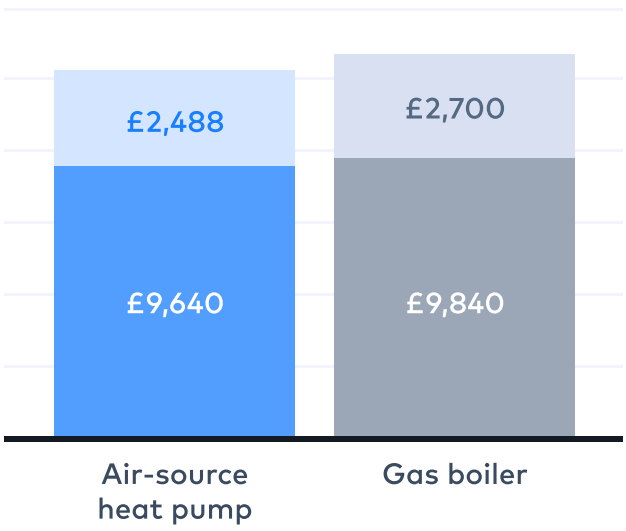
Reaching price parity

The Regulatory Assistance Program found that the lifetime cost of a residential heat pump in the UK reached parity with a gas boiler for the first time in 2022. Although a heat pump still has higher upfront costs, they are cheaper across the total cost of ownership (TCO). This is due to tax cuts and government incentives (a £5,000 grant for sufficiently insulated homes and reduced VAT from 5 percent to zero), combined with lower running costs (£261 cheaper per year) and roughly double the lifespan on average (20-25 years versus 10-15 years for a gas boiler).[6] With similar incentives in other countries, this price comparison over ten years would be comparable in most European countries – see details on the next page.

TOTAL COST OF OWNERSHIP OVER 10 YEARS IN THE UK

Air-source heat pump: £12,128
- £2,488 installation (presuming 20yr life)
- £9,640 running costs

Gas boiler: £12,540
- £2,700 installation (presuming 10yr life)
- £9,840 running



SOURCE: 6

Incentives and subsidies across Europe

21 European countries currently provide heat pump subsidies, each with its own eligibility criteria.

Germany	The operator receives 25% of the investment costs in the modernization back when installing a new heat pump.
The Netherlands	The government in offers, on average, a subsidy of 30% of the purchase price of a new heat pump.
Austria	The government provides grants up to a maximum of €5000 for single-family buildings and €1000 for multi-storey homes for air, water and ground-source heat pumps.
Norway	Energy efficiency technologies and renewables, including heat pumps, receive financial support to reduce 25% off the documented total expenses.
Finland	A government subsidy covers up to 20% of the costs of switching to a heat pump.

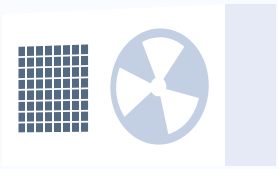
Lowering these costs even further with self-sufficiency

Average annual heating costs for an average single family home:
(assuming 2021 gas price of 13 cents/kwh, electricity 32 cents/kWh, PV 10 cents/kWh)

Gas

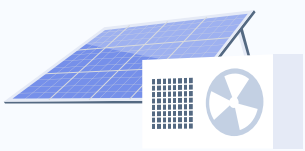
2.340€

Heat pump



1.440€

Heat pump + PV



1.242€

Covering 20% of heat pump electricity needs with photovoltaic (PV)

SOURCE: 7

Intelligently integrating flexible energy-consuming assets with volatile renewables

The rising number of assets that consume electricity (e.g. heat pumps and electric vehicles), combined with the increase in volatile renewable energy sources make balancing supply and demand in decentralized energy systems the cornerstone of the energy transition. This must be done through intelligent integration. As we saw above, combining heat pumps with PV systems increases self-sufficiency, lowers and stabilizes heating costs and relieves pressure on the grid. Further benefits of heat pumps can only be unlocked if this intelligence is extended to enable smart and holistic integration in wider energy systems.

Jan Rosenow
Executive Director,
Regulatory Assistance Project

"With so many electric vehicles and heat pumps coming to market, there's a tremendous opportunity to use them as a resource to integrate more renewables and lower gas consumption. Using heat pumps in a flexible way – reducing or shifting the times at which they use electricity – saves individual households money, but also provides benefits at the grid level. Deploying flexibility at the household level reduces overall system costs by reducing the need for grid extensions and easing grid congestion."

The importance of integrating heat pumps and making them smart

The challenges of rolling out heat pumps can be turned into opportunities if they are integrated in a smart and holistic manner. Controlling and optimizing heat pumps in line with other assets and the grid opens up a number of benefits, irrespective of the type of system in which they are installed.

Home Energy Management Systems (HEMS)

Integrating heat pumps with other electrified assets in a household allows energy flows to be holistically and intelligently managed to better balance supply and demand. This involves any asset that generates, consumes or stores electricity – PV systems, electric vehicles or batteries, to name a few. Heat pumps are a crucial element of Home Energy Management Systems (HEMS) because they account for a large share of household electricity consumption and can be used as flexible loads, thereby unlocking demand-side flexibility. Combining them with an energy management system enables cost savings for end users at a local level and better integration of heat pumps and renewables into the grid, thus also lowering costs on a system level.

Smart districts

Installing heat pumps across entire smart districts and connecting them to an energy management system allows them to be controlled and optimized and all data from heat-related assets to be visualized and analyzed on a broader scale. On top of controlling heat pumps with direct interfaces, data from third-party heat providers can also be integrated into an EMS. This enables visualization, data-access via API-interfaces and sector coupling by taking current usage and future flexibilities into account in the holistic optimization logic. By combining all forecasts, heat-related optimizations and other electricity-related data, the efficiency, sustainability and savings across an entire smart district can be maximized.

HEMS use cases with heat pump control on XENON

Heat pumps offer valuable flexibility due to their ability to store heat, for example in buffer tanks, and intelligently control consumption. Their control, however, is inherently complex – many constraints must be considered to ensure components aren't damaged and user comfort isn't reduced.

For example, heat pumps can be controlled via:

SG-Ready states

A label used for heat pumps in Germany, Austria and Switzerland that allows for third-party control. Here, the heat pump uses its internal logic and EMS recommendations to decide what is best. gridX is able to map SG-Ready modes via protocols, such as Modbus, or connect directly to existing dry contacts to implement self-consumption maximization, among other features.

Incentive tables implemented via EEBUS

The EMS sends incentive tables at specific time intervals based on price and weather forecasts. The logic and use cases are defined by the EEBUS Initiative to standardize the control of Distributed Energy Resources (DERs). As part of the EEBUS initiative, gridX has completed EEBUS integration, which opens up many more interesting use cases in the near future.

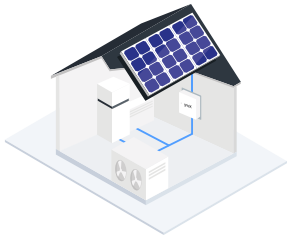
By understanding the possibilities of these different control methods and using a holistic energy management system, XENON enables a wide range of use cases for controlling heat pumps. Supporting implementation for a range of interfaces and enabling seamless integration into an energy solution is vital for the accelerated expansion of heat pumps.

More intelligent integration, more benefits

End users with outdated, fossil fuel assets have limited transparency or control over their consumption. With skyrocketing costs, many people are now more interested than ever to become self-sufficient, reduce dependencies and take an active role in the energy transition by gaining control of their energy consumption and management.

Installing a heat pump with a monitoring and diagnostics system makes heating transparent, and thanks to intelligent analyses, reduces support efforts. This enables increased customer engagement and provides them with more control over their consumption. For example, end users can view and influence heat pump costs by setting the temperature for all rooms via an app with a thermostat connection.

Combining a heat pump and PV system allows users to maximize their self-consumption by automatically shifting heat pump loads towards periods of PV surplus. This maximizes cost savings and eases pressure on the grid.



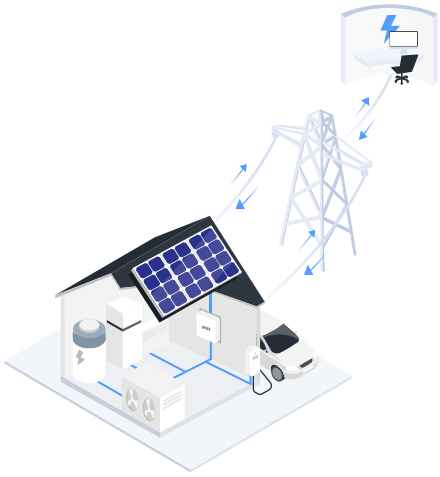
The more electrified assets a household has, the smarter the energy flows and the greater the benefits. Heat pumps can store thermal energy as additional flexible loads, complementing for example batteries to give households the freedom to only draw from the grid when prices are low.

An energy management system uses flexibility to react to price signals and forecasts – this enables time-of-use tariffs, capacity tariffs and peak shaving. By automatically shifting heat pump loads away from periods of high forecasted consumption peaks and/or towards low tariff time intervals, heating costs can be reduced without any loss of comfort for the user.

An EMS is able to receive and react to signals from Distribution System Operators (DSOs) to curtail heat consumption at specific times.

This saves costs on a system level and further enhances the integration of renewables into the grid. DSO curtailment can also offer savings to end users, depending on local regulation.

In the future, gridX's EMS can be used for flexibility marketing, such as balancing group management for a Virtual Power Plant. This enables additional cost savings and better balancing of supply and demand across systems, while also offering additional financial benefits for end users.



Each of these use cases depends on local regulatory frameworks and requirements, as well as the technical setup at a location. Regardless, however, the future energy system needs flexibility, making a smart energy management system its core foundation. Intelligently integrating assets within a household – aka. rolling out a heat pump with an energy management system – is the key to unlocking system-wide benefits. Connecting more energy assets (such as electric vehicles or PV), creates more upselling opportunities for businesses and provides increased benefits for end users – because higher electricity production and consumption equates to a greater number of flexible loads, meaning the value provided by an EMS increases.

Till Sonnen
Business Development Manager, gridX

"To overcome the many challenges facing society and energy systems, companies must digitally integrate assets into energy management systems. Only then can companies simultaneously help on a systemic level and future-proof their position in the energy market. Smart, holistic solutions allow them to create added value and lower costs for customers, thereby enhancing customer loyalty and satisfaction. In addition, companies are more adaptable to changing requirements, regulations and maturing technologies, and can ensure their business thrives in the new energy era."

Overcoming hurdles to accelerate the rollout of heat pumps

Installation

One of the major hurdles to ensure we reach the ambitious heat pump rollout is skilled installers. However, Octopus Energy's Centre for Net Zero forecast that the UK would need an additional 30,000 trained heat pump installers by 2028 to avoid short to medium-term constraints. There are currently 120,000 gas-safe registered engineers in the UK[8], meaning

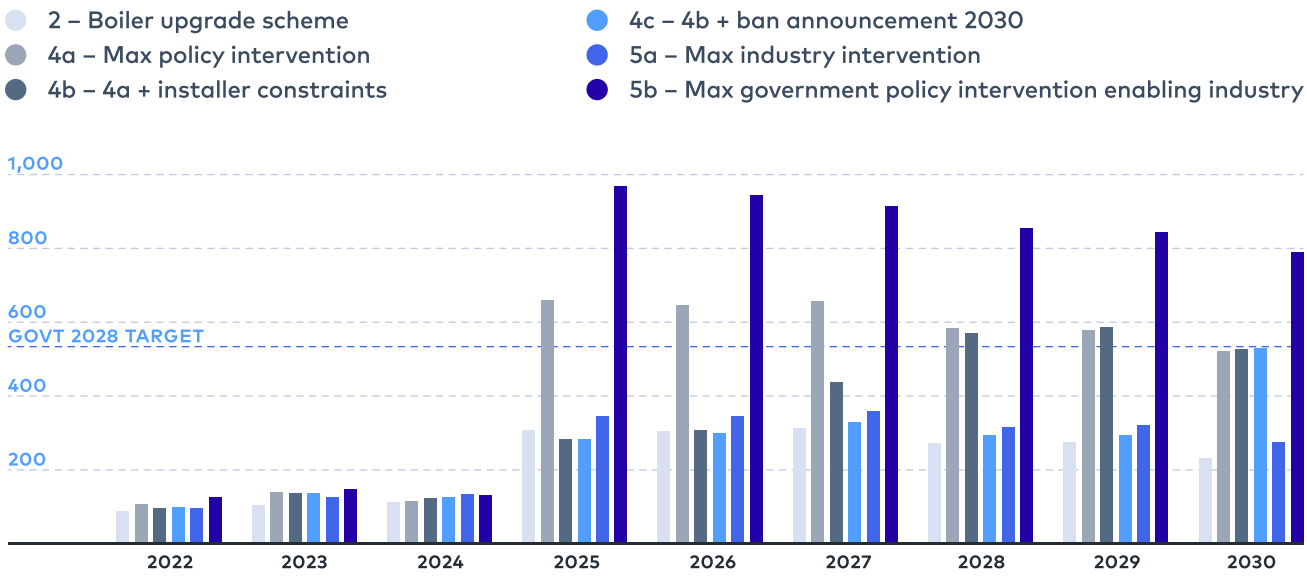
a third of this workforce would need to be trained in the coming years, thus providing a promising opportunity and achievable switch for green jobs.[9]

Phasing out fossil fuels

The Centre for Net Zero's research also highlights the importance of combining incentives and subsidies for heat pumps with fossil fuel bans – with plenty of notice – to increase adoption. Their analysis didn't find any scenarios that met the UK's targets that didn't also include the announcement of a ban on fossil fuel heating systems. They also found that providing 10 rather than five years' notice before the ban is implemented could result in 63% more installations for the earlier announcement.[9]

HEAT PUMPS ON THE RISE IN ENGLAND AND WALES

Annual heat pump uptake in six different scenarios in England and Wales in thousands.



SOURCE: 9

This graph also emphasizes the importance of regulatory intervention. Regulation must stimulate demand-side flexibility and the renewable energy directive must be overhauled to encourage clean and efficient heating technologies on an ongoing basis. On top of this, processes must be digitized.

Slow bureaucratic processes

Christian Rellensmann
Product Manager, thermondo

"Regulatory and bureaucratic processes, such as registration with grid operators, are still very manual and are the same as they were 30 years ago. These need to accelerate and digitize so that we can tackle these challenges. We also need to accelerate the smart meter rollout as these are critical infrastructure for allowing heat pumps to provide demand-side flexibility."

Supply chain challenges

Another hurdle is of course supply chain challenges, which are increasing wait times for heat pumps. However, manufacturers are aware of these issues and are already diversifying supply chain management and finding innovative ways to ramp up production to meet the growing demand.

Tim Steinmetz
CGO & Managing Director
gridX

"At gridX, we are committed to turning current challenges into opportunities to accelerate the energy transition, which can only be done with digital solutions. Creating an intelligent link between heating and electricity in smart homes, is the prerequisite to maintaining grid stability across all levels, minimizing energy costs and phasing out fossil fuels."

Conclusion

Like all energy sectors, heating is in a state of rapid upheaval. To reach decarbonization goals, we must build out renewables and electrify sectors, which simultaneously leads to a more decentralized and intermittent system, and increases the need for grid extensions. These concurrent challenges can only be quickly and efficiently overcome by intelligently optimizing assets' full flexibility. While initially heat pumps may be seen to add to this strain on electrical grids, if combined with an intelligent energy management solution and connected to other assets, they can actually help to reduce strain on power grids.

Leveraging the flexibility of heat pumps by using them for storage and shifting their consumption helps to better balance supply and demand and relieve pressure on the grid. By combining heat pumps with other DERs in home energy management systems, it is possible to maximize self-sufficiency and lower costs for end users without reducing comfort, empower grid operators to curtail consumption to ease strain on the grid and be used at low tariff time intervals to lower both end users' and overall system costs. Intelligent integration and automatic optimization therefore unleash the full power of heat pumps to enable more cost-efficient scaling of renewables, a reduced dependence on fossil fuels and an accelerated decarbonization of heat.

Sources

[1] IEA, The Future of Heat Pumps
[2] Trading Economics
[3] IEA, Heat Pump Deep Dive
[4] Regulatory Assistance Program
[5] European Heat Pump Association
[6] Daily Mail / RAP Online
[7] Wegatech, Wärmepumpe & Photovoltaik
[8] Greenmatch
[9] Centre for Net Zero, Hitting the target

gridX

About us

gridX is a leading smart energy company based in Munich and Aachen with over 120 employees.

Our digital energy platform, XENON allows companies to connect, monitor and control distributed energy resources.

The solutions built on XENON dynamically distribute available energy, intelligently optimize charging processes and ensure that peak loads are avoided. Companies such as E.ON, Viessmann and Fastned already rely on our customized solutions.

Get started with your heat pump control today.

With our **XENON platform** as the base, our customizable **Home Energy Management Solution** connects heat pumps with other assets to enable a range of use cases, from time-of-use tariffs to DSO curtailment.

XENON holistically and intelligently optimizes energy flows to increase self-sufficiency, ease grid congestion and lower costs for all players.

XENON supports devices from more than 44 manufacturers.

Get in touch to learn more about our platform and how you can build your own solutions with it.