

Crossing the tipping point

Heat Pumps Case Study



University
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Tipping point: current status

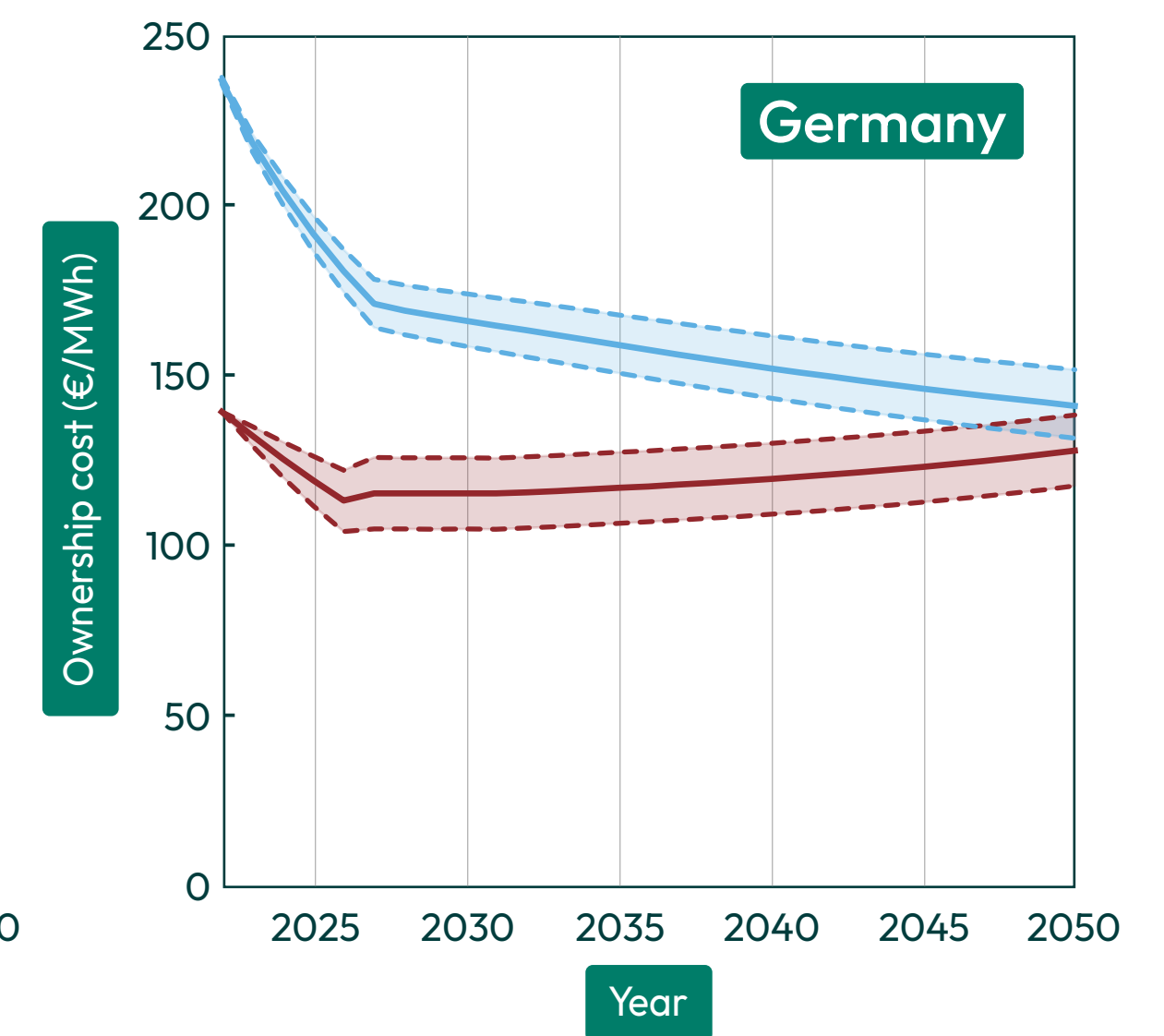
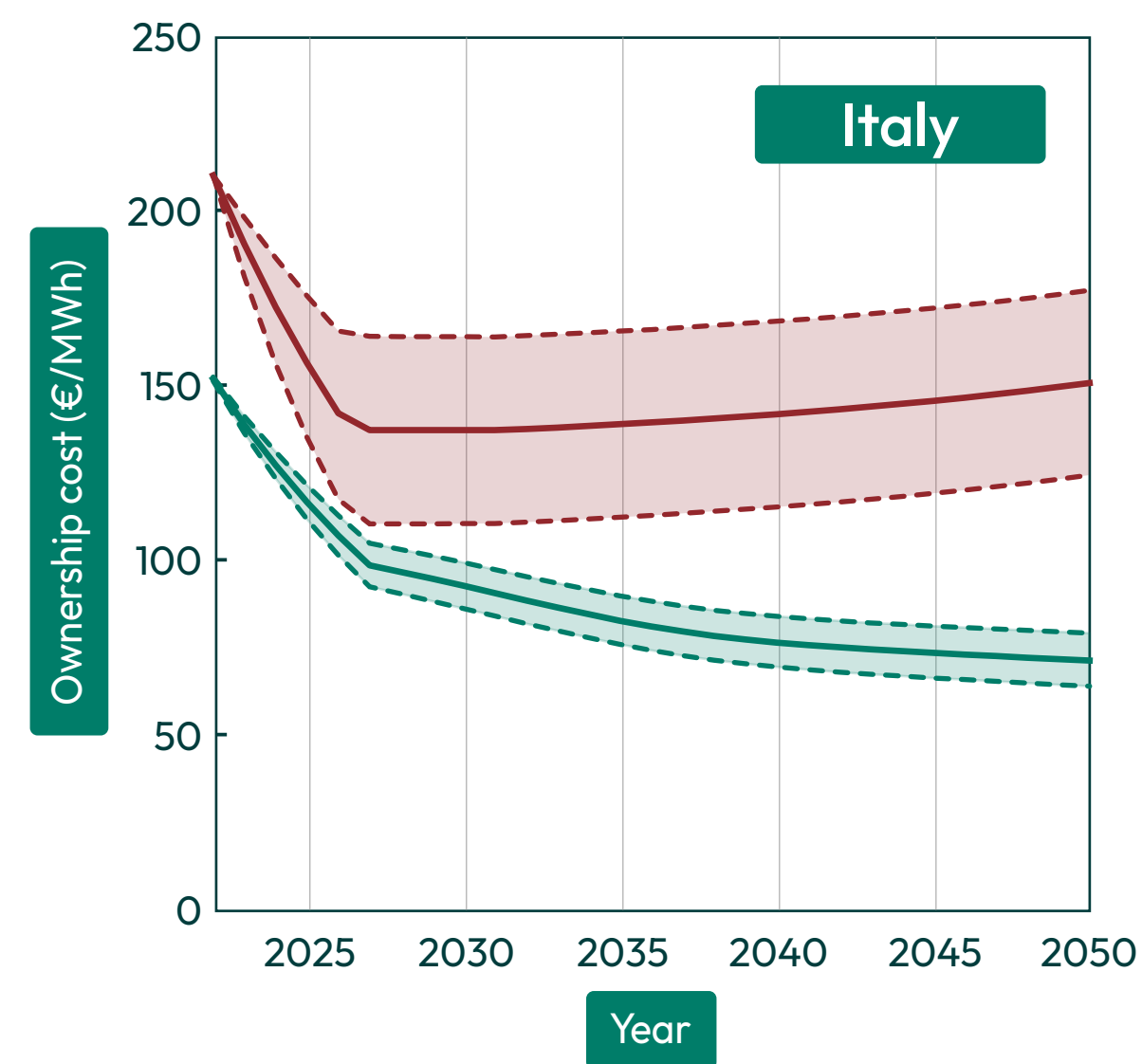
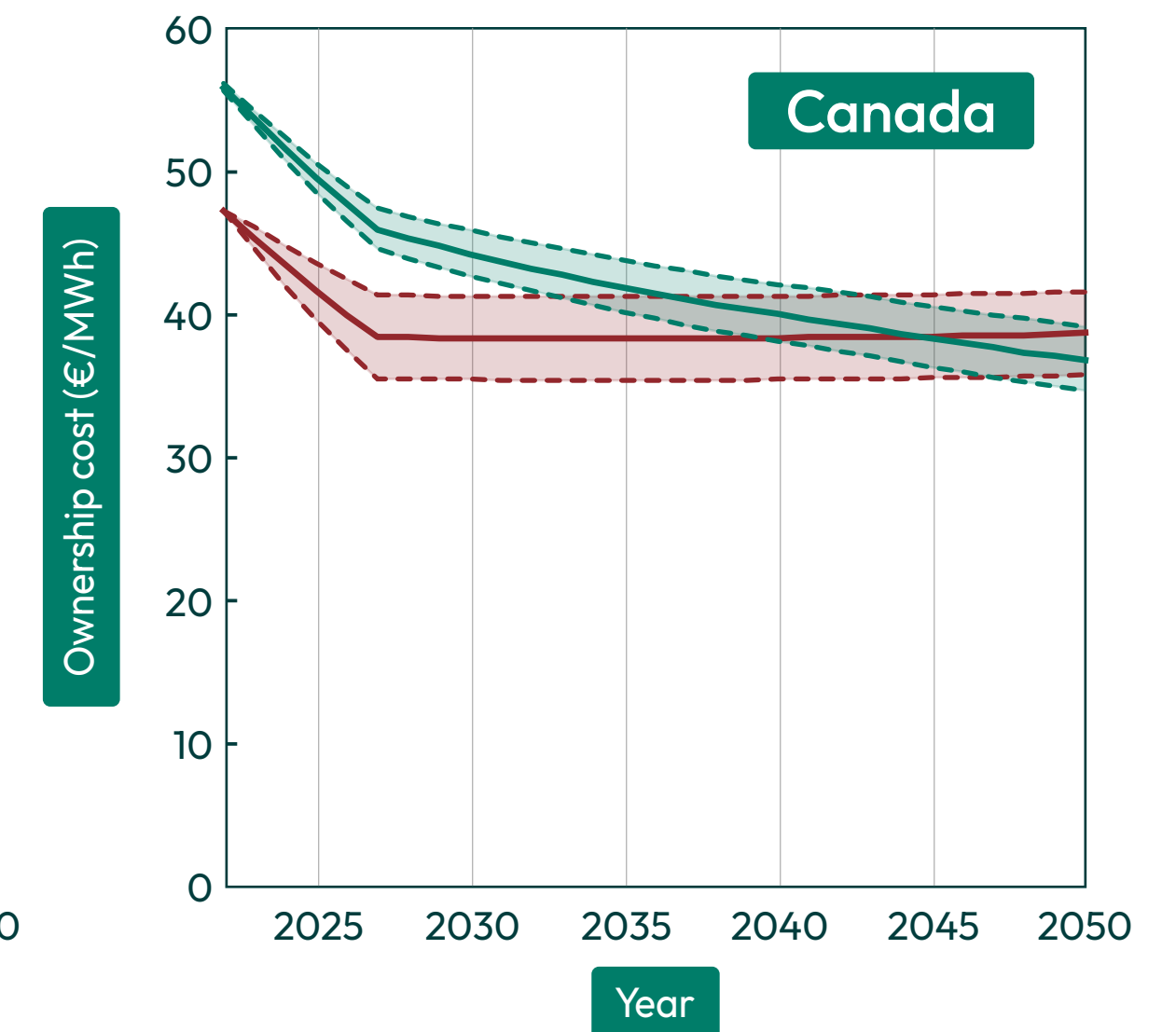
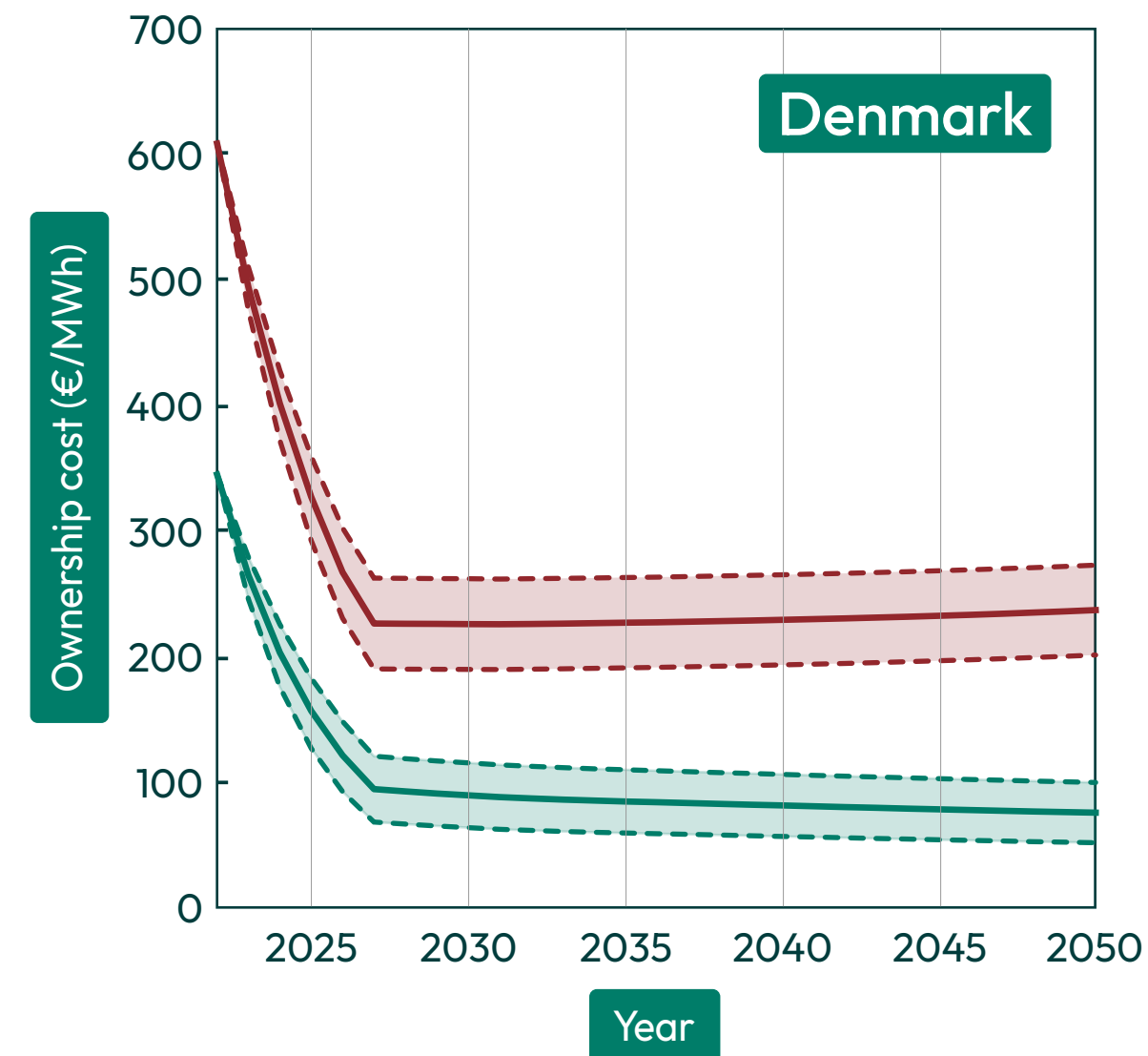
Heat pumps are already cheaper to own than boilers in leading markets

- **Successfully decarbonising residential heating requires the widespread adoption of highly efficient heat pumps, powered by low-emissions electricity [1].** Heat pumps are already less emission-intensive than fossil fuel boilers in almost all countries [2]. The emissions intensity of heat pumps will only decrease over time as fossil fuels continue to be phased-out of the power sector.
- **A tipping point, where it is cheaper to own (buy and run) a heat pump than a fossil fuel boiler, has already been reached in some countries, including Denmark and Italy.** High gas prices can increase heat pumps' advantage^a [3].
- **In markets that are further behind, such as Canada and Germany, this tipping point can be brought forward with the right policies, such as subsidies or mandates.**
- **Further deployment of heat pumps is likely to bring down their purchase price and increase their performance^b so that they produce more heat for each unit of electricity.**
- **Air-to-air heat pumps are the cheapest type of heat pump to own but the popularity of different types is influenced by the heating infrastructure that each country has.** In central European countries such as Germany, where water-based heating systems with radiators are widely used, air-to-water heat pumps have a much larger market share [4].

^a Data on the short-term price of fuels taken from: Eurostat - Energy statistics - natural gas and electricity prices. Long-term fuel prices taken from the FTT-Power model.

^b Heat pump learning rate assumptions taken from: Junginger & Louwen (2019)

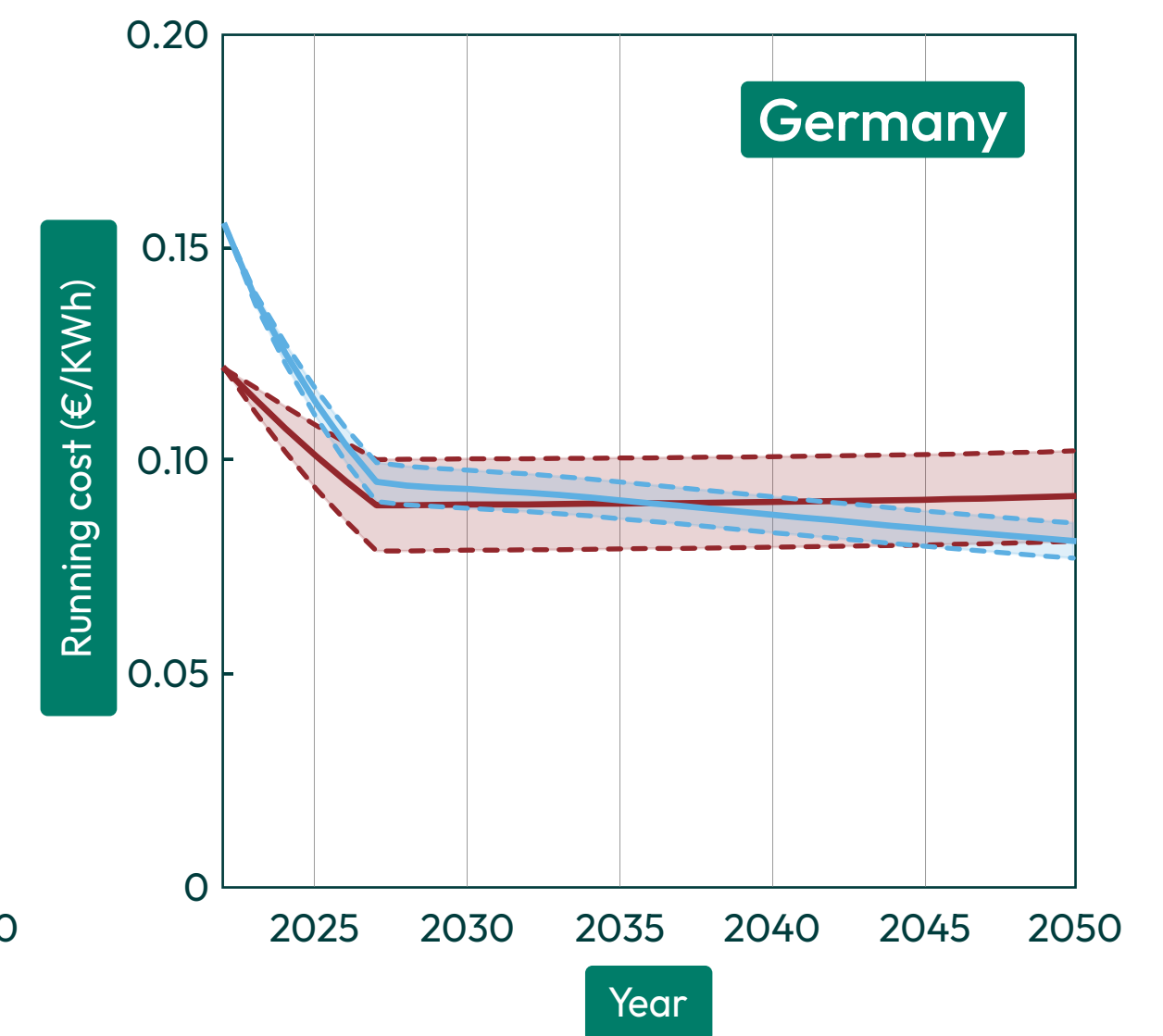
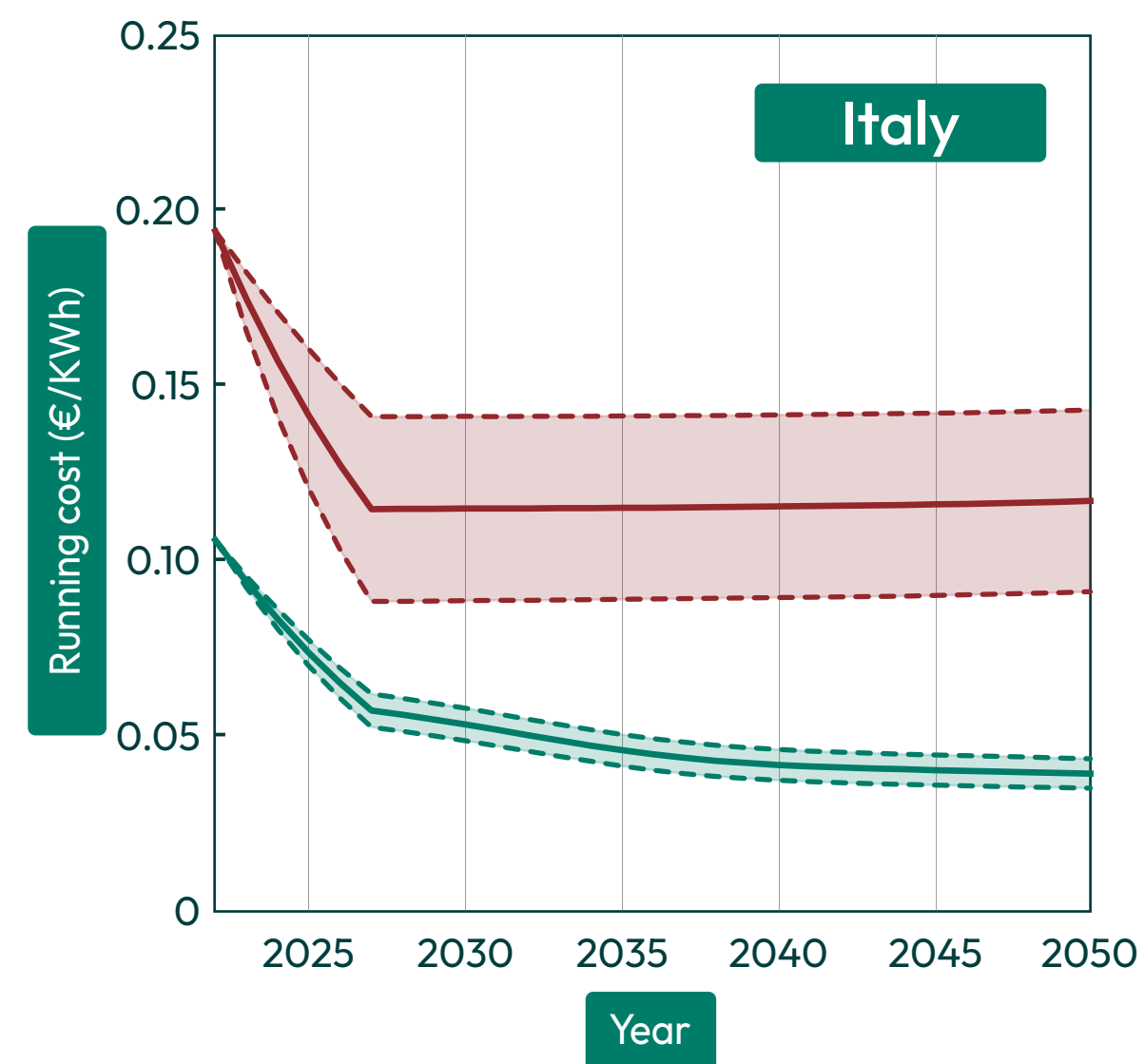
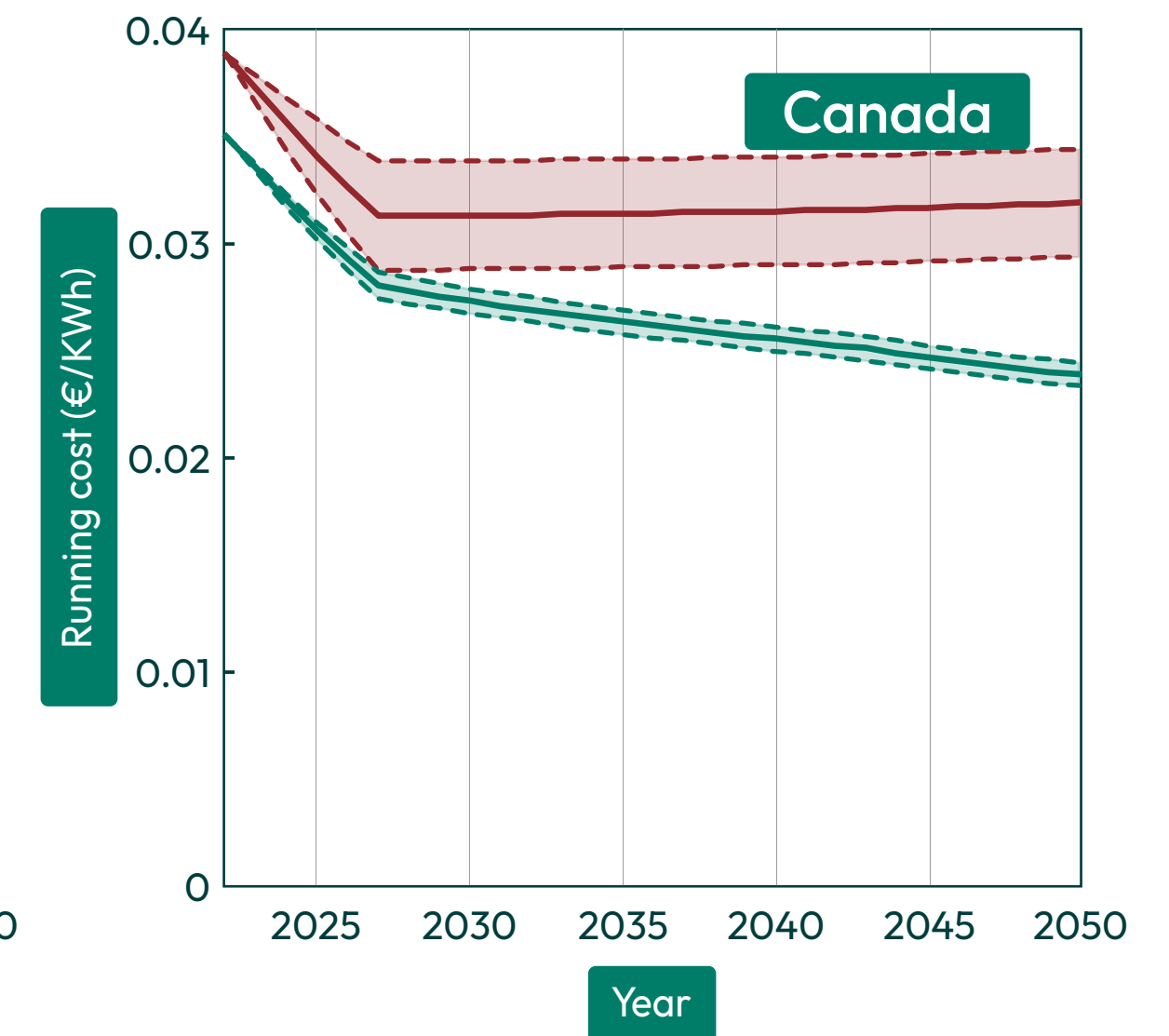
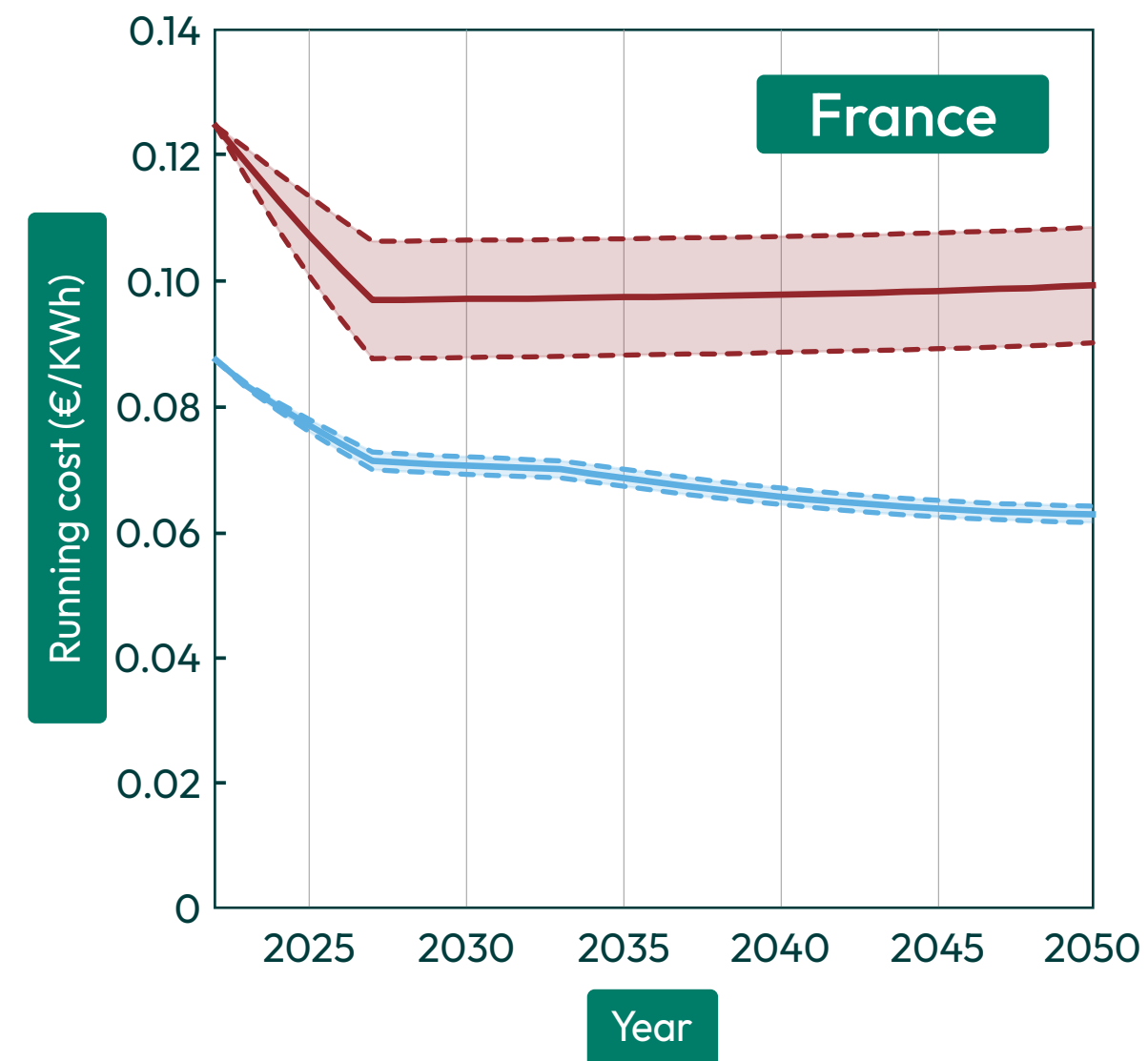
Sources: [1] IEA (2022), [2] Knobloch et al. (2020), [3] FT (2023), [4] IRENA (2022)



Shaded envelope indicates uncertainty regarding gas and electricity prices and the heat pump learning rate. The choice of heat pump shown is determined by most popular type in each country.

Heat pump running costs are typically cheaper than gas boilers – reducing exposure to gas price spikes and reducing fuel poverty

- **Heat pumps are 3-5x more efficient than a typical fossil fuel boiler [1].** This means that, even though electricity is generally more expensive than gas, it can be cheaper to run a heat pump than a gas boiler.
- **Where electricity prices are particularly high, so that gas or oil boilers are initially cheaper to run, policy can reduce or reverse the difference.** In some countries, such as Denmark, consumers pay a lower rate of tax on their electricity if they own a heat pump [2].
- **The cost savings from running a heat pump compared to a gas or oil boiler are likely to increase over time.** As well as improving in efficiency, heat pumps will benefit from renewables increasing their share of power generation, which is likely to reduce the price of electricity [3]. Any increase in gas prices would further increase heat pumps' advantage.
- **The lower running costs of heat pumps can reduce people's exposure to fuel price spikes** such as those currently seen in Europe due to the Russian invasion of Ukraine. This can help to decrease fuel poverty [1]. It can also help people living in rental accommodation, if heat pumps are installed by landlords.



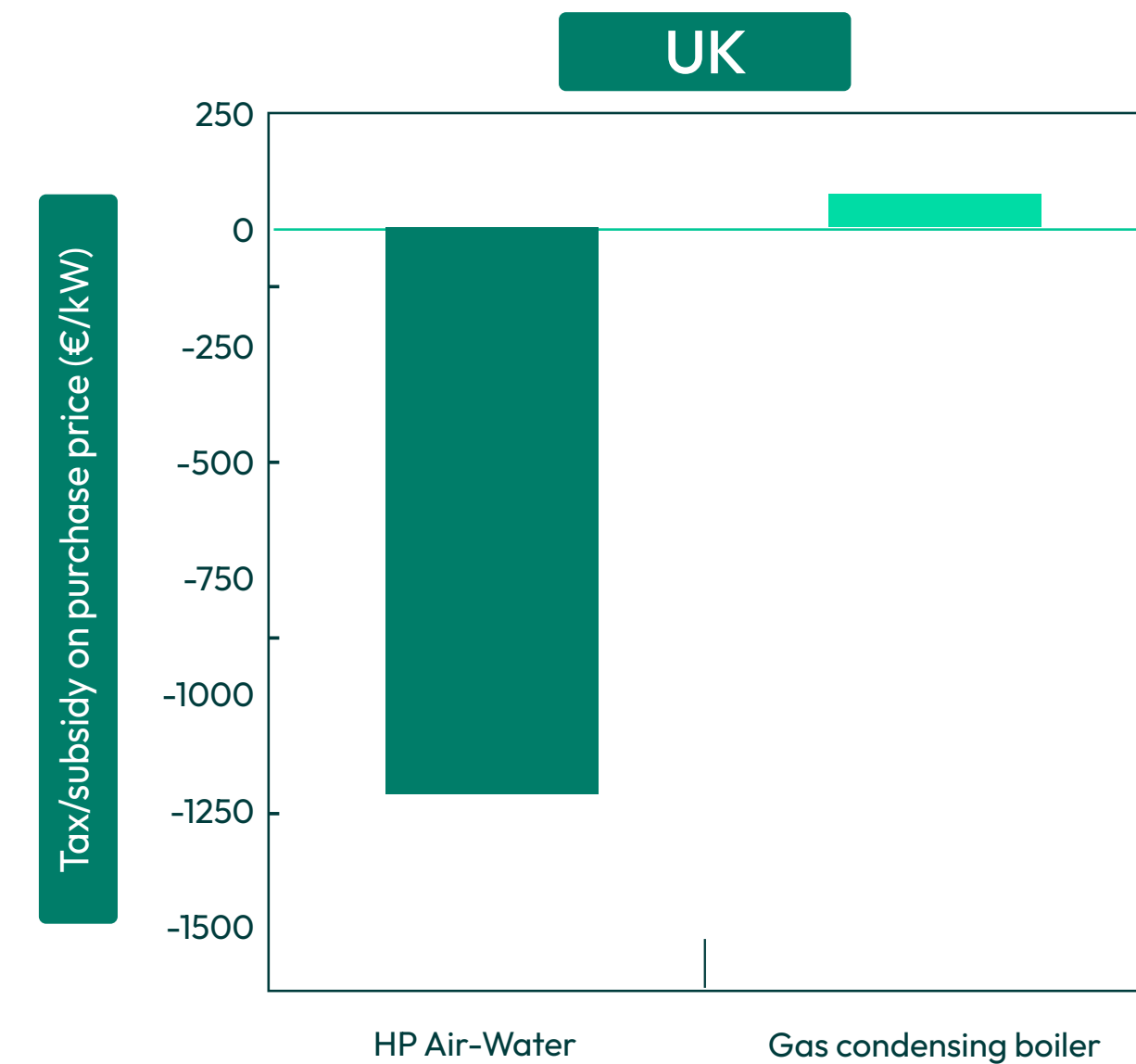
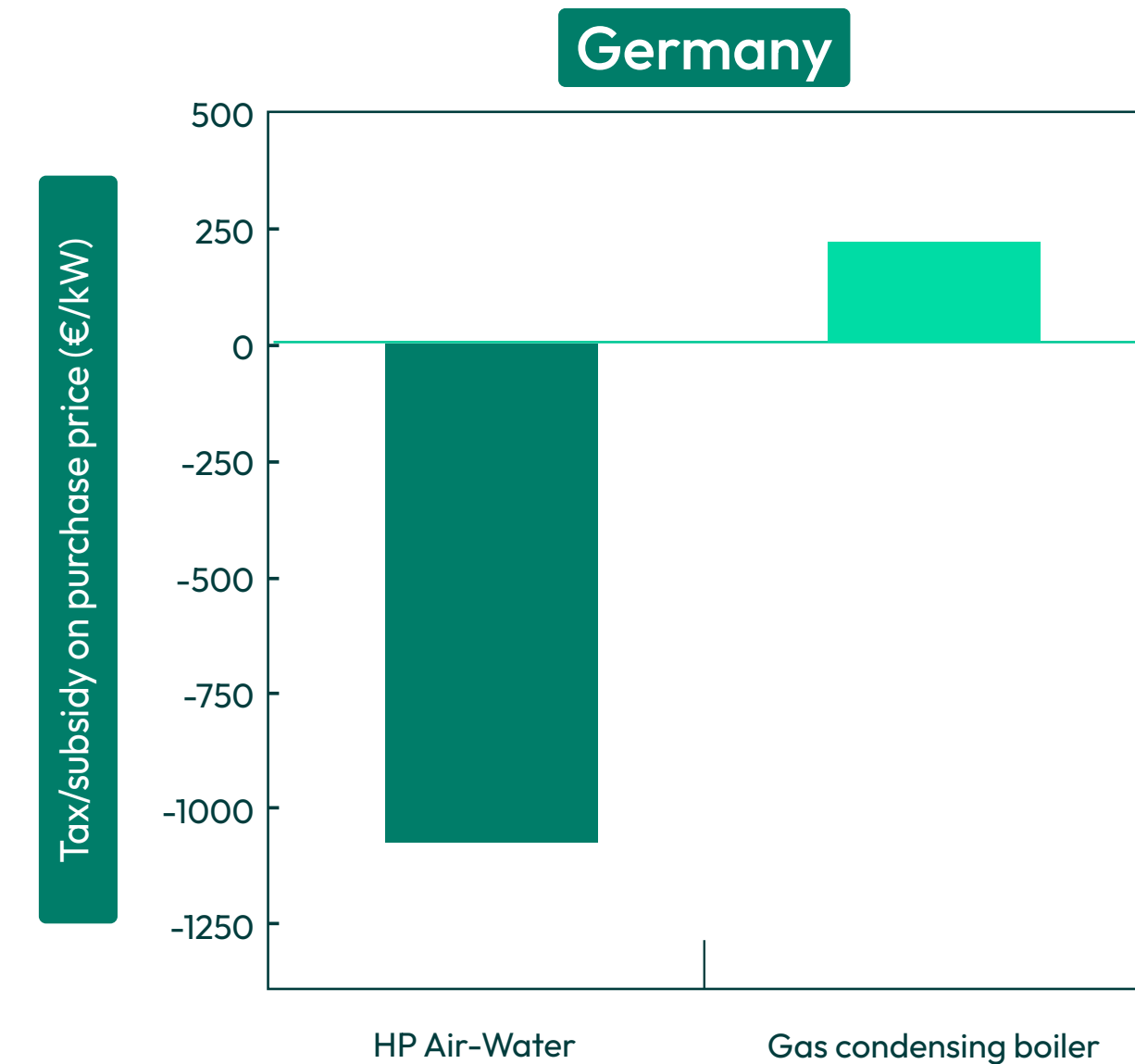
Air-air heat pump (green lines)

Shaded envelope indicates uncertainty regarding gas and electricity prices. The choice of heat pump shown is determined by most popular type in each country.

Revenue-neutral subsidies and better finance mechanisms can help to overcome purchase price barriers

- **Despite lower running costs, the purchase price of heat pumps is almost always higher than that of fossil fuel boilers.** A large part of this difference is due to higher installation costs, particularly when retrofitting existing buildings [1]. In most countries, policy will be needed to overcome this difference.
- **Purchase price parity can be achieved through a revenue-neutral ‘feebate’.** This is where heat pump subsidies can be paid for by taxing gas boilers at the point of purchase. This makes heat pumps more attractive to consumers without placing additional financial pressure on governments. Such a scheme would be most suitable in countries where heat pumps have a small share of the market.
- **Loans with low or zero interest will also help to overcome high purchase prices and can help consumers move to heat pumps and save money in the longer term.** This can especially help lower-income households, who will benefit most from the lower running costs that heat pumps can provide. Several countries already offer such schemes [1].
- **Denmark has made heat pumps cheaper to buy than fossil fuel boilers** using a combination of tax exemptions, subsidies, and an innovative “heat as a service” scheme, where companies own and maintain the heat pump and households pay a subscription [2].

Revenue neutral ‘feebates’ that make heat pumps cheaper to buy than gas boilers



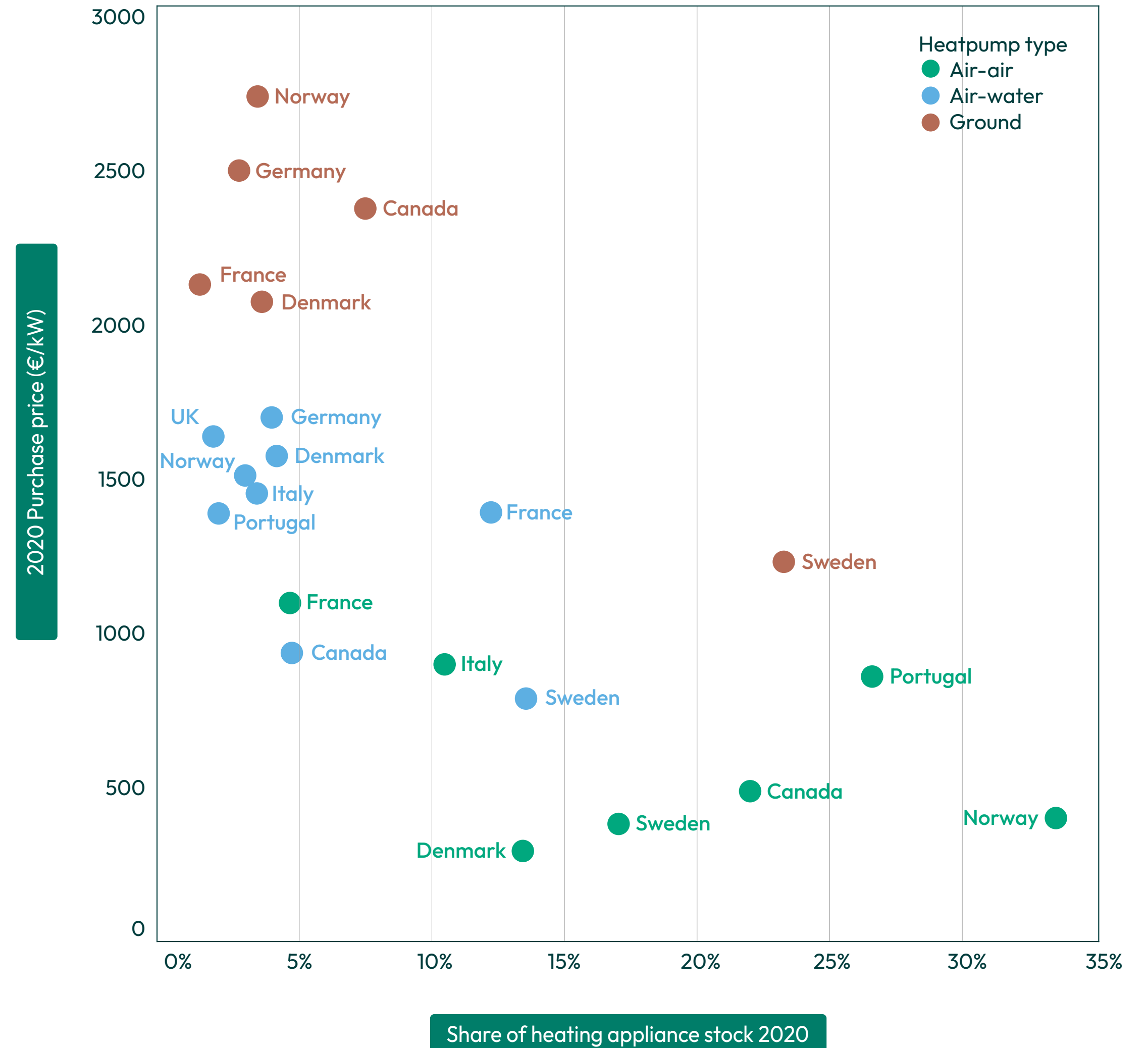
Market leaders

Heat pump prices are lower in countries that have grown larger markets for them

- The purchase price of heat pumps is significantly lower in countries where heat pumps have a larger share of the heating market. This is because larger markets can bring down costs through economies of scale and learning-by-doing [1].
- **Scandinavian countries* have the highest heat pump market shares, and the lowest heat pump purchase prices.** Their policies, which were motivated by a desire to reduce exposure to oil price spikes [2], provide an example that other countries can follow. Sweden has used a combination of carbon and energy taxes, subsidies, and building regulations to move away from oil and electric heaters towards district heating and heat pumps [3]. It now has heat pumps that are half the price of those in other European countries.
- **Warmer countries that already have significant air-conditioning markets, such as Portugal and Italy, are not far behind.** This is because many air conditioners are 'reversible', meaning they can also provide space heating.
- **Ground source heat pumps typically have the highest purchase cost and are the most complex to install.** However, their running costs, particularly in colder climates, are usually lower than air-to-water heat pumps.

*Heat pumps offer much more efficient heating than gas boilers and electric heaters even at temperatures well below freezing [4]. This is despite frequent questions of heat pump operability at low temperatures. Back-up heaters may only be required in extremely cold climates where temperatures reach below -10°C.

Sources: [1] Knobloch et al. (2019), [2] Rosenow et al. (2022), [3] Gross & Hanna (2019), [4] Gibb et al. (2023)

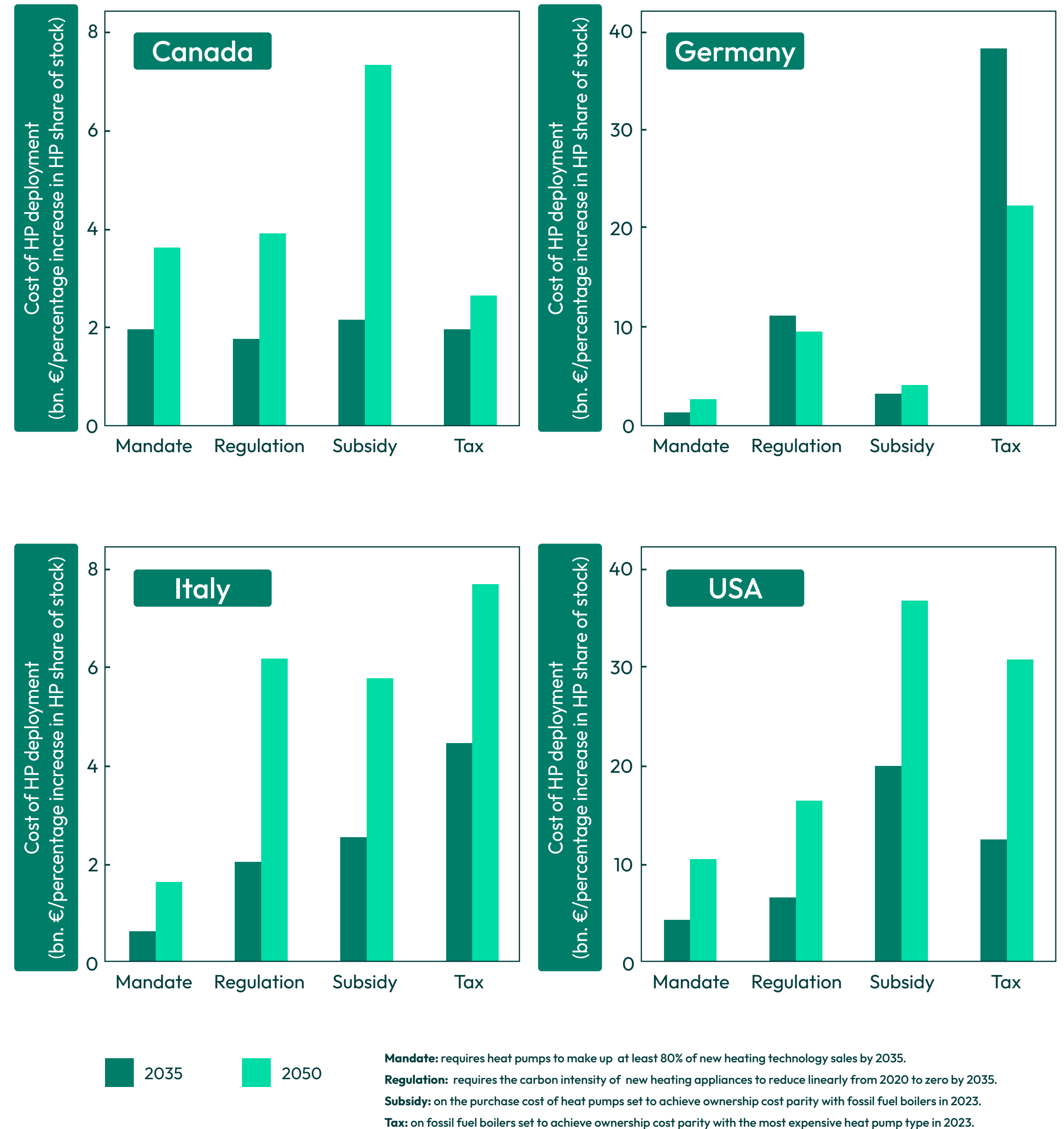


National policy recommendations

Heat pump mandates are likely to be the most cost-effective policy to accelerate deployment

- **Mandates on the sale and installation of heat pumps are likely to be a more cost-effective policy than subsidies and taxes to increase heat pumps' market share.** Mandates would require manufacturers of fossil fuel boilers to ensure that a rising portion of their sales come from heat pumps. This forces a reallocation of industry investment, improving the technology as the market grows.
- **Mandates are not yet commonly used for heat pumps, but their effectiveness has been demonstrated in the transition to electric vehicles [1].**
- **Subsidies are typically more cost-effective than taxes.** This is because early in the transition, subsidies are only applied to a small part of the heating market while, to be effective, taxes must cover the larger fossil fuel boiler share of the market. However, taxes can be more cost-effective where a sizable heat pump market is already established (e.g. in Canada, where heat pumps make up a large share of heating appliance sales).
- **As well as being relatively cost-effective when used alone, mandates can also be viewed as an 'enabling' policy [2].** This means that they can enhance the effects of other policies including regulations and taxes by increasing the size of the heat pump market.

Sources: [1] Lam & Mercure (2022), [2] Lam & Mercure (2021)

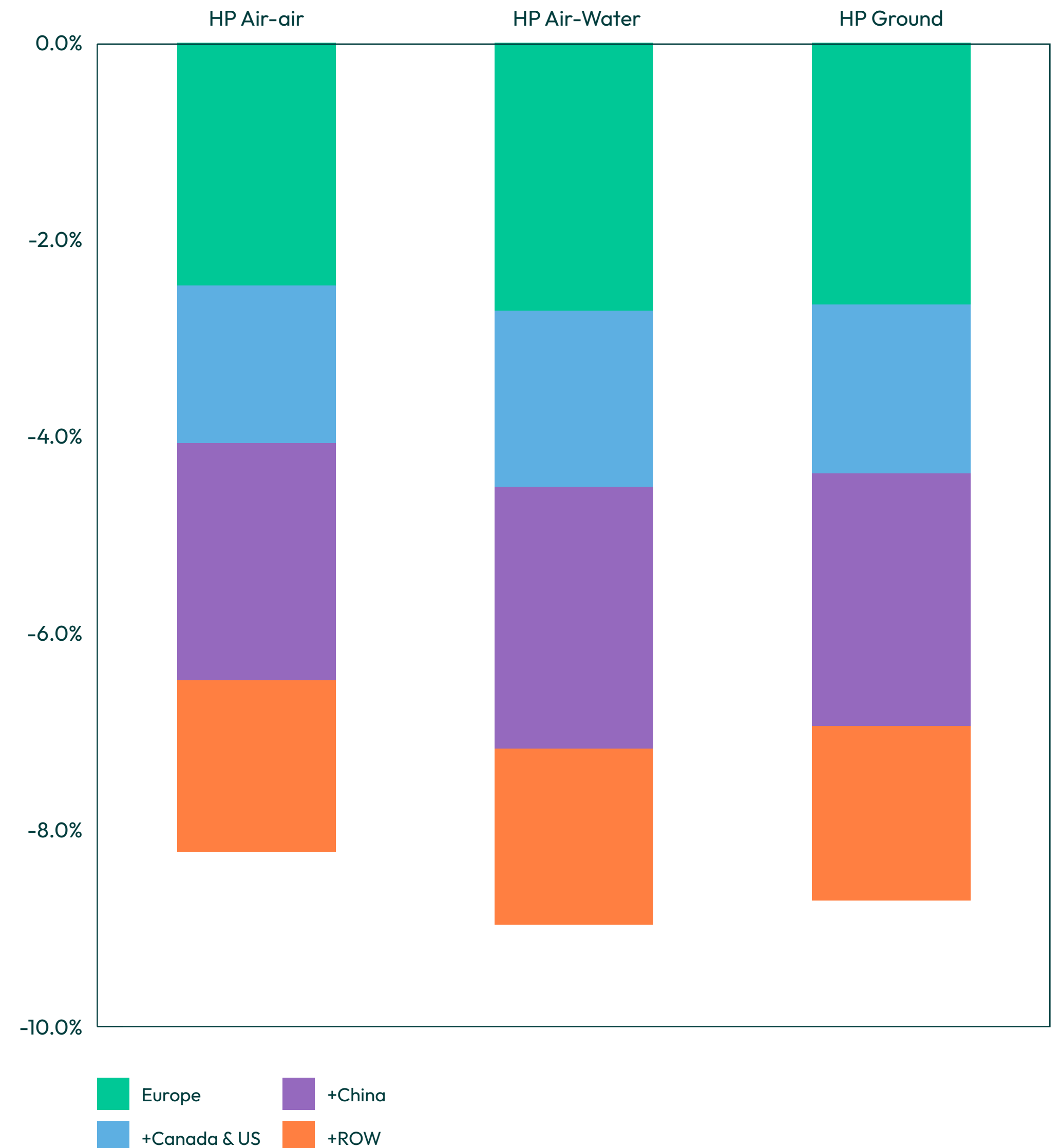


International action

Aligning action in large markets with a fast transition can accelerate cost declines globally

- The transition to heat pumps is likely to be less international than the transition to renewables and electric vehicles due to differences between countries in building stock, legacy heating systems, and climate. These differing circumstances at least partially explain the widely differing purchase costs of heat pumps between countries.
- Nevertheless, if the largest markets for heating technology align their policies towards heat pumps making up at least 80% of new heating appliance sales by 2035, the purchase price of heat pumps globally could be reduced by an extra 8-9% by 2050, on top of the 30-35% reduction expected on current trends. This is because a faster transition increases heat pump production and accelerates cost declines through technology learning and economies of scale.
- The more countries that align their actions in this way, the faster costs will decline. Since purchase prices remain a significant barrier to heat pump adoption, this could be helpful to all countries.
- Individual countries can drive their heat pump purchase prices down further by growing domestic markets, stimulating learning-by-doing, and investing in training to increase the number and productivity of skilled installers [1].
- International standardisation of heat pump performance requirements or installer qualifications can also help bring costs down. This is because similar requirements lower the costs of compliance for manufacturers [2].

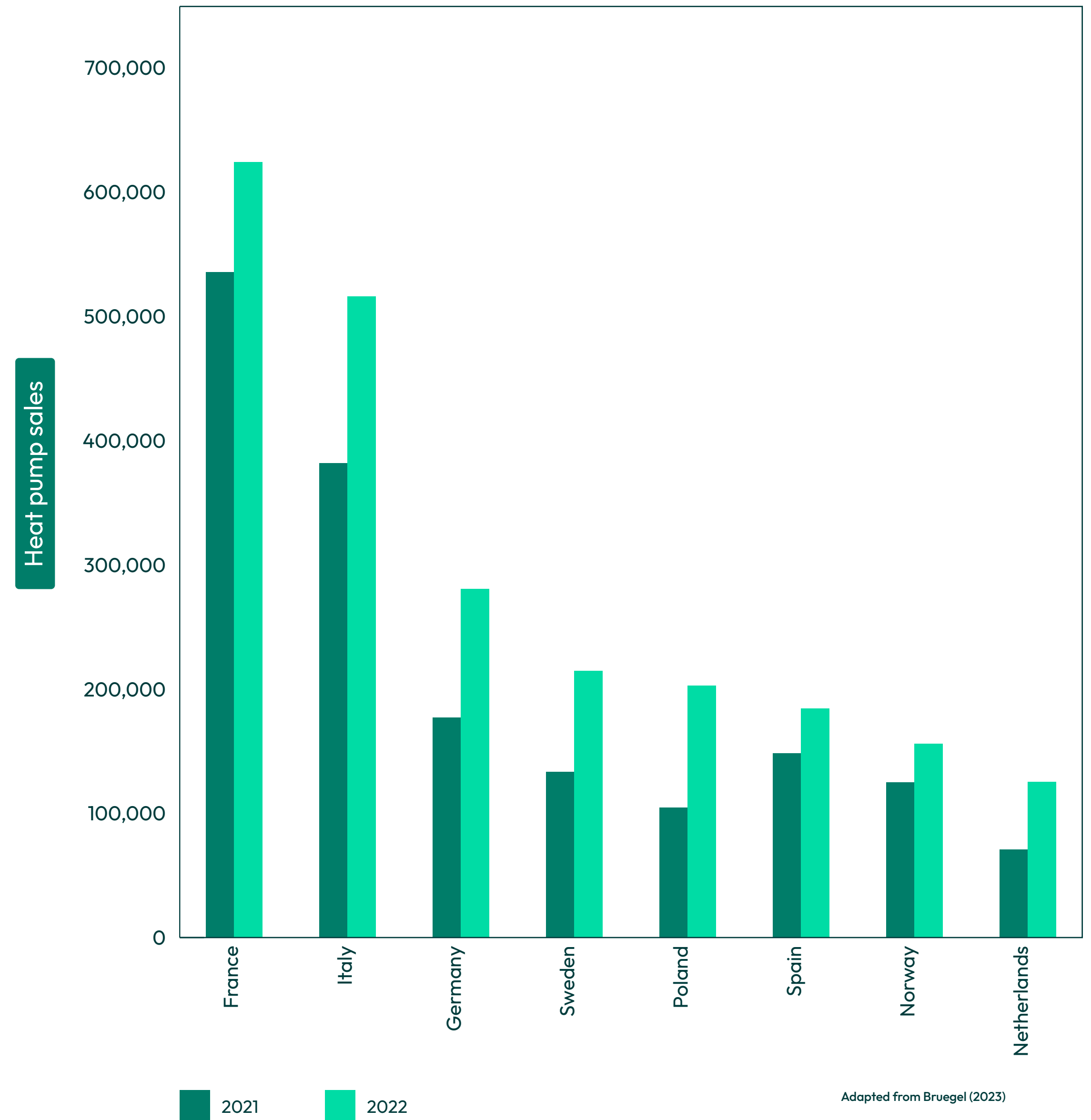
Additional global purchase price decline from aligned action in major markets, beyond 30-35% expected



Wider benefits

Decarbonising residential heating can reduce imports and improve energy security

- **80% of the global population lives in countries that are net importers of fossil fuels [1]. In many of these countries, accelerating the deployment of heat pumps can save significant sums on oil and gas imports.** For instance, in the EU alone, €60 billion worth of imports could be avoided by 2030 if gas demand in buildings is reduced by 40% [2].
- **Reducing dependence on imported fossil fuels improves energy security.** Heat pumps protect consumers from energy price spikes which are typically more severe for oil and gas than for electricity [2]. Heat pump adoption in Europe has accelerated in response to the recent energy price spike.
- **Heat pumps can make energy systems more flexible [3] by using heat storage systems to heat up when the demand for electricity is low.** This will require the widespread adoption of digital technologies and many buildings will need improved signals from the electricity grid to communicate when flexibility is required.



Adapted from Bruegel (2023)

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