Abstract 6: Environmental impact of HP's

From the paper "Drivers to heat pump adoption by European Households".

Heat Pumps are one of the key solutions for reaching EU decarbonization goals. Case study shows that Daikin heat pump is 2-24 times less carbon intensive helping to save from 0.2 to 2 tons of CO2-eq during the use phase on a yearly basis (depending on the emission factor of each country electricity grid).

Heat pumps role in decarbonization

The EU Green Deal's main objective is to decarbonize the EU by 2050. This comprehensive plan aims to cut greenhouse gas emissions by 55% across all sectors, including energy and buildings. Buildings currently consume 40% of the region's energy and contribute to 36% of its emissions. Heat pumps are vital for achieving the EU's decarbonization goal, offering energy-efficient and eco-friendly heating compared to fossil fuel-based systems. Six key advantages of heat pumps aiding decarbonization efforts are high energy efficiency, use of renewables, reduced fossil fuel dependency, heating electrification, retrofitting opportunities, and smart cooling. The International Energy Agency expects heat pumps to reduce Europe's gas demand for building heating by 21 billion cubic meters in 2030. The EU is working on the EU Heat Pump Action Plan, targeting 10 million additional heat pump installations by 2027, assessing funding options for individual buildings and heating networks supplied by large heat pumps, and integrating this assessment into local and regional heating and cooling strategies.

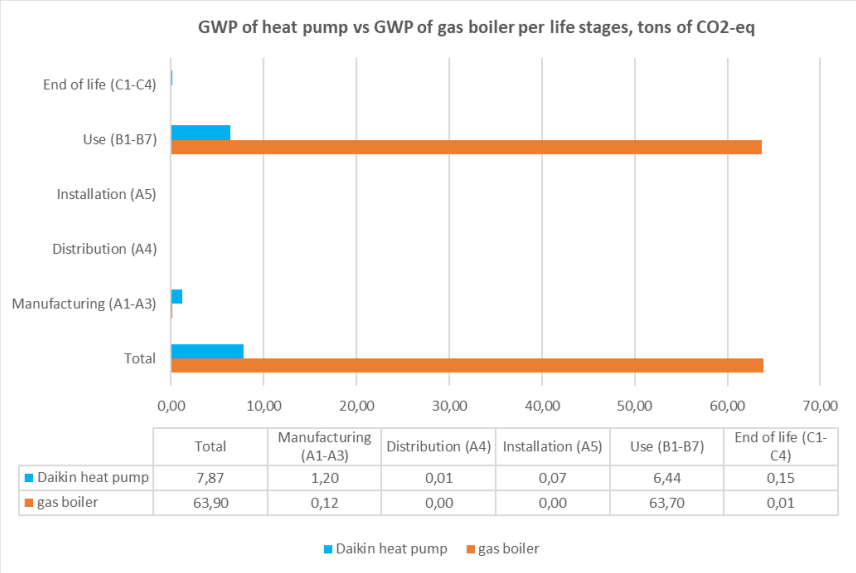
LCA of heat pumps

Daikin follows the standardized Life Cycle Assessment (LCA) method since 2021 for heat pump products, evaluating their entire life cycle from resource extraction to disposal of waste. This 'cradle-to-grave' LCA approach provides a holistic understanding of environmental footprints, covering manufacturing to end-of-life stages. It aligns with the concept of whole life carbon (WLC), considering the total carbon footprint throughout a product's existence. Daikin's LCA is verified by an independent third party and presented as an Environmental Product Declaration (EPD). EPDs aid in obtaining credits in certification schemes like LEED and BREEAM, becoming essential in meeting country regulations such as France's RE2020 environmental regulations, promoting energy-efficient buildings. EPDs for France can be accessed in databases like PEP Ecopassport and INIES.

Case study: carbon footprint of Daikin heat pumps vs gas boiler

The case study was conducted for Daikin Altherma 3 R 180L (air to water heat pump) and a highly efficient gas boiler (90% efficiency).

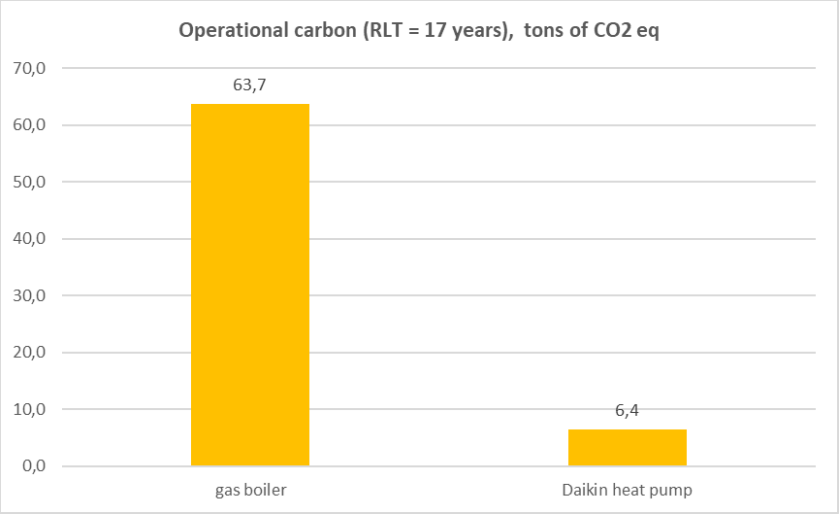
Whole life carbon



	Total	Manufacturing (A1-A3)	Distribution (A4)	Installation (A5)	Use (B1-B7)	End of life (C1-C4)
Daikin heat pump	7,87	1,20	0,01	0,07	6,44	0,15
gas boiler	63,90	0,12	0,00	0,00	63,70	0,01

The total GWP of Daikin heat pump is nearly eight times less than total GWP of gas boiler: 7,87 tons of CO2-eq versus 63,9 tons of CO2-eq (over a period of reference life time = 17 years). This difference is explained by high contribution of use phase to the total values of both products compared where Daikin heat pump consumes less energy and works on electricity with lower GWP (here: France electricity mix).

Operational carbon



Operational carbon represents the biggest part of the total CO2 emissions of both heat pump and gas boiler. Emissions from gas boiler used in this study are almost 10 times bigger than from the heat pump. The energy use was calculated for France. Carbon footprint of the use phase of heat pump will vary in each country due to their specific emission factor of electricity grid.

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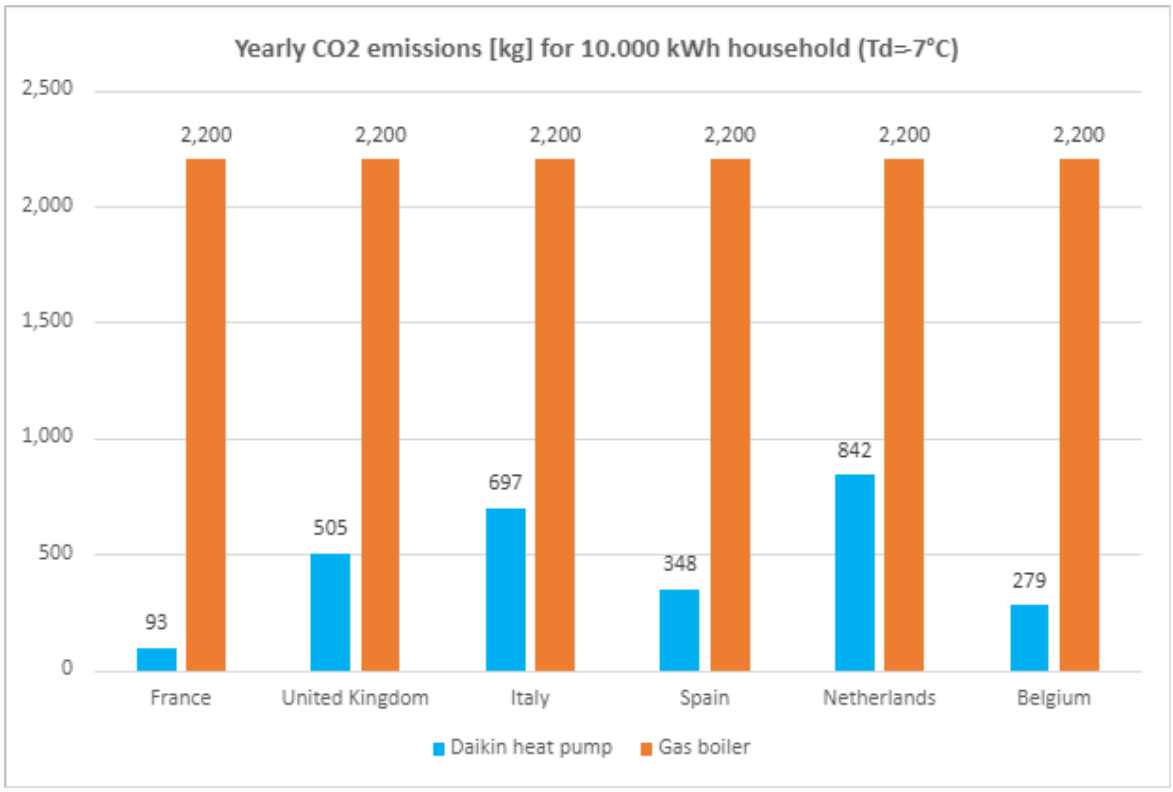
Heat pump carbon emissions benefits during the use stage per country

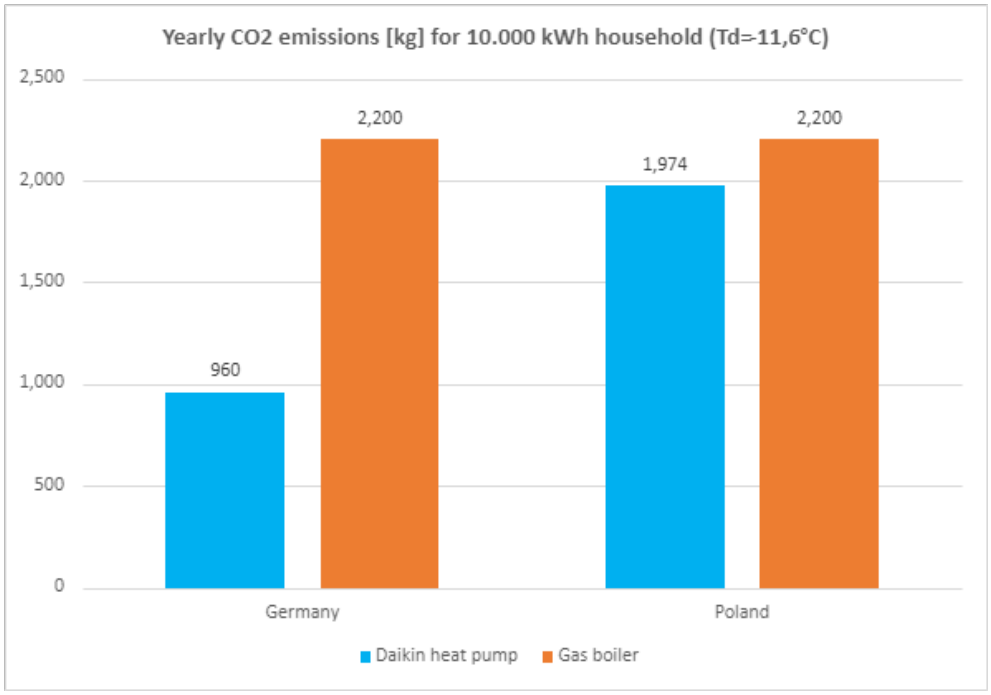
Replacing a gas boiler with a heat pump will result in significant CO2 emission savings in a typical single-family buildings in European countries. To illustrate this the CO2 emissions over the period of one year in different European markets are calculated, for a typical medium-sized household of 10.000 kWh annual energy consumption - representative for the new build market. The countries considered in this study are France, UK, Italy, Spain, Netherlands, Belgium, Germany, and Poland. The countries were divided into two big groups based on their average minimum temperature or so-called design temperature, abbreviated as Td. The chosen design temperature of the two different groups in consideration are -7 and -11.6°C respectively.

Countries with Td=-7°C



	Daikin heat pump CO2 EF electricity [kg/kWh]	Yearly CO2 emission [kg]	Gas boiler CO2 EF gas [kg/kWh]	Yearly CO2 emission [kg]	Absolute Delta Yearly difference in CO2 emissions [kg]	Relative Delta Times less of yearly CO2 emissions [kg]	
France	0.041	93	0.198	2,200	2,107	24	
United Kingdom	0.2223	505	0.198	2,200	1,695	4	
Italy	0.3069	697	0.198	2,200	1,503	3	
Spain	0.1533	348	0.198	2,200	1,852	6	
Netherlands	0.3704	842	0.198	2,200	1,358	3	
Belgium	0.1226	279	0.198	2,200	1,921	8	

Countries with Td=-11,6°C



	Daikin heat pump CO2 EF electricity [kg/kWh]	Yearly CO2 emission [kg]	Gas boiler CO2 EF gas [kg/kWh]	Yearly CO2 emission [kg]	Absolute Delta Yearly difference in CO2 emissions [kg]	Relative Delta Times less of yearly CO2 emissions
Germany	0.3776	960	0.198	2,200	1,240	2.3
Poland	0.7766	1,974	0.198	2,200	226	1.11

Case study results

As seen from the graphs, yearly emissions from the use of heat pumps are 2-24 times lower than emissions from gas boiler providing the same air and water heating and cooling for the household in all the countries studied. Since EF of electricity are only expected to decrease within the near and long-term future due to the investments in renewable energy by the EU and UK, heat pumps will also continue to have less use phase emissions, therefore, helping them to achieve their climate goals.

In conclusion, heat pumps are a ready-to-use climate-positive solution with far-reaching environmental benefits compared to traditional gas boilers.

For a more precise quantitative assessment, for sources and references, please refer to the complete paper.