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# Decarbonizing heating in Germany by 2050: Cost comparison of technology options

The German federal government has the ambitious goal to decarbonize the country by 2050, which means all sectors must come close to decarbonizing over the next decades. Decarbonizing the home heating sector will be an important part of this plan, as in German residences, about two-thirds of space heating demand is met with fossil fuels. At the same time, many Germans spend a high proportion of their income on energy bills. As a result, German policymakers need to identify which heating technologies can decarbonize the energy system at the lowest cost for consumers.

A new ICCT paper compares the GHG impacts and cost effectiveness of four heating pathways in the year 2050 in Germany: hydrogen boilers, hydrogen fuel cells with an auxiliary hydrogen boiler for cold spells, air-source heat pumps using renewable electricity, and heat pumps with an auxiliary hydrogen boiler for cold spells. The analysis includes low-carbon hydrogen from steam-methane reforming (SMR) using natural gas combined with carbon capture and storage (CCS), or SMR + CCS, and zero-carbon hydrogen produced from renewable electricity using electrolysis.

## KEY FINDINGS

- Air-source heat pumps are the most cost-effective residential heating technology in 2050 and are at least 40% lower in cost than the hydrogen-only technologies. Even if natural gas costs were 50% lower or renewable electricity prices were 50% higher in 2050, heat pumps would still be more cost-effective than hydrogen boilers or fuel cells.
- A hybrid heat pump using either a limited amount of low-cost electrolysis hydrogen (imported from within the EU) or SMR + CCS hydrogen in the auxiliary boiler is the second most cost-effective heating pathway. Hydrogen fuel cells are the most expensive heating option in 2050.
- The use of SMR + CCS hydrogen will not completely decarbonize heating because of upstream natural gas leakage and carbon capture inefficiencies. Even in a scenario where zero- and low-carbon energy is used to fuel the SMR process, this pathway still releases 7%–31% of the GHG emissions of natural gas. In contrast, the use of wind and solar power for heat pumps and electrolysis hydrogen would be fully zero-carbon.

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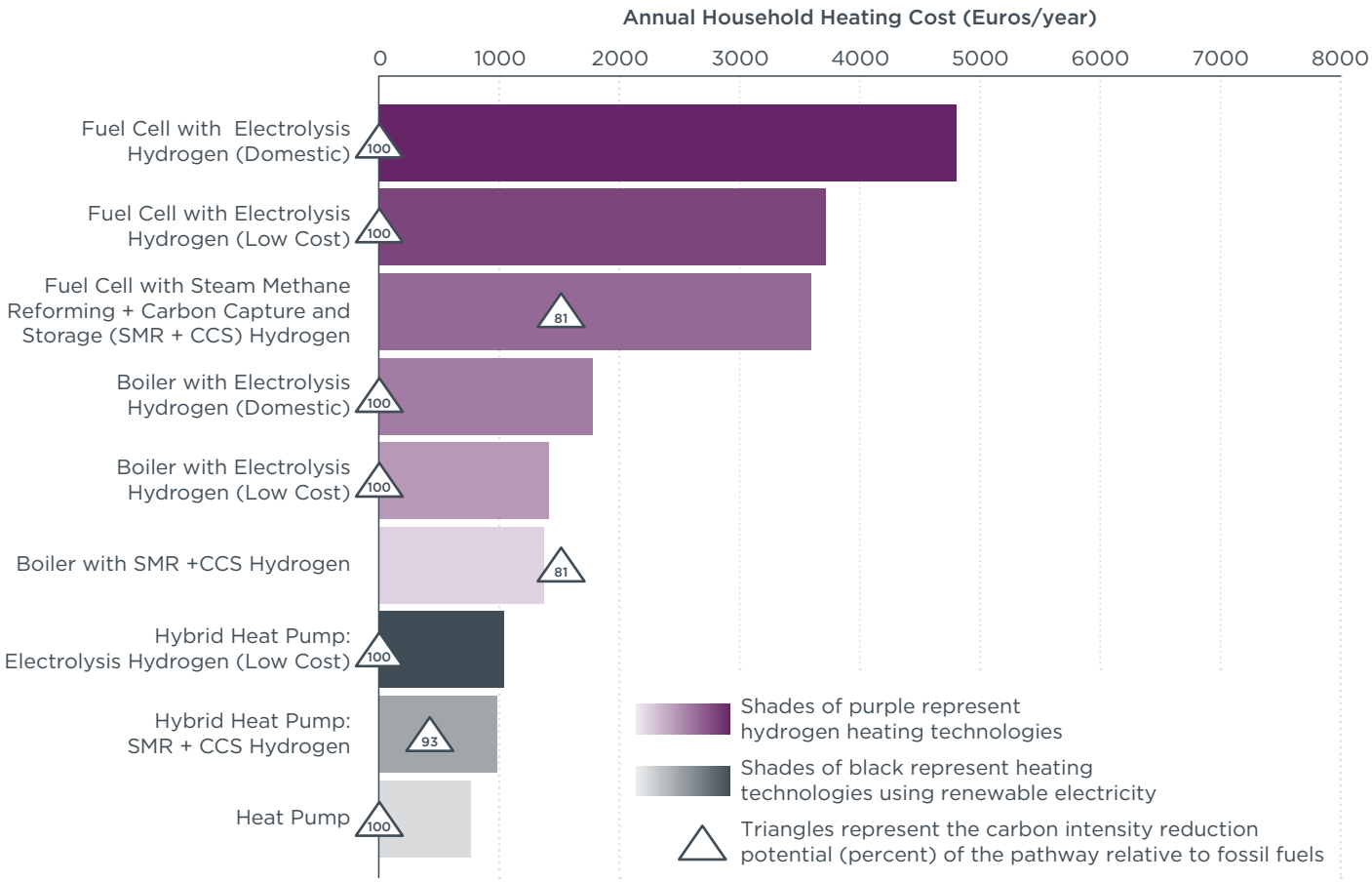
» The use of renewable electrolysis hydrogen can be cost competitive with SMR + CCS hydrogen in 2050 if it is imported from countries that can produce it at a lower cost than Germany, although electrolysis hydrogen is not produced at scale today.

» Energy efficiency measures to reduce heat demand would be a more cost-effective strategy for achieving GHG reductions than any of the low-GHG heating pathways assessed in the study.





## PUBLICATION DETAILS

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