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Decarbonizing heating in the European Union in 2050: Cost comparison of technology options

The European Commission has proposed raising the 2030 greenhouse gas (GHG) reduction target to at least 55% compared to 1990 levels. Decarbonizing the home heating sector will be an important part of this plan, as it is responsible for the most energy demand from private residences. At the same time, the European Commission aims to alleviate energy poverty in line with commitments made in the Renovation Wave Initiative. As a result, policymakers need to identify which heating technologies can decarbonize the energy system in Europe 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: 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 50% lower 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 a limited amount of low-cost electrolysis hydrogen (from within the EU) in the auxiliary boiler is the second most cost-effective heating pathway in our analysis, being 30%–40% less expensive than using a hydrogen boiler. 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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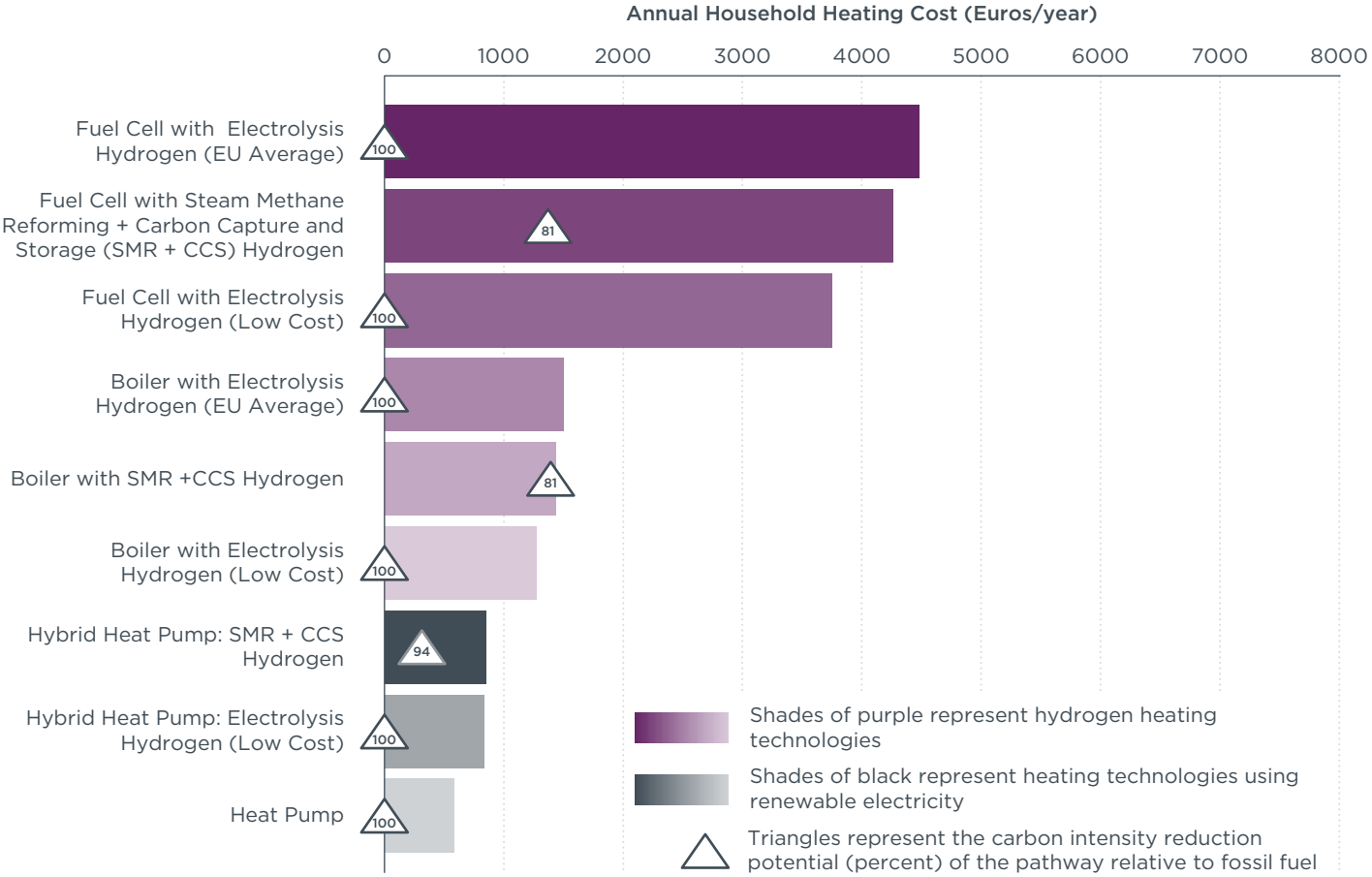
» The use of renewable electrolysis hydrogen can be cost competitive with SMR + CCS hydrogen in 2050, although electrolysis hydrogen is not produced at scale today.

» 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.



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