

Feasibility study of a centralised electrically driven air source heat pump water heater to face energy poverty in block dwellings in Madrid (Spain)

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Abstract-

Energy poverty can be defined as the inability to pay the bills that are required for maintaining the comfort conditions (usually in winter) in dwellings. The use of energy efficient systems is one way forward to mitigate this problem, with one option being the electrically driven air source heat pump water heater. This paper assesses the performance of a centralised heat pump (200 kW of heating capacity) to meet the space heating demand of block dwellings in Madrid (tier four out of five in winter severity in Spain). Two models have been developed to obtain the following variables: the hourly thermal energy demand and the off-design heat pump performance. The proposed heat pump is driven by a motor with variable rotational speed to modulate the heating capacity in an efficient way. A back-up system is also considered to meet the peak demand. A levelised cost of heating of 92.22 €/MWh is obtained for a middle-level energy efficiency in housing (class E, close to D). Moreover, the following energy-environmental parameters have been achieved: more than 74% share of renewable energy in primary energy and 131.7 g CO₂ avoided per kWh met. A reduction of 60% in the heating cost per dwelling is obtained if an energy retrofit is carried out, improving the energy performance class from E to C. These results prove that the proposed technology is among the most promising measures for addressing energy poverty in vulnerable households.

Index Terms- energy poverty; centralised heat pump; hourly heating demand; off-design heat pump model

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