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HIGH-TEMPERATURE HEAT PUMPS FOR INDUSTRIAL APPLICATIONS: AN ECONOMIC ANALYSIS IN DIFFERENT EUROPEAN CONTEXTS

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ABSTRACT

Decarbonizing hard-to-abate sectors, particularly energy-intensive industries, remains one of the greatest challenges of the energy transition. This presentation illustrates the economic performance of high-temperature heat pumps as substitutes for natural gas in existing industrial processes across EU Member States. The techno-economic analysis integrates sector- and country-specific conditions with historical industrial prices for natural gas and electricity, together with technology-specific capital and operating expenditures based on design data from industrial manufacturers. The analysis presented in this paper is based on the estimation of the levelized cost of heat, as the main indicator to evaluate the economic competitiveness of heat pumps compared to the traditional solution based on natural gas, which remains the standard reference in most of EU countries. The analysis identifies the key factors driving the economic competitiveness of low-carbon heat production technologies in European industry, with a specific focus on the spread between electricity and natural gas prices for the final users. The analysis highlights the substantial variability in the electricity-to-natural gas price ratio across EU countries, industrial consumption classes, and over time. The median value of this ratio is approximately 3.1, with the first and third quartiles equal to 2.5 and 3.7, respectively. However, the observed range is considerably wider, spanning from 0.6 to 10.3. This pronounced variability underscores the need to assess the economic viability of heat pumps within the specific context of each country, sector, and consumer category, rather than relying on generalized assumptions. Furthermore, the results indicate that differences in the taxation of electricity and natural gas generally increase, rather than reduce, the electricity-to-gas price ratio, thereby affecting the relative competitiveness of electricity-based heating technologies. The findings provide evidence to support researchers working on industrial energy system modelling and techno-economic assessments. In addition, the results offer valuable input for policymakers in designing effective strategies to accelerate industrial decarbonization while strengthening competitiveness across EU countries.