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Estimating hydrogen demand: a system dynamics approach

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Extended Abstract

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Abstract Summary

Low-carbon hydrogen is a key lever for the transition of many sectors toward carbon neutrality. However, demand for the molecule remains uncertain and poorly documented. This article aims at estimating the aggregate demand for hydrogen compared to direct electrification to decarbonize industrial heating. We use a ''putty-clay'' model adapted from Abada et al. (2013). The model tracks the aging of the industrial capital stock to simulate investment decisions when equipment is replaced. Using France as a case study, we show that the model aligns well with observed trends in fuel substitutions. We iteratively run the model to simulate and construct aggregate demand curves for low-carbon heating options, namely hydrogen and direct electrification, and have three key findings. First, the delays involved in replacing industrial equipment significantly reduce the sector's medium-term decarbonation potential. We find that at most 30% of fossil-based heating equipment can be replaced by 2030. Second, allowing the retrofitting of existing natural gas equipment with mixed-feeding technologies (''H2-ready'' feeders) enables faster decarbonation. Third, aggregate demand curves for low-carbon heating energy vectors can be accurately approximated by inverse logit demand functions calibrated using aggregate market data.