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Between Competitiveness, Climate, and Industrial Policy: Modelling the EuropeanPetrochemical Sector under Decarbonization

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Extended Abstract

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Abstract Summary

The European petrochemical sector faces a dual challenge: decarbonizing its production base while remaining competitive against lower-cost producers in the United States, Middle East, and China. Over the past decade, European producers have lost their historic feedstock and energy cost advantage, and between 2022 and 2025 announced closures rose sixfold, representing about 9% of European chemical production capacity. At the same time, existing research on chemical-sector decarbonization has focused heavily on ammonia and methanol as hydrogen derivatives, while olefins and aromatics, the backbone of the plastics value chain, have received far less attention despite posing harder decarbonization challenges due to their deep integration in steam-cracker clusters and their reliance on carbon as an intrinsic feedstock.

This paper addresses this gap by extending the open-source whole-energy-system model PyPSA-Eur with a granular endogenous representation of European olefin and aromatic production. Both incumbent fossil routes and low-carbon pathways (e.g., methanol-to-olefins, electric crackers, CCS-equipped processes) are modelled as competing technology options, with production capacity spatially anchored to existing chemical clusters and permitted to expand, contract, or relocate under cost optimization. Through scenario-based sensitivity analysis, the study identifies levers that could enable a decarbonized yet competitive European petrochemical industry, including carbon border adjustments, differentiated carbon pricing, and international import competition.

Preliminary results from a baseline scenario show that by 2050, fossil steam cracking is nearly phased out, replaced by electrified and methanol-based routes. Production relocates from legacy clusters in northwestern Europe toward southern Europe, driven by lower renewable electricity costs. The integrated modelling framework enables analysis of spatial redistribution, resource competition with other sectors, and the identification of

policy levers together with their system costs, providing an evidence base for designing industrial and energy policy for the European chemical sector in an integrated manner.

Presenting Author Biography

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