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Long-term contracts for biomethane development in the energy transition

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Russia's full-scale invasion of Ukraine in February 2022 catalysed the most dramatic reordering of Europe's gas market in recent history. Within this crisis context, biomethane —a pipeline-quality renewable gas produced by upgrading biogas—was rapidly elevated from a niche fuel to a strategic instrument for security of supply, decarbonisation, and rural value creation. The European Commission's RE-PowerEU Plan crystallised this momentum, proposing to raise EU biomethane output to 35 bcm per year by 2030—roughly a tenfold increase over early-2020s volumes. Three years on, however, the divergence between ambition and reality has become stark.

The central economic fact about biomethane in Europe is its persistent cost disadvantage relative to fossil gas—one that has not materially narrowed since the 2010s. Best-available estimates place production costs typically between €50 and €175/MWh, far above recent TTF (Title Transfer Facility, the reference gas spot market in Europe) levels after the 2022 2023 crisis spike receded. Even looking ahead to 2050, foresight studies surveyed in the literature do not anticipate widespread convergence with average natural-gas prices; the associated learning curve remains relatively flat compared with those observed for wind and solar technologies for instance.

Since REPowerEU, gas prices have been fading, and so has the emphasis on biomethane. The 2022 shock temporarily aligned energy security and climate narratives: high fossil-gas prices made biomethane look more competitive, and its domestic character promised resilience. As prices fell back towards long-run "normal", however, that alignment weakened.

Existing works have so far mainly focused on co-benefits and positive externalities with respect to the electricity system, energy sovereignty, and GHG emissions, while also

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invoking arguments related to enhanced waste management, agricultural co-benefits, and positive externalities associated with the circular economy.

We argue that these are not the only rationale in favour of biomethane and that biomethane may increase welfare because it improves the mitigation and allocation of market risk between producers and consumers.

We develop a structural model of gas trading in which gas consumers strive to minimise their risk-adjusted gas-supply costs, and a set of biomethane producers invest in production capacity subject to some operational constraints with the objective of maximising their risk adjusted profits. The model focuses primarily on financial risk trading. We develop a detailed application of our model to the French case, France being a country in which the potential for and support of biomethane are among the highest in Europe.

Consumers are split into two segments: residential consumers and large industrial firms. We apply the latter segment to the case of steel producers, who use natural gas to generate heat and, in many production processes, manufacture their final product with the aim of quantifying the welfare gains associated with biomethane production and BPAs.

We find that long-term contracts raise overall economic welfare in France by about €1.9 billion a year compared with a market without them. The share of the available biomethane potential that gets built rises from 76% without contracts to 95% with them. The use on contracts depends on the endues: Households would sign contracts covering about 34% of their gas use. Steel producers would sign none since steel prices correlate with gas.

Biomethane production and the contracts cut greenhouse gas emissions by an estimated 7.7 million tonnes of CO2-equivalent a year.

Though the qualitative results of the second contribution are relatively intuitive, the fact that market and climate risk considerations could foster biomethane investment is not straightforward, given the strong cost disadvantage of biomethane relative to fossil gas.

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