Analysis of an Electricity-Price Optimized Operating Strategy of a Carbon Capture and Power-to-Methanol Pilot Plant

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Abstract:
The electricity-based production of methanol is a potential key technology for the long-term storage of CO_2 captured from unavoidable point sources like incineration plants. Due to the explicitly higher energy consumption for the capturing process and synthesis, e-methanol is far from being economically competitive with fossil-based methanol. In this work, we explore the potential reduction in operating costs by optimizing the operating modes of two coupled, dynamically operated pilot plants with intermittent storage. Based on electricity price forecasts, the model determines which operating mode is financially favored, considering emitted CO_2, produced methanol, and required electricity and utility inputs over the span of a reference year. As both pilot plants have been designed following basic and detailed engineering, the underlying assumptions introduced into a Python-based model provide accurate estimations of operating costs. The results show that a reduction in operating costs of approximately 30% is possible when fluctuating electricity prices and various operating modes are adapted. Additionally, sensitivity analysis reveals that with rising CO_2 certificate costs, cost savings increase by more than five times due to non-emitted CO_2, highlighting the financial impact of carbon capture and power-to-X processes at unavoidable point sources.

Topics:
Dynamic operation of carbon capture and power-to-methanol processes

Keywords:
Carbon Capture, Power-to-Methanol, Dynamic Operation, Python modelling