ABSTRACT/SUMMARY

Modelling power-to-ammonia production for a clean hydrogen carrier in energy and export

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Ammonia is a versatile chemical that is distributed widely as a commodity for the fertilizer industry, and it is also identified as a carbon-free fuel to store hydrogen for energy and export. Converting low-carbon electricity to ammonia (i.e., power-to-ammonia, or P2A) is a critical process to decarbonize ammonia production. In this talk, I will highlight two P2A-related modelling activities in my research group. First, we designed a P2A plant powered by offshore wind from Sable Island and estimated its production cost and carbon intensity. Even though offshore wind farms in Atlantic Canada are expected to have high capacity factors, we found it necessary to connect the plant with the electrical grid to maintain high ammonia outputs. Yet grid-connection could raise carbon intensities of the produced ammonia. Second, we developed a time-based levelized cost of carbon abatement (LCCA) model to study the costs to reduce one ton of CO2-eq emissions by using P2A to substitute fossil-fuel based productions in Canada. Technology learning curves and adoption rates, and the mismatch between production capacity and demand over time were considered for fertilizer, hydrogen, and export sectors. Results show that the slow increase in technology adoption will result in a large electrolytic ammonia shortage, which can cost the industry a significant amount to meet the carbon reduction targets. Additionally, under the base case with conservative assumptions, clean ammonia for domestic hydrogen use has a LCCA that is projected to be lower than the proposed carbon price, making it competitive with fossil fuel-based production.

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