Cross-border infrastructure plays a pivotal role in decarbonizing industries

The case of ammonia production in the Antwerp-Rotterdam-Rhine-Ruhr-Area

The research institutes DVGW-EBI, Dechema (both Germany), EnergyVille/VITO (Belgium), and TNO (the Netherlands) have joined their expertise and conducted a high-level study on what cross-border challenges and opportunities can be identified for the production of ammonia, a key industry in the Antwerp-Rotterdam-Rhine-Ruhr region. The three analysed sites are located within a 185 km radius and combined produce almost 2 million tons ammonia per year, consuming large amounts of electricity and natural gas for energy and feedstock in the process.

The European Commission with the Green Deal has set out on an ambitious pathway aiming for a significant reduction in CO_2 emissions by 2030 and carbon neutrality by 2050. At the same time many process or technology specific projects are being initiated by the industrial sector ranging from carbon capture applications (CCU and CCS) to the replacement of fossil fuels with carbon free molecules (e.g. electrolyzer based hydrogen) to serve as feedstock and energy carriers.

Today, industrial clusters in geographical proximity are highly interconnected benefiting from joint infrastructures such as harbours, pipelines, and power grids within countries and across national borders. But what are the infrastructure requirements of the future serving a carbon-neutral chemical industry? Is new infrastructure needed or can existing assets be repurposed, e.g. can the natural gas grid in part be utilised for hydrogen or CO_2 transport and would potential capacities be sufficient to carry the quantities of electrons and molecules needed? How could defossilization pathways for the energy and feedstock supply of large chemical sites look like when based on renewable gases (hydrogen from electrolysis with or without a methanation step, biogas or syngas from biomass) or novel and large-scale processes (methane pyrolysis, CCS)? Which compromises need to be accepted between fossil energy supply and steadily growing supply of renewable energy to favour an acceptably quick transformation?

The research consortium analysed and compared four technically feasible routes to carbon neutrality for the three ammonia sites, taking into account the evolution of key drivers and calculating the CO_2 emission reduction potential and production costs along the four pathways until 2050 and beyond.

The results of the trilateral research collaboration identify challenges shared by all three sites while better understanding individual characteristics for each location. For example, the pathway of steam methane reforming with CCS application has been identified as a cost competitive pathway for all three sites, but it would require the infrastructure for approximately 2.7 million tons per year of CO_2 long-term storage. This potential pathway results in a shared challenge with technical, regulatory, and societal acceptance dimensions in all three countries. On the other hand, harbour or costal locations, such as in Antwerp, may offer future opportunities for molecule imports by transforming shipping terminals or access to large scale offshore parks in the North Sea without in-country grid improvement projects.
The decarbonisation of industrial processes will require site-specific solutions, but the research shows that they need to be developed within an integrated infrastructure in transition. It will be essential to look beyond the spatial limits of an industrial cluster and political borders to make the transition an economic and sustainable success.

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