Clean Hydrogen for Poland’s Decarbonisation

Policy Brief

Poland faces significant challenges in transitioning to a decarbonised energy system, given its historical reliance on coal and the need to diversify away from fossil fuels. To ensure a sustainable, resilient, and just transition, the country must implement a comprehensive, sector-specific plan that will deploy a diverse portfolio of decarbonisation solutions, including electrification, carbon capture and storage, and zero-carbon fuels, including clean hydrogen and its derivatives.

What is clean hydrogen?

Most hydrogen produced today is via steam or autothermal reforming of methane (SMR/ATR) from natural gas, with a smaller percentage produced through coal gasification, and is highly emissions-intensive, globally emitting almost 1 Gt of carbon dioxide per year.

There are several ways to produce ‘clean’ hydrogen where associated greenhouse gas (GHG) emissions are significantly reduced or eliminated entirely. Production pathways include installing carbon capture technologies onto an SMR/ATR facility and controlling upstream methane leakage, or via water-based electrolysis powered by low-carbon energy sources, such wind and solar, nuclear, or other emerging energy options like superhot rock geothermal.

1 Clean hydrogen as a definition here includes both ‘renewable’ and other ‘low-carbon’ hydrogen production pathways, regularly referred to as ‘green’, ‘blue’ and ‘pink’ hydrogen.
Why does Poland need clean hydrogen?

Clean hydrogen can be a critical lever for transitioning Poland to a net zero economy. The country is already the third largest producer of hydrogen in Europe, made almost exclusively from carbon-intensive, unabated steam reforming of natural gas. This hydrogen is used primarily as a crucial feedstock and fuel in Poland’s significant industrial sector, particularly in petroleum refining, petrochemicals, and fertiliser production – sectors that collectively contribute around 14% of national GHG emissions.

Other sectors may also benefit from the application of clean hydrogen where it is not currently used, such as transportation. Poland’s transportation sector contributes almost 18% of total GHG emissions and although a significant proportion will likely be offset by vehicle electrification, some segments face limited decarbonisation options.

Hydrogen demand in Poland could exceed 100 TWh, over 3 million tonnes, by 2040. However, Poland will likely be faced with limited resources to meet this amount entirely through domestic clean hydrogen production.

The national Polish Hydrogen Strategy (PHS), published in 2021, established six initial objectives to 2030 that will kickstart the clean hydrogen economy. The PHS is a commendable first step but requires updating with further granularity on tailored production plans, off-taker prioritisation, and a policy framework of measures that will support streamlining clean hydrogen implementation, particularly in the medium- to long-term (2030-2050).

This policy brief provides five recommendations that can help strengthen the next iteration of the PHS and support Poland in implementing a successful clean hydrogen economy.

Recommendations

1. **Prioritise clean hydrogen off-takers in no regrets sectors**

Given Poland’s limited domestic energy resources for producing its own clean hydrogen - both in terms of natural gas supply and renewable energy capacity - clean hydrogen should be viewed as a precious molecule and prioritised for use in the hardest-to-abate sectors. These sectors, also known as ‘no regrets’ sectors, are often where carbon-intensive hydrogen is used today and where the deployment of other energy- and cost-effective decarbonisation options is not feasible (Figure 1).

The PHS highlights several sectors as priority off-takers for forthcoming clean hydrogen, which includes no regrets segments of heavy industry, power, heating, and transportation. Whilst the PHS lays the foundations to develop Poland’s national clean hydrogen market, the lack of evidence-based off-taker prioritisation (particularly in the short- to medium-term) risks distorting the hydrogen market and limiting supplies to sectors that need it the most. Alternatives for power production and heating supply - such as solar and wind energy, heat pumps, and district heating - might offer better cost, energy and emissions benefits, as well as reduce safety risks.

Poland is therefore encouraged to prioritise deploying clean hydrogen in no regrets sectors so that existing industries can begin to decarbonise without jeopardising their operations. Clean hydrogen provides an essential tool for reducing emissions in certain sectors, but it should not be deployed indiscriminately to all sectors as if every potential end-use has equal merit, particularly considering limited domestic resources.

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3. Hydrogen use in certain settings (e.g., home heating) poses safety risks due to its high tendency for leakage and having an ignition range that is six times that of natural gas.
Poland has the potential to leverage initiatives to build out its clean hydrogen ecosystem in collaboration with no regrets sector off-takers. One example is through establishing Hydrogen Valleys, regionally co-located networks of hydrogen production, distribution, and end-use infrastructure. Such large-scale, full value chain demonstration projects have the potential to build and scale a clean hydrogen network from the bottom up, clustered around heavy industry end-use sectors that need the molecule the most. Poland envisions at least five national Hydrogen Valleys and so far, over 10 Valley agreements have been announced. Policymakers must ensure that no regrets sectors lie at the heart of these developments and are well coordinated across the country to ensure their success.

Figure 1: CATF priority ranking of potential clean hydrogen end use sectors.

### Table: CATF Priority Ranking of Potential Clean Hydrogen End Use Sectors

<table>
<thead>
<tr>
<th>No.</th>
<th>Categories</th>
<th>Example Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No-regrets applications of low-carbon hydrogen</td>
<td>Crude oil refining, NH₃ production, Methanol production, Steel manufacturing</td>
</tr>
<tr>
<td>2</td>
<td>Other potential applications of low-carbon hydrogen</td>
<td>Aviation, Marine shipping, Heavy-duty trucking</td>
</tr>
<tr>
<td>3</td>
<td>Niche applications for low-carbon hydrogen</td>
<td>Power generation, Long-duration energy storage</td>
</tr>
<tr>
<td>4</td>
<td>Applications that lack justification</td>
<td>Residential use, Light-duty vehicles</td>
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Focus on segments of the transportation sector where clean hydrogen is needed the most

In addition to no regrets sectors, clean hydrogen will likely be needed to decarbonise segments of the transportation sector - such as maritime shipping, aviation, and possibly parts of heavy-duty road transport - where electrification will be difficult or infeasible.

In aviation, clean hydrogen will be required to upgrade biomass-based sustainable aviation fuels (bio-SAF), to synthesise jet fuel from hydrogen and captured carbon (synthetic SAF), and, potentially, to power aircraft that directly utilise hydrogen as fuel. However, biomass feedstocks are limited, and synthetic fuel production is at present technically and economically challenging.

Clean ammonia is a strong contender as a sustainable fuel in maritime shipping, so long as it is made from clean hydrogen and does not draw available volumes away from other present-day ammonia applications. Another low-carbon fuel may be methanol and many cargo ships being built today incorporate dual fuel capability to handle a future mix of marine oil and methanol. However, ‘sustainable’ carbon atoms would need to be sourced for the methanol production process to ensure that the fuel is low-carbon, which may be in limited supply.

For road transport, long-haul hydrogen fuel cell vehicles may play an important role alongside battery-electric vehicles in decarbonising trucks and other heavy-duty road vehicles. Implementation in Poland, however, will ultimately be determined by several factors, including cost, fuel and fuelling infrastructure availability and well-to-wheel lifecycle emissions. Other road vehicles, such as light-duty passenger cars, may benefit by prioritising electrification as their primary pathway to decarbonisation, for reasons of cost as well as scalability.

Given its established and sizeable industries across these three highlighted transportation segments, Poland should consider how it will prioritise some clean hydrogen availability for their future decarbonisation as associated hydrogen-based transportation technologies begin to scale.

Implement a technology optionality approach to producing clean hydrogen

The PHS already indicates that it will take a technology optionality approach to its domestic clean hydrogen production. Such an approach will utilise all available clean production pathways to ensure sufficient supply, considering the limited domestic energy resources that Poland – and Europe as a whole – has. For example, SMR/ATR with installed carbon capture has the potential to be scaled quickly compared to electrolytic-based hydrogen, as the reforming technology is more mature and the input energy source is more readily available today. Additionally, using scarce renewable power to produce hydrogen in the short- to medium-term could be counterproductive from a resource deployment perspective, particularly while the national grid still needs to be decarbonised.

Any produced clean hydrogen should be measured against GHG emission reduction merits based on rigorous emissions accounting. CATF’s lifecycle analysis (LCA) tool allows users to calculate and compare different emissions profiles associated with pathways of delivered clean hydrogen, covering production and transportation, to capture emissions across the entire value chain. Poland is encouraged to work with its neighbours, the EU and potential trading partners to implement a collective clean hydrogen certification framework and strong standards so that any clean hydrogen produced in or delivered to Poland is truly low carbon.

Poland must ensure that a technology-optionality approach is effectively implemented, reducing the risk of competition and trade-off between one production technology over another and allowing the clean hydrogen market to scale in a timely and effective manner.

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When setting clean hydrogen targets, Poland should carefully forecast its national hydrogen demand, identifying what share can be met with domestic production and what share will need to be imported. Any shortfall in domestic production should be met by the most cost- and energy-effective methods of import from nearby regions.

CATF analysis\(^8\) concludes that large-scale hydrogen transportation will be challenging, due to the inherent properties of the molecule, and that the most cost-effective and energy-efficient methods of transport will be from nearby countries or regions, either via pipeline or maritime transport of clean ammonia for direct use\(^9\) (such as for use in fertiliser production or as a maritime fuel). Compared to other import methods via ship, such as liquefied hydrogen or liquid organic hydrogen carrier (LOHC), ammonia is much cheaper and more stable to transport via ship and truck. Furthermore, ammonia also already has an established transportation network and value chain, which can be scaled more quickly to accommodate its potential growth for application as decarbonised fuel and feedstock.

Where hydrogen imports are necessary, transportation via pipeline from nearby neighbouring countries is recommended, particularly where import distances are relatively short. Cross-border collaborative projects, such as international Hydrogen Valleys, may help streamline such efforts and mitigate implementation barriers.\(^{10}\)

To avoid costly but ultimately unsuccessful ventures and stranded assets, Poland must carefully assess and select the most efficient pathways for importing hydrogen and ammonia and coordinate closely on international projects before any significant investments are made.

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\(^8\) See: https://www.catf.us/resource/techno-economic-realities-long-distance-hydrogen-transport/

\(^9\) ‘Cracking’ ammonia to liberate pure hydrogen incurs significant energy penalties, due to the process of dehydrogenation, making hydrogen transportation even less efficient and more costly.

\(^{10}\) One Hydrogen Valley example is the ‘Hydrogen Delta’ project, covering a regional heavy industry cluster across Belgium and the Netherlands: https://www.smartdeltasources.com/en/hydrogen-delta
Poland should leverage existing support mechanisms at the EU, national, and regional levels and consider setting up additional mechanisms that will provide support to the most promising clean hydrogen projects. Such projects should cover the development and deployment of the entire clean hydrogen value chain, covering production, transportation, and off-taker deployment. Poland must work closely with EU-level officials to advocate for needed support to develop its clean energy economy as a priority Member State.

Champion projects should be identified and prioritised, mitigating any barriers to accessing such support. For example, any public funding relevant to clean hydrogen development should be open to all forms of hydrogen that are truly low-carbon, based on projects that will move the decarbonisation needle (rather than based on arbitrary colour coding) and scale up the clean hydrogen economy in a timely and efficient manner.

Poland must involve relevant demand-side industries from no regrets sectors in clean hydrogen planning and implementation, and work to build public-private partnerships to ensure offtake and a higher chance of projects reaching a final investment decision (FID).

In addition, Poland must also consider the socio-economic implications of any clean hydrogen project, to build local support and demonstrate regional benefits, including benefits to the local workforce and economy, as well as ensuring that any hydrogen developments deliver environmental benefits, such as improved air quality and water availability and security.

For more information, visit A Vision for Poland’s Clean Energy Transition.

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11 Such as the Innovation Fund (including the EU Hydrogen Bank) and Hydrogen Valleys programme (financed via the Clean Hydrogen Partnership).

12 For example, the EU has earmarked EUR 158 million to partially replace conventional ‘grey’ hydrogen facility with electrolytic hydrogen at a refinery and petrochemicals facility in Gdansk. See: https://www.hydrogeninsight.com/industrial/eu-approves-158m-polish-grant-for-green-hydrogen-plant-that-will-partially-replace-refinery-s-grey-h2/2-1-1433166