EXECUTIVE SUMMARY

SHIELD

Green Hydrogen Use-Cases: **Global realism and Ukrainian relevance**

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This report analyses potential use-cases for green hydrogen (GH_2) in Ukraine to inform the Strategic Hydrogen Integration for Effective Low-Carbon Development (SHIELD) project. This project aims to determine the strategic placement of low-carbon infrastructure for short-term energy security and long-term energy transition in Ukraine, with a focus on hydrogen potential.

GH^2 is a crucial energy carrier for decarbonization which may be relevant to Ukraine's reconstruction and EU accession aspirations. It can be used across industrial, transport, power, and residential sectors.

However, not every use-case is realistic and feasible everywhere. Here we therefore analyse each potential use case for relevance and realism within Ukraine.

Approach

GH_2 use-cases covering fuel and feedstock applications are systematically studied through desktop review of literature and policy. Each is evaluated for global realism and Ukrainian on a five-point scale, visualised from red to green as shown in the table below. The scores for realism and relevance are averaged to give a net importance of including the use-case in SHIELD scenario analysis.

TABLE: **Summary of study results on use-case realism, relevance, and importance for further study.**

Sector	Type	GH_2 Application	Global realism	Ukraine relevance	Further study
Industry	Feedstock	Steel (H2-DRI)			
		Ammonia/Fertilizer			
		E-fuels and petrochemicals			
		Refining processes			
		Others			
	Fuel	Low-temperature heat			
		Medium-temperature heat			
		High-temperature heat			
Transport	Fuel	Cars			
		Trucks			
		Public transport			
		Rail transport			
		Airplanes			
		Ships and maritime sector			
Power	Fuel	Energy shifting and storage			
		Grid balancing and ancillary services			
		Combined heat and power			
		Off-grid and emergency generation			
Residential	Fuel	Residential power & heat supply			
		Heat networks			

Scale: Very unlikely *Unlikely* *Possible* *Likely* *Very likely*

Key findings by sector

1. **Industrial Sector:** GH_2 shows strong potential in high-temperature industrial processes such as steel, glass, and cement production. Ukraine's reconstruction needs and EU accession goals make decarbonizing these industries crucial. Blast furnaces do however dominate Ukrainian steel production, presenting a challenge for GH_2 integration. GH_2-based ammonia and fertilizer production is viable but faces cost barriers. The disruption of fertilizer supply chains due to the conflict highlights the need for domestic production.
2. **Transport Sector:** GH_2 and derivative e-fuels are promising for decarbonization of aviation and shipping. Challenges include infrastructure development to support this and management of chemical properties within vessels and aircraft. EU regulations on sustainable aviation fuels and maritime emissions create a favorable policy environment for Ukraine's adoption. In ground transport, battery electric vehicles currently dominate, but fuel cell electric vehicles show potential for trucking in the medium term. Rail decarbonization is likely to use a mix of hydrogen and electric vehicles across different routes and must be considered given the vital importance of Ukraine's train network.
3. **Power Sector:** GH_2 offers flexibility and resilience for grid management (i.e., balancing and ancillary services) especially with growing renewable energy integration. Electrolysis offers rapid ramp-up and -down, ideal for short-term grid balancing and frequency regulation. Economic viability of this use-case requires value-stacking, combining grid services with hydrogen production for other sectors. GH_2 also enables long-term energy storage to manage seasonal variations in renewable energy supply. It has lower round-trip efficiency compared to batteries which limits viability for short-term storage.
4. **Residential Sector:** GH_2 integration into district heating networks is possible but faces competition from heat pumps. Use of GH_2 in individual home heating has limited practicality due to the higher efficiency of heat pumps for space heating.

Overall assessment

GH_2 holds significant promise for Ukraine, particularly in high-heat industrial processes, fertilizer production, aviation, shipping, and power sector applications. Critical use-cases are identified as fertiliser, direct reduction of iron (DRI) in steelmaking, aviation and maritime fuels, and rail transport. High-temperature heat industrial applications, power applications, and heat networks are also seen as important to study. Other applications, such as e-fuels and petrochemicals, other industrial feedstock applications, trucking, and residential heat could be studied if deemed politically important to the country. Meanwhile, applications in low- and medium-temperature heat, refining, cars, and public transport are unlikely to be feasible in the near future. While cost and infrastructure remain barriers, EU accession goals and the need for energy security and reconstruction present strong drivers for GH_2 adoption.

Recommendations for Further Study

Based on this assessment, GH_2 use-cases are assigned the following priority levels for further study:

- **High:** high-heat industrial applications, steelmaking, fertilizer production, aviation and maritime fuel, rail transport, power applications, heat networks.
- **Medium:** E-fuels and petrochemicals, other industrial feedstocks, trucking, residential heat.
- **Low:** low and medium heat applications in industry, cars, public transport, refining processes.

ACKNOWLEDGEMENTS

The authors receive funding from the Foreign, Commonwealth and Development Office of the UK Government via the Strategic Hydrogen Integration for Effective Low-Carbon Development programme. However, the views expressed herein do not necessarily reflect the UK government's official policies.

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