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# **COOPERATION OPPORTUNITIES IN HYDROGEN PROJECT SUPPORT AND DEVELOPMENT IN V4 COUNTRIES**

Working paper

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# Cooperation opportunities in hydrogen project support and development in V4 countries

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## TABLE OF CONTENTS

Table of contents.....	4
1. Goal of the paper.....	5
2. Strategic priorities of v4.....	6
3. Overview of current hydrogen projects in V4.....	9
4. Points to discuss.....	16

## 1. GOAL OF THE PAPER

This short paper serves as a discussion paper for the internal expert meeting of Ministries of the V4. To complement the online Workshop organized 8 Dec 2021, we build upon the main findings of the open workshop to facilitate discussion and find cooperation opportunities for the V4 countries in the field of hydrogen projects. Hydrogen economy is at an infant stage and often faces a chicken-and-egg problem: namely which part of the value chain should be developed first? Current infrastructure and economic background of the countries may show some comparative advantage and guide the direction of investments. Moreover, V4 countries may find themselves as competitors for EU funding when lobbying for support.

To address these issues, first we identify the strategic priorities of the V4 by reviewing the hydrogen strategies as of November 2021. All V4 countries have prepared their hydrogen strategies so far.

As a second step, we list the current status of hydrogen projects of the V4 based on publicly available hydrogen project databases of ENTSOG and IEA. As projects target various parts of the value chain and are at different level of maturity it is difficult to compare them directly. Nevertheless, the number of projects and their focus at the value chain will show the priorities of promoters, which will be compared with the priorities set out in the hydrogen strategies.

Finally, we formulate points to discuss to start the thinking process.

## 2. STRATEGIC PRIORITIES OF V4

In 2021, the climate ambitions have been slightly braked by the urgent challenges coming from the pandemic situation, which halt being finally expressed in the moderate success of the COP2021 agreement. However, the ambitions in the field of hydrogen were not hold back at the same time, and plenty strategies, commitment and pilot projects have been announced throughout the world. Just some month later than ["A hydrogen strategy for a climate-neutral Europe"](#) has been published by the European Commission, the Visegrad Countries have also announced their plans: [Hungary](#) (May 2021), Slovakia (July 2021), the [Czech Republic](#) (September 2021) and Poland (Nov 2021, however draft published for consultation purposes in January).

### 2.1. PRIORITIES OF HYDROGEN STRATEGIES IN THE V4

Czech Republic:

- Hydrogen production (even from nuclear) is considered unlikely to be economic viable – it is not a priority. Current grey hydrogen + CCS is reality on short term. Long term there will be import need for green H<sub>2</sub>
- Hydrogen consumption: priority for transport sector (city bus; freight and road transport; railway) and chemical industry – 1728 thousand tonne of H<sub>2</sub> by 2050
- Czech potential for the industry: production of components for vehicles and transport infrastructure; hydrogen production equipment (electrolysis and pyrolysis)
- Import/Export: never be a hydrogen exporter due to its geographical location (no significant RES overproduction expected), so it will be necessary to connect to a trans-European hydrogen pipeline system in the future

Hungary

- Production
  - 20,000 t/year low carbon hydrogen production
  - 16,000 t/year green and carbon free hydrogen production
  - 240 MW electrolyser capacity
- Industry
  - 20,000 t/year low carbon hydrogen
  - 4,000 t/year green and carbon free hydrogen
  - Transdanubian and North-Eastern Hydrogen Valley
- Transport
  - 10,000 t/year green and carbon-free
- Energy sector

- 2% blending
- 60 MW downward regulatory reserve capacity

#### Poland objectives

1. Energy sector transformation
  - Hydrogen as energy storage
  - Hydrogen in DH production
2. Transport sector
  - Hydrogen fuelled buses (100-250 by 2025)
  - Hydrogen refuelling stations (32)
  - Hydrogen fuelled trains
  - Aviation and maritime
3. Industry
  - Electrification and switching from fossil fuels to hydrogen in industrial heat processes
4. Production, distribution and storage
  - Low-carbon hydrogen and RES
  - UGS facilities conversion to hydrogen
  - Blending and retrofitting existing pipelines
5. Regulatory environment
  - To be finalized in 2021

#### Slovakia

Strategic document accepted by the Parliament does not indicate priorities or funding. Nevertheless, projects are well-developed.

## 2.2. SUMMARY OF FINANCING MAIN AREAS BASED ON THE STRATEGIES

	CZ	HU	PL	SK
Production, transmission and storage Mn EUR	Numerous support schemes but with general focus, not dedicated to hydrogen only	85-113 (29-30%, whole H2 value chain support)	198 (57%, support for electrolysers)	n.a.
Demand: industry Mn EUR		85-99 (29-26%)	0	n.a.
Demand: transport Mn EUR		127-169 (43-44%)	153 (43%)	n.a.
Demand: buildings Mn EUR		0 (0%)	0	n.a.
Total support Mn EUR		296-380	351	n.a.



## 3. OVERVIEW OF CURRENT HYDROGEN PROJECTS IN V4

Using two publicly available databases, ENSTOG's, hydrogen project visualisation platform<sup>1</sup> and IEA's global hydrogen project database<sup>2</sup> we have compiled a list of projects in the V4. These databases offer a comprehensive view and due to their wider geographical coverage may help to show the strengths and weaknesses of V4 projects.

### 3.1. ENTSOG HYDROGEN PROJECT VISUALISATION PLATFORM

The platform includes more than 300 hydrogen projects located in the EU. Projects are classified in the following categories:

- Retrofitting/repurposing existing infrastructure projects – retrofitting is an upgrade of existing infrastructure that allows the injection of certain amounts of hydrogen into a natural gas stream (blending) while repurposing is converting an existing natural gas pipeline into a dedicated hydrogen pipeline
- Hydrogen at end-use projects – including projects where hydrogen is used in end-use applications (industry, buildings, mobility, and other)
- Integrated hydrogen projects – including projects encompassing the whole value-chain (hydrogen production, transport and end-use)
- Hydrogen production projects – including renewable and low-carbon hydrogen production
- Hydrogen storage projects – including salt caverns, aquifers and depleted reservoirs
- Newly built hydrogen infrastructure projects – including newly built infrastructure for transporting hydrogen

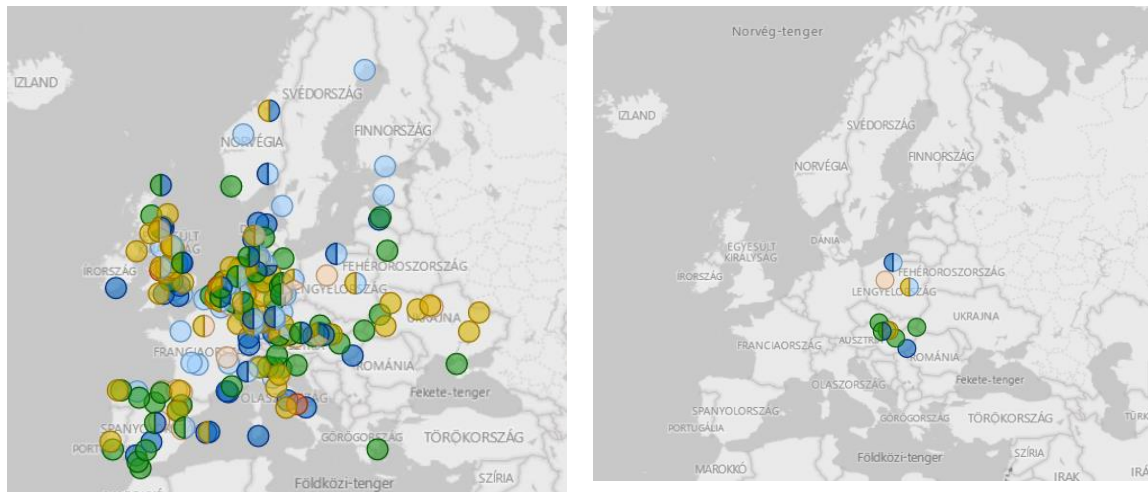
Most projects are located in North-West Europe or South-West Europe. In the V4 region 15 projects were listed out of the total ~300.

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<sup>1</sup> <https://h2-project-visualisation-platform.entsog.eu/>

<sup>2</sup> IEA (2021), Hydrogen Projects Database, <https://www.iea.org/reports/hydrogen-projects-database>

FIGURE 1. HYDROGEN PROJECTS IN EUROPE (LEFT) AND IN THE V4 (RIGHT)



Legend: Retrofitting/repurposing existing infrastructure projects, Hydrogen at end-use projects, Integrated hydrogen projects, Hydrogen production projects, Hydrogen storage projects, Newly built hydrogen infrastructure projects

However, classification is ad-hoc in many instances and may be based on submission of the project promoters without any further control. The database includes name, promoter, location, year of commissioning and a short description of the project. No harmonized data is available on electrolyser capacity, investment cost or support or any quantifiable data.

TABLE 1. ENTSOG LIST OF HYDROGEN PROJECTS IN THE V4

Project name	Country	Promoter	Year	Short description	Sector refitted
Akvamarin	HU	MFGT	2021-2023	2.5 MW electrolyser and hydrogen compressor at Kardoskut UGS	H2 storage
Black horse	CZ-SK-HU-PL	consortium	?	Electrolysers for transport sector, rollout of large scale hydrogen powered trucks, fuelling stations	Integrated H2
Greening of gas	CZ	Net4gas	2018-2029	P2G (0,5MW) hydrogen and bio-methane production and injection into the transmission system.	Retrofitting/re-purposing
Gas to Future	SK	Nafta	?	Storage of H2 and mixtures of H2 in Nafta UGS facilities	H2 storage
GreenH2	SK	Eustream	2021-2023	Production of H2 from PV. Hydrogen blended with NG to fuel compressor station Velké Kapušany	Retrofitting/re-purposing
H2I-T	SK	Eustream	2022-2030	Testing of components of gas transmission grid such as pipes, valves, regulators in relation to material and function.	Retrofitting/re-purposing
H2EU storage	SK	ECO Optima, RAG, Bay-erngas, bay-ernets, OGE, Eustream	2020-2050	H2 from PV and wind produced in UA and transported to DE and AT using retrofitted gas infra/blending.	Integrated H2
Hydrogen valley of Vah	SK	VSWE	?	Production, transport and use of H2 in the region of Váhovce	Integrated H2
Damaslawek storage	PL	Gaz-System	2024-2036	Hydrogen storage in salt cavern to support industry and storage of H2 from offshore RES	H2 storage
Ingrid H2	PL	PgNiG	2022-	Electrolyser based on solar PV	Retrofitting/re-purposing
Green H2	PL	LOTOS	2020-2027	Large-scale electrolyser capacity development	H2 production
Pure H2	PL	LOTOS	2021-	Hydrogen purification unit with distribution and refuelling infra-structure.	H2 production

By simply looking at this classification, a few points may be made at the first glance:

- Slovakian projects prioritize (i) the better use of existing gas infrastructure by retrofitting and hydrogen storage projects (ii) integrated hydrogen projects and hydrogen

valleys. Slovakia aims to have a role of hydrogen transiting country from Ukraine to Austria and Germany building on its historical transit role and experiences.

- Polish projects focus on the hydrogen production and upstream, while making the existing gas infrastructure fit for accommodating hydrogen. Considerable hydrogen production capacity is envisaged.
- Czech projects focus also on the TSO's ability to inject gas in the network.
- Hungarian project focuses on setting up an electrolyser at UGS facility.
- The Black Horse project covering all V4 countries targets hydrogen mobility by setting up electrolysers, fuelling stations and hydrogen powered truck fleet.
- The most projects are located in Slovakia (6) and Poland (5). These projects seem more mature compared to Czech and Hungarian ones. Poland focuses on hydrogen production and switching from coal in its projects. Slovakia aims at building up transit role in the hydrogen infrastructure and setting up hydrogen valleys with integrated supply and demand chains. In the Czech Republic and Hungary projects are not targeting strategic priorities, rather are at the start of building up capacities, knowledge and experiences for further scaling up of hydrogen economies. Black Horse, the only overarching project in the region targets mobility.
- No dedicated hydrogen infrastructure is envisaged in any of the V4 countries.
- No targeted end-use project exists in the V4 (e.g. use of hydrogen in the industry)
- Hydrogen valleys are mentioned in the strategies of all V4 countries, yet only Slovakia develops an actual project
- Hydrogen storage projects are present in Hungary, Poland and Slovakia, but not in the Czech Republic
- Hydrogen retrofitting of gas networks is present in Czech Republic, Slovakia and Poland, but not in Hungary

TABLE 2. CLASSIFICATION OF PROJECTS AND PRIORITIES

	CZ	HU	SK	PL	Total
Retrofitting/ repurposing	1 (Greening of gas Net4gas)	-	2 (GreenH2eust- ream, H2-IT eustream)	1 (Ingrid H2 PgNiG)	4
Hydrogen end- use	-	-	-	-	0
Integrated pro- ject	2 (Black Horse, Hydrogen Eagle)	1 (Black Horse)	4 (Black Horse, H2EU storage, Hydrogen valley of Vah, Hydrogen Eagle)	2 (Black Horse, Hydrogen Eagle)	9
Hydrogen pro- duction	-	-	-	3 (Green H2 LOTOS, Pure H2 LOTOS, Konin power plant)	3
Hydrogen sto- rage	-	1 (Akvamarin)	1 (Gas to Future Nafta)	1 (Damaslawek Gaz- system)	3
Newly built hydrogen infra- structure	-	-	-	-	0
Total	3	2	7	7	19

### 3.2. IEA'S GLOBAL HYDROGEN PROJECT DATABASE

Compared to ENTSOG, the IEA database is more detailed and contains data on planned electrolyser capacity, as well as a more nuanced classification of hydrogen projects by end-use sector. The 2021 October edition of the database contains nearly 1000 projects, of which 60% are located in the wider EU (EU27+UK+NO+CH), and 22 in the V4. All projects which are included in ENTSOG's interactive map are part of the IEA database, and the list is complemented by other upstream projects.

V4 projects focus on mobility area (63%) followed by grid injection (19%). The European and all projects have industrial sector (Refining, Ammonia, Methanol, Iron&Steel and other industry) with a strong emphasis (30%), while this is less focused in the V4 (5%). Grid injection

projects are more pronounced (19% in the V4 versus 12% in the EU). Power sector integration is more important in the EU (6% in the V4 versus 15% in the EU).

It is apparent that industry sector use of hydrogen (which is a driving force in Europe) has not started yet in the V4.

FIGURE 2 AREAS OF HYDROGEN PROJECTS

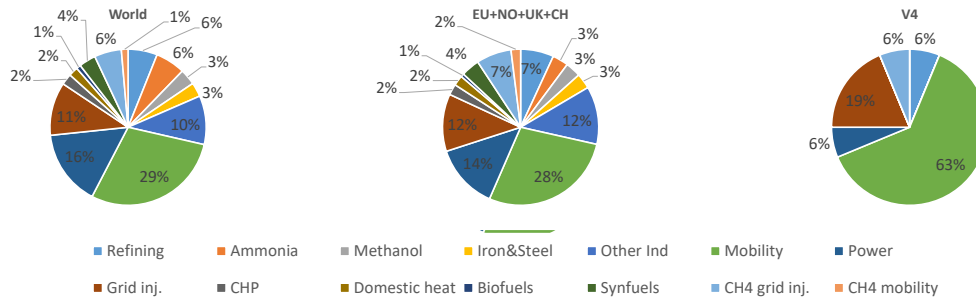


TABLE 3. LIST OF V4 PROJECTS IN IEA HYDROGEN PROJECT DATABASE

Project name	Co.	Date online	Status	End-use sector	Technology	Normalised capacity			IEA zero-carbon normalized capacity [nm <sup>3</sup> H <sub>2</sub> /hour]
						MWel	nm <sup>3</sup> H <sub>2</sub> /h	kt H <sub>2</sub> /y	
Aquamarine	HUN	2023	FID	Power	Other Electrolysis	2.5	556	0	556
Matra power plant	HUN		Concept	-	Other Electrolysis				0
Solar Global group hq, phase 1	CZE	2021	Under cons.	-	Other Electrolysis	0.7	156	0	156
Solar Global group hq, phase 2	CZE		Feasibility study	-	Other Electrolysis				0
Greening of Gas (GoG) - Net4Gas	CZE	2023	Feasibility study	-	Other Electrolysis	0.45	100	0	100
Hydrogen Eagle (Litvínov)	CZE	2030	Feasibility study	Mobility	Other Electrolysis	26	5778	5	5778
Hydrogen Eagle (Spolana)	CZE	2030	Feasibility study	Mobility	Other Electrolysis	18	4000	3	4000
Hydrogen Eagle (Spolana)	CZE	2030	Feasibility study	Mobility	Other Electrolysis	36	8000	6	8000
IPCEI Black Horse (40 electrolysis production sites)	POL CZE SVK HUN	2030	Concept	-	Other Electrolysis	674	149813	117	149813
G2F - Gas to Future, phase 1	SVK	2025	Feasibility study	Grid injection	Other Electrolysis	84	18667	15	18667
G2F - Gas to Future, phase 2	SVK	2035	Concept	Grid injection	Other Electrolysis	248	55111	43	55111

Hydrogen Eagle (various hubs)	SVK	2030	Feasibility study	Mobility	Other Electrolysis	60	13333	10	13333
Tauron CO2-SNG	POL	2019	Operational	CH4 grid injection	Other Electrolysis	0.081	18	0.0	18
PGNiG - INGRID	POL	2022	Feasibility study	Grid injection	Other Electrolysis				
Grupa Lotos refinery	POL	2025	Feasibility study	Refining	Other Electrolysis	100	22222	17	22222
Konin Power Plant, phase 1	POL	2022	Under cons.	Mobility	PEM	2.5	481	0	481
Hydrogen Eagle (various hubs)	POL	2030	Feasibility study	Mobility	Other Electrolysis	100	22222	17	22222
Hydrogen Eagle (various hubs)	POL	2030	Feasibility study	Mobility	Other Electrolysis	10	2222	2	2222
Hydrogen Eagle (various hubs)	POL	2030	Feasibility study	Mobility	Biomass		19240	15	19240
Konin Power Plant, phase 2	POL	2022	Under cons.	Mobility	PEM	2.5	481	0	481
Konin Power Plant, phase 3	POL		Feasibility study	Mobility	PEM	45	8654	7	8654
Hydrogen Utopia waste-to-plastic	POL	2022	Feasibility study	-	Biomass		1404	1	1404

## 4. POINTS TO DISCUSS

- I. Is there a need for joint project development, or should V4 countries do their own work in their hydrogen market?
  - PRO
    - Information sharing and new R&D results help to develop every V4 market
    - Joint project submission for IPCEI and European funds
    - Harmonized regulation helps trade and cooperation in the V4
    - No parallel capacities (e.g. no two competing hydrogen refuelling networks)
  - CON
    - V4 countries may have differing economic and regulatory background which pre-determines different hydrogen sector development pathways
    - Competition for EU funding
    - Hydrogen and other strategies set out differing goals and this may hamper the cooperation
  
- II. What are the opportunities for cooperation envisaged by Ministries?
  - On which part of the hydrogen value chain do Ministries see possibilities for cooperation?
    - Hydrogen production: joint development of production capacities
    - Hydrogen transport on retrofitted gas infrastructure: V4 countries have historically been in a transit role, and this experience and know-how may be utilised in hydrogen transport as well.
    - Hydrogen end-use: promotion of green hydrogen in industry, transport, power&heat or other sectors (e.g. setting up refuelling stations and infrastructure may create a business case for electrolyser capacity development)
    - Hydrogen storage: utilising the well-developed UGS capacities of the region. Is there a way for cooperation?
    - Dedicated hydrogen infrastructure? If yes -> Planning hydrogen pipeline routes
  - Information sharing, e.g.

“Recent developments in the field of IPCEI Hydrogen on 15th of February, a “match making” event took place between the V4 countries, which helped to establish bilateral relationships between companies interested in IPCEI projects.

6 Hungarian presenting companies participated (MVM, MOL, Tungfram, Waberer’s, Horge Technologies, Linde Kft.) and another 10 listeners. A similar number of



participants took part from Slovakia, Poland and the Czech Republic, but from there specific project ideas were presented, while Hungarian participants mostly plan to join existing initiatives.”<sup>3</sup>

- III. What are the opportunities for cooperation envisaged by project promoters?
- How should projects relate to existing hydrogen cooperations? (e.g. TSOs: European Hydrogen Backbone<sup>4</sup>, DSOs: Ready4H2<sup>5</sup>, European Clean Hydrogen Alliance<sup>6</sup>)

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<sup>3</sup> <https://nkfi.gov.hu/for-the-applicants/innovation-ecosystem/ipcei-project/about-projects>

<sup>4</sup> <https://gasforclimate2050.eu/>

<sup>5</sup> <https://www.ready4h2.com/>

<sup>6</sup> [https://ec.europa.eu/growth/industry/strategy/industrial-alliances/european-clean-hydrogen-alliance\\_en](https://ec.europa.eu/growth/industry/strategy/industrial-alliances/european-clean-hydrogen-alliance_en)