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HyEfRe

D.2.2.1 Economic Framework assessment report

Report

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INVOLVED PARTNERS

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1	Landshut University of Applied Sciences	Deutschland (DE)
2	Mazovia Energy Agency	Polska (PL)
3	Regional Development Agency of South Bohemia – RERA	Česko (CZ)
4	Energieinstitut an der Johannes Kepler Universität Linz	Österreich (AT)
6	Energy Institute Hrvoje Požar	Hrvatska (HR)
7	HyFuture GmbH	Deutschland (DE)
8	Energy Agency of Savinjska, Šaleška and Koroška Region	Slovenija (SI)
9	South-Transdanubian Regional Innovation Agency	Magyarország (HU)
11	WeEurope Srl SB	Italia (IT)

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1. General information

This report evaluates assessment of economic and financial conditions for hydrogen implementation and waste heat usage. Through the evaluation of regional/national financing schemes, financial incentives, economic inefficiency, prices and price interdependencies, the report will identify the economic conditions for hydrogen projects including an assessment of good business practices. Based on the results, business models for hydrogen implementation (*Act.2.4 Development of business models)* will be developed.

2. Introduction

2.1. Context of the HYEFRE Project

The HYEFRE project promotes sector coupling by integrating hydrogen into renewable energy systems, aiming to replace fossil fuels and achieve a decarbonized economy. Key project goals include:

- Supporting planning and decision-making for green hydrogen projects in 5 CE regions (Work Package 1);
- Improving social, regulatory, and economic frameworks to support hydrogen implementation and industry business models (Work Package 2);
- Establishing 8 hydrogen ecosystems and fostering collaborative networks for joint actions (Work Package 3).

2.2. Objectives of the report and expected results

The main objective of the report is **to support the development of business models for hydrogen implementation,** starting from collection and analysis of the legal policies framework of the country of each partner.

Specific objectives of the report are:

- To evaluate regional/national financing schemes and financial incentives.
- To assess economic and financial conditions for hydrogen implementation and waste heat usage.
- To develop business models for hydrogen implementation (*Act.2.4 Development of business models)*.

The main expected results are:

- Identification of the main critical economic issues.
- Evaluation of good business practices.
- Proposal of recommendations to improve the economic and financial sustainability of projects.

3. Policy assessment of good practices

This chapter presents of a collection and a critical analysis of relevant policies for the implementation of hydrogen projects, starting from the findings of document *D211 Policy Framework Assessment Report* and integrating insights from local contexts provided by the partners.

3.1. Policy collection: insights from D211 and questionnaires

Below a description of key regulatory, economic, and operational measures highlighted in *D211 Policy Framework Assessment Report* focusing and from the annexes questionnaires on the 3 aspects described below.

3.1.1. Financial incentives for hydrogen

COUNTRY	FINANCIAL INCENTIVES FOR HYDROGEN
Germany	**National Hydrogen Strategy (NWS)**: Launched in June 2020, the NWS outlines Germany's plan to invest €9 billion in hydrogen projects, focusing on production, infrastructure, and research. This includes €7 billion for domestic hydrogen economy development and €2 billion for international partnerships **Important Projects of Common European Interest (IPCEI):** Germany is actively participating in IPCEIs, aiming to fund large-scale hydrogen projects. The federal government and states plan to support 62 such projects with over €8 billion, intending to trigger €33 billion in private investment **KfW Development Bank Programs:** The KfW Development Bank offers loans and grants to support hydrogen innovation and industrial applications, contributing to the advancement of hydrogen technologies in various sectors. **Carbon Contracts for Difference (CCfD):** Germany has introduced CCfDs to support low-carbon hydrogen by covering the cost difference compared to fossil fuels. In October 2024, the government announced the first CCfDs, providing up to €2.8 billion to 15 companies to reconfigure their manufacturing processes to reduce CO_2 emissions.
Italy	Italy actively participates in the Important Projects of **Common European Interest (IPCEI)** on hydrogen. In particular, the IPCEI Hydrogen 1 (Hy2Tech) supports research and development activities across the hydrogen value chain, with funding provided to six companies and two research institutions in Italy. Additionally, the Ministry of the Environment and Energy Security (MASE) has launched a public consultation to define tariff incentives for renewable hydrogen production, aiming to stimulate investments in industrial and transport sectors. Italy has recently developed the national hydrogen strategy 2024. Main Goals: • Decarbonization: hydrogen will be used in hard-to-abate sectors, contributing to emissions reductions in industries such as steel, cement, heavy transport, shipping and aviation.

	• Energy integration: fostering the creation of an integrated, resilient and flexible energy system, with hydrogen serving as both an energy carrier and storage tool. • Industrial development: strengthen the national hydrogen supply chain to foster technological innovation and employment, consolidating Italy's role in the European context. • Energy security: diversify energy supply sources, reducing dependence on fossil fuels. • Geopolitical role: positioning Italy as a strategic hub in the Mediterranean for the import-export of hydrogen and its derivatives.
Austria	Austria has outlined a **National Hydrogen Strategy 2022** that includes financial incentives for hydrogen production and utilization projects, particularly in the industrial and transport sectors. Key aspects are: • Replace fossil-based hydrogen with climate neutral hydrogen in energy intensive industries: 80% until 2030. • Install 1GW of electrolyser capacity by 2030. • Create a supporting framework for the production of renewable hydrogen. • Establish the production of hydrogen as integral part of the energy system. • Develop a targeted hydrogen infrastructure. • Enhance international partnerships for climate neutral hydrogen. • Strengthen the innovation and technology potential in Austria through focused development of hydrogen technologies.
Poland	Poland has adopted a **National Hydrogen Strategy 2030 (2024 outlook)** that includes financial support measures for the development of hydrogen-related technologies, aiming to reduce emissions and promote innovation in the energy sector. The Polish Hydrogen Strategy (PHS) identifies six specific objectives: • Implementation of hydrogen technologies in the power and heating sectors; • Use of hydrogen as an alternative fuel in transport; • Support for the decarbonisation of industry; • Production of hydrogen in new installations; • Efficient and safe transmission, distribution and storage of hydrogen; • Creation of a stable regulatory environment. The implementation of the PHS objectives will contribute to accelerating the decarbonisation process in the most energy-intensive sectors. Its provisions will enable the environmentally friendly production of hydrogen on an industrial scale and the gradual pursuit of a zero-emission economy in Poland. It will support the development of individual regions of Poland by, among other things, creating hydrogen valleys in them, which will allow the construction of a value chain related to the hydrogen economy, such as the production, transport, storage and final use of hydrogen in industry. The Strategy also defines horizontal activities concerning

the utilisation of Polish research and development potential in the field of hydrogen technologies and the development of hydrogen-powered vehicle production plants and components necessary for the hydrogen economy. PHS supports all methods of low-and zero-emission hydrogen production, with an emphasis on: the water electrolysis process, biomass gasification, fermentation or pyrolysis technology, biogas steam reforming, biomethane steam reforming, gasification, thermal processing or pyrolysis of waste, waste gases, steam reforming of hydrocarbons with CO2 capture and storage (CCS/CCU) technology, coal gasification with CCS/CCU technology, IGCC and IGFC technology.

The indicators for achieving the objectives of the National Energy Strategy by 2030 will be:

- Installed capacity of low-carbon hydrogen production facilities: 50 MW by 2025 and 2GW by 2030;
- Number of hydrogen valleys: at least 5;
- Number of hydrogen buses in use: 100-250 by 2025 and 800-1000 by 2030;
- Number of hydrogen stations: min. 32 by 2025;
- Conclusion of the Sectoral Agreement for the Construction of a Hydrogen Economy (concluded on 14.10.2021);
- Creation of the Hydrogen Valleys Innovation Ecosystem;
- Creation of the Hydrogen Technology Centre.

The **National Fund for Environmental Protection and Water Management (NFOŚiGW)** is also involved in financing the hydrogen economy. Among the programmes of the National Fund for Environmental Protection and Water Management (NFOŚiGW), there are activities related to the support of projects related to the purchase of hydrogen vehicles under the 'Green Public Transport' programme.

Another programme in which funds were available for hydrogen-related projects was the **'Support for electric vehicle charging and hydrogen refuelling infrastructure'** programme with a budget of PLN 870 million.

The currently available funding is related to the implementation of the **National and Resilience Recovery Plan instrument by Bank Gospodarstwa Krajowego.** Investments in hydrogen technologies are being financed, and the programme provides non-repayable support for projects related to the production, storage and transport of hydrogen. The budget for these investments is 640 million euros and is part of a larger pool allocated to rebuilding the economy after the pandemic. Installations with a capacity of 20 MW or more will be eligible for support.

Modernisation Fund managed by the **National Fund for Environmental Protection and Water Management**, which will also offer grants for hydrogen-related investment projects. Companies planning to build a plant with a capacity of at least 1 MW will be able to apply for support. The planned budget for this programme is 5 billion PLN. On 10 January 2025, public consultations were completed to determine the details of the new programme.

Czech Republic	The **Hydrogen strategy of the Czech Republic** can be divided into three phases: local islands (2023-2030), global bridges (2027-2050) and new technologies (2040-2060). The 1st phase LOCAL ISLANDS aims to create decentralized system of electrolysers with capacity of at least 400 MWe that will be able to produce approximately 20.000 tons of RFNBO hydrogen annually. This set goal should be met until the year 2030. The 2nd phase GLOBAL BRIDGES aims to co-create a system of linear structures that will be able to import cheaper hydrogen from abroad. Two main hydrogen pipelines are now under consideration: first one from Sachsen, Germany (Czech German Hydrogen Interconnector) and second one from west Ukraine through Slovakia (Central European Hydrogen Corridor). Both projects are expected to be completed by 2030. The 3rd phase NEW TECHNOLOGIES plans to use future technologies for the production of hydrogen, such as geothermal energy or new generation of nuclear reactors suitable for producing cheap hydrogen using high-temperature electrolysis. Due to the difficult-to-predict technological, political and legislative developments, the goals of the Hydrogen Strategy are now focused primarily on the time horizon until 2030. Main overall goes of the strategy are: • Build at least 400 MWe of electrolyser capacity with priority by 2027, until 2030, and ensure appropriate support programs; • By 2025, ensure simplification and acceleration of related processes: environmental impact assessment, building law and acceleration zones; • By the end of 2024, analyse and adjust subsidy titles necessary for the development of the hydrogen economy; • By the end of 2024, create conditions for the emergence of hydrogen valleys, especially in transforming coal regions; • By the end of 2024, announce specific calls for support for the development of the hydrogen valley concept and the application of comprehensive application chains of hydrogen technologies, in cooperation with emerging hydrogen valleys, especially in transforming coal regions; • By the end of 2024, create conditions and ensure full cooperation of all components of the central state administration with the aim of accelerating, according to the needs of emerging hydrogen valleys, especially in transforming coal regions, the preparation of development projects and the activation of implementation processes of specified projects; • By 2025-2026, create a comprehensive legislative and regulatory framework for the hydrogen economy, including a framework for guarantees of origin, certificates, technical standards, etc.;

	• By 2030, repurposing 2 branches of the gas transmission system (Lanžhot – Brandov, Brandov – Waidhaus) and strengthening the role of the Czech Republic in the area of hydrogen transit transport; • By 2025, analyse the method and form of repurposing the gas distribution infrastructure; • In the 2024-2028 horizon, prepare the gas infrastructure for a blend of hydrogen and natural gas, in accordance with the requirements of European legislation and according to the results of related analyses; • In the 2026-2028 horizon, analyse the possibilities and technical feasibility of storing hydrogen in existing storage tanks, or other possibilities for storing hydrogen; • Ensure the fulfilment of the objectives of the NAP CM in the field of hydrogen mobility: support for the purchase of hydrogen road and rail vehicles, development of hydrogen public transport, in a coordinated manner with the construction of a backbone network of hydrogen filling stations and the development of mobile filling stations; • Prepare, as necessary, in the context of the Export Strategy, trade missions for Czech companies and cooperate with foreign partners in the field of hydrogen technologies and hydrogen production. This should be done in cooperation with the CzechTrade agency and its foreign offices, with the Czech Republic's embassies and, if necessary, the CzechInvest agency; • Prepare an awareness campaign for companies and launch related information websites; • Support education and research in the field of hydrogen technologies, with particular emphasis on applied research.
Slovenia	There is no specific legal framework established in Slovenia, that would regulate the areas of green hydrogen infrastructure development/hydrogen policy in general. Such acts have not yet been adopted in the Republic of Slovenia. While there is no dedicated national hydrogen strategy, Slovenia has included hydrogen-related goals in its **National Energy and Climate Plan**, providing incentives for industrial decarbonization and the development of large-scale electrolysers. Slovenia has taken a significant step forward in the development of clean hydrogen technologies by signing a cooperation memorandum with the **EU Clean Hydrogen Partnership**. This collaboration aligns with the nation's renewable energy targets and reinforces its commitment to advancing the North Adriatic Hydrogen Valley project.
Hungary	Hungary has launched initiatives to promote hydrogen as an energy carrier, offering financial incentives for projects focused on green hydrogen production and its application in the transport sector: • Implementation of developments for the conversion of carbon-free, surplus electricity into gas energy (hydrogen, biomethane) through innovative technologies (2020-3.1.2-ZFR-KVG);

	• RRF financed national laboratory project, focusing on renewables: RRF-2.3.1-21-2022-00009; • Green Bus Programme (support includes electric and hydrogen powered local buses); • Green Truck Programme (support includes hydrogen production, hydrogen vehicles, and hydrogen refuelling); • Relevant calls of the Environmental and Energy Efficiency OP Plus; • Economic Development and Innovation OP Plus; • REPowerEU Plan planned investment programmes; • Building green economic manufacturing capacity; • Use of green technologies; • Hydrogen investments. In 2021 Hungary launched the **National Hydrogen Strategy 2021** or the introduction of clean hydrogen and hydrogen technologies to the domestic market and for establishing background infrastructure for the hydrogen industry. Main objectives are: • Production of large volumes low-carbon and decentralized carbon-free hydrogen; • Decarbonisation of industrial consumption, partly with hydrogen; • Green transport; • Electricity and (natural) gas support infrastructure.
Croatia	The **National H2 Strategy** outlines opportunities for clean hydrogen utilization within four strategic goals and defines performance indicators for these goals. The key strategic goals for hydrogen production in Croatia by 2050 are as follows: - Increasing renewable hydrogen production: the aim is to scale up hydrogen production from renewable energy sources, reducing dependence on fossil fuels and improving energy self-sufficiency. By 2030, 70 MW of electrolyser capacity is planned, which is expected to rise to 2,750 MW by 2050. - Maximizing the potential of renewable energy sources for hydrogen production: the Strategy seeks to maximize hydrogen's share in total energy consumption, contributing to the stability of the power system. By 2030, hydrogen is projected to account for 0.2% of total energy consumption, increasing to 11% by 2050. - Increasing the use of hydrogen: the Strategy promotes hydrogen adoption across various sectors, including industry, transport, and energy, to reduce CO2 emissions and support economic decarbonization. By 2030, 15 hydrogen fuel stations are planned, with the number increasing to 100 by 2050. - Encouraging the Development of Science and Research in Hydrogen Technologies: the Strategy emphasizes the importance of advancing science, research, and innovation in hydrogen technologies. By 2030, the

	goal is to achieve five patents related to the hydrogen-based economy, increasing this number to 50 by 2050. Key documents: - Croatian Hydrogen Strategy until 2050 (OG No. 40/2022); - Energy Strategy of the Republic of Croatia; - Study of the Development Plan and Implementation of the Croatian Hydrogen Strategy until 2050 - National Energy and Climate Plan (NECP); - The National Recovery and Resilience Plan 2021-2026; - National Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG No. 13/2021); - Strategy for Low-Carbon Development of the Republic of Croatia until 2030 with a view to 2050 (OG No. 63/2021); - Energy Development Strategy of the Republic of Croatia until 2030 (OG No. 25/2020); - Law on Biofuels for Transport (OG, No. /09, 145/10, 26/11, 144/12, 14/14, 94/18 and 52/21); - Law on the Deployment of Alternative Fuels Infrastructure (OG No. 120/16 and 33/22); - Law on Renewable Energy Sources and High-Efficiency Cogeneration (OG No. 138/21 and 83/23).

Table 1: financial incentives for H2

3.1.2. Regulations related to waste heat utilization

COUNTRY	REGULATION RELATED TO WASTE HEAT UTILIZATION
Germany	**German Energy Act (EnWG):** The EnWG supports sector coupling, enabling the integration of waste heat into hydrogen production processes. This legislative framework facilitates the efficient use of energy across sectors. **Federal Immission Control Act (BImSchG):** This act regulates industrial emissions, impacting waste heat recovery projects. It sets standards to control pollution, thereby influencing the implementation of waste heat utilization in hydrogen production. **Renewable Energy Sources Act (EEG 2023):** The EEG 2023 offers incentives for green hydrogen production using renewable-based electricity, promoting the use of renewable energy sources in hydrogen generation
Italy	Italian law does not impose explicit obligations for the utilization of waste heat. However, the Environmental Code encourages energy efficiency measures and the adoption of practices that reduce environmental impact, which can encompass the recovery and use of waste heat. In Italy, the utilization of waste heat is primarily governed by **Legislative Decree No. 152/2006, known as the Environmental Code**. This comprehensive legislation outlines the country's environmental policies, including those related to energy efficiency and the recovery of waste heat.

	Italian national legislation does not provide a specific definition for "waste heat." Consequently, Italy adheres to the definition outlined in Article 2(9) of the Renewable Energy Directive (Directive [EU] 2018/2001), which defines waste heat and cold as "unavoidable heat or cold generated as by- products in industrial or power generation installations, or in tertiary sector, which would be dissipated unused in air or water without access to a district heating or cooling system." Regarding cost-benefit analyses, Article 14 of the Energy Efficiency Directive (Directive 2012/27/EU) requires member states to conduct comprehensive assessments of the potential for high-efficiency cogeneration and efficient district heating and cooling. This includes evaluating the utilization of waste heat. While Italy has transposed this directive into national law, specific obligations to perform cost-benefit analyses concerning waste heat potentials are not explicitly detailed in the Environmental Code.
Austria	Austrian policies encourage the integration of waste heat into district heating systems, supporting projects that enhance energy efficiency through the use of residual heat sources. **Hydrogen Promotion Act (Wasserstoffförderungsgesetz, WFöG):** enacted on July 4, 2024, this law provides the legal basis for funding the construction and operation of facilities producing renewable hydrogen of non-biological origin. It introduces a competitive bidding mechanism, allocating up to €820 million between 2024 and 2026 in the form of fixed premiums per unit of renewable hydrogen produced. **Renewable Gas Act (Erneuerbare-Gase-Gesetz, EGG):** approved by the Council of Ministers on February 21, 2024, and submitted to parliament, the EGG aims to expand domestic renewable gas production, including green hydrogen. It mandates that gas suppliers ensure a certain percentage of the gas supplied to customers comes from renewable sources, with a target of at least 7.5 terawatt-hours of green gas fed into the Austrian gas grid annually by 2030. The Act was not passed yet. **Renewable Energy Expansion Act (Erneuerbaren-Ausbau-Gesetz, EAG):** implemented to accelerate the growth of renewable energy sources, the EAG includes provisions for investment grants supporting the construction of plants that convert renewable electricity into renewable hydrogen or synthetic gases. On June 26, 2024, the draft of the EAG Investment Subsidies Ordinance for Hydrogen was submitted for review. **Hydrogen Strategy for Austria**: developed jointly by the Federal Ministry of Labour and Economy and the Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology, this strategy lays the foundation for building an innovative hydrogen economy in Austria. It sets goals such as establishing 1 GW of electrolysis capacity by 2030 and forming international partnerships to develop suitable hydrogen infrastructure. Additional national funding mechanisms for hydrogen research projects, including support for mobility and industry are available.
Poland	Poland has introduced regulations favouring waste heat utilization, particularly in district heating networks, as part of efforts to increase energy efficiency and reduce reliance on fossil fuels. **Act of 21 November 2024** amending the Energy Law introduced new regulations for the hydrogen sector in Poland and is part of a legislative package referred to as the Constitution for Hydrogen. The changes to the energy law that came into force on 20 January 2025 should be of key importance for the development of the hydrogen economy in Poland through:

	• the introduction of a stable regulatory framework: ensuring certainty for investors should accelerate investment decisions in hydrogen infrastructure and projects. In some cases, the requirement to obtain a licence or certification will lengthen the investment process. • infrastructure development: regulating the transmission, distribution and storage of hydrogen will enable the creation of a comprehensive hydrogen system that will be compatible with gas and electricity systems. • support for small installations: definitions and regulations for small storage installations support local initiatives based on renewable energy sources, which can increase the availability of hydrogen in rural and industrial regions. • synergies in the energy system: cooperation between gas, electricity and hydrogen system operators will enable the efficient integration of hydrogen into the existing energy infrastructure. • certification and transparency: the introduction of certificates for renewable and low-carbon hydrogen promotes the development of a market that complies with EU requirements and enables international trade. **Act of 21 November 2024** amending the Energy Law Act and certain other acts (Journal of Laws of 2024, item 1881). **Energy Policy of Poland** until 2040 (EPP2040). **Poland's National Energy and Climate Plan** for the years 2021-2030 (NECP) **Strategy for Responsible Development** for the period up to 2020 (including the perspective up to 2030).
Czech Republic	In the Czech Republic, there is currently no single comprehensive law that would exclusively regulate all aspects of hydrogen use. However, it is affected by several existing legal regulations and strategic documents, and active work is being done to create a more comprehensive legislative framework. Key legal documents: • **Energy Act (No. 458/2000 Coll.):** an amendment to this Act, effective from 1 January 2024, included hydrogen among the gases that can be distributed through the gas network. Hydrogen is thus placed on an equal footing with natural gas within the distribution infrastructure. The Act allows for both a mixture of hydrogen and natural gas (up to 20%) and the distribution of pure hydrogen. • **Act on Fuels (No. 311/2006 Coll.):** this Act defines hydrogen as an alternative fuel and regulates the conditions for the sale and distribution of fuels, which also applies to hydrogen as a fuel for vehicles. • **Air Protection Act (No. 201/2012 Coll.):** this Act transposes the RED III Directive, which introduces obligations for fuel suppliers regarding the minimum amount of renewable fuels of non-biological origin (including hydrogen) and for industrial hydrogen consumers regarding the share of renewable hydrogen. • **Act on Supported Energy Sources (No. 165/2012 Coll.):** this Act regulates guarantees of origin of energy, which also applies to hydrogen produced from renewable sources. Implementing Decree No. 328/2022 Coll. on guarantees of origin of energy further specifies this.

	• **Pressure equipment:** the use of hydrogen, in particular its storage and transport, falls under the legal regulations relating to pressure equipment, such as Decree No. 18/1979 Coll., which determines reserved pressure equipment, and related technical standards (e.g. ČSN 07 8304, ČSN 69 0012). • **Regulation (EC) No 79/2009 of the European Parliament and of the Council**: this Regulation concerns the type-approval of hydrogen-powered vehicles. Strategic documents: • **Hydrogen Strategy of the Czech Republic** • **National Recovery Plan:** the update of the Hydrogen Strategy of the Czech Republic is part of the reforms within the framework of the implementation of the National Recovery Plan.
Slovenia	Slovenia supports waste heat utilization through policies that incentivize companies to integrate heat recovery systems into their production processes. **ZIAG** - Act on infrastructure for alternative fuels and promoting the transition to alternative fuels in transport: a detailed action plan to promote the transition to alternative fuels for transport and the establishment of the relevant infrastructure shall be drawn up, which shall also be coordinated with strategic plans in the field of hydrogen production and the development of infrastructure for the production, distribution and use of hydrogen. **ReNPRP30** - Resolution on the national programme for the development of transport in the republic of Slovenia for the period up to 2030: the national program within measure Ro.35 foresees the following sub-measure among the many measures for infrastructure for alternative fuel sources: »publicly accessible hydrogen supply points« **Strategy for the development of transport in the Republic of Slovenia until 2030:** the Directive requires Member States to adopt their own strategy in this area, namely in relation to passenger cars for electric and CNG and hydrogen vehicles. Market development strategy for the establishment of an adequate infrastructure for alternative fuels in the transport sector in the Republic of Slovenia **Action programme for alternative fuels for transport 2022 and 2023.** **NEPN - Comprehensive National Energy and Climate Plan** **Energy law - EZ2: rticle 115 of the Energy Act (EZ-1)** provides that investment projects in electricity generation from renewable energy sources, energy storage, sources of flexibility of the electricity system (including hydrogen technologies) and energy utility infrastructure that promotes the connection of these projects do not require an overall return on investment of 4% or more for the assessment of economic viability to be positive. **Electricity supply act**: this Law establishes the rules for the functioning of the electricity market, the production, transmission, distribution, storage and supply of electricity, the rights and protection of final consumers, the methods and forms of performing public utility services in the field of electricity transmission and distribution and the electricity market, the principles and measures for achieving a reliable supply of electricity, and regulates the measures for preventing energy poverty and other issues related to the supply of electricity. **Energy efficiency act** **Gas supply act**

	Act on the promotion of the use of renewable energy sources: this law regulates the implementation of the policy of the State and municipalities in the field of the use of renewable energy sources, sets a binding target for the share of energy from renewable sources in the gross final consumption in the Republic of Slovenia,

Hungary	Hungary has adopted measures encouraging the use of waste heat, particularly by supporting projects aimed at energy efficiency improvements in industries.
	
	Hungary's National Hydrogen Strategy (NHS) is highly aligned with EU policies like the European Green Deal, the Fit for 55 packages, and the REPowerEU initiative by focusing on green hydrogen production, infrastructure development, and regional cooperation. The first three priority objectives of the NHS directly contribute to Green Deal's carbon neutrality target by 2050. Besides, Hungary aims to develop the infrastructure for hydrogen, integrating it into the energy grid and boosting its use in transportation and industry, supporting EU goals of creating a more interconnected and decarbonized energy system. This is mainly supported by priority objective 4, which therefore contributes to the achievement of the EU aims to reduce emissions by at least 55% by 2030 with hydrogen playing a key role in decarbonizing energy systems. By the green hydrogen production targets (priority objective 1) the NHS supports the achievement of EU 's Hydrogen Strategy target to scale up green hydrogen production, by producing 10 million tons of renewable hydrogen by 2030. The Hungarian policy also promotes hydrogen fuel cell vehicles (buses, trucks, and trains), in line with EU Alternative Fuels Infrastructure Regulations (AFIR) and the push for hydrogen refuelling networks, while also integrating with EU plans for a hydrogen backbone network and cross-border hydrogen trade. In addition, Hungary is accessing EU funding instruments such as the Innovation Fund, Horizon Europe and ERDF for hydrogen R&D and pilot projects in line with the key actions of the EU Hydrogen Strategy.
	
	The National Hydrogen Strategy is the cross-sectoral national hydrogen strategy document; it sets strategies for industrial, transportational and energy application of hydrogen. The strategy focuses on green hydrogen, but in addition to hydrogen based on electricity from renewable sources, mainly solar energy, Hungary does not ignore the potential of hydrogen production based on carbon-free electricity from nuclear or grid electricity.
	
	The document defines 4 priority objectives and 3 support objectives:
	
	Priority objectives:
	
	• Production of large volumes low-carbon and decentralized carbon-free hydrogen: establishing the conditions necessary to produce low-carbon and carbon-free hydrogen that is in compliance with user requirements and is competitively priced.
	  ○ 20 thousand tons / year low-carbon hydrogen
	  ○ 16 thousand tons / year "green" and other carbon-free hydrogen
	  ○ 240 MW electrolyser capacity
	• Decarbonisation of industrial consumption, partly with hydrogen: at first, predominantly low-carbon hydrogen will be used to make the industrial processes and product use "greener", with a shift to carbon-free hydrogen usage on the longer term.
	  ○ 20 thousand tons / year low-carbon hydrogen
	  ○ 4 thousand tons / year "green" and other carbon-free hydrogen

	○ avoiding the emission of 95 thousand tons of CO2 • Green transport: accelerating the transition to clean modes of transportation by a gradual transition from gas oil usage to clean alternatives. Within this framework, on the 2030 timeline, hydrogen may become a realistic alternative primarily in heavy-duty vehicle traffic. ○ 10 thousand tons / year "green" and other carbon-free hydrogen ○ 20 hydrogen refuelling stations / 40 refuelling points ○ 4.8 thousand HFC vehicle ○ avoiding the emission of 130 thousand tons of CO2 • Electricity and (natural) gas support infrastructure: building sector integration ability - primarily seasonal energy storage ability - by utilising intersectoral synergy, establishing infrastructure that will enable the transition to carbon neutrality, and reconstructing existing infrastructure. ○ 60 MW average cut-off capacity ○ min. 2% per year volume blending ratio in the natural gas system (where appropriate) Support objectives: • Taking advantage of industrial and economic development opportunities: enhancing the activities at the intersection of industrial trends and Hungary's domestic strengths in order to promote competitiveness and stimulate domestic penetration. • Horizontal conditionality: establishing a stimulating operational environment • Establishment of comprehensive regulatory and operational frameworks, • Promoting partnership and international cooperation. • RDI and education to promote the success of hydrogen during the transition: it is essential for the implementation of strategic objectives to establish a system of scientific, technological and horizontal competencies that can serve as a foundation for the domestic use and development of new technologies and for demonstrating the legitimacy of such technologies on the domestic market. It is important to note that the National Energy and Climate Plan 2024 has already taken into account further EU legislation such as REDIII. The NECP therefore already states that there will be a significant need for imports to meet the demand for hydrogen, the supply chain of which needs to be developed as soon as possible, taking into account cost-effective modes of transport in the long term. Hungary is working to develop a comprehensive legal and regulatory framework to support the integration of hydrogen into its energy system. The country is in the process of transposing relevant EU directives into national law, updating its National Hydrogen Strategy and developing a dedicated hydrogen law.
CROATIA	**Law on Biofuels for Transport** (OG, No. /09, 145/10, 26/11, 144/12, 14/14, 94/18 and 52/21) – by the amendments from 2021 introduction of the hydrogen on the Croatian market is foreseen. In accordance with this Law, the person liable for placing biofuels or renewable energy in transport on the market, is obligated to prepare a Program (for three years) and

	a Plan (for one year) that includes the projected quantities of hydrogen from renewable sources for transport purposes that it intends to place on the market as well as report on the use of hydrogen as an alternative fuel on the market. **Law on the Deployment of Alternative Fuels Infrastructure** (OG No. 120/16 and 33/22) – defined technical specifications for vehicle hydrogen filling stations. This law defines hydrogen as an alternative fuel, i.e., as a fuel or energy source that serves, at least partially, as a substitute for fossil fuel sources in the energy supply of transport and that has the potential to contribute to the decarbonization of the transport system and improve the environmental efficiency of the transport sector. This law transposed Directive 2014/94 EU of the European Parliament and the Council of October 22, 2014, on the establishment of infrastructure for alternative fuels (AFID) into Croatian legislation. In accordance with the Law, hydrogen filling stations will be built following the National Policy Framework (NPF). Hydrogen is also mentioned in the **Law on Electricity Market** (OG. No. 11/21, 83/23), which states that electricity, among other things, can be stored in electrolysers with hydrogen storage. As the national coordinating body for hydrogen, the **Law on Renewable Energy Sources and High-Efficiency Cogeneration** (OG No. 138/21 and 83/23) has designated the Croatian Hydrocarbons Agency (CHA). Further to the above, the introduction of hydrogen as a new energy carrier in the transport sector of the Republic of Croatia will be accompanied by legal and by-law regulations, which will include new standards related to hydrogen as an alternative fuel, including new technologies that appear in the process from production to consumption of hydrogen as energy storage and alternative fuel. Also, it is necessary to build an appropriate infrastructure for the production, distribution, and supply of hydrogen and, at the same time, encourage the procurement of vehicles, ships, and trains that use hydrogen as a fuel with the aim of creating consumption. As for hydrogen in the transport sector, it is necessary to mention the **Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure (AFIR) that repealed AFID. T**his Regulation is directly applicable in all Member States including Croatia. AFIR sets mandatory national targets for EU Member States to deploy publicly accessible alternative fuels infrastructure (for electricity and hydrogen) for road vehicles, explicitly focusing on the trans-European networks. According to the AFIR, mandatory deployment targets for publicly accessible hydrogen refueling points should ensure a sufficiently dense network across the EU Trans-European Transport Network (TEN-T) core network to allow for the seamless travel of hydrogen-powered light-duty and heavy-duty vehicles throughout the EU

Table 2: regulation related to waste heat utilization

3.1.3. Regional/national funding schemes

COUNTRY	REGIONAL/NATIONAL FUNDING SCHEMES
Germany	**H2Global Initiative**: Germany has established the H2Global Foundation to facilitate long-term contracts, bridging the gap between supply and demand for green hydrogen. This initiative aims to create a reliable market for green hydrogen by securing purchase agreements.

	State-Level Programs: various federal states, such as Bavaria and North Rhine-Westphalia, provide additional funding for hydrogen pilot projects, reflecting regional commitments to advancing hydrogen technologies. **IPCEI-projects with German partners** **NIP II National Innovation Program Hydrogen and Fuel Cell Technologies** **Energy Research Program** **HyLand-Program** **KFW-Programs** and further 50 programs, with hydrogen being involved Additional programs of the German States
Italy	Italy's energy and climate strategies are closely aligned with its commitment to achieving carbon neutrality by 2050, as outlined in key national documents such as the National Hydrogen Strategy and the **Integrated National Energy and Climate Plan (PNIEC).** At the national level, the focus is on promoting the production and utilization of renewable hydrogen as a cornerstone of decarbonization, particularly in hard-to-abate sectors. Simultaneously, Italy is enhancing energy efficiency through waste heat recovery, integrating it into district heating networks and industrial processes. Regional strategies complement these efforts, with pilot projects and localized initiatives aimed at leveraging industrial and urban heat sources for sustainable energy use. All these coordinated actions show Italy's ambition to transition to a low-carbon economy while fostering innovation and energy resilience. At national level Italy provides various subsidies, funding mechanisms, and incentives to support hydrogen development, covering production, infrastructure, and use. The key initiatives include: • **National Recovery and Resilience Plan (PNRR):** Italy has allocated €3.64 billion from its PNRR funds to hydrogen-related projects. This includes €2 billion for green hydrogen production in hard-to-abate sectors such as steel and cement, €530 million for hydrogen refueling infrastructure for transportation, and €450 million for pilot projects involving hydrogen valleys. • **Hydrogen Valleys:** through regional pilot projects, Italy incentivizes the creation of hydrogen valleys, focusing on localized hydrogen ecosystems that integrate production, storage, and use. These projects are often co-financed by regional and national funds. • **Production Incentives:** companies investing in renewable hydrogen production facilities can benefit from grants or low-interest loans provided under national funding schemes and EU-backed programs like Horizon Europe. • **Infrastructure development support:** financial incentives are provided for the construction of hydrogen refueling stations and pipelines, with the aim of integrating hydrogen into the transportation network and industrial processes.

	• **Tax incentives and subsidies:** businesses implementing hydrogen technologies may qualify for tax deductions under Italy's energy efficiency and decarbonization programs. For example, the "Industry 4.0" tax credit can be applied to hydrogen-related innovations. Subsidies and incentives for waste heat recovery in Italy are aimed at improving energy efficiency and promoting the circular economy. Key measures include: • **PNRR Funding**: approximately €1 billion is allocated to energy efficiency improvements, including waste heat recovery projects in industry and district heating networks. Industrial facilities investing in heat recovery technologies can receive grants or subsidies under this funding scheme. • **Energy Efficiency Certificates (TEE):** also known as white certificates, this mechanism rewards companies that achieve energy savings through measures like waste heat recovery. Eligible projects receive certificates that can be sold on the energy market, providing a financial return for energy-saving investments. • **Tax incentives**: waste heat recovery investments can qualify for tax deductions under the "Ecobonus" and "Superbonus" schemes, which cover energy efficiency upgrades. Industrial players can also benefit from reduced taxes on equipment used for heat recovery systems. • **Regional programs**: many regions offer additional financial support for waste heat recovery projects through their energy and climate plans, including co-financing opportunities for local projects. • **District heating incentives:** funding is available for the expansion and modernization of district heating networks that incorporate waste heat sources, with a focus on urban and industrial areas. **Non-financial incentives:** Italy simplifies administrative procedures and accelerates permitting for waste heat recovery systems to reduce costs and encourage adoption.
Austria	Austria offers national funding programs for hydrogen-related projects, supporting initiatives ranging from research and development to the construction of hydrogen infrastructure. Incentives and subsidies within the **EAG (Renewable Energy Expantion Act).** Anchored in the EAG is an exemption from the renewables subsidy flat rate and subsidy contribution for electrolysis plants for the production of renewable hydrogen, exemption from grid utilisation and grid provision fees for electricity for electrolysis plants for the production of renewable hydrogen. Additionally, within EAG CAPEX support for electrolysers is planned for around 40 M€ per year
Poland	The National Centre for Research and Development has announced the strategic programme 'New Technologies for Energy'. It includes three thematic areas, including 'Technologies for the production and use of hydrogen', with an allocation of PLN 141.2 million. In addition, another programme, 'New Energy', which provides funding mainly in the form of loans on preferential terms up to 85 percent of eligible costs, with the possibility of obtaining a premium to reduce the amount of the loan principal to be repaid. It is divided into four project categories: Smart Energy Cities - with a budget of up to PLN 150 million, Multi-fuel units with heat or cold storage - up to PLN 150 million, Stable emission-free

	energy sources - up to PLN 250 million and Self-sufficient energy clusters - up to PLN 150 million. A very significant share of the total funds which, according to the assumptions of the document, were to be allocated to the development of green and low-emission hydrogen production capacity, is money from the National Reconstruction Plan. As much as EUR 800 million (nearly PLN 3.8 billion) was earmarked for this purpose, which accounts for as much as 35% of the total funding of the Polish Hydrogen Strategy. In addition to increasing the production potential of hydrogen, these funds were to support its practical use in energy, industry and low- or zero-emission transport, mainly by further developing the NFOŚiGW programmes described above and funding IPCEI (Important Projects of Common European Interest) projects. Unfortunately, funds from the NIP have still not reached Poland due to the lack of agreement between the Government of the Republic of Poland and the European Commission, in particular through the lack of progress in achieving the so-called 'milestones', i.e. the conditions necessary for disbursement. This situation puts the realisation of some of the goals of the Polish Hydrogen Strategy until 2030 under question. The **Modernisation Fund**, funded by the EU Emissions Trading System (EU-ETS), allocates funds for energy transformation in 13 EU countries, including Poland. It is estimated that by 2030, round PLN 60 billion could come to Poland from the Modernisation Fund for projects improving energy efficiency and developing zero-emission transport.
Czech Republic	The update of the Hydrogen Strategy of the Czech Republic responds to new conditions resulting from the approval or negotiation of a number of documents and legal regulations of the European Union (EU), such as: • The Paris Agreement; • the EU Hydrogen Strategy; • the EU System Integration Strategy; • the Fit for 55 package; • the Renewable Energy Directive (RED); • the Delegated Act establishing the EU methodology for detailed rules for the production of renewable fuels of domestic origin; • the restoration of the domestic gas market; • the Domestic Gas Regulation; • the Alternative Gas Regulation with Hydrogen Deployels (AFIR); • the Block Exemption Regulation (GBER); • the Climate, Environment and Energy Port State Guidelines (CEEAG); • the Regulation governing the European Ecosystem Management Framework for the Production of Zero-Emission Products, the European Union REPowerEU plan. At the national level there are several subsidy programmes that supports hydrogen development: • **Modernisation Fund** is one of the main supportive programmes for energy transition, uses financial resources gained through emission permits. RES+ sub-programme focuses on licenced energy providers and support development of photovoltaics including energy accumulators such as electrolysers and H2 storage

	solutions. ENERG ETS sub-programme focuses on decrease of emissions in industries including replacement of fossil fuels with renewable hydrogen. TRANSCom sub-programme focuses on purchase of emission-free vehicles, including H2-powered vehicles. TRANSGov sub-programme focuses on public entities and their transportation services, specifically on purchase of emission-free vehicles. GREENGAS sub-programmes supports private companies in production and storage of renewable energy in selected industries. This sub-programme can also support repurposing of gas transmission systems or creation of hydrogen valleys. I+ sub-programme focuses on individual complex innovation solutions reaching beyond the Modernisation fund and are subject of evaluation in EIB. • **Innovation fund** strengthens innovative potential of companies in energy transition. • **Operational Programme Just Transformation** aims at three past-coal regions in the Czech Republic, offering several axes, where energy transition is the biggest one. • **Recovery and Resilience Facility** supports clean mobility and decreasing the dependency on fossil fuels. Key component is decarbonisation of road transportation. • **Operational Programme Transportation** supports creation of H2 filling stations. In the future the programme aims to support development of H2 linear infrastructure. • **Integrated Regional Development Programmes** focuses on transformation of multimodal urban mobility with purchase of vehicles or creation of filling stations for public transportation.
Slovenia	**Ministry of the Environment, Climate, and Energy** - Call for proposals for the co-financing of the purchase of vehicles for the establishment of an emission-free public passenger transport line. **Subsidies for the purchase of EVs - natural persons and private sector.** Subsidy up to 7200,00 € for the purchases of new or used (up to 4 years) EVs (including FCEVs). The purpose of the public call is to support individuals in the transition to zero-emission mobility by granting financial incentives for the purchase of CO2-free electric vehicles intended for road transport. **ECO-FUND 118FS-PO24** Non-returnable financial incentives for new investments in energy efficiency and renewable energy sources for businesses
Hungary	Hungary offers funding for hydrogen-related initiatives, particularly for the development of green hydrogen production and its use in mobility and industry. Hungary does not yet have a dedicated, comprehensive legal framework for hydrogen. Instead, hydrogen projects fall under existing energy, industrial, and environmental laws, which were not originally designed for hydrogen applications. In Hungary, one of the most important pieces of legislation for hydrogen is Act XL of 2008 on Natural Gas Supply, which applies to the licensing of facilities for the production, use and storage of hydrogen, as well as pipelines for the transportation of hydrogen. In addition, the Hungarian government has adopted several strategic documents and plans. The main objective of these plans is to have strategic level documents and strategic plans to promote the hydrogen economy.

Croatia	To meet the objectives stated in the National Recovery and Resilience Plan 2021-2026 (NRRP) and National Programme for Cohesion and Coherence (NPCC) envelope from 2021 to 2027, the Ministry of Economy decided to subsidize the construction of filling stations (CAPEX subsidy) for hydrogen vehicles with a non-reimbursable EUR 23 million (EUR 15 million in 2024 and EUR 8 million in 2026). The highest amount of support per HRS station is EUR 2 million for passenger cars, and EUR 3.5 million for buses and heavy vehicles. Beneficiaries of grants in accordance with this Program can be micro, small, medium, and large enterprises

Table 3: regional/national funding schemes

3.2. Lessons learned from Policy Framework Assessment Report and questionnaires

3.2.1. Comparative analysis of collected policies

Identification of common policies across partners experiences

Partners widely prioritize decarbonization, green hydrogen production, and waste heat recovery. Shared policy measures include:

- **National Hydrogen Strategies**: many European nations have developed comprehensive hydrogen strategies aiming to integrate hydrogen into their energy systems to achieve decarbonization goals.
- **Financial incentives and funding mechanisms**: countries have established financial incentives to promote hydrogen production and utilization.
- **Research and innovation support**: there is a collective emphasis on supporting research and innovation in hydrogen technologies. The EU's research framework programs provide substantial funding for hydrogen projects, underscoring the importance of advancing hydrogen applications through research and industrial innovation.

Significant differences between regional/national contexts:

- **Policy ambition and targets:** the level of ambition in hydrogen strategies varies. For example, while the EU has set a goal to produce 10 million tons of clean hydrogen annually within the EU by 2030, some experts estimate that actual production might reach around 1 million tons per year by that time, indicating a potential gap between targets and realistic outcomes.
- **Regulatory frameworks**: the complexity and clarity of regulatory frameworks differ, affecting the speed and efficiency of hydrogen project implementation. In some countries, bureaucratic processes and lack of harmonization among policies can delay project timelines.
- **Economic support and market development**: the availability and structure of financial incentives and funding vary, leading to disparities in market development. Some regions may offer substantial subsidies and support mechanisms, while others provide limited financial backing, impacting the scalability and attractiveness of hydrogen projects.

3.2.2. Evaluation of challenges

Regulatory Barriers:

- **Lack of harmonization among policies of different partners**: divergent regulations across countries create complexities for cross-border hydrogen initiatives. The absence of standardized certification and regulatory frameworks can impede the development of a cohesive European hydrogen market.

- **Bureaucratic complexity delaying project implementation**: intricate permitting processes and administrative hurdles can lead to significant delays in project execution. Streamlining these processes is essential to accelerate hydrogen deployment.

Economic Barriers:

- **Insufficient funding or incentives in some contexts**: while some countries have robust financial support mechanisms, others lack adequate funding, making it challenging to initiate and sustain hydrogen projects. This disparity can lead to uneven development across regions.
- **Gaps in long-term financial planning**: uncertainty regarding long-term financial support and market stability can deter investment. Clear and consistent financial planning is crucial to build investor confidence and ensure the viability of hydrogen projects.

3.2.3. Identified opportunities

- **Possibility of transferring best practices between contexts:** sharing successful strategies and policies among countries can facilitate the adoption of effective measures, optimizing resource utilization and accelerating progress.

- **Opportunities for harmonizing policies at regional and European levels:** developing standardized regulations and certification processes can promote a unified hydrogen market, enabling seamless integration and collaboration across borders.

4. Critical analysis of best cases

This chapter investigates the analysis and the collection through desk research and partners contribution of the best cases of hydrogen and waste heat projects that were successfully financed, identifying:

- Locations where these projects were activated.
- Business models that proved effective.
- Policies that enabled success.

4.1. Geographic distribution of best cases

4.1.1. Analysis of activated projects

COUNTRY	REGIONAL/NATIONAL FUNDING SCHEMES
	GERMANY
REGIONAL OVERVIEW	• **Project: GET H2 Nukleus North Rhine-Westphalia (NRW):** the GET H2 Nukleus project aims to establish the first publicly accessible hydrogen infrastructure in Germany, connecting green hydrogen production in Lingen with industrial consumers in Lower Saxony and North Rhine-Westphalia. The project plans to build a 300-megawatt electrolyzer at RWE's Emsland gas-fired power plant site, with the first 100 MW unit scheduled to commence operation in 2025. The project is recognized as an Important Project of Common European Interest (IPCEI), facilitating financial support from national funding bodies. **Public-Private Collaboration**: partnerships between RWE, bp, Evonik, Nowega, and OGE have been instrumental in advancing the project. • **Project: Hamburg Green Hydrogen Hub:** this initiative involves converting a former coal-fired power plant into a 100 MW green hydrogen production facility. The project aims to supply green hydrogen to various industries, including shipping, aviation, and steel production. The project secured a €38 million grant from the European Union to support its development. • **Project: Hy2B Hydrogen Cluster (Pfeffenhausen, Bavaria):** the Hy2B project focuses on creating a decentralized hydrogen production and distribution network, primarily for mobility applications in the region. The electrolysis plant generates an average of 1,200 kilograms of green hydrogen per day, compress it to up to 450 bar and fill it in a filling station in compressed gas trailers with a capacity of 1,250 kg. • **Project: Clean Hydrogen Coastline Frankfurt-Rhine-Main Region**: this large-scale project aims to establish a hydrogen import and distribution hub to serve industrial users in the region. The project aligns with the European Green Deal, facilitating access to funding.
GEOGRAPHICAL TRENDS	• Concentration of projects in regions with strong policy support: the analysed projects are predominantly located in regions with robust policy frameworks and governmental support for hydrogen initiatives. For instance, the German National Hydrogen Strategy outlines the country's commitment to becoming a

	global leader in hydrogen technologies, providing a conducive environment for such projects. • Correlation between project activation and availability of funding or incentives: there is a clear correlation between the activation of hydrogen projects and the availability of funding or incentives. Projects like the Hamburg Green Hydrogen Hub have secured substantial federal grants, underscoring the importance of financial support in project realization
INSIGHTS FROM DISTRIBUTION	**Regions with proactive approaches to hydrogen and waste heat utilization:** • GET H2 Nukleus: regions with heavy industry and existing energy infrastructure are ideal for hydrogen integration. • Hamburg Green Hydrogen Hub: regions with port access and industrial demand can serve as major hydrogen trade and logistics hubs. • Hy2B Hydrogen Cluster: regions investing in decentralized hydrogen production can support local energy needs and create self-sufficient energy systems. • Rh2ein-Main Connect: regions with high energy demand require large-scale hydrogen networks integrated with national infrastructure. **Industrial & Infrastructure Synergies:** • Regions with established industrial hubs have built-in hydrogen demand, making projects more viable. • Natural gas pipelines can be repurposed for hydrogen, reducing the need for new infrastructure investments. • Example: The Rh2ein-Main Connect project in Frankfurt will connect to the national hydrogen network, ensuring large-scale hydrogen distribution. **Regulatory & Political Support:** • The German National Hydrogen Strategy sets clear hydrogen production and demand targets, ensuring alignment with EU climate goals. • Regional initiatives (e.g., Bavarian Hydrogen Alliance, NRW Hydrogen Roadmap) create additional funding and incentives at the state level. • Example: Hamburg's Green Hydrogen Hub received €154M in federal funding, demonstrating strong government commitment.
ITALY	
REGIONAL OVERVIEW	• **H2 Valle Padana Project**: interregional network with public-private participation (e.g., SNAM, SAPIO, FNM, highways, local authorities) to create hydrogen refuelling infrastructure along TEN-T corridors (such as Brenner and Mediterranean Corridor). Funded with PNRR funds (Mission 2, Component 2), regional funds, and regulatory support for sustainable mobility. The project proposes a systemic approach to decarbonization of heavy transport; interoperability between regions and integration with ports, interports and logistics areas. • **Hydrogen Valley in Puglia**: Regional initiative led by ARTI and Apulia Region, with consortia between energy companies (e.g., Edison, Enel Green Power),

	local authorities and research (Bari Polytechnic) funded with PNRR funds for Hydrogen Valleys, ERDF programming, regional green hydrogen strategy. • **ENEA Offshore Hydrogen Production Project**: public coordination led by ENEA, with involvement of private actors (e.g., offshore wind operators and energy utilities) developed with European ondi for research and innovation (Horizon Europe), MASE support for strategic projects related to green transition. Feasibility study to produce green hydrogen directly offshore from floating wind plants, reducing transmission costs and onshore infrastructure. • **North Adriatic Hydrogen Valley:** Cross-border cooperation led by FVG Region, support from universities (e.g., Trieste, Ljubljana), utilities (e.g., SNAM, HSE), and industrial companies. Project funded by Clean Hydrogen Partnership (Horizon Europe) and Interreg programs; strong alignment with Adriatic-Ionian Macroregional Strategy. This is Europe's first transnational Hydrogen Valley; replicable models for hydrogen production, distribution, and use in ports, industries, and public mobility. • **Hydrogen Park - Porto Marghera (VE):** public-private infrastructure with strong involvement of chemical and logistics companies (ENI, Decal, etc.) supported by regional and national funding, and redevelopment of brownfield sites with support from the European Horizon program. will focus on the production of hydrogen for industrial uses and the decarbonization of chemistry. • **Hydrogen Valley di Bolzano - H2 Südtirol**: Public coordination (Autonomous Province of Bolzano + STA - South Tyrolean Transport Facilities) with operation of a production plant from electrolysis and a refuelling network for heavy mobility. project with European funding (Interreg and Horizon) and provincial incentives for the purchase of hydrogen buses. • **Hydrogen Pilot Project di FNM e Trenord (H2iseO**): public-private project with direct investment from FNM Group, support from PNRR funds and collaboration with mobility operators and energy companies. Funded with PNRR Mission 2 funds, support from Lombardy Region, regulatory simplifications for experimentation. First case in Italy of full replacement of diesel rail transport with hydrogen trains; planning of an energy district based on renewables and hydrogen. • **Hydrogen Hub di Civitavecchia:** Collaboration between Enel Green Power, SNAM, Lazio Region, and port operators for local hydrogen production and utilization enabled with PNRR funds and sthe upport of port decarbonization policies. The project focuses on the use of hydrogen for powering port vehicles and short-haul logistics.
GEOGRAPHICAL TRENDS	• Strong investment in industrialized regions. Hydrogen investments are focused on high-energy-demand regions such as Lombardy, Veneto, and Puglia, where industrial applications benefit from decarbonization efforts. • Interest in hydrogen production in areas with abundant renewable energy. Coastal and offshore regions offer opportunities for hydrogen production linked to renewable energy sources, particularly offshore wind farms.

	• Investments are aligned with Italy's broader energy transition goals, integrating hydrogen within sustainable mobility and energy resilience strategies.
INSIGHTS FROM DISTRIBUTION	• Hydrogen projects are closely tied to the development of sustainable transport solutions, particularly in long-haul freight and public transport. • Strong collaboration between government agencies and energy companies ensures an integrated and well-funded hydrogen ecosystem. • The integration of hydrogen into industrial clusters ensures higher adoption rates and economic feasibility, creating a multiplier effect for further investments
AUSTRIA	
REGIONAL OVERVIEW	• **HyCentA (Graz):** research center for green hydrogen production and its integration into the energy system. • **Upper Austria Hydrogen Initiative:** project for the development of hydrogen distribution infrastructure.
GEOGRAPHICAL TRENDS	• Focus on research and innovation: Austria focuses on hydrogen R&D, particularly in academic and industrial research centers in Graz and Linz. • Development of infrastructure for hydrogen transportation: the country's natural gas infrastructure provides an opportunity for repurposing pipelines for hydrogen distribution. • Hydrogen innovation hubs are emerging, fostering technology transfer and industry-led initiatives.
INSIGHTS FROM DISTRIBUTION	• Strong collaboration between universities and industries has led to rapid technological advancements. • Austria plays a crucial role in hydrogen transit and storage, serving as a hub for Central Europe. • Decentralized hydrogen projects ensure energy security and economic resilience across multiple sectors
POLAND	
REGIONAL OVERVIEW	• Orlen Hydrogen Hub: green hydrogen production to reduce industrial emissions. • PKP Cargo Hydrogen Trains: introduction of hydrogen-powered trains for freight transport • The Mazovian Hydrogen Valley, which is being developed in Mazovian region, is based on four pillars that will contribute to the effective development and dissemination of hydrogen technologies both regionally and nationally. The main goal is to build a hydrogen value chain in the Mazovia region, as exemplified by the first hydrogen projects planned to be implemented by ORLEN, including hydrogen hubs in Płock and Ostrołęka, a prototype hydrogen locomotive and hydrogen refuelling stations. Other pillars include the implementation of research and development projects, the creation of systemic solutions for the training of specialised personnel and activities to support regulatory processes. A milestone in the development of the hydrogen

	valley was the positive decision in August 2024 to award funding of almost 9 million euros from the Clean Hydrogen Partnership under the Horizon Europe programme for the HySPARK project. The project aims to develop the full hydrogen economy value chain, including the production, distribution, storage and use of hydrogen in transport and industry.
GEOGRAPHICAL TRENDS	• Growing interest in hydrogen transport • Poland prioritizes hydrogen adoption in the industrial and transportation sectors, leveraging its strong manufacturing base. • Government-backed initiatives aim to integrate hydrogen into public transport and logistics. • The country is transitioning from coal reliance, using hydrogen as a bridge towards cleaner energy
INSIGHTS FROM DISTRIBUTION	• Heavy industry and logistics networks serve as key hydrogen adopters. • Poland's energy transition strategy incorporates hydrogen to reduce coal dependency. • Hydrogen mobility projects are being integrated with the national transport infrastructure, ensuring a smooth transition
CZECH REPUBLIC	
REGIONAL OVERVIEW	**ČEZ Hydrogen Program**: research on hydrogen production using nuclear energy. **Brno Hydrogen Public Transport**: hydrogen bus project.
GEOGRAPHICAL TRENDS	• Hydrogen investments are concentrated in Prague and Brno, where public transportation networks are being modernized to incorporate hydrogen-powered vehicles. • The country's strong reliance on nuclear energy creates an opportunity for large-scale hydrogen production using excess electricity from nuclear plants. • Research institutions play a key role in shaping hydrogen innovation, particularly in fuel cell technologies and hydrogen storage
INSIGHTS FROM DISTRIBUTION	• Hydrogen deployment is closely tied to government-supported pilot projects, which test economic feasibility before wider implementation. • The public transport sector acts as a driver for hydrogen adoption, with buses and municipal fleets transitioning to hydrogen fuel. • Hydrogen infrastructure is still limited, with an emphasis on expanding refueling stations in strategic urban locations
SLOVENIA	
REGIONAL OVERVIEW	• **North Adriatic Hydrogen Valley:** A cross-border initiative with Italy and Croatia, aiming to develop hydrogen production and distribution infrastructure.
GEOGRAPHICAL TRENDS	• Slovenia's hydrogen projects are clustered in regions with strong industrial activity, particularly along the Italian border where cross-border collaborations enhance supply chain efficiency.

	• Efforts are being made to integrate hydrogen into transport and industry, leveraging EU funding to accelerate deployment. • The country is strategically positioned as a transit hub for Central and Southeastern Europe, making it a key player in regional hydrogen logistics.
INSIGHTS FROM DISTRIBUTION	• Hydrogen adoption is closely linked to EU-funded projects, demonstrating reliance on external financing. • Public awareness and policy frameworks are still in early development, slowing large-scale adoption. • Slovenia benefits from regional energy strategies, collaborating with neighboring countries to develop a shared hydrogen ecosystem.
HUNGARY	
REGIONAL OVERVIEW	• **Budapest Hydrogen Mobility Project**: aimed at integrating hydrogen-powered buses into the capital's transport network. • **MOL Green Hydrogen Refinery**: production of hydrogen for refining processes, reducing dependency on fossil fuels.
GEOGRAPHICAL TRENDS	• Hungary's hydrogen initiatives are concentrated in Budapest and major industrial hubs, where energy demand is highest. • Government policies favor hydrogen production as a means of reducing natural gas reliance, particularly given geopolitical concerns over energy security. • Investments in hydrogen are supported by the private sector, with leading companies driving refinery and industrial applications.
INSIGHTS FROM DISTRIBUTION	• Strong collaboration between government and private companies is accelerating hydrogen adoption in the energy sector. • The development of hydrogen refueling infrastructure remains limited, with planned expansions aligning with mobility projects. • Hungary is exploring hydrogen blending with existing natural gas networks as a transition strategy.
CROATIA	
REGIONAL OVERVIEW	• **Project: North Adriatic Hydrogen Valley (NAHV)**: a cross-border initiative with Italy and Croatia, aiming to develop hydrogen production and distribution infrastructure.
GEOGRAPHICAL TRENDS	• Projects are concentrated in industrial regions and near cross-border logistic hubs, such as the port of Rijeka. • Croatia is focusing on renewable hydrogen, with plans to install 70 MW of electrolysis capacity by 2030, increasing to 2,750 MW by 2050. • Emphasis on hydrogen mobility: 15 hydrogen refuelling stations are planned by 2030 and 100 by 2050.
INSIGHTS FROM DISTRIBUTION	• Hydrogen is being integrated into the national energy system through Laws on biofuels and alternative fuels infrastructure and the National Hydrogen Strategy (OG No. 40/2022) and the National Recovery and Resilience Plan (NRRP).

	• Participation in the NAHV enables Croatia to access EU funding and collaborate with neighbouring countries for infrastructure development and knowledge transfer. • The Ministry of Economy has allocated €23 million (2024–2026) to subsidize hydrogen refuelling stations, with up to €2 million per station for cars and €3.5 million for buses and heavy-duty vehicles

Table 4: analysis of activated projects

4.2. Successful business models identified

4.2.1. Business plan and business model

Usually, a business model (BM) is one of the strategic and key elements within a business plan BP). A business model could be defined as the company's model that describes how a business creates, distributes and captures value. It is the fundamental structure that guides the operation of the business, defining sources of revenue, customer relationships, key partners, core activities and key costs.

The first crucial aspect is understanding market demand, customer expectations, and competitors' behaviour, that is essential to position the business effectively.

Starting from this, several key areas of expertise branch out, forming the core structure of the business plan:

ASPECT	DESCRIPTION
ECONOMIC ASPECTS	To deliver what the market demands, a detailed cost analysis is required. These costs are divided into: • CAPEX (Capital Expenditures): initial investments in infrastructure, machinery, technology, patents, etc. • OPEX (Operational Expenditures): recurring operational costs, such as raw materials, logistics, labor, maintenance, energy, and services. A thorough cost assessment helps determine the minimum viable selling price to ensure profitability and cover expenses while identifying strategies to improve operational efficiency.
FINANCIAL ASPECTS	The financial sustainability of a business depends on its ability to secure and manage the necessary capital. This section focuses on: • Available capital: how much capital has already been invested? Who are the shareholders or investors? • Financial needs: how much additional funding is required to start and sustain the business until it reaches breakeven? • Debt and funding sources: if the available capital is insufficient, what financing options are viable (banks, venture capital, private equity, crowdfunding, public grants)? This analysis is crucial as it shapes the business model, defining how the company will generate revenue and repay investments.
Business entity definition	Choosing the appropriate legal structure for the business is a fundamental step, as it impacts:

	• Legal and tax responsibilities: a limited liability company protects personal assets, whereas sole proprietorships or partnerships may expose owners to direct financial risks. • Access to financing: some corporate structures are more attractive to investors and lenders. • Regulatory and administrative obligations: business registration, licenses, certifications, employment contracts, and industry regulations. A well-defined legal framework ensures clarity in ownership, governance, and compliance with the law.
Risk analysis	Every business must assess and manage potential risks that could impact its success, to allow businesses to develop mitigation strategies and reduce vulnerabilities. These risks can be classified into: • Market risks: changes in demand, increased competition, price fluctuations. • Financial risks: limited credit access, customer defaults, interest rate volatility. • Operational risks: supply chain disruptions, production inefficiencies, challenges in hiring skilled personnel. • Regulatory risks: changes in tax laws, environmental regulations, industry compliance requirements.
Communication and marketing strategy	Effective communication differentiates a business from its competitors, translating its value proposition into tangible market demand. A business cannot thrive without a clear communication and marketing strategy that outlines: • Brand identity: core values, mission, and market positioning. • Promotion strategy: advertising channels, digital marketing, social media campaigns, public relations, and customer engagement strategies. • Sales strategy: distribution models (e-commerce, retail, etc.) pricing policies, and customer retention programs.

Successful business models

From the business plan we arrive at the business model through a process of synthesizing and structuring the value of the enterprise, based on the areas analysed in the plan. The identification of which entity, how it will contribute to the business and through which activities represent the key financial aspect of the business model.

Business models based on public-private partnerships (PPP)**,** community-driven projects**, and** hybrid models **have emerged as highly successful strategies across various sectors**. Their success is linked to their ability to combine resources, expertise, and objectives from different stakeholders to maximize economic, social, and environmental impact.

PPP, community-driven, and hybrid models are winning strategies because they leverage collaboration, innovation, and sustainability to address complex challenges. Their ability to merge public and private resources, engage communities, and maintain flexible structures makes them highly effective in an increasingly interconnected and demanding world.

4.2.2. public-private partnerships (PPPs)

The **public-private partnership (PPP) model** is a form of collaboration between public entities and private investors aimed at developing infrastructure projects and public services. This model allows for the sharing of risks and benefits by leveraging financial resources and the managerial efficiency of the private sector, while the public sector ensures regulatory compliance and serves the public interest.

These examples demonstrate the success of the **PPP model** in facilitating the deployment of innovative technologies and the execution of impactful infrastructure projects, since **PPPs** bring together the best of both worlds: the stability and resources of the public sector with the efficiency, innovation, and risk management capabilities of the private sector.

Key characteristics of the PPP Model

- **Risk-sharing:** public and private sectors collaborate to distribute financial, operational, and technical risks. The distribution of financial and operational risks is allocated between public and private partners.
- **Access to private financial resources**: the private sector contributes capital and management expertise to execute the project.
- **Efficiency and innovation**: private sector involvement introduces market-driven mechanisms, improving efficiency in project execution and management.
- **Improved service quality**: PPPs often result in higher quality infrastructure and better maintenance compared to exclusively public projects.

Examples of projects funded through PPPs

EXAMPLE	DESCRIPTION	OUTCOME
HYDROGEN BUS PROJECT (UK AND GERMANY)	Deployment of hydrogen-powered bus fleets in various cities through mixed public and private funding	Reduction in urban pollution and increased adoption of hydrogen in public transportation.
H2PORTS PROJECT (SPAIN)	Implementation of hydrogen technology for the decarbonization of port operations in the Port of Valencia.	Reduction of CO_2 emissions in port logistics activities and increased interest in hydrogen adoption for maritime hubs.
HYDEAL AMBITION PROJECT (FRANCE AND SPAIN)	A large-scale initiative for the production and distribution of green hydrogen, involving both private companies and public entities.	Lower production costs for green hydrogen and the development of a European ecosystem for its use.
BRENNER MOTORWAY (ITALY)	An infrastructure project financed through PPPs for the management and maintenance of the motorway, with investments in low-emission solutions, including hydrogen mobility.	Improved transport efficiency and reduced environmental impact.
HAMBURG GREEN HYDROGEN HUB	In Hamburg, a significant PPP has been established to develop the Hamburg	Decarbonize the port's economy by producing green hydrogen through a 100

	Green Hydrogen Hub. The project is a collaboration between public authorities and private companies, including Shell, Mitsubishi Heavy Industries, Vattenfall, and Wärme Hamburg. The partnership facilitates the sharing of resources, expertise, and risks, contributing to the project's success.	MW electrolyzer, utilizing renewable energy sources Enhanced Financial Viability: Access to diverse funding sources reduces the financial burden on individual entities. Accelerated Implementation: Combined efforts expedite project development and deployment. Policy Alignment: Ensures that projects align with governmental policies and regulatory frameworks.

Table 5: examples of projects funded through PPPs

4.2.3. Community-driven models

The **Community-driven model** is a decentralized approach to project development where local communities, cooperatives, or grassroots organizations take the lead in financing, managing, and operating renewable energy and hydrogen initiatives. This model emphasizes local ownership, social engagement, and sustainability, ensuring that the benefits remain within the community.

Community-driven models have proven to be effective in fostering **energy democracy**, strengthening local economies, and ensuring a more inclusive and sustainable transition to renewable energy solutions. Community-driven projects leverage the active involvement of users to create solutions that meet real needs. Inclusion and active participation generate trust and long-term sustainability.

Key characteristics of the community-driven model

- **Local ownership and governance**: projects are initiated, owned, and managed by local communities or cooperatives, ensuring that decision-making reflects local needs.
- **Sustainable energy production**: it focuses on renewable energy sources, such as hydrogen and waste heat utilization, to enhance environmental and economic sustainability.
- **Economic benefits for the community**: revenue generated from these projects is often reinvested into the local economy, supporting job creation and social services.
- **Social engagement and acceptance**: it encourages community participation, increasing public trust and accelerating the adoption of new energy solutions.

Examples of community-driven projects

EXAMPLE	DESCRIPTION	OUTCOME
ORKNEY HYDROGEN PROJECT (SCOTLAND, UK)	A community-led initiative that produces hydrogen using excess wind and tidal energy to power ferries and heating systems. Tidal power devices located at the European Marine Energy Centre test site at the Fall of Warness, in the sea just west of the island of Eday, and the Eday Renewable Energy community-owned	A circular energy economy that reduces fossil fuel dependency and benefits the local population.

	onshore wind turbine, route their surplus electricity to a 500kW electrolyser, which generates hydrogen by splitting water. The hydrogen is stored as compressed gas then transported on a trailer by road and sea to Kirkwall, the capital of Orkney. There it powers a fuel cell to generate clean electricity on demand.	
ENERGIEGENOSSENSCHAFTEN (GERMANY)	Over 900 energy cooperatives in Germany have successfully implemented local renewable energy projects, including hydrogen production and distribution.	Increased energy independence for local communities and widespread adoption of green energy.
HVIDOVRE GREEN HYDROGEN COMMUNITY PROJECT (DENMARK)	A municipality-driven initiative where local residents co-own and benefit from hydrogen production used for transport and heating.	Greater public engagement in green energy projects and enhanced local energy resilience.
EFARM PROJECT IN NORTH FRIESLAND	Initiated by GP JOULE, the project involves local citizens and businesses in the production of green hydrogen using wind energy. The hydrogen is utilized for transportation and heating within the community, promoting local sustainability and energy independence.	Demonstrating how community involvement can lead to successful implementation of renewable energy solutions. Economic empowerment: it generates local employment and retains economic benefits within the community. Environmental stewardship: it encourages sustainable practices tailored to local ecological contexts. Social cohesion: it strengthens community bonds through collective action and shared goals

Table 6: example of community-driven projects

4.2.4. Hybrid funding models

The **hybrid funding model** combines multiple financial sources—such as public funding, private investments, and end-user revenue—to support infrastructure and energy projects. This approach balances initial capital expenditures (**CAPEX**) with operational expenses (**OPEX**), ensuring financial sustainability and reducing investment risks. Hybrid models are particularly useful for hydrogen and renewable energy projects, where large upfront investments are needed before revenue generation becomes stable.

These models are flexible and well-suited for evolving markets. hybrid funding models have proven essential in **bridging the gap between innovation and commercialization**, ensuring that hydrogen and renewable

energy projects can scale effectively while minimizing financial risks. Hybrid models combine elements of the public, private, and community sectors to maximize value creation.

Key characteristics of the hybrid funding model

- **Diversified financial sources**: it uses a mix of public grants, private sector investments, and revenue from energy consumers.
- **Risk mitigation**: it spreads financial risks among different stakeholders, increasing project resilience.
- **Scalability**: it supports both small-scale pilot projects and large-scale energy infrastructures.
- **Financial sustainability**: It ensures long-term viability by securing multiple funding streams.

Examples of hybrid funding projects

EXAMPLE	DESCRIPTION	OUTCOME
NORTH SEA WIND POWER HUB (EU, UK, AND NORWAY)	A large-scale offshore wind and hydrogen production project funded through a mix of EU grants, private investments, and energy sale revenues.	Increased cross-border energy integration and reduced dependency on fossil fuels.
H2 ENERGY EUROPE (SWITZERLAND & GERMANY)	A hydrogen production and distribution network co-financed by public funding, private investors, and partnerships with local businesses.	Expansion of hydrogen refueling stations and greater industry adoption.
H21 LEEDS CITY GATE (UK)	A hydrogen heating initiative in the UK financed by a combination of government funding, energy company investments, and private sector loans.	A scalable model for transitioning natural gas networks to hydrogen
WUNSIEDEL GREEN HYDROGEN PLANT	The project, led by Siemens, involves an 8.75 MW electrolyzer producing approximately 1,350 tons of hydrogen annually. Funding was sourced from Siemens Financial Services, local utility company SWW Wunsiedel GmbH, and additional private investors.	Financial resilience: it reduces dependence on a single funding source, enhancing financial stability. Risk mitigation: it distributes financial risk across multiple stakeholders. Enhanced credibility: it attracts a broader range of investors through demonstrated commitment from diverse parties.

Table 7: examples of Hybrid funding projects

5. Strategic recommendations

5.1. Summary of findings

The analysis conducted has highlighted several challenges and opportunities for the development of hydrogen and the use of waste heat in industrial and transport sectors. The key findings include:

- **Lack of regulatory harmonization**: differences in regulatory frameworks across various countries create obstacles to large-scale hydrogen implementation.
- **Limited access to financing**: while some countries benefit from robust incentive schemes, others suffer from a lack of financial resources.
- **Need for sustainable business models**: PPPs, community-driven models, and hybrid financing emerge as effective solutions to ensure project scalability.
- **Underdeveloped infrastructure**: the lack of hydrogen transportation and storage infrastructure slows down large-scale adoption.
- **Opportunities for best practice transfer**: adopting successful strategies from other regions could accelerate the hydrogen transition.
- **Growing importance of decision support tools:** As hydrogen ecosystems become increasingly integrated with renewable energy and exposed to volatile market dynamics, the use of digital decision support tools is particularly strategic in planning hydrogen hubs.

5.2. Strategic recommendations: enhancing policy framework

Below a summary of the elements from which strategic recommendations described in the chapters below have been developed (*see the number of recommendation list*)

Establish a common regulatory framework at the European level to support hydrogen projects - 1, 2, 3	Simplify bureaucratic processes to enable faster project activation - 4	Increase access to funds for partners operating in contexts with fewer resources to reduce barriers to entry - 5	Provide tax incentives for operational efficiency and innovation - 6
Introduce mandates or quotas for hydrogen use in industrial and transportation sectors - 7	Support public awareness campaigns to promote hydrogen adoption - 8	Establish a hydrogen policy evaluation framework and monitoring sytem- 9	Key financial and business model optimization measures - 10, 11
Scalable Business Models - 12,13	Encourage collaboration between research institutions, private companies, and public entities establishing regional and international platforms for sharing best practices and lessons learned - 14,15	Develop pilot programs to test innovative solutions and scale successful ones 16,17	Support the development of infrastructure to enable large-scale hydrogen deployment - 18

5.2.1. Policy harmonization

Establish a common regulatory framework at the European level to support hydrogen projects

Challenges:

- Inconsistent hydrogen regulations across EU countries create barriers for cross-border trade and infrastructure development.
- Varying certification, safety, and grid-integration standards complicate operations for companies in different EU markets.
- EU state-level policies are not fully aligned, leading to disparities in permitting, incentives, and infrastructure development.
- Some regions, have more advanced hydrogen strategies, while others lack clear policies.

Recommendations:

1. **Develop a standardized EU-wide hydrogen regulatory framework to unify to develop safety protocols for hydrogen transport and storage and provide certification processes and Guarantee of Origin (GO) tracking. The regulatory framework could also provide a classification of hydrogen types (green, blue, turquoise) in line with the EU Renewable Energy Directive (RED III).**
2. **Create an EU-wide "hydrogen acceleration fund" to ensure equal access to financing for hydrogen projects across Europe. The creation of this specific fund will implement cross-border hydrogen trading mechanisms to facilitate a single European hydrogen market.**
3. **Establish a national hydrogen regulatory authority to coordinate policies across all EU states able to standardize permitting and safety regulations across EU states members to create uniformity in hydrogen project approvals and to align EU state member hydrogen policies with existing natural gas frameworks to facilitate faster hydrogen infrastructure integration.**

Simplify bureaucratic processes to enable faster project activation

Challenges:

- Lengthy permitting and approval processes delay private sector investment in hydrogen.
- Project activation timelines in some countries (Germany, Slovenia) remain slower than in countries like the Netherlands and France, which have implemented faster approval frameworks.

Recommendations:

4. **Introduce a digital "One-Stop Hydrogen Permitting Platform" to streamline project approvals and increase transparency. This platform could drastically simplify hydrogen storage and transport regulations by aligning them with existing gas infrastructure regulations to speed up approvals.**

5.2.2. Financial support

Increase access to funds for partners operating in contexts with fewer resources to reduce barriers to entry

Challenges:

- Smaller companies, municipalities, and research institutions lack direct access to major funding programs like IPCEI.

- Hydrogen infrastructure projects require high capital investment, making it difficult for emerging markets and local governments to participate
- The lack of hydrogen refueling infrastructure limits vehicle adoption. Expanding EU state members hydrogen refueling network is essential.
- Prioritize strategic locations such as highways, logistics hubs, and urban centers.

Recommendations:

5. **Launch a "Regional Hydrogen Development Fund to include SMEs-specific funding streams. The Regional Fund could provide direct grants and low-interest loans for SMEs investing in hydrogen production, storage, and transport, introducing a dedicated "SME Hydrogen Accelerator Program" to ensure funding access for smaller players. The fund targets underdeveloped regions that lack hydrogen infrastructures and could provide regional subsidies for green hydrogen production to decentralize the hydrogen economy.**

Provide tax incentives for operational efficiency and innovation

Challenges:

- Hydrogen projects require long-term financial viability, but operating costs (OPEX) remain high.
- Tax incentives can encourage private sector participation and accelerate infrastructure development.
- Current financial mechanisms focus on capital expenditures (CAPEX), but operational costs must also be addressed.

Recommendations:

6. **Introduce a "hydrogen innovation tax credit" that provides depreciation benefits for hydrogen infrastructure and reduce energy taxes for hydrogen producers. This could stimulate companies investing in hydrogen R&D, infrastructure, and waste heat utilization and incentivize research into cost-effective hydrogen production technologies. Moreover, it allows companies to deduct hydrogen infrastructure investments faster, similar to renewable energy tax incentives and encourage the early adoption of hydrogen pipelines, refueling stations, and electrolysis plants. Lastly it could apply VAT reductions on hydrogen supply chains to reduce consumer costs.**

5.2.3. Stimulating market demand

Introduce mandates or quotas for hydrogen use in industrial and transportation sectors

Challenges:

- Heavy industries (steel, cement, chemicals) are responsible for a significant portion of CO_2 emissions and require hydrogen-based decarbonization solutions.
- Transport remains one of the hardest sectors to decarbonize, and hydrogen fuel cell vehicles provide a viable alternative, particularly for long-haul freight and public transport.

Recommendations:

7. **Set a minimum hydrogen usage quota for industries and implement a hydrogen mandate for heavy-duty transport. Defining standards such as at least 10% of hydrogen used in industrial processes to be green hydrogen by 2030, or introduce financial penalties for industries exceeding carbon limits, requiring a percentage of newly registered heavy trucks, buses, and public fleets to be hydrogen- powered by 2030 will help and stimulate H2 investments and lower emissions.**

Support public awareness campaigns to promote hydrogen adoption

Challenges:

- Public perception of hydrogen remains limited, and industries are reluctant to invest due to uncertainty about long-term adoption.
- Countries like Japan and South Korea have successfully driven hydrogen adoption through large-scale public awareness initiative

Recommendations:

8. **Launch a national hydrogen awareness campaign to achieve a "hydrogen certified" label for businesses. It's extremely strategic to educate the PAs and industries on the economic and environmental benefits of hydrogen through the showcase of successful hydrogen projects through media and business conferences. The creation a certification program for companies using green hydrogen, similar to EU energy efficiency labelling will encourage businesses to brand themselves as hydrogen-friendly, increasing consumer trust and corporate engagement.**

5.2.4. Continuous policy monitoring

Establish a hydrogen policy evaluation framework

Challenges:

- The hydrogen sector is evolving rapidly, requiring policies that can adapt to technological advancements and market shifts.
- Policies should be reviewed and updated to reflect new challenges, breakthroughs, and global market trends.
- Without data-driven monitoring, it is difficult to assess whether policies are effective or require modification.
- A structured evaluation system will help track industry adoption, infrastructure development, and investment flow.

Recommendations:

9. **Implement a hydrogen policy review mechanism developing a national hydrogen policy dashboard. The dashboard should collect real-time data on hydrogen production, industrial use, and transport adoption and provide transparent reporting on policy effectiveness for policymakers and investors based on annual monitoring reports.**

5.2.5. Optimizing financial and business models

Key financial and business model optimization measures

Challenges:

- The cost of capital for hydrogen infrastructure is high, making projects less attractive to investors
- Hydrogen infrastructure requires long-term financing, but traditional investor's view hydrogen projects as high-risk due to uncertain demand and policy fluctuations.
- Blended finance mechanisms (combining public and private funds) can help bridge the investment gap.

- Investors and project developers face high uncertainty due to fluctuating input prices (e.g. electricity, water), unpredictable hydrogen demand, and policy shifts.

Recommendations:

10. **Explore green bonds and sustainability-linked financing. Green bonds could help funding hydrogen production, transport infrastructure, and industrial decarbonization offering lower interest rates for companies meeting hydrogen adoption targets.**
11. **Advanced Decision Support Tools (DSTs)—such as the one developed in HyEfRe WP1— should be integrated into all phases of hydrogen business model development. These tools enable scenario-based analysis, optimal infrastructure sizing, and responsive management, supporting both investment decisions and long-term operational efficiency.**

Scalable Business Models

Challenges:

- Hydrogen adoption requires flexible, scalable business models to ensure sustainable market growth.

  Community-driven hydrogen initiatives struggle to access funding, limiting the potential for decentralized hydrogen production.

  Community-driven hydrogen projects can increase local energy resilience and foster public engagement.
- Public-private partnerships (PPPs) are underutilized, despite their potential to share risks and accelerate large-scale hydrogen deployment.
- Public-Private Partnerships (PPPs) can accelerate large-scale hydrogen infrastructure by sharing risks and resources.

Recommendations:

12. **Promote community-driven hydrogen models for localized projects supporting cooperative-based hydrogen projects where local communities, municipalities, and industries decide to co-invest in hydrogen infrastructure.**
13. **Strengthen Public-Private Partnerships (PPPs) to share risks and resources effectively, focusing on hydrogen refuelling stations for heavy-duty transport, electrolysis plants connected to renewable energy sources, hydrogen storage and distribution networks.**

5.2.6. Promoting collaboration and knowledge sharing

Encourage collaboration between research institutions, private companies, and public entities establishing regional and international platforms for sharing best practices and lessons learned

Challenges:

- Facilitates the exchange of successful strategies, reducing redundancy and accelerating progress.
- Encourages standardization and harmonization of hydrogen technologies and policies.
- Combines diverse expertise and resources, fostering innovation and accelerating technology development.

Recommendations:

14. **Create a national hydrogen best practice forum. The establishment of public-private research consortia, the participation to international hydrogen alliances and the launch of collaborative**

innovation challenges could facilitate the exchange of successful strategies, combine diverse expertise and resources and align research objectives with industry needs and public policy goals. Examples are the organization of annual conferences and workshops where stakeholders can present case studies, project outcomes, and lessons learned, the development of an online repository of best practices accessible to all industry participants, the creation an online platform where stakeholders can share research findings, project reports, technical data, and best practices.

15. **Encourage open data policies to promote the sharing of non-confidential data among industry participants to foster transparency and collective learning and developing guidelines for data sharing that protect intellectual property while encouraging collaboration.**

Develop pilot programs to test innovative solutions and scale successful ones

Challenges:

- Validates new technologies and business models in real-world settings before large-scale implementation.
- Identifies potential challenges and refines solutions to ensure scalability and commercial viability.

Recommendations:

16. **Implement regional hydrogen pilot projects selecting specific regions to host pilot projects focusing on various aspects of the hydrogen value chain, such as production, storage, distribution, and end-use applications. Key aspect is the monitoring and the evaluation of pilot projects to gather data and insights for broader deployment.**
17. **Enhance funding for hydrogen R&D. Increase government funding for R&D projects focused on developing cost-effective and efficient hydrogen production methods, such as advanced electrolysis and thermochemical processes and encourage private sector investment in R&D through tax incentives and public-private partnerships.**

Support the development of infrastructure to enable large-scale hydrogen deployment

Challenges:

- Robust infrastructure is essential for the production, storage, distribution, and utilization of hydrogen at scale.
- Developing infrastructure reduces bottlenecks and facilitates the integration of hydrogen into various sectors, including industry and transportation.

Recommendations:

18. **Accelerate the development of hydrogen pipelines and storage facilities and the development of hydrogen refuelling infrastructure. Investments need to be oriented towards the construction of hydrogen pipelines to connect production sites with key industrial and transportation hubs and towards large-scale hydrogen storage solutions to manage supply and demand fluctuations. The expansion of the network of hydrogen refuelling stations is extremely necessary to support the adoption of hydrogen-powered vehicles, particularly in the heavy-duty transport sector.**

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7. Annexes

7.1. Questionnaire Landshut University of Applied Sciences (PP01 TZE)

1. General information

1.1. Scope of legal policy framework

Does your country/region have specific legal frameworks addressing hydrogen policies?

yes

If yes, briefly describe the scope of these frameworks

These frameworks contribute to Germany's hydrogen economy by increasing production, extending infrastructure, and regulating network prices and access. They advocate for sustainability, competitiveness, and Germany's leadership in hydrogen technology.

2. National Hydrogen Strategy

2.1. Existence of a National Strategy

Is there a national strategy for hydrogen development in your country?

yes

If yes, what are the main goals and targets outlined in the strategy?

The National Hydrogen Strategy aims to increase green hydrogen electrolyser capacity to 10 GW by 2030 and create a 1,800 Kilometer hydrogen infrastructure by 2027/2028. It aims to advance hydrogen use in industry, transportation, and power plants while placing Germany as a global leader in hydrogen technology and guaranteeing favourable conditions at the European international levels.

2.2 Key Legal Documents

List key legal or regulatory documents supporting hydrogen policies (e.g., acts, regulations, directives):

Hydrogen Acceleration Act: Create a solid regulatory structure to allow for rapid development and expansion of generation and supply capacities, with the goal of considerably increasing market usage of hydrogen by 2030. One important stipulation is that initiatives falling under the scope of the hydrogen acceleration act are generally regarded to be the overriding public interest and serve public safety.
Hydrogen Network Regulation Ordinance (WasserstoffNEV): This regulation creates the framework for hydrogen network operators by describing the foundation for calculating network costs as well as the rules for determining access charges (network tariffs) for hydrogen networks.
Energy Industry Act (Energiewirtschaftsgesetz): A framework policy that encourages competitiveness, supply security, and sustainbale energy production, requires energy labelling based on the kind of energy source.

2.3 Policy Alignment

How does the national hydrogen policy align with EU-wide strategies (such as the European Green Deal)?

The National Hydrogen Strategy and Hydrogen Acceleration Act are consistent with the European Green Deal as they promote sustainable energy targets, increase hydrogen use in important sectors, and expand the infrastructure. These steps improve EU energy security, lower emissions, and highlight Germany's leadership in hydrogen technology. The focus is on the industry, transport, and electricity sectors with goals such as: creating the right framework conditions, establishing hydrogen applications, and increasing the domestic electrolyzer capacity for green hydrogen production.

3. Regulatory Environment

3.1. Incentives and Subsidies

Are there financial incentives or subsidies for hydrogen-related projects?

yes

If yes, describe these incentives:

The German scheme: Germany has launched a 350-million-euro initiative using the European Hydrogen Bank's "Auctions-as-a-Service" platform to boost renewable hydrogen production. The initiative will fund up to 90 MW of electrolysis capacity, allowing to produce almost 75,000 tonnes of renewable hydrogen. This endeavour corresponds with Germany's goal of generating at least 10 GW of domestic electrolysis capacity by 2030, as well as the EU's renewable energy targets of 42.5% renewable energy by 2030, with a 45% aspirational goal.

The Federal Government is pursuing hydrogen production efforts through the national hydrogen strategy, which includes several billion euros in federal and state grants to boost hydrogen production, establish necessary infrastructure, and facilitate practical uses.

3.2 Licensing and Permitting

What are the main challenges in licensing and permitting hydrogen projects in your country?

Licensing hydrogen projects in Germany is difficult due to uncertain regulatory frameworks, high investment prices, restricted subsidies for building energy systems, and complex approval rules for innovative technologies.

3.3 Regulatory Barriers

Identify any regulatory barriers that may hinder hydrogen integration:

At the EU level, the lack of a consistent green hydrogen definition and imprecise certification restrict progress. Regulatory challenges to hydrogen integration include a lack of precise standards for new technologies and difficult approval laws, which cause project delays.

At German level, there are a few regulatory barriers. Regarding approval procedures and funding policy there's a lack of coordination between the bodies involved, and with that, a lack of speed for the new projects. The competition and unrevealed preferences of funding bodies are a source of inefficiencies in

the funding system. Subsidies are also evaluated as controversial, some of stakeholders' state that subsidies are a barrier for innovation adoption since distort prices and damages the adoption of new technologies by impairing technological openness. Lastly, Diesel subsidies are seen as price distortion hampering cost-effectiveness of hydrogen technologies (Bolz, S., 2024).

4. Section 4: Stakeholder Engagement

4.1. Key Stakeholders

List the primary stakeholders involved in hydrogen policy development (e.g., government agencies, private sector, NGOs)

The German Federal Government.
The German National Hydrogen Council.
Ministerium's.
Private sector (Energy companies, transportation firms, technology providers, …).
Research institutions.

4.2. Stakeholder Consultation

Are stakeholders regularly consulted during the policy development process?

yes

If yes, describe the consultation mechanisms:

Example: The German National Hydrogen Council, which was appointed by the German government, serves as an independent, nonpartisan advisory council. Its goal is to assist and advice the State Secretaries' Committee on the future formulation and implementation of Germany's National Hydrogen Strategy.
Research institutions provide scientific input to the government and private sectors to support policy decisions. Examples on the consultation of research institutions are such as environmental, economic, and social assessments and developing concrete recommendations for action.

5. Future Developments

5.1. Planned Policies

Are there any planned legal or regulatory changes related to hydrogen?

yes

If yes, provide details

Updated National Hydrogen Strategy: the national hydrogen strategy was updated in 2023 with the original strategy was published in 2020. The updated strategy focuses on increasing the electrolysis capacity, develop the hydrogen infrastructure and determine the priority consumption sectors.

7.2. Questionnaire Mazovia Energy Agency (PP02 MAE)

1. General information

1.1. Scope of legal policy framework

Does your country/region have specific legal frameworks addressing hydrogen policies?

Yes, the Act of 21 November 2024 amending the Energy Law introduced new regulations for the hydrogen sector in Poland and is part of a legislative package referred to as the Constitution for Hydrogen.

If yes, briefly describe the scope of these frameworks

The changes to the energy law that came into force on 20 January 2025 should be of key importance for the development of the hydrogen economy in Poland through:

- the introduction of a stable regulatory framework. Ensuring certainty for investors should accelerate investment decisions in hydrogen infrastructure and projects. In some cases, the requirement to obtain a licence or certification will lengthen the investment process.
- infrastructure development. Regulating the transmission, distribution and storage of hydrogen will enable the creation of a comprehensive hydrogen system that will be compatible with gas and electricity systems.
- support for small installations: Definitions and regulations for small storage installations support local initiatives based on renewable energy sources, which can increase the availability of hydrogen in rural and industrial regions.
- synergies in the energy system: Cooperation between gas, electricity and hydrogen system operators will enable the efficient integration of hydrogen into the existing energy infrastructure.
- certification and transparency: The introduction of certificates for renewable and low-carbon hydrogen promotes the development of a market that complies with EU requirements and enables international trade.

2. National Hydrogen Strategy

2.1. Existence of a National Strategy

Is there a national strategy for hydrogen development in your country?

In 2021, Poland adopted its own 'Hydrogen Strategy until 2030 with an outlook until 2040'.

If yes, what are the main goals and targets outlined in the strategy?

The Polish Hydrogen Strategy (PHS) identifies six specific objectives:

Objective 1 - implementation of hydrogen technologies in the power and heating sectors;

Objective 2 - use of hydrogen as an alternative fuel in transport;

Objective 3 - support for the decarbonisation of industry;

Objective 4 - production of hydrogen in new installations;

Objective 5 - efficient and safe transmission, distribution and storage of hydrogen;

Objective 6 - creation of a stable regulatory environment.

The implementation of the PHS objectives will contribute to accelerating the decarbonisation process in the most energy-intensive sectors. Its provisions will enable the environmentally friendly production of hydrogen on an industrial scale and the gradual pursuit of a zero-emission economy in Poland.

The PHS sets out a total of 44 measures to enable the achievement of its objectives. It will support the development of individual regions of Poland by, among other things, creating hydrogen valleys in them, which will allow the construction of a value chain related to the hydrogen economy, such as the production, transport, storage and final use of hydrogen in industry. The valleys will be home to R&D&I projects and investment projects that will contribute to cooperation between local, national and foreign stakeholders.

The Strategy also defines horizontal activities concerning the utilisation of Polish research and development potential in the field of hydrogen technologies and the development of hydrogen-powered vehicle production plants and components necessary for the hydrogen economy.

PHS supports all methods of low- and zero-emission hydrogen production, with an emphasis on: the water electrolysis process, biomass gasification, fermentation or pyrolysis technology, biogas steam reforming, biomethane steam reforming, gasification, thermal processing or pyrolysis of waste, waste gases, steam reforming of hydrocarbons with CO2 capture and storage (CCS/CCU) technology, coal gasification with CCS/CCU technology, IGCC and IGFC technology.

The indicators for achieving the objectives of the National Energy Strategy by 2030 will be:

- Installed capacity of low-carbon hydrogen production facilities: 50 MW by 2025 and 2GW by 2030;
- Number of hydrogen valleys: at least 5;
- Number of hydrogen buses in use: 100-250 by 2025 and 800-1000 by 2030;
- Number of hydrogen stations: min. 32 by 2025;
- Conclusion of the Sectoral Agreement for the Construction of a Hydrogen Economy (concluded on 14.10.2021);
- Creation of the Hydrogen Valleys Innovation Ecosystem;
- Creation of the Hydrogen Technology Centre.

2.2 Key Legal Documents

List key legal or regulatory documents supporting hydrogen policies (e.g., acts, regulations, directives):

- Act of 21 November 2024 amending the Energy Law Act and certain other acts (Journal of Laws of 2024, item 1881).
- Energy Policy of Poland until 2040 (EPP2040).
- Poland's National Energy and Climate Plan for the years 2021-2030 (NECP)
- Strategy for Responsible Development for the period up to 2020 (including the perspective up to. 2030).

2.3 Policy Alignment

How does the national hydrogen policy align with EU-wide strategies (such as the European Green Deal)?

The Polish Hydrogen Strategy is consistent with international and national strategic documents. Above all, it is in line with European Union initiatives such as the EU Hydrogen Strategy and the

European Green Deal. In addition, it refers to international climate agreements, including the Paris Agreement, which commit Poland to taking action to reduce greenhouse gas emissions.

3. Regulatory Environment

3.1. Incentives and Subsidies

Are there financial incentives or subsidies for hydrogen-related projects?

Currently, a wide range of funding sources for hydrogen projects is available in Poland, which is related to the implementation of both the National Recovery and Resilience Plan and operational programmes planned to be implemented in the 2021-2027 financing perspective.

If yes, describe these incentives:

In 2021, the National Centre for Research and Development (NCBR) announced a competition in the strategic programme 'New energy technologies', which included support for hydrogen production and utilisation technologies. The total budget allocated to support hydrogen technologies was PLN 141.2 million. Earlier in 2018, as part of the 'Modern Methods of Hydrogen Storage' programme, the National Centre for Research and Development was involved in activities aimed at developing an innovative, mobile hydrogen tank for use with fuel cells. The programme's budget amounted to PLN 32 million.

The National Fund for Environmental Protection and Water Management (NFOŚiGW) is also involved in financing the hydrogen economy. Among the programmes of the National Fund for Environmental Protection and Water Management (NFOŚiGW), there are activities related to the support of projects related to the purchase of hydrogen vehicles under the 'Green Public Transport' programme. Another programme in which funds were available for hydrogen-related projects was the 'Support for electric vehicle charging and hydrogen refuelling infrastructure' programme with a budget of PLN 870 million.

Projects aimed at implementing technologies such as the production of 'emission-free' hydrogen using wind or solar energy, the use of hydrogen in road, rail or water transport, adapting the existing infrastructure to hydrogen transport or building new installations for the transport and storage of this element, liquefaction, transport and storage of hydrogen in liquid form, large-scale storage of hydrogen from renewable energy sources, as well as the use of hydrogen in industry, e.g. in steel production. Six projects with a total requested funding of PLN 395.6 million were selected in the competition and pre-selection process.

The currently available funding is related to the implementation of the National and Resilience Recovery Plan instrument by Bank Gospodarstwa Krajowego. Investments in hydrogen technologies are being financed, and the programme provides non-repayable support for projects related to the production, storage and transport of hydrogen. The budget for these investments is 640 million euros and is part of a larger pool allocated to rebuilding the economy after the pandemic. Installations with a capacity of 20 MW or more will be eligible for support.

Additionaly, the Centre for EU Transport Projects (i.e. CEUTP) provides funding support for the purchase of zero-emission bus fleets (electric, hydrogen) together with the necessary charging/refuelling infrastructure (if applicable), for:

- the operation of newly created non-urban bus lines, including services connecting the city, a neighbouring municipality and at least one municipality other than a neighbouring one
- replacement of the bus fleet on existing non-urban bus lines, including services connecting the city, a neighbouring municipality and at least one municipality other than a neighbouring one.

The source of funding awaiting launch is the Modernisation Fund managed by the National Fund for Environmental Protection and Water Management, which will also offer grants for hydrogen-related investment projects. Companies planning to build a plant with a capacity of at least 1 MW will be able to apply for support. The planned budget for this programme is 5 billion PLN. On 10 January 2025, public consultations were completed to determine the details of the new programme.

3.2 Licensing and Permitting

What are the main challenges in licensing and permitting hydrogen projects in your country?

According to new regulations, in force in Poland since the beginning of 2025, a licence is required to carry out certain activities related to the storage and trade of hydrogen. In principle, a licence is required for the storage of hydrogen, with the exception of local storage in small hydrogen storage facilities (i.e. the storage of hydrogen at the place of its production or at the place intended for sale for transport purposes in a facility with a capacity of less than or equal to 55,000 Nm3). The trading of hydrogen is also subject to a licence requirement, which only does not apply if the annual trading volume does not exceed the equivalent of one million euros.

Operators of hydrogen systems are obliged to keep records of hydrogen storage facilities connected to the hydrogen system. The obligation to obtain a registration applies to installations that are not small hydrogen storage facilities.

The construction or reconstruction of hydrogen networks with an operating pressure of no more than 0.5 MPa, as well as the construction of hydrogen connections and the construction of hydrogen purification equipment with a capacity of no more than 250 kg of hydrogen per day do not require a building permit, only a notification of construction or other construction work.

The construction and maintenance of installations and equipment for the transport or storage of hydrogen, as well as other facilities and equipment necessary for the use of these installations and equipment, have been recognised as a public purpose. This regulation has made it possible to speed up the process of obtaining the necessary administrative permits and to limit the possibility of challenging such permits in disputes before administrative authorities or administrative courts.

After the change in regulations, the transport of hazardous substances by hydrogen pipelines did not allow the plant to be classified as a plant with an increased risk of failure or a high risk of failure - except when such transport takes place in a plant that has already been classified as one of the specified categories. Thanks to this regulation, the plant operator is not subject to increased control obligations and extensive administrative duties.

3.3 Regulatory Barriers

Identify any regulatory barriers that may hinder hydrogen integration:

The new regulatory package addressed most of the problems reported by stakeholders of the hydrogen market in Poland. We are currently in the phase of observing the effects of introducing the regulation. A possible assessment of potential barriers and their impact on the development of the use of renewable hydrogen will be possible in the longer term.

4. Section 4: Stakeholder Engagement

4.1. Key Stakeholders

List the primary stakeholders involved in hydrogen policy development (e.g., government agencies, private sector, NGOs)

- Ministry of Climate and Environment;
- Ministry of Infrastructure
- Ministry of Development Funds and Regional Policy
- The National Development Bank (Polish: Bank Gospodarstwa Krajowego, BGK);
- Industrial Development Agency JSC (Polish: Agencja Rozwoju Przemysłu S.A.);
- National Fund for Environmental Protection and Water Management (Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej, NFOŚIGW);
- The Institute of Power Engineering - National Research Institute
- The Central Mining Institute - National Research Institute (GIG-PIB)
- The Oil and Gas Institute - National Research Institute
- City of Warsaw
- Metropolis GZM
- City of Wałbrzych
- City of Chełm
- Warsaw University of Technology
- Silesian University of Technology
- ORLEN S.A.
- Gas Transmission System Operator GAZ-SYSTEM S.A.
- PESA Bydgoszcz S.A.
- Grupa Azoty S.A.
- Polenergia S.A.
- ZE PAK (NESO).
- TAURON Polska Energia S.A.
- Alstom Konstal S.A.
- Toyota Central Europe
- Eneria CAT Polska
- Port of Gdynia Authority S.A.
- The Polish Energy Storage Association
- The Lower Silesia Hydrogen Valley
- The Cluster of Hydrogen Technologies and Clean Coal Technologies for the Pomeranian Voivodeship
- The New Mobility Association (PSNM)

4.2. Stakeholder Consultation

Are stakeholders regularly consulted during the policy development process?

Yes, the key executive instrument of the Polish Hydrogen Strategy until 2030 with an outlook until 2040 is the Sectoral Agreement for the Development of the Hydrogen Economy.

If yes, describe the consultation mechanisms:

Within the framework of the Sector Agreement, the Coordination Council for the Hydrogen Economy (Coordination Council) was established on 15 March 2022 to ensure the implementation of the objectives set out in the document. The Coordination Council currently consists of 40 people representing the following sectors:

- business community - 16 representatives;
- public administration - 10 representatives;
- academia - 8 representatives;
- business support organisations - 6 representatives.

In order to achieve the objectives of the Sector Understanding, the Coordination Council has established Working Groups that deal with the development of individual segments of the hydrogen economy. The work of each Working Group is led by a Working Group Coordinator, whose selection was approved at the 2nd Meeting of the Coordination Council. There are currently six working groups within the framework of the Sector Agreement. The working group coordinators have the option of appointing sub-working groups within their working group to implement and realise specific areas of the working group's activities. The sub-working groups are led by group leaders selected by the group coordinator.

An annual meeting of all signatories is held to summarise the work and achievements and to set goals for the following year. The event also serves as a platform for the exchange of experiences and the development of potential partnerships and business synergies between the parties to the sector agreement.

5. Future Developments

5.1. Planned Policies

Are there any planned legal or regulatory changes related to hydrogen?

This year's amendment (2025) to the regulations introduces the expected changes to facilitate the functioning of hydrogen technologies in Poland.

If yes, provide details

-

5.2 Vision for Hydrogen Economy

What is your organization's vision for the hydrogen economy in your country/region?

The Mazovian Hydrogen Valley, which is being developed in our region, is based on four pillars that will contribute to the effective development and dissemination of hydrogen technologies both regionally and nationally. The main goal is to build a hydrogen value chain in the Mazovia region, as exemplified by the first hydrogen projects planned to be implemented by ORLEN, including hydrogen hubs in Płock and Ostrołęka, a prototype hydrogen locomotive and hydrogen refuelling stations. Other pillars include the implementation of research and development projects, the creation of systemic solutions for the training of specialised personnel and activities to support regulatory processes.

A milestone in the development of the hydrogen valley was the positive decision in August 2024 to award funding of almost 9 million euros from the Clean Hydrogen Partnership under the Horizon Europe programme for the HySPARK project. The project aims to develop the full hydrogen economy value chain, including the production, distribution, storage and use of hydrogen in transport and industry.

https://www.orlen.pl/en/about-the-company/media/press-releases/2024/August-2024/orlen-secures-eu-grant-for-hydrogen-projects

6. Additional Comments

6.1. Other Insights

Please provide any additional comments or insights you believe are relevant:

-

7.3. Questionnaire Regional Development Agency of South Bohemia (PP03) RERA

1. General information

1.1. Scope of legal policy framework

Does your country/region have specific legal frameworks addressing hydrogen policies?

Yes, hydrogen is addressed in the Energy Act (458/2000 Coll.) after its novelization in 2024. Hydrogen is now recognised as energy gas and it is set into the same legal framework as natural gas. The Czech Republic also has a national Hydrogen strategy, which is a key strategic document for the development of hydrogen in Czechia. There is no legislative framework created on the regional level.

If yes, briefly describe the scope of these frameworks

The novelization of the Energy Act that came into force from 1st January 2024 now classifies hydrogen among gases that are eligible to be distributed though the gas pipeline network. This change allows companies to mix natural gas and hydrogen.

2. National Hydrogen Strategy

2.1. Existence of a National Strategy

Is there a national strategy for hydrogen development in your country?

Yes, the Hydrogen strategy of the Czech Republic.

If yes, what are the main goals and targets outlined in the strategy?

The Hydrogen strategy of the Czech Republic can be divided into three phases: local islands (2023-2030), global bridges (2027-2050) and new technologies (2040-2060).

The 1st phase LOCAL ISLANDS aims to create decentralized system of electrolysers with capacity of at least 400 MWe that will be able to produce approximately 20.000 tons of RFNBO hydrogen annually. This set goal should be met until the year 2030.

The 2nd phase GLOBAL BRIDGES aims co create a system of linear structures that will be able to import cheaper hydrogen from abroad. Two main hydrogen pipelines are now under consideration: first one from Sachsen, Germany (Czech German Hydrogen Interconnector) and second one from west Ukraine through Slovakia (Central European Hydrogen Corridor). Both projects are expected to be completed by 2030.

The 3rd phase NEW TECHNOLOGIES plans to use future technologies for the production of hydrogen, such as geothermal energy or new generation of nuclear reactors suitable for producing cheap hydrogen using high-temperature electrolysis.

Due to the difficult-to-predict technological, political and legislative developments, the goals of the Hydrogen Strategy are now focused primarily on the time horizon until 2030.

Main overall goes of the strategy are:

- Build at least 400 MWe of electrolyser capacity with priority by 2027, until 2030, and ensure appropriate support programs;
- By 2025, ensure simplification and acceleration of related processes: environmental impact assessment, building law and acceleration zones;
- By the end of 2024, analyze and adjust subsidy titles necessary for the development of the hydrogen economy;
- By the end of 2024, create conditions for the emergence of hydrogen valleys, especially in transforming coal regions;
- By the end of 2024, announce specific calls for support for the development of the hydrogen valley concept and the application of comprehensive application chains of hydrogen technologies, in cooperation with emerging hydrogen valleys, especially in transforming coal regions;
- By the end of 2024, create conditions and ensure full cooperation of all components of the central state administration with the aim of accelerating, according to the needs of emerging hydrogen valleys, especially in transforming coal regions, the preparation of development projects and the activation of implementation processes of specified projects;
- By 2025-2026, create a comprehensive legislative and regulatory framework for the hydrogen economy, including a framework for guarantees of origin, certificates, technical standards, etc.;
- By 2030, repurposing 2 branches of the gas transmission system (Lanžhot – Brandov, Brandov – Waidhaus) and strengthening the role of the Czech Republic in the area of hydrogen transit transport;
- By 2025, analyse the method and form of repurposing the gas distribution infrastructure;
- In the 2024-2028 horizon, prepare the gas infrastructure for a blend of hydrogen and natural gas, in accordance with the requirements of European legislation and according to the results of related analyses;
- In the 2026-2028 horizon, analyse the possibilities and technical feasibility of storing hydrogen in existing storage tanks, or other possibilities for storing hydrogen;
- Ensure the fulfilment of the objectives of the NAP CM in the field of hydrogen mobility: support for the purchase of hydrogen road and rail vehicles, development of hydrogen public transport, in a coordinated manner with the construction of a backbone network of hydrogen filling stations and the development of mobile filling stations;
- Prepare, as necessary, in the context of the Export Strategy, trade missions for Czech companies and cooperate with foreign partners in the field of hydrogen technologies and hydrogen production. This should be done in cooperation with the CzechTrade agency and its foreign offices, with the Czech Republic's embassies and, if necessary, the CzechInvest agency;
- Prepare an awareness campaign for companies and launch related information websites;
- Support education and research in the field of hydrogen technologies, with particular emphasis on applied research.

2.2 Key Legal Documents

List key legal or regulatory documents supporting hydrogen policies (e.g., acts, regulations, directives):

In the Czech Republic, there is currently no single comprehensive law that would exclusively regulate all aspects of hydrogen use. However, it is affected by several existing legal regulations and strategic documents, and active work is being done to create a more comprehensive legislative framework.

Key legal documents:

- Energy Act (No. 458/2000 Coll.): An amendment to this Act, effective from 1 January 2024, included hydrogen among the gases that can be distributed through the gas network. Hydrogen is thus placed on an equal footing with natural gas within the distribution infrastructure. The Act allows for both a mixture of hydrogen and natural gas (up to 20%) and the distribution of pure hydrogen.
- Act on Fuels (No. 311/2006 Coll.): This Act defines hydrogen as an alternative fuel and regulates the conditions for the sale and distribution of fuels, which also applies to hydrogen as a fuel for vehicles.
- Air Protection Act (No. 201/2012 Coll.): This Act transposes the RED III Directive, which introduces obligations for fuel suppliers regarding the minimum amount of renewable fuels of non-biological origin (including hydrogen) and for industrial hydrogen consumers regarding the share of renewable hydrogen.
- Act on Supported Energy Sources (No. 165/2012 Coll.): This Act regulates guarantees of origin of energy, which also applies to hydrogen produced from renewable sources. Implementing Decree No. 328/2022 Coll. on guarantees of origin of energy further specifies this.
- Pressure equipment: The use of hydrogen, in particular its storage and transport, falls under the legal regulations relating to pressure equipment, such as Decree No. 18/1979 Coll., which determines reserved pressure equipment, and related technical standards (e.g. ČSN 07 8304, ČSN 69 0012).
- Regulation (EC) No 79/2009 of the European Parliament and of the Council: This Regulation concerns the type-approval of hydrogen-powered vehicles.

Strategic documents:

- Hydrogen Strategy of the Czech Republic
- National Recovery Plan: The update of the Hydrogen Strategy of the Czech Republic is part of the reforms within the framework of the implementation of the National Recovery Plan.

2.3 Policy Alignment

How does the national hydrogen policy align with EU-wide strategies (such as the European Green Deal)?

The update of the Hydrogen Strategy of the Czech Republic responds to new conditions resulting from the approval or negotiation of a number of documents and legal regulations of the European Union (EU), such as:

- The Paris Agreement,
- the EU Hydrogen Strategy,

- the EU System Integration Strategy,
- the Fit for 55 package,
- the Renewable Energy Directive (RED),
- the Delegated Act establishing the EU methodology for detailed rules for the production of renewable fuels of domestic origin,
- the restoration of the domestic gas market,
- the Domestic Gas Regulation,
- the Alternative Gas Regulation with Hydrogen Deployels (AFIR),
- the Block Exemption Regulation (GBER),
- the Climate, Environment and Energy Port State Guidelines (CEEAG),
- the Regulation governing the European Ecosystem Management Framework for the Production of Zero-Emission Products,
- the European Union REPowerEU plan.

3. Regulatory Environment

3.1. Incentives and Subsidies

Are there financial incentives or subsidies for hydrogen-related projects?

Yes, there are several subsidy programmes that supports hydrogen development.

If yes, describe these incentives:

- **Modernisation Fund** is one of the main supportive programmes for energy transition, uses financial resources gained through emission permits. **RES+** sub-programme focuses on licenced energy providers and support development of photovoltaics including energy accumulators such as electrolysers and H2 storage solutions. **ENERG ETS** sub-programme focuses on decrease of emissions in industries including replacement of fossil fuels with renewable hydrogen. **TRANSCom** sub-programme focuses on purchase of emission-free vehicles, including H2-powered vehicles. **TRANSGov** sub-programme focuses on public entities and their transportation services, specifically on purchase of emission-free vehicles. **GREENGAS** sub-programmes supports private companies in production and storage of renewable energy in selected industries. This sub-programme can also support repurposing of gas transmission systems or creation of hydrogen valleys. I+ sub-programme focuses on individual complex innovation solutions reaching beyond the Modernisation fund and are subject of evaluation in EIB.
- **Innovation fund** strengthens innovative potential of companies in energy transition.
- **Operational Programme Just Transformation** aims at three past-coal regions in the Czech Republic, offering several axes, where energy transition is the biggest one.
- **Recovery and Resilience Facility** supports clean mobility and decreasing the dependency on fossil fuels. Key component is decarbonisation of road transportation.
- **Operational Programme Transportation** supports creation of H2 filling stations. In the future the programme aims to support development of H2 linear infrastructure.

- **Integrated Regional Development Programmes** focuses on transformation of multimodal urban mobility with purchase of vehicles or creation of filling stations for public transportation.

3.2 Licensing and Permitting

What are the main challenges in licensing and permitting hydrogen projects in your country?

The main challenges in licensing and permitting hydrogen projects in the Czech Republic comes from the lack of a comprehensive and specific legal framework for hydrogen, the complexity of applying existing regulations to novel hydrogen technologies and infrastructure, uncertainties surrounding the definition and certification of low-carbon hydrogen, the need for streamlined permitting processes for infrastructure development, the importance of robust safety regulations, and the ongoing alignment with evolving EU policies.

Addressing these challenges through the development of clear, specific hydrogen legislation and streamlined permitting procedures will be crucial for unlocking the potential of hydrogen in the Czech Republic's energy transition.

Currently, there is no dedicated act in the Czech Republic that specifically addresses the production, transportation, storage, and utilization of hydrogen. Hydrogen is integrated into the Energy Act, but more complex solution is needed. The legal framework for hydrogen projects is fragmented across various existing laws, including the mentioned Energy Act, Chemical Act, Act on Protection of Public Health, transport regulations, and environmental protection legislation. This can lead to complexity and uncertainty for project developers.

The permitting processes for energy projects in general can be lengthy and complex in the Czech Republic, involving multiple authorities and regulations. Applying these existing frameworks to novel hydrogen projects can create additional problems due to a lack of specific guidelines and expertise within the regulatory bodies. Obtaining necessary permits might involve navigating environmental impact assessments, building permits, operational licenses, and safety approvals under different pieces of legislation. Coordination between different ministries and regional authorities involved in the permitting process can be challenging and time-consuming.

3.3 Regulatory Barriers

Identify any regulatory barriers that may hinder hydrogen integration:

The main barriers include insufficient legislation and a regulatory framework specific to hydrogen. There is a lack of comprehensive legislation that would clearly define the rules for the production, transport, storage and use of hydrogen, which leads to complications.

Significant barrier is the permitting processes, which are often time-consuming and complex. The application of existing energy construction regulations to new hydrogen technologies and infrastructure can be problematic due to the lack of specific hydrogen standards and experience of the approval authorities.

Economic aspects represent another significant obstacle. The high initial investment costs for the development and construction of hydrogen technologies and infrastructure, together with the relatively high production costs of low-carbon hydrogen, hinder its competitiveness compared to conventional fuels. Insufficient financial support and incentives for hydrogen projects further exacerbate this problem.

Third aspect to mention is the insufficient infrastructure for the transport and storage of hydrogen. There is a lack of a backbone network of hydrogen pipelines and the necessary storage capacity in the Czech Republic. Building new infrastructure is expensive and time-consuming, and using existing gas infrastructure for hydrogen transport faces technical and regulatory limits.

Technological readiness and innovation are other areas where barriers exist. Some key hydrogen technologies, especially in the area of efficient and cost-effective hydrogen production, storage and use, are still in the development phase and require further research and innovation.

Safety aspects and public perception also play a role. It is necessary to ensure a high level of safety when handling hydrogen while building public trust in this technology through education and transparent communication.

Last but not least, the lack of coordination and cooperation between relevant actors should be mentioned - state administration, industry, research institutions and local governments. Effective cooperation is key to overcoming barriers and accelerating the development of the hydrogen economy.

4. Section 4: Stakeholder Engagement

4.1. Key Stakeholders

List the primary stakeholders involved in hydrogen policy development (e.g., government agencies, private sector, NGOs)

Ministry of Industry and Trade of the Czech Republic

Ministry of Transportation of the Czech Republic

Ministry of Environment of the Czech Republic

Ministry of Regional Development of the Czech Republic

Confederation of Industry and Transport of the Czech Republic

Czech hydrogen technology platform (HYTEP)

The Czech Gas Association

Energy Regulatory Office Czech Republic

Association of Regions of the Czech Republic

Hydrogen Coordination Group

National Hydrogen Council

Moravian-Silesian Hydrogen Cluster

ČEZ

ORLEN Unipetrol

GasNet

MND

Veolia

BorsodChem MCHZ:

Vítkovice, a.s.

4.2. Stakeholder Consultation

Are stakeholders regularly consulted during the policy development process?

Yes, stakeholders are consulted during the policy development process.

If yes, describe the consultation mechanisms:

The description of mechanism is rather vague. Overall, the consultation mechanisms emphasize collaboration among government agencies, engagement with advisory bodies, and broader stakeholder involvement to ensure that the hydrogen strategy reflects diverse perspectives and expertise.

5. Future Developments

5.1. Planned Policies

Are there any planned legal or regulatory changes related to hydrogen?

Yes

If yes, provide details

Yes, legal and regulatory changes are planned in connection with the development of the hydrogen economy in the Czech Republic. The reason is the current insufficient legal framework that slow down the wider application of hydrogen. There is a significant need to create a comprehensive legislative framework that will regulate all aspects related to the production, transport, storage and use of hydrogen. This framework should, among other things:

- Simplify and accelerate the permitting processes for hydrogen projects.
- Establish clear rules and standards for the safety of the operation of hydrogen facilities and infrastructure.
- Define the conditions for the integration of hydrogen into the existing energy infrastructure, especially the gas network.
- Specific planned changes include, for example:

The aim of these changes is to create a predictable and supportive regulatory environment that will facilitate investments in hydrogen technologies and contribute to the development of the hydrogen economy in the Czech Republic.

5.2 Vision for Hydrogen Economy

What is your organization's vision for the hydrogen economy in your country/region?

The development of hydrogen economy in the Czech Republic is heavily influenced by the lack of massive investments to the renewable energy sources. The state clearly states that it will rely on import of H2 from abroad, because Czechia won't be able to create massive capacity of solar or wind energy sources in the near future. In this decade, pilot projects will run to show the applicability. As mentioned in the H2 strategy, linear connection from Sachsen, Germany will be made and will most likely go through the South Bohemian Region. That is a good opportunity for local ecosystem to adapt and prepare for it.

7.4. Questionnaire Energieinstitut an der Johannes Kepler Uniersitat Linz (PP04 EI-JKU)

1. General information

1.1. Scope of legal policy framework

Does your country/region have specific legal frameworks addressing hydrogen policies?

Yes

If yes, briefly describe the scope of these frameworks

Beside the national hydrogen strategy, there is a legal framework supporting electrolysers construction and renewable hydrogen production, however some specific detailed legal policies are still missing.

2. National Hydrogen Strategy

2.1. Existence of a National Strategy

Is there a national strategy for hydrogen development in your country?

Yes, there is an Austrian Hydrogen Strategy, developed in 2022

If yes, what are the main goals and targets outlined in the strategy?

Main targets are:

- Replace fossil-based hydrogen with climate neutral hydrogen in energy intensive industries: 80% until 2030
- Install 1GW of electrolyser capacity by 2030
- Create a supporting framework for the production of renewable hydrogen
- Establish the production of hydrogen as integral part of the energy system
- Develop a targeted hydrogen infrastructure
- Enhance international partnerships for climate neutral hydrogen
- Strengthen the innovation and technology potential in Austria through focused development of hydrogen technologies

2.2 Key Legal Documents

List key legal or regulatory documents supporting hydrogen policies (e.g., acts, regulations, directives):

Hydrogen Promotion Act (Wasserstoffförderungsgesetz, WFöG): Enacted on July 4, 2024, this law provides the legal basis for funding the construction and operation of facilities producing renewable hydrogen of non-biological origin. It introduces a competitive bidding mechanism, allocating up to €820 million between 2024 and 2026 in the form of fixed premiums per unit of renewable hydrogen produced.

Renewable Gas Act (Erneuerbare-Gase-Gesetz, EGG): Approved by the Council of Ministers on February 21, 2024, and submitted to parliament, the EGG aims to expand domestic renewable gas production, including green hydrogen. It mandates that gas suppliers ensure a certain percentage of the gas supplied to customers comes from renewable sources, with a target of at least 7.5 terawatt-hours of green gas fed into the Austrian gas grid annually by 2030. The Act was not passed yet.

Renewable Energy Expansion Act (Erneuerbaren-Ausbau-Gesetz, EAG): Implemented to accelerate the growth of renewable energy sources, the EAG includes provisions for investment grants supporting the construction of plants that convert renewable electricity into renewable hydrogen or synthetic gases. On June 26, 2024, the draft of the EAG Investment Subsidies Ordinance for Hydrogen was submitted for review.

Hydrogen Strategy for Austria: Developed jointly by the Federal Ministry of Labour and Economy and the Federal Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology, this strategy lays the foundation for building an innovative hydrogen economy in Austria. It sets goals such as establishing 1 GW of electrolysis capacity by 2030 and forming international partnerships to develop suitable hydrogen infrastructure.

Additional national funding mechanisms for hydrogen research projects, including support for mobility and industry are available.

2.3 Policy Alignment

How does the national hydrogen policy align with EU-wide strategies (such as the European Green Deal)?

Austria's national hydrogen policy aligns closely with EU-wide strategies, particularly the European Green Deal and the EU Hydrogen Strategy and focuses particularly on renewable hydrogen and use of hydrogen to decarbonise hard-to-abate sectors.

3. Regulatory Environment

3.1. Incentives and Subsidies

Are there financial incentives or subsidies for hydrogen-related projects?

Incentives and subsidies within the EAG (Renewable Energy Expantion Act)

If yes, describe these incentives:

Anchored in the EAG is an exemption from the renewables subsidy flat rate and subsidy contribution for electrolysis plants for the production of renewable hydrogen, exemption from grid utilisation and grid provision fees for electricity for electrolysis plants for the production of renewable hydrogen.

Additionally, within EAG CAPEX support for electrolysers is planned for around 40 M€ per year.

4. Section 4: Stakeholder Engagement

4.1. Key Stakeholders

List the primary stakeholders involved in hydrogen policy development (e.g., government agencies, private sector, NGOs)

Energy producers, public utilities, gas storage companies, industry representatives etc. are involved in the hydrogen policy development in general, however no exact organisation names can be given here, as no publicly information is available, except the information on stakeholder exchange process organised by HyPa (Hydrogen Partnership) organisation (https://www.hypa.at/en/politik/dialogue-process).

4.2. Stakeholder Consultation

Are stakeholders regularly consulted during the policy development process?

Generally, there are stakeholder consultations, including energy producer, public utilities, gas storage companies, industry representatives etc.

Within the project HyEfRe – Austrian assoc. partner hydrogen association WIVA P&G and policy stakeholders will be consulted during the A 2.3 “development of Policy Recommendations”.

If yes, describe the consultation mechanisms:

The discussion on specific policy adjustments will be carried out during a bilateral meeting with WIVA P&G and policy stakeholders.

5. Future Developments

5.1. Planned Policies

Are there any planned legal or regulatory changes related to hydrogen?

Revised Gas Act 2011 (Gaswirtschaftsgesetz 2011 – GWG 2011)

Ordinance on investment grants for electrolysis plants based on EAG (Renewable Energy Expantion Act)

If yes, provide details

The Gas Act 2011 (Gaswirtschaftsgesetz 2011 – GWG 2011) is planned to be adopted according to the new Gas Directive (EU) 2024/1788 including the provisions for renewable gases, hydrogen and low-carbon gases. The aim is to establish a separate hydrogen economy with defined roles for all actors like production, distribution, storage, consumption, etc.

Ordinance on investment grants for electrolysis plants based on EAG (Renewable Energy Expantion Act) is in development since 2023. Investments for about 40 M€ annually to cover CAPEX are foreseen.

5.2 Vision for Hydrogen Economy

What is your organization's vision for the hydrogen economy in your country/region?

Our institute do not have any specific visions on hydrogen economy, however, we believe that renewable hydrogen will be one of the options to especially decarbonise the hard-to-abate industries, industries, which are represented within Austria and particularly in Linz, where our institute is based.

6. Additional Comments

6.1. Other Insights

Please provide any additional comments or insights you believe are relevant:

7.5. Questionnaire Energy Institute Hrvoje Pozar (PP06 EIHP)

1. General information

1.1. Scope of legal policy framework

Does your country/region have specific legal frameworks addressing hydrogen policies?

Yes

If yes, briefly describe the scope of these frameworks

The following laws of the Republic of Croatia regulate the possibilities of using hydrogen:

Law on Biofuels for Transport (OG, No. /09, 145/10, 26/11, 144/12, 14/14, 94/18 and 52/21) - by the amendments from 2021 introduction of the hydrogen on the Croatian market is foreseen. In accordance with this Law, the person liable for placing biofuels or renewable energy in transport on the market, is obligated to prepare a Program (for three years) and a Plan (for one year) that includes the projected quantities of hydrogen from renewable sources for transport purposes that it intends to place on the market as well as report on the use of hydrogen as an alternative fuel on the market.

Law on the Deployment of Alternative Fuels Infrastructure (OG No. 120/16 and 33/22) - defined technical specifications for vehicle hydrogen filling stations. This law defines hydrogen as an alternative fuel, i.e., as a fuel or energy source that serves, at least partially, as a substitute for fossil fuel sources in the energy supply of transport and that has the potential to contribute to the decarbonization of the transport system and improve the environmental efficiency of the transport sector. This law transposed Directive 2014/94 EU of the European Parliament and the Council of October 22, 2014, on the establishment of infrastructure for alternative fuels (AFID) into Croatian legislation. In accordance with the Law, hydrogen filling stations will be built following the National Policy Framework (NPF).

Hydrogen is also mentioned in the Law on Electricity Market (OG. No. 11/21, 83/23), which states that electricity, among other things, can be stored in electrolyzers with hydrogen storage.

As the national coordinating body for hydrogen, the Law on Renewable Energy Sources and High-Efficiency Cogeneration (OG No. 138/21 and 83/23) has designated the Croatian Hydrocarbons Agency (CHA).

Further to the above, the introduction of hydrogen as a new energy carrier in the transport sector of the Republic of Croatia will be accompanied by legal and by-law regulations, which will include new standards related to hydrogen as an alternative fuel, including new technologies that appear in the process from production to consumption of hydrogen as energy storage and alternative fuel. Also, it is necessary to build an appropriate infrastructure for the production, distribution, and supply of hydrogen and, at the same time, encourage the procurement of vehicles, ships, and trains that use hydrogen as a fuel with the aim of creating consumption.

As for hydrogen in the transport sector, it is necessary to mention the Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure (AFIR) that repealed AFID. This Regulation is directly applicable in all Member States including Croatia. AFIR sets mandatory national targets for EU Member States to deploy publicly accessible alternative fuels infrastructure (for electricity and hydrogen) for road vehicles, explicitly focusing on the trans-European networks. According to the AFIR, mandatory

deployment targets for publicly accessible hydrogen refueling points should ensure a sufficiently dense network across the EU Trans-European Transport Network (TEN-T) core network to allow for the seamless travel of hydrogen-powered light-duty and heavy-duty vehicles throughout the EU

2. National Hydrogen Strategy

2.1. Existence of a National Strategy

Is there a national strategy for hydrogen development in your country?

Yes

If yes, what are the main goals and targets outlined in the strategy?

The Strategy outlines opportunities for clean hydrogen utilization within four strategic goals and defines performance indicators for these goals. The key strategic goals for hydrogen production in Croatia by 2050 are as follows: • Increasing renewable hydrogen production: The aim is to scale up hydrogen production from renewable energy sources, reducing dependence on fossil fuels and improving energy self-sufficiency. By 2030, 70 MW of electrolyser capacity is planned, which is expected to rise to 2,750 MW by 2050. • Maximizing the potential of renewable energy sources for hydrogen production: The Strategy seeks to maximize hydrogen's share in total energy consumption, contributing to the stability of the power system. By 2030, hydrogen is projected to account for 0.2% of total energy consumption, increasing to 11% by 2050. • Increasing the use of hydrogen: The Strategy promotes hydrogen adoption across various sectors, including industry, transport, and energy, to reduce CO2 emissions and support economic decarbonization. By 2030, 15 hydrogen fuel stations are planned, with the number increasing to 100 by 2050. • Encouraging the Development of Science and Research in Hydrogen Technologies: The Strategy emphasizes the importance of advancing science, research, and innovation in hydrogen technologies. By 2030, the goal is to achieve five patents related to the hydrogen-based economy, increasing this number to 50 by 2050.

2.2 Key Legal Documents

List key legal or regulatory documents supporting hydrogen policies (e.g., acts, regulations, directives):

Croatian Hydrogen Strategy until 2050 (OG No. 40/2022)
Energy Strategy of the Republic of Croatia
Study of the Development Plan and Implementation of the Croatian Hydrogen Strategy until 2050
National Energy and Climate Plan (NECP)
The National Recovery and Resilience Plan 2021-2026
National Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (OG No. 13/2021)
Strategy for Low-Carbon Development of the Republic of Croatia until 2030 with a view to 2050 (OG No. 63/2021)
Energy Development Strategy of the Republic of Croatia until 2030 (OG No. 25/2020)

Law on Biofuels for Transport (OG, No. /09, 145/10, 26/11, 144/12, 14/14, 94/18 and 52/21)
Law on the Deployment of Alternative Fuels Infrastructure (OG No. 120/16 and 33/22)
Law on Renewable Energy Sources and High-Efficiency Cogeneration (OG No. 138/21 and 83/23)

2.3 Policy Alignment

How does the national hydrogen policy align with EU-wide strategies (such as the European Green Deal)?

Croatian Hydrogen Strategy until 2050 is fully aligned with EU strategies.

3. Regulatory Environment

3.1. Incentives and Subsidies

Are there financial incentives or subsidies for hydrogen-related projects?

Yes

If yes, describe these incentives:

To meet the objectives stated in the National Recovery and Resilience Plan 2021-2026 (NRRP) and National Programme for Cohesion and Coherence (NPCC) envelope from 2021 to 2027, the Ministry of Economy decided to subsidize the construction of filling stations (CAPEX subsidy) for hydrogen vehicles with a non-reimbursable EUR 23 million (EUR 15 million in 2024 and EUR 8 million in 2026). The highest amount of support per HRS station is EUR 2 million for passenger cars, and EUR 3.5 million for buses and heavy vehicles. Beneficiaries of grants in accordance with this Program can be micro, small, medium, and large enterprises

3.2 Licensing and Permitting

What are the main challenges in licensing and permitting hydrogen projects in your country?

There are currently not enough projects in development that would demonstrate the system's shortcomings.

3.3 Regulatory Barriers

Identify any regulatory barriers that may hinder hydrogen integration:

There are currently not enough projects in development that would demonstrate the system's shortcomings.

4. Section 4: Stakeholder Engagement

4.1. Key Stakeholders

List the primary stakeholders involved in hydrogen policy development (e.g., government agencies, private sector, NGOs)

Ministry of economy

Croatian hydrocarbon agency

4.2. Stakeholder Consultation

Are stakeholders regularly consulted during the policy development process?

-

If yes, describe the consultation mechanisms:

-

5. Future Developments

5.1. Planned Policies

Are there any planned legal or regulatory changes related to hydrogen?

Yes

If yes, provide details

it is planned to harmonize the regulatory framework related to the promotion and use of hydrogen technologies in order to meet the requirements of EU directives!

5.2 Vision for Hydrogen Economy

What is your organization's vision for the hydrogen economy in your country/region?

The role of hydrogen in energy and transport systems is expected to become more significant in the future, especially as the goals for reducing greenhouse gas emissions become more ambitious.

6. Additional Comments

6.1. Other Insights

Please provide any additional comments or insights you believe are relevant:

7.6. Questionnaire HyFuture GmbH (PP07 HyFuture)

1. General information

1.1. Scope of legal policy framework

Does your country/region have specific legal frameworks addressing hydrogen policies?

Hydrogen Acceleration Act, National Hydrogen Strategy

If yes briefly describe the scope of these frameworks

Targets: - Harmonization of legal pre-requisites on national, European and international - Accelerate the Ramp-Up of hydrogen generation and supply capacities by simplification of planning, permission and procurement procedures

2. National Hydrogen Strategy

2.1. Existence of a National Strategy

Is there a national strategy for hydrogen development in your country?

National Hydrogen Strategy

If yes, what are the main goals and targets outlined in the strategy?

Subsidies for green hydrogen as central element of Energiewende Increase of electrolyzer capacity to 10 GW until 2030 Establishment of import structures for hydrogen Development of international partnerships

2.2 Key Legal Documents

List key legal or regulatory documents supporting hydrogen policies (e.g., acts, regulations, directives):

Erneuerbare-Energien-Gesetz(EEG) -- Reduced fees for green hydrogen Energiewirtschaftsgesetz (EnWG) -- Regulation of hydrogen grids Bundes-Immissionschutzgesetz (BImSchG) - simplified permission procedures EU-Regulations RED II & RED III - Establishment of minimum quotas Planning of hydrogen core grid -- 9.700 km until 2032 H2Global - Secure imports of green hydrogen by subsidies

2.3 Policy Alignment

How does the national hydrogen policy align with EU-wide strategies (such as the European Green Deal)?

EU-specifications get transferred into national regulations by EEG, EnWG, BImSchG, RED III, Hydrogen Acceleration Act and H2Global.

3. Regulatory Environment

3.1. Incentives and Subsidies

Are there financial incentives or subsidies for hydrogen-related projects?

IPCEI-projects with German partners

NIP II National Innovation Program Hydrogen and Fuel Cell Technologies

Energy Research Program

HyLand-Program

KFW-Programs

and further 50 programs, with hydrogen being involved

Additional programs of the German States

If yes, describe these incentives:

Incentive programs with diverse quote levels, depending partially from the size of the enterprises. Subsidy calls often with a short response time from about 6-8 weeks.

Credit programs with reduced interest rates and security possibilities

Support regarding OPEX by:

- Reduction oft truck toll
- Eliminated vehicles taxes
- GHG-Quota

4. Section 4: Stakeholder Engagement

4.1. Key Stakeholders

List the primary stakeholders involved in hydrogen policy development (e.g., government agencies, private sector, NGOs)

Bundesregierung & Ministerien:

- Ministry of Economy and Climate Protection (BMWK) → Responsible for the National Hydrogen Strategy, Hydrogen Support Programs and Industrial Policy
- Ministry for Digitalization and Mobility (BMDV) → Supports hydrogen mobility and infrastructure

- Ministry for Environment (BMUV) → Responsible for the environmental and sustainability aspects of hydrogen
- Ministry for Education and Research (BMBF) → Responsible for Hydrogen research and innovative technologies

Regulation and Financial Support Institutes:

- **Bundesnetzagentur (BNetzA)** → Department for regulation of hydrogen grids and infrastructure
- **Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie (NOW GmbH)** → Coordination of subsidy programs for hydrogen mobility and infrastructure
- **H2Global** → Subsidy mechanism for the import of green hydrogen
- **Kreditanstalt für Wiederaufbau (KfW)** → Offers financial services for hydrogen projects

Industrial Associations & Networks:

- **German Hydrogen and Fuel Cell Association (DWV)**
- **Hydrogen Council of the German Government** → Policy Consulting regarding hydrogen strategy

Research & Science

- **Fraunhofer-Instituts (z. B. Fraunhofer ISE, IKTS, UMSICHT)** → Development of new technologies for hydrogen generation and storage
- **Max-Planck-Instituts & Helmholtz-Gemeinschaft** → Research regarding hydrogen applications and materials
- **Deutsche Wasserstoff- und Brennstoffzellen-Forschungszentrum (ZSW, DLR, Jülich)** → Testing of industrial hydrogen applications

NGOs & Environmental Organizations

- **Greenpeace, BUND, WWF** → Critical accompaniment of national hydrogen strategy, support of green hydrogen
- **Hydrogen Europe & Clean Hydrogen Partnership** → Lobby groups for supporting hydrogen projects in the EU

4.2. Stakeholder Consultation

Are stakeholders regularly consulted during the policy development process?

International Agreements by EU and bilateral partnerships

Strategical steering by national government and ministries

Regulatoric adjustments by Bundesnetzagentur & research institutes

Scientific & economic consultation by the national hydrogen council & NOW GmbH

If yes, describe the consultation mechanisms:

Permanent checking and adjustment of strategies. All adjustments get communicated, for example by the Hydrogen Council

The National Organization for Hydrogen and Fuel Cell Technologies (NOW GmbH) coordinates subsidy programs and projects and therefore operates as interface between government, economy and research. Publishing of reports regarding hydrogen economy on a regular time base.

5. Future Developments

5.1. Planned Policies

Are there any planned legal or regulatory changes related to hydrogen?

Kraftwerkssicherheitsgesetz - Transfer of gas powered utilities towards hydrogen

If yes, provide details

Construction of new gas fired power plants for Germany´s safe power supply when coal fired power plants get more and more reduced. These gas fired power plants should later be fired with hydrogen.

5.2 Vision for Hydrogen Economy

What is your organization's vision for the hydrogen economy in your country/region?

Top down: Establishment of an import structure for green hydrogen, successive transfer of the gas grid to hydrogen, construction of a resilient infrastructure for a broad use of hydrogen in the sectors industry, mobility, commercial and households.

Bottom up: Installation of self supplying systems with hydrogen as energy carrier (energy autark islands); Production and use of hydrogen with own green electricity; hydrogen as a regional commodity.

Fusion of both approaches to a functionable, CO2-free energy market.

6. Additional Comments

6.1. Other Insights

Please provide any additional comments or insights you believe are relevant:

7.7. Questionnaire Energy Agency Savinjska,Šaleška and Koroška Region (PP08 KSSENA)

1. General information

1.1. Scope of legal policy framework

Does your country/region have specific legal frameworks addressing hydrogen policies?

There is no specific legal framework established in Slovenia, that would regulate the areas of green hydrogen infrastructure development/hydrogen policy in general. Such acts have not yet been adopted in the Republic of Slovenia.

The mentioned area is covered by very different laws, as follows:

1.ZIAG - Zakon o infrastrukturi za alternativna goriva in spodbujanju prehoda na alternativna goriva v prometu (ZIAG)

ZIAG - Act on infrastructure for alternative fuels and promoting the transition to alternative fuels in transport

2.ReNPRP30 - Resolucija o nacionalnem programu razvoja prometa v Republiki Sloveniji za obdobje do leta 2030 (ReNPRP30)

ReNPRP30 - Resolution on the national programme for the development of transport in the republic of Slovenia for the period up to 2030

3.Strategija razvoja prometa v Republiki Sloveniji do leta 2030

Strategy for the development of transport in the Republic of Slovenia until 2030

4.Strategija na področju razvoja trga za vzpostavitev ustrezne infrastrukture v zvezi z alternativnimi gorivi v prometnem sektorju v Republiki Sloveniji

Market development strategy for the establishment of an adequate infrastructure for alternative fuels in the transport sector in the Republic of Slovenia

5.Akcijski program za alternativna goriva v prometu za leti 2022 in 2023

Action programme for alternative fuels for transport 2022 and 2023

6.NEPN – CELOVITI NACIONALNI ENERGESKI IN PODNEBNI NAČRT

NEPN - COMPREHENSIVE NATIONAL ENERGY AND CLIMATE PLAN

7.Energetski Zakon – EZ2

Energy law - EZ2

8.ZOEE – Zakon o oskrbi z električno energijo

Electricity supply act

9.ZURE – Zakon o učinkoviti rabi energije

Energy efficiency act

10.ZOP - Zakon o oskrbi s plini

Gas supply act

11.ZSROVE – Zakon o spodbujanju rabe obnovljivih virov energije

Act on the promotion of the use of renewable energy sources

If yes, briefly describe the scope of these frameworks

1. **ZIAG - Act on infrastructure for alternative fuels and promoting the transition to alternative fuels in transport**

   A detailed action plan to promote the transition to alternative fuels for transport and the establishment of the relevant infrastructure shall be drawn up, which shall also be coordinated with strategic plans in the field of hydrogen production and the development of infrastructure for the production, distribution and use of hydrogen. The targets for hydrogen supply for transport are set in the national policy framework in line with binding targets set for Member States by the European Union. In planning the targets for hydrogen supply infrastructure, the maximum possible account shall be taken of the ability to supply hydrogen produced from renewable energy sources. In order to make the best use of surplus electricity from the grid or electricity produced from renewable energy sources, provision shall be made for the possibility of supplying hydrogen at identified locations as derived from the national plan of suitable locations for refuelling parks of the public service operator.

2. **ReNPRP30 - Resolution on the national programme for the development of transport in the republic of Slovenia for the period up to 2030**

   The national program within measure Ro.35 foresees the following sub-measure among the many measures for infrastructure for alternative fuel sources: »publicly accessible hydrogen supply points«.

3. **Strategy for the development of transport in the Republic of Slovenia until 2030**

   The Directive requires Member States to adopt their own strategy in this area, namely in relation to passenger cars for electric and CNG and hydrogen vehicles, in relation to freight vehicles for LNG

vehicles, in relation to maritime transport for LNG and shore-side charging of ships, and in relation to aviation for the charging of aircraft at airports. The Directive also sets deadlines for this, mostly by 2025.

4. Market development strategy for the establishment of an adequate infrastructure for alternative fuels in the transport sector in the Republic of Slovenia

The Strategy dedicates a chapter (6.2) to the hydrogen implementation in the transport.

"6.2 Measures to promote the use of hydrogen and fuel cell vehicles

As an alternative source of energy, hydrogen is intended as an energy carrier for the production of electricity in fuel cells for direct use to drive a vehicle. Currently, the biggest obstacle is the faster expansion of the charging infrastructure of hydrogen filling stations, the modest offer of hydrogen vehicles on the market and their high price compared to other vehicles.

In September 2013, the first public filling station for hydrogen (300/350 bar) was installed in Slovenia at the Petrol service station in Lesce. The filling station was set up as a "demo project", with which the necessary experience for the construction of such facilities was also to be gained in Slovenia.

The directive allows Member States to decide independently whether to include hydrogen refueling points in their national policy frameworks. Slovenia is opting for hydrogen

technologies, so it is obliged to provide an adequate number of publicly accessible charging points by 31 December 2025, which will enable both local traffic and cross-border connections.

6.2.1 Promotion of research work and innovation

Hydrogen technologies are still a big challenge for the automotive industry, so research work and the search for innovations that would make vehicles and charging infrastructure cheaper are essential. Slovenia will promote industry-related research work in order to maintain its place among manufacturers and suppliers for the automotive industry.

6.2.2 Charging infrastructure

Slovenia has a hydrogen filling station. In accordance with the chosen technology, the installation of four or eight hydrogen filling stations is envisaged. Subsidized construction of charging stations/infrastructure is necessary in its entirety (mainly grants from the EU - according to experience so far, only strong consortia of EU cities and the largest bus manufacturers have obtained such funds). Due to the economy of scale of the use of hydrogen vehicles, from an economic point of view, the investment is not recouped in an acceptable time. Private investors therefore have no economic interest. At the same time, as with charging stations for electric vehicles, charging stations must be subsidized in accordance with the latest standards. The technical specifications for hydrogen refueling points specified in point 2 of Annex II of the Directive will be taken into account.

6.2.3 Financial incentives

The financial incentives provided for electric vehicles are also provided for hydrogen vehicles. Measures to encourage the use of hydrogen vehicles are specifically managed so that they can continue even when the threshold values for incentives for electric vehicles have already been reached.

6.2.4 Placement in the premises

In particular, the largest municipalities should be encouraged to consider hydrogen-powered public passenger transport in their integrated transport strategies, and to ensure appropriate conditions in their municipal spatial plans in the event of a decision to use hydrogen for the installation of charging stations. Until the appropriate legislation is drawn up, it is important to enable the construction of

charging infrastructure according to already known technical guidelines and to ensure the possibility of placement in locations that already offer other energy sources.

6.2.5 Promotional activities to encourage the use of hydrogen

Due to the very limited range of vehicles and the great lack of knowledge and, as a result, mistrust of hydrogen technologies, a special communication campaign for hydrogen technologies is necessary. It is prepared in accordance with the layout of the hydrogen charging infrastructure.

6.2.6 Demonstration Project

The demonstration project envisages the installation of 700 bar filling stations (4-8 filling stations), worth €2.8 to €3.2 million. At the same time, it is also necessary to provide means for raising awareness and informing the public about the safe use of hydrogen vehicles. As part of the demonstration project, demonstration drives and public demonstrations of the functioning

of hydrogen vehicles would be carried out, especially in schools and public institutions. In the introduction of hydrogen technologies in transport, there are still many open questions, which to a large extent prevent its use on a larger scale. The support of the demonstration project also supports research that would answer open questions and accelerate the implementation of hydrogen technologies. This would establish the Slovenian value chain of hydrogen technologies.

6.2.7 Supply of energy products and pricing policy

The price of hydrogen for driving vehicles on the Slovenian market has not yet been established, as there is no such offer yet. In the first, promotional phase, the price for a kilogram of hydrogen is estimated at eight euros. At the same time, it is considered that the price of hydrogen will have to be subsidized.

6.2.8 Introducing content about hydrogen technologies into educational programs

Educational programs for secondary schools and vocational and professional education programs include content on hydrogen technologies in order to educate and train professionals who will work with hydrogen technologies in all fields. 6.2.9 Elimination of administrative obstacles Obtaining a building permit for the installation of a filling station represents a major obstacle, as there is no legal basis. There are only good engineering practices. In order to establish the infrastructure for hydrogen vehicles, it is therefore necessary to adapt the legislation."

5. Action programme for alternative fuels for transport 2022 and 2023

A part addressing hydrogen is as it follows:

»To encourage the transition to electric vehicles, the following measures are planned in the field of public passenger transport:

· U1: Purchase of new passenger transport vehicles (M2, M3). The purchase of new vehicles for the implementation of public urban and intercity passenger transport, for the transport of passengers and their luggage, namely new vehicles for road transport with electric drive or hydrogen, categories M2 and M3, which also includes vehicles such as vans, minibuses, is co-financed and road tourist trains.

· U2: Purchase of new vehicles for carrying out passenger traffic (M1, M2, M3). The purchase of new vehicles for the implementation of public city and intercity passenger transport and school transport, for the transport of passengers and their luggage, is co-financed, namely new electric or hydrogen-powered road transport vehicles, categories M1, M2 and M3, which also includes vehicles, such as vans, minibuses and road tourist trains.«

In the following text, they define the goals until 2030 with numbers. Part of the text under Measures to promote the use of hydrogen and fuel cell vehicles is copied from the Strategy in the field of

market development for the establishment of appropriate infrastructure related to alternative fuels in the transport sector in the Republic of Slovenia.

6. NEPN - COMPREHENSIVE NATIONAL ENERGY AND CLIMATE PLAN

SLOVENIA'S KEY OBJECTIVES AND CONTRIBUTIONS BY 2030

- gradual decarbonisation of hard to decarbonise sectors of energy-intensive industry: providing financial incentives for restructuring production processes through the introduction of green technologies, renewable and low-carbon gases, including hydrogen, and green fuels, as well as technologies for the capture, transport and use of CO2
- Accelerate the development of energy storage technologies, infrastructure and services and meet the following sub-objectives: o Ensure that the share of their capacity (in GWh) in daily EE use exceeds the share of total annual solar and wind generation in annual EE use by accelerating the construction of EE storage systems (SHEE): pumped storage plants, batteries, hydrogen-to-hydrogen converters and others
- Encourage the construction of two large electrolysis units to store the excess electricity generated into hydrogen and explore storage options.
- Ensure the further development of the gas pipeline system and prepare the system for the introduction (operation) of hydrogen in line with gas flows and system capacities, and the introduction of hydrogen and other new sources of renewable and low-carbon gases.
- Prepare the regulatory and supportive environment for the production of alternative renewable and low-carbon gases and the preparation of pipeline networks for the transport and supply of new gases (indicative target of at least 10% of renewable and low-carbon methane and hydrogen in the transmission and distribution network by 2030) and support research and development and domestic production projects for these gases.

7. Energy law - EZ2

Article 115 of the Energy Act (EZ-1) provides that investment projects in electricity generation from renewable energy sources, energy storage, sources of flexibility of the electricity system (including hydrogen technologies) and energy utility infrastructure that promotes the connection of these projects do not require an overall return on investment of 4% or more for the assessment of economic viability to be positive. This is the case regardless the public finance regulations governing the uniform methodology for the preparation and treatment of investment documentation and regardless the due diligence required under the Companies Act in companies in which the Republic of Slovenia or local authorities hold, directly or indirectly, a majority stake.

8. Electricity supply act

This Law establishes the rules for the functioning of the electricity market, the production, transmission, distribution, storage and supply of electricity, the rights and protection of final consumers, the methods and forms of performing public utility services in the field of electricity transmission and distribution and the electricity market, the principles and measures for achieving a reliable supply of electricity, and regulates the measures for preventing energy poverty and other issues related to the supply of electricity.

9. Energy efficiency act

- This Act lays down measures to promote energy efficiency, measures to increase the efficient use of energy and measures to improve the energy performance of buildings.

- This Act also determines the competences of the authorities performing the tasks under this Act and the implementation of the State policy in the field of energy efficiency.

10. Gas supply act

This Act lays down the rules for the functioning of the gas market, the production, transmission, distribution, storage and supply of gas, the rules for the protection of customers, the methods and forms of exercising public utility functions in the transmission and distribution of gas, and the principles and measures for achieving security of gas supply.

The purpose of this Law is to ensure a competitive, secure, reliable, and affordable gas supply, taking into account the principles of sustainable development, and to establish comprehensive competitive, flexible, fair, and transparent gas markets, taking into account the important role of natural gas as a transitional energy source in the transition to a carbon-free economy.

The provisions of this Act shall apply to all types of gases, including hydrogen, provided that they can be safely taken into and transported through the system in a technically feasible manner.

The provisions of this Act shall apply to gas undertakings and customers in the field of supply of gas from an interconnected transmission and distribution system.

11. Act on the promotion of the use of renewable energy sources

This law regulates the implementation of the policy of the State and municipalities in the field of the use of renewable energy sources, sets a binding target for the share of energy from renewable sources in the gross final consumption in the Republic of Slovenia, and the measures to achieve this target and the ways of their financing, regulates the certificates of origin, the self-supply of electricity from renewable sources, the use of energy from renewable sources and excess heat in the heating and cooling sector and the transport sector, and the provision of information and training for installers.

2. National Hydrogen Strategy

2.1. Existence of a National Strategy

Is there a national strategy for hydrogen development in your country?

NO.

As explained by the national developers (mainly the Ministry of Infrastructure & the Ministry of Environment, Climate and Energy), the hydrogen strategy should be part of the updated version of the NECP (National Climate and Energy Plan).

Slovenia has not yet set clear target goals related to the rollout of green H2 technology, nor has it decided to develop a National Hydrogen Strategy in the form of a comprehensive and all-encompassing document, but rather disclosed some basic targets only in the renewed version of the National Energy and Climate Plan (NECP), which was updated in December 2024.

Key hydrogen targets of the NEPC document:

- gradual decarbonisation of hard to decarbonise sectors of energy-intensive industry: providing financial incentives for restructuring production processes through the introduction of green technologies, renewable and low-carbon gases, including hydrogen, and green fuels, as well as technologies for the capture, transport and use of CO2

- Accelerate the development of energy storage technologies, infrastructure and services and meet the following sub-objectives: o Ensure that the share of their capacity (in GWh) in daily EE use exceeds the share of total annual solar and wind generation in annual EE use by accelerating the construction of EE storage systems (SHEE): pumped storage plants, batteries, hydrogen-to-hydrogen converters and others
- Encourage the construction of two large electrolysis units to store the excess electricity generated into hydrogen and explore storage options.

If yes, what are the main goals and targets outlined in the strategy?

N/A

2.2 Key Legal Documents

List key legal or regulatory documents supporting hydrogen policies (e.g., acts, regulations, directives):

Already explained in the section "1.1 Scope of legal Policy Framework".

2.3 Policy Alignment

How does the national hydrogen policy align with EU-wide strategies (such as the European Green Deal)?

N/A

3. Regulatory Environment

3.1. Incentives and Subsidies

Are there financial incentives or subsidies for hydrogen-related projects?

YES

If yes, describe these incentives:

- Ministry of the Environment, Climate, and Energy - **Call for proposals for the co-financing of the purchase of vehicles for the establishment of an emission-free public passenger transport line.**

3.2 Licensing and Permitting

What are the main challenges in licensing and permitting hydrogen projects in your country?

Slovenia has not yet set clear target goals related to the rollout of green H2 technology, nor has it decided to develop a National Hydrogen Strategy in the form of a comprehensive and all-encompassing document, but rather disclosed some basic targets only in the renewed version of the National Energy and Climate Plan (NECP), which was updated in December 2024. In this light, there are currently no laws in Slovenia, regulating the construction and operation of hydrogen infrastructure development, nor the safety measures and conditions of certification, licensing, and operational standards that such locations should

have regulated. Thus, regulatory barriers, or licensing and permitting challenges, that may hinder the national hydrogen integration, depend on the hurdles and setbacks of the individual pilot projects in the country, which in the operational sense, does not exist at the moment. Individual pilots are still being developed at the moment, but given that the field of green H2 roll-out is currently covered by several different laws, which are also contradictory to each other, it is impossible to summarize these problems at this moment. Everything will depend on the success of the pilot projects, which are currently still in the development phase.

3.3 Regulatory Barriers

Identify any regulatory barriers that may hinder hydrogen integration:

The answer is the same as above. (3.2 - Licensing and Permitting)

4. Section 4: Stakeholder Engagement

4.1. Key Stakeholders

List the primary stakeholders involved in hydrogen policy development (e.g., government agencies, private sector, NGOs)

The following list of stakeholders is not involved but is highly important for H2 policy development:

- Holding Slovenske elektrarne, d.o.o (Holding of Slovenian Powerplants)
- Termoelektrarna Šoštanj d.o.o. (Thermal Power Plant Šoštanj)
- Ecubes Tehnologije d.o.o. (Ecubes technlogies)
- Steklarna Hrastnik d.o.o. (Hrastnik Glasworks)
- Alpacem Cement d.d.
- Univerza v Ljubljani (University of Ljubljana)
- Institut »Jožef Stefan« (»Jožef Stefan« Institute)
- Ministry of Infrastructure Slovenia of the Republic of Slovenia
- Minister for the Environment, Climate and Energy of the Republic of Slovenia
- ETRA d.o.o.
- IMP Promont d.o.o.
- Gospodarska Zbornica Slovenije (Slovenian Chamber of Commerce)
- Slovenian National Hydrogen Association
- Plinovodi d.o.o.
- LPP d.o.o.
- City Municipality of Ljubljana
- City Municipality of Velenje

- City Municipality of Kranj
- Municipality of Šoštanj
- Meta circularity d.o.o.
- Slovenian Armed Forces
- ELES d.o.o.
- HESS d.o.o. (Hydro Power Plants on lower Sava)
- Etc.

4.2. Stakeholder Consultation

Are stakeholders regularly consulted during the policy development process?

No

If yes, describe the consultation mechanisms:

N/A

5. Future Developments

5.1. Planned Policies

Are there any planned legal or regulatory changes related to hydrogen?

Not in the near future, as far as we know.

If yes, provide details

N/a

5.2 Vision for Hydrogen Economy

What is your organization's vision for the hydrogen economy in your country/region?

Currently, several smaller pilot projects are under development in the Republic of Slovenia, which primarily focus on hydrogen mobility. Most of these pilot projects are still under development and are mostly independent and private investments. We also presented the three largest pilot projects in the framework of Activity A1.1 - Best Practice Assessment. Considering that the HyEfRe project mostly focuses on the production and storage of green Hydrogen, such hydrogen mobility pilots are rather not so relevant to us. However, within the scope of the project, there is at least one relevant pilot project for green hydrogen production and storage - the NAHV pilot project (North Adriatic Hydrogen Valley), whose pilot location (Thermal Power Plant Šoštanj - TEŠ) is also included as a pilot in HyEfRe.

The pilot location of the Šoštanj's Power Plant, or the brown-field investment, which is planned at the location, is also the only competent example of a pilot in connection with the production and storage of large quantities of green H2 in the Republic of Slovenia.

The details of the mentioned pilot are the following:

The planned pilot focuses on the production of green hydrogen using renewable energy sources, primarily through solar photovoltaic (PV) installations. In phase 1, it will utilize an electrolyzer with a capacity of up to 3 MW (PEM technology), achieving a minimum production of 300 tons of hydrogen per year, alongside an on-site hydrogen refueling station (HRS). Phase 2 will expand the electrolyzer capacity to up to 20 MW, targeting a minimum annual production of 2,700 tons of hydrogen, and will include the same on-site HRS with a hydrogen storage capacity of 4 tons. This initiative aims to significantly enhance sustainable hydrogen production in the SAŠA region and in Slovenia. The plan is to set up the biggest floating solar power plant (Up to 140 MWp on 70 hectares) in Europe on the deluded area of the Družmirje lake. The lake is currently in industrial use, and has all the related permits due to underground lignite mining. The planned H2 production is approximately 2.700 tons of green hydrogen annually. A side plan is also to optimize the local district heating system through energy restructuring and coupling of hydrogen and smart grid technologies. For this project, the initial plan was to establish a solar power plant with a capacity of 250 MWp, with the estimated final cost for setting up such a hydrogen ecosystem projected at €260 million. However, as it is still uncertain which phase will ultimately be implemented, it is difficult to discuss the final costs.

To sum up, the project focuses on the integration of hydrogen as a primary energy source and the decarbonization of the TEŠ facility in Šoštanj. It represents a pioneering effort to transition from coal to hydrogen, utilizing renewable energy, particularly solar power, with a capacity of somewhere around 140 MWp to produce approximately 2,700 tons of green hydrogen annually through advanced electrolyzers. A significant aspect of this initiative is the optimization of the local district heating system, which includes waste heat utilization strategies and smart grid technologies. The estimated installation costs are projected at €9.5 million, primarily funded by climate change funds and local municipality contributions. However, the project faces economic challenges, including high initial investments and reliance on subsidies, which are crucial for its long-term viability. Technological performance features advanced sector coupling and energy system optimization, highlighting the integration of hydrogen refueling stations and modern public transport systems powered by fuel-cell electric vehicles. Environmentally, the project is expected to result in substantial reductions in CO_2 emissions, aiding Slovenia's transition towards a zero-emission public transport system. Overall, the pilot project serves as a model for future projects aimed at scaling hydrogen production, investing in infrastructure, and fostering public-private partnerships to support the hydrogen economy's development. The current 200 kW electrolyzer at the Šoštanj Thermal Power Plant (TEŠ) has the capacity to produce 32 kg of grey hydrogen per day.

6. Additional Comments

6.1. Other Insights

Please provide any additional comments or insights you believe are relevant:

European Court of Auditors, Special report 11/2024 The EU's industrial policy on renewable hydrogen

The EU's commitment to achieving climate neutrality by 2050 positions renewable hydrogen as a critical element in decarbonizing sectors that are hard to electrify, such as heavy industry. The European Commission has introduced hydrogen production and import targets under the 2020 EU Hydrogen Strategy, updated by the REPowerEU plan in 2022. This report evaluates the EU's progress towards its hydrogen targets, the legal framework established, funding availability, and coordination between the Commission, Member States, and industry.

In the development of our semi-structured questionnaire, we relied heavily on the findings and insights from the recent report by the **European Court of Auditors** (special report 11/2024: "The EU's industrial policy on renewable hydrogen - Legal framework has been mostly adopted). This fact-based report, which

is grounded in over 120 key observations, provided valuable guidance in identifying the challenges and gaps in the current legal framework that we believe are relevant and need to be pointed out.

Unrealistic targets and limited progress

The commission set ambitious hydrogen targets without a solid analytical foundation, estimating the need for 10 million tonnes of renewable hydrogen produced domestically and another 10 million tonnes imported by 2030. However, these goals have not been met, largely due to a lack of alignment between the EU's overall targets and individual member states' strategies. For example, while the total capacity needed for electrolysis is around 40 GW by 2030, the actual commitments from member states are well below that figure.

Many member states have not yet set clear targets for hydrogen production, and only a few, like Germany, have committed to importing hydrogen. Most member states' strategies were established after the EU's hydrogen strategy was published, and as of the end of 2023, substantial divergence in their ambitions remains. This divergence has complicated the achievement of EU-wide hydrogen production and import goals.

Legal framework: incomplete and delayed

A key issue highlighted in the report is that the legal framework necessary for hydrogen market development was delayed. For instance, essential regulations on renewable hydrogen, such as the Delegated Act, were delayed until mid-2023, hindering investment decisions in the hydrogen sector. While the legal framework is now mostly complete for renewable hydrogen, several legislative pieces for low-carbon hydrogen are still under discussion.

The report also emphasizes that the rules for renewable hydrogen production, particularly those concerning temporal and geographic correlation (ensuring hydrogen production is aligned with renewable energy availability), are complex and could delay market ramp-up. Industry stakeholders have expressed concern that these rules, especially those starting in 2028, may increase production costs by 25% to 35% due to the requirement for hourly matching of renewable energy generation.

Funding and investment challenges

The EU has committed approximately €18.8 billion for hydrogen-related projects under various programs, including the Recovery and resilience facility and the Innovation fund. However, the distribution of funds is scattered across different programs, each with its own eligibility criteria and objectives. This fragmentation creates challenges for industries trying to secure funding and delays the development of a robust hydrogen value chain.

Moreover, the overall funding need to meet the EU's hydrogen goals is enormous, and current funding levels are insufficient to harness the full hydrogen production potential across the EU. The report also notes that investment decisions for many hydrogen projects have been delayed due to the lack of certainty in regulatory and funding frameworks.

Coordination and market development

Coordination among the European Commission, member states, and industry stakeholders is essential but insufficient. While the commission has established fora, such as the Clean hydrogen alliance, to facilitate dialogue, there is still a lack of strategic alignment on key issues. This lack of coordination hampers the creation of a cohesive hydrogen market.

Member states with advanced industrial sectors, such as Germany, the Netherlands, and Spain, are making more progress in project development, while others lag behind. The Commission has not yet effectively ensured that all member states are on the same page when it comes to hydrogen strategy implementation. Moreover, despite the EU's goals, there is a growing risk of "carbon leakage," where industries may relocate production outside of the EU to avoid stringent emissions regulations.

Conclusions and recommendations

The report concludes that the Commission has only been partially successful in creating the necessary conditions for a thriving hydrogen market. Key recommendations include:

Conduct a reality check to adjust strategies without creating new strategic dependencies on external sources of hydrogen.

Develop an EU-wide hydrogen roadmap and closely monitor progress.

Ensure that EU funding arrangements are sufficient and aligned with national funding commitments.

Improve monitoring and streamline permitting processes for hydrogen projects at the member state level.

Strengthen support and coordination between the commission and the hydrogen industry to ensure timely project development.

Overall assessment

The commission has made important strides in developing the regulatory framework for renewable hydrogen, but critical gaps remain in aligning member states' strategies, securing funding, and coordinating efforts across the EU. Without significant improvements in these areas, the EU is unlikely to meet its 2030 hydrogen production and import targets, compromising its broader climate neutrality goals.

7.8. Questionnaire South Transdanubian Regional Innovation Agency (PP09 STRIA)

1. General information

1.1. Scope of legal policy framework

Does your country/region have specific legal frameworks addressing hydrogen policies?

Yes

If yes, briefly describe the scope of these frameworks

Hungary does not yet have a dedicated, comprehensive legal framework for hydrogen. Instead, hydrogen projects fall under existing energy, industrial, and environmental laws, which were not originally designed for hydrogen applications.

In Hungary, one of the most important pieces of legislation for hydrogen is Act XL of 2008 on Natural Gas Supply, which applies to the licensing of facilities for the production, use and storage of hydrogen, as well as pipelines for the transportation of hydrogen. In addition, the Hungarian government has adopted several strategic documents and plans. The main objective of these plans is to have strategic level documents and strategic plans to promote the hydrogen economy.

2. National Hydrogen Strategy

2.1. Existence of a National Strategy

Is there a national strategy for hydrogen development in your country?

Yes: Hungary's National Hydrogen Strategy (2021)

National Energy and Climate Plan (2024)

If yes, what are the main goals and targets outlined in the strategy?

The National Hydrogen Strategy is the cross-sectoral national hydrogen strategy document; it sets strategies for industrial, transportational and energy application of hydrogen. The strategy focuses on green hydrogen, but in addition to hydrogen based on electricity from renewable sources, mainly solar energy, Hungary does not ignore the potential of hydrogen production based on carbon-free electricity from nuclear or grid electricity.

The document defines 4 priority objectives and 3 support objectives:

Priority objectives:

1. Production of large volumes low-carbon and decentralized carbon-free hydrogen: Establishing the conditions necessary to produce low-carbon and carbon-free hydrogen that is in compliance with user requirements and is competitively priced.

- 20 thousand tons / year low-carbon hydrogen

- 16 thousand tons / year “green”* and other carbon-free hydrogen
- 240 MW electrolyser capacity

2. Decarbonisation of industrial consumption, partly with hydrogen: At first, predominantly low-carbon hydrogen will be used to make the industrial processes and product use “more green”, with a shift to carbon-free hydrogen usage on the longer term.

- 20 thousand tons / year low-carbon hydrogen
- 4 thousand tons / year “green”* and other carbon-free hydrogen
- avoiding the emission of 95 thousand tons of CO2

3. Green transport: Accelerating the transition to clean modes of transportation by a gradual transition from gas oil usage to clean alternatives. Within this framework, on the 2030 timeline, hydrogen may become a realistic alternative primarily in heavy-duty vehicle traffic.

- 10 thousand tons / year “green”* and other carbon-free hydrogen
- 20 hydrogen refuelling stations / 40 refuelling points
- 4.8 thousand HFC vehicle
- avoiding the emission of 130 thousand tons of CO2

4. Electricity and (natural) gas support infrastructure: Building sector integration ability - primarily seasonal energy storage ability - by utilising intersectoral synergy, establishing infrastructure that will enable the transition to carbon neutrality, and reconstructing existing infrastructure.

- 60 MW average cut-off capacity
- min. 2% per year volume blending ratio in the natural gas system (where appropriate)

Support objectives:

1. Taking advantage of industrial and economic development opportunities: Enhancing the activities at the intersection of industrial trends and Hungary’s domestic strengths in order to promote competitiveness and stimulate domestic penetration.

2. Horizontal conditionality: establishing a stimulating operational environment

- Establishment of comprehensive regulatory and operational frameworks,
- Promoting partnership and international cooperation.

3. RDI and education to promote the success of hydrogen during the transition: It is essential for the implementation of strategic objectives to establish a system of scientific, technological and horizontal competencies that can serve as a foundation for the domestic use and development of new technologies and for demonstrating the legitimacy of such technologies on the domestic market.

It is important to note that the National Energy and Climate Plan 2024 has already taken into account further EU legislation such as REDIII. The NECP therefore already states that there will be a significant need for imports to meet the demand for hydrogen, the supply chain of which needs to be developed as soon as possible, taking into account cost-effective modes of transport in the long term.

2.2 Key Legal Documents

List key legal or regulatory documents supporting hydrogen policies (e.g., acts, regulations, directives):

- National Energy Strategy 2030 (2020)
- The National Hydrogen Strategy (2021)
- The REPowerEU Plan of Hungary (2023)
- The updated National Energy and Climate Plan (2024)

2.3 Policy Alignment

How does the national hydrogen policy align with EU-wide strategies (such as the European Green Deal)?

Hungary's National Hydrogen Strategy (NHS) is highly aligned with EU policies like the European Green Deal, the Fit for 55 package, and the REPowerEU initiative by focusing on green hydrogen production, infrastructure development, and regional cooperation. The first three priority objectives of the NHS directly contribute to Green Deal's carbon neutrality target by 2050. Besides, Hungary aims to develop the infrastructure for hydrogen, integrating it into the energy grid and boosting its use in transportation and industry, supporting EU goals of creating a more interconnected and decarbonized energy system. This is mainly supported by priority objective 4, which therefore contributes to the achievement of the EU aims to reduce emissions by at least 55% by 2030 with hydrogen playing a key role in decarbonizing energy systems. By the green hydrogen production targets (priority objective 1) the NHS suports the achievement of EU's Hydrogen Strategy target to scale up green hydrogen production, by producing 10 million tons of renewable hydrogen by 2030. The Hungarian policy also promotes hydrogen fuel cell vehicles (buses, trucks, and trains), in line with EU Alternative Fuels Infrastructure Regulations (AFIR) and the push for hydrogen refueling networks, while also integrating with EU plans for a hydrogen backbone network and cross-border hydrogen trade. In addition, Hungary is accessing EU funding instruments such as the Innovation Fund, Horizon Europe and ERDF for hydrogen R&D and pilot projects in line with the key actions of the EU Hydrogen Strategy.

3. Regulatory Environment

3.1. Incentives and Subsidies

Are there financial incentives or subsidies for hydrogen-related projects?

Yes

If yes, describe these incentives:

- Implementation of developments for the conversion of carbon-free, surplus electricity into gas energy (hydrogen, biomethane) through innovative technologies (2020-3.1.2-ZFR-KVG)
- RRF financed national laboratory project, focusing on renewables: RRF-2.3.1-21-2022-00009
- Green Bus Programme (support includes electric and hydrogen powered local buses)
- Green Truck Programme (support includes hydrogen production, hydrogen vehicles, and hydrogen refuelling)
- Relevant calls of the Environmental and Energy Efficiency OP Plus
- Economic Development and Innovation OP Plus
- REPowerEU Plan planned investment programmes:
    - Building green economic manufacturing capacity
    - Use of green technologies
    - Hydrogen investments

3.2 Licensing and Permitting

What are the main challenges in licensing and permitting hydrogen projects in your country?

The licensing and permitting of hydrogen projects in Hungary faces several key challenges, many of which are similar to those across the EU, but with specific national complexities. As mentioned above, Hungary does not yet have a specific, comprehensive regulatory framework for hydrogen, which complicates the licensing and permitting process. Hydrogen projects often face uncertainty regarding their classification (e.g., whether they fall under natural gas infrastructure, renewable energy, or industrial facilities), which leads to delays in the permitting process. The licensing and permitting process is also quite complex; hydrogen projects require multiple permits (environmental, safety, grid connection, and industrial operation licenses), involving different authorities that may not have hydrogen-specific expertise. Unlike solar and wind, hydrogen lacks a fast-track approval mechanism, resulting in longer project timelines.

3.3 Regulatory Barriers

Identify any regulatory barriers that may hinder hydrogen integration:

- No standalone hydrogen law
- Unclear classification
- Delayed implementation of EU directives (e.g. Hydrogen and Decarbonised Gas Market Package, REDIII)
- Hungary's natural gas grid is not yet hydrogen-ready, and blending rules are unclear

4. Section 4: Stakeholder Engagement

4.1. Key Stakeholders

List the primary stakeholders involved in hydrogen policy development (e.g., government agencies, private sector, NGOs)

Intersectoral professional consultation forums:

Hungarian Hydrogen Technology Association (MHTSz)
Hungarian Hydrogen and Fuel Cell Association – 44 industrial members and research institutes
Hungarian Battery Association

Governmental bodies:

Ministry of Energy

Ministry of Economic Affairs

Industrial actors:

MOL Group (national oil and gas company)
MVM Group (national power company)
Hungarian Gas Storage Ltd.
BorsodChem Zrt.
Linde Gas Hungary Zrt.

Messer Hungarogaz Zrt.
FGSZ Zrt.

Research institutes:

HUN-REN Research Centre for Natural Sciences
HUN-REN Centre for Energy Research
Regional Centre for Energy Policy Research (REKK)
Several universities, like University of Pécs, coordinator of the National Renewable Energy Laboratory (MENL) project, financed by RRF

4.2. Stakeholder Consultation

Are stakeholders regularly consulted during the policy development process?

Not regularly. Some organisations took part in the consultation process of the definition of the content of the NHS (see below).

If yes, describe the consultation mechanisms:

Consultation was organised with:

Ministry of Innovation and Technology
Ministry of National Development
MOL Group
MVM Group
Gas and Electricity Suppliers (DSO)
Hungarian Academy of Sciences
Institute of Transport and Energy Sciences
Hungarian universities, such as the Budapest University of Technology and Economics (BME)
Environmental NGOs and sustainability and climate protection organisations (e.g. Green Civil Forum, Energiaklub)
Some municipalities in priority industrial positions

The Budapest Hydrogen Summit, an annual industry conference from 2021, brings together leading industry stakeholders and policymakers from Hungary and Central and Eastern Europe to discuss the opportunities and challenges of hydrogen technologies.

5. Future Developments

5.1. Planned Policies

Are there any planned legal or regulatory changes related to hydrogen?

Yes

If yes, provide details

Hungary is working to develop a comprehensive legal and regulatory framework to support the integration of hydrogen into its energy system. The country is in the process of transposing relevant EU directives into national law, updating its National Hydrogen Strategy and developing a dedicated hydrogen law.

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