Interreg CENTRAL EUROPE

Co-funded by the European Union

H2CE

Summary of the results of regional analyses regarding the planning of "H2 readiness"

H2CE – WP1 Deliverable 1.1.2

Version 1 – 03/2025

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1. Introduction

1.1. The Project H2CE

Transitioning to **green energy is essential** for the global **fight against climate change** and **building resilient, sustainable economies**. **Green hydrogen produced** through electrolysis holds significant promise due to its **wide range of applications**. For example, it can be used as an **energy source** for generating electricity and heat, as a crucial **raw material** in industrial processes, and as a **clean fuel alternative** in the transport sector. Nevertheless, it currently makes up less than 2 percent of Europe's energy use[1].

The **H2CE project** empowers central European regions to **actively incorporate hydrogen and renewable energies** in their local and regional energy planning. **Current support materials** understand public authorities primarily as **passive framework conditions**, focusing on the perspectives of project owners and industry. This approach lacks recognition of the public authorities' **valuable expertise and authority**, missing the opportunity to empower them as proactive drivers of change. H2CE recognizes the critical role of public authorities as **proactive agents of change**. By equipping these authorities with **tailored planning tools**, the project **aims to accelerate the deployment of hydrogen infrastructure** and enhance the efficient use of resources. Key outcomes of the project include new mechanisms to empower regional decision-makers in advancing a hydrogen-based energy transition, the creation of a cross-regional and transnational network of hydrogen-ready regions, and the implementation of a digital collaboration platform.[2]

Work package 1[3] of 3, titled *H2-ready for European Regional Spatial Planning and Development*, will **analyze and identify shared obstacles** in planning and governance for hydrogen-ready regions, and approaches to overcome them. Focusing on regional, transregional, and transnational perspectives, this work package aims to develop coordinated strategies and action plans. The **aim is to answer the questions below**:

Which challenges and opportunities are facing regions in Central Europe regarding green hydrogen?

Which commonalities and differences can be identified?

Therefore, **two activities** are included: *Activity 1.1* focuses on understanding the **challenges and issues** regions face in building a hydrogen economy. To do this, a **deeper understanding of the current situation** in each region is required. This analysis is based on a **fact sheet with common indicators** (D.1.1.1), through which the project partners were surveyed on **various metrics and assessments** related to hydrogen. This includes their ongoing activities, the challenges they face, and the opportunities they see for their region. By examining the responses, both commonalities and differences across regions can be identified. The findings will be summarized in the subsequent document, which may also be useful for other regions in Central Europe. Therefore, the methodology will be described in more detail in the first part. The second part is the results section, reflecting the structure of the survey, divided into the indicators of production, infrastructure, hydrogen demand and use, and governance. In the end, the results will be summarised to answer the questions of challenges and opportunities as well as commonalities and differences. Based on these insights, a *strategy and action plan* will be developed in *Activity 1.2*. The key components of WP 1 are shown in Figure 1.

[1] Interreg Central Europe (2024): H2CE. Online available at https://www.interreg-central.eu/projects/h2ce/.

[2] Ibid.

[3] Subsequently referred to as WP 1

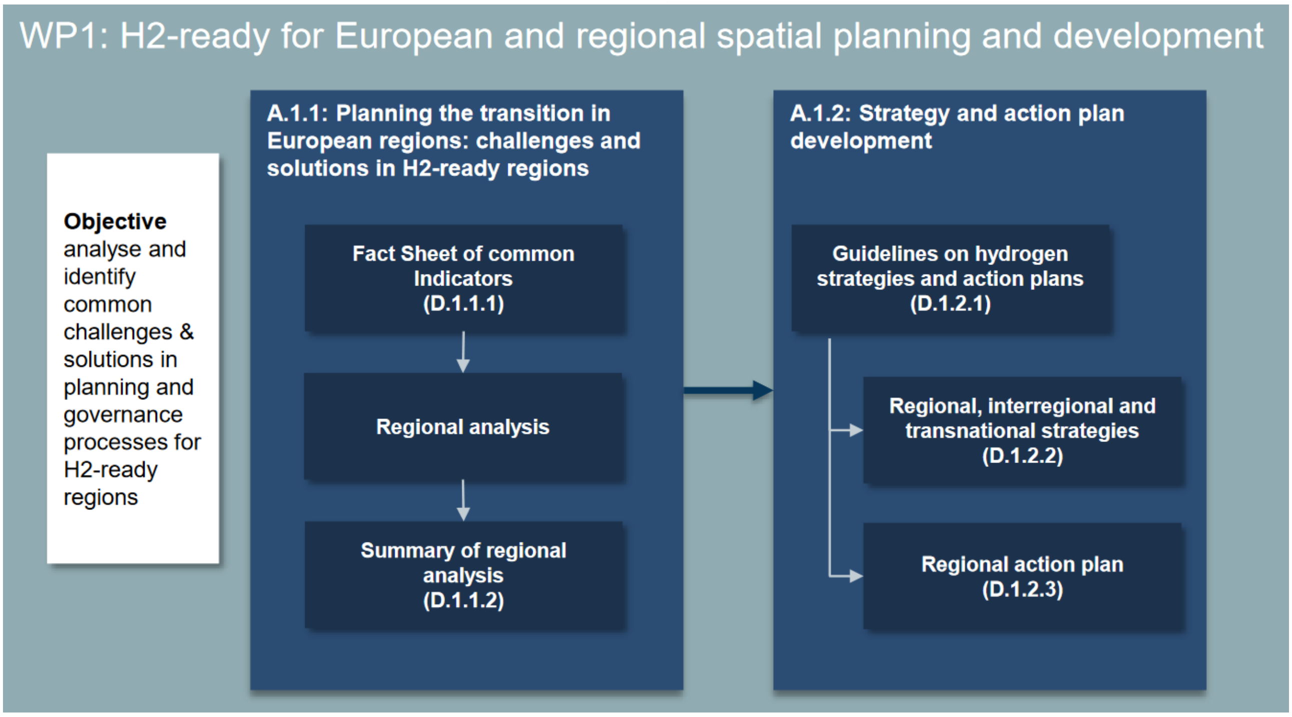


Figure 1: Key Components of Work Package 1

2. Methodology

Deliverable D1.1.1 defines a **comprehensive set of indicators** for assessing the development of a regional hydrogen economy. To evaluate the **current status within a region**, a **structured questionnaire** has been developed. The questions are divided into two main categories: systematic indicators and hydrogen value chain indicators, as illustrated in Figure 1.

The **hydrogen value chain indicators** focus on the **technical aspects** and **regional prerequisites** that influence the production, distribution, and utilization of hydrogen. The **systematic indicators** address broader **non-technical factors**, including political, social, and geographical considerations. They also encompass governance and overarching challenges.

Each indicator category is further **broken down** into **specific sub-indicators**, each associated with targeted questions designed to gather relevant insights. In total, the questionnaire comprises 105 questions, providing a structured approach to capturing the current state of regional hydrogen development. The *Summary of Regional Analysis* provides a **comprehensive overview** of the responses from project partners and offers valuable insight into the status quo of the regions. The summary serves as a resource for understanding technical and non-technical readiness and challenges in developing a hydrogen economy across Central Europe.

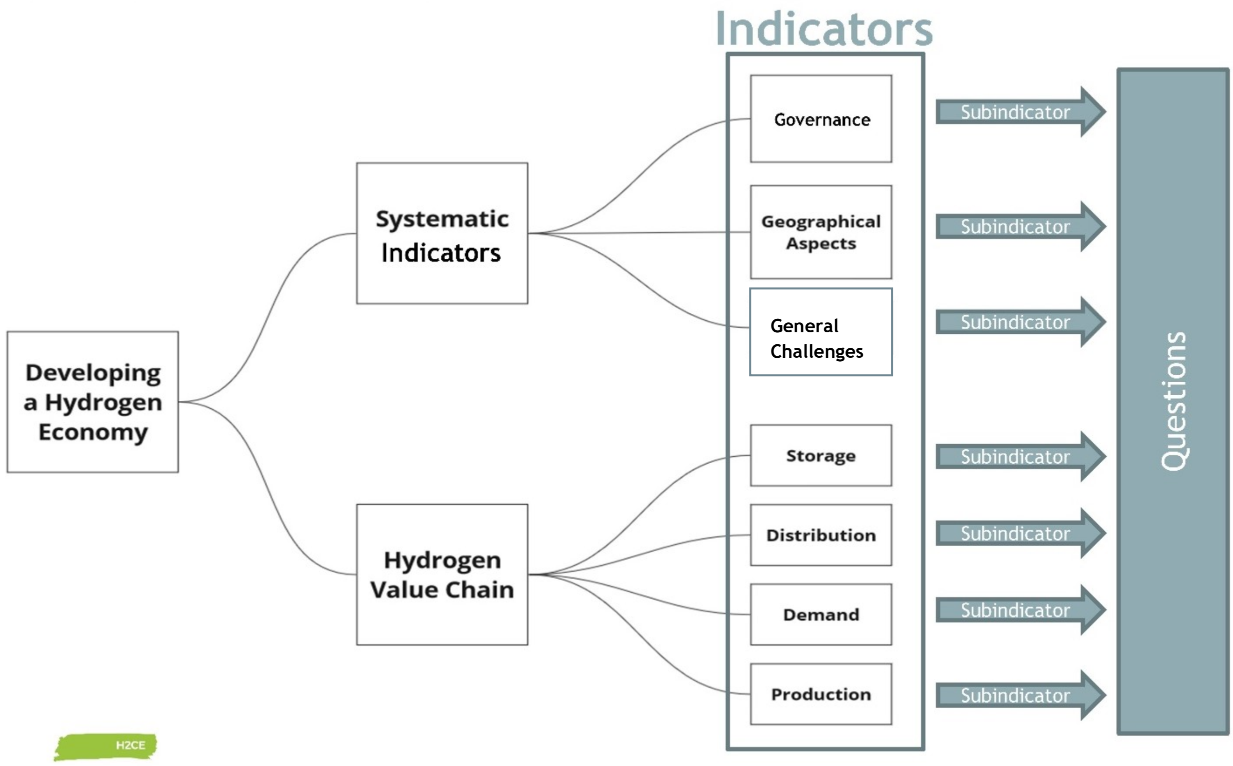


Figure 2: Overview of the different categories of the questionnaire.

3. Results

The subsequent section **summarizes, evaluates and visually presents** the **survey results**. The key themes of *Production, Infrastructure, Hydrogen Demand and Use* as well as *Governance*, which are derived from the indicators, are explored in detail to provide a comprehensive understanding of the regional findings.

3.1. Production

As the world faces the urgent challenge of reducing carbon emissions, **hydrogen** has emerged as **a key energy carrier** for the decarbonization of hard-to-abate sectors, such as heavy industry and the energy sector. Hydrogen production is critical to the global energy transition, offering a versatile solution where electrification may not be feasible. The method of production plays a crucial role in determining the climate impact of hydrogen. Current methods such as Steam Methane Reforming (SMR), which relies on natural gas, contribute significantly to CO2 emissions. While carbon capture and storage (CCS) technologies can mitigate some of these emissions, their effectiveness in practice remains limited, and methane leakage adds to the environmental footprint. As a result, both grey hydrogen produced by SMRs and blue hydrogen produced by CCS pose ongoing climate challenges (UBA 2022; IEA 2019).

In contrast, **green hydrogen**, produced through electrolysis using renewable energy sources such as wind and solar power, **offers a more sustainable and emission-free alternative**. However, the widespread adoption of green hydrogen depends on the availability of renewable energy and advancements in electrolysis technology. With countries such as Spain, Portugal, and Norway possessing great potential for low-cost renewable hydrogen production, the establishment of a European hydrogen market represents a key opportunity.

In **Central Europe**, **Italy** holds the **highest renewable energy potential** and is best positioned for **low-cost hydrogen production**. **Germany**, despite **strong ambitions**, **faces higher costs** due to a renewable energy deficit. Austria is making progress, though on a smaller scale. Countries like **Croatia, Czechia,** and **Poland face significant challenges** due to limited renewable energy potential and a lack of large-scale hydrogen projects (Fragoso García et al. 2022). An overview of the hydrogen production cost potential is provided in Table 1.

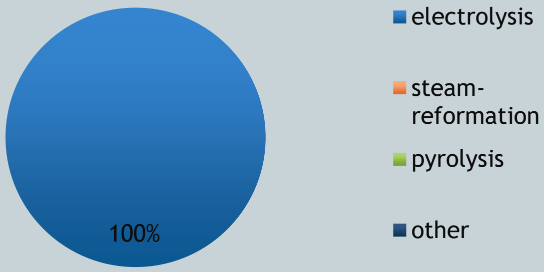
Table 1: Hydrogen Potential by Country (Fragoso García et al. 2022)

Country	**Renewable Energy Potential**	**Hydrogen Production Cost Potential**	**Ambition**
Italy	High	Lower costs due to significant renewable energy potential	Ambitious targets, positioned to become a surplus producer
Germany	Moderate to High	Moderate, with strong investments but may need imports	Well-established strategy with significant funding
Austria	Moderate	Moderate, growing commitment but smaller scale	Progress in hydrogen development, part of EU partnerships
Poland	Moderate	Limited, slower development and modest targets	Emerging with slow progress in hydrogen infrastructure
Croatia	Moderate	Limited, fewer projects and moderate renewable energy potential	Modest targets, likely to rely on imports
Czechia	Low	High, low renewable energy potential and large energy deficit	Limited progress, reliant on imports

Focusing on **local and regional hydrogen production** will **increase energy independence** and security, and stimulate technological innovation, job creation, and regional economic growth. Given the logistical and environmental risks associated with hydrogen imports, **establishing a robust European hydrogen production** and **infrastructure network** is **crucial for long-term sustainability** and **resilience**. This requires a balanced approach that prioritizes local and European hydrogen production while selectively incorporating imports.

What is your preferred hydrogen production method?

Producing hydrogen through electrolysis offers significant benefits. Until now, it's the only process of producing hydrogen without releasing significant amounts of CO2. Furthermore, using electrolysis enables sector coupling between electricity production and such as industry and mobility, resulting in a diverse energy portfolio. In the H2CE project, all regions prefer electrolysis as a production method.

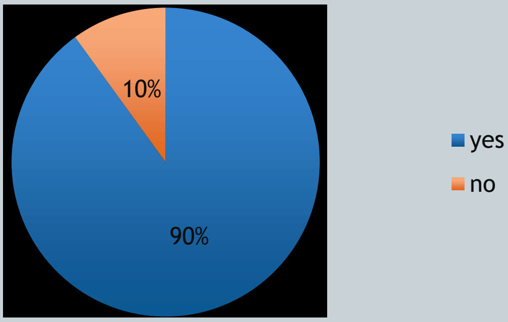


Lübben - High renewable potential and challenges in the heating sector

The Region in South Brandenburg to which the town of **Lübben** belongs, has a **high potential for renewable energies**. Currently, the high production of wind and solar power leads to an **energy surplus**, which can not be used locally. Still, the primary **energy demand** (including the use of other energy carriers like oil and gas) is **higher than** the **regional energy production**. Since the region lacks heavy industry and the most energy consumption occurs in the residential housing sector, **decarbonizing heating** is one of the **main challenges**. Using locally produced renewables in different sectors is a key factor for a successful energy transition.

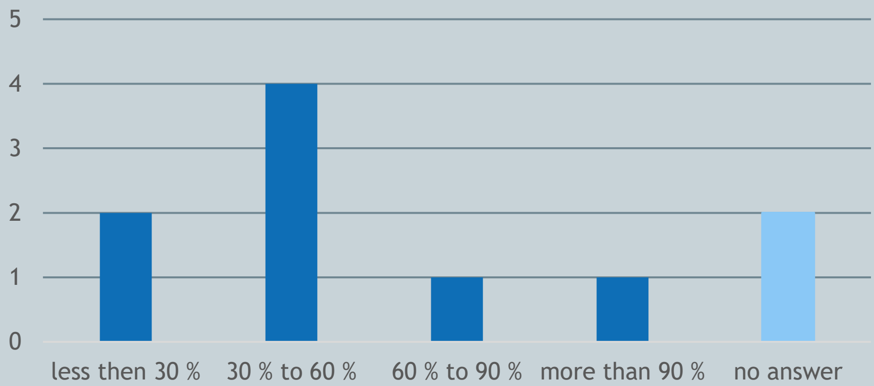
Is the region frequently subject to episodes of water stress or droughts?

Since **electrolysis uses water** to produce hydrogen **concerns** about water **often arise**. For each kilogram of hydrogen produced, electrolyzers require about 15 to 30 liters of water. By comparison, a European household uses approximately 144 liters of water per person per day. Recent Studies suggest that decentralized and regional hydrogen production has a minimal impact on a region's overall water use. Nevertheless, detailed analyses for each specific use case are necessary to address potential conflicts. Public information on the water use of hydrogen production can also raise awareness and can help to overcome public resistance to hydrogen projects. 90 % of regions participating in the H2CE project frequently experience water stress or droughts.



What percentage of your regions yearly electricity production is renewably produced?

As all regions prefer electrolysis as their production method, the **share of renewable energies** in the region **is a significant factor** for regional hydrogen production. Given that renewable energies are an important pillar in various sectors, the direct use of electric energy is often the more efficient option (See Chapter 3.3). A **low share** of renewables also results **in higher electricity prices**, which at the same time **increases the production cost** of hydrogen. Currently, 75 % of regions have a renewable share of 60 % or less. **Increasing renewable production** should therefore be **a high priority** for regions aiming to produce hydrogen regional.



3.2. Infrastructure

Well-developed hydrogen infrastructure is **essential** for an efficient European hydrogen market and demonstrates a region's readiness to transform its energy system. By **connecting low-cost production areas with regions of high hydrogen demand** and extensive geological storage potential, Europe can build a robust and resilient hydrogen infrastructure. This infrastructure will facilitate reliable energy availability, reduce costs, and foster European cooperation while creating an opportunity for regulation to ensure a secure and stable hydrogen supply.

The **low energy density** of hydrogen **poses challenges** for **transport and storage**, which can be addressed by **compressing or liquefying the hydrogen**. This results in two primary forms: compressed gaseous hydrogen (CGH2) and liquefied hydrogen (LH2).

Since large-scale hydrogen production and use rarely occur in the same location, transportation and storage are essential to ensure continuous energy availability and system flexibility. **Transportation methods vary** based on distance, cost, and hydrogen's form. **Pipelines provide an efficient, low-pressure solution** for distributing gaseous hydrogen continuously over both short and long distances. For **short-distance transport**, high-pressure hydrogen **road tankers** are a viable option. While road tankers and local hydrogen pipelines serve as immediate solutions to enable transportation, the development of a European **hydrogen pipeline network** offers a **long-term, cost-effective solution** for transporting gaseous hydrogen over short and long distances, with the added benefit of inherent storage potential within the pipelines. For **intercontinental transport**, **ships are preferred**, especially for liquefied hydrogen or its derivatives, which offer a higher energy density than compressed gas.

The intermittency of renewable energy sources like **wind and solar power presents challenges** in **maintaining a stable energy supply**. As an **energy carrier**, hydrogen can store excess energy generated during peak times and release it when renewable output is low. This **storage** capability provides a **strategic solution**, allowing hydrogen produced during phases of excess renewable energy to be reserved during periods of high demand. Locating **electrolyzers** near renewable energy sources reduces transmission losses **improves grid stability** and **lowers infrastructure costs**, **helping to stabilize energy grids** across Europe and balance energy supply and demand on a continental scale.

Hydrogen can be stored as compressed gas or liquefied hydrogen, providing a versatile energy reserve. It plays a crucial role in integrated renewable energy systems, balancing the variability of renewables and ensuring stability throughout the energy transition. Hydrogen storage methods vary based on pressure, temperature, and energy density requirements.

Table 2: Classification of Hydrogen Storage Tanks

Gas Pressure Containers	**Type I**	**Type II**	**Type III**	**Type IV**
Pressure	Max. 200 bar	Max. 1000 bar	350 or 700 bar	Max. 1000 bar
Application	Gas industry, stationary storage, transport	Stationary applications	Mobility, stationary	Transportation
Material/Structure	Metal (steel)	Steel with fiber winding	Metal with composite	PE/PA liner, carbon fiber shell
Load Capacity	Low	Moderate	High	High
Cost	Low	Moderate	High	High

Table 2 summarises the key characteristics of hydrogen **storage types**. **Low-pressure tanks** (Type I) are **cost-effective for buffer storage**, while **higher-pressure systems** (Types II to IV) require reinforced designs, which **increase costs**. The **Iberdrola project** in Spain uses 11 tanks to store 30 tonnes of hydrogen for PV-coupled electrolysis, highlighting the space requirements for low-pressure storage. Since on-site storage capacity is often limited, suitable regions for large-scale storage are required for a resilient energy system.

Liquefied hydrogen (LH2) is stored at **cryogenic temperatures**, which significantly **increases its energy density**. LH2 is ideal for **long-distance transport and large-scale storage**, but the liquefaction process requires large industrial facilities and is energy-intensive, consuming approximately 33% of the energy content of hydrogen. In addition, boil-off losses of about 0.2% to 1% per day occur in LH2 storage systems.

Storage solutions for CGH2 and LH2 can be **fixed installations** or **mobile units**, with the latter offering modular expansion as demand grows. Mobile systems streamline trailer-based hydrogen delivery, enabling stored hydrogen to be conveniently replaced or relocated.

Cavern storage requires **specific geological conditions** and is essential to meet **higher hydrogen demand** and **seasonal shortages**. While essential for the resilience of larger hydrogen networks, they also present risks of contamination.

Building a robust hydrogen infrastructure is essential for decarbonizing the energy system, as without it, hydrogen's potential as an energy carrier in the renewable transition cannot be fully realized.

The **European Hydrogen Backbone** (EHB) is a critical infrastructure project designed to enable a seamless hydrogen transport network across Europe. With a **planned expansion of 53,000 kilometers by 2040**, the network will connect areas of low-cost hydrogen production with regions of high demand and storage potential, ensuring a reliable and flexible energy supply. The backbone will **primarily utilize repurposed natural gas pipelines**, offering a cost-effective solution for transporting hydrogen over short and long distances. The infrastructure will be **developed in phases**, **starting with regional hydrogen hubs** and gradually **linking them into a unified, cross-border network**. This will provide continuous, low-pressure hydrogen **distribution and storage**, with some **pipelines** offering storage capacity to balance supply and demand. For **large-scale storage**, the EHB will incorporate **geological reserves**, such as salt caverns, in regions with suitable conditions. These storage solutions will help manage seasonal energy shortages and ensure stability in the hydrogen supply. In addition to storage, the **infrastructure will support the efficient transport** of compressed and liquefied hydrogen, depending on the distance and energy density requirements. This versatile network will play a key role in supporting Europe's decarbonization goals, improving energy security, and fostering cooperation between countries.

What are the expansion stages of the European Hydrogen Backbone?

2020-2030: The Initial Phase

- Development of regional hydrogen hubs and local infrastructure
- Early connections between production and consumption regions to establish "hydrogen valleys"

2030-2040: The Mid-Term Phase

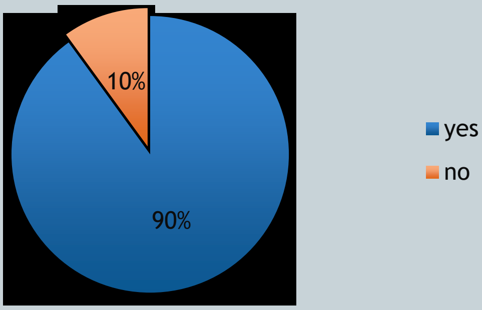
- Linking regional networks into a cohesive, cross-border system
- Integration of large-scale hydrogen storage facilities to ensure supply stability
- Increased trade between regions with surplus production and high-demand areas

2040 and Beyond: The Long-Term Vision

- Full European network Integration
- Possible extensions to non-European regions, such as North Africa and Ukraine, to import hydrogen produced using renewable energy

Will your region be reached by the European Hydrogen Backbone?

The connection to a large transnational pipeline significantly promotes the use of hydrogen. A region can thus both import and export hydrogen. Nearly all partners of the H2CE project are connected to the Hydrogen Backbone.



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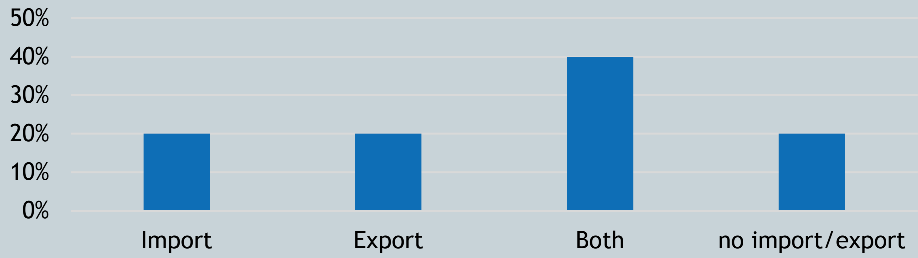
Does your region plan to import/export hydrogen?

Importing hydrogen allows a region to decarbonize its sectors, even when local renewable energy production is insufficient to meet the demand. In this way, regions where hydrogen production is not feasible for various reasons can still contribute to the reduction of greenhouse gas emissions. Conversely, regions with abundant renewable energy resources can export hydrogen to the market, thereby generating profit. Both the import and export of hydrogen require the necessary infrastructure. Some project partners need to import hydrogen to fulfill their future demands. Others can export renewable hydrogen due to their surplus in renewable energies.

Regional plans to import or export hydrogen



Is there available infrastructure in your region?

Infrastructure is essential for both import and export activities as well as for the regional economy. An overview of the existing infrastructure enables a strategic alignment of the region, allowing it to leverage its strengths or address existing gaps.

Available infrastructure in the region:

60 %	50 %	100 %	40 %
Airport	Refueling Station	Gas Pipelines	Ports

How Infrastructure Development Influences Regional Hydrogen Uptake

In the **first draft** of the **German national hydrogen pipeline network**, the region of **North-West Brandenburg** was part of the initial network. In the **final plan**, the **part passing through the region was canceled** due to a lack of bigger production or demand. To not to be left behind in the ramp-up of the hydrogen economy, **H2 projects** in the region **must be planned independently** of the pipeline. For those projects, the **whole hydrogen value chain must be planned together**, since there is no access to the national hydrogen market via the pipeline to deal with over- or underproduction.

3.3. Hydrogen demand and use

Hydrogen plays a **pivotal role** in decarbonizing sectors that are challenging to electrify, such as heavy industry, transportation, and energy storage. It is particularly important for **industries and applications that require high energy densities** or specialized processes **where electrification is not feasible** – so-called *no-regret applications*. Due to various challenges, hydrogen should not be used when the application is associated with high uncertainties, risks, or inefficient results. A limitation to the no-regret applications is recommended.

Hydrogen production requires significantly **more renewable energy than direct electrification**, with considerable energy losses in processes such as electrolysis and compression. For example, hydrogen used in transport can consume up to three times more energy than battery electric vehicles (BEVs), making it less efficient where electrification is possible. The widespread use of hydrogen would therefore put additional pressure on limited renewable resources.

The **cost of hydrogen is a significant barrier**, making it heavily reliant on public funding. In addition, expanding its use requires substantial investments in infrastructure for production and storage, adding to the cost. Hydrogen is likely to remain cost-competitive or subsidized only in sectors where cheaper alternatives are not technically available. Widespread application of hydrogen could reduce its availability for these critical sectors.

Heavy Industry:

Hydrogen is essential for **decarbonizing steel production, cement manufacturing, and chemical processes** that rely on high-temperature operations. Given the limited alternatives to replace fossil fuels in these industries, the use of hydrogen is considered indispensable.

- **Hydrogen as a Feedstock:** In industries like steel production, hydrogen is used as a feedstock in processes such as hydrogen direct reduction for producing green steel. This is considered a no-regret application because there are few viable alternatives for decarbonizing steel production. In the chemical sector, hydrogen is crucial for producing compounds like ammonia and methanol, where finding suitable substitutes is challenging.
- **Hydrogen for High-Temperature Heat Applications**: Hydrogen can be utilized to provide high temperatures needed in energy-intensive processes like cement, glass, and ceramics production. However, these processes may compete with electrification or biomass as alternative heat sources. Hydrogen's application in these areas is still in the early stages, and challenges remain in scaling it for continuous, high-temperature production.

Transportation:

Hydrogen is crucial for aviation and maritime shipping, where electrification is challenging. In road transport, however, hydrogens' high costs and inefficiencies make it less competitive than battery electric vehicles. Ongoing advancements in battery technology are driving improvements and cost reductions, further enhancing the appeal of electrification. Hydrogen may become a niche solution for long-haul heavy-duty vehicles, limited to applications where faster refueling and longer range are particularly important and provide a competitive advantage.

- **Power-to-Liquid (PtL) technology** allows for the storage of renewable energy in liquid fuels, which can be easily transported and utilized with existing infrastructure. This makes PtL particularly suitable for intercontinental imports, where production costs may be more competitive than in Europe. These fuels are essential for aviation and maritime shipping, where high energy density is required. In shipping, synthetic fuels like methanol and ammonia are promising alternatives, while in aviation, e-kerosene is favored due to the long lifespan of aircraft and flexible fuel blending options.

- **Hydrogen, as a direct energy carrier**, can be used in vehicles, though it is often less efficient than battery-electric options. In shipping and aviation, hydrogen is suitable only for short distances and smaller engines, but battery-electric drives are generally more cost-effective. Fuel cells are used in hydrogen-powered vehicles, where electricity is generated for an electric drivetrain, with a battery buffer for energy management and improved performance. These fuel cells require hydrogen with a purity of 99.995%. In trucks, hydrogen is stored in 350-bar or 700-bar tanks, offering ranges of up to 1,500 km in future models. Liquid hydrogen storage is still in development, with uncertain market timelines.

Energy Sector

Hydrogen enables long-term energy storage and grid balancing. It stores excess renewable energy during peak production and releases it during periods of high demand or low generation. This flexibility makes hydrogen essential for stabilizing renewable energy systems, ensuring a continuous energy supply even during fluctuations in wind or solar power output.

- **Hydrogen in Power Generation for Grid Stability**: Hydrogen is expected to play an important role in electricity generation, especially during periods of *dark doldrums* (when both wind and solar power are insufficient). Hydrogen-fuelled power plants, often referred to as peaker or sprinter plants, can be used to stabilize the grid by providing electricity during high-demand periods when renewable energy generation is low. Hydrogen can be used in combined heat and power (CHP) plants to produce both heat and electricity. However, its use for heating applications will be limited, as heat pumps and direct electrification are more efficient and cost-effective. The consensus is that hydrogen will be crucial for grid stability and in combined heat and power scenarios during specific high-demand periods. These no-regret applications illustrate hydrogen's central role in the transition to a low-carbon economy.

What is the preferred sector for using hydrogen?

Due to its wide range of potential applications, hydrogen can be utilized across various sectors. To optimize infrastructure development, it is important to prioritize certain sectors. However, this prioritization should not neglect other sectors. Furthermore, the decision should be based on the regional availability, the environmental benefits, and the technological maturity of the respective applications.

Mobility

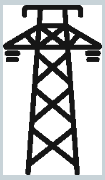
50 %

Industry

40 %

Heating

0 %



Energy

10 %

3.4. Governance

The goal of the H2CE project is to enable public administration to play an active role in the ramp-up of the hydrogen economy. The survey results highlight four key areas of action where public administration can promote the growth of a hydrogen economy.

Reduction of Barriers

To facilitate the successful development of hydrogen infrastructure, public administration must work to remove existing barriers. Since hydrogen is a new technology, public authorities often lack experience with permitting processes, which can lead to avoidable project delays. At the same time, a well-organized permitting procedure is essential for ensuring the safety of hydrogen facilities. Specialized points of contact for hydrogen technologies, which can assist companies with their applications, will help to ensure the smooth establishment of hydrogen projects within a given region.

Promotion of Regional and Cross-Regional Cooperation

Hydrogen projects often fail due to the so-called *chicken-and-egg problem*. The production of green hydrogen can not develop without the necessary infrastructure and demand, and vice versa. As a result, many projects consider the entire value chain of green hydrogen, ranging from production and distribution to end-use. To identify suitable partners for each project, ongoing regional exchange is necessary. Public administration can actively support the networking of regional stakeholders in the hydrogen sector by organizing networking events or other regular forums for stakeholders to connect and exchange ideas in the hydrogen sector.

Knowledge Transfer and Public Acceptance

Public acceptance of hydrogen projects and the associated renewable energy technologies is often a significant obstacle to their successful implementation. Targeted education and direct engagement with citizens can be key to fostering this acceptance. Regions can highlight through campaigns and events how such projects can create or sustain jobs, while simultaneously ensuring the supply of clean and affordable energy.

Strategies

Strategies set the direction for the long-term period, specifying concrete goals and outlining the path to achieve them. Based on these strategies, companies can plan for the long term and make informed investment decisions. Active development of strategies by public authorities, in close consultation with local stakeholders, supports the establishment of a hydrogen economy. Typically, national strategies are available, providing guidance for regional strategic alignment.

Country	Region	Status of hydrogen strategy
DE	Berlin/Brandenburg	Strategy available
DE	Lübben/Lubin	No regional strategy, Strategy for Brandenburg available
DE	Northwest Brandenburg	Regional strategy available
HR	Northwest Croatia / Zagreb	No regional strategy
AT	Styria	No regional strategy, currently in progress
PL	Pomorskie Voivodeship	"Pomorskie on light gases" as a preparation for regional strategy
PL	Lubina	No regional Strategy
IT	Emilia Romagna	No regional strategy
IT	Veneto Region	No regional strategy
CZ	Usti Region	Regional strategy available

Strategies

Hydrogen strategies provide a long-term roadmap that stakeholders can follow. The availability of strategies at both, the national and regional levels provides a strong foundation for a successful ramp-up.

Availability of strategies in the H2CE Partner Countries and regions:

National	Regional
100 %	40 %

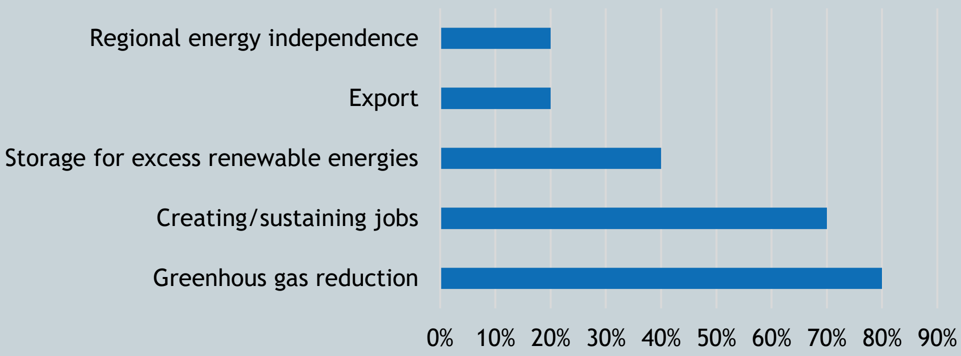
Lower Silesia - regional specifics demand regional strategies

The **region of lower Silesia** is home to the **biggest copper and silver mine** in Europe. The mine and the accommodating infrastructure make the region unique. While Poland has a national strategy, the region wants to **develop a regional strategy**. The aim is **not to replace the national hydrogen strategy** but to set a strategic pathway to fit the unique needs and assist the target-oriented transition towards renewable energies and hydrogen. This example shows that national strategies sometimes are not meant to reflect a very specific regional need but to give a direction for the development of the hydrogen economy on a national scale. Participation in both directions is a key factor for successful strategy development.

portunities

Hydrogen offers various advantages for a region. Therefore, the motivations for its adoption vary from one region to another.

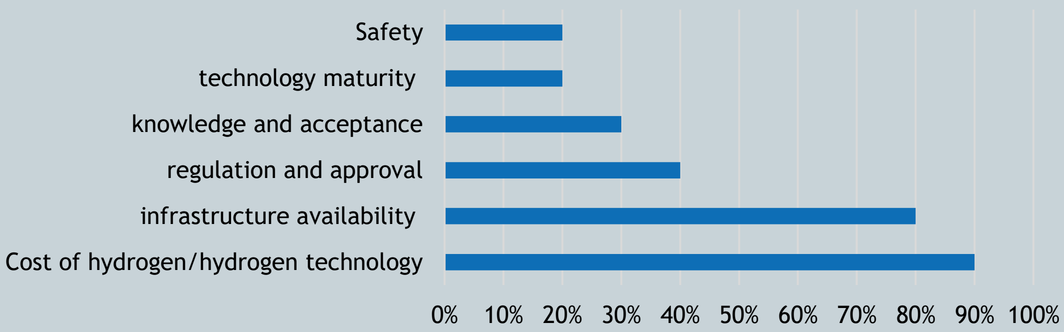
What are the biggest opportunities that you see in a hydrogen economy?



Reduction of Barriers

Removing barriers is one of the main challenges facing public administrations. Based on the responses of the H2CE partners, the biggest obstacles are the price of hydrogen technologies and the availability of infrastructure.

What are the biggest obstacles to establishing a regional hydrogen economy?



4. Results

The following section **summarizes the survey results** to address the following questions and to lay the foundation for strategy and action plan development:

Which challenges and opportunities are facing regions in Central Europe regarding green hydrogen? Which commonalities and differences can be identified?

The **renewable energy potential varies significantly** across Central European regions. Countries like Czechia, Poland, and Croatia have low to moderate potential, resulting in slower progress, higher production costs, and a reliance on imports. Austria, with moderate potential, is progressing in developing its hydrogen economy, though on a smaller scale compared to some neighboring countries. Germany's hydrogen production costs are moderate but are supported by strong investment and ambitious targets. Italy, with abundant renewable resources, is well-positioned for low-cost hydrogen production and aims to become a surplus producer.

All surveyed countries **share the need for extensive infrastructure development** and **see economic benefits**, such as job creation and improved energy security. Differences emerge in renewable potential and ambition levels, with Italy and Germany leading in both ambition and infrastructure plans, while other countries progress more slowly. Developing a robust European hydrogen market offers these countries a collaborative opportunity to address disparities in production capacity and advance the hydrogen economy collectively.

Electrolysis is the **preferred production method** across surveyed regions, given its suitability for green hydrogen. However, **concerns about water usage** are common, as 90% of regions report frequent water stress or drought conditions. Renewable energy is a prerequisite for green hydrogen production, and there is a need for expansion: currently, 75% of regions have a renewable energy share of 60% or less. Increasing renewable energy production should therefore be a high priority for regions aiming to produce hydrogen locally.

Infrastructure is essential for a functional European hydrogen market. Nearly all survey participants are connected to the European hydrogen backbone. All regions are equipped with gas pipelines, 60% have an airport, and 40% have a harbor. Half of the regions have hydrogen refueling stations. The availability of infrastructure has significant influence on the development of regional hydrogen projects as seen in the example of Northwest Brandenburg.

Hydrogen production requires significantly more renewable energy than direct electrification due to considerable energy losses in processes like electrolysis and compression. Hydrogen usage spans various sectors, such as heavy industry, transportation, and energy. Half of the participating regions plan to prioritize hydrogen use in the transportation sector, while 40% intend to use it in industry. Only 10% plan to use hydrogen in the energy sector and none of the surveyed regions indicated plans to use green hydrogen primarily for heating.

When asked about the **biggest obstacles** to establishing a hydrogen economy, **commonalities and differences emerged** among the surveyed regions. The primary challenges are high costs and technology, with 90% of regions identifying these as major obstacles. Limited infrastructure availability is the second-largest barrier, cited by 75% of respondents. Regulatory and approval issues pose significant challenges for about half of the regions, while moderate obstacles include knowledge and public acceptance (30%). Safety concerns are minimal, with only 20% of regions viewing this as an issue.

Hydrogen also presents **opportunities** for regional development, and the **motivations for adopting a hydrogen economy vary** among the regions. The biggest opportunity identified is greenhouse gas reduction, with around 80% of respondents seeing this as a benefit. Creating and sustaining jobs is perceived by 60% of the regions as an advantage. Additionally, storage for excess renewable energy is viewed by half of the regions as an opportunity. Other benefits, such as export potential and regional energy independence, are noted by fewer regions (both 20%).