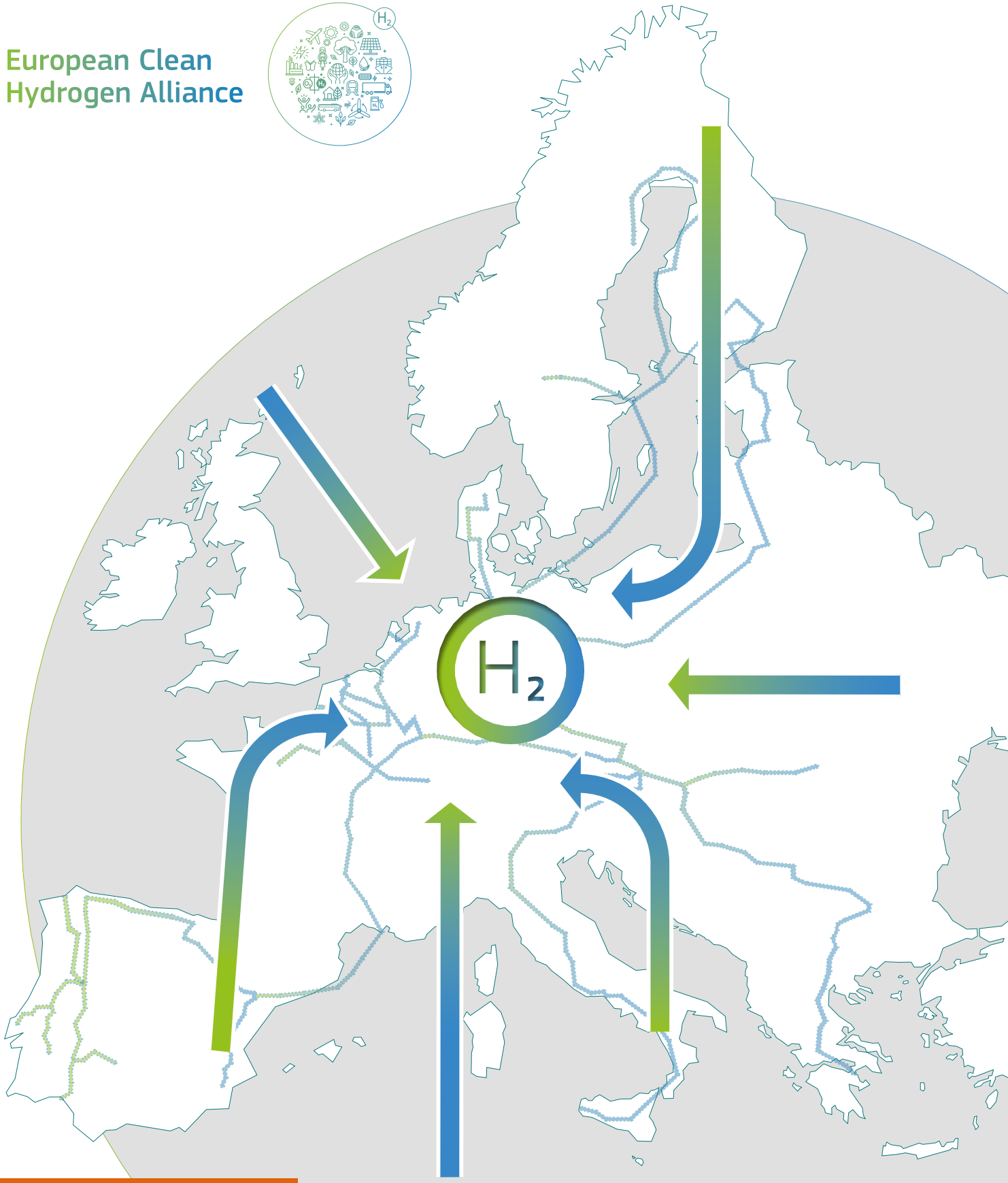
LEARNBOOK: IMPLEMENTATION OF SUPPLY CORRIDORS

European Clean Hydrogen Alliance



November 2024

Disclaimer:

This document reflects the work of the Transmission and Distribution round-table of the set up in the context of the European Clean Hydrogen Alliance. The input identified does not necessarily represent the position of the European Commission nor the position of individual members of the Alliance.

1 INTRODUCTION

The **European Clean Hydrogen Alliance (ECH_2A – the Alliance)** was founded in July 2020 to support and facilitate the implementation of the EU's Hydrogen Strategy. Its main aim is to create a European economy for clean (renewable and low-carbon) hydrogen that covers the entire value chain from production to transportation to end-use in different sectors until 2030. More than 1,700 members form part of the ECH_2A and represent many different stakeholders including private and public companies, research institutions, public authorities, financial institutions, NGOs, and associations.

The Alliance is determined to promote investments in clean hydrogen across the value chain and to play a pivotal role in achieving the transformation of the European economy to a more sustainable, carbon-free economy. One key element to achieve this is a pipeline of investments that is regularly updated and that supports investors to implement their projects.

The Alliance's work is led by the European Commission's Directorate-General for Industry and the Internal Market. The Alliance is organised into six roundtables representing all parts of the value chain: production, transmission and distribution, energy, buildings, industrial applications, and mobility. Two additional working groups on electrolysers and standards complete the setup..

The **Roundtable on clean hydrogen transmission & distribution (T&D RT)** focuses on the infrastructure necessary for the transportation of gaseous hydrogen, liquid organic hydrogen carriers (LOHC), liquid hydrogen (LH_2), hydrogen carriers (green ammonia and methanol, etc.) and ports.

The scope of the Roundtable is on the following four Archetypes:

- Transmission and distribution pipelines for local, regional, national, and international transport and storage facilities,
- Marine storage and handling terminals in ports covering both existing as well as new terminals,
- Shipping covering deep sea and short-distance maritime routes,
- Inland distribution modes of transport including trucks, rail, barges, hubs, and operational storage (such as bullets, tanks, containers, etc.).

THE T&D RT HAS ALREADY PUBLISHED THE FOLLOWING LEARNBOOKS:

'Hydrogen Supply Corridors' with the aim to build on this framework, providing industry expertise and knowledge on three key areas: i) identify the potential and specificities of each corridor; ii) provide visual representation of each corridor with a list of planned H_2 transmission, distribution, storage, terminal and production/demand projects; iii) identify region specific bottlenecks and provide recommendations to mitigate them (March 2023).

'Hydrogen Imports to the EU market', which outlines the benefits, options, and environmental implications of importing H_2 to the EU and provides a list of barriers and recommendations supported by the members of the roundtable (November 2023).

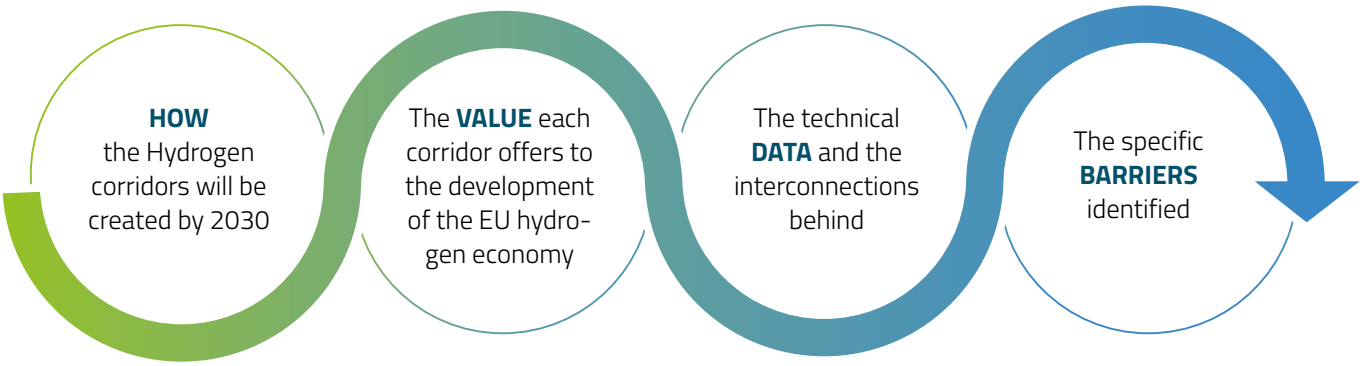
'Financing of Projects', which illustrates how hydrogen infrastructure financings could be carried out and which financing sources exist or could be established. It is meant to contribute to the ongoing discussion on how to best support the financing of hydrogen infrastructure (September 2024).

The Learnbooks are available on DocsRoom – European Commission (europa.eu)

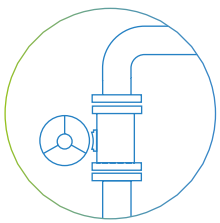
2 EXECUTIVE SUMMARY & RECOMMENDATIONS

As described in the first Learnbook by the Transmission & Distribution Roundtable of the European Clean Hydrogen Alliance, EU needs hydrogen supply corridors to fulfil the targets set by the REPowerEU plan. Creating an integrated hydrogen network is the only efficient way for Europe to connect different large production sites, import routes and options with the main industrial clusters and demand centers, and at the same time manage to diversify sources and secure supplies, maintaining energy affordability, security, and independence.

THE LEARNBOOK ON THE IMPLEMENTATION OF THE SUPPLY CORRIDORS DESCRIBES:

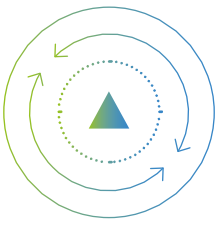


THE SET OF MAPS INCLUDED GIVES A CLEAR VIEW OF WHAT IS TO BE EXPECTED BY 2030. SIX DIFFERENT IMPORT ROUTES THAT:



Transport hydrogen imported via offshore pipeline or from the ports/ terminals (in the form of hydrogen carriers) to the demand centers

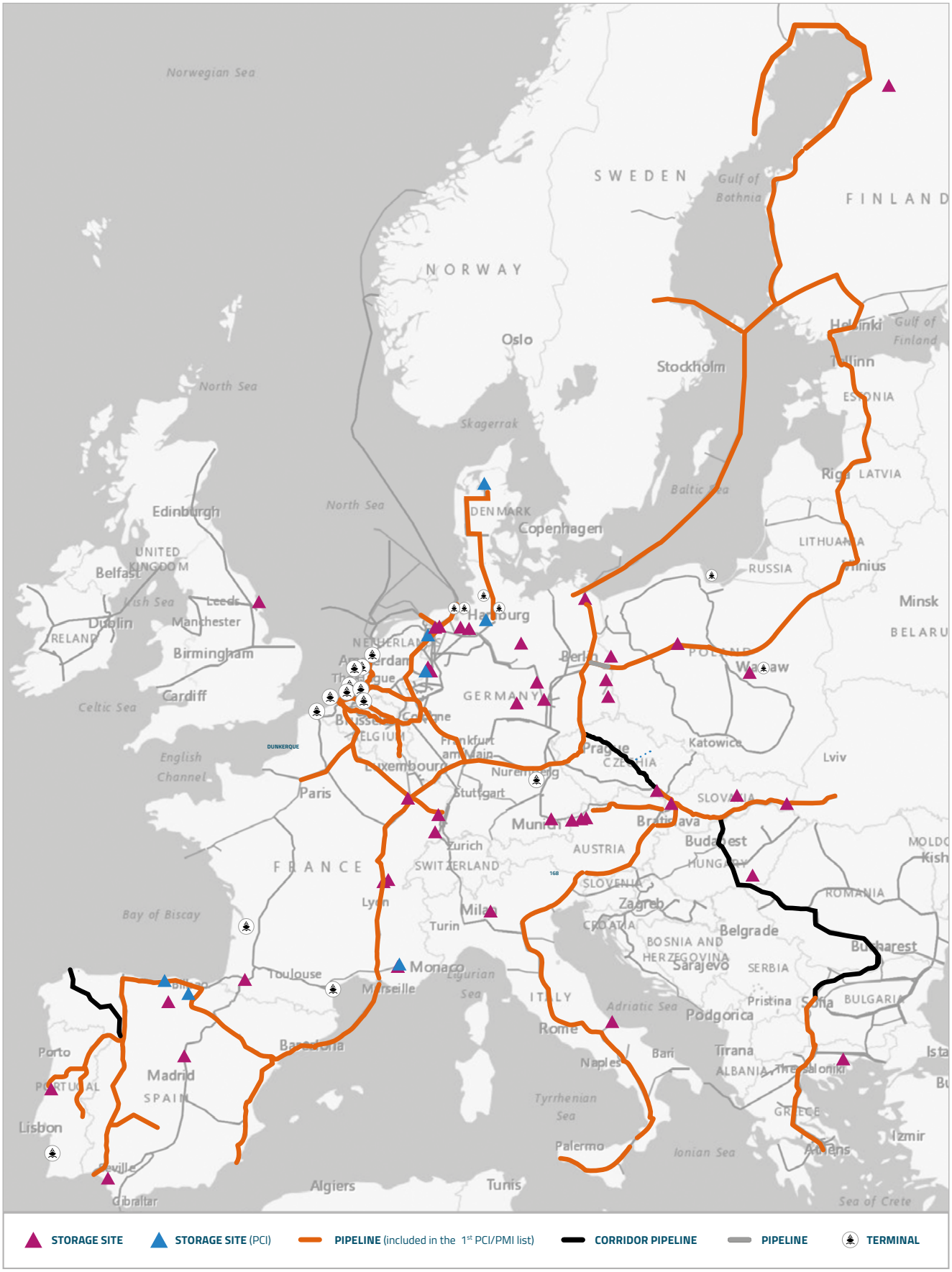
Interconnect all future national hydrogen backbones and can create an EU hydrogen internal market



Serve the internal H_2 market, conneting production with storage sites, industrial demand and regional valleys

Create the basis of a pan-EU hydrogen network

THE SIX EU H_2 SUPPLY CORRIDORS



Almost all the projects that contribute to the creation of the six corridors are already in the 1st PCI/PMI list published, based on the revised (in 2022) TEN-E Regulation, having the support of the respective MSs and the national regulatory authorities. Nevertheless, there are still barriers to overcome, as we need to reach the Final Investment Decision status and start construction works the soonest and in a coordinated way.

The proposed actions are categorized in Policy / Regulation, Financing / Finding, and Value Chain. As a next step, the Roundtable proposes the establishment of an annual EU-wide Progress Monitoring with pre-agreed key metrics for all MSs.

Annual EU-wide Progress Monitoring Report						
Number of **permitting procedures** accomplished	Number of **projects** (FIDs) taken	Dates of the **projects** availabilities **for the markets**	**Emissions abatement** enabled by the infrastructure and achieved by its users	Number of **certificates** on the market	Support for **industrial processes** continuation (number of jobs retained/ created in H_2- based industries/ services)	Number of **storage sites** delivering flexibility services (injection and withdrawal rates).

3 WHY EU NEEDS THE HYDROGEN SUPPLY CORRIDORS

The European Hydrogen Strategy ('A hydrogen strategy for a climate-neutral Europe') published by the European Commission in 2020 recognised the important role of hydrogen in decarbonising industrial processes and other hard-to-abate sectors of the economy. Within the framework of the European Green Deal, Europe has set the target to become climate-neutral by 2050.

In 2022 the European Commission published its REPowerEU plan, which aims to rapidly reduce dependence on Russian fossil fuels and accelerate the green transition. Hydrogen plays a key role in this plan. The REPowerEU plan calls for the diversification of supply sources to minimise Russian gas imports by increasing supply of renewable and low carbon molecules and sets renewable hydrogen import and production targets. In parallel – with the goal of reducing EU emissions by at least 55% by 2030 – the 'Fit for 55 Package', has introduced multiple pieces of legislation with binding demand side targets for RFNBOs (renewable H_2 and H_2 derivatives) by 2030.

The only efficient way for Europe to achieve these targets is by developing corridors that connect different large production sites, import routes and options with the main industrial clusters and demand centers.

The development of such corridors, forming an integrated pan-European hydrogen network, offers the opportunity to diversify sources and secure supplies, and at the same time develop regional and national hydrogen markets through interconnections. The corridors are of critical importance to Europe's goals for the energy transition, including energy affordability, security, and independence.

4 AIM & CONTENT OF THE LEARNBOOK

The 1st Learnbook on 'Hydrogen Supply Corridors' from the T&D RT identified six supply corridors, based on the RePowerEU's schematic representation of the H_2 supply routes:

- **South Central H_2 corridor**
- **Iberian H_2 corridor**
- **North Sea H_2 corridor**
- **Baltic Sea Region H_2 corridor**
- **Eastern H_2 corridor**
- **South-eastern H_2 corridor**

This new Learnbook from the T&D RT builds on the experience gained from the 1st Learnbook and includes the latest project information that reflects the current landscape on the planned hydrogen supply corridors across Europe.

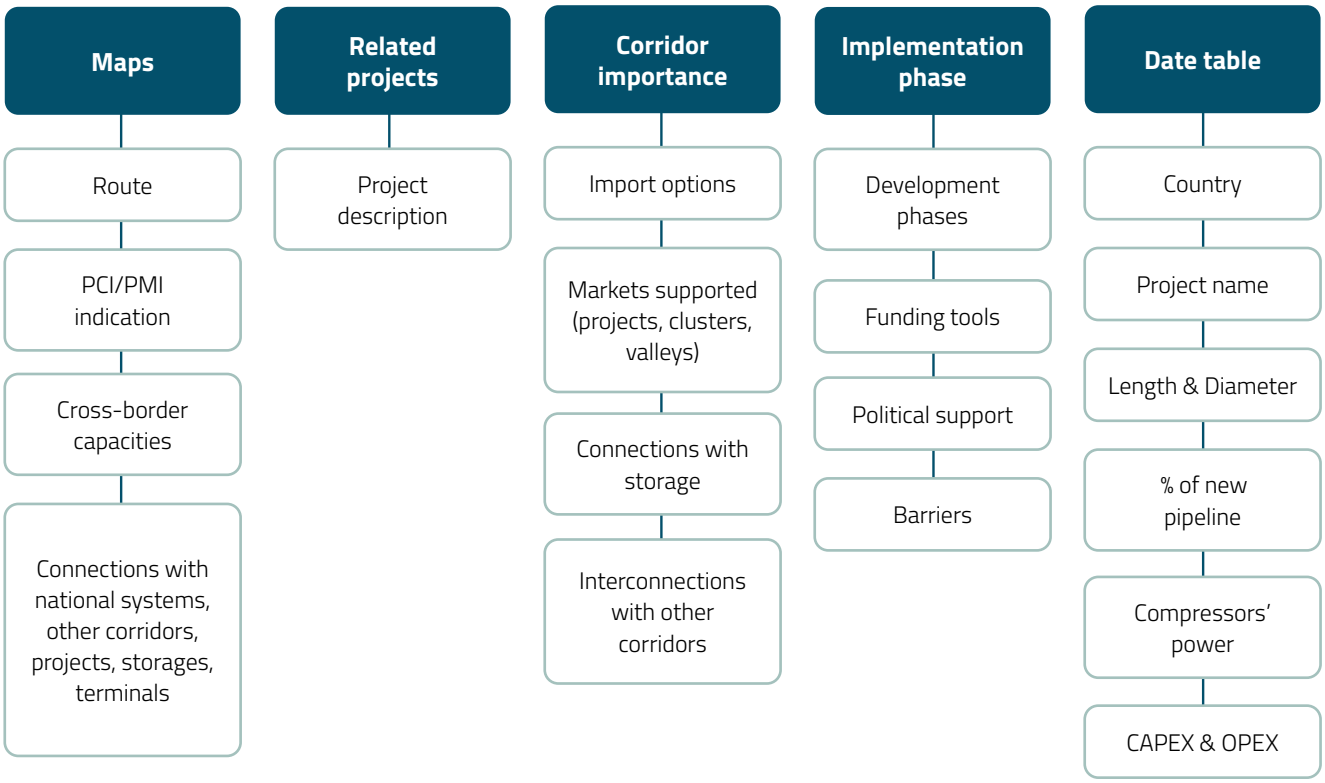
Each one of the corridors has its own and unique characteristics, contributing to the achievement of the RePowerEU targets, as all routes will be necessary for covering the EU expected demand. At the same time, they also contribute to a swift energy transition for all regions of the EU in a secure and affordable way.

The Learnbook aims to be more specific on:

- **How** the six aforementioned corridors **will be created** by 2030, based on current ongoing projects. These projects might have a wider or a more 'national' focus, but contribute to the establishment of a specific flow route.
- **The routing** of each corridor **for connecting** import points (for onshore and offshore pipelines), import terminals (for hydrogen and its derivatives), storage sites, and clean hydrogen production with the industrial demand areas and distribution clusters, including for instance industrial clusters, ports and hydrogen Valleys.
- **The interconnection** of national hydrogen systems that these corridors will offer, establishing a solid base for market development and security of supply.
- **The** technical **data**, an estimation of the development and implementation costs and possible financial tools for each of these corridors. It is noted that the cost elements refer only to the part of the projects that contribute to the creation of the corridors.
- **The specific barriers** identified for the related projects to reach the FID status the soonest.

LEARNBOOK DATA CONTENT

The Learnbook includes the following data per corridor:



BASIC PRINCIPLES OF THE LEARNBOOK

For the preparation of this Learnbook the following principles were followed:

- A corridor is a supply route, connecting EU production sites and hydrogen imports with main demand centers.
- A corridor is created by a number of projects and/or including parts of national hydrogen systems.
- The data used refers only to the parts of the related projects that contribute to the establishment of a corridor.
- The data sets included are collected from publicly available sources or were submitted by project promoters in a non-confidential way and should be considered as best estimates for the purposes of this Learnbook at the time that it was prepared. It is noted that they are subject to changes when more detailed studies are performed per project.
- The Learnbook is not related to any official process for the hydrogen infrastructure (ENTSOG TYNDP, PCIs, ...) and is not a list of projects.

SOUTH CENTRAL H_2 CORRIDOR

The South Central H_2 supply corridor links North Africa with the European market.

RELATED PROJECTS

— **SoutH$_2$ Corridor,** a project initiative with the ambition to enable hydrogen flows from Italy to Germany crossing Austria and to import (green) hydrogen from North Africa. This corridor plays a key role in establishing security of hydrogen supply by connecting production/import areas to storage facilities along the route. Additionally, it will foster competitive domestic hydrogen production and imports by facilitating transportation both within and across national borders. The corridor consists of the following individual PCI projects included in the sixth PCI list, approved and published by the European Commission in April 2024:

- **Italian H_2 Backbone:** consists of the development of an H_2 corridor in Italy that connects with North Africa, Austria and potentially Switzerland enabling the transport of low-cost renewable hydrogen produced in the South to key European clusters of demand. The Italian H_2 Backbone is composed of around 1920 km of pipelines, mostly repurposed (> 60 %). With an import capacity of circa 448 GWh/day from North Africa, this project is a major European renewable hydrogen import artery, serving Italian demand clusters and with a capacity to export circa 168 GWh/day to Austria and beyond.

- **H_2 Readiness of the TAG pipeline system:** consists of repurposing one of the three existing natural gas pipelines of the TAG system to hydrogen (380 km) to connect Italian-Austrian border (Arnoldstein) and the Austrian-Slovakian border (Baumgarten).

- **H_2 Backbone WAG + Penta West:** creates cross-border bidirectional transport possibilities for hydrogen between Austria and Slovakia, as well as Austria and Germany with a parallel line for hydrogen transport that supplements the West Austria Gas Pipeline (WAG) and the Penta- West Pipeline (PW)

- **HyPipe Bavaria – The Hydrogen Hub:** consists of a hydrogen network running from Austria to the gates of Munich and creates a connection to Baden-Württemberg and Czech Republic as well as to central Germany. With an import capacity of 150 GWh/d it is the entry gate to the southern Germany hydrogen market (more details in the dedicated section).

— **SunsHyne Corridor:** a project initiative with the ambition to enable hydrogen flows from Italy to Germany crossing Italy, Austria, Slovakia, and the Czech Republic and enabling import from North Africa. This corridor is envisioned to be 3,400 km long and has about 85 % repurposed pipelines and will enable the development of common hydrogen market also with the wider Central Easter European (CEE) region, supporting competition and security of supply.

WHY IS THE CORRIDOR IMPORTANT

IMPORT OPTIONS

The corridor aims also to supply competitive renewable hydrogen from North Africa to European demand clusters. With a hydrogen import capacity of 4 Mtpa, the **corridor could deliver more than 40% of the total REPowerEU import target.**

Italy has the potential to become an import hub for hydrogen carriers. Ship imports will be relevant to diversify import streams and ensure a reliable capacity utilization of the transmission pipeline.

MARKETS SUPPORTED (projects, valleys & clusters)

Italy

Demand from hard to abate industrial clusters such as: Augusta, Taranto in south Italy and others in northern Italy.

— Valleys, Projects and Initiatives (non-exhaustive)

- **'Puglia Green Hydrogen Valley':** this project provides for the construction of two plants in Brindisi and Taranto, with a total electrolysis capacity of 160 MW. It also involves developing around 100 km of hydrogen infrastructure, much of which will be repurposed from existing networks. The main objective is to decarbonize industry and mobility around Taranto area. The project obtained the IPCEI (Important Project of Common European Interest) status by European Commission in 2024, in the Hy2Infra wave.
- **PNRR Hydrogen Valleys (Recovery and Resilience Fund):** To support the ramp-up of Italian hydrogen market the Italian Government established this investment which aims to support the local production and use of green hydrogen in industry, SMEs and local transport. The objective is the completion of at least 10 hydrogen production projects in disused areas, for a total capacity of at least 10 – 50 MW. Last year, over 50 projects have been pre-selected for a total electrolyser capacity of more than 100 MW, with an investment of around EUR 164 m.
- **IPCEI Hy2Use:** EUR 500 m have been allocated at Italian level to finance 4 selected projects which are related to hydrogen industrial applications and the related infrastructures along the hydrogen value chain.
- **PNRR Hydrogen Refueling Stations (Recovery and Resilience Fund):** To support the ramp-up of Italian hydrogen market the Italian Government established this investment which aims to support the development of hydrogen for road transport. Last year, 36 refueling station projects were pre-selected, with an investment of around EUR 128 m.

Austria

Demand from hard to abate industrial clusters such as: Styria, Vienna and Linz

— Valleys, Projects & Initiatives (non-exhaustive)

- RAG Energy Valley
- WIVA P&G Projekt HyWest
- H2 Valley East (H2REAL)
- Flagship region 'Wasserstoffinitiative Vorzeigeregion Austria Power & Gas'

— H2 Import Alliance Austria (HIAA)

- 'The HIAA (Hydrogen Import Alliance Austria) is an initiative of eight leading Austrian energy companies, infrastructure operators and hydrogen offtakers, primarily from industry. The member companies consider the import of green hydrogen as an essential contribution to achieving climate targets and securing Austria as an industrial business location. Their common goal is to enable hydrogen imports to Austria via pipelines by 2030 and beyond – in order to cover the significantly increasing demand for green hydrogen in the long term.' (Source: www.hiaa.eu)

— Hydrogen Partnership Austria (HyPA)

› 'To support the ramp-up of an Austrian hydrogen economy, the joint platform will ensure a continuous exchange between companies, researchers, administration and civil society, facilitate their networking, offer an international showcase and an overview of funding opportunities, and communicate on current developments in the field of hydrogen. The platform conducts an ongoing dialogue process in order to productively incorporate different positions into the design of regulations and funding mechanisms. The platform is supported by a high-level advisory board chaired by Wolfgang Anzengruber. The advisory board will draw up recommendations for the responsible ministries. HyPA is an initiative of the BMK and BMAW as well as the federal state of Tyrol and is implemented by the Austrian Energy Agency and the Standortagentur Tirol.' (Source: www.hypa.at/en/)

— Production (in operation; source: HYPA)

› H2Future (6 MW, Linz)
› Underground Sun Conversion (0,5 MW; Linz)
› HotFlex (0,15 MW, Mellach)
› Renewable Gasfield (1 MW, Gabersdorf)
› SolHub (0,3 MW, NÖ)
› Demo4Grid (3,2 MW, Völs)
› Underground Sun Storage 2030 (2 MW, Gampern)
› H2Pioneer (2 MW, Villach)
› Wien Energie Simmering (3 MW, Wien)

— Production (planned; source: HYPA)

› Power2X (5 MW, 2025, Kufstein)
› UpHy II (10 MW, 2024, Schwechat)
› LAT Nitrogen (60 MW, 2025, Linz)
› Plansee (4 MW, 2025 Reutte)
› IFE – Innovation Flüssige Energie (1 MW, 2024, Graz)
› PanHy – Pannonia Green Hydrogen (60 MW, 2027, Burgenland)

— Storage

› EUH2STAR
› Underground Sun Storage 2030
› Underground Sun Conversion – Flexible Storage
› HyUSPRe

— Wasserstoffförderungsgesetz – WFöG (Hydrogen subsidy law): To promote the production of hydrogen – which must be RFNBO-certified – federal funds totaling up to € 820 million are available for hydrogen production projects

Germany

Demand from hard to abate industrial clusters such as: Burghausen and Ingolstadt

— HyPipe Bavaria – The Hydrogen Hub: connects regions of hydrogen demand with numerous production regions both within Germany and abroad. It will connect the chemical cluster 'Chemical Triangle' in the South of Bavaria and the refineries in the Ingolstadt region in central Bavaria. From 2025, the first pipeline section with a length of 14 kilometres will be commissioned in the Bavarian chemical triangle. The network is expected to be 300 km long by 2030, of which 95 % will be from converted, already existing natural gas pipelines.

— The IPCEI LOHC handling terminal 'Green Hydrogen @ Blue Danube' notified in the Hy2Infra wave, provides an additional hydrogen stream, aiming to inject into the pipeline.

Slovakia

— Demand from industrial clusters in Bratislava
— Košice and Western Slovakia hydrogen valleys

Czech Republic

— H_2 valley of Ústí region
— Moravian-silesian hydrogen valley

Slovenia

— Through 'Croatia-Slovenia-Austria H_2 corridor' project there will be bidirectional cross-border hydrogen transport possibilities between Slovenia and Austria to the extent of 33 GWh/day. The project will also enable the establishment of a new interconnection point with Croatia. The repurposed part of the project consists of 165 km of existing pipelines and is expected to be completed by 2029.

Austria

— The H_2 Backbone Murfeld project will provide bi-directional cross-border hydrogen transport between Austria and Slovenia at a rate of 33 GWh/day. The project will also enable the establishment of a new interconnection point with Croatia. The hydrogen-ready SOL loop will be about 26 km long and is expected to be completed by 2030.

Croatia

Croatia intends to prepare a hydrogen backbone from the coastal areas of the county, where a large production of renewable hydrogen is expected, to the main centres of consumption in northern Croatia and, via the interconnections with Slovenia (Rogatec) and Hungary (Dravaszerdahely). Also, the existing LNG terminal on the island of Krk which will become the entry point for the supply of renewable hydrogen after repurposing will be connected to the corridor.

CONNECTIONS WITH STORAGE

One new site and a reconversion of a natural gas existing site in Italy will be dedicated to hydrogen storage for a total of 1.5 bcm capacity (IT)

INTERCONNECTIONS WITH OTHER CORRIDORS

— Through Slovakia with the South-Eastern H_2 supply corridor

— Through Slovakia with the Eastern H_2 supply corridor

— Valleys and projects supported:

› The Northern Adriatic Hydrogen Valley: a special form of international cooperation in the field of hydrogen achieved among the Republic of Croatia, the Republic of Slovenia and the Italian region Friuli Venezia Giulia. It is anticipated as a regional system on the territory of several countries that connects hydrogen production, its transport and various end uses (such as traffic) in one place and it aims to popularize the possibilities and potential of hydrogen technologies in order to attract additional investments in areas included in the hydrogen valley and to secure the hydrogen value chain, from production to use. Northern Adriatic Hydrogen Valley will be interconnected with the neighbouring valleys WIVA P&G – Wasserstoffinitiative Vorzeigeregion Austria Power & Gas in Austria and Yellow Swallow in Hungary.

› Green Energy Park KRK: the project foresees the build-out of a green ammonia terminal in KrK, produced in Piauof Brazil, which will be a Central European Gateway for renewable ammonia supply. The green ammonia, converted to green hydrogen, can be transported to Italy through the re-purposed Pula-Ravenna existing (and not used) gas pipeline, or to Austria (Arnoldstein) via the Adria LNG gas pipeline.

CURRENT IMPLEMENTATION STATUS

DEVELOPMENT PHASES

— **Italian part**

- Feasibility and studies: 11/2021 – 12/2024
- Construction: from 2026
- In operation: 2030

— **Austrian part**

- H_2 Readiness of the TAG pipeline system
  - Current Status: feasibility ongoing
  - Construction: from 2027
  - In operation: 2030
- H_2 Backbone WAG and Penta West
  - Current status: feasibility ongoing
  - Construction: from 2026
  - in operation 2030

— **Czech part:** commissioning 2029

FUNDING TOOLS

— All related projects of SouthH_2 Corridor have been included in the 1st PCI/PMI list, which gives the opportunity for CEF funding.

— Wasserstoffförderungsgesetz – WFöG (Hydrogen subsidy law): To promote the production of hydrogen - which must be RFNBO-certified - federal funds totaling up to EUR 820 m. are available for hydrogen production projects.

POLITICAL SUPPORT

— **JDOI:** The German, Austrian and Italian ministries responsible for energy signed a joint declaration of intent with the intention of further intensifying cooperation on the creation of the hydrogen corridor.

BARRIERS

— Uncertainty of hydrogen market development

— Financing/Funding in combination with uncertainties due to lack of market maturity

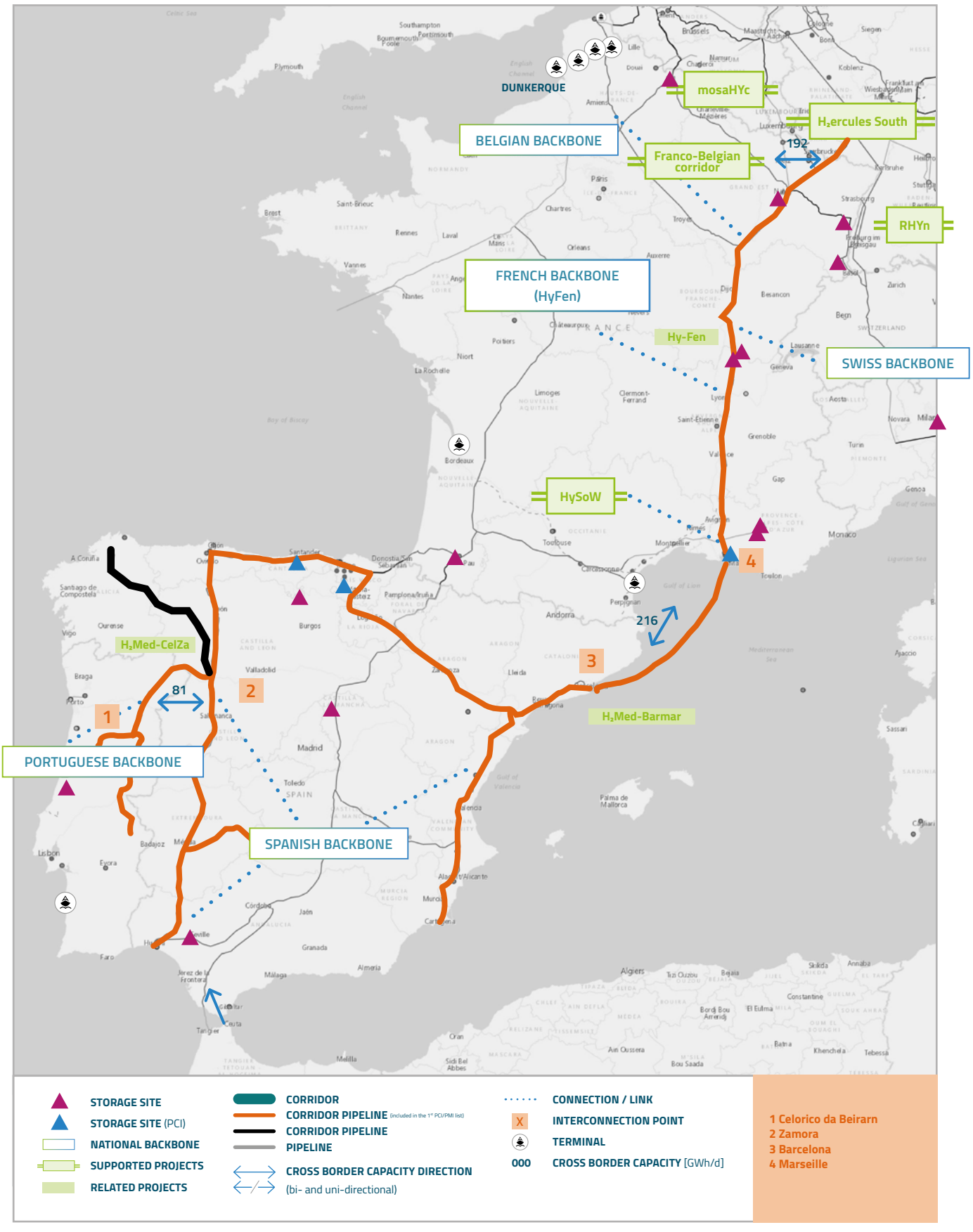
— European standards (technical, international H_2 certification)

— National level transposition of EU regulation

Country	Project name	Length (km)	Diameter (mm)	New pipeline/ total length (%)	Compressor (MW)	CAPEX (EUR m)	OPEX (EUR m p.a.)
Italy	Italian H_2 Backbone	1,920	400 – 1,200	> 30	100 in first phase, Up to 500	3,200 ± 30 %	58 ± 30 %
Austria	H_2 Readiness of the TAG pipeline system	380	900 – 1,050	0	60	369 ± 50 %	5 ± 50 %
Austria	H_2 Backbone WAG + Penta West	340	800 – 1200	59	16	921 ± 25 %	41 ± 50 %
Slovakia	H_2 transmission infrastructure	85	900	0	0	15	0,3*

*Estimated value

IBERIAN H_2 CORRIDOR



The Iberian H_2 Corridor will link the Iberian Peninsula to Germany, and includes the two international interconnections of the H2med project (CelZa, linking Portugal and Spain, and BarMar, linking Spain and France) that link the Portuguese Hydrogen Backbone, the Spanish Hydrogen Backbone, and the Hy-Fen project in France, entering Germany through the H2ercules South project.

The whole corridor is included in the first PCI/PMI list, approved and published by the European Commission in April 2024.

RELATED PROJECTS

- **Portuguese Hydrogen Backbone:** the project includes the construction of a new Figueira da Foz – Cantanhede pipeline (with the possibility of linking to the Carriço underground storage) and the repurposing of the current Cantanhede - Celorico da Beira - Monforte pipeline of the national gas network.
- **H_2Med-CelZa:** The project will join Portugal and Spain, connecting Celorico da Beira (Portugal) to Zamora (Spain). It will be a bridge between the developing core hydrogen backbones of both countries. It will be a 100% hydrogen transmission infrastructure that will be the prime export medium for hydrogen produced in Portugal from renewable energy sources, most notably solar and wind.
- **H_2Med-Barmar:** an offshore hydrogen pipeline project that will join Barcelona (Spain) to the industrial hub in Fos-sur-Mer, near Marseille (France). The project will be a major connection to export hydrogen produced in Portugal and Spain from renewable sources (essentially solar and wind) at competitive costs, to the French hydrogen backbone itself connecting to the developing hydrogen infrastructure in Germany and the rest of Northwest Europe.
- **Spanish backbone:** It is the Spanish core hydrogen network that will span across the main production and consumption hubs in the country by 2030, as well as two underground storage reservoirs in the North of Spain. The network will include both existing pipelines (already identified that a fraction of the Spanish gas network to be converted into hydrogen pipelines) as well as new pipelines and two storage capacities, with expected investments up to EUR 3.5 bn for the PCI Spanish Hydrogen backbone, and EUR 1.23 bn for the PCI storage sites. The link between Coruña and Zamora is an integral part of the Spanish Hydrogen Backbone for 2030, but it is not part of the 1st PCI/PMI list.
- **Hy-Fen (FR):** The project aims to develop a French H_2 transmission network via pipeline connected to Spain via H_2Med-Barmar, Germany and national storages by 2030. It will consist of new and existing assets converted to H_2, and cover 1,000 km of pipelines across France.

WHY IS THE CORRIDOR IMPORTANT

DOMESTIC EU PRODUCTION

This corridor is the only EU H_2 Supply corridor which is 100% based on domestically produced EU renewable hydrogen, contributing to the industrial development within the EU and to ensure EU's strategic autonomy.

IMPORT OPTIONS

- In 2040, the Iberian Peninsula will be connected with North African producers to allow import flows from Morocco to Spain by the repurposing of existing interconnection.
- In the form of green ammonia from the terminal at Dunkerque.
- The Iberian Peninsula might also export H_2 derivatives to other parts of Europe via maritime route.

MARKETS SUPPORTED (PROJECTS, VALLEYS & CLUSTERS)

Portugal

— The system consists of a new H_2 pipeline between Figueira da Foz and Cantanhede and the repurposing of the existing axis Cantanhede – Celorico da Beira – Monforte, allowing the connection of Green H_2 Valley at Figueira da Foz and green H_2 producers along the corridor.

Spain

— The system gathers hydrogen transmission and storage projects developing the national hydrogen network. Hydrogen transmission pipelines will be developed linking production to consumption, including Hydrogen Valleys, and storages in the Northwest of Spain, enabling also future cross border trade flows between Spain and Portugal. Hydrogen transmission pipelines will also be developed in the Northeastern side of the country enabling cross border of hydrogen flows with France and establishing a hydrogen supply corridor to Northwest Europe from the Iberian Peninsula.

France

— **Hy-Fen supports:**

- **Hynframed (FR):** a hydrogen grid project covering the Fos-sur-Mer region, near Marseille. It will connect producers and consumers to storage capacities, thus guaranteeing security of supply to the many industrial companies in the region.
- **Connection HY-FEN-GeoH$_2$ (FR):** The project aims to develop a hydrogen transmission pipeline connecting HY-FEN with Manosque and its underground storage GeoH$_2$. This connection will strengthen the security of supply and flexibility of the whole Iberia-France-Germany corridor thanks to GeoH$_2$ storage site in Manosque.
- **HySoW (FR):** project group consisting of a hydrogen storage project in Lacq together with a transmission pipeline in the South of France divide in two sections:
  - Bayonne/Larrau-Bordeaux
  - Lussagnet–Cruzy
- Also supported major industrial and mobility centers of the Occitanie and Nouvelle-Aquitaine (FR)
- RHYn (FR/DE/CH), a cross-border hydrogen network linking several producers of renewable and low carbon hydrogen with industrial and mobility consumers across France and Germany in the Mosel-Saarland region at the heart of Europe.

Belgium

— Franco-Belgian Corridor (FR/BE) - The project aims to develop a cross-border large-scale network from the Dunkirk port along the whole of the Franco-Belgian border region. In the first stage, a 80 km infrastructure near the cities of Valenciennes in France and Mons in Belgium will be developed to connect various producers and consumers on a non-discriminatory and transparent basis. In parallel, a 25 km network will be developed in the Port of Dunkirk ultimately interconnecting it with Channel ports in Belgium. The project will thus significantly contribute to the decarbonization of a major industrial hub and emissions zone in the North of France and Belgium. In later stages, the project will expand southwards towards the Paris metropolitan region and East into the Grand-Est region, serving road and air mobility users too, and further integrate a cross-border European network spanning France, Belgium, Germany, Norway and the Netherlands through the joint development and expansion of the CH_2-4EU project.

Luxembourg

— HY4Link (please see details below, under the North Sea H2 supply corridor).

— 'Grand Region Hydrogen' is a Certified European valley founded in August 2021 by transmission and distribution network operators, and hydrogen producers. It is a non-profit organisation based in Luxembourg. The members of the European Economic Interest Grouping (EEIG) of the Grande Region Hydrogen have set themselves the goal of establishing an integrated cross-border hydrogen system in the Grande Region by linking cross-sectoral projects for the decarbonisation of the industry and some segments of the mobility sectors. The focus is on the federal state of Saarland (Germany), the Grand-Est region in France and the Grand Duchy of Luxembourg. The aim is to promote a hydrogen economy along the entire value chain, taking advantage of the outstandingly suitable structural conditions of our area. The Grande Region Hydrogen sees itself as the nucleus of a regional hydrogen-related value chain with the aim of initiating a sustainable transformation process from industry and parts of the mobility to hydrogen technologies in the border region. In addition to the strong regional transformation potential, the Grande Region Hydrogen contributes to develop and optimise the European hydrogen economy. Through the interaction of the members of the initiative, the coordinated development of the entire value chain (production, infrastructure and use) for a flourishing hydrogen economy should be made possible.

In the centre of the ecosystem lies the mosaHYc cross-border pipeline, described further in the Learnbook, and the members of the Grande Region Hydrogen are companies from the entire value chain of hydrogen economy, that have a project of an installation producing or using hydrogen and have plans to physically connect to it.

Germany

- MosaHyc (FID Status) project, converts 70 km of gas pipelines between Saarland (DE) and Lorraine (St Avold) as far as the Luxembourg border, to develop a regional hydrogen hub and create 90 km of H_2 network.
- RHYn project, the first H_2 network in the Upper Rhine, created by the redevelopment of around 60 km of gas pipelines between Mackolsheim - Fessenheim - Chalampé/ Ottmarsheim - Mulhouse and Saint Louis to create a 100 km H_2 network with connections to Germany and Switzerland.
- H_2ercules network south, supplying consumers in the south and west of Germany with green hydrogen from domestic production and via import.

CONNECTIONS WITH STORAGE

- GeoH_2 – Manosque (250 GWh by 2029)
- HySoW (500 GWh by 2028) and future salt cavern projects in Etrez and Tersanne/Hauterives in the Rhône Valley
- Spain North-1 (272 GWh by 2029)
- Spain North-2 (164 GWh by 2029)
- StorgrHyn – Nancy (50 GWh)
- Current storage sites Etrez, Tersanne and Hauterives in the Rhone Valley

INTERCONNECTIONS WITH OTHER CORRIDORS

- North-Sea Corridor through Belgium (Franco-Belgian H_2 corridor)

CURRENT IMPLEMANTATION STATUS

DEVELOPMENT PHASES

— **H_2Med**

- Currently (2022 – 2025) pre-FEED studies (RFQ are launched):
  - CBA (Cost Benefit Analysis)
  - Feasibility studies
  - Environmental impact study
  - Technical proposal
  - Public consultations
  - Open seasons
  - Definition of tariffs and access rules
- FID end of 2026
- Implementation (2026 – 2029):
  - Engineering
  - Permits Management
  - Procurement
  - Execution, 48 months for H_2Med-Celza and 56 months for H_2Med-BarMar by the end of 2029
- Commercial operation 2030

— **Hy-Fen**

- 2022: Pre-feasibility study.
- 2024: Feasibility Study
- 2026: FEED and FID
- 2029: Forecast commissioning date.

FUNDING TOOLS

— All related projects have been included in the 1st PCI/PMI list, which gives the opportunity for CEF funding.

POLITICAL SUPPORT

— The H_2Med project has been announced on the 20th of October 2022 in Brussels by the President of the French Republic, Emmanuel Macron, Spain's President of the Government, Pedro Sánchez, and Portugal's Prime Minister António Costa.

— The project was then officially launched in Alicante on 9th of December 2022. This corridor is designed as the most direct and efficient option to connect the Iberian Peninsula to Central Europe, as part of a Green Energy Corridor connecting Portugal, Spain and France with the EU's energy network. It has received a 'warm welcome' during Ursula Von Der Leyen's statement at the Summit of Southern European Union countries.

— Since October 2023 a German infrastructure operator is actively involved in the H_2Med initiative, which stresses the vital importance for Germany of a reliable hydrogen import corridor.

— On the 8th of April 2024, the list of Projects of Common Interest (PCI) / Projects of Mutual Interest (PMI) was officially published in the Official Journal of the European Union, which includes the H_2med project.

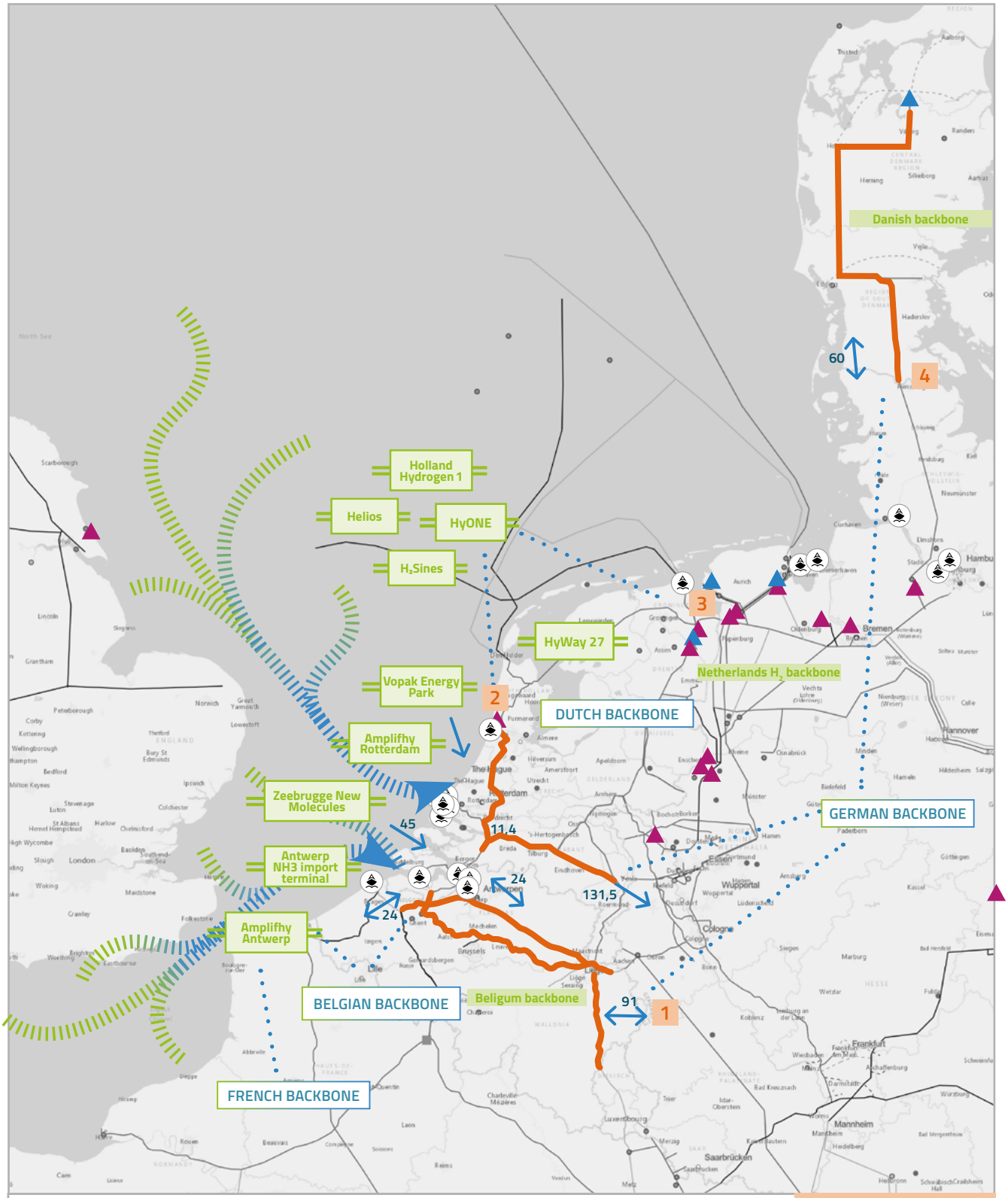
— The project is also mentioned in the Spanish and Portuguese NECPs as a measure with high added value that will strengthen solidarity between the countries and develop the hydrogen valleys.

BARRIERS

- The storage and transport infrastructure should be developed consistently all over the corridor.
- Coordination needed on national funding and regulatory frameworks between France, Germany, Portugal and Spain.
- Need to ensure that permitting processes and the corresponding the manuals of procedures for permit granting are available and aligned.
- H_2Med will connect supply from the Iberian Peninsula with demand centers in Germany. Processes to connect supply and demand along the route must be supported.
- Agility to transpose the Hydrogen and Gas Decarbonised Markets Package
- In the longer term North Africa imports must be supported and developed to further foster the corridor potential.
- Availability of funding and regulatory mechanism to cover the financing gap

Country	Project name	Length (km)	Diameter (mm)	New pipeline/ total length (%)	Compressor (MW)	CAPEX (EUR m)	OPEX (EUR m p.a.)
Portugal	H_2Med/CelZa	162	700	100		204 ± 40%	2 ± 50%
Spain	H_2Med/CelZa	86	700	100	24.6	157 ± 30%	9 ± 40%
Spain / France	H_2Med-BarMar	450	1,050	100	140	2,135 ± 40%	22 ± 40%
Spain	Levante, Valle de Ebro and Cantabrian corridor	1,506	762–914	80	31	2,225 ± 30%	98.66 ± 30%
Spain	Via de la plata & Puertollano + Coruña-Zamora	1,338 (1,075 +263)	660–762	75	72.2	1,767 ± 30%	
France	HyFen	1,000	900–1,200	62	15 – 90	4,000 ± 30%	80 ± 30%

NORTH SEA H_2 CORRIDOR



The North Sea corridor combines several types of infrastructure assets to establish itself as a hub for (i) liquid imports of hydrogen and derivatives, (ii) pipeline imports and wider transmission, (iii) storage, (iv) production, and (v) end-use. To build up this full ecosystem the corridor leverages existing infrastructure of the ports in Antwerp, Rotterdam, Zeebrugge, Amsterdam, Gent, Terneuzen, Vlissingen, which will form the start of an energy import and transport corridor. Also it leverages on the extensive offshore renewable capacity in the North Sea with import capacity and connection to the national and regional H_2 backbones in the Netherlands and Belgium to the hinterland in Germany.

RELATED PROJECTS

- **Delta Rhine Corridor H_2:** Multiple pipelines connecting Rotterdam with major inland industry clusters in the Netherlands and Germany

- **Interconnection Netherlands** -Belgium (Zelzate & Kallo)

- **The Vlieghuis-Ochtrup project:** enabling the first border crossing point between the Netherlands (import) and Germany (consumer) and is part of the GET H_2 IPCEI programme that includes GET H2Nukleus, SALCOS and Green Octopus, three existing hydrogen projects. The project also connects to a hydrogen electrolysis and the planned hydrogen storage in Gronau-Epe via the GETH$_2$ system in Ochtrup.

- **Belgium H_2 backbone:** a network of pipelines that link hydrogen import facilities in 4 ports (Antwerp, Zeebrugge, Ghent and Dunkirk) and local hydrogen production in Belgium with industrial clusters through an interconnected hydrogen backbone.

- **Netherlands National H_2 backbone:** It is the national hydrogen network that will connect supply and demand with the future hydrogen storage facility in the northern Netherlands, with import and with other cross-border networks for hydrogen transportation. The development of the hydrogen network is taking place step by step, starting with the Dutch industrial regions (Eemshaven, North Sea Canal area, Rotterdam, Zeeland). The network will be based on the current natural gas network, part of which will become available for the transmission of hydrogen. The network will cover approximately 642 km of converted natural gas and newly built H_2 pipelines. Once complete, the Dutch H_2 Backbone will connect offshore H_2 production sites as well as imported H_2 with consumers in the Netherlands, Germany and Belgium. The network will have a capacity of around 4 GW in 2030.

- **Danish H_2 backbone West:** Pipeline project connecting a potential hydrogen storage in Ll. Torup with towns of Esbjerg and Fredericia and the German border. It enables utilization of a large Danish RES potential of hydrogen production in the North Sea and export to Germany.

- **Interconnection Germany-Belgium**

WHY IS THE CORRIDOR IMPORTANT

IMPORT OPTIONS

- Via HyONE offshore pipeline from North Sea wind farms
- At the request of the Dutch national government, the Port of Rotterdam has signed MoUs with 25 different countries to work together on hydrogen corridors (among which the U.S.A., Brazil, Canada, Australia, Namibia, Norway, Spain, Portugal). Based on these agreements several companies are working on Hydrogen export projects (see also below: 9 new import terminals announced).
- Via Houston to Antwerp (MOU Houston with Exmar, Port of Antwerp-Bruges and WaterstofNet)
- Via Chile to Antwerp (MOU Ministery of Energy in Chile with Port of Antwerp-Bruges)
- Via Namibia to Antwerp (MOU NamPort with Port of Antwerp-Bruges)
- Via Oman to Antwerp (Port of Duqm investment of Port of Antwerp-Bruges and MOU between Belgium and Oman)
- Via H_2A to Amsterdam (LOHC import hub, MoU signed by Evos, Hydrogenious and Port of Amsterdam)
- 9 new Import terminals have been announced in Rotterdam by different companies (e. g. AirProducts, Gunvor, Vopak, OCI, VTTI, Chane, GES, a.o.). 6 of those focus on ammonia, 2 on LOHC, 1 on Liquid Hydrogen.

MARKETS SUPPORTED (PROJECTS, VALLEYS & CLUSTERS)

Netherlands

- Amplifhy Rotterdam
- Conversion Park I Rotterdam for Hydrogen production:
  - Elektrolyser Holland Hydrogen I
  - Elektrolyser H2-Fifty
  - Elektrolyser Curthyl
- Conversion Park II Rotterdam for Hydrogen production
- H_2 production Uniper Rotterdam
- Amphytrite Rotterdam
- Multiplhy Rotterdam
- Eneco elektrolyser Rotterdam
- Sapphire Rotterdam
- H-Vision Rotterdam
- ACE Terminal
- H2A
- HEAVENN Valley
- HyStock
- HyNetherlands
- National Hydrogen network Netherlands by Gasunie
- 9 new hydrogen import terminals announced in Rotterdam

Belgium

- Amplifhy Antwerp
- Zeebrugge New Molecules
- Antwerp Ammonia Terminal
- Vopak Energy Park Antwerp
- Ammonia cracker
- Flanders Hydrogen Ports Valley (North Sea Port, Port of Antwerp-Bruges and WaterstofNet)
- H_2BE
- PlugPower

Luxembourg

- LuxHyVal: a 5-year long project funded by the EC (Horizon Europe Programme), aiming to contribute to the achievement of the European target on decarbonisation of the industrial sector before 2030 by launching a flagship hydrogen valley in Luxembourg to boost its penetration in various sectors.
- HY4Link will establish an integrated cross-border hydrogen transport system in the Greater Region, linking Belgium, Luxembourg, the Grand-Est region in France, and the federal state of Saarland in Germany. As a part of the European Hydrogen Backbone, the project links industrial hydrogen demand clusters in France, Germany, and Luxembourg with hydrogen supply centres at the North Sea coast and import hubs in Antwerp, Zeebrugge and Dunkirk. The 1st part is the development of an interconnection network running from Bouzonville in France to the south of Luxembourg via Thionville and connection to the mosaHYc project. In the 2nd part a pipeline will connect Luxembourg to the Belgian Hydrogen Backbone via the border crossing point Bras (BE). This will be complemented by the construction of a hydrogen pipeline across Luxembourg to France and Germany. During the 2nd phase a new pipeline from Thionville to Cerville, connecting HYFEN and the Hydrogen Storage project in Cerville, will be built.
- 'Grand Region Hydrogen' (please see details above, under the Iberian H2 corridor).

Germany

- MosaHyc (FID Status) project, converts 70 km of gas pipelines between Saarland (DE) and Lorraine (St Avold) as far as the Luxembourg border, to develop a regional hydrogen hub and create 90 km of H_2 network.
- Hamburg: H_2 infrastructure: HH.WIN – H_2 hydrogen-industry network by 2040, including future connection to Hyperlink III , 40 km of this pipeline as IPCEI project, in total 60 km
- Hamburg: H_2 production: Hamburg Green Hydrogen Hub (electrolyser capacity 100 MW by 2027), IPCEI project
- Hamburg: Hamburg Blue Hub (Evos Hamburg GmbH and Lother Group): Global import and storage of H_2 derivatives like e-fuels, e-methanol and synthetic fuels
- Hamburg: Ammonia Import terminal of Mabanaft Deutschland GmbH and Air Products (Ammonia cracker)
- Projekt SaltHy (Storage Alignement with Load and Transport of Hydrogen) – salt cavern for hydrogen storage, capacity by 2030 of 5.2000 t of hydrogen; Harsefeld near Hamburg
- Hamburg: Renewable Energy Hamburg Cluster Agency

CONNECTIONS WITH STORAGE

- Hystock Opslag H_2 storagy (1000 GWh by 2026)
- DK H_2 storage (116 GWh by 2026)

INTERCONNECTIONS WITH OTHER CORRIDORS

- Iberian Corridor through the interconnection with the French backbone

CURRENT IMPLEMANTATION STATUS

DEVELOPMENT PHASES

- For the Belgian Hydrogen backbone, FID is planned for March 2025. The first phase of the Backbone (150 km) is scheduled to be ready in mid-2026, while the commissioning for the whole network is at the end of 2029
- The Netherlands National H_2 backbone is under construction (9/2023 – 10/2027), with commissioning date 31/12/2027
- The Belgian – German interconnection is planned for 2028

POLITICAL SUPPORT

- In Belgium, a national hydrogen strategy has been published in 2021 and updated in 2022. The national hydrogen vision puts great emphasis on import of molecules (20 TWH in 2030 and 200 – 350 TWH in 2050)
- EUR 95 m has been foreseen in Belgium for the first phase hydrogen network developments and EUR 250 m for later phase developments

FUNDING TOOLS

- All related projects have been included in the 1st PCI/PMI list, which gives the opportunity for CEF funding.
- The Belgian Hydrogen Backbone has obtained the IPCEI label in 2022

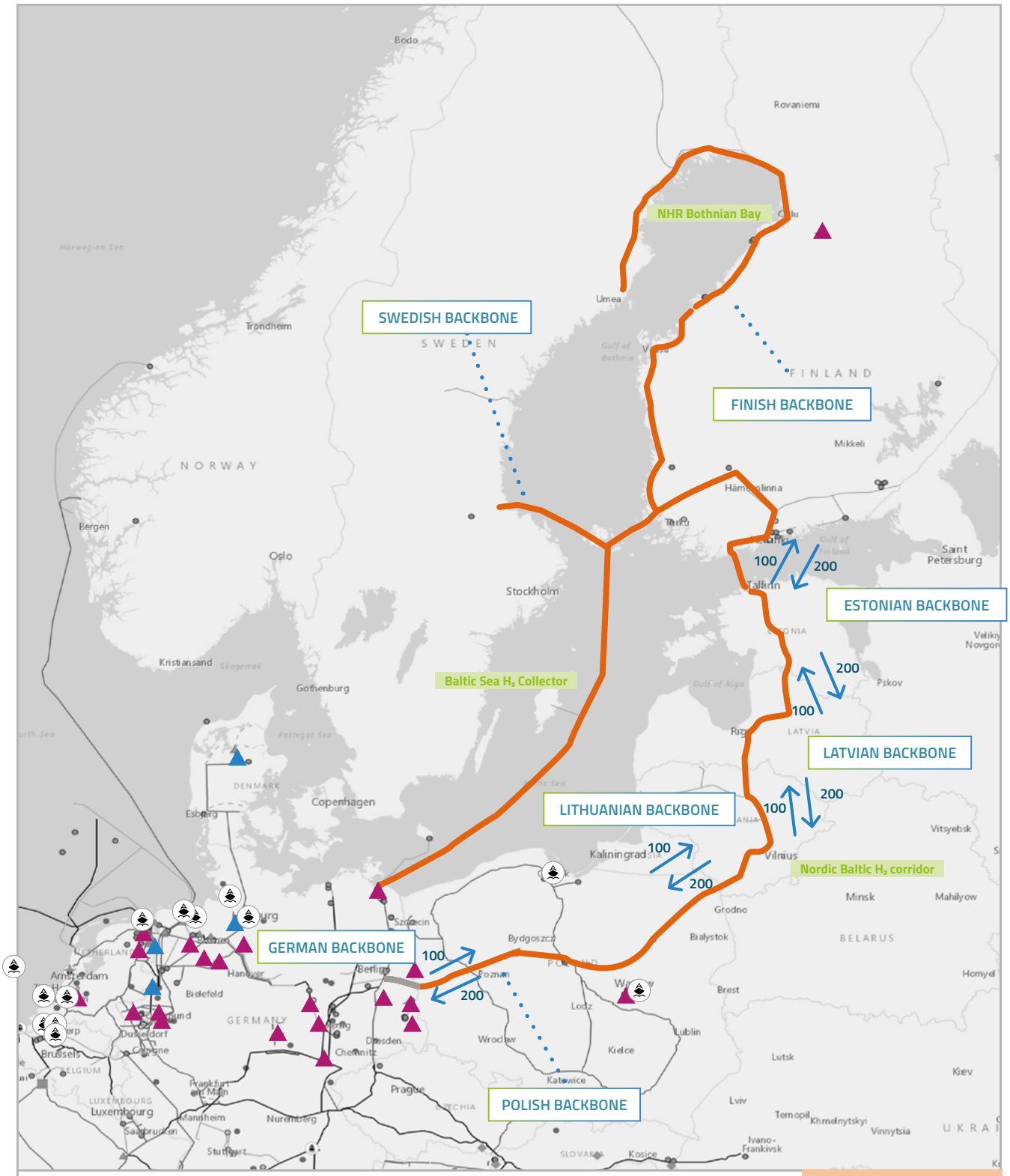
BARRIERS

- Availability of funding in Belgium to kickstart hydrogen production

Country	Project name	Length (km)	Diameter (mm)	New pipeline/ total length (%)	Compressor (MW)	CAPEX (EUR m)	OPEX (EUR m p.a.)
Belgium	Belgian Hydrogen backbone	150 – 500	250 – 900	tbd		1,000 ± 40 %	10 ± 40 %
Nether-lands	Dutch Hydrogen Backbone	641,6				900	18*
Denmark	DK/DE Hydrogen IP	347	900 and 700	73	0 base case + 55 enhancer 1 + 90 enhancer 2	1,546 ± 50 %	12 ± 50 %
Nether-lands	Delta Rhine Corridor	250	1,050	60	tbc	2,545 ± 15 % **	2,545 ± 15 % **

*Estimated value ** The value includes the cost of the German part of the project

BALTIC SEA REGION H_2 CORRIDOR



The Baltic Sea Region H_2 Corridor mainly consists of three project groups:

— the Nordic Hydrogen Route-Bothnian Bay (NHR), which enables significant deployment of new RES (mainly onshore wind and solar) and connects to Finnish section of Nordic Baltic Hydrogen Corridor,

— the Nordic Baltic Hydrogen Corridor (NBHC), which enables the transport of hydrogen produced in the Baltic Sea region to supply consumption points and industrial clusters along the corridor and in Central Europe, and

— the Baltic Sea Hydrogen Collector (BHC), which unlocks the offshore wind potential in the Baltic Sea region, thus creating a connection between both supply and demand of Hydrogen.

The corridor integrates the Nordic, Baltic, Polish and German hydrogen national infrastructure and triggers further infrastructure developments to connect additional hydrogen suppliers and consumers (demand centres) in the concerned countries.

RELATED PROJECTS

— Hydrogen Interconnector between Sweden and Finland (Nordic Hydrogen Route – Bothnian Bay)

— Hydrogen Interconnector between Finland, Estonia, Latvia, Lithuania, Poland, and Germany (Nordic-Baltic Hydrogen Corridor)

— Hydrogen Interconnector between Sweden, Finland, and Germany (the Baltic Sea Hydrogen Collector)

WHY IS THE CORRIDOR IMPORTANT

MARKETS SUPPORTED (projects, valleys & clusters) by the Nordic Baltic H_2-Corridor

Finland

— The corridor will enable the scale-up of renewable energy investments creating a significant opportunity for the hydrogen economy to form in the Baltic Sea region.

— BalticSeaH_2, the first large-scale, cross-border hydrogen valley in Europe to create and integrate hydrogen economy around the Baltic Sea, by enabling 25 demonstration and investment cases to showcase different sectors.

Estonia

— The Corridor will enable more renewable energy build-out and connection with new industrial clusters and hydrogen valleys on the pipeline route.

Latvia

— The Corridor will create conditions for investment in industrial and technological innovations along the entire pipeline route. It will give the opportunities to develop renewable energy generation projects.

Lithuania

— The Corridor will contribute to meeting demand for hydrogen to replace gas in fertilizer, refining sectors and in longer-run to use for flexible power production as well to use in transport sector in pure hydrogen form or as other e-fuels.

Poland

— The Corridor will provide stable and vast low-cost renewable hydrogen supplies to the consumption points and industrial clusters along the route and in Central Europe. There is a large industrial base that may be decarbonised by using green hydrogen. Moreover, Poland is already in TOP 3 largest hydrogen consumers in Europe, in particular in fertiliser, chemical and petrochemical sectors. The Corridor will provide a very important contribution to fast decarbonisation of industries that already use hydrogen in Poland, as well as sectors that are considered as hard-to-abate including: steel, ammonia, industries requiring high temperatures, transport (urban transport, heavy and long-distance transport, rail, maritime) and district heating systems.

Germany

— The NBHC will be linked to 'Doing Hydrogen', a hydrogen infrastructure in Eastern Germany and also to industrial demands near the German and Polish border. Through its connection to Doing Hydrogen, the corridor project will also be connected to the German hydrogen core network and thus to the whole future German hydrogen market.

— The Baltic Sea Hydrogen Collector will be linked to the 'FLOW – making hydrogen happen (East)' project in Germany, which is part of the envisaged German hydrogen core grid.

CONNECTIONS WITH STORAGE

— Damasławek (Poland) Hydrogen Storage (through NBHC).

CURRENT IMPLEMANTATION STATUS

DEVELOPMENT PHASES

— **Nordic Baltic Hydrogen Corridor**

- 2023 – 2024 pre-feasibility
- 2025 – 2029 feasibility study, design and construction phase (planned)
- 2029 commissioning (planned)
- 2030 H_2 market in operation (planned)

— **Nordic Hydrogen Route-Bothnian Bay**

- 2022 – 2023 Phase 1 – PLAN
- 2024 – 2026 Phase 2 – DESIGN
- 2026 – 2030 Phase 3 – CONSTRUCT
- 2030 onwards Phase 4 – OPERATION

— **Baltic Sea Hydrogen Collector**

- 2024 – 2025 Feasibility and FEED studies
- end of 2027 FID
- 2027 – 2029 Construction
- End of 2029 Commissioning

FUNDING TOOLS

— All related projects have been included in the 1st PCI/PMI list, which gives the opportunity for CEF funding.

POLITICAL SUPPORT

— On 30th of August 2022 Prime Ministers of Denmark, Estonia, Finland, Germany, Lithuania, Latvia, Poland, and Sweden signed Marienborg Declaration to call for urgent actions to make Europe independent of Russian energy and to identify infrastructure needs to enable the integration of renewable energy.

— In December 2022 and January 2023 the relevant Ministries of the countries involved in the Project signed a Letter of Support to demonstrate their interest and support for the implementation of the Project by its partners.

BARRIERS

— Missing or incomplete regulatory framework for infrastructure planning of low carbon or renewable gases in the different states

— Missing or incomplete framework for financing hydrogen infrastructure

— Uncertainty of hydrogen market development

— The continued presence of gas in the power mix, particularly in Poland and Lithuania, will limit ability of gas infrastructure to be repurposed for hydrogen. New pipelines will be needed, impacting project's CAPEX and timeline.

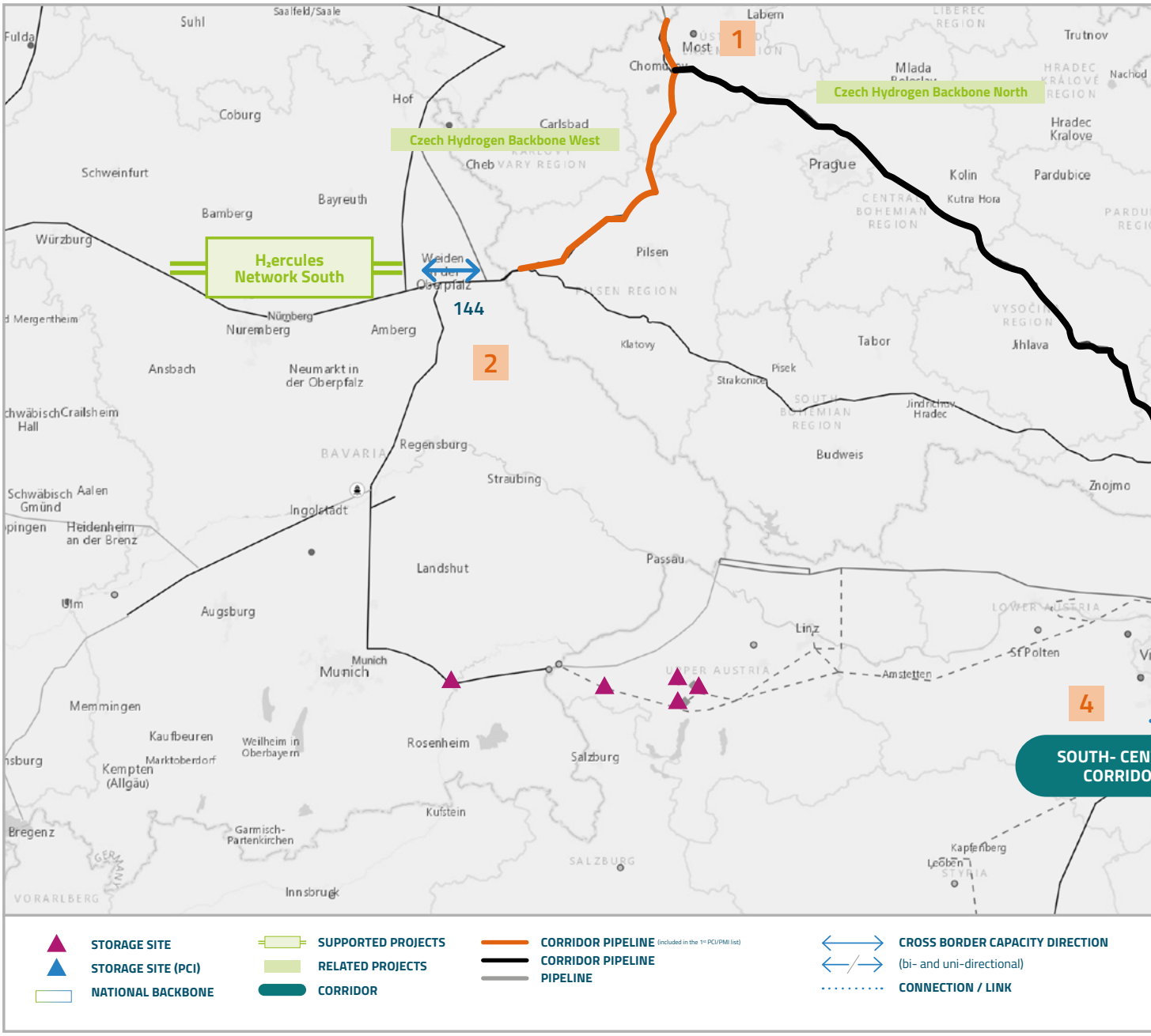
— Missing pieces of regulations together with delayed transposition of EU regulations by MS (especially RED II & III) are impacting market development, especially the ability of offtakers to commit to the infrastructure projects.

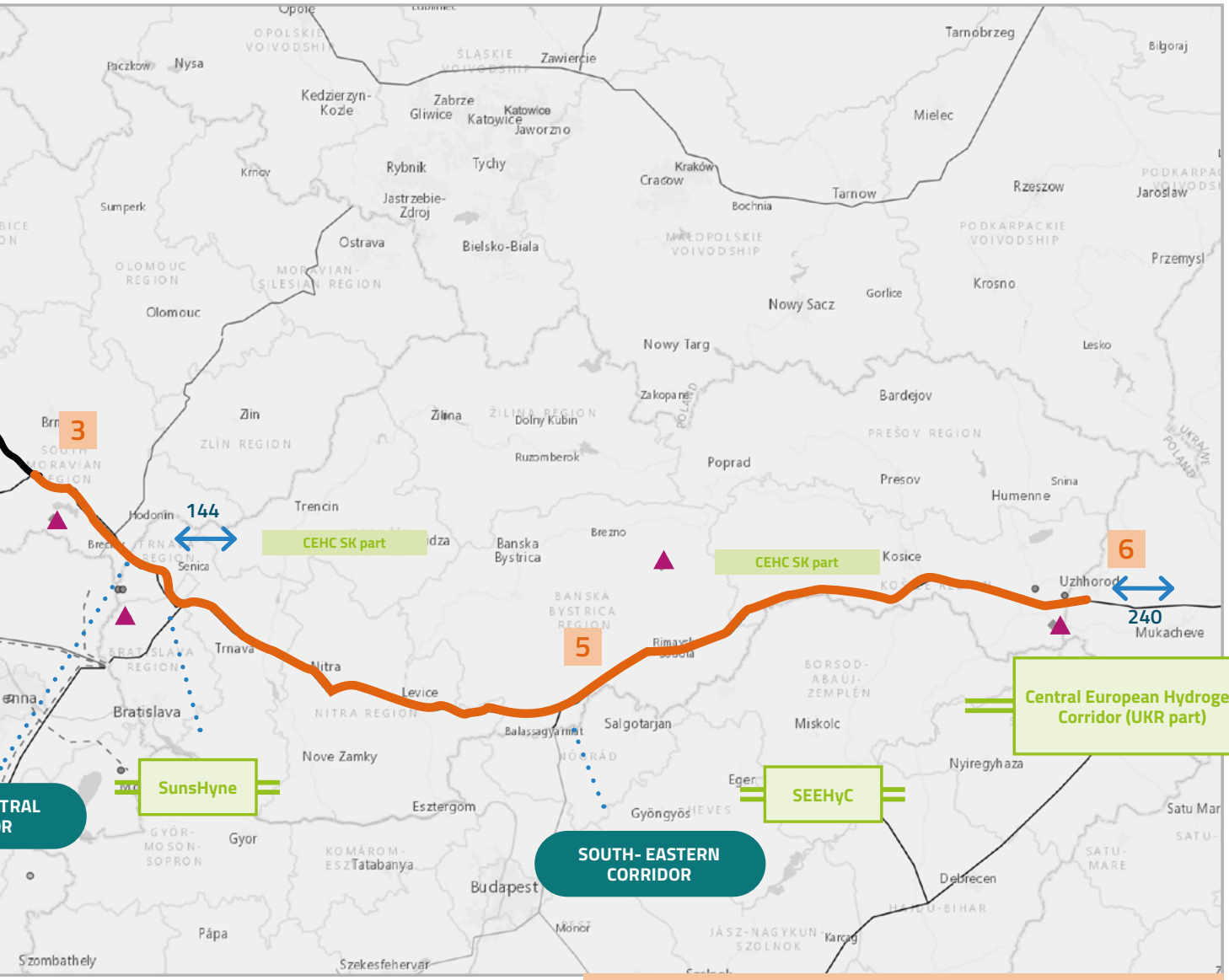
Country	Project name	Length (km)	Diameter (mm)	New pipeline/ total length (%)	Compressor (MW)	CAPEX (EUR m)	OPEX (EUR m p. a.)
Sweden	NHR	526	1,200	100	260	4,603	92*
Finland	NHR	495	1,200	100	260		
Finland	NBHC	770	To be determined	100	To be determined	7,241	144.8*
Estonia	NBHC	290	To be determined	100	To be determined		
Latvia	NBHC	274	To be determined	100	To be determined		
Lithuania	NBHC	346	To be determined	100	To be determined		
Poland	NBHC	720	To be determined	100	To be determined		
Germany	NBHC	10	To be determined	100	To be determined		
Sweden	BHC	336	To be determined	100	To be determined	15,800	316*
Finland	BHC	160	To be determined	100	To be determined		
Germany	BHC	1,710	To be determined	100	To be determined		

* Estimated value

EASTERN H_2 CORRIDOR

The Eastern H_2 supply corridor utilises the potential of renewable hydrogen production in Ukraine. Ukraine is a very promising future major supplier of renewable hydrogen with excellent conditions for large-scale, green hydrogen production development.





X **INTERCONNECTION POINT**

TERMINAL

000 **CROSS BORDER CAPACITY** [GWh/d]

1 Deutschneudorf
2 Waidhaus
3 Lanžhot
4 Baumgarten
5 Balassagyarmat/Veľké Zlievce
6 Veľké Kapušany

RELATED PROJECTS

— **The Central European Hydrogen Corridor (CEHC)**: an initiative driven by the vision to develop a hydrogen 'highway' through Central Europe. The initiative explores the feasibility of creating a hydrogen pipeline corridor in Central Europe for transporting hydrogen from major hydrogen supply areas in Ukraine via Slovakia and the Czech Republic to hydrogen demand areas in Germany. The hydrogen corridor will also enable the transport of hydrogen between hydrogen production facilities and hydrogen consumers in the Czech Republic and Slovakia. Projects included are:

- Central European Hydrogen Corridor SK part
- Czech Hydrogen Backbone West
- Czech Hydrogen Backbone North

WHY IS THE CORRIDOR IMPORTANT:

IMPORT OPTIONS

— From Ukraine, via the Central European Hydrogen Corridor.

— From Northern Africa via the South-Central H_2 corridor (SunsHyne project).

MARKETS SUPPORTED (projects, valleys & clusters)

Slovakia

— Interconnections with Ukraine, Austria and Poland

— Košice and Western Slovakia hydrogen valleys

Czech Republic

— Interconnection with Slovakia

— H_2 valley of Ústí region

— Industrial clusters along Czech Hydrogen Backbone

— Moravian-Silesian hydrogen valley

Germany

— Czech-German Hydrogen Interconnector project: The project, consisting of part of the 'Czech H2 Backbone' and 'FLOW – making hydrogen happen (East)' and H2ercules Network South, directly supports production cluster in the Baltic Sea area and industrial clusters in Southern Germany e. g., in Bavaria. Via the Hydrogen core network draft application, as submitted by the German TSOs in 11/2023 to the Federal Network Agency and the Federal Ministry for Economic Affairs and Climate Action, further clusters in Germany e. g., in Eastern Germany, the Rhein-Main Area and Baden-Württemberg benefit, as the project on the German side, 'FLOW – making hydrogen happen (East)', is part of the envisaged German hydrogen core grid.

CONNECTIONS WITH STORAGE

— Czech Republic: Háje, Třanovice, Lobodice Štramberk, Tvrdonice, Dolní Dunajovice, Uhřice, Dambořice and Dolní Bojanovice.

— Slovakia: Láb Complex (Láb I – IV, Gajary – Báden)

INTERCONNECTIONS WITH OTHER CORRIDORS

— South Central Corridor via Baumgarten and SunsHyne project

— South-Eastern Corridor via Balassagyarmat / Veľké Zlievce

CURRENT IMPLEMANTATION STATUS

DEVELOPMENT PHASES

Czech Republic part

- PCI application: December 2022
- Pre-feasibility phase: 2022 – 2023
- Feasibility phase: 2024
- FEED: 2025 – 2027
- Construction: 2028 – 2029
- Trial operation: 2029
- Commercial operation: planned to start end of 2029, with an offered capacity of 144 GWh/d, and possible increase through compression

German part (FLOW – making hydrogen happen (East))

- PCI application: December 2022, PCI status granted in November 2023
- Feasibility phase: 2023 – 2025
- FEED: 2024 – 2025
- Commercial operation: 2029

FUNDING TOOLS

Czech Republic part

- Currently available options are:
- European funding programs after receiving PCI/PMI status
- National funding programs after receiving IPCEI status
- Potentially upcoming national funding programs, e. g. GreenGas program within the Modernisation Fund
- Financing options will be subject to further discussions.

Slovakian part

- The project is included in the approved by EC list of the Important Project of Common European Interest (IPCEI) 'Hy2Infra' thus having the possibility for national grants.

POLITICAL SUPPORT

Czech Republic

- The Corridor has received support from the Ministry of Industry & Trade and the National Regulation Authority for the application of PCI status.
- The corridor will be a part of the update of the Czech National H_2 Strategy as one of the import routes.

Slovakia

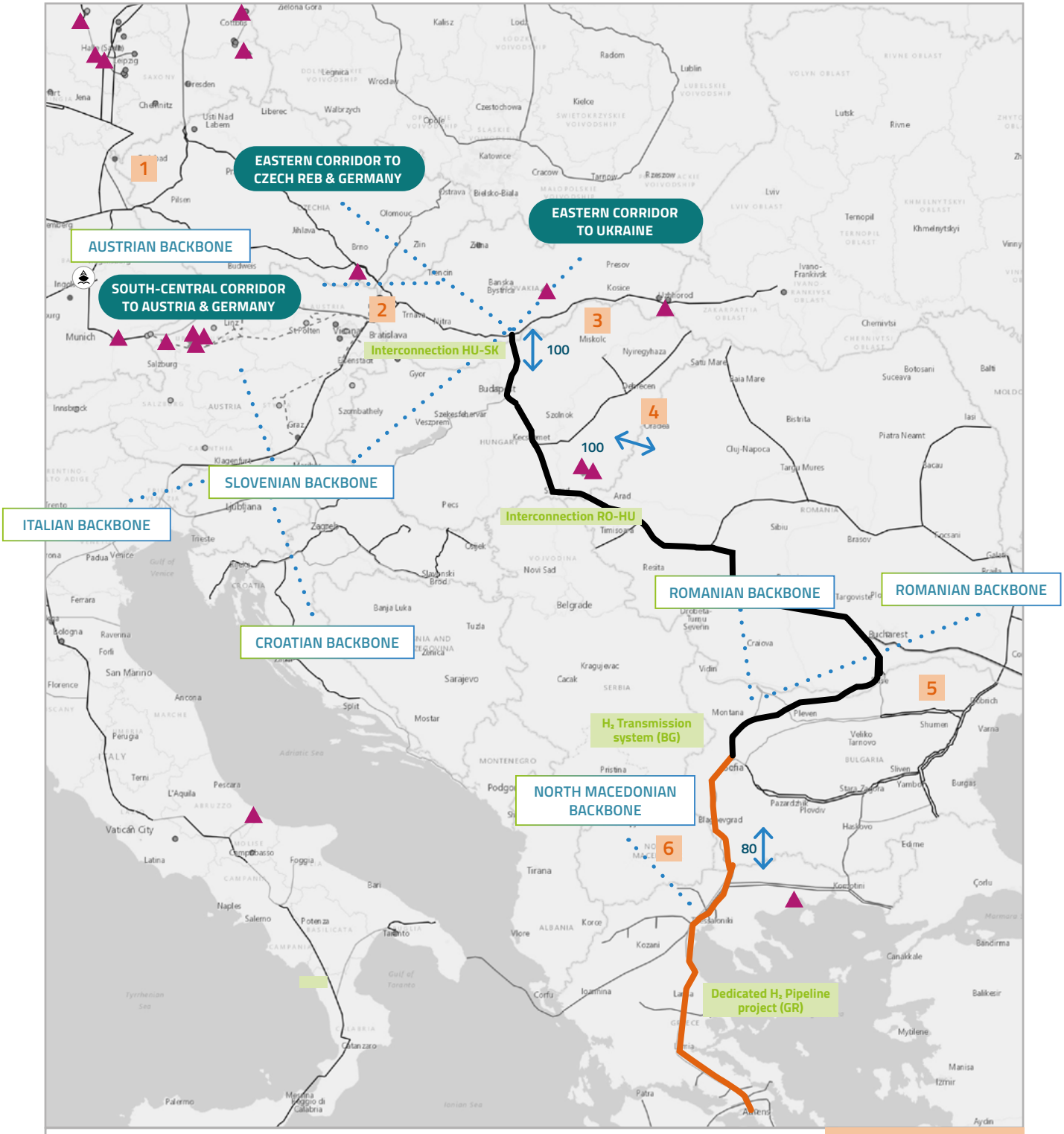
- The Corridor shares the significant part with the Central European Hydrogen Corridor which has been supported by the Ministry of Economy of the Slovak Republic for the application of the PCI status.
- The project is in the list of the Important Project of Common European Interest (IPCEI) 'Hy2Infra'.

BARRIERS

- Missing regulatory framework, incl. uncertainties regarding financing and risk coverage for TSOs
- Lack of market maturity
- Risk that hydrogen production and demand perspectives will be significantly later implemented than 2030
- Availability of funds and associated conditions
- Other permit granting difficulties (absence of clarity on permitting framework)
- Repurposing of existing storages connecting to the grid

Country	Project name	Length (km)	Diameter (mm)	New pipeline/ total length (%)	Compressor (MW)	CAPEX (EUR m)	OPEX (EUR m p. a.)
Slovakia	CEHC	455	900 & 1,200	0	120	700 ± 30 %	90 ± 30 %
Czech Republic	Czech Hydrogen Backbone West	163	1,400	0	0	50 ± 33 %	2 ± 50 %
Czech Republic	Czech Hydrogen Backbone North	381	1,000	0	0	100 ± 33 %	4 ± 50 %

SOUTH EASTERN H_2 CORRIDOR



Due to the vicinity to North Africa and Middle East, the corridor could in the future facilitate hydrogen imports from the neighboring countries via shipping or subsea pipeline transportation. The area offers abundant renewables potential, due to land availability and high-capacity factors for solar and onshore wind.

RELATED PROJECTS

— **South-East European Hydrogen Corridor (SEEHyC):** is a cooperation of seven European gas infrastructure companies driven by the vision to secure green hydrogen supply to South-East and Central Europe. The planned hydrogen pipelines connect promising supply areas in Greece and Bulgaria via Romania, Hungary, Slovakia, and the Czech Republic with demand centres in Germany, while contributing to the supply of demand centres along the route and in future offer the possibility for hydrogen imports from the Near and Middle East.

Project included are the:

- Dedicated H_2 Pipeline project in Greece
- H_2 Transmission system in Bulgaria
- Interconnection Bulgaria–Romania
- Interconnection Romania–Hungary
- H_2 Interconnection Hungary–Slovakia

— South-Eastern and Eastern Corridors are connected in Slovakia, connecting flows of hydrogen to Central Europe.

WHY IS THE CORRIDOR IMPORTANT:

IMPORT OPTIONS

— Possible future imports from North Africa (Egypt) and Middle East countries.

MARKETS SUPPORTED

(projects, valleys & clusters)

Greece

— Interconnection with Northern Macedonia

— Industrial clusters of Athens and Thessaloniki

Bulgaria

— Maritsa East and ZAHYR (Zagora Sustainable Hydrogen Region), bLion production project

Hungary

— Interconnections with Ukraine and Slovenia

— Pannonian and Borsod H_2 valleys

Slovakia

— Interconnections with Ukraine, Austria and Poland

— Košice and Western Slovakia hydrogen valleys

CONNECTIONS WITH STORAGE

— **Hungary:** There are six gas storage facilities Zsana, Pusztaederics, Hajdúszoboszló, Kardoskút and Szőreg, the latter in close proximity to the route of the envisaged from Romania through Hungary to Slovakia.

— **Greece:** South Kavala

INTERCONNECTIONS WITH OTHER CORRIDORS

— Eastern corridor

— South-Central Corridor

CURRENT IMPLEMANTATION STATUS

DEVELOPMENT PHASES

— **GR:** The project is currently in the pre-feasibility phase and it is expected to be operational by 2029

— **BG:** The first phase of the project (GR>BG) is currently in the pre-feasibility phase and it is expected to be operational by 2029. The second phase (BG>RO) is with horizon 2030 of implementation.

— **HU section:** RO>HU>SK corridor is preliminary planned to be fully operational by 2029, the capacity according to demand up to 100 GWh/d. Phases depends on demand.

FUNDING TOOLS

— The 'Dedicated H_2 Pipeline project in Greece' and the 'H_2 Transmission system in Bulgaria' have been included in the 1st PCI/PMI list, which gives the opportunity for CEF funding.

POLITICAL SUPPORT

— **Greece:** Both the Greek NRA and Ministry of Energy have significantly supported the proposal of Greek part of the corridor within the PCI process.

— **Bulgaria:** The project has been included in the 1st PCI/PMI list. Ministry of Energy has significantly supported the proposal of Bulgarian part of the corridor within the PCI process.

— **Hungary:** The RO/HU/SK H_2 corridor is part of the HU 10 years national development plan as studied development and part of EU TYNDP 2022.

BARRIERS

— Missing regulatory framework, incl. uncertainties regarding financing and risk coverage for TSOs

— Lack of market maturity

— Availability of funds and associated conditions

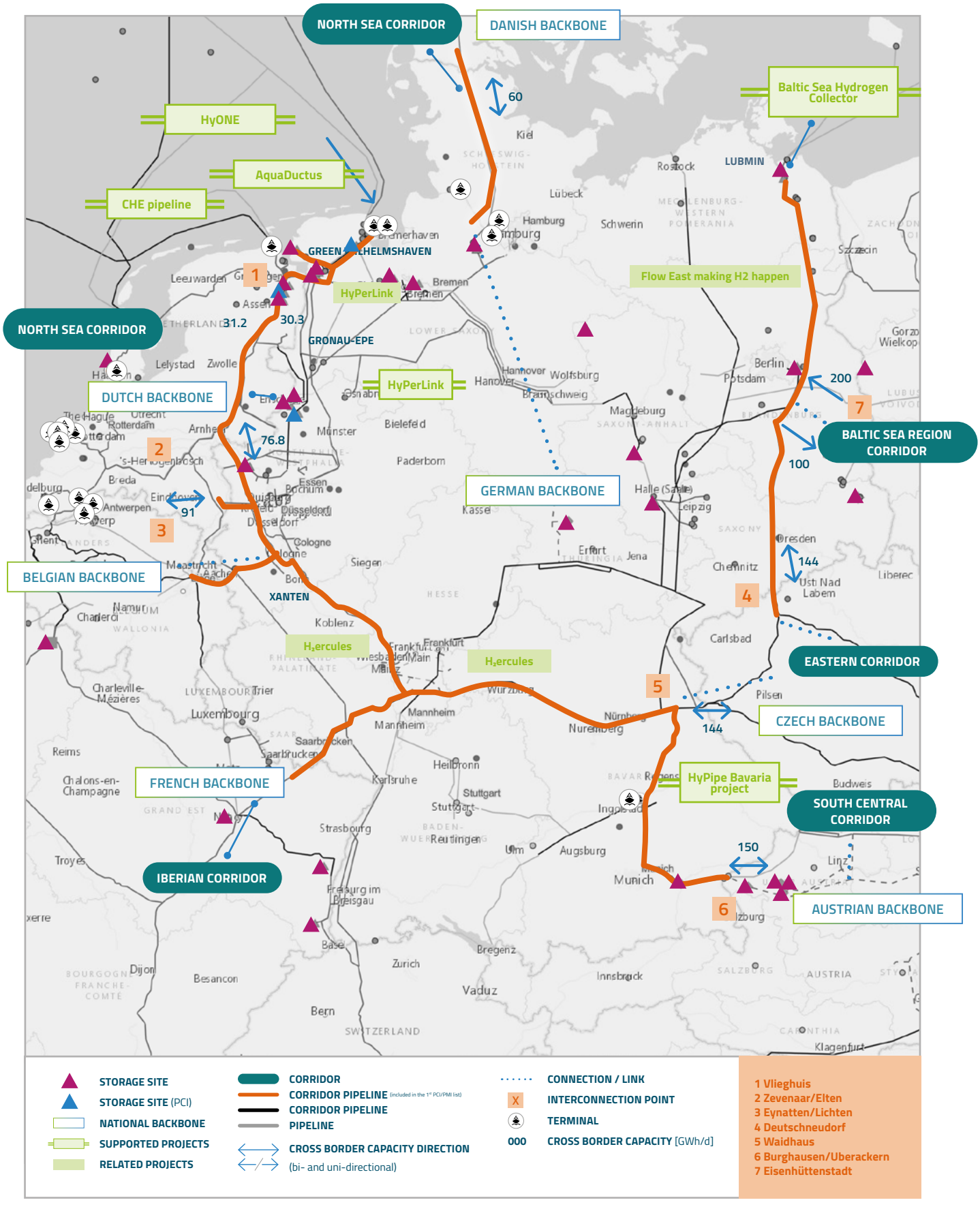
— Other permit granting difficulties (absence of clarity on permitting framework)

— Repurposing of existing storages connecting to the grid

— Risk that hydrogen production and demand perspectives will be significantly later implemented than 2030 causing uncertainty in the profitability on the corridor (Investment Recovery Challenge)

Country	Project name	Length (km)	Diameter (mm)	New pipeline/ total length (%)	Compressor (MW)	CAPEX (EUR m)	OPEX (EUR m p.a.)
Greece	Dedicated H_2 Pipeline project	540	915	100	60	1,000 ± 25 %	26 ± 25 %
Bulgaria	H_2 Transmission system in Bulgaria	250	1,000	100	48	860 ± 20 %	5 ± 20 %
Bulgaria	Interconnection Romania	330	1,000	100	72	1152 ± 20 %	5 ± 20 %
Romania	Interconnection Romania–Hungary with link to H_2 Production in Romania	663	800	100	100	2,264+30 %	34+30 %
Hungary	Interconnection Romania–Hungary	127	800 – 1,000	100	30	322 ± 30 %	15 ± 25 %
Hungary	H_2 Interconnection Hungary–Slovakia (new)	210	800	100	30	454 ± 30 %	40 ± 30 %
Slovakia	H_2 Interconnection Hungary–Slovakia (new)	20	800	100	0	30 ± 30 %	0.6 ± 30 %

GERMANY


NORTH SEA CORRIDOR
DANISH BACKBONE
HyONE
AquaDuctus
CHE pipeline
Baltic Sea Hydrogen Collector
LUBMIN
60
Kiel
Rostock
Lübeck
Hamburg
Schwerin
GREEN
HELMSHAVEN
Bremerhaven
Bremen
HyPerLink
Flow East making H2 happen
NORTH SEA CORRIDOR
31.2
30.3
GRONAU-EPE
Leeuwarden
Assen
Lelystad
Zwolle
Hannover
Wolfsburg
Braunschweig
Berlin
Potsdam
200
7
DUTCH BACKBONE
HyPerLink
Magdeburg
BALTIC SEA REGION CORRIDOR
100
Münster
Bielefeld
76.8
2
Paderborn
Arnhem
Rotterdam
Utrecht
Breda
Antwerpen
Eindhoven
91
3
Essen
Bochum
Düsseldorf
Cologne
Kassel
GERMAN BACKBONE
Halle (Saale)
Leipzig
Erfurt
Jena
Dresden
144
Chemnitz
Ústí nad Labem
Liberec
4
BELGIAN BACKBONE
XANTEN
Siegen
Koblenz
Carlsbad
H2ercules
H2ercules
EASTERN CORRIDOR
Frankfurt
Wiesbaden
Mainz
5
Pilsen
Trier
Luxembourg
Mannheim
Nürnberg
144
CZECH BACKBONE
Saarbrücken
Heilbronn
Karlsruhe
Stuttgart
HyPipe Bavaria project
Budweis
SOUTH CENTRAL CORRIDOR
FRENCH BACKBONE
Strasbourg
Reutlingen
Ulm
Augsburg
Ingolstadt
150
Linz
Troyes
IBERIAN CORRIDOR
Freiburg im Breisgau
Munich
6
Salzburg
AUSTRIAN BACKBONE
Basel
Bregenz
Zurich
Innsbruck
Besançon
Dijon
Vaduz
Bern
SWITZERLAND
AUSTRIA
Klagenfurt
STORAGE SITE
STORAGE SITE (PCI)
NATIONAL BACKBONE
SUPPORTED PROJECTS
RELATED PROJECTS
CORRIDOR
CORRIDOR PIPELINE (included in the 1st PCI/PMI list)
CORRIDOR PIPELINE
PIPELINE
CROSS BORDER CAPACITY DIRECTION
(bi- and uni-directional)
CONNECTION / LINK
INTERCONNECTION POINT
TERMINAL
000 CROSS BORDER CAPACITY [GWh/d]
1 Vlieghuis
2 Zevenaar/Elten
3 Eynatten/Lichten
4 Deutschneudorf
5 Waidhaus
6 Burghausen/Uberackern
7 Eisenhüttenstadt

Germany is the targeted country of all six mentioned corridors, as it is expected to import large amounts of hydrogen to meet the largest national hydrogen demand. Development of the network in Germany (selected projects). shows the key projects of some German TSOs as part of the planned Hydrogen Core Network, which will enable the connection of domestic hydrogen production and neighboring countries for hydrogen imports to the demand centers. The German TSOs are closely cooperating on several projects in Germany, the Netherlands, Belgium, France, Norway, Austria, Denmark, Poland and the Czech Republic.

The network described below is only a small part of the German Hydrogen Core Network, as proposed by the FNB Gas e. V., and it interconnects the six EU supply corridors with the national system.

Please note that the data provided (above and below) on the German hydrogen core grid is not yet final. Official data on the German hydrogen core grid is still outstanding and has to be approved by the national regulator.

RELATED PROJECTS

- **H_2ercules:** The project aims to create a substantial part of the German Hydrogen Core network and is planned to be realised by 2032. It consists of about 2,000 km of pipelines, mostly repurposed, establishing connection to five European countries - Norway, the Netherlands, Belgium, France, and Czech Republic - via pipeline and a terminal for the import of hydrogen derivatives by ship.
- **HyPerLink:** The project will develop an open access, cross-border H_2 backbone in Northern DE that will connect H_2 producers, cross-border points between NL-DE and later DE-DK, storage facilities, and industrial consumers in Northern DE via repurposed pipelines.
- **HyPipe Bavaria – The Hydrogen Hub.:** By 2030, the hydrogen pipeline will connect Austria and creates a connection to Baden-Württemberg and Czech Republic as well as to central Germany. The HyPipe Bavaria network will then be 300 kilometres long and 95 % of the network will consist of converted existing natural gas pipelines.
- **Czech-German Hydrogen Interconnector** (FLOW East – Making Hydrogen Happen): a hydrogen interconnector to connect high potential hydrogen supply areas in Northern Germany and Baltics with expected high demand clusters in the EU (predominantly in South Germany and North Bohemia). Additionally, it will also enable the connection of local suppliers and consumers along the corridor.
- **Nordic-Baltic Hydrogen Corridor - DE section:** The aim is to create H_2 corridor from Finland to Germany via Estonia, Latvia, Lithuania and Poland. The project foresees the transport of green H_2 from Baltic Sea countries to industrial clusters along the corridor and to Central Europe. The end of the corridor will be connected to the German hydrogen core grid at the German-Polish border.
- **Danish-German Hydrogen Network; German Part - HyPerLink Phase III:** The project will develop an open access, cross-border H_2 backbone in Northern DE that will connect H_2 producers, cross-border points between NL-DE and later DE-DK, storage facilities, and industrial consumers in Northern DE via repurposed pipelines.
- **AquaDuctus:** The offshore hydrogen pipeline will be capable to connect adjacent offshore hydrogen pipelines (e. g., from NO, UK or NL) aiming for export of local hydrogen production to the European market as well as offshore hydrogen wind farm sites in the German EEZ, such as the first large-scale offshore hydrogen wind farm site SEN-1 (up to 1 GW generation capacity, located in the German EEZ, 150 km north-west of the island of Heligoland). Through an additional onshore pipeline a direct link to HyPerLink and H_2ercules will secure a downstream connection to hydrogen consumers as well as to the German-Dutch border in Bunde.

WHY IS THE CORRIDOR IMPORTANT

IMPORT OPTIONS

- Via Green Wilhelmshaven Terminal/Storage/Cracker
- Via Ammonia Import Terminal Brunsbüttel
- Via the AquaDuctus offshore hydrogen pipeline (IPCEI notified project) that connects the first large-scale offshore hydrogen wind farm site SEN-1 (up to 1 GW generation capacity) located in the German EEZ, 150 km north-west of the island of Heligoland
- Via the HyONE-DE project in the German EEZ that connects hydrogen produced by wind energy in the EEZ (max target of 10 GW)
- Via pipeline (Nordic-Baltic Hydrogen Corridor - DE section) which provides the link to the Nordic Baltic Corridor and access to the potential in the Baltic Sea region.

MARKETS SUPPORTED

(projects, valleys & clusters)

Germany

- The envisaged German Hydrogen Core Grid will connect main production and import areas with main consumption areas facilitating the ramp-up of the German hydrogen economy.

CONNECTIONS WITH STORAGE

- Wasserstoff Storage-Burghausen (903 MWh by 2032)
- Xanten (139 GWh by 2031)
- Staßfurt (209 GWh by 2031)
- Ruedersdorf (455 GWh by 2032)
- Bad Lauchstaedt (xxx GWh by xxx)
- Gronau-Epe (131 GWh by 2029)
- SaltHy Harsefeld (205 GWh by 2030)
- Green Hydrogen Hub Harsefeld-Stade (400 GWh by 2028)
- UHS Bremen – Lesum (205 GWh by 2030)
- Clean Hydrogen Coastline – Storage Huntorf (51 GWh by 2026)
- Green Hydrogen Hub Etzel (200 GWh by 2028)
- Green Hydrogen Hub Leer (400 GWh by 2028)
- JemgumH_2 (177 GWh by 2027)
- Green Hydrogen Hub Moeckow (400 GWh by 2029)
- H_2 Umstellung UGS Kirchheilingen (140 GWh by 2031)

INTERCONNECTIONS WITH CORRIDORS

- South Central H_2 corridor (Austrian Backbone) via Burghausen/Uberackern
- Iberian H_2 corridor (French backbone) via Obergailbach
- North Sea H_2 corridor: the Belgian Backbone via Eynatten/Lichtenbusch, the Danish backbone via Ellund, and the Dutch backbone via Vlieghuis, Oude and Zevenaar/Elten
- Nordic Baltic H_2 corridor via Lubmin (connection to FLOW – making hydrogen happen (East)) and Germany-Polish border at German town Eisenhüttenstadt (connection to the Nordic-Baltic Hydrogen Corridor)
- Eastern H_2 corridor & South-eastern H_2 corridor via Waidhaus (MEGAL/ H2ercules Network South network) and route via Uberackern (H2EU+Store project)

CURRENT IMPLEMENTATION STATUS

DEVELOPMENT PHASES

— **H_2ercules:** Pre-feasibility and feasibility phases.

— **Czech-German Hydrogen Interconnector**

› PCI application	December 2022, PCI status granted in November 2023
› Feasibility phase	2024 – 2025
› FEED	2024 – 2026
› Commercial operation	2029

— **AquaDuctus,**

› PCI application	December 2022, PCI status granted in November 2023
› Feasibility phase	2024
› FEED	2024 – 2028
› Commercial operation	2030

— **HyPipe Bavaria – The Hydrogen Hub**

› PCI application	December 2022, PCI status granted in November 2023
› Feasibility phase	2022 – 2024
› Construction	from 2025 – 2030
› Commercial operation	from 2030

— **Nordic Baltic Hydrogen Corridor**

› 2023 – 2024	Pre-feasibility
› 2025 – 2029	Feasibility study, design and construction phase (planned)
› 2029	commissioning (planned)
› 2030	H_2 market in operation (planned)

FUNDING TOOLS

— All related projects have been included in the 1st PCI/PMI list, which gives the opportunity for CEF funding.

— Hyperlink 1 & 2 have IPCEI status.

POLITICAL SUPPORT

A new section of article 28 of the German Energy Industry Act (Energiewirtschaftsgesetz (EnWG)) provides the basis for the creation of a hydrogen core network. IPCEI and PCI are part of the network planning.

The German Hydrogen core network draft application was submitted by the German TSOs in 11/2023 to the Federal Network Agency and the Federal Ministry for Economic Affairs and Climate Action.

The Hydrogen core network, which is much supported by the Federal Ministry for Economic Affairs and Climate Action, is to be decided upon by the German regulatory authority.

On 11 January 2024 the Czech Republic and the Free State of Saxony, Germany signed a Memorandum of Understanding in support of hydrogen transmission projects.

On the 30 May 2024 Germany, Austria and Italy signed a Joint Declaration of Intent for the Development of the SoutH2 Corridor.

The German TSOs submitted its final joint application for the hydrogen core network to the Federal Network Agency on 22 July 2024.

BARRIERS

— Missing or incomplete regulatory framework for infrastructure planning of low carbon or renewable gases

— Uncertainty of hydrogen market development

Country	Project name	Length (km)	Diameter (mm)	New pipeline/ total length (%)	Compressor (MW)	CAPEX (EUR m)	OPEX (EUR m p.a.)
Germany	H2ercules Network South	561	1,000 – 1,100	0	0	170 ± 30%	21 ± 30%
Germany	HyPipe Bavaria – The Hydrogen Hub	294	450 – 700	5		163 ± 30%	0.761 ± 30%
Germany	H2ercules Network West	500	800 – 900	36		1,020 ± 30%	23 ± 30%
Germany	H₂ercules Network North-West	190	500 – 900	0	6.5	250 ± 30%	9 ± 30%
Germany	Delta Rhine Corridor	413	900	100	To be determined	25.45 ± 15% **	25.45 ± 15% **
Germany	H2ercules Network North	434	600 – 1,000	83	52	1690 ± 30%	20 ± 30%
Germany	FLOW – making hydrogen happen (East)	480	1,400	0	22	499 ± 30%	6 ± 30%
Germany	Nordic-Baltic Hydrogen Corridor	10	To be determined	100	To be determined	37,1 ± 40%	0,3 ± 40%
Germany	Danish-German Hydrogen Network; German Part – HyPerLink Phase III	198		0		500	10*
Germany	AquaDuctus	516	1,200	100		1,500 ± 30%	15 ± 30%

* Estimated value ** The value includes the costs of the Dutch part of the project

5 MAIN FINDINGS OF THE LEARNBOOK

Each corridor contributes to a specific import route, while interconnecting national markets, terminals, storages, valleys:

- Six different import routes are supported, via offshore pipelines, or via maritime in the form of hydrogen carriers.
- 25 national hydrogen systems will be, directly or indirectly, interconnected through these corridors, offering the possibility for market integration, security of supply and diversification of sources.
- 17 ports/terminals for green ammonia and LOHC.
- Around 40 storage sites, currently used for natural gas storage, which will be repurposed for hydrogen.
- A big number national valleys and industrial clusters.

Projects of the 1st PCI/PMI list contribute to the establishment of a significant part of the 6 corridors, calculated to be around 92 %. It is worth noting that the next PCI / PMI list to be adopted is expected to cover all.

Out of the around 21,000 km of six supply corridors, almost 35 % is expected to be repurposed pipelines, which will help reduce the total cost of development.

Though ranges have been provided for each project, an accurate estimate of total CAPEX and OPEX for the six corridors is not possible. It may be the case that detailed future studies will enable these calculations.

There are **projects qualified to receive support as ‚Important Project of Common European Interest' (IPCEI)**, which means that they are eligible for national state aid, but most of the projects have the option to **apply for Connecting Europe Facility for Energy (CEF-E) EU funding,** being selected for the PCI/PMI list.

Current status of corridors implementation exhibits existing political support from the Member States and is far more concrete in the numbers of projects labelled as PCIs/ PMIs/ IPCEIs, thus acknowledged as bringing substantial, objective and recognised emissions abatement potential.

MAIN IDENTIFIED BARRIERS TO REACH FID ARE:

Policy/Regulatory issues

- **National level transposition of EU regulation**, including RED II & III, impacting market development, especially the ability of offtakers to commit to the infrastructural projects.
- **European standards** (technical rules, international H_2 certification).
- **Missing or incomplete regulatory framework** for infrastructure planning of low carbon or renewable gases in the different states
- Concrete timeline for transitioning from natural gas to low carbon gases, resulting in **unclear repurposing timelines**
- Other **permit granting difficulties** (absence of clarity on permitting framework)

Financing/Funding

- Missing or incomplete **framework for financing hydrogen infrastructure**
- **Availability of funding instruments**, both for CAPEX and OPEX, and associated conditions, especially in the early stage in order to de-risk the investments.
- **Investment attractiveness**, in combination with uncertainties due to lack of market maturity

Value Chain

- Uncertainty on hydrogen **supply contract**
- Potential large-scale off-takers and production projects should be linked with specific timelines
- The **storage and transport infrastructure should be developed consistently** all over the corridor

6 CONCLUSIONS & NEXT STEPS

The six mentioned corridors are the cornerstones of a pan-EU network, and their development will lead to a successful early rollout of hydrogen infrastructure to achieve Europe's decarbonisation targets (for imports and local production) by 2030 and beyond. The hydrogen transport corridors support the scale-up of renewable energy and bolsters security of supply, with connections between supply and demand regions directly contributing significant savings compared to a fragmented, isolated clusters development approach.

While most of the projects have the necessary political support up to now (pre-requisite to be in the PCI/PMI list), more concrete commitments might be necessary for them to reach the FID status, coming from intergovernmental agreements that will support implementation alignment.

WHAT IS NECESSARY:

Policy/Regulatory issues

- **Swift transposition of EU law** into the national systems. Proper implementation and consistency between national regulatory frameworks and the EU level should be ensured
- Address the lack of **certification, standards and guarantees of origin** for H_2 Imports. We need common rules for measuring carbon intensity.
- **Intergovernmental agreements** necessary and coordinated infrastructure planning along all energy sectors
- EU to **support international strategic partnerships** and cooperation with 3rd countries, which have the potential to produce and export renewable H_2.
- Continue allocating **funding to R&D and Innovation initiatives** and public-private partnerships that contribute to improving and lowering the costs of imported technologies and help address and better understand the climate and environmental impacts of hydrogen.
- Enable and promote the development of **regulatory sandboxes**.
- **Accelerate permitting** procedures for infrastructure projects

Financing/Funding

- Tools to **de-risk investments**
- **Support in studies** that will help project maturing
- **Increase** EU and national **funding**

Value Chain

- **Stimulate industry demand** for Renewable and low-carbon H_2 and bridge the cost gap with the fossil benchmark.
- Clear **incentives and targets for demand-side**
- **Timely repurposing of storage sites** and their connection with the hydrogen grids, as they will be an important part of the value chain.
- Support the growth of **large-scale production projects in 3rd countries** – a sound support mechanism with the international pillar of the EU Hydrogen Bank

As it is stated in the Learnbook on Financing of Hydrogen Projects: 'The identified hydrogen corridors all stretch over several member states with a specific corridor being implemented only so fast as the slowest member state. To avoid these corridors becoming political footballs and being delayed, a mechanism could be introduced that allows the European Commission to accelerate the respective planning decision in the affected member state.

The following can be used as such:

- Demand commitments in the numbers of offtake contacts signed
- Date of full implementation of the missing regulatory frameworks
- Number of permitting procedures accomplished
- Number of projects (FIDs) taken
- Dates of the projects availabilities for the markets
- Emissions abatement enabled by the infrastructure and achieved by its users

This would contribute to the energy transition taking place in a timely manner and in accordance with the aims and timeline of the RePowerEU Plan'

As a next step it is proposed to have **annual EU-wide Progress Monitoring** with pre-agreed key metrics for all MSs.

- Number of certificates on the market
- Support for industrial processes continuation (number of jobs retained/ created in H_2-based industries/ services)
- Number of storage sites delivering flexibility services (injection and withdrawal rates).

The agreement on such metrics requires a proper discussion between Member States, policy makers, regulators and industry.

The T&D Roundtable could assist in the work of such a monitoring report.

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8 ABBREVIATIONS AND ACRONYMS

CAPEX	CApital EXpenditure
CEF-E	Connecting Europe Facility for Energy
ECH_2A	European Clean Hydrogen Alliance
H_2	Hydrogen
FID	Final Investment Decision
IPCEI	Important Project of Common European Interest
LH_2	Liquefied Hydrogen
LOHC	Liquid Organic Hydrogen Carrier
MoU	Memorandum of Understanding
MS	Member State
NGO	Non-Governmental Organisation
NH_3	Ammonia
OPEX	OPerational EXpenditure
PCI	Project of Common Interest
PMI	Project of Mutual Interest
REPowerEU	European Commission communication to quickly reduce dependence on Russian fossil fuels and fast forward the green transition (link)
RES	Renewable Energy Sources
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan

UNITS

GWh	gigawatt hours
GW	gigawatt
m^3	cubic meter
Mt	million tonnes
MWh	megawatt hours
t	tonne
TWh	terawatt hours
y	year

IMPRINT

BACKGROUND MAPPING

Hydrogen Infrastructure Map

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PICTURES

p. 19	courtesy of Enagás
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European Clean Hydrogen Alliance

Kick-starting the EU Hydrogen Industry
to achieve the EU climate goals