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COMMISSION STAFF WORKING DOCUMENT

Report on implementation and monitoring of large-scale hydrogen deployment projects: the IPCEIs on hydrogen and the ECH2A project pipeline

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Report on implementation and monitoring of large-scale hydrogen deployment projects: the IPCEIs on hydrogen and the ECH2A project pipeline

Contents

1. Executive summary

This report analyses the implementation and monitoring of large-scale hydrogen deployment projects that are included in the four important projects of common European interest (IPCEIs) on hydrogen - Hy2Tech, Hy2Use, Hy2Infra, and Hy2Move [1,2,3,4]. The Commission approved in 2022 and 2024 State aid notified by several Member States for the execution of these four IPCEIs. The report also covers the project pipeline of the European Clean Hydrogen Alliance (ECH2A).

The analysis of hydrogen projects confirms the challenging situation of the sector, with many projects facing implementation delays and 10 projects (out of 122 approved projects) have been abandoned. In the case of IPCEI's projects, the review of the projects' state of play shows that nearly two thirds of projects are not on track. Funding issues and lack of off-takers are listed as the main reasons for the delays. Implementation is also hindered by other factors, including: (i) the immaturity of technology; (ii) regulatory and permitting issues; (iii) access to electricity; (iv) investment costs; and (v) significant uncertainties due to projected substantial increases in costs of capital and operational expenditures given the still nascent state of the market.

On the positive side, by the end of 2024, 17 projects (5 in Hy2Use and 12 in Hy2Infra) had reached final investment decision status and therefore are under construction. This marks a big improvement compared to the first IPCEI General Assembly in Berlin in December 2023.

Regarding the ECH2A project pipeline, projects face similar issues as the IPCEIs. Out of the 425 projects, 77 had reached final investment decision status by 15 December 2024. However, the absence of mandatory reporting requirements has led to a big data gap and points to the need to develop a monitoring framework using data collected through an annual survey. This should be discussed at the European Hydrogen Forum.

This report presents the monitoring framework developed by the European Commission's Joint Research Centre to measure the performance of the hydrogen IPCEIs during their implementation. This monitoring framework includes: (i) a list of hydrogen specific key performance indicators designed to track projects' progress towards their objectives; and (ii) a project classification system for the hydrogen IPCEIs that will contribute to the future technical assessment of the four IPCEIs based on a set of key performance indicators common to all four IPCEIs.

In addition, this report describes the recent work done by the Joint Research Centre on the Energy and Industry Geography Lab to include information about hydrogen projects in Europe using data on IPCEIs and ECH2A projects, but also hydrogen projects funded under the EU Emissions Trading System Innovation Fund and the projects of common/mutual interest. This mapping and the data could support the potential future planning of hydrogen infrastructure and hydrogen facilities.

In conclusion it appears that hydrogen projects designed some 3-4 years ago and promoted by the Alliance for support, were rather pre-mature given the very nascent state of the hydrogen

[1] Commission decision on case SA.64647 Germany and others – Important Project of Common European Interest on Hydrogen Technology (Hy2Tech), C(2022) 5158 final.
[2] Commission decision on case SA.64631 Austria and others – Important Project of Common European Interest on Hydrogen Industry (Hy2Use), C(2022) 6847 final.
[3] Commission decision on case SA.102825 Germany and others – Important Project of Common European Interest on Hydrogen Infrastructure "Hy2Infra" – RRF, C(2024) 1053 final.
[4] Commission decision on case SA.104676 Germany and others – Important Project of Common European Interest on Hydrogen on Mobility & Transport (IPCEI 'Hy2Move') – RRF, C(2024) 3631.

market. This has resulted in 2/3 of those projects either being abandoned or delayed or requiring significant modifications.

2. Introduction

The European Clean Hydrogen Alliance (ECH2A)[5] was created in July 2020 as one of the actions of the EU's hydrogen strategy[6], to promote investments and stimulate clean hydrogen production and use. It was part of the EU's efforts to ensure industrial leadership and accelerate the decarbonisation of industry in line with the EU's climate-change objectives. One of the main objectives of the Alliance Declaration[7] was to develop a pipeline of viable investment projects and an investment agenda until 2030.

In 2022, the first two important projects of common European interest (IPCEIs) – Hy2Tech and Hy2Use – were adopted, and the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), was tasked with ensuring the monitoring of the IPCEIs on hydrogen.

In 2023, the European Court of Auditors (ECA) carried out an audit on how effective the European Commission has been in creating the right conditions for the emerging renewable and low-carbon hydrogen markets, given the significant implications of this transition for the future of key EU industries. about delayed funding of IPCEIs by MS

In their report published in July 2024, entitled *The EU's industrial policy on renewable hydrogen – Legal framework has been mostly adopted – time for a reality check*[8], the auditors acknowledge that the Commission has played a critical role in stimulating the development of the hydrogen market in EU. However, the ECA also called for a reality check to ensure that the EU's targets are realistic, and that its strategic choices will not impair the competitiveness of key industries or create new dependencies. It also specifically mentioned delayed funding of IPCEIs by MS.

Several other organisations have also carried out comprehensive analyses of the hydrogen sector, in particular the International Energy Agency, with the Global Hydrogen Review report[9]; Hydrogen Europe, with the Clean Hydrogen Monitor[10]; and, more recently, the EU Agency for the Cooperation of Energy Regulators, with the 2024 Market Monitoring Report[11].

This report aims to provide an overview of the monitoring and implementation of large-scale hydrogen project deployment under the responsibility of DG GROW, focusing on the four IPCEIs and the ECH2A project pipeline.

The report does not include detailed information on projects funded under other EU or national funding instruments and initiatives, but for the sake of completeness, it is worth briefly mentioning them.

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[5] European Commission, *European Clean Hydrogen Alliance*, available at: https://single-market-economy.ec.europa.eu/industry/industrial-alliances/european-clean-hydrogen-alliance_en.
[6] European Commission, *A Hydrogen Strategy for a Climate-Neutral Europe*, COM(2020) 301 final, 8 July 2020.
[7] European Commission, *Declaration of the European Clean Hydrogen Alliance*, available at: https://ec.europa.eu/docsroom/documents/43526.
[8] European Court of Auditors, *The EU's industrial policy on renewable hydrogen Legal framework has been mostly adopted – time for a reality check*, available at: https://www.eca.europa.eu/ECAPublications/SR-2024-11/SR-2024-11_EN.pdf.
[9] International Energy Agency, *Global Hydrogen Review 2024,* available at: https://iea.blob.core.windows.net/assets/89c1e382-dc59-46ca-aa47-9f7d41531ab5/GlobalHydrogenReview2024.pdf.
[10] Hydrogen Europe, *Clean Hydrogen Monitor,* available at: https://hydrogeneurope.eu/wp-content/uploads/2023/10/Clean_Hydrogen_Monitor_11-2023_DIGITAL.pdf.
[11] European Union Agency for the Cooperation of Energy Regulators (ACER), *European hydrogen markets – 2024 Market Monitoring Report,* available at: https://www.acer.europa.eu/sites/default/files/documents/Publications/ACER_2024_MMR_Hydrogen_Markets.pdf.

- Emissions Trading System (ETS) Innovation Fund[12]. The 2023 call of the Innovation Fund supports the deployment of 15 hydrogen-related projects on electrolysers, clean steel, ammonia, and e-fuels. The results of the 2024 call have been published. Regarding hydrogen, projects will provide a significant contribution to the EU objectives with 9.3 GW of electrolyser manufacturing capacity.

- Innovation Fund auction[13]. The auction refers to the European Hydrogen Bank financing mechanism, using the revenues of the ETS, and implemented via the calls for proposals of the Innovation Fund. The auction aimed at supporting projects in producing renewable hydrogen and supporting the producers via the green premia. The results of the first auction were announced in April 2024, with six projects awarded, covering 1.4 GW of electrolyser capacity. A second renewable hydrogen auction opened on 3 December 2024 and will award up to EUR 1.2 billion of support to renewable hydrogen producers located in the European Economic Area (EEA), contributing to the further creation of a European market for renewable hydrogen by de-risking investments with public support.

- Hydrogen valleys[14]. Staff working document SWD(2024) 159 final takes stock of the achievements to date, and outlines the measures being implemented to have 50 hydrogen valleys under construction or operational in the EU by 2030. Currently, 98 valleys have been identified globally[15], with 67 located in the EU. Of these, 19 are financially supported by the Clean Hydrogen Joint Undertaking, with another three grants in preparation.

- Significant investments in hydrogen of at least EUR 13.6 billion are also scheduled under the Resilience and Recovery Facility (RRF). 19 Member States have included measures dedicated either partly or exclusively to hydrogen in their RRPs. The measures cover the whole hydrogen value chain – from production to transport, storage and end-use in hard-to-electrify industrial sectors.

- Other State aid schemes/rules – Guidelines on State aid for climate, environmental protection and energy (CEEAG)[16], the General Block Exemption Regulation (GBER)[17] and the Temporary Crisis and Transition Framework (TCTF)[18]. Under the CEEAG, the Commission has approved State aid notified by the Member States for the deployment of renewable hydrogen and for the use of hydrogen for a total budget exceeding EUR 11 billion[19]. The TCTF also allows Member States to support the deployment of

[12] The ETS Innovation Fund finances innovative low-carbon projects using EU ETS revenues. More information available at: https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund_en.
[13] The Innovation Fund auction. More details can be found at: https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen/european-hydrogen-bank_en.
[14] Hydrogen valleys are integrated hydrogen ecosystems that cover the entire hydrogen value chain. More information available at: https://www.clean-hydrogen.europa.eu/get-involved/hydrogen-valleys_en.
[15] European Commission, *Towards a roadmap for accelerating the deployment of Hydrogen Valleys across Europe: challenges and opportunities*. SWD(2024) 159 final, 24 June 2024. Available at: https://research-and-innovation.ec.europa.eu/document/download/e5e75789-d4d8-42aa-8c99-3f33b2f5b935_en?filename=ec_rtd_swd-2024-159-f1.pdf.
[16] European Commission, *Guidelines on State aid for climate, environmental protection and energy 2022,* 2022/C 80/01, 18 February 2022.
[17] European Commission, *General Block Exemption Regulation*, Regulation (EU) No 651/2014, OJ L 187, 26 June 2014, as amended.
[18] European Commission, *Temporary Crisis and Transition Framework for State Aid measures to support the economy following the aggression against Ukraine by Russia*, 2023/C 101/03, OJ C 101, 17 March 2023.
[19] Part of this amount can be RRF – to avoid double counting.

renewable energy sources, including renewable hydrogen, and the manufacturing of strategic equipment for the transition to a net-zero economy, including hydrogen electrolysers. In addition, the GBER and the Framework for State aid for research and development and innovation provide opportunities for Member States to support the development and deployment of renewable generation technologies.

- Trans-European energy network[20], trans-European transport network[21] and Connecting Europe Facility[22]. The projects of common interest (PCIs)[23] and projects of mutual interest (PMIs)[24] have been approved by the European Commission, as have hydrogen refuelling station projects under the Alternative Fuels Infrastructure Facility[25]. All these funding schemes support the development of hydrogen infrastructure.

This report covers the deployment of large-scale clean hydrogen projects across the EEA in the period from 01 July 2023 until 31 August 2024. It covers: (i) all major clean hydrogen projects that are included in the first two hydrogen IPCEIs– Hy2Tech and Hy2Use. However, the second set of hydrogen-related IPCEIs, Hy2Infra and Hy2Move have not submitted any implementation reports yet and are mentioned only for completeness; and (ii) those reported to the ECH2A and included in its project pipeline[26].

This first edition of this report on implementation and monitoring of large-scale hydrogen deployment projects is timely, given that the facilitating EU regulatory framework to encourage the roll-out of such projects is almost complete – the only missing piece being a delegated act on low-carbon hydrogen and, where necessary, implementation at Member State level of legislation such as the revised Renewable Energy Directive (RED III)[27].

The third chapter provides an overview of the four hydrogen IPCEIs, using common key performance indicators (KPIs) that have been agreed with the Member States to give an up-to-date assessment of the deployment of these projects and to identify potential bottlenecks to the roll-out of these projects at national or European level.

Chapter 4 presents the monitoring framework proposed by the Joint Research Centre (JRC) for the four IPCEIs which has been presented at the Joint IPCEI General Assembly in Paris on 17 December 2024. This chapter describes the value-chain analysis and project classification system used to this effect, which will be instrumental for the future technical assessment of hydrogen IPCEI projects.

[20] European Commission, *Guidelines for trans-European energy infrastructure*, Regulation (EU) 2022/869, OJ L 152, 3 June 2022.
[21] European Commission, *Union guidelines for the development of the trans-European transport network*, Regulation (EU) No 1315/2013, OJ L 348, 20 December 2013, as amended.
[22] European Commission, *Connecting Europe Facility,* Regulation (EU) No 1316/2013, OJ L 348, 20 December 2013, as amended.
[23] PCIs are key cross-border infrastructure projects that help achieve the EU's energy policy and climate objectives. More information available at: https://ec.europa.eu/energy/topics/infrastructure/projects-common-interest_en.
[24] PMIs are infrastructure projects between the EU and non-EU countries that aim to improve energy security, supply diversification, and regional cooperation. More information available at: https://energy.ec.europa.eu/topics/infrastructure/projects-common-interest-and-projects-mutual-interest_en.
[25] The Alternative Fuels Infrastructure Facility provides EU funding to support the deployment of alternative fuel infrastructure, including hydrogen refuelling stations, across the EU. More information available at: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/cef/wp-call/2024/call-fiche_cef-t-2024-afifgen_en.pdf.
[26] The ECH2A project pipeline is a curated list of hydrogen projects that supports investment, fosters collaboration across the hydrogen value chain, and increases market visibility. More information available at: https://single-market-economy.ec.europa.eu/industry/industrial-alliances/european-clean-hydrogen-alliance/project-pipeline_en.
[27] European Commission, *Renewable Energy Directive*, Directive (EU) 2023/2413, OJ L, 2023/2413, 31 October 2023.

The fifth chapter provides an update on the deployment of the ECH2A project pipeline.

Chapter 6 covers the mapping of large-scale hydrogen deployment done by the JRC, with the development of hydrogen-specific layers within the Energy and Industry Geography Lab (EIGL)[28].

The report concludes with an assessment of whether deployment to date is encouraging the development of a European market for clean hydrogen. It considers whether national or EU policy responses are needed to address the identified bottlenecks so that the scale and scope of the single market can be fully leveraged.

[28] EIGL is a tool for geographical data related to energy, industry and infrastructure. Available at: https://energy-industry-geolab.jrc.ec.europa.eu/.

3. The IPCEIs on hydrogen

Following the adoption of the two additional hydrogen IPCEIs – Hy2Infra and Hy2Move, respectively in February and May 2024. 2024 marked the conclusion of a four-year process since the signature of the hydrogen Manifesto back in December 2019, for which ministers of 22 EU Member States and Norway committed to support the development and deployment of clean and low-carbon hydrogen in Europe and to invest billions of euros accordingly

IPCEI Hy2Tech
Focus: development of novel technologies for production, storage, transportation and distribution of hydrogen and applications in the mobility sector.
Formally approved by COM on 15 July 2022.
15 MSs (AT, BE, CZ, DE, DK, EE, EL, ES, FL, FR, IT, NL, PL, PT, SK), 41 Projects.
€5.5bn aid approved, triggering €8.8bn private investments.

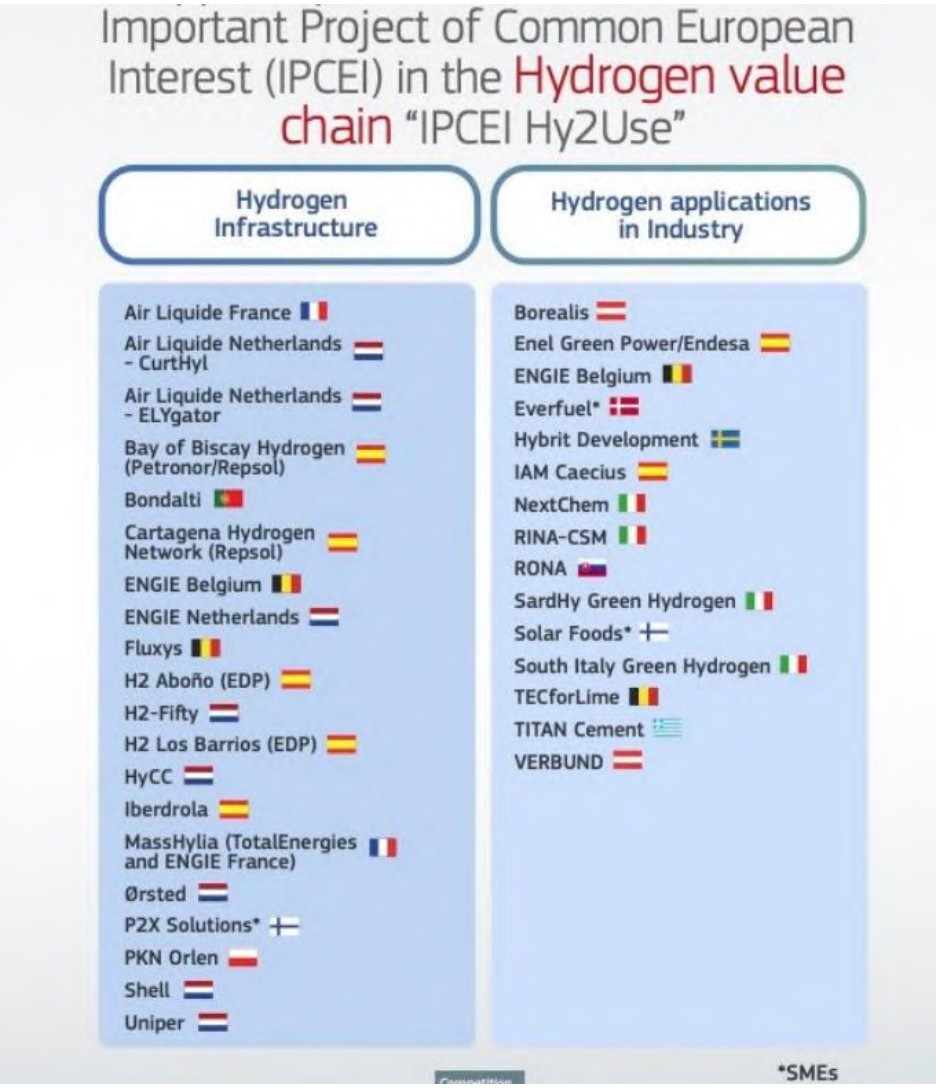
IPCEI Hy2Use
Focus: boosting supply of renewable and low-carbon hydrogen, enabling the development and first industrial deployment of clean and innovative hydrogen technologies in industrial sectors.
Formally approved by COM on 21 September 2022.
13 MSs (AT, BE, DK, EL, ES, FL, FR, IT, NL, PL, SE, SK) + NO, 37 Projects.
€5.2bn aid approved, triggering €7bn private investments.

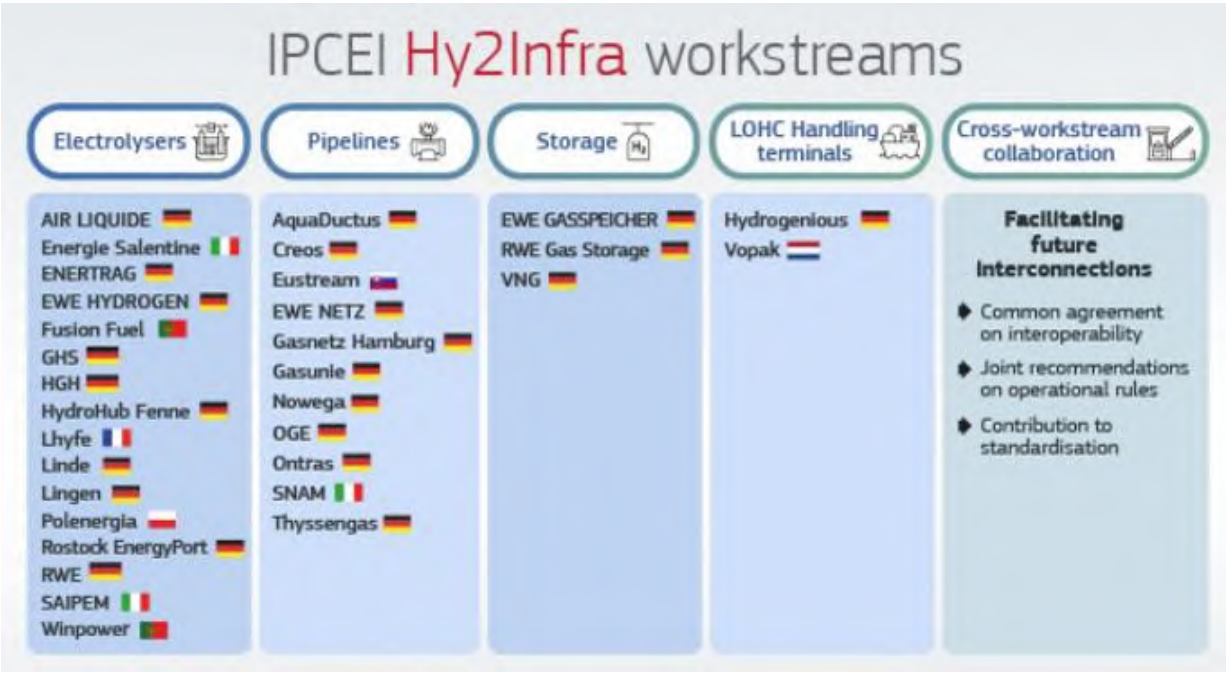
IPCEI Hy2Infra
Focus: hydrogen production and infrastructure (pipelines, storage facilities, handling terminals…).
Formally approved by COM on 15 February 2024.
7 MSs (DE, FR, IT, NL, PL, PT, SK), 33 Projects.
€6.9bn aid approved, triggering €5.4bn private investments.

IPCEI Hy2Move
Focus: hydrogen use in the mobility and transport sectors
Formally approved by COM on 28 May 2024.
7 MSs (DE, EE, FR, IT, NL, SK, ES), 13 Projects.
€1.4bn aid approved, triggering €3.3bn private investments.

Figure 1: General information on the four IPCEIs at the time of adoption.

The four IPCEIs are expected to enable a total investment amounting to EUR 43.5 billion with a total support of EUR 18.9 billion in aid approved, which is expected to trigger a total of EUR 24.7 billion in private investments.


Important Project of Common European Interest (IPCEI) in the Hydrogen value chain "IPCEI Hy2Use"
Hydrogen Infrastructure
Air Liquide France
Air Liquide Netherlands - CurtHyl
Air Liquide Netherlands - ELYgator
Bay of Biscay Hydrogen (Petronor/Repsol)
Bondalti
Cartagena Hydrogen Network (Repsol)
ENGIE Belgium
ENGIE Netherlands
Fluxys
H2 Aboño (EDP)
H2-Fifty
H2 Los Barrios (EDP)
HyCC
Iberdrola
MassHylia (TotalEnergies and ENGIE France)
Ørsted
P2X Solutions*
PKN Orlen
Shell
Uniper
Hydrogen applications in Industry
Borealis
Enel Green Power/Endesa
ENGIE Belgium
Everfuel*
Hybrit Development
IAM Caecius
NextChem
RINA-CSM
RONA
SardHy Green Hydrogen
Solar Foods*
South Italy Green Hydrogen
TECforLime
TITAN Cement
VERBUND
*SMEs


IPCEI Hy2Infra workstreams
Electrolysers
AIR LIQUIDE
Energie Salentine
ENERTRAG
EWE HYDROGEN
Fusion Fuel
GHS
HGH
HydroHub Fenne
Lhyfe
Linde
Lingen
Polenergia
Rostock EnergyPort
RWE
SAIPEM
Winpower
Pipelines
AquaDuctus
Creos
Eustream
EWE NETZ
Gasnetz Hamburg
Gasunie
Nowega
OGE
Ontras
SNAM
Thyssengas
Storage
EWE GASSPEICHER
RWE Gas Storage
VNG
LOHC Handling terminals
Hydrogenious
Vopak
Cross-workstream collaboration
Facilitating future interconnections
Common agreement on interoperability
Joint recommendations on operational rules
Contribution to standardisation

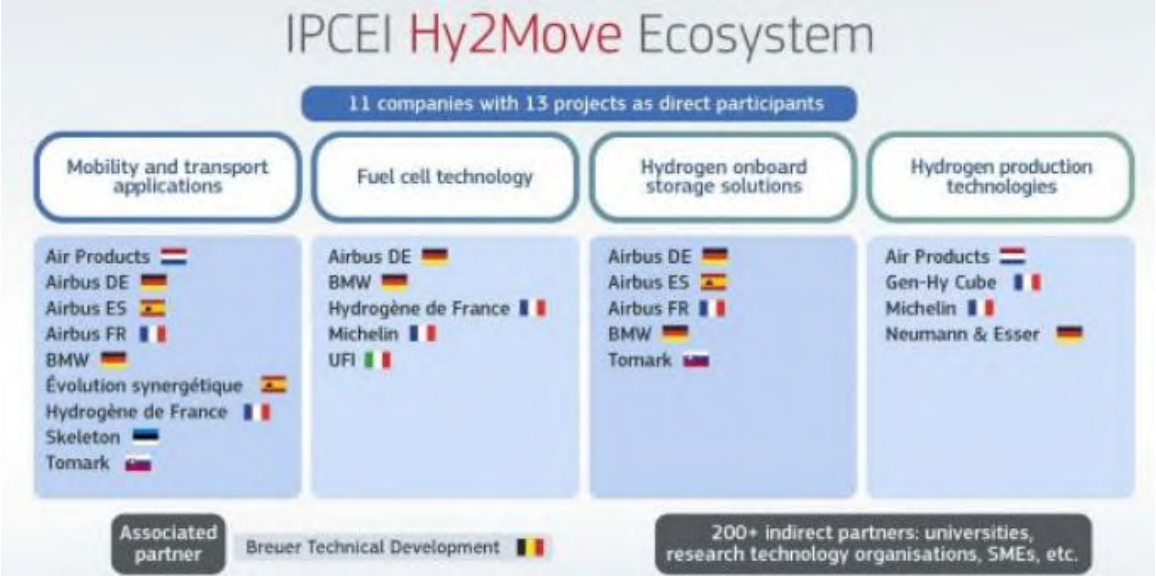


Figure 2: IPCEI ecosystems at the date of notification of each individual IPCEI.

The hydrogen IPCEI ecosystem is shown in Figure 2. It lists the direct participants in different technology fields or workstreams.

Overall, the four IPCEIs included, as of the end of November 2024, a total of **113 active projects** from 16 Member States (Austria, Belgium, Czechia, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Italy, the Netherlands, Poland, Portugal, Sweden and Slovakia), plus two projects from Norway.

As of end of November 2024, 10 projects have withdrawn from the scheme: five in Hy2Tech and five in Hy2Use.

There are 18 small to medium-sized enterprises (SMEs) involved, representing 16% of direct participants: three in Hy2Use; seven in Hy2Tech; four in Hy2Infra; and four in Hy2Move.

The total number of Indirect Partners is 693: 322 IPs in Hy2Tech; 160 IPs in Hy2Use, 211 IPs in Hy2Move, and no Indirect Partners specifically mentioned in the Hy2Infra decision while however 82 collaborations with research organisations and academia are planned.

The total number of associated partners is now three. There is one Associated Partner in Hy2Move mentioned in the approved decision of the European Commission, and on 14 November 2024, an exceptional supervisory board meeting voted on the first two applications – from ENEA and Fondazione Bruno Kessler – for the recently introduced associated partner status in Hy2Tech.

3.1 IPCEI projects – implementation

The second summary annual reports submitted by the two coordinating Member States (Germany for Hy2Tech and the Netherlands for Hy2Use) were received, as required, by the end of June 2024. These cover the period from January 2023 until December 2023.

Most Member States also provided the survey responses submitted by the direct participants falling under their jurisdiction, in line with the preliminary agreement reached at the previous General Assembly in Berlin in December 2023. Direct participants agreed to share their survey responses with the Commission and demonstrated goodwill on their part to assist the Commission in its efforts to ensure smooth implementation of IPCEIs.

Since adoption of the approval decisions by the European Commission, ten projects withdrew from Hy2Tech and Hy2Use. The facilitating group chair should then assess the consequences of projects leaving the IPCEI in terms of collaboration and the potential impact of the direct participant leaving on the technology field / workstream.

The table below shows the status of the 66 projects in Hy2Tech and Hy2Use, based on the information and data included in the Facilitating Group's reports.

Project status	**Number of projects**	**Percentage of the total number of projects**
Not yet started – no funding received or granted*	16 projects*	24.2%
Projects delayed or seeking extension	26 projects	39.4%
On schedule – green	12 projects	18,2%
Relocation	2 projects	3%
Pre-Front-End-Engineering-Design (FEED) - FEED	3projects	4.5%
Final investment decision*,[+]	5 (Hy2Use)*	7.5%
Did not report	2 projects	3%

Table 1: Project status and number of projects falling under each category; as of end November 2024 for projects with *.

[+] Final investment decision (FID) status is used to monitor project implementation and the number of FIDs taken is commonly used as a good proxy to monitor the deployment of the hydrogen ecosystem. Until an FID is reached, a project has a significant risk of not being implemented.

The review of the project portfolio shows that nearly two thirds of projects are not on track. This figure reflects the difficulties direct participants face in implementing their projects as described in Section 3.5 'Challenges regarding project implementation'.

3.2 Collaborations/spillovers

Considering that many projects are facing delays or have not started yet, it seems premature to analyse if Hy2Tech and Hy2Use are delivering in terms of both collaborations and positive

spillovers effects. However, it was reported at the General Assembly that many DPs have got together, often to set up consortia and to share technical information to help determine feasibility, etc. Moreover, there have been additional collaborative activities that were not mentioned in the Commission Decision, indicating the goodwill of project owners to work across borders to get coordinated projects off the ground in challenging regulatory and financial conditions.

Most collaborations between direct participants in the same technology field and across fields have been in areas such as: (i) standardisation, certification and classification of solutions; and (ii) discussions with main stakeholders and original equipment manufacturers to validate the market requirements and needs, establishing cooperation through knowledge exchange, mutual agreements, and product-development specifications. There continues to be much dissemination and collaboration, like in the previous reporting period. Participation in various national and international events has further elevated the visibility of the projects and created valuable exchanges with stakeholders.

The facilitation groups also reported progress in the IPCEI stimulating EU innovation performance, mentioning 12 patent licences issued and 26 patent applications; and in the IPCEI stimulating skills/employment growth in the EU's hydrogen ecosystem.

Although there have been collaborations and spillovers effects already, there is significant potential to deepen collaboration among participants and with indirect partners.

3.3 General information – Hy2Infra

The kick-off meeting of Hy2Infra took place on 12 June 2024, meaning that no mandatory reporting on Hy2Infra has taken place yet.

Hy2Infra is intended to kick-start the development of European infrastructure for the supply of green hydrogen.

To this end, funding has been granted in the following areas:

1. installation of large-scale electrolysers with a capacity of 3.2 GW for the production of renewable hydrogen.
2. construction of new and repurposed long-distance and distribution lines for hydrogen with a length of around 2 700 kilometres.
3. development of large-scale hydrogen storage facilities with a capacity of at least 370 GWh; and
4. construction of trans-shipment terminals and associated port infrastructure for liquid organic hydrogen carriers, with the capacity to handle 6 000 tonnes of hydrogen per year.

Regarding the timeline, it is expected that some large-scale electrolysers will be put into operation between 2026 and 2028, and all long-distance pipelines between 2027 and 2029. The commissioning time depends on the geographical area in question. The projects are to be completed by 2029, although the concrete timing differs depending on the project and the company.

Nonetheless, thanks to information provided by the facilitation group chair, the below points can already be mentioned.

- By the end of 2024, a high share of Hy2Infra projects had received a funding decision at national level. The German government handed over the funding decisions for all 24 projects in Germany on 15 July 2024. Further funding decisions at national level were issued in the Netherlands and Italy. This means that more than 80% of projects received a positive funding decision within nine months of EU notification. As a result, at the end of 2024, almost all projects stated that implementation had started.
- However, many projects have reported being behind schedule. This affects about 60% of projects, which face similar challenges as the projects in Hy2Tech and Hy2Use (see Section 3.5).

Nevertheless, by the end of 2024, final investment decisions had already been taken on 12 projects, thanks mainly to the final approval of the German hydrogen core network, described in Box 1, which helped create greater investor certainty.

Box 1. The German hydrogen core network

In Germany, a state-initiated transmission network for hydrogen was developed in parallel with the Hy2Infra notification procedure – the German hydrogen core network. The hydrogen core network comprises the approximately 2 000 km of pipelines of the German Hy2Infra projects and expands them to a total of 9 040 km. The core network aims to link up currently known large consumption and production regions for hydrogen in Germany, and to connect central locations, such as large industrial centres, storage facilities, power plants and import corridors. The core network is to contain important hydrogen infrastructure, which is to be put into operation by 2032. On 22 October 2024, The German transmission system operators have obtained a permit to build the hydrogen core network. This permit allows the construction of 9 040 km of pipelines, of which around 60% will be converted natural gas pipelines. The expected investment costs amount to EUR 18.9 billion.

The prospective integration of the core network into a European hydrogen network is in line with the national hydrogen strategy and the hydrogen import strategy of the German federal government. The aim is to establish stronger and closer cooperation with interested EU Member States to enable a coordinated market ramp-up, set common standards, facilitate coordination, and enable coordinated imports. A large part of the hydrogen required in Germany will be covered by imports, and according to the federal government's estimates, evaluating the current scenarios, around 50-70% of hydrogen demand will be covered by imports as early as 2030. Projects of common interest are already an integral part of the hydrogen core network scenario. These are cross-border infrastructure projects that connect the energy systems of EU Member States (and non-EU countries, if applicable).

In principle, the core network is to be financed entirely by the private sector. For this reason, the German government, together with market players, has developed a financing concept that incentivises private-sector investment and enables the full financing of the hydrogen core network – as is the case with natural gas and electricity – through network charges. However, since there will be relatively few customers at the beginning, the investment costs cannot be fully passed on to the users – so the grid fees will be capped. An amortisation account ensures that the loss of revenue in the first phase is compensated for by additional revenue at a later date when more hydrogen consumers are connected to the grid. With the exception of the German Hy2Infra pipeline projects, no federal funds flow into the core grid lines – the

financing concept only contains financial protection for the German public sector against unforeseeable developments, backed by public money.

3.4 General information – Hy2Move

The kick-off meeting of Hy2Move took place on 9 October 2024. Therefore, it is too early to provide information on implementation beyond the general project description that was provided at the IPCEI Joint General Assembly in Paris on 17 December 2025.

3.5 Challenges regarding project implementation

Direct participants have reported a number of challenges in relation to the implementation of their projects and have provided a number of reasons why a majority of projects are delayed. Consequently, many projects are at risk of not reaching financial investment decision status.

In many cases, delays are not due to just one issue but are the result of a combination of issues. The following section summarises the input received from DPs; not all the DPs face the issues below and they do not necessarily face them all cumulatively. Also, some issues were solved in the meantime but caused delays, nevertheless.

- **Funding by public authorities**
    - General project delays due to long funding approval process, and delays in some Member States in giving funding approval; uncertainty regarding the availability of public funds[29]. However, some direct participants have started implementing projects at their own risk.
    - For Spain and Germany: granting decisions were confirmed on 10 July 2024 and 15 July 2024, respectively. As a result, delays are affecting the start of the Spanish and German projects. Extension of the implementation period of the projects has been requested.
    - Aid granted, when combined with increased costs and a lack of accessible renewable hydrogen, is insufficient to de-risk the project and render it bankable; projects are trying to find finance from other sources.
    - Funding has not been issued to all the direct participants with whom the company plans to collaborate.

- **Maturity of technology**
    - Electrolyser technology is less mature than expected.
    - Innovative technologies and processes; first of their kind.
    - Commissioning stage longer than expected; design issues with electrolysers.
    - Need to industrialise the balance of stack and balance of plant.
    - Low maturity of cell technologies (degradation, lifespan).
    - Market maturity in maritime sector; safety and reliability of all systems involved; on-board integration of fuel cells; material identification.

[29] Refer to *paragraph 76 pf the ECA audit report (Special report 11/2024: The EU's industrial policy on renewable hydrogen (europa.eu), The Commission's approval for the provision of state aid for the IPCEIs does not necessarily mean that public funding will eventually become available.*

- **Access to electricity – water supply**
    - Complex development of the required renewable Power Supply agreements with renewable Power developers; Difficulties in power sourcing (PPAs).
    - Delays in Electrical Grid access and connection.
    - Power supply congestion.
    - High cost of grid tariffs; Higher PPAs prices than anticipated; energy taxes.

- **Regulatory matters**
    - Lack of clarity of the legislation on renewable fuels of non-biological origin (RFNBOs) affecting notably e-fuel projects and clarification was provided only after the approval of the first two IPCEIs
    - Lack of regulatory certainty regarding RED III implementation rules by Member States; lack of clarity of the cross-border regulatory framework. Member States have also proceeded, in the interim, to implement their own targets and hydrogen definitions, which creates barriers in the single market.
    - Delays affect sourcing and negotiations with off-takers.
    - Certain projects are waiting for the Commission to recognise certification schemes for RFNBOs; lack of regulation on certification, CO_2 or e-fuels.

- **Permitting**
    - Challenges in the permit timing are causing delays in overall project implementation.
    - Takes more time than expected.

Regarding permitting, in 2024, DG GROW commissioned a study to identify and address the root causes of permitting delays. This study, entitled *Permitting of clean hydrogen projects in Europe - barriers & best practices*, provides a quantitative overview of the main barriers faced by hydrogen project promoters and gathers insights from regional authorities on best practices[30].

The conclusions of this study are similar to the feedback received from some direct participants: *'The permitting process for hydrogen projects is characterized with barriers that have a negative effect on timelines, increase costs, and complicate development. One of the identified challenges is the length and unpredictability of the process. ... This uncertainty makes project planning challenging and introduces significant risks for developers. Contributing to these delays are unclear or inconsistent communication from permitting authorities ... leaving developers without a clear understanding of how to proceed or plan effectively.'*

'Another major issue is the lack of standardisation in the permitting process for hydrogen projects. Hydrogen, as an emerging industry, lacks dedicated regulatory frameworks, forcing authorities to rely on outdated or mismatched regulations from other sectors. This reliance on unsuitable standards results in inefficiencies and places undue burdens on developers.'

[30] final report: https://ec.europa.eu/docsroom/documents/63554, available on ECH2A's website: European Clean Hydrogen Alliance - European Commission

- **Off-takers**
    - Most off-takers not willing to pay (high) premiums for renewable hydrogen and/or derived e-fuels.
    - The lack of commitment from off-takers in terms of memoranda of understanding, notably in the hard-to-abate sectors.
    - Uncertainty on the customer side due to cost increases and delays.
    - Challenge of signing off-take contracts for the full electrolyser capacity.
    - Lack of mature off-take market for e-fuels – no commitment on off-take at relevant prices.

- **Market situation**
    - Delayed hydrogen market; market not ready to take off, leading to postponement of investment decisions by customers.
    - Projects affected by more adverse price developments than anticipated on the input as well as the off-taker side; investments postponed.
    - Delays in the market transition, which is due to (lack of) availability of and infrastructure for green hydrogen.
    - Limited suppliers and long delivery times for essential/key components.

  Specific to the maritime sector:
    - Supply chain: a very limited number of partners or suppliers are available to implement projects in the maritime sector, which has specific requirements in terms of size of the systems needed. For some technologies, it has been necessary to seek partners outside Europe.
    - Variable pricing and innovativeness: in several instances, requests have been made for variable pricing or price increases due to the innovative nature of this initial application, affecting both recurring and non-recurring costs.

- **Investment costs**
    - Cost increases (both capital expenditure and operational expenditure) due to inflation compared to the submission; rise in the price of raw materials and equipment; rise in the price of green electricity and utilities.
    - Higher investment costs.
    - Capital-cost fluctuations due to price inflation (power, engineering, procurement, and construction (EPC) contracts, grid connection) further increases the funding gap.

- **Changes in timelines**
    - Changes are related to the delays mentioned above, with many projects reassessing their workplan.

A series of preliminary conclusions can be drawn from the analysis of the overview provided by this first report on the implementation of the four hydrogen IPCEIs.

This year's reports mention most of the same challenges as last year's reports, making it clear that the overall market conditions did not improve during 2024. Funding issues and a lack of off-takers are again indicated as the main reasons for delays. Some projects even report that, in

the absence of a business case, they are at risk of never reaching final investment decision status.

Direct participants mentioned that further incentives and additional funding support from the EU and national governments are strongly needed. There is a need for flexibility to adapt to the changing market situation.

Overall, the market needs to continue to mature. The fact that governments are beginning to work on setting up demand-side support schemes to ensure visibility on price and volumes for off-takers is very much welcome.

Electrolyser manufacturers indicate that there is no business case in building a giga factory when demand is still insufficient. This was confirmed at the last Electrolyser Summit, which took place on 19 November 2024, where manufacturers announced that they have a manufacturing capacity in Europe of almost 10 GW per year. However, much of this capacity is not utilised due to a lack of final investment decisions in downstream projects.

Regarding end-use sectors, the development of hydrogen applications in the mobility sector has been slower than anticipated. It is expected that with the implementation of Hy2Move, new demand will be created in heavy-duty applications in the maritime and aviation sectors.

4. KPIs and projects classification system

The JRC worked closely with DG GROW to develop a common set of specific hydrogen KPIs to measure the performance of the hydrogen IPCEIs during their implementation. These KPIs will provide data for policy objectives. The KPI will be applied in addition to the common reporting template developed in the context of the JEF-IPCEI, which will be used for the reporting of all approved and all future IPCEIs.

The JRC also developed a project classification system for the hydrogen IPCEIs. This section outlines the JRC's contribution to these activities. In the first part, it provides an overview of the KPI sheets that were developed. The second part describes the project classification methodology. Several graphs show the outcome of the classification work.

4.1 Development of KPIs

The first version of the KPI sheet was sent to the direct participants of Hy2Tech and Hy2Use as a follow-up to the General Assembly in Berlin in December 2023. Work continued during 2024 to develop a set of technical KPIs specific to each IPCEI, also including the two IPCEIs that were approved in the first half of the year (Hy2Infra and Hy2Move). The KPI sheets were shared with the facilitator groups for comments, and they were presented at the General Assembly in Paris for final endorsement.

These technical KPI tracking sheets were agreed upon by the DPs and the Member States representatives to form the basis of the information collection for the annual reports.

The KPI master file now recently integrated in the common reporting template of the JEF-IPCEI is a spreadsheet that includes the KPIs in 5 tabs, each covering a specific aspect of the hydrogen IPCEI projects. These 5 tabs are:

A. Manufacturing

B. Generation

L. Transport and Storage

M. Application Mobility and HRS

N. Industry

In addition to these tabs, the KPI master file also includes an initial tab, called 'Assistance', which provides guidance on how to complete compile the file and a tab comprising all the abbreviations appearing in the file.

To address the need for confidentiality of the projects, there is a colour-coding system to highlight confidential data, as explained in the 'Assistance' tab. Confidential data will only be used for reporting when anonymisation is feasible. Additionally, further discussions between with DG GROW and the Member States are necessary to develop a clear protocol for handling confidential data.

Completing the KPI master file

The KPI master file is designed to be straightforward and easy to use.

Detailed description of each tab

- **Tab A – Manufacturing** includes information about the project's manufacturing activities, referring to electrolysers, fuel cells, and other manufacturing activities.
- **Tab B – Generation** includes information about the project's hydrogen generation activities, referring to electrolyser stack installations and system operation.
- **Tab C – Transport and Storage** includes information about the project's transportation and storage activities, including shipping, road transport, pipelines, and hydrogen storage.
- **Tab D – Application Mobility and Hydrogen refuelling stations (HRS)** includes information about the project's mobility applications, including the sector (road, marine, aviation), fuel cell information (lifetime, power, stack, efficiency), and HRS information (pressure levels, capacity, energy source, number of operations, expected lifetime).
- **Tab E – Industry** includes information about the project's industrial applications, including product and process descriptions, yearly output capacity, and electricity consumed.

Additional environmental and energy-related information

In addition to the specific information requested in each tab, tabs A-E also ask for information on environmental and energy-related metrics, such as greenhouse gas emissions, hydrogen leaks, water use and water source, land use, and electricity use and source, where relevant to the project's activities.

Methodology

For certain data, it is left to the project participants to decide on the specific methodologies and units to use. This allows for flexibility and adaptability in the data collection process. However, project participants are requested to provide information on their chosen methodologies and units, which will help to understand their data and provide a more accurate assessment of their project's progress.

Final remarks

The KPI master file provides a comprehensive framework to track the progress of the hydrogen IPCEI projects.

This information will be used by the JRC to provide a technical assessment report for each hydrogen IPCEI to DG GROW. The information provided will be primarily used to monitor the implementation of the four IPCEIs. The confidentiality of the information will be ensured, meaning that information will be reported in an aggregated form; thus, it will not be attributable to individual projects or individual Member States.

4.2 Value-chain analysis and Projects Classification System

Challenge

The projects of the four IPCEIs in the hydrogen value chain have been assigned to technology fields (TFs) and workstreams (WSs). These are based on the main focus of the specific IPCEI, such as deploying infrastructure or developing and manufacturing hydrogen technologies.

While assigning a project to a TF or WS is useful within a particular hydrogen IPCEI, and provides information on the technologies and applications covered, the TF and WS definitions are not readily transferable across the four IPCEIs. The TF and WS definitions are not referring to an overarching keyword structure with consistent categories. Moreover, the current classification of projects is not unique: projects can belong to more than one WS/TF, but often the various objectives of a project are still not all captured. Therefore, the JRC has set up a new, complementary classification scheme, based on a defined set of categories. Some of the categories have sub-tiers, for example technology (see Figure 3).

Methodology

Each project is divided into main work packages (MWP). The work packages and different tasks described in project proposals are considered MWPs when they represent a significant share of the overall project budget. These MWPs are then manually ranked in terms of priority according to the overall project's ambition.

For the correspondence between the TFs and WSs and the JRC classification, see Table 2.

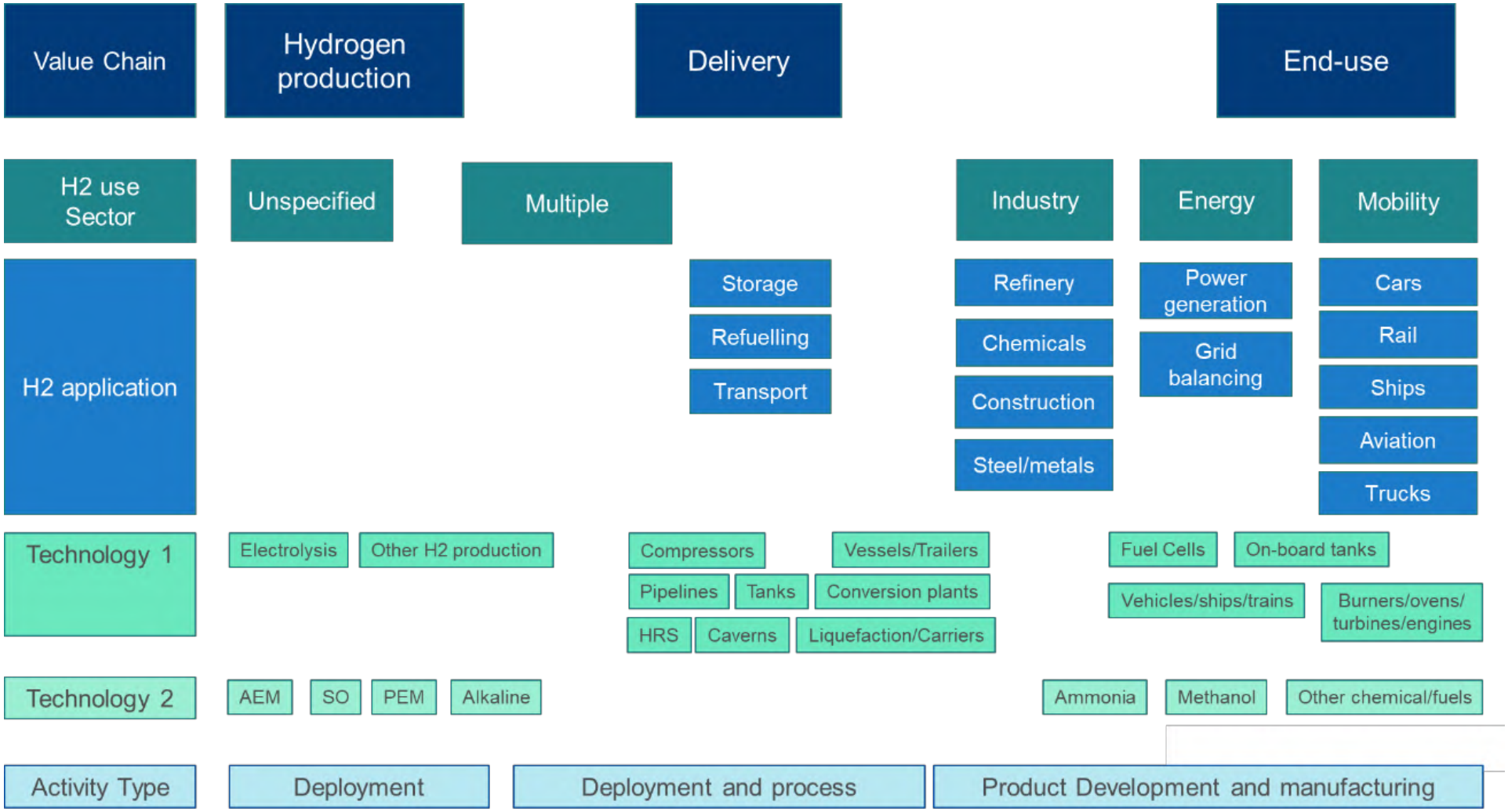


Figure 3: JRC classification scheme for hydrogen IPCEI projects.

Each MWP was assigned a value for each of five categories:

1. hydrogen value chain;
2. hydrogen end-use sector;
3. hydrogen application;
4. hydrogen technology; and
5. activity type.

The 'hydrogen value chain' category refers to the location of each MWP in the hydrogen value chain. It can be either 'production' (hydrogen production only), 'end use' (anything that uses or transforms hydrogen), or 'delivery' (getting hydrogen to the point of use, or storage).

The 'hydrogen end-use sector' category refers to the economic areas that will be consuming the hydrogen or deploying the technology developed within each MWP. This can be 'industry' end uses, 'mobility' end uses (light, heavy, general), 'energy' end uses (heat, power generation, grid balancing), 'multiple' (more than one sector), or 'unspecified' if the project proposal does not contain information about the final consumer.

By way of example, projects developing and manufacturing a product for which the end use is not yet determined, such as an electrolyser, are labelled 'unspecified'. 'Multiple' is given to all deployment projects that have more than one end user, for example if the hydrogen is being injected into a pipeline.

The 'hydrogen application' category provides specific information about the final system or industrial processes to which the MWP is related.

The 'activity type' category provides information on the focus of the activity undertaken within each MWP.

- 'deployment' (Infrastructure type projects). Examples of deployment projects are those building pipelines and electrolyser capacity.
- 'product development and manufacturing'. Many projects, mainly those in the IPCEI Hy2Tech, are developing and manufacturing a product. For such projects, the level of the research object can be: 'stack', 'balance of plant', 'component' or 'system'.
- 'deployment and process development'. Some projects, especially in the IPCEI Hy2Use, also have a process development aspect, such as an electrolyser for producing ammonia for which the industrial process needs to be adapted.

For the keywords related to sector and technology categories, a hierarchical structure was created in order to have a consistent classification of keywords across all projects.

The key objectives of projects – such as deployment of electrolyser and manufacturing capacity – have been tracked as well.

This classification enables a schematic representation of the objectives of all four hydrogen IPCEIs. This classification scheme will also be used for project monitoring.

Table 2: Correspondence between IPCEI classification (into TFs and WSs) and JRC classification.

Hy2Tech	Hy2Infra	Hy2Use	Hy2Move	JRC value chain	JRC sectors	JRC technology 1
TF 1 – Development of hydrogen generation technologies	WS 1 – Installation of hydrogen generation capacity as hydrogen infrastructure	TF 1 – Development of hydrogen generation and transport infrastructure	WS 4 – Hydrogen production technology for mobility applications	*Hydrogen production*	*Unspecified, multiple, industry, energy, mobility*	*Electrolysis*
TF 2 – Development of fuel cell hydrogen technologies			WS 2 – Fuel cell technology for mobility applications	*End use*	*Mobility*	*Fuel cells*
TF 3 – Development of technologies for storage, transportation and distribution of hydrogen	WS 2 – Hydrogen transport and distribution via pipelines / technical grid infrastructure WS 3 – Large-scale hydrogen storage WS 4 – Handling of liquid or embedded hydrogen / port infrastructure	TF 1 – Development of hydrogen generation and transport infrastructure	WS 3 – On-board storage solutions for mobility applications	*Delivery*	*Unspecified*	*On-board tanks, pipelines, stationary tanks, caverns, carriers, compressors ….*
TF 4 – Development of hydrogen technologies for end users		TF 2 – Development of hydrogen technologies for industry applications	WS 1 – Hydrogen mobility applications	*End use*	*Mobility, Industry*	*Burners, ovens, turbines, fuel cells, vehicles*

4.3 Project classification and results

The projects were reviewed and labelled based on the latest project proposal available at the time of the classification work (November 2024). As described above, projects were broken down into MWPs and each MWP was assigned a value for each of five categories.

Figure 4 provides an overview of the four hydrogen IPCEIs, counting the number of main workstreams from Member States to end-use sectors and technologies.

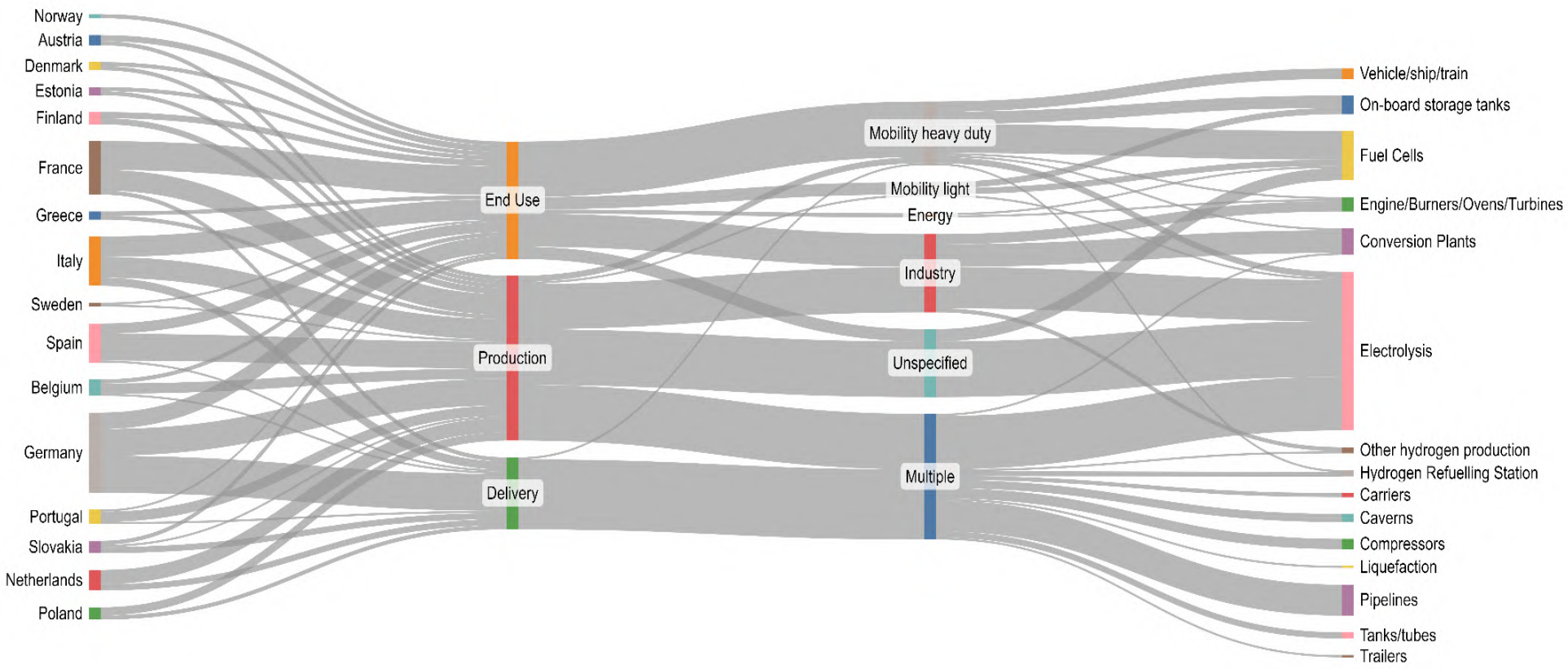


Figure 4: Sankey diagram – General overview of the four hydrogen IPCEIs.

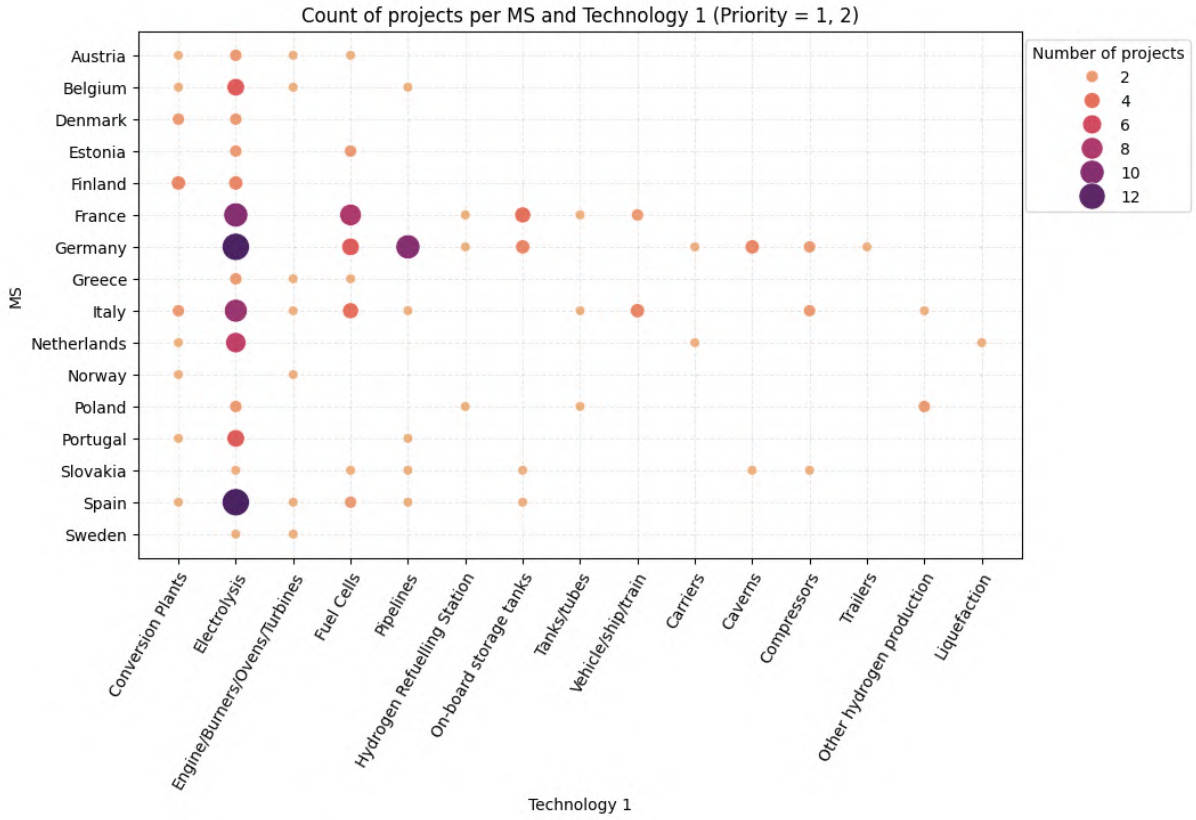


Figure 5: Technology by Member State.

Figure 5 provides the same grid information for Member States and end-use sectors.

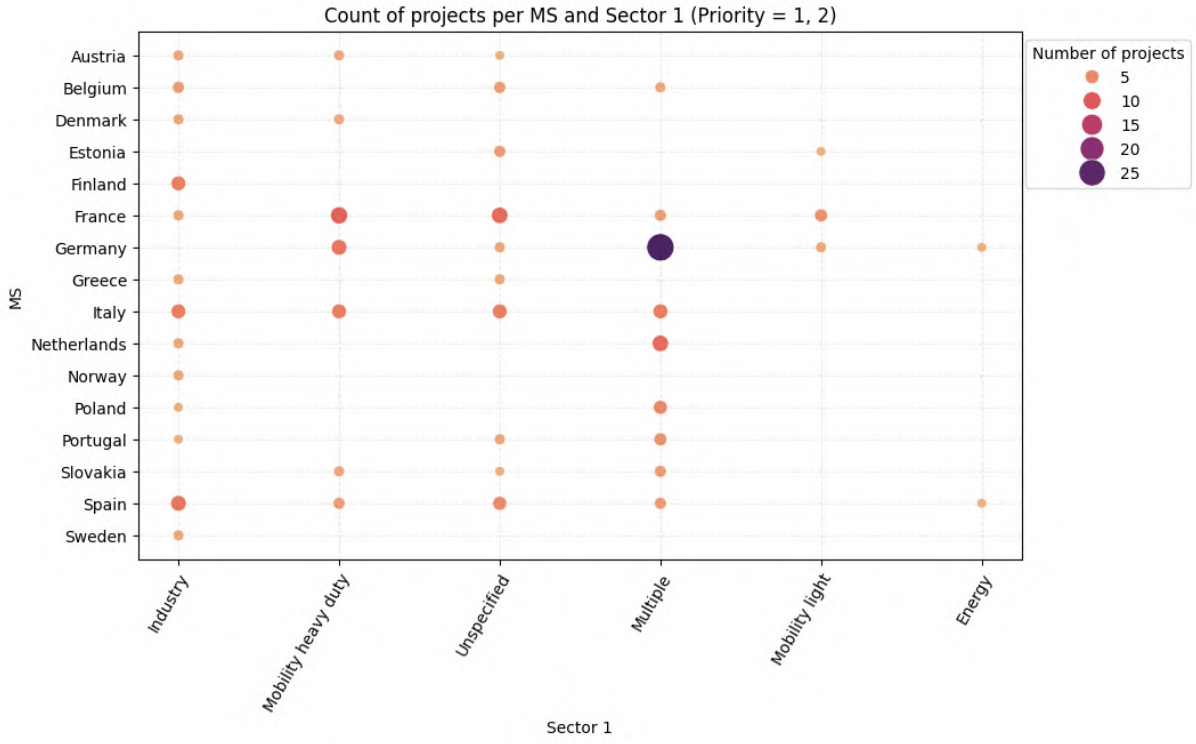


Figure 6: End sector by Member State.

Figure shows the distribution of each project's focus by technology.

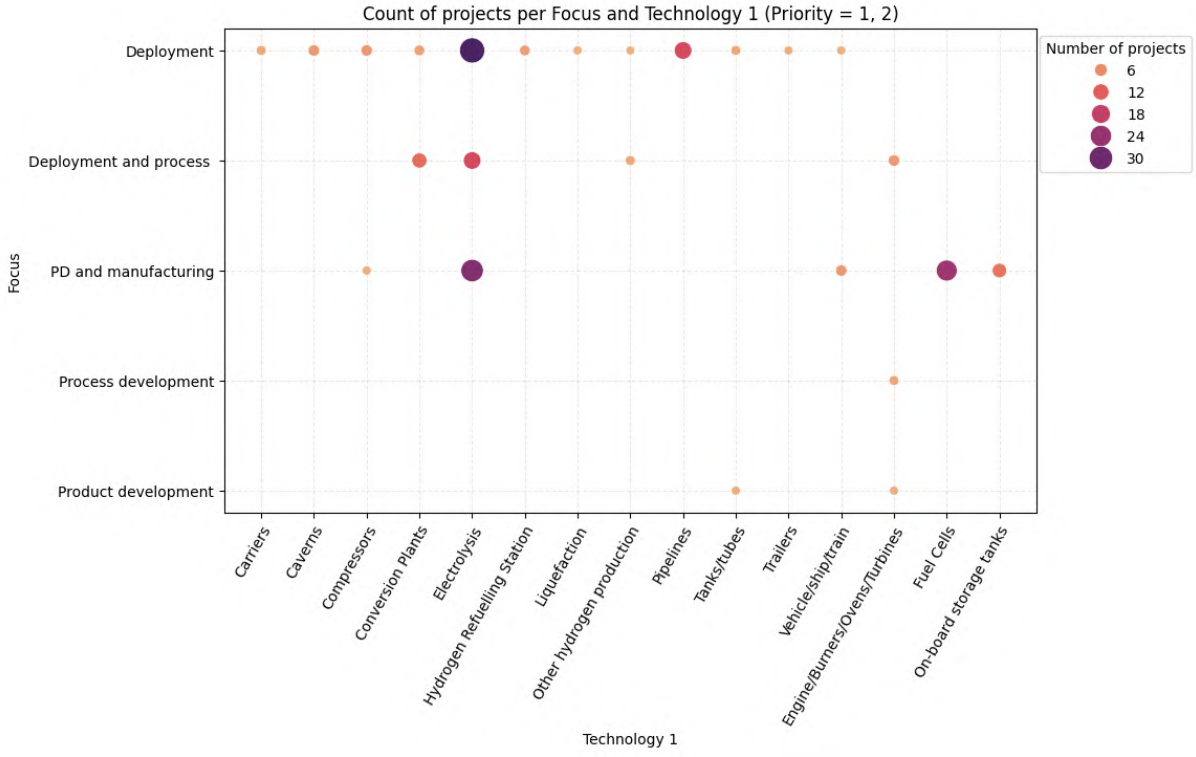


Figure 7: Technology by focus.

The Figures 5 to 7 demonstrate the added value of classifying projects by linking end sectors and technologies to projects developed in each Member State. This type of classification could help identify potential future collaborations, such as new cross-IPCEIs collaborations, and it will facilitate future technical assessment of projects falling under each category.

4.4 Next Steps

Regarding the monitoring of the implementation of the four IPCEIs, to enable more standardised reporting, the reports submitted by the facilitating groups and the executive report from Hy2Use could help to develop a template suitable for all four hydrogen IPCEIs.

The reporting is now based on an agreed list of common KPIs for all hydrogen IPCEIs. Upon request of the participating Member States, the reporting will be extended to cover associated partners.

On spillover effects, the current reporting process is not optimal since DPs report on a limited number of KPIs that are not necessarily the most meaningful from a policy point of view. To address the issue, DG JRC will work to define more specific "spillover KPIs" that could better measure the impact of the four Hydrogen IPCEIs.

It is important to mention that the monitoring scheme developed by JRC will have now to be aligned with the reporting work done at the JEF-IPCEI, in particular regarding the dashboard.

The common reporting template developed in the context of the JEF-IPCEI will actually integrate the list of metrics defined for the dashboard with the hydrogen specific KPIs developed by JRC. The final goal will be to have only one reporting template that will be distributed to the DPs.

5. The European Clean Hydrogen Alliance and its project pipeline

The European Clean Hydrogen Alliance (ECH2A) supports the large-scale deployment of clean hydrogen technologies by bringing together production, transport and storage of renewable and low-carbon hydrogen, and demand for it in industry, mobility, and other sectors.

ECH2A was created in July 2020 as one of the actions of the EU's hydrogen strategy. One of the main objectives of the Alliance Declaration was to build a pipeline of viable investment projects and an investment agenda until 2030.

5.1 State of play of the project pipeline

The project pipeline was first published in November 2021 and included 840 projects. Revised in February 2024, the pipeline now includes just over 420 projects.

As part of the revision of the pipeline, project promoters provided information against a set of KPIs and questions that were developed based on the lessons learnt from the first version of the pipeline.

Since ECH2A's creation, these projects have been presented to investors through matchmaking events, calls for projects (with the European Bank for Reconstruction and Development and the European Investment Bank) and two pitch events organised together with EIT InnoEnergy's European Green Hydrogen Acceleration Center. Nonetheless, the pace of deployment remains slow, similar to that of the IPCEIs on hydrogen.

In the following section, we will review the data on projects in the pipeline, as provided by the project promoters in the most recent survey, conducted in February 2024.

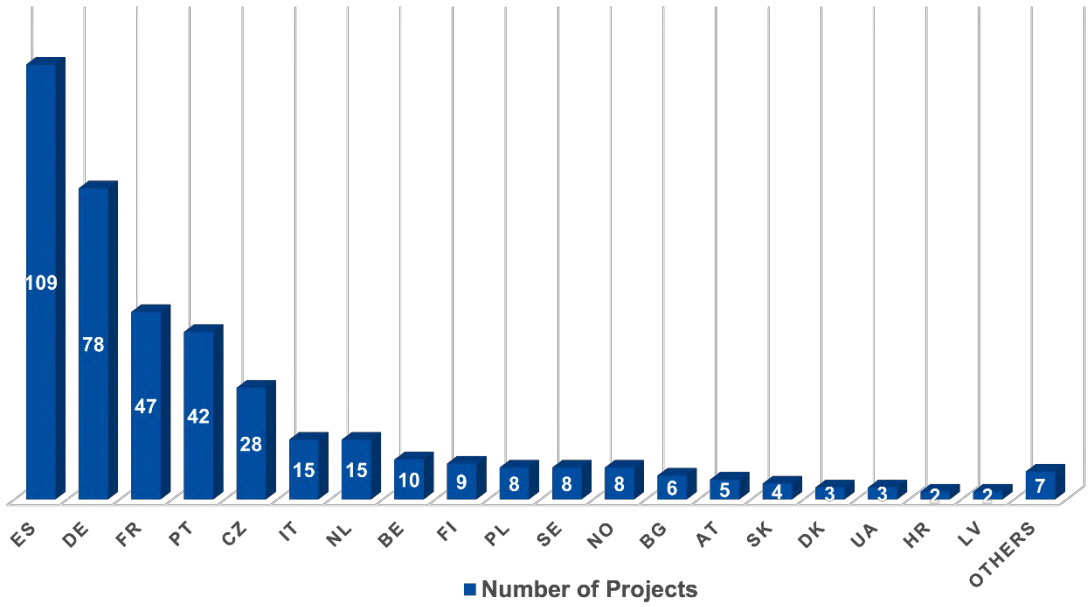


Figure 8: ECH2A project distribution by country.

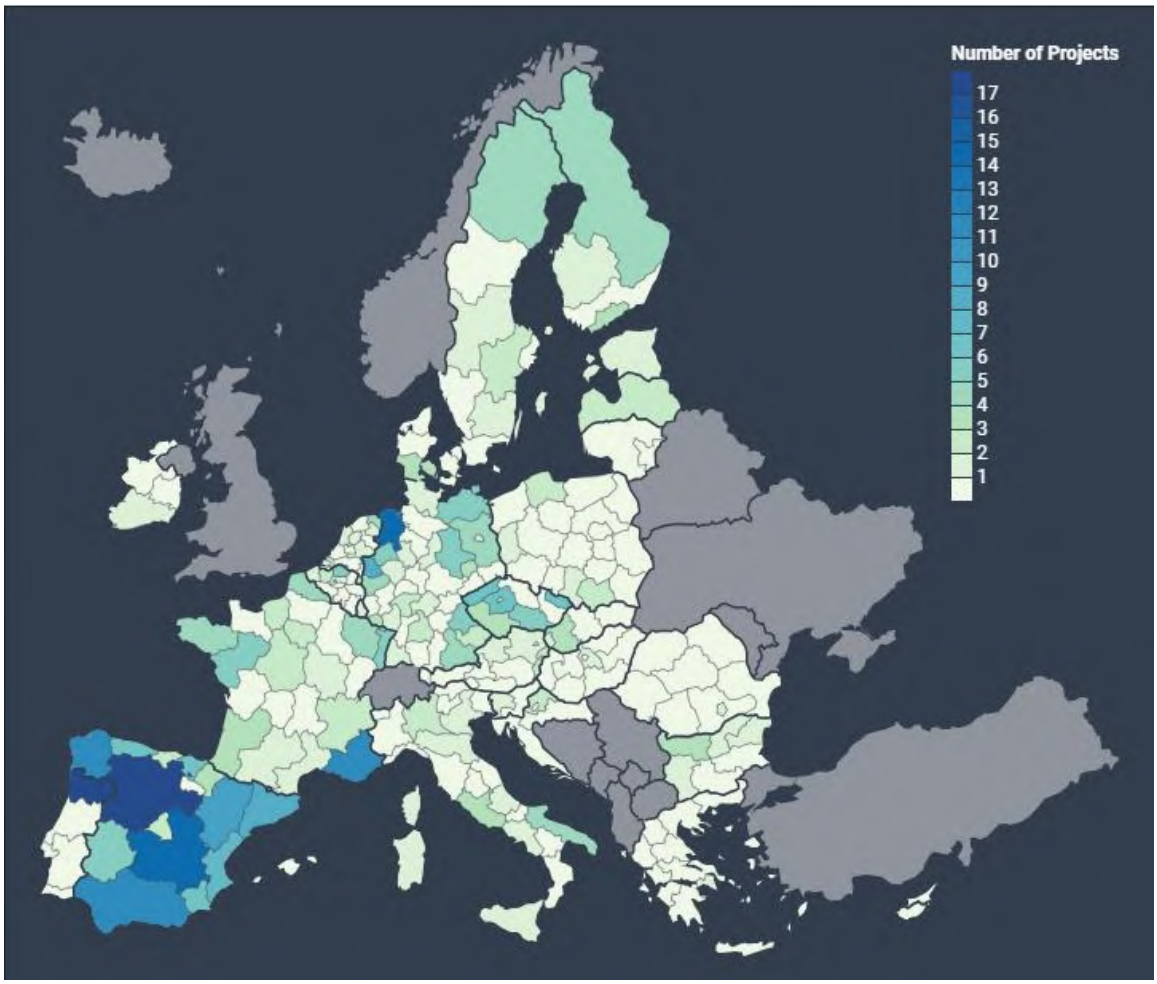


Figure 9: Map of ECH2A project distribution by region.

Figures 8 and 9 illustrate the distribution of projects across European countries, highlighting significant regional variations. The Iberian Peninsula – as a region rich in relatively cheap renewable energy – emerges as the most prominent location, with Spain accounting for 109 projects, and Portugal for 41. This is followed by Germany (78) and France (48). These four nations alone represent a substantial portion of the projects submitted, suggesting concentrated project implementation in western Europe. While there are exceptions, such as Czechia (28), most other nations are minimally represented.

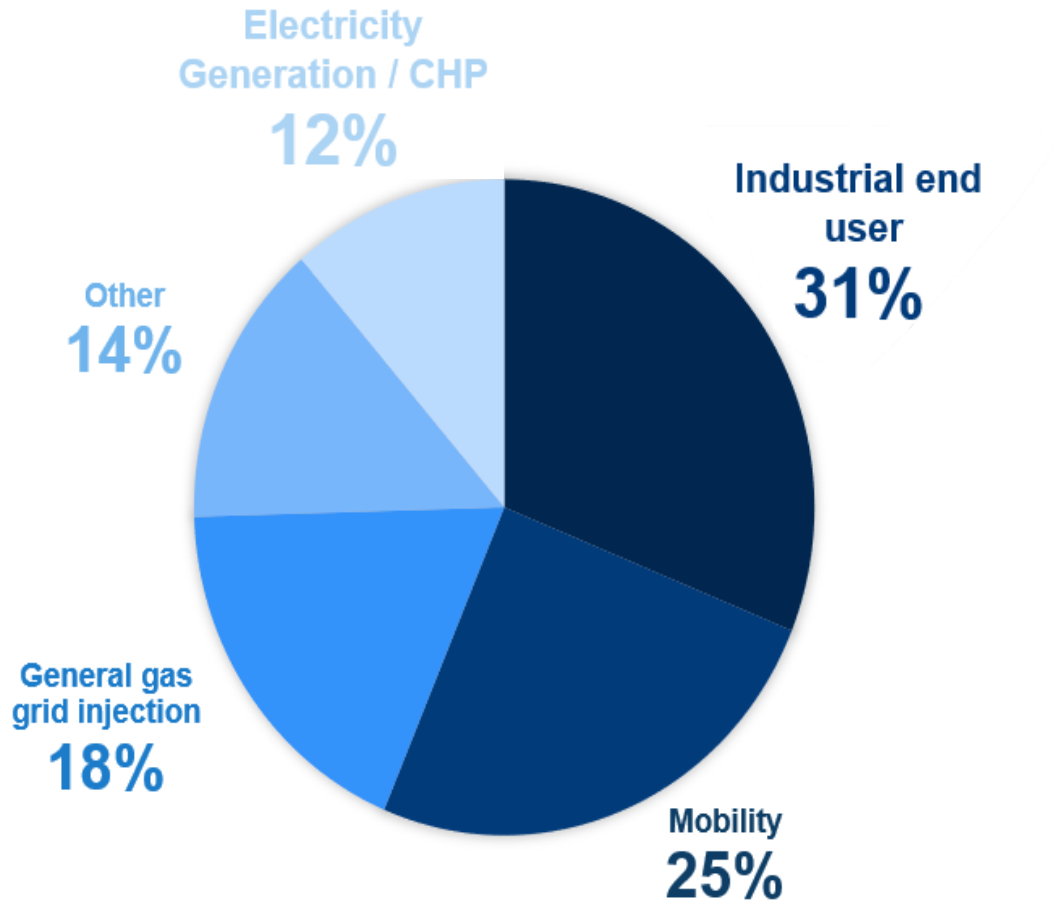


Figure 10: Off-take type / end user.

Figure 10 categorises the hydrogen projects by the sector(s) in which they are applied, with multiple answers possible per project. Industrial end use – in sectors such as chemicals, steel, and refining – accounts for 236 projects, while mobility accounts for another 191 projects. Together, these two categories account for most projects. General gas grid injection accounts for 138 projects, highlighting efforts to integrate hydrogen into existing energy infrastructure to reduce carbon intensity. Electricity generation, including combined heat and power (CHP), features in 86 projects. The 'Other' category, with 107 projects, contains various emerging applications.

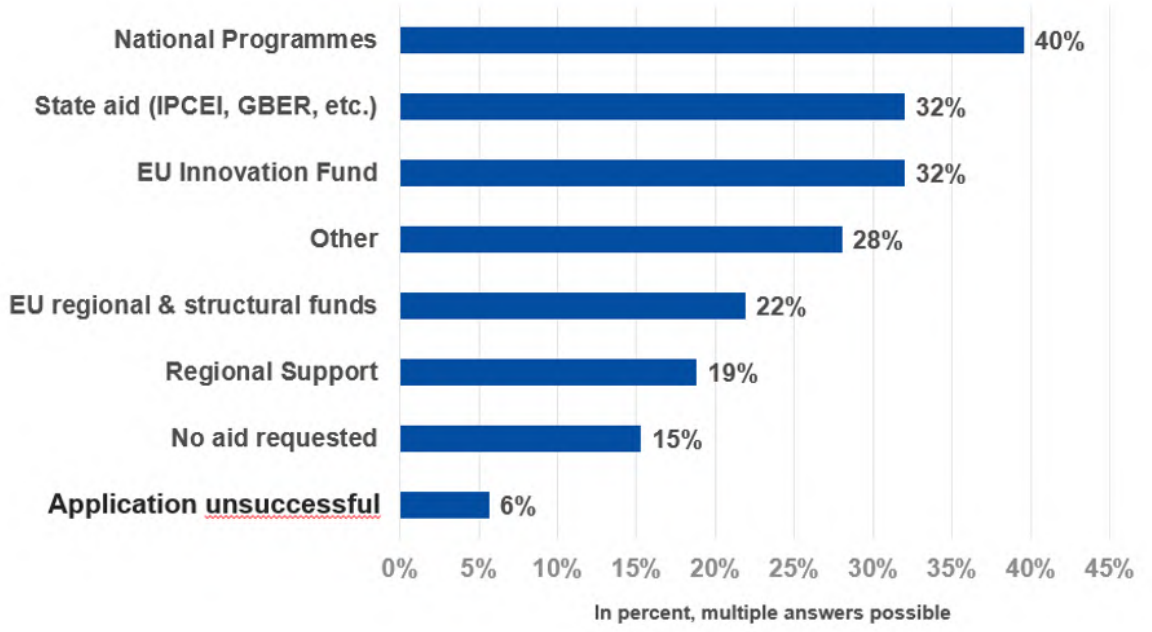


Figure 11: Type of public funding.

Figure 11 shows the distribution of funding instruments. A significant portion of the project pipeline relies on State aid support (32%), with national funding sources playing a crucial role – 40% of projects have successfully accessed other national programmes. Moreover, only 15% of projects have not applied for any public funding, highlighting the important role that both Member States and the EU play in project financing. Additionally, only 6% of projects reported being unsuccessful in one or more funding applications.

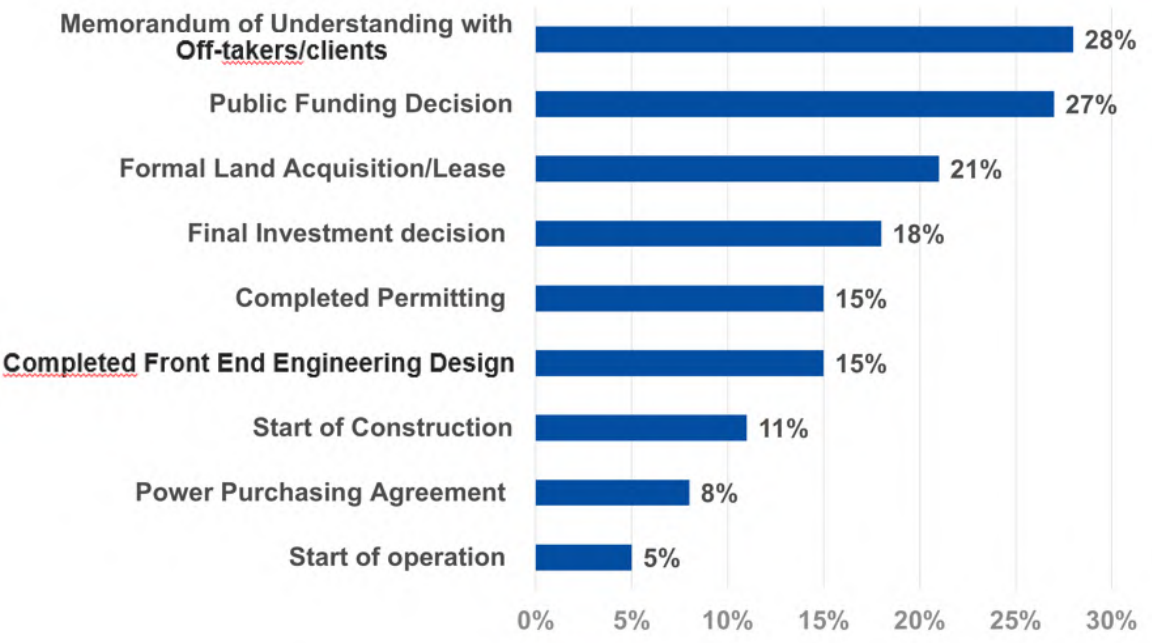


Figure 12: Milestones reached as of 15 December 2024.

Figure 12 shows the progress of the projects using key development milestones, with percentages indicating the proportion of projects having reached each stage. Early-stage activities, such as memoranda of understanding with off-takers or clients (28%) and public funding decisions (27%) are the most prevalent, emphasising the importance of foundational agreements and financial support. Mid-stage milestones include formal land acquisition or leasing (21%) and final investment decisions (18%) – The drop-off in later stages, however, such as permitting (15%), construction (11%) and actual operations (5%), highlights the challenges in entering into operation.

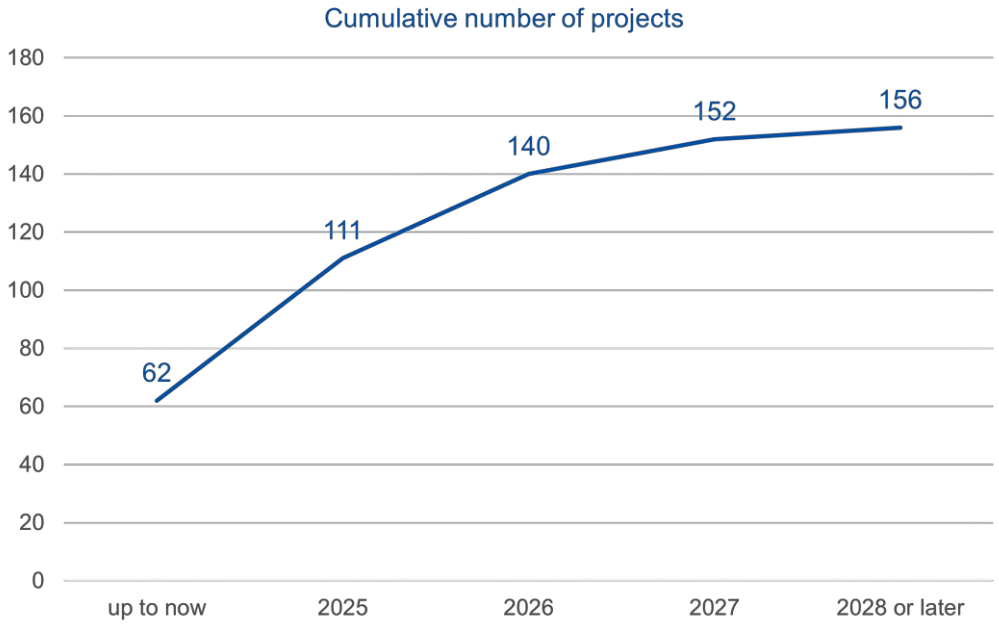


Figure 13: Date of expected completion of front-end engineering design (36% of projects reported).

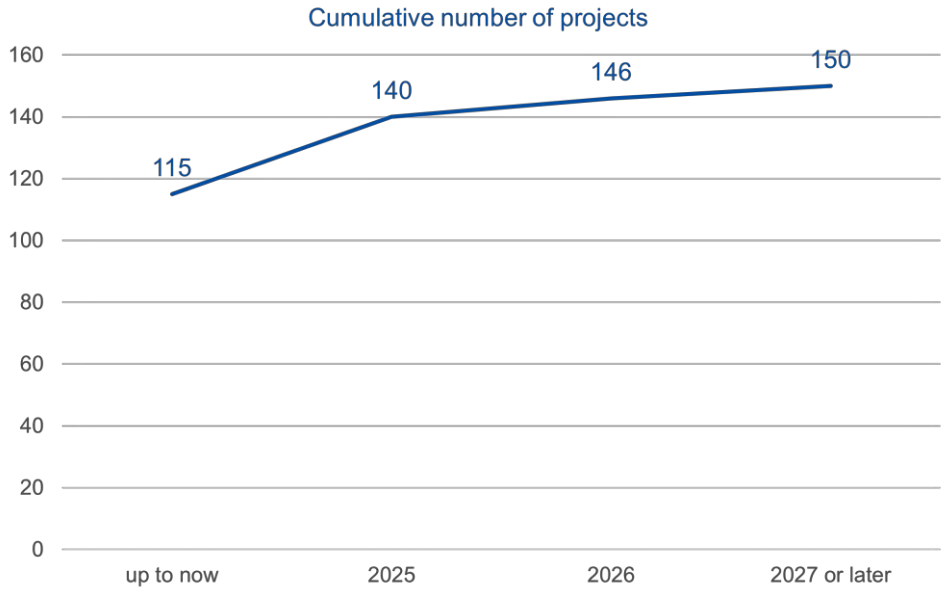


Figure 14: Date of expected public funding decision (35% of projects reported).

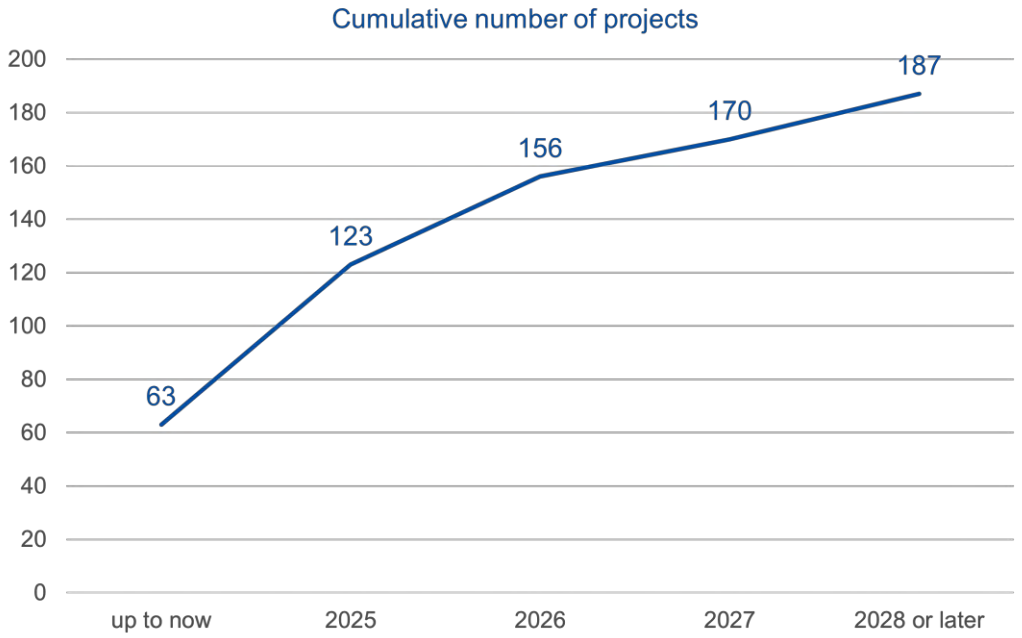


Figure 15: Date of expected completion of permitting (44% of projects reported).

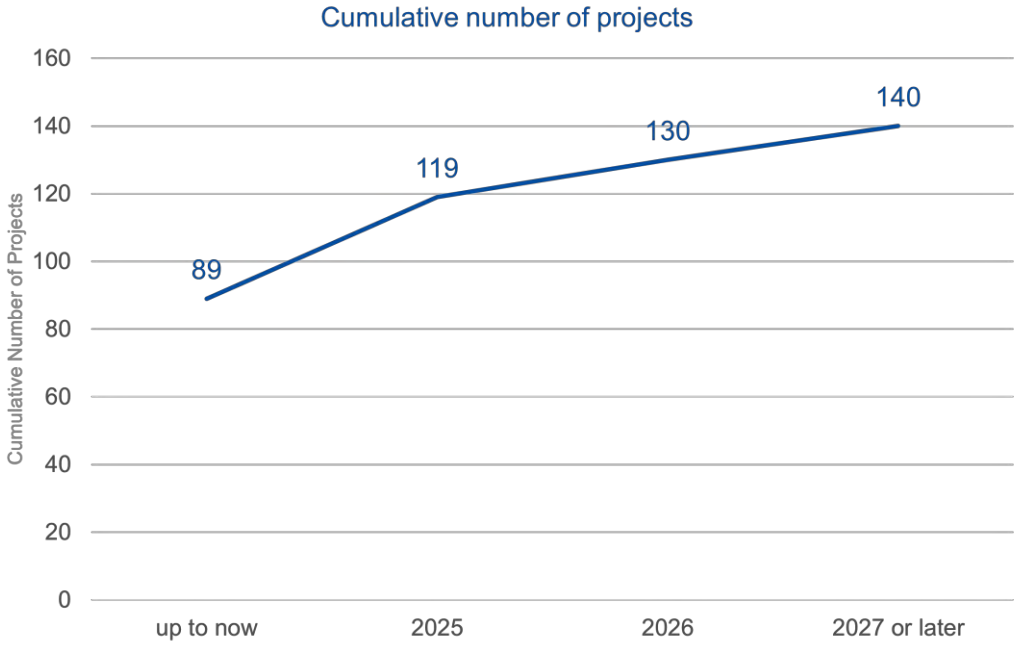


Figure 16: Date of expected formal land acquisition/lease (33% of projects reported).

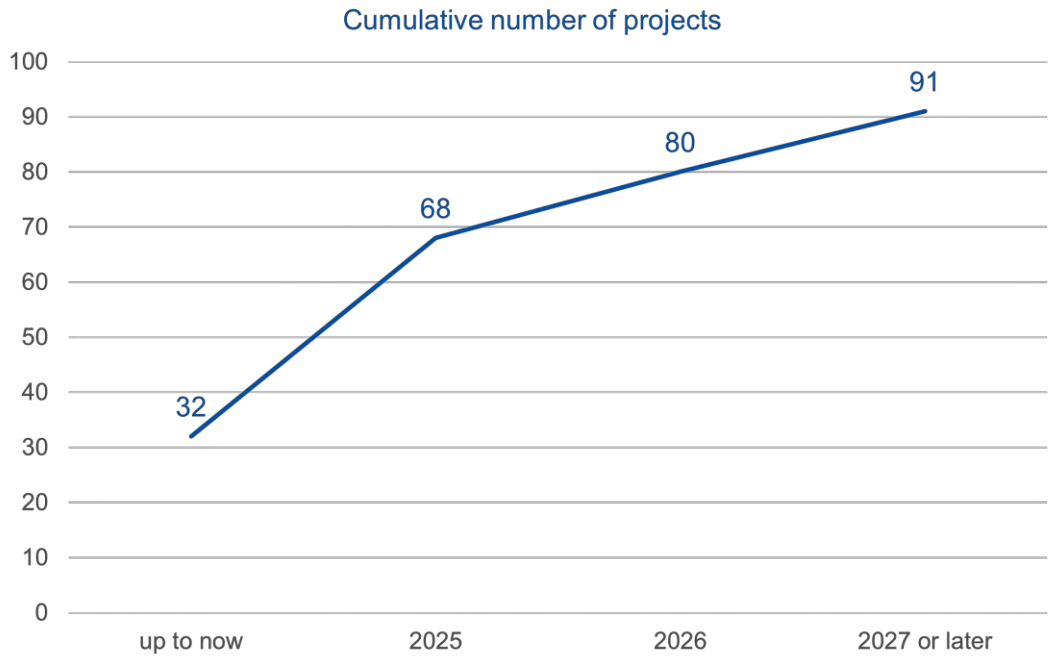


Figure 17: Date of expected power purchase agreement (21% of projects reported).

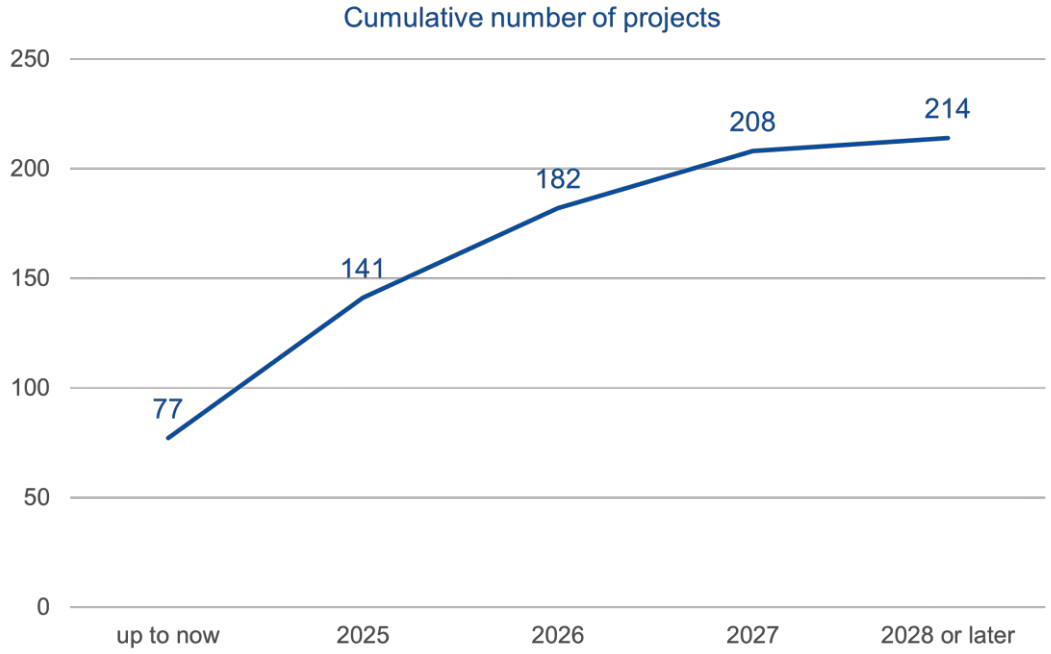


Figure 18: Date of expected final investment decision (50% of projects reported).

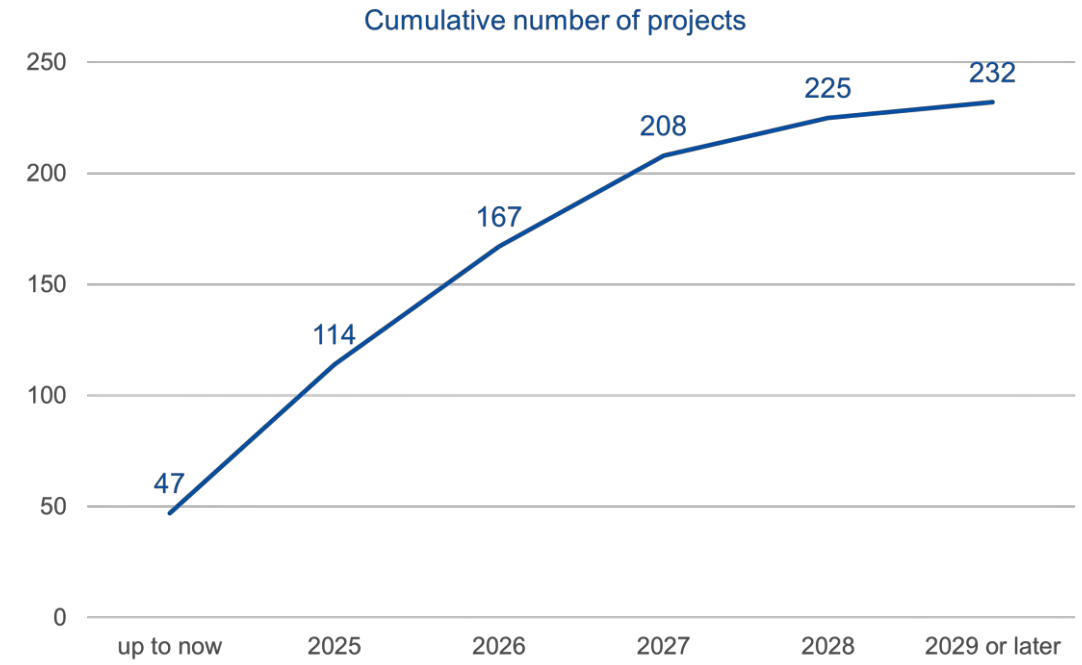


Figure 19: Date of expected start of construction (54% of projects reported).

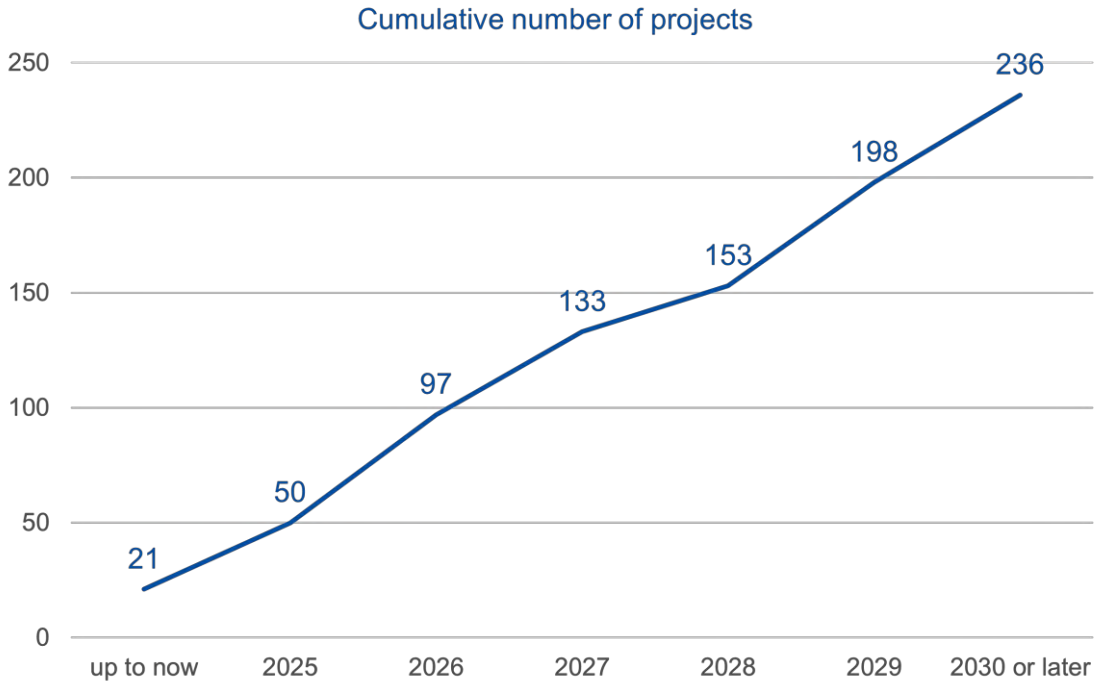


Figure 20: Date of expected start of operation (55% of projects reported).

Figures 13 to 20 show when the projects in the ECH2A pipeline are expected to reach certain milestones. It is worth mentioning that, of the projects that have reported data presented in this section, the overwhelming majority expect to start to operate before 2030, indicating a positive outlook. However, since 45% have not reported a date, significant insecurity remains.

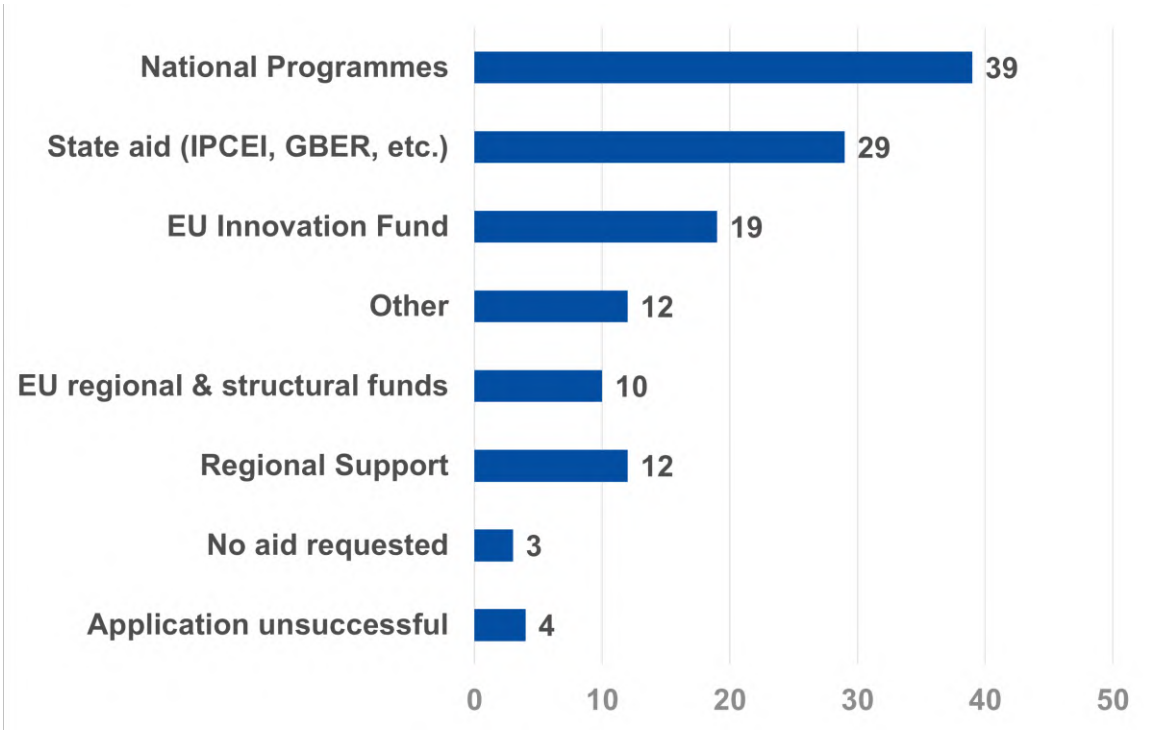


Figure 21: Projects that had reached final investment decision status as of 15 December 2024, by type of public funding.

Figure 21 shows that national governments and their funding schemes played a very significant role in the financing of projects that had reached final investment decision status by the end of 2024. It also shows that almost no projects advanced without any public financing, which underlines the significance of public support for the development of the still nascent hydrogen sector.

Of all projects on which a final investment decision has been taken so far, 41 are electrolyser projects. The combined electrolyser capacity of these projects is 1 572 MW. It needs to be noted that these data are an approximation, and we do not have data on the project type for all projects.

5.2 Barriers to deployment

Project promoters mention barriers hindering the implementation of their projects that are similar to those of the IPCEI projects.

5.3 Next steps

The results of the analysis of the implementation of the project pipeline show the limitations of this review. It is based on the results of surveys, leading to potentially biased results since not all promoters provided information on the progress of their projects. There is no defined set of KPIs and this review relies on the goodwill of project promoters to provide information, since there are no mandatory reporting requirements as is the case for IPCEI projects.

As reported by the JRC in Chapter 5, there are many data gaps. Furthermore, there is a need to go beyond ECH2A's objective to build a pipeline of viable investment projects by actively monitoring the implementation of projects.

To do this, it will be necessary to launch an annual survey or to develop a specific reporting template for the project pipeline.

A proposal will be on the agenda of the forthcoming European Hydrogen Forum, which takes place at the beginning of March 2025.

This work is vital to creating a mandate for ECH2A, which was necessitated by the recommendations from the Court of Auditors in its report *The EU's industrial policy on renewable hydrogen – Legal framework has been mostly adopted – time for a reality check*. The Court of Auditors said that the Commission must 'decide on the future of the Clean Hydrogen Alliance in terms of its scope and number of roundtables and adopt a clear and time-bound mandate for its future work'. The target implementation date for this mandate is mid-2025.

To orient ECH2A's future work, the Commission has already sought the feedback of ECH2A's members, initiating a reflection on the future of the industrial alliances.

6. The Energy and Industry Geography Lab

The Energy and Industry Geography Lab (EIGL) is a tool developed by the Joint Research Centre (JRC) of the Commission, in collaboration with DG GROW.

EIGL is a mapping tool for geographical data related to energy, industry and infrastructure. The tool makes it possible to find and filter energy-related data and create and share maps displaying this data. The mapping tool includes more than 120 data layers and covers Europe, with a focus on the EU's 27 Member States.

It shows where to find clean energy, if the necessary infrastructure is in place, or whether there is land available for the installation of renewable energies. In addition, it maps the location of energy-intensive industrial plants. It also includes socio-economic information and features forward-looking capabilities, as it includes geospatial data from scenario work by the Commission and third parties. EIGL supports spatial assessments that aid Europe's transition to climate neutrality, and it is publicly available here: https://ec.europa.eu/jrc/en/energy-industry-geography-lab.

6.1 Mapping of ECH2A and IPCEI projects

EIGL now also includes information about hydrogen projects in Europe. This includes data on IPCEI and ECH2A projects but also hydrogen projects funded under the Innovation Fund and hydrogen projects from the PCI/PMI list. The information collected includes publicly available data and data directly shared with the Commission. The hydrogen projects are grouped according to asset category:

- hydrogen production (see Figure 22);
- hydrogen transport;
- hydrogen storage;
- manufacturing of components and cells; and
- mobility applications for hydrogen.

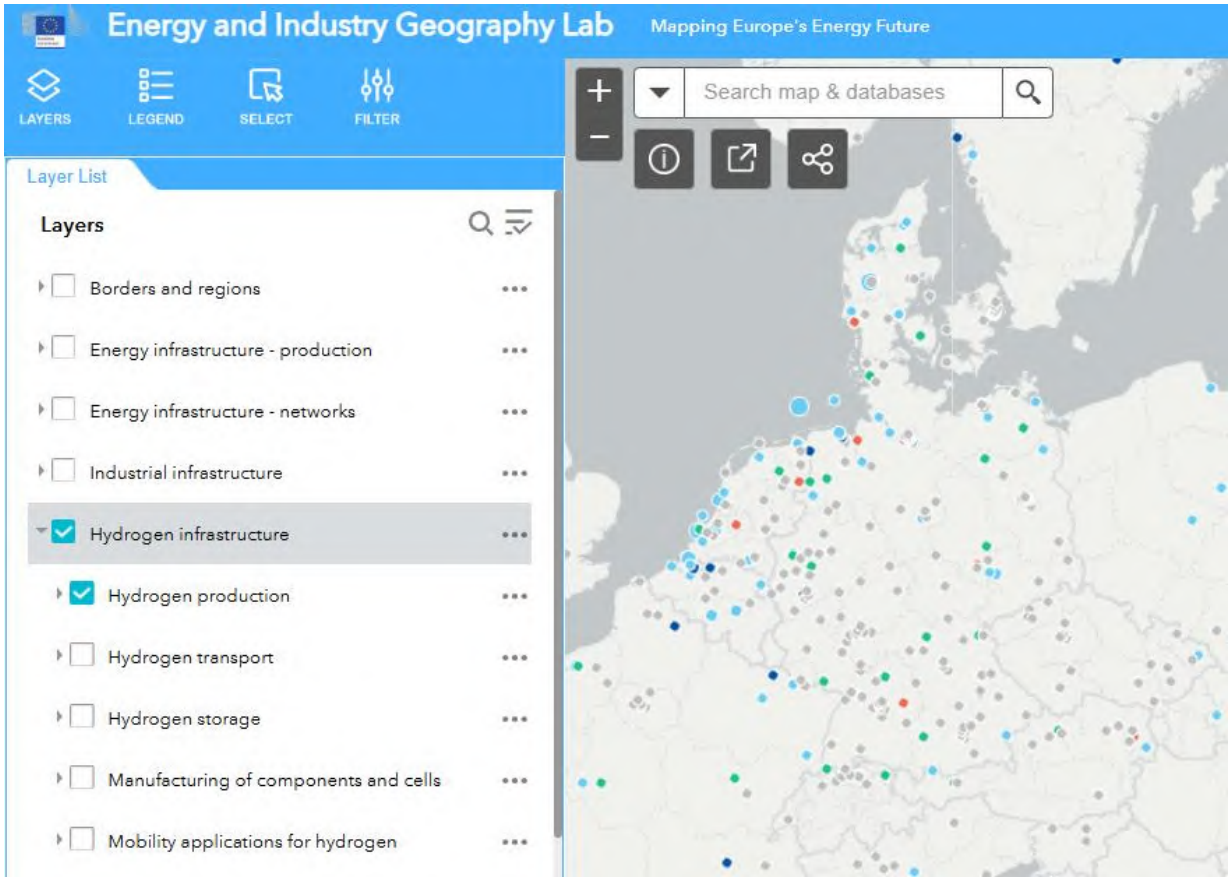


Figure 22: Screenshot of the specific hydrogen layer – hydrogen production.

Also, a specific layer group makes it possible to display only projects related to different programmes or funding schemes (e.g. ECH2A projects, IPCEI projects).

However, for some parameters, data gaps exist. This concerns information about the current status of projects, the estimated start date, the location[31], and the type of project. Also, some simplifications had to be made for consistency and to build a consistent dataset (classification of project status is relatively coarse).

Figures 23 and 24 show the ECH2A and IPCEI projects, respectively.

[31] For some projects, the centre of the NUTS region was used as a proxy.

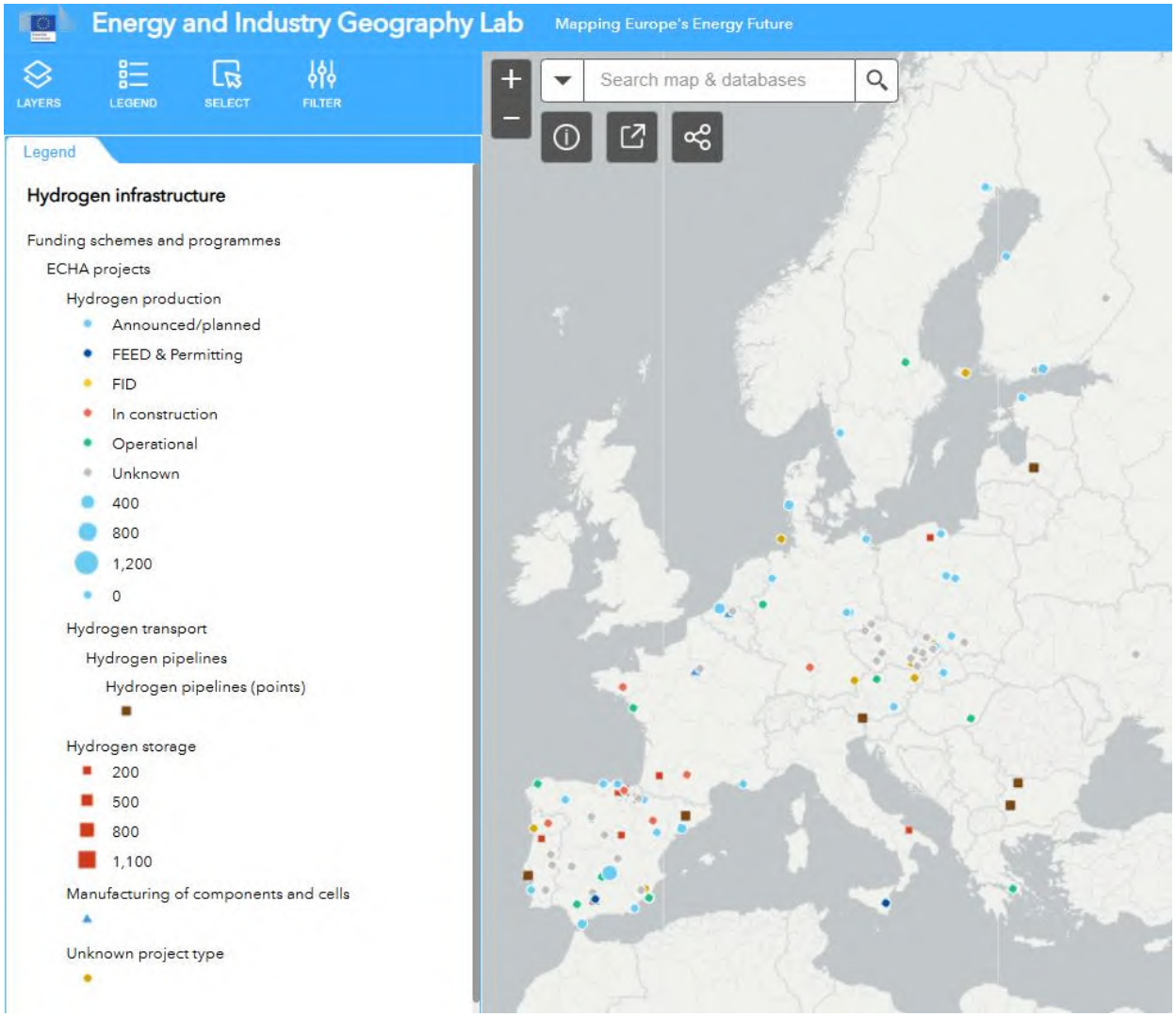


Figure 23: Screenshot of the specific hydrogen layer – ECH2A projects.

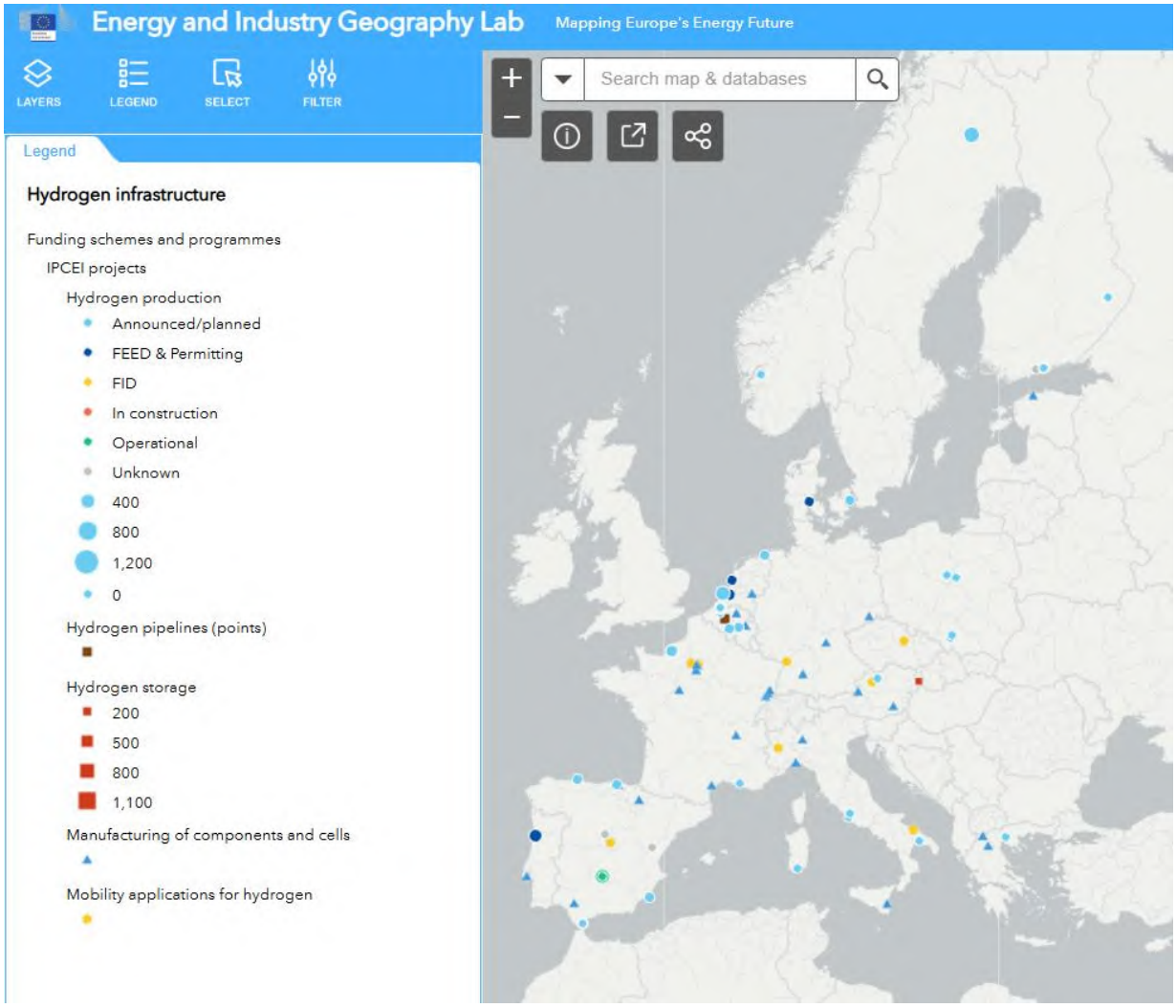


Figure 24: Screenshot of the specific hydrogen layer – IPCEI projects (not yet including Hy2Infra or Hy2Move projects).

EIGL also offers additional data related to future hydrogen infrastructure, for example the maps of the European Hydrogen Backbone initiative[32]. In addition, the tool offers data on industrial installations and their greenhouse gas emissions (e.g. ETS installations). By combining EIGL datasets, the tool can answer policy questions but could also be instrumental in planning the infrastructure of the future, for example in determining what would be the best location to build electrolysers and where there is a need for hydrogen transport infrastructure.

[32] https://ehb.eu/.

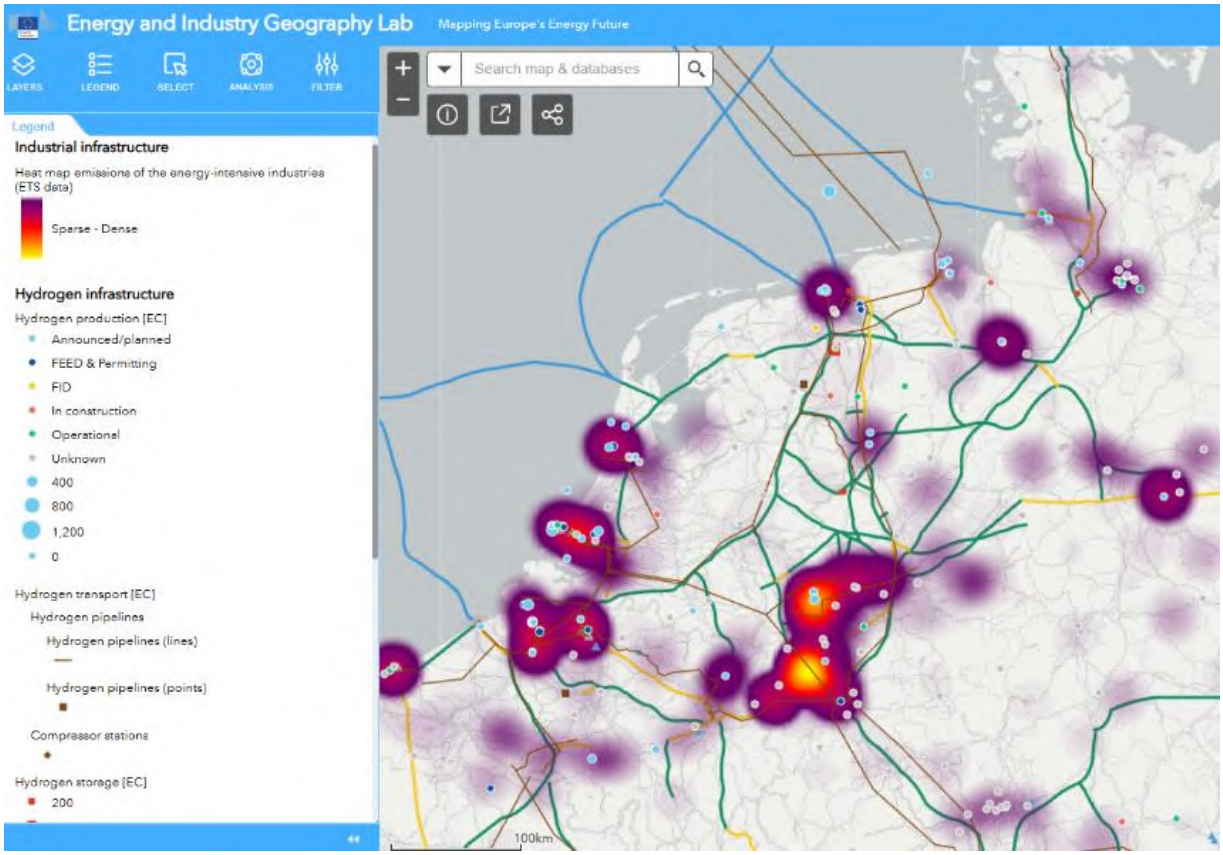


Figure 25. Example of visualisation: European hydrogen backbone map, current hydrogen projects, and heat map of industrial greenhouse gas emissions.

6.2 Next steps

The mapping of hydrogen projects was performed as part of the clean transition dialogue on hydrogen. Hopefully, the hydrogen sector can benefit from this mapping and the data have significant added value for the potential future planning of hydrogen infrastructure and hydrogen facilities.

EIGL will keep the layers with hydrogen projects up to date, in particular by monitoring the status of project development (hence the importance of monitoring schemes). It aims to become the most up-to-date and comprehensive EU platform on large-scale hydrogen deployment projects.

EIGL will be key in assessing the state of play of the hydrogen sector in the EU, and industrial stakeholders are invited to submit data and suggestions. The team can be reached at JRC-EIGL@ec.europa.eu.

7. Conclusion

This report constitutes the first attempt to assess whether the deployment to date of both IPCEIs and the ECH2A project pipeline is encouraging the development of a European market for clean hydrogen.

We have seen that even though project implementation faced many challenges in 2024, some positive signs emerged with an acceleration of final investment decisions taken, in particular in the recently adopted IPCEIs Hy2Infra and, to a lesser extent, Hy2Use.

In addition, the work done within the Joint European Forum for IPCEI and the collaboration with the JRC on both the KPIs and the mapping of hydrogen projects provide a very good basis for future monitoring and more in-depth technical assessment of IPCEI projects.

However, it is clear that in order to do this, it will be crucial for all Member States participating in the hydrogen IPCEI to comply with their reporting obligations and submit complete monitoring reports to the Commission on an annual basis.

The analysis in Chapter 3 of the challenges and bottlenecks faced by projects has allowed us to identify whether national or EU policy responses are needed. The issues related to the EU regulatory framework would have to be addressed at EU level. Several issues should be tackled by national authorities (funding support, permitting issues, access to electricity….) and by industry (lack of off-takers; immaturity of technology, investment costs, …..), some of which with pro-active assistance from the Commission.

Important to mention is that with the adoption of the Clean Industrial Deal on 26 February 2025[33] The Commission will also work closely with the Member States to speed-up the design of new IPCEIs, and important for the hydrogen sector, to strengthen the efficiency of the tool to support industrial decarbonisation and the clean tech manufacturing in the EU. It will offer a new support hub to accelerate getting IPCEI projects off the ground.

Analysis of the revised ECH2A project pipeline has revealed the importance of monitoring the implementation of projects in the coming years. For that purpose, there will be the need to work/agree on a questionnaire for a survey that would include, to the largest extent possible, KPIs from the IPCEIs monitoring.

In conclusion, the first deep analysis of hydrogen large-scale deployment projects and the proposed monitoring framework, has allowed us to show the complexity of creating a more developed hydrogen market. It also highlights the importance of having a robust monitoring framework in place to check if projects are delivering, and that creating a new hydrogen market requires coordination and collective efforts by all stakeholders in the value chain.

[33] European Commission, The Clean Industrial Deal: *A joint roadmap for competitiveness and Innovation*, COM(2025) 85 final, 26 February 2025.