



Council of the
European Union

192086/EU XXVII. GP
Eingelangt am 09/07/24

Brussels, 9 July 2024
(OR. en)

12091/24

ENER 373
ENV 776
CLIMA 277
IND 355
RECH 354
COMPET 773
ECOFIN 849

COVER NOTE

From:	Secretary-General of the European Commission, signed by Ms Martine DEPREZ, Director
date of receipt:	24 June 2024
To:	Ms Thérèse BLANCHET, Secretary-General of the Council of the European Union
No. Cion doc.:	SWD(2024) 159 final
Subject:	COMMISSION STAFF WORKING DOCUMENT Towards a roadmap for accelerating the deployment of Hydrogen Valleys across Europe: challenges and opportunities

Delegations will find attached document SWD(2024) 159 final.

Encl.: SWD(2024) 159 final



Brussels, 24.6.2024
SWD(2024) 159 final

COMMISSION STAFF WORKING DOCUMENT

**Towards a roadmap for accelerating the deployment of Hydrogen Valleys across
Europe: challenges and opportunities**

1. INTRODUCTION

Renewable hydrogen is a key pillar in the EU's clean energy transition, replacing natural gas, coal and oil in hard-to-decarbonise industries and certain transport applications (in particular heavy road transport, maritime and aviation). Hydrogen Valleys, local industrial or transport clusters where renewable hydrogen supply feeds local demand, are the cornerstones and building blocks of a viable European hydrogen economy. They are defined as geographic areas where several hydrogen applications are combined into an integrated hydrogen ecosystem that consumes a significant amount of hydrogen (see section 3).

In the Joint Declaration on Hydrogen Valleys¹ with leading hydrogen stakeholders signed in March 2023, the Commission announced a Roadmap for accelerating the deployment of Hydrogen Valleys across Europe. Through a wide public consultation², stakeholders highlighted the key challenges and opportunities for the renewable hydrogen sector. This Staff Working Document takes stock of the achievements to date, and outlines the strategic priorities and actions being implemented to have at least 50 Hydrogen Valleys under construction or operational by 2030 within the EU.

2. POLICY CONTEXT

The European Commission has set an ambitious policy goal for Europe to become the first climate-neutral continent by 2050, while transforming the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy that protects, conserves and enhances the EU's natural capital, and protects the health and well-being of citizens from environment-related risks and impacts. The **European Green Deal**³ mentions renewable hydrogen as one of the priority areas where innovative and market-ready technologies are needed to accelerate the phasing-out of fossil fuels and to ensure economic and social welfare to EU citizens, in a sustainable economy that addresses the three interdependent environmental crises: climate change, biodiversity loss and pollution. The **EU Strategy on Hydrogen**⁴ was adopted in 2020 and suggested policy actions in 5 areas: investment support; support production and demand; creating a hydrogen market and infrastructure via the launch of the European Clean Hydrogen Alliance⁵; research and innovation, and international cooperation. The Hydrogen strategy mentions that the cumulative investments in renewable hydrogen in Europe could be up to EUR 180-470 billion by 2050.

¹ ANNEX to the Commission Decision on the signing on behalf of the European Commission of the Joint Declaration on Hydrogen Valleys - Moving the hydrogen economy from niche to scale, C(2023) 1131 final. [C 2023 1131 F1 ANNEX EN V4 P1 2523210.PDF \(europa.eu\)](https://eur-lex.europa.eu/eli/dec/2023/1131/f1/annex_en)

² European Commission, *Call for evidence REPowering the EU with Hydrogen Valleys (roadmap)*. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13875-REPowering-the-EU-with-Hydrogen-Valleys-roadmap_en

³ European Commission, *The European Green Deal*. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

⁴ European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions A hydrogen strategy for a climate-neutral Europe*, COM/2020/301. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0301>

⁵ European Commission, *European Clean Hydrogen Alliance*,. https://single-market-economy.ec.europa.eu/industry/strategy/industrial-alliances/european-clean-hydrogen-alliance_en

Following the Russian war of aggression against Ukraine, the crucial role of renewable hydrogen to ensure the continent's energy security was reaffirmed. The **REPowerEU Plan**⁶ set the target to phase out Russian fossil fuel imports as soon as possible. Its Hydrogen Accelerator sets out an aim to double the previous EU renewable hydrogen production target to 10 million tons of annual domestic production, plus an additional 10 million tons of annual renewable hydrogen imports by 2030.

In addition, the Renewable Energy Directive⁷ specifies the Renewable Fuels of Non-Biological Origin (RFNBOs, such as electrolytic hydrogen) and sets the targets of 1% for transport and 42% for the industry by 2030 for the Union and its Member States. It is also supplemented by the Commission Delegated Regulations⁸ specifying the conditions under which hydrogen is accounted as renewable.

Yet, many challenges remain to develop a European hydrogen market.

The European Commission has presented its ex-ante impact assessment for a 2040 climate target for the EU⁹. This recommends reducing the EU's net greenhouse gas emissions by 90% by 2040 relative to 1990. The modelling also includes projections for potential future hydrogen production and demand. In other words, the required volumes of hydrogen could increase in conjunction with decarbonisation beyond what was set out in the REPowerEU Plan.

Hydrogen Valleys are specifically highlighted as a key example when it comes to industrial alliances and symbiotic industrial clusters within the EU and its neighbourhood. This is important because clusters help suppliers of clean technologies to scale up their operations and improve their commercial viability by supplying several industrial off-takers within a cluster, while manufacturing industry could decarbonise their operations more effectively and at a lower cost by securing access to clean technologies and sharing costs.

Another reason why the Hydrogen Valleys are at the core of the ambitious EU agenda on renewable hydrogen, is because they uniquely bring together production, storage, distribution and end-use into fully functioning and sustainable local or regional value chains, which can also support workers and communities depending on declining industries, ensuring that the transition leaves no-one behind. Furthermore, they create ecosystems where research and innovation results can be demonstrated and find immediate use, leading to further advances in the hydrogen sector. Hydrogen Valleys are therefore likely to be key elements in the development of a hydrogen market, and a strong instrument to showcase towards companies, public authorities and citizens how hydrogen integration works at the local level.

In line with the **Sustainable and Smart Mobility Strategy**¹⁰, Flagship 2 on zero emission ports and airports, one clear example of how Hydrogen Valley can leverage on existing

⁶ European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions REPowerEU Plan*, COM/2022/230 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A230%3AFIN&qid=1653033742483>

⁷ https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302413

⁸ [Renewable hydrogen - European Commission \(europa.eu\)](#)

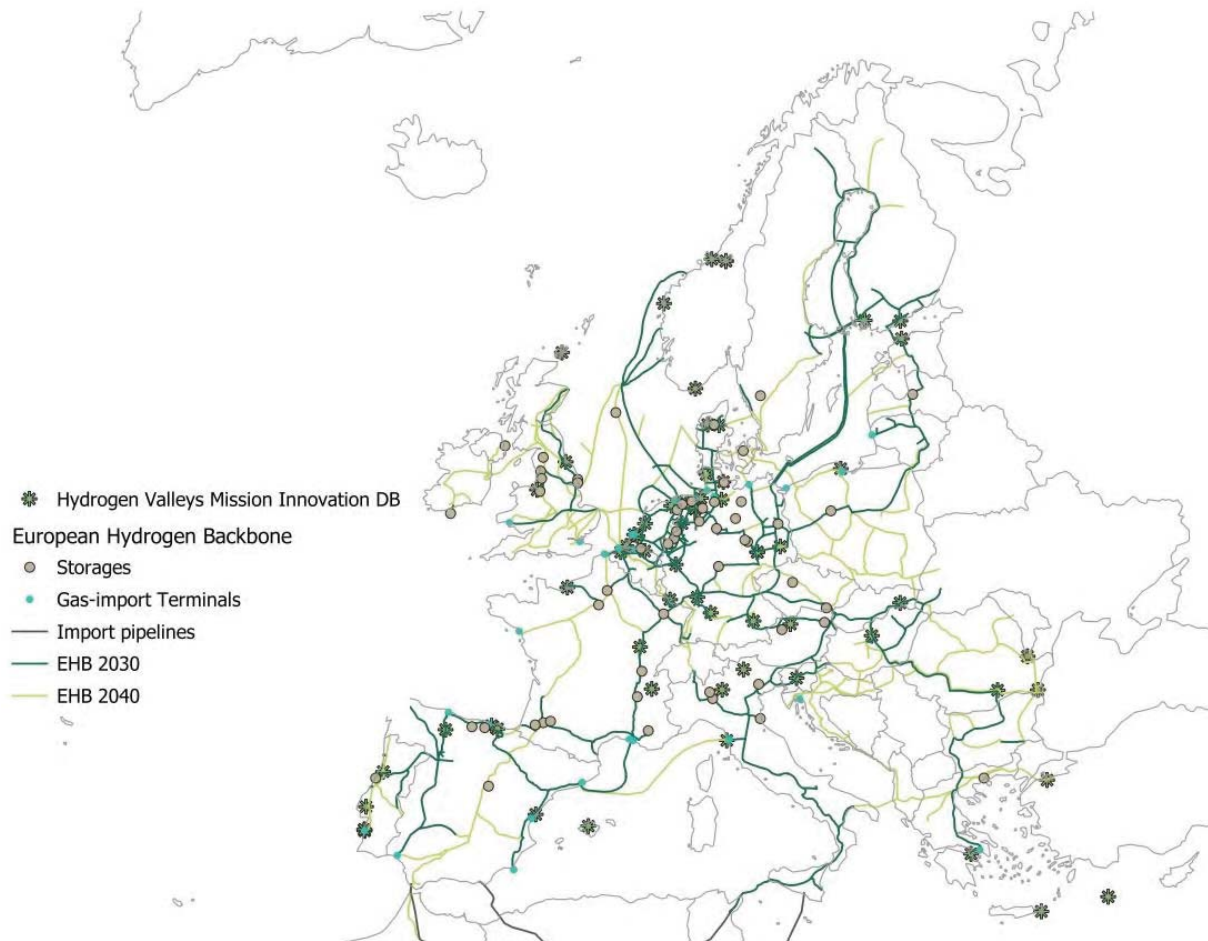
⁹ European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Securing our future Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society*, COM/2024/63 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2024%3A63%3AFIN>

¹⁰ European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Sustainable and Smart Mobility*

infrastructure to support the green transition is their connection to ports. Ports in the European Union already serve as a hub to import and store fuel in large quantities, to support the European economy. In addition, ports provide bunkering services for waterborne transport. Additionally, industrial ports host fuel processing (refineries), and other heavy-energy industries production sites such as chemicals, cement, etc in their premises, which would also benefit from links to green hydrogen to their decarbonization efforts. However, most existent infrastructures would require to be renovated to adapt them to hydrogen instead of fossil fuels.

This Staff Working Document follows-up on the Joint Declaration on Hydrogen Valleys by analysing the challenges and opportunities for accelerating the deployment of Hydrogen Valleys across Europe. The lessons learned may also be useful in terms of speeding up global deployment and assist in facilitating the necessary interconnections of Hydrogen Valleys both on land and at sea.

Figure 1: Hydrogen Valleys and the European Hydrogen Backbone



The European Hydrogen Backbone is an initiative of European Gas Transmission System Operators. Please note that the EHB-maps contain visionary data and that the EHB-maps do not represent concrete planned projects. The shapefile is dynamic and up for change. The latest version will always be shown on the EHB website: <https://www.ehb.eu>

3. HYDROGEN VALLEYS: DEFINITION AND STAGES OF DEVELOPMENT

Hydrogen Valleys are geographic areas - a city, a region, an island or an industrial cluster - where several hydrogen applications, new and/or existing, are combined into an integrated hydrogen ecosystem that consumes a significant amount of hydrogen. These projects should cover the entire value chain: production, storage, distribution, and multiple end-uses. In the EU, existing Hydrogen Valleys differ with regards to the amount of clean hydrogen produced, the number of end-uses, or areas around which they are developed¹¹ (i.e., cities, regions, islands, ports, industrial clusters, other; see figure 1). Many of them also have a cross-border component. However, what these projects have in common is the ability to demonstrate business cases for various uses of renewable hydrogen as well as to contribute to the wider acceptance of hydrogen technologies. In other words, Hydrogen Valleys are “hydrogen ecosystems” with a strong potential to speed up the development of a renewable hydrogen sector in the EU. In this regard, many Hydrogen Valleys are likely to qualify as

¹¹ See for example [HEAVENN](#) in The Netherlands, [BIG HIT](#) in Orkney or [Green Hysland](#) in Mallorca.

geographically confined areas pursuant to Article 52 of the draft Hydrogen and Natural Gas Market Directive¹². The characteristics of Hydrogen Valleys are typically:

A - Large in scale: The project scope goes beyond mere demonstration activities. It contributes to building a clean energy transition and the decarbonisation of industrial sectors. It has a long-term perspective and the system is sustainable. It will therefore entail at minimum a two-digit multi-million-euro investment. It typically includes several subprojects that make up the larger Valley ‘portfolio’.

B - Clearly defined geographic scope: Hydrogen Valleys are hydrogen ecosystems that cover a specific geography. Their footprint can range from a local or regional focus to a specific national or international region.

C - Covering multiple steps in the hydrogen value chain: These steps range from hydrogen production (and often even dedicated renewables production) to the subsequent storage of hydrogen and distribution to off-takers via various modes of transport.

D - Supply to various end sectors: Hydrogen Valleys usually showcase the versatility of hydrogen by ideally supplying several hard-to-abate sectors in their geography such as mobility, industry, and end-use energy. Thus, Hydrogen Valleys are ecosystems or clusters where various final applications share a common hydrogen supply infrastructure.

In the development of Hydrogen valleys there are several stages. From idea to the build and operation of the valleys the following phases can be distinguished:

Phase 1 - Project concept developed: In this phase the project development team is developing a vision for the specific region and will bring different stakeholders together to define the Hydrogen Valley in more detail and to create commitment to bring the Hydrogen Valley beyond “a project idea”.

Phase 2 - Feasibility study ongoing: The consortium brings the initial concept into a Hydrogen Valley plan, where all the different elements from hydrogen production, distribution and storage and potential end-users are described in detail. Supply and demand are balanced, leading to a sound business plan. Towards the end of this phase the project team delivers concrete engineering plans, and a financial investment plan.

Phase 3 - Pre- final investment decision (‘FID’): In this phase the project development team will start the permitting procedures, and work towards a financial close. At the end of this

¹² The hydrogen and natural gas market Directive (Directive (EU) .../... of the European Parliament and of the Council of ... on common rules for the internal markets for renewable gas and natural gas and for hydrogen, amending Directive 2012/27/EU and repealing Directive 2009/73/EC (recast)) together with the accompanying regulation (Regulation (EU) 2024/... of the European Parliament and of the Council of ... on the internal markets for renewable gas and natural gas and for hydrogen, amending Regulations (EU) No 1227/2011, (EU) 2017/1938, (EU) 2019/42 and (EU) 2022/869 and Decision (EU) 2017/684 and repealing Regulation (EC) No 715/2009 (recast)) set out the new regulatory framework for hydrogen and renewable gases. It provides the legal certainty and long-term visibility required to attract much-needed investments into decarbonisation. The regulatory framework for hydrogen is based on proven regulatory principles in the electricity and gas networks: non-discriminatory third-party access to transport infrastructure, regulated network tariffs, and a structural separation of energy production from energy transport (unbundling). Other key elements are the creation of a dedicated European association for hydrogen network operators (ENNOH) and rules on the certification of renewable hydrogen. The introduction of these principles should be in step with the gradual development of the hydrogen. Therefore, a two-phase approach has been adopted: a transitional phase where more flexibilities exist, and a final phase. Today, investors can thus know in what world they will operate in the longer run.

stage relevant stakeholders and investors will take an FID. It is important that local authorities supporting the decision base it on their regional clean energy transition vision.

Phase 4 - Post-FID: In this phase the preliminary engineering is transformed in final engineering plans, and the project developers secure the necessary permits, as well as financial resources (including public and private funding).

Phase 5 - Under construction: After securing the permits and financial resources the project team will start to build the various elements of the Hydrogen Valley in the specific region.

Phase 6 - Operational: At this point all building elements have been completed, and the Hydrogen Valley starts operation.

The Mission Innovation Hydrogen Valley Platform¹³ was launched in 2021 with 21 Hydrogen Valleys in Europe. This platform, which is a joint initiative by the Clean Hydrogen Joint Undertaking¹⁴ and Mission Innovation, aims to bring together the most advanced Hydrogen Valleys around the globe to share insights into their project development. When the REPowerEU communication was published in May 2022, there were 23 Hydrogen Valleys across 11 EU Member States present on the platform. At the time, many of these only had a high-level plan or a project concept, while some others had already started with the implementation. By Autumn 2023, there were already more than double the initial amount of Hydrogen Valleys on the platform, and the counter currently stands at 98 valleys globally with 67 located in the EU. Due to the influx of new projects, the majority (around 3/4) is in the early stages, and in need of support to mature so they can reach final investment decision in a timely manner and start construction. The European Commission's inspirational target is to have at least 50 Hydrogen Valleys *under construction or operational* by 2030 across the entire EU.

Based on the reported production estimates on the Hydrogen Valley platform for the projects located in the EU, and using average figures for projects without reported estimates, the total planned production capacity for the Hydrogen Valleys in the EU would amount to 4.4 million tonnes per year. This is almost half of the REPowerEU objective of 10 million tonnes domestic production in the EU by 2030.

4. ACCELERATING HYDROGEN VALLEYS IN EUROPE

The European Commission is committed to the deployment of the strategic priorities and actions that are being implemented with respect to Hydrogen Valleys. To accelerate this game-changing development, substantial investments in research and innovation are needed as well as a joint public and private effort. Horizon Europe, the current Framework Programme for Research and Innovation¹⁵, supports the Clean Hydrogen Joint Undertaking¹⁶ with EUR 1 billion (2021-2027), matched by the same amount from industry and research partners. The Commission has allocated in the REPowerEU plan an additional EUR 200 million to double the number of Hydrogen Valleys in the EU by 2025. This additional budget,

¹³ Mission Innovation, *Hydrogen Valley Platform*. <https://h2v.eu/>

¹⁴ https://european-union.europa.eu/institutions-law-budget/institutions-and-bodies/search-all-eu-institutions-and-bodies/clean-hydrogen-joint-undertaking_en#:~:text=Role%3A%20The%20Clean%20Hydrogen%20Joint,Cells%20and%20Hydrogen%20Joint%20

¹⁵ European Commission, *Horizon Europe*. https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

¹⁶ European Commission, *Clean Hydrogen Joint Undertaking*. https://www.clean-hydrogen.europa.eu/index_en

coming from Horizon Europe and implemented by the Clean Hydrogen Joint Undertaking, is being used to both support the development of Hydrogen Valleys projects across the EU, and to fund the first research and innovation building blocks to develop the hydrogen value chain based on local conditions. From the calls for proposals of the Clean Hydrogen Joint Undertaking dedicated to Hydrogen Valleys, 17 projects have so far received support for a total budget of EUR 262 million, and additional activities are being planned in the future based on the funding made available mainly from REPowerEU.

For Europe to remain a frontrunner in rolling out Hydrogen Valleys, companies, scientific community, regions and national stakeholders, together with the European Commission, have to collaborate more and make much better use of existing tools. The Joint Declaration on Hydrogen Valleys has highlighted the following areas for further cooperation:

- 1) Reinforcing the research and innovation agenda for clean hydrogen¹⁷ by providing a strategic framework aimed at accelerating the development and deployment of Hydrogen Valleys.
- 2) Continued investments in research and innovation for clean hydrogen technologies including via the Clean Hydrogen Joint Undertaking under Horizon Europe.
- 3) Maximise funding impact by working together to strengthen synergies.
- 4) Promote knowledge sharing and partner matchmaking to build on the existing experience and accelerate successful development of new projects.
- 5) Stimulate the development of education and training for skills, building on the existing initiatives across the EU.
- 6) Spearhead the development of Hydrogen Valleys as steppingstones to incubate and grow a European - and by extension global - hydrogen market.

In order to provide an overview of existing challenges to Hydrogen Valley development in Europe, the Commission launched a public consultation (19 July - 5 September 2023). This included a Call for Evidence that received 102 responses from companies, public authorities, academia, NGOs, and individuals, which still remain publicly available¹⁸. An accompanying questionnaire was also made available during the same period to compliment the qualitative responses in the Call for Evidence. To this there were 120 anonymised respondents overall. The feedback received during the public consultation highlights challenges related to access to renewable energy, hydrogen production costs, infrastructure, storage, access to finance, skills, regulations, permitting, and public acceptance. What became very clear is that regions have a particularly important role to play.

The aim of this SWD is to outline the strategic priorities and actions that are being implemented to have at least 50 Hydrogen Valleys under construction or operational by 2030 within the EU. These actions have been grouped into the following five building blocks.

4.1. Research and innovation

It will be important to stimulate the use of research results in the demonstration of Hydrogen Valleys to realise cost efficiencies, and improved operation considering safety and environmental preservation. For instance, electrolysis is a water-consuming technology:

¹⁷ Clean hydrogen refers to renewable hydrogen.

¹⁸ European Commission, *Call for evidence REPowering the EU with Hydrogen Valleys (roadmap)*.
<https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13875-REPowering-the-EU-with-Hydrogen-Valleys-roadmap-en>

producing renewable hydrogen can be challenging in areas that already suffer water stress or scarcity. The recent revision of the Strategic Energy Technology Plan¹⁹ includes a new Implementation Working Group on hydrogen to coordinate efforts by Member States and stakeholders. This builds on the Strategic Research and Innovation Agenda (SRIA) of the European Research Area Pilot on Green Hydrogen²⁰ led by the Member States and is complementary to the activities of the Clean Hydrogen Joint Undertaking and its States Representatives Group. Together with the network of the Member States led by the European Commission, the Hydrogen Energy Network²¹, the new Implementation Working Group on hydrogen within the Strategic Energy Technology Plan will help ensure Member States' support for Hydrogen Valleys in their national programming. The SRIA is also intended to serve as an orientation and impulse for countries that have not yet developed their own hydrogen strategy or who are revising or updating their national strategies.

The new European Research Area Forum sub-group on 'Access to Excellence', which brings together Member States' research and innovation authorities and cohesion policy authorities in charge of research and innovation, can serve as a platform to define, share and encourage concrete examples of synergies in areas of shared policy interest such as Hydrogen Valleys.

A more coordinated research and innovation framework will help with the development of Hydrogen Valleys. The Strategic Energy Technology Plan Implementation Working Group on hydrogen will help ensure optimal alignment of EU, national and regional initiatives, capitalising on and expanding the existing research and technology infrastructures (cf. the Hydrogen Valley declaration).

Under Horizon Europe, the Commission supports Open Innovation Test Beds, development of new technologies, improvement of industrial, materials and resources efficiency and sustainability (notably related to water and energy) across the value chain involving digital technologies, the use of data-driven approaches and systematic integration of the principle of 'circularity by design'. The Commission is also supporting the uptake/use of hydrogen by different end-user sectors to enable decarbonization of hard-to-abate sectors²². Predictable availability of hydrogen supply will have a positive impact on strengthening the position of the innovative industrial ecosystems, including planned research and innovation activities within ecosystems such as Hubs4Circularity²³ and Regional Innovation²⁴ valleys.

Furthermore, the uptake of key enabling technologies for the twin transition must be accelerated. This includes advanced materials, that can offer sustainable and cost-effective solutions for an efficient hydrogen production. Advanced (nanostructured) materials are also of crucial importance for hydrogen storage solutions for sustainable energy systems based on

¹⁹ European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the revision of the Strategic Energy Technology (SET) Plan*, COM(2023) 634 final. eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0634

²⁰ European Commission, *Strategic Research and Innovation Agenda for the European Research Area Pilot on Green Hydrogen2*. https://research-and-innovation.ec.europa.eu/research-area/energy/hydrogen_en

²¹ European Commission, *HyENet*. https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen/hydrogen-energy-network_en

²² European Commission, *Interactive map of publicly funded industrial demonstrators for energy intensive industries with potential relevance for hydrogen needs /uptake*. <https://projects.research-and-innovation.ec.europa.eu/en/research-area/industrial-research-and-innovation/era-industrial-technologies-roadmaps/demonstrators-scaling-up-innovative-technologies-climate-neutral-industries>

²³ Hubs4Circularity, 2024. <https://www.h4c-community.eu/>

²⁴ European Commission, *Regional Innovation Valley*. https://ec.europa.eu/regional_policy/whats-new/newsroom/24-09-2023-regional-innovation-valley-matchmaking-map-now-available_en

renewables, as well as for enabling hydrogen as a fuel and thus accelerate the use of hydrogen for decarbonisation.

What also became clear from the stakeholder feedback is that a more advanced form of Project Development Assistance may be needed to help Hydrogen Valley stakeholders through the phases of development. There is a need for capacity building and support programmes for national and regional administrations, and further strengthening collaborations between the Clean Hydrogen Joint Undertaking, Hydrogen Valleys S3 Partnership²⁵ on the Hydrogen Valley Platform²⁶. Moreover, the use of digital tools and knowledge platforms to support project design or accelerate knowledge exchange, access to data and matchmaking would help Hydrogen Valleys significantly. Considering the distinct phases in the development of Hydrogen Valleys, tailor-made Project Development Assistance may be needed.

To that end, a ‘**Hydrogen Valley Facility**’ is envisaged to be set up, aiming at accelerating the number of Hydrogen Valleys in Europe. The facility, funded through Horizon Europe and implemented by the Clean Hydrogen Joint Undertaking, will include project development assistance to support Hydrogen Valleys at various levels of maturity. Whilst the focus will be on EU Members States and countries associated to Horizon Europe, such project development assistance may inform also the support to renewable hydrogen development in partner countries. In addition, it will include activities aiming to ensure that the knowledge gathered, and the lessons learnt from Hydrogen Valleys (including skills) are retained, collected, analysed and widely disseminated and used in a structured and efficient way. The Facility will also be used to maintain and update the Hydrogen Valley Platform.

One critical part of research and innovation is the role of ports as a main entry point of energy imports into the EU. For example, 13% of all EU energy imports in 2023 came through the Port of Rotterdam (in the form of LNG, crude oil, coal, or others). The same port aims to maintain the same share of the market but changing the sources (mostly switching to hydrogen and electricity, but they don’t discard CO₂). With the goal of importing 10 million tonnes of renewable hydrogen by 2030, ports will clearly be key to achieve this. The Global Ports Hydrogen Coalition is part of the Hydrogen initiative (H2I) originating from the Clean Energy Ministerial (CEM) and has been established in 2021 to support the scale-up of clean hydrogen in the global economy.

Import can be in the form of hydrogen directly or derivatives such as ammonia. There are clear research and innovation challenges at various technology readiness levels, such as the deployment of ammonia cracking solutions at industrial capacity in ports, or the efficient storage on-board of hydrogen as a cargo. Huge investments will be also needed to deploy these solutions: current infrastructures are hardly adapted to renewable hydrogen. In order to ensure resilience and energy independence, it is important to have a well-developed network of ports for imports of renewable hydrogen, ensuring the highest levels of safety. As such, knowledge sharing and project development may be pursued in several ports based on their strategic, geographic, market, port layout and available space, and other characteristics. This needs to be supported by appropriate links between ports and hinterland (through pipelines, but also barges where inland waterway transport is available) so that hydrogen imports can reach their destination.

²⁵ European Commission, *Hydrogen Valleys S3 Partnership*.
https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/partnership_industrial_mod_hydrogen_valleys_en

²⁶ Mission Innovation, *Hydrogen Valley Platform*, <https://h2v.eu/>

Overall, to maximise the investment opportunities for the further scaling up and deployment of Hydrogen Valleys in the EU, synergies between various innovation support schemes could be further enhanced along three main axes:

- Continue the cooperation on synergies between Horizon Europe partnerships and/or Missions either by shaping together mutual relevant topics or by allowing the exchange of data between projects across partnerships. This work may notably cover the cooperation for end-use domains of the Hydrogen Valleys, with partnerships dealing with industry²⁷ and transport²⁸. Through cooperation between the Clean Hydrogen Joint Undertaking and the Climate-Neutral and Smart Mission²⁹, the ‘twinning’ of Hydrogen Valleys in Europe that have elements relevant for cities distributed generation with cities that are interested to decarbonise using hydrogen can be promoted. Such twinning activities could also target Enlargement countries, such as the Western Balkans, Ukraine, and Moldova. Given that many Hydrogen Valleys include ports and maritime operations, similar approach may be particularly relevant between the Clean Hydrogen Joint Undertaking and the Horizon Europe Partnership on Zero-Emission Waterborne Transport³⁰.
- Actions on cooperation with national and regional levels. Work is ongoing under the Clean Hydrogen Joint Undertaking to strengthen synergies with regions. Once the funding made available through REPowerEU is no longer available, labels like Seal of Excellence or Sovereignty Seal may be explored. Finally, the Strategic Energy Technology Plan and the Clean Energy Transition co-funded partnership³¹ supporting the Strategic Energy Technology Plan offer additional opportunities to support Hydrogen Valleys.
- Specific actions on project development assistance for Hydrogen Valleys. This will “onboard” the Hydrogen Valleys to both regional, national, and EU investment programmes such as the Innovation Fund³², the Just Transition Fund³³, the European Regional Development Fund³⁴ and the Recovery and Resilience Facility³⁵. Moreover, a “one-stop-shop” for hydrogen calls is also being developed in order to help applicants find relevant public funding options. The Hydrogen Valley Facility and the “one-stop-shop” will therefore reinforce one another in making it easier for project developers.

²⁷ Strategic Energy Technology-Plan, which constitutes the research and innovation pillar of the EU Energy Union, and the partnerships on Clean Steel and Processes for Planet.

²⁸ Aviation, Rail, Maritime and Road.

²⁹ https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en

³⁰ WATERBORNE Technology Platform, *Zero-Emission Waterborne Transport*.

<https://www.waterborne.eu/vision/green-and-clean-waterborne-transport>

³¹ CETPartnership, *Clean Energy Transition Partnership*. <https://cetpartnership.eu/>

³² European Commission, *Innovation Fund*. https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund_en

³³ European Commission, *Just Transition Fund*. https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/just-transition-fund_en

³⁴ European Commission, *European Regional Development Fund*. https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/european-regional-development-fund-erdf_en

³⁵ European Commission, *Recovery and Resilience Facility*. https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility_en

4.2. Regulatory framework

Several of the challenges that have been raised by stakeholders, have since then been addressed by EU legislation that has either adopted or proposed.

The **New European Innovation Agenda**³⁶ builds on the REPowerEU plan by including the target of doubling the number of Hydrogen Valleys in the EU by 2025. The Fit for 55 legislative package³⁷, combined with other recent initiatives, provides a solid basis for the development of the necessary policy, regulatory and investment framework conditions for reaching this target. For instance, the **Green Deal Industrial Plan**³⁸ aims at strengthening the industrial and manufacturing basis of the European Union, decreasing import dependency of the fossil fuels, and increasing resilience and sustainability. The proposal for the Regulation on the **Net-Zero Industry Act**³⁹ ('NZIA', adopted on 27 May 2024) and a **Critical Raw Material Act** ('CRMA', adopted on 11 April 2024)⁴⁰ are the key elements of this plan. The NZIA aims at ensuring that the manufacturing capacity in the Union of strategic net-zero technologies (which includes electrolyzers and fuel cells) approaches or reaches at least 40% of the Union's annual deployment needs by 2030. Large parts of the hydrogen industry already aim to go beyond this. Furthermore, it will accelerate permitting for setting up manufacturing facilities, support a market for more sustainable and resilient net-zero technologies, enhance upskilling and reskilling of the qualified workforce, and foster better coordination between Member States. Meanwhile, the CRMA aims to strengthen the accessibility and the value chain of critical raw materials used in the production of hydrogen via electrolysis, with a particular focus on circularity.

In addition, the **revised Renewable Energy Directive (RED)**⁴¹ lays down specific minimum binding targets for the use of renewable fuels of non-biological origin in industry and transport. When implemented, the RED will also simplify and shorten permitting procedures in a comprehensive and structural manner.

In terms of hydrogen permitting in particular, Article 8 of the Hydrogen and Natural Gas Market Directive⁴² focusses on accelerating and streamlining the permitting of infrastructure and production installations that Member States are obliged to implement. In addition, Article 52 of the recast Gas Directive envisages the possibility of exempting geographically confined hydrogen networks from the requirement of vertical unbundling.

³⁶ European Commission, *New European Innovation Agenda*. https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda/new-european-innovation-agenda-roadmap_en

³⁷ European Commission, *Fit for 55*. <https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55/>

³⁸ *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on A Green Deal Industrial Plan for the Net-Zero Age*, COM/2023/62 final. https://commission.europa.eu/document/41514677-9598-4d89-a572-abe21cb037f4_en

³⁹ *Proposal for a Regulation of the European Parliament and of the Council on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act)*, COM/2023/161 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023PC0161>

⁴⁰ *Proposal for a Regulation of the European Parliament and of the Council on establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020*, COM/2023/160 final. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023PC0160>

⁴¹ *Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652*, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023L2413&qid=1699364355105>

⁴² Supra note 12.

Policy experimentation is a useful mechanism for assessing innovative interventions or evaluating the effectiveness of existing policies to enhance their design and implementation. Member States can engage in policy experimentation by using the flexibility provided under the Hydrogen and Natural Gas Market Directive and its accompanying Regulation⁴³ to design a regulatory regime for the ramp-up phase of the hydrogen market. This flexibility during the ramp-up phase enables technical experimentation, in order to ascertain how the technology in question fits into the current national regulation, which changes may be necessary there or where regulation is missing.⁴⁴ Policy experimentation may receive proper consideration as a suitable instrument to allow the accelerated rollout of Hydrogen Valleys without compromising the EU *acquis*, notably environmental, and therefore ensuring environmental protection and industrial and consumer health and safety and the integrity of EU's market rules.

Hydrogen networks in geographically confined Hydrogen Valleys and interconnections between Hydrogen Valleys are of particular importance as a starting point for the European hydrogen market. It will increase the resilience and efficiency of the hydrogen and energy system by providing access to important system assets such as hydrogen networks, large scale storage and hydrogen terminals. EU legislation supports the development of hydrogen infrastructure, including the revised **Trans-European Networks for Energy (TEN-E) Regulation**⁴⁵. This contains streamlining permitting provisions for cross-border infrastructure projects. TEN-E Regulation provides the regulatory framework for identification of cross-border hydrogen priority infrastructure corridors and projects.

Equally important for creating an accessible and comprehensive Hydrogen Refuelling Infrastructure across the TEN-T network is the Alternative Fuels Infrastructure Regulation⁴⁶ that requires hydrogen refuelling stations serving both cars and lorries to be deployed by 2030 in all urban nodes and every 200 km along the TEN-T core network.

Finally, The Smart and Sustainable Mobility Action Plan⁴⁷ highlights the great potential of inland and sea ports to become new clean energy hubs for integrated electricity systems, hydrogen and other low-carbon fuels, and testbeds for waste reuse and the circular economy. Ports have an untapped potential to become green hubs.

⁴³ Regulation (EU) 2024/... of the European Parliament and of the Council of ... on the internal markets for renewable gas and natural gas and for hydrogen, amending Regulations (EU) No 1227/2011, (EU) 2017/1938, (EU) 2019/42 and (EU) 2022/869 and Decision (EU) 2017/684 and repealing Regulation (EC) No 715/2009 (recast)

⁴⁴ Network codes are delegated or implementing acts as foreseen under the hydrogen and natural gas package, in particular Article 54 of Regulation (EU) 2024/...

of the European Parliament and of the Council of .. on the internal markets for renewable gas and natural gas and for hydrogen, amending Regulations (EU) No 1227/2011, (EU) 2017/1938, (EU) 2019/42 and (EU) 2022/869 and Decision (EU) 2017/684 and repealing Regulation (EC) No 715/2009 (recast).

Network codes often regulate more technical and detailed operational aspects of the energy system that can have pertinent consequences for the operation and economic viability of hydrogen assets.

⁴⁵ Regulation (EU) 2022/869 of the European Parliament and of the Council of 30 May 2022 on guidelines for trans-European energy infrastructure, amending Regulations (EC) No 715/2009, (EU) 2019/942 and (EU) 2019/943 and Directives 2009/73/EC and (EU) 2019/944, and repealing Regulation (EU) No 347/2013.

<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32022R0869>

⁴⁶ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1804>

⁴⁷ European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Sustainable and Smart Mobility Strategy – putting European transport on track for the future COM(2020)789 final*. https://eur-lex.europa.eu/resource.html?uri=cellar:5e601657-3b06-11eb-b27b-01aa75ed71a1.0001.02/DOC_1&format=PDF

The first list of **Projects of Common Interest and Projects of Mutual Interest under the new TEN-E Regulation**⁴⁸ includes hydrogen infrastructure projects for the first time. Those projects are eligible for the EU financial support from the Connecting Europe Facility⁴⁹ for Energy. When useful and cost-effective, Member States may therefore facilitate the interconnection of Hydrogen Valleys across the Union's borders and even beyond, by using the planning instruments as foreseen in Chapter VIII of the Hydrogen and Natural Gas Market Directive⁵⁰ that prescribes integrated network planning, including for hydrogen transmission and distribution network operators.

Almost all Member States are accompanying this regulatory overhaul with permitting reforms included in their Recovery and Resilience Plans. The **Technical Support Instrument (TSI)**⁵¹ foresees that Member States can receive, through either stand-alone or multi-country projects, technical expertise for accelerating permitting for hydrogen projects, including the digitalisation of permitting, a possibility which has already been used by six Member States. The fairness and efficiency of connection and access, which is also a pre-condition for Hydrogen Valleys, is guaranteed in the hydrogen and gas market Directive and Regulation. This also sets obligations for third party access to important infrastructure such as pipelines, large storage, and terminals, which will be central to the hydrogen market. For geographically confined Hydrogen Valleys that are (not yet) interconnected a regulatory regime is foreseen that provides flexibility whilst ensuring that they will be fully integrated in the hydrogen system once interconnected.

A **Clean Hydrogen Knowledge Hub** is currently being set up⁵². The goal is to gradually integrate the internal platforms developed by the Clean Hydrogen Joint Undertaking, depending on their scope, type of information and provided services, such as the European Hydrogen Observatory⁵³. This new Hub aims to keep up with the developments and expectations of the sector, which has been increasingly looking towards creating a single point of data and information. The objective is that this new tool will constitute the main repository of information related to the hydrogen sector and the focal point for the sector's stakeholders to further expand the hydrogen economy and its inclusion into the energy system. This tool will support and provide stakeholders and final users with the information they require, allowing for automated data analysis and reporting to support knowledge-based decision making. The platform will have a publicly accessible website, where non-sensitive information and aggregated data will be available to the public, and an internal portal with restricted access for users with the correct credentials, to manage the sensitive and confidential type of information and data coming e.g., from the Clean Hydrogen Joint Undertaking projects. Depending on the type of data, both the public website and the internal

⁴⁸ ANNEX to the Commission Delegated Regulation (EU) .../... amending Regulation (EU) No 2022/869 of the European Parliament and of the Council as regards the Union list of projects of common interest and projects of mutual interest. C(2023)7930 final. https://energy.ec.europa.eu/document/download/3db5e3d1-9989-4d10-93e3-67f5b9ad9103_en?filename=Annex%20PCI%20PMI%20list.pdf

⁴⁹ European Commission, Connecting Europe Facility. https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/connecting-europe-facility_en

⁵⁰ European Parliament and Council, Directive (EU) .../... of the European Parliament and of the Council of ... on common rules for the internal markets for renewable gas and natural gas and for hydrogen, amending Directive 2012/27/EU and repealing Directive 2009/73/EC (recast).

⁵¹ European Commission, Technical Support Instrument. https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/technical-support-instrument/technical-support-instrument-tsi_en

⁵² Contracting authority: Clean Hydrogen Joint Undertaking, Clean Hydrogen Knowledge Hub eTendering, 2024. <https://etendering.ted.europa.eu/document/document-old-versions.html?docId=154165>

⁵³ European Commission, European Hydrogen Observatory. <https://observatory.clean-hydrogen.europa.eu/>

portal will have dashboards where aggregated information will be available to the users for their reference.

In order to fully take advantage of this information, closer integration between different initiatives (such as the Hydrogen Valley Platform and the Hydrogen Infrastructure Map⁵⁴) may be explored, and relevant authorities could be encouraged to facilitate exchanges of best practices, especially on the regional level.

4.3. Crowding-in investments and funding

EU research and innovation policies have been showing longstanding financial support towards Hydrogen Valleys. The EU Framework Programmes for Research and Innovation from 2007 to 2023 contributed in total EUR 2,9 billion to 776 projects to hydrogen-related topics. In 2024, the EU has until now spent EUR 308 million to support 19 Hydrogen Valleys. Despite the large funding for research and innovation, significant investments are still needed for deployment of Hydrogen Valleys. In fact, projects are expected to mobilise additional private and public investments of at least 5 times the amount of funding provided by the EU⁵⁵. In most cases, the capital needed is much higher.

Investment is therefore a major challenge for the Hydrogen Valleys. The EU funding programmes offer opportunities of support to the clean hydrogen sector, and by extension hydrogen derivatives such as ammonia and e-fuels. The **Innovation Fund**⁵⁶, which can support scaling up innovative manufacturing projects, has selected since 2020 more than 18 hydrogen specific projects for a total support of more than EUR 720 million. In November 2023, two calls were launched: a call for proposals for action grants⁵⁷, including a specific topic for clean-tech manufacturing, and a specific pilot auction for hydrogen producers following the guidelines for renewable liquid and gaseous transport fuels of non-biological origin (RFNBO)⁵⁸, as part of the **European Hydrogen Bank**⁵⁹. The European Hydrogen Bank⁶⁰ aims at unlocking investments in hydrogen value chains in the EU and in third countries by connecting renewable hydrogen supply with the emerging demand by European off-takers, and thus to establish an initial market for renewable hydrogen. The first auction was launched in autumn 2023. Seven projects across the EU will receive a total of EUR 720 million, in the form of a fixed premium for each kg of renewable hydrogen produced over a period of 10 years. An additional EUR 2.2 billion is reserved for a second auction in the second half of 2024.

⁵⁴ h2inframap, *Hydrogen Infrastructure Map*. <https://www.h2inframap.eu/>

⁵⁵ For example, Green Hysland on Mallorca received a EUR 10 million grant through Horizon 2020, for a total current investment volume of EUR 50 million; HEAVENN received a EUR 20 million grant through Horizon 2020 for a EUR 100 million budget envelope at start, with total current investment volume of EUR 2.8 billion.

⁵⁶ European Commission, *Innovation Fund*. https://climate.ec.europa.eu/eu-action/eu-funding-climate-action/innovation-fund_en

⁵⁷ European Commission, *Innovation Fund 2023 Call*. https://cinea.ec.europa.eu/funding-opportunities/calls-proposals/innovation-fund-2023-call_en

⁵⁸ European Commission, *Commission Delegated Regulation (EU) 2023/1184 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin*, C/2023/1087. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1184>

⁵⁹ European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the European Hydrogen Bank*,

A number of Member States are making use of the **Recovery and Resilience Facility**⁶¹ to support the build-up of industrial capacity for renewable technologies. Manufacturing and deployment can benefit from guarantees offered under **InvestEU** programme⁶². Project promoters can benefit from loans and venture capital supported by the EU⁶³. The European Innovation Council⁶⁴, which can support any deep tech along the whole innovation journey from early-stage lab scientific innovations up to small and medium sized business scale up, selected since 2018 more than 30 hydrogen projects. Moreover, the European Institute of Innovation and Technology⁶⁵ has been supporting the uptake of hydrogen through its Knowledge and Innovation Communities⁶⁶, in particular the EIT InnoEnergy⁶⁷, which is running the European Green Hydrogen Acceleration Centre⁶⁸ to crowd-in investments. However, there is still a need to mobilise industry to generate mature investment projects, in which industrial alliances play a key role, such as the Clean Hydrogen Alliance and the Renewable and Low-Carbon Fuels Value Chain Industrial Alliance⁶⁹.

When it comes to State aid rules, the General Block Exemption Regulation⁷⁰ (GBER), the Climate, Energy and Environmental Aid Guidelines⁷¹ (CEEAG) and the Framework for State aid for research and development and innovation⁷² provide opportunities for Member States to support the development and deployment of renewable generation technologies, while the Regional aid Guidelines⁷³ allow support to manufacturers of renewable hydrogen equipment.

COM(2023) 156 final, 16.3.2023. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023DC0156&qid=1682349760946>

⁶⁰ Competitive bidding - European Commission (europa.eu)

⁶¹ Recovery and Resilience Facility Country Snapshots - European Commission (europa.eu)

⁶² European Commission, *InvestEU*. https://investeu.europa.eu/index_en

⁶³ Your Europe, *Access to EU Finance*. <https://youreurope.europa.eu/business/finance-funding/getting-funding/access-finance/search/>

⁶⁴ European Commission, *European Innovation Council*. https://eic.ec.europa.eu/index_en

⁶⁵ European Institute of Innovation & Technology, *European Institute of Innovation and Technology*. <https://eit.europa.eu/>

⁶⁶ European Institute of Innovation & Technology, *European Institute of Innovation and Technology Knowledge and Innovation Communities*. <https://eit.europa.eu/news-events/news/eits-knowledge-and-innovation-communities-tackling-water-scarcity-southern-europe>

⁶⁷ European Institute of Innovation & Technology, *EIT InnoEnergy*. <https://eit.europa.eu/our-activities/opportunities/eit-innoenergys-open-letter-partners-decarbonisation>

⁶⁸ European Institute of Innovation & Technology, *EIT InnoEnergy European Green Hydrogen Acceleration Centre*. <https://eit.europa.eu/news-events/news/eit-innoenergy-launched-european-green-hydrogen-acceleration-centre>

⁶⁹ European Commission, *Renewable and Low-Carbon Fuels Value Chain Industrial Alliance*. https://transport.ec.europa.eu/transport-themes/clean-transport/alternative-fuels-sustainable-mobility-europe/renewable-and-low-carbon-fuels-value-chain-industrial-alliance_en

⁷⁰ European Commission, *Consolidated text: Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty (Text with EEA relevance)*. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02014R0651-20230701>

⁷¹ European Commission, *Communication from the Commission – Guidelines on State aid for climate, environmental protection and energy*, 2022, (2022/C 80/01). https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ%3AC%3A2022%3A080%3ATOC&uri=uriserv%3AOJ.C_.2022.080.01.0001.01.EN.G

⁷² European Commission, *Communication from the Commission Framework for State aid for research and development and innovation*, (2022/C 414/01). [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022XC1028\(03\)](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022XC1028(03))

⁷³ European Commission, *Communication from the Commission Guidelines on regional State aid*, (2021/C 153/01). [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021XC0429\(01\)](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021XC0429(01))

Under the CEEAG, the Commission has approved aid measures for the deployment of renewable hydrogen or for the use of hydrogen for a total budget exceeding EUR 11 billion.

Furthermore, the Temporary Crisis and Transition Framework (TCTF)⁷⁴ allows Member States to support the deployment of renewable energy sources, including renewable hydrogen, decarbonisation of industrial processes through electrification and the use of hydrogen, and the manufacturing of strategic equipment for the transition towards a net-zero economy, including among others hydrogen electrolyzers. On this basis, the European Commission has among others approved an Italian scheme to support the development of hydrogen valleys in brownfield industrial areas⁷⁵ as well as schemes set up by several Member States for clean-tech manufacturing expansion, and is currently assessing additional ones. In addition, the Commission has approved Italian and German schemes to foster industrial decarbonisation by supporting investments enabling the substitution of fossil fuels by renewable hydrogen and the electrification of industrial processes.

Following the signature in 2022 of the hydrogen manifesto by 22 EU Member States and Norway aiming at the development of a European clean hydrogen value chain, the Commission approved four hydrogen Important Projects of Common European Interest (IPCEI)⁷⁶. Together, these initiatives aim to raise over EUR 43 billion from a blend of public and private funds, supporting more than 120 projects involving nearly 100 European companies. The first of these hydrogen IPCEI, Hy2Tech, was approved in 2022. It involves 41 projects on technologies for electrolyzers, fuel cells; storage, transmission and distribution; and end user technology. The second IPCEI, Hy2Use, will deploy 3.5 GW of electrolysis and support the development of several hydrogen applications in industry. As a particularly relevant example, the third IPCEI, Hy2Infra⁷⁷, approved in 2024, is already a significant step in terms of infrastructure development and which will support the gradual emergence of an EU-wide hydrogen infrastructure starting from 6 regional clusters, which could be considered as hydrogen valleys. The fourth IPCEI, Hy2Move, approved also in 2024, will develop mobility and transport applications, high-performance fuel cells, on-board storage solutions and technologies to produce hydrogen for mobility and transport.

New legislation can also support the development of Hydrogen Valleys, and the ramp-up phase of the hydrogen market. The Hydrogen and Natural Gas Market Directive and Regulation distinguish between the regulatory frameworks for the ramp-up phase (and thus provides more flexibility to adapt it to specific situations/businesses), and the more mature phase of the market. The regime to grant derogations provides, in essence, flexibility to design a regulatory framework around a given project and, to the transition of the regulatory framework to a mature system where justified, in full compliance with the EU legislation.

Cohesion policy can also support the uptake of hydrogen-based solutions in line with priorities identified at national and regional level, e.g., for the production⁷⁸ or end-use⁷⁹ of green hydrogen. European Regional Development Fund (ERDF) programmes provide an important sources of EU funding for hydrogen-related research and innovation in Member

⁷⁴ European Commission, *Temporary Crisis and Transition Framework*. https://competition-policy.ec.europa.eu/state-aid/temporary-crisis-and-transition-framework_en

⁷⁵ Commission Decision C(2023) 2395 final of 3 April 2023 in case SA.106007 (OJ C 231, 30.6.2023, p. 10), https://ec.europa.eu/competition/state_aid/cases1/202323/SA_106007_B0249088-0000-CDFA-8703-079DFC3F9C4B_58_1.pdf

⁷⁶ https://competition-policy.ec.europa.eu/state-aid/ipcei/approved-ipceis/hydrogen-value-chain_en

⁷⁷ https://ec.europa.eu/commission/presscorner/detail/en/IP_24_789

⁷⁸ European Commission, *H2 Green @ Sines Refinery*. <https://kohesio.ec.europa.eu/en/projects/Q4435316>

⁷⁹ European Commission, *Waterstofregio 2.0*. <https://kohesio.ec.europa.eu/en/projects/Q4299259>

States and regions with related priorities and capabilities. Also, within the framework of cohesion policy, a dedicated Thematic Smart Specialisation Partnership on “Hydrogen Valleys”⁸⁰ connects regions with shared and complementary interests, while the Interregional Innovations Investments (I3) supports specific interregional innovation investments in the ground⁸¹.

A new Hydrogen Valley Investment Guide would be needed for stakeholders to identify public funding sources for hydrogen projects in the various stages of project development. Such a guide could then identify potential synergies/blending options between regional, national and EU public funding sources (particularly for SMEs) to leverage necessary private investments. In order to reach all relevant stakeholders, the Hydrogen Valley Investment Guide might then be made available through the Knowledge Hub.

4.4. Education, training and skills

Training and education are needed to increase the number of skilled people to realise the development of the Hydrogen Valleys, including for regulators and local administrations implementing permitting rules. As part of the policy priorities of the Pact for Skills, the new **European Hydrogen Academy**⁸² has been set up, coordinated by the University of Chemistry and Technology in Prague. It will last for 54 months, having kicked-off last January 2024, and funded with an EU contribution of EUR 3 million from Horizon Europe. The consortium counts with 17 members and the project focuses on 200 occupational projects, aiming to produce university-type courses, facilitate the reskilling and upskilling of workers and create a network of schools and higher education institutions. National initiatives are also being set up to train workforce or scholars in the field of hydrogen technology.

The scope of the Academy is envisaged to transform into a European Net Zero Industry Academy as announced in the NZIA Regulation⁸³. This ‘NZIA’ Academy will contribute to the process of mutual recognition of skills across the union, in order to ensure that national and regional projects can be followed up and extrapolated to other Member States. It will build on existing initiatives across the EU (Hydrogen Valley Declaration point 5) by stimulating and promoting initiatives for the reskilling of workers currently employed by pollutant industries, a critical dimension of the concept of a just transition. It will also provide targeted funding for skills development and stronger links between projects, and train civil servants in developing a regulatory environment for clean hydrogen. In addition to this, it can be explored how the Renewable Energy Skills Partnership⁸⁴, in the context of the Pact for Skills, can be used to develop skills for hydrogen workers and permitting authorities. Lastly, the knowledge sharing and partner matchmaking through the Hydrogen Valley platform, building on the existing experience with well-defined profiles, will facilitate the formation of clusters of excellence, and accelerate the successful development of new projects (Hydrogen Valley Declaration point 4).

⁸⁰ European Commission, *Hydrogen Valleys S3 Partnership*.

https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/partnership_industrial_mod_hydrogen_valleys_en

⁸¹ I3 Instrument, 2024. https://eisma.ec.europa.eu/programmes/interregional-innovation-investments-i3-instrument_en

⁸² European Commission, *European Hydrogen Academy*. <https://cordis.europa.eu/project/id/101137988>

⁸³ Supra note 39

⁸⁴ European Commission, *Renewable Energy Skills Partnership*. https://energy.ec.europa.eu/news/pact-skills-launch-large-scale-renewable-energy-skills-partnership-2023-03-21_en

Furthermore, as part of the revision on the SET Plan, a temporary task force on skills has been established through public procurement under Horizon Europe. The task force will perform an analysis of the work needed to reduce the skills gaps related to the Strategic Energy Technology Plan priorities and proposing actions at EU level within its frame. For hydrogen, this gap is already being targeted, at the vocational education level, by the Erasmus+ project GreenSkills4H2⁸⁵. As part of its main deliveries, the development of a European Hydrogen Skills Strategy is a very important steppingstone. Hydrogen Valleys also needs awareness raising, notably to help with public acceptance. To this end additional requirements on this can be included in the topics of the Clean Hydrogen Joint Undertaking. In addition, the EU Mission on Climate-Neutral and Smart Cities⁸⁶ could be used for further awareness raising.

4.5. Developing Hydrogen Valleys globally

While originally being a European research and innovation concept, Hydrogen Valleys are now spreading across the globe. The **Clean Hydrogen Mission** under **Mission Innovation (MI)**⁸⁷, which is a global cooperation forum for interested governments and that is co-led by the Commission, has set the target of developing 100 Hydrogen Valleys across the globe by 2030. Given the closer interlink with deployment, they could be developed in cooperation with the Clean Energy Ministerial H2 initiative⁸⁸. As the global hydrogen market develops, it will be important to connect Hydrogen Valleys. This will require efficient and cost-effective solutions for distribution and storage of hydrogen, and will put major emphasis on the role of ports worldwide. Identification and support to research and innovation that is of high relevance for deployment of Hydrogen Valley around the world is needed. Synergies may be sought with the waterborne sector, and the Global Ports Coalition under the Clean Energy Ministerial (CEM) Hydrogen initiative, which has been already brought together over 60 ports globally. The Clean Hydrogen Mission also aims to work with non-MI countries, including Enlargement and Neighbourhood, African and Latin-America countries, to support the global development of Hydrogen Valleys. This will be done through the Hydrogen Exchange Program, part of this mission.

Solving challenges related to the demand-side of hydrogen and derivatives (such as methanol and ammonia) will require increased multilateral cooperation. On land, the demand is mainly centred around industry. The Mission Innovation Net-Zero Industries Mission⁸⁹ focuses on hard-to-abate industries like steel, cement, and chemicals, which require extremely high temperatures and use massive amounts of energy. These sectors also encounter high investment costs for process equipment with long payback periods and a lifetime of more than 20 years. Unlocking emissions reductions at the end of their next refurbishment cycles could prevent nearly 60Gt CO2 and help put industrial sectors on a pathway to net zero emissions by 2050⁹⁰. Conversely, at sea the main increase in demand will likely be long major shipping lanes. The MI Zero-Emission Shipping Mission aims to facilitate commercially viable, zero-

⁸⁵ Green Skills for Hydrogen, *GreenSkills4H2*. <https://greenskillsforhydrogen.eu/>

⁸⁶ European Commission, *EU missions, 100 climate-neutral and smart cities*, 2024.

<https://op.europa.eu/en/publication-detail/-/publication/6e8763a7-68c0-11ee-9220-01aa75ed71a1/language-en>

⁸⁷ Mission Innovation, *Clean Hydrogen Mission*. <https://explore.mission-innovation.net/mission/clean-hydrogen/>

⁸⁸ CHM, *Clean Energy Ministerial H2 initiative*. <https://www.cleanenergyministerial.org/initiatives-campaigns/hydrogen-initiative/>

⁸⁹ Mission Innovation, *Net-Zero Industries Mission*. <https://explore.mission-innovation.net/mission/net-zero-industries/>

⁹⁰ Mission Innovation, *Net-Zero Industries Mission*. <https://explore.mission-innovation.net/mission/net-zero-industries/>

emission ocean-going vessels in the global fleet by 2030 through Green Shipping Corridors, which will showcase zero-emission fuels and technologies along maritime trade routes between two (or more) ports, many of which are also developing Hydrogen Valleys. Green shipping corridors require strong partnerships across regions, countries, and even continents. A matchmaking tool has therefore been developed to address this challenge by showing interested stakeholders from across the maritime value chain on easy-to-use map⁹¹ In both cases of these missions, there are clear advantages to leverage the sharing of best practices and know-how, especially in terms of how to secure the necessary investments to realise these kinds of projects.

Cooperation on Hydrogen Valleys outside the EU may take place with international partners on renewable hydrogen deployment and the development of hydrogen markets, in accordance with the EU policy priorities and legislation. As the EU will rely on renewable hydrogen imports to achieving its decarbonisation plans, EU demand for renewable hydrogen imports can contribute to accelerate investments in partner countries by reducing the off-taker risk. It may also prioritise the local needs in terms of renewable energy and water, as well as assess the actual impact of potential imports to the EU.

Support to the development of a hydrogen market around the Mediterranean, including Northern-Africa, can include the exchange of best practices and knowledge on Hydrogen Valleys with Mediterranean countries through the mentioned Hydrogen Exchange Program under Mission Innovation. Furthermore, specific possibilities for technical assistance for the Mediterranean countries to support the establishment of hydrogen projects, including Hydrogen Valleys, may be explored through the new Hydrogen Facility supported through the Clean Hydrogen Joint Undertaking. A relevant initiative in this context is also the ‘Global Gateway Green Maritime Corridor’ flagship⁹², which can benefit from exchanging data on Hydrogen Valley projects. The Annual Work Programme 2024 of the Clean Hydrogen Joint Undertaking⁹³ will support the development of innovative technologies for direct seawater electrolysis. This will facilitate the renewable hydrogen production in geographic regions deprived of freshwater reservoirs but with abundant renewable energy resources, such as Africa.

The Annual Work Programme 2022 of the Clean Hydrogen Joint Undertaking included a call for tenders for a study to assess the renewable hydrogen potential in Ukraine. The topic of this tender is ‘*Study on Opportunities for cooperation on clean hydrogen with neighbouring countries and regions, in particular Ukraine*’. This could support Ukraine in its fast decarbonisation and potentially support the exportation of excess renewable hydrogen at competitive costs to different places of the EU where local demand is expected to exceed local production capacity in time.

5. CONCLUSION

Hydrogen Valleys are the cornerstones and building blocks of a viable European hydrogen economy, which is a priority area instrumental to materialise the European Green Deal. The challenges to bring hydrogen ‘from niche to scale’ are many, and they are of a widely

⁹¹ Mission Innovation, *Zero-Emission Shipping*. <https://mission-innovation.net/missions/shipping/green-shipping-corridors/matchmaker/>

⁹² [Global Gateway - flagship projects - European Commission \(europa.eu\)](https://european-council.europa.eu/media/en/press-room/pages/press-room-detail.aspx?lang=en&id=12345)

⁹³ European Commission, Clean Hydrogen JU Annual Work Programmes. https://www.clean-hydrogen.europa.eu/about-us/key-documents/annual-work-programmes_en

different nature. This Staff Working Document takes stock of the achievements to date, and outlines the measures being implemented to have at least 50 Hydrogen Valleys under construction or operational in the EU by 2030. The main directions in this roadmap can be summarised as follows:

Multiplying new Hydrogen Valleys in Europe

In May 2022, there were 23 valleys across 11 EU Member States. Many of these only had a high-level plan or a project concept. The counter currently stands at 98 valleys globally with 67 located in the EU, of which 17 are supported through the calls of the Clean Hydrogen Joint Undertaking. The EUR 200 million REPowerEU top-up to the Clean Hydrogen Joint Undertaking is being put in operation via calls for proposals exclusively dedicated to the deployment of Hydrogen Valleys (both small- and large-scale), as well as to a Hydrogen Valley Facility providing project development assistance to support Hydrogen Valleys at different level of maturity.

Scaling-up supply and stimulating demand

Accelerating a European hydrogen economy requires a drastic cost reduction and upscaling of hydrogen production, distribution, and use. To this end, the Green Deal call under Horizon 2020 specifically called for the development of large (100 MW) electrolyzers. The 2023 call of the Innovation Fund supports the deployment of 15 hydrogen-related projects on electrolyzers, clean steel, ammonia, and e-fuels. In addition, for the first time, 65 hydrogen infrastructure projects will be eligible to receive funding from the Connecting Europe Facility.

To stimulate the demand side, the first auction of the Hydrogen Bank was launched in autumn 2023. Seven projects across the EU will receive a total of EUR 720 million, in the form of a fixed premium for each kg of renewable hydrogen produced over a period of 10 years. An additional EUR 2.2 billion is reserved for a second auction expected to be launched later in 2024.

Strengthening cooperation and synergies at European and global level

Cooperation and synergies at all levels will allow a more efficient and targeted use of resources.

The Commission has so far approved four hydrogen-related IPCEIs, allowing State aid to promote the market ramp-up of green hydrogen technologies (Hy2Tech), infrastructure (Hy2Use and Hy2Infra), and end-use applications in industry (Hy2Use) and mobility (Hy2Move). In addition, the Commission has approved under the TCTF and the CEEAG several aid measures specifically targeting the production of renewable hydrogen, including a measure targeted specifically at hydrogen valleys.

Under the umbrella of the Strategic Energy Technology Plan (SET Plan), a new workstream is planned to implement the 'ERA pilot on Green Hydrogen'. The cooperation with global partners through the Clean Hydrogen Mission under Mission Innovation, which is co-led by the Commission, will be intensified with the objective to have 100 large-scale hydrogen valleys up and running worldwide by 2030.

Building a hydrogen knowledge and skills community

In a nascent sector such as renewable hydrogen, sharing of best practices and lessons learned is paramount. The European Hydrogen Observatory has been relaunched in September 2023 and will be further developed into a Clean Hydrogen Knowledge Hub to provide stakeholders with the information they need for knowledge-based decision making.

The hydrogen economy also needs new or improved skills to be made available for students and workers. The European Hydrogen Academy, launched in January 2024, focuses on developing university-type courses, re-training, and a network of schools. The Academy is planned to be transformed into a European Net Zero Academy as announced in the NZIA Regulation, providing a broad portfolio of education, training, upskilling, and reskilling.