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Subject:

State Aid SA.102821 – France
State Aid SA.102825 – Germany
State Aid SA.102815 – Italy
State Aid SA.102807 – The Netherlands
State Aid SA.102810 – Poland
State Aid SA.103494 – Portugal
State Aid SA.102811 – Slovakia

Important Project of Common European Interest on Hydrogen Infrastructure “Hy2Infra” – RRF

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Excellencies,

1. PROCEDURE

(1) On 17 December 2020, 23 Member States and Norway agreed on a "Manifesto for the development of a European "Hydrogen Technologies and Systems" value chain" ([1]). This manifesto recognises the importance of promoting cross-border collaborations and of working on large-scale joint investment projects, in order to support the development and deployment of hydrogen technologies and systems ([2]), in particular in view of the contribution of this value chain to the creation of sustainable industrial jobs and to the attainment of the European Union's (the "EU" or the "Union") energy and climate targets also in light of the EU Hydrogen Strategy ([3]). On this basis, the signatories agreed to promote the realisation of Important Projects of Common European Interest ("IPCEI") on hydrogen.

(2) In this context, several Member States launched national calls for pre-selecting potential projects and, during the period from January 2021 to August 2021, held several technical meetings to prepare and develop a common programme for IPCEI on hydrogen. Given the large interest from stakeholders and the variety of technologies and systems identified within the value chain, Member States decided to design more than one potential IPCEI on hydrogen, each having a different focus.

(3) On 15 July 2022, the European Commission (the "Commission") adopted a decision ([4]) not to raise objections on the first IPCEI on Hydrogen Technology ("Hy2Tech"), involving 35 undertakings from 15 Member States and focussing on the development of novel technologies for the production, storage, transportation and distribution of hydrogen as well as applications in the mobility sector.

(4) On 21 September 2022, the Commission adopted a decision ([5]) not to raise objections on the second IPCEI on Hydrogen Industry ("Hy2Use"), involving 29 undertakings from 13 Member States and focussing on boosting the supply of

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([1]) https://www.bmwk.de/Redaktion/DE/Downloads/M-O/manifesto-for-development-of-european-hydrogen-technologies-systems-value-chain.pdf?__blob=publicationFile&v=10

([2]) The Manifesto emphasis that the joint projects shall include sectors along the whole hydrogen value chain, notably (i) the safe and sustainable low-carbon production of hydrogen, where emphasis should be given to hydrogen from renewable sources, and its derivatives, (ii) equipment manufacturing (…), (iii) solutions for hydrogen storage, transmission and distribution (incl. refuelling stations along roads, rails and ports), and (iv) industrial applications of hydrogen (incl. the decarbonisation of industrial facilities).

([3]) Communication from the Commission, to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Region, "A hydrogen strategy for a climate-neutral Europe", COM(2020)301 final, 8.7.2020.

([4]) SA.64647 (2022/N) and others – Important Project of Common European Interest on Hydrogen Technology (Hy2Tech) (not yet published).

([5]) SA.64631 (2022/N) and others – Important Project of Common European Interest on Hydrogen Technology (Hy2Use) (not yet published).

renewable and low-carbon hydrogen and on enabling the development and first industrial deployment ("FID") of clean and innovative hydrogen technologies in other industrial sectors, such as cement, steel and glass.

(5) Between 29 April 2022 and April 2023, France, Germany, Hungary, Italy, the Netherlands, Poland, Portugal, Slovakia, and Sweden, pre-notified their plans to participate in an IPCEI on Hydrogen Infrastructure ("Hy2Infra", initially called "Regional Hubs And Their Links", "RHATL") based on a common draft overall descriptive text (so-called "Chapeau" document), as well as detailed information on Hy2Infra and its components and individual projects.

(6) The Commission requested and received complementary information from the Member States listed in recital (5) and the relevant undertakings during the period between December 2022 and November 2023. Meetings also took place between the Commission and the Member States at the technical level during that period.

(7) On the following dates, the following Member States (the "participating Member States") notified State aid for the execution of Hy2Infra: Germany on 12 January 2024, France on 12 January 2024, Portugal on 17 January 2024, Poland and Slovakia on 23 January 2024, Italy and the Netherlands on 24 January 2024. All the participating Member States have individually notified the common Chapeau document and their planned aid measures.

(8) By letters accompanying each notification, the participating Member States agreed to waive their rights deriving from Article 342 of the Treaty on the Functioning of the European Union (the "TFEU") in conjunction with Article 3 of Regulation 1 ([6]) and to have this Decision adopted and notified in English.

2. CONTEXT AND DESCRIPTION OF HY2INFRA

2.1. Context of Hy2Infra

(9) The participating Member States place the significance of Hy2Infra in the wider context of the development of the European hydrogen value chain. To this end, the participating Member States recall (i) the main goals of the EU Hydrogen Strategy, and (ii) the current market situation of hydrogen in the EU, and (iii) explain that market failures hinder the development of a European hydrogen infrastructure.

2.1.1. Hydrogen strategy of the Union

(10) Hydrogen plays an important role in the Union's climate and energy strategies. The "EU Hydrogen Strategy" ([7]) sets out the EU priority policy actions for the development of the hydrogen ecosystem in order to implement the ambition of the

([6]) Council Regulation No 1 determining the languages to be used by the European Economic Community (OJ 17, 6.10.1958, p. 385).

([7]) 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", 8 July 2020, COM(2020)301 final.

European Green Deal ([8]). The EU Hydrogen Strategy focuses on the following five areas: (i) investment support; (ii) support production and demand; (iii) creating a hydrogen market and infrastructure; (iv) research and cooperation; and (v) international cooperation. The strategy describes how the future hydrogen transmission network is foreseen to evolve from local clusters of high industrial demand to regional and finally long-distance cross-border connections while ensuring interoperability right from the start. The EU Hydrogen Strategy expects the need for an EU-wide logistical infrastructure to emerge gradually from 2025 to 2030. Initially, local hydrogen networks will cater for industrial demand. With increasing demand, hydrogen supply will have to be secured and is likely to require longer-range transportation. After 2030, the market may require large-scale cross-border transport of hydrogen. The revised trans-European energy **infrastructure Regulation ("TEN-E Regulation")** ([9]) **and the "Hydrogen and decarbonised gas market package"** ([10]) will accompany this market development. The EU Hydrogen Strategy starts from the observation that hydrogen can be used as a feedstock, a fuel or an energy carrier and storage, and has many possible applications across industry, transport, power and buildings sectors. Most importantly, it does not emit CO2 and almost no air pollution when used.

(11) Renewable hydrogen thus offers a solution to decarbonise a series of industrial processes currently based on fossil energy and feedstock (e.g. steel) and which are otherwise difficult to decarbonise, as well as industrial processes using fossil-based hydrogen (e.g. fertiliser production). Renewable hydrogen is currently rarely used given that it has not yet been widely deployed and remains costly. Thanks to its high energy density, hydrogen may be used also as a fuel in the mobility sector, such as heavy-duty road transport, maritime, or aviation, areas where electrification is difficult or even impossible. In addition, the storage potential of hydrogen is beneficial for power grids, as it allows for renewable energy to be kept not only in large quantities but also for long periods of time. This means that renewable hydrogen can help improve the flexibility of energy systems by balancing out supply and demand when there is either too much or not enough power being generated, helping to boost energy efficiency throughout the EU.

(12) **All this makes hydrogen essential to support the EU's commitment to reach** carbon neutrality by 2050 and for the global effort to implement the Paris Agreement while working towards zero pollution. Yet, for hydrogen to contribute

([8]) Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions**, "The European Green Deal"**, 11 December 2019, COM(2019) 640 final.

([9]) 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, OJ L 152, 3.6.2022, p. 45–102.

([10]) The review and revision of the Gas Directive 2009/73/EC and Gas Regulation (EC) No 715/2009, published in December 2023. The agreed versions of the texts between the Parliament and the Council can be found here: text of the Regulation: https://data.consilium.europa.eu/doc/document/ST-16522-2023-INIT/en/pdf; text of the Directive: https://data.consilium.europa.eu/doc/document/ST-16516-2023-INIT/en/pdf.

to climate neutrality, it needs to be produced in much larger volumes compared to now (see recital (23)) and its production must become fully decarbonised.

(13) Hydrogen can be obtained via electrolysis using electricity to split water into hydrogen and oxygen. It qualifies **as "renewable fuels of non-biological origin" ("RFNBO") within the meaning of the** Renewable Energy Directive **("REDII")** ([11]) when it is produced in accordance with the methodologies set out in the first([12]) and second delegated act ([13]) of the REDII, in particular when the electricity used is fully renewable in accordance with the methodology set out in the first delegated act.

(14) The EU Hydrogen Strategy ambitions to install at least 6 **gigawatt ("GW")** of renewable hydrogen electrolysers in the EU by 2024 and 40 GW of renewable hydrogen electrolysers by 2030. This ambition has been reinforced in the REPowerEU Plan([14]), where, in addition to measures that promote energy savings, the diversification of energy supplies, the accelerated rollout of renewable energy and the reduction and replacement of fossil fuel consumption in industry and **transport, the implementation of a 'Hydrogen Accelerator'** has been included, setting a target of 10 million tonnes of domestic renewable hydrogen production and 10 million tonnes of renewable hydrogen imports by 2030. The REPowerEU Plan also foresees supporting the development of an integrated gas and hydrogen infrastructure, hydrogen storage facilities and port infrastructure.

(15) The EU Hydrogen Strategy acknowledges that a condition for a widespread use of hydrogen as an energy carrier in the EU is the availability of energy infrastructure for connecting supply and demand. Hydrogen may be transported via pipelines, but also via non-network-based transport options, e.g. trucks or ships docking. Transport can happen as pure gaseous or liquid hydrogen, or bound in bigger molecules that are easier to transport (for example liquid organic hydrogen carriers **("LOHC")**, such as benzyltoluene ([15])). The EU Hydrogen Strategy

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([11]) 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, OJ L 2023/2413, 31 October 2023.

([12]) 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 (OJ L 157, 20.6.2023, p. 11).

([13]) Commission Delegated Regulation (EU) 2023/1185 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and by specifying a methodology for assessing greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels (OJ L 157, 20.6.2023, p. 20).

([14]) On 18 May 2022, the Commission presented the REPowerEU Plan, in response to the hardships and **global energy market disruption caused by Russia's invasion of Ukraine. See** Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic **and Social Committee and the Committee of the Regions, "REPowerEU Plan", 18 May 2022,** COM(2022)230 final.

([15]) Benzyltoluene is a thermal oil which can be chemically bound to hydrogen for its transport via vessel or trucks at ambient conditions. From a toxicity and flammability point of view, it has similar characteristics to diesel oil.

further recognises that hydrogen can also provide cyclical or seasonal storage, e.g. in salt caverns, to produce electricity to cover peak demand, secure hydrogen supply, and allow electrolysers to operate flexibly.

(16) In the REPowerEU Plan, the Commission stresses the need for accelerated efforts to deploy hydrogen infrastructure for producing, importing and transporting 20 million tonnes of hydrogen by 2030. Total investment needs for key hydrogen infrastructure categories are estimated to be in the range of EUR 28 to 38 billion for EU-internal pipelines and EUR 6 to 11 billion for storage. The Commission considers that a rapid development of infrastructure that connects supply and demand constitutes a key ingredient for the hydrogen accelerator envisaged in the REPowerEU Plan ([16]). This concerns transport via pipelines, storage, as well as non-network based options (for instance liquid hydrogen, ammonia, LOHC, etc.), which can be relevant for imports.

(17) In the REPowerEU Plan, the Commission further indicates that in order to facilitate the import of up to 10 million tonnes of renewable hydrogen, it will support the development of three major hydrogen import corridors via the Mediterranean, the North Sea area and, as soon as conditions allow, with Ukraine.

(18) Furthermore, the Next Generation EU package has been adopted as a temporary instrument designed to boost the recovery of Member States from the pandemic by addressing among others, climate and environmental challenges ([17]). The **Resilience and Recovery Facility ("RRF") for Europe constitutes a centrepiece of** the Next Generation EU ([18]). The RRF Regulation requires each Member State to **dedicate at least 37% of its recovery and resilience plan's ("RRP") total allocation** to measures contributing to climate objectives. This supports the green transition **by contributing to the achievement of the EU's 2030 climate targets and by** complying with the target of EU climate neutrality by 2050. Particularly, the RRF supports investments in flagship areas, such as hydrogen. Some projects under Hy2Infra, including those from Portugal, Poland, France and some from Germany will be funded by the RRF.

(19) Renewable hydrogen is also viewed as an economic policy opportunity. The expansion of the European economy by using clean and sustainable technologies **is a key tenet of the Commission's** Recovery Plan ([19]). It highlights the need to unlock investment in key clean technologies and value chains to boost recovery from the COVID-19 crisis. It stresses clean hydrogen as one of the essential areas to address in the context of the energy transition and as area in which to unlock investment to create sustainable jobs and growth.

([16]) Commission Staff Working Document Implementing REPowerEU Plan, SWD/2022/230 final.

([17]) Communication from the Commission, to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, ***Europe's*** *moment: Repair and Prepare for the Next Generation*, COM(2020) 456 final, 27.5.2020.

([18]) Regulation (EU) 2021/41 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility (OJ L 57, 18.2.2021, p. 17).

([19]) **European Commission: "Europe's moment: Repair and Prepare for the Next Generation", COM(2020)** 456 final.

(20) Reliable and open-access energy infrastructures are a crucial fundament for economic growth of national economies. The Commission therefore has acknowledged the importance of developing interoperable trans-European energy network systems ([20]), including for renewable energy carriers. Based on the Europe 2020 ([21]) strategy of the EU, the TEN-E Regulation aimed at modernising and expanding trans-European energy infrastructures. With the overall objective to complete the EU internal energy market, the regulation provided guidelines for the development of "Trans-European Energy Networks" ("TEN-E"). The TEN-E framework addresses fragmented interconnections between Member States, isolation of Member States from the gas and electricity networks, secure and diversified energy supply for the EU and interoperability of national energy infrastructures. Since the role of hydrogen and its respective infrastructure development is emphasized in the EU Hydrogen Strategy to reach European climate targets, the adopted framework explicitly includes the development of hydrogen infrastructures and includes three priority corridors: (i) Hydrogen interconnections in Western Europe, (ii) Hydrogen interconnections in Central Eastern and South Eastern Europe, and (iii) Baltic Energy Market Interconnection Plan in hydrogen ([22]).

(21) With the TEN-E Regulation, the Commission has aligned the criteria for Projects of Common Interest ("PCI") with the European Green Deal and the targeted transformation towards renewable energy carriers and infrastructure. To receive the PCI status, projects must fulfil five criteria: (i) have a significant impact on at least two Member States; (ii) enhance market integration and contribute to the integration of Member States' networks; (iii) increase competition on energy markets by offering alternatives to consumers (iv) enhance security of supply; and (v) contribute to the EU's energy and climate goals and they should facilitate the integration of energy from renewable energy sources. The projects will benefit from streamlined permitting and regulatory procedures, and become eligible for applying to EU financial support from the Connecting Europe Facility ("CEF") ([23]).

([20]) Article 170 of the TFEU.

([21]) Communication from the Commission "Europe 2020 – A strategy for smart, sustainable and inclusive growth", 3 March 2010, COM(2010) 2020.

([22]) Article 16 of the adopted TEN-E regulation states that […] "the trans-European energy networks policy should include new and repurposed hydrogen transmission infrastructure and storage as well as electrolyser facilities." Concerning production capacities, the TEN-E regulation defines electrolysers with a capacity of at least 50 MW as infrastructure relevant (Annex II 4(a)(i)). In addition, the production must comply with a life cycle greenhouse gas emissions savings requirement of 70% relative to a fossil fuel comparator of 94g CO2 e/MJ (Annex II 4(a)(ii)) and must have a network-related function, particularly with a view to overall system flexibility and overall system efficiency of electricity and hydrogen networks (Annex II 4(a)(ii)). It is further stated in Paragraph 16 in the introduction that comparable to conventional energy infrastructures, hydrogen transmission and storage infrastructures should be included in the Union-wide ten-year network development plan with the objective to create a hydrogen backbone for the Union.

([23]) On 28 November 2023, the Commission adopted first list of Projects of Common Interest ("PCIs") and Projects of Mutual Interest ("PMIs") ("First PCI/PMI list"). The PCI and PMI list is adopted as a delegated act by the Commission, and is transmitted to the European Parliament and Council, which have two months to decide whether to accept or reject the list. The Parliament and the Council cannot introduce amendments to the list. The scrutiny period of two months may be extended by an additional

2.1.2. *Current situation of the EU hydrogen market*

(22) **In 2022, hydrogen accounted for less than 2% of Europe's energy consumption** and was primarily used to produce chemical products, such as plastics and fertilisers. 96% of this hydrogen was produced with natural gas, resulting in significant amounts of CO2 emissions ([24]). Substituting this hydrogen with renewable hydrogen would therefore reduce CO2 emissions. In 2022, only 0.3% of the European **hydrogen production** capacity was produced by water electrolysis ([25]), equivalent to 30,000 metric tons **("tonnes")**. This contrasts with **the European Hydrogen Strategy's goal of producing 10 million** tonnes or 330 terawatt/**hour** ("TWh") of renewable and low-carbon hydrogen by 2030. The participating Member States submit that this shows that there is currently no liquid market for renewable and low-carbon hydrogen in Europe. This is due, in particular, to the absence of production facilities and the absence of the necessary infrastructures for transport and storage. In addition, the production of hydrogen requires the coordinated development of hydrogen and electricity infrastructures.

(23) In September 2023, only 228 **megawatt ("MW")** of water electrolysis capacity for renewable and low-carbon hydrogen production was installed in Europe ([26]). Although many projects were announced in recent years, current electrolyser capacities account for less than one percent of the 40 GW goal for 2030 defined by the European Hydrogen Strategy.

(24) The participating Member States stress that the average system size of current European Power-to-Gas projects is well below 20 MW ([27]). They are hence too small to meet the projected consumption and too small also to deliver network stabilising effects envisaged by the TEN-E Regulation. In addition, most of these are demonstration projects only. The participating Member States underline that large-**scale production would need to be deployed at fast pace to meet the Union's** 2030 objectives.

(25) **Hydrogen pipelines** in Europe currently in operation are mostly in private ownership, dedicated to connecting industry sites and not open for third-party access ([28]). Currently there are several dedicated hydrogen pipeline networks with a total length of around 1,500 km. The hydrogen produced and transported is

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two months upon their request. If, within this timeframe, neither the Parliament nor the Council rejects the list, it will enter into force, replacing the current 5th PCI list.

([24]) See: https://energy.ec.europa.eu/topics/energy-systems-integration/hydrogen_en#renewable-hydrogen.

([25]) See Figure 2.1. of the Clean Hydrogen Monitor of 2023, accessible here: https://hydrogeneurope.eu/wp-content/uploads/2023/10/Clean_Hydrogen_Monitor_11-2023_DIGITAL.pdf.

([26]) See page 39 of the Clean Hydrogen Monitor of Hydrogen Europe, accessible here : https://hydrogeneurope.eu/wp-content/uploads/2023/10/Clean_Hydrogen_Monitor_11-2023_DIGITAL.pdf.

([27]) Power-to-Gas (or P2G) is a term used to describe a technology allowing energy from electricity to be transformed into compressed gas, making it easier to store and transport. Electrolysis is a Power-to-Gas technology.

([28]) For a map of hydrogen pipelines currently in operation see: https://www.fchobservatory.eu/observatory/technology-and-market/hydrogen-pipelines.

fossil-based hydrogen which is used in the chemical and petrochemical industry. The production is highly centralized and distributed solely to the contractual customers. The participating Member States refer to estimates from Transmission **System Operators ("TSOs") according to which an open access hydrogen network** might require 6,800 km of pipelines by 2030 and 23,000 km by 2040 ([29]).

(26) Today, no **large-scale storage facility for hydrogen** is in operation in Europe. Operation of regional hydrogen infrastructure, without hydrogen-storage facilities, is possible to a certain extent. However, the creation of large hydrogen clusters with enlarged hydrogen generation capacities and multiple off-takers is not possible without large-scale ([30]) storage capacity. In that sense, the participating Member States submit that hydrogen-storage facilities are indispensable for decoupling the hydrogen production-side, using intermittent and seasonal renewable energy sources, from the demand-side with an almost steady use of hydrogen.

2.1.3. Market failures hindering the development of a European hydrogen infrastructure

(27) The participating Member States submit that the development of a European hydrogen infrastructure is restrained by several market failures, consisting in coordination problems, negative externalities, and positive externalities.

(28) **Coordination problems** occur when the profitability of various projects is interdependent, and the multiple actors may end up underinvesting. The participating Member States explain that in the hydrogen sector, in Europe, the value chain for hydrogen is only embryonic. While renewable hydrogen is expected to play an important role in decarbonisation (see recital (10)), hydrogen is not a widespread commodity yet but rather a niche market dominated by fossil-based hydrogen and there is no large-scale hydrogen infrastructure capable of supporting the development of the wider market that would be needed for the green transition. Grey hydrogen is generally produced in-house in on-site steam methane reformer or delivered in private local hydrogen networks located around industrial sites. Investments in hydrogen generation and transport need to be aligned to facilitate a swift transition from dedicated local fossil-based hydrogen use to an open liquid renewable and low-carbon hydrogen market. As a result of the coordination problems, there is no obvious commercial way for a potential hydrogen customer to be supplied in large quantities by renewable hydrogen suppliers; and vice versa for a renewable hydrogen producer to easily find customers within their reach.

([29]) European Hydrogen Backbone report: How a dedicated hydrogen Infrastructure can be created; Several European TSOs; July 2020. https://ehb.eu/files/downloads/2020_European-Hydrogen-Backbone_Report.pdf.

([30]) In the Directive within the Hydrogen and decarbonised gas package, **'hydrogen storage facility' means** a facility used for the stocking of hydrogen of a high grade of purity: (a) including the part of a hydrogen terminal used for storage but excluding the portion used for production operations and facilities reserved exclusively for hydrogen network operators in carrying out their functions; (b) including large, in particular underground, hydrogen storage but excluding smaller, easily replicable hydrogen storage installations..

(29) Developing a hydrogen value chain is a "chicken-and-egg" dilemma: it requires strong coordination and planning between different entities across production, transport, storage and end-use, especially as such value chains have not been established yet and there are no market signals for production or demand. For the hydrogen produced by electrolysis to become competitive, some of the prerequisites are the availability of large-scale electrolysers, distribution network, and storage facilities to ensure continuous supply for off-takers. However, for such manufacturing, distribution, and storage capabilities to develop, they need to be reasonably confident in their load for the coming years and in the commitments of their partners.

(30) There have also been coordination failures in the deployment of the hydrogen infrastructure. The potential deployment of a hydrogen network first requires as prerequisites i) the development of several fast-track initial projects in a short and common timeframe, ii) harmonizing technical specifications (including standards) for various hydrogen needs, and iii) coordination between supply and transport. The supply of hydrogen to industry is not secured by the construction of electrolysers alone if no transport system is built on time, so that large quantities of hydrogen cannot be continuously supplied. In addition, large-scale storage systems are needed to secure the supply.

(31) The participating Member States submit that Hy2Infra will address several of these coordination problems. The coordinated approach followed in the framework of Hy2Infra will create an opportunity for multiple actors on the demand- and supply-side to invest and ramp up production capacities together with the transport and storage infrastructure. This includes also integrated planning, common technical, and safety standards for interoperability, and a joint and coordinated approach of relevant stakeholders at the different levels of the hydrogen supply chain (e.g. generation, distribution, logistics, refuelling and end use): a) installation of large-scale electrolyser capacities in to ramp up production of renewable and low-carbon hydrogen, b) establishment of required infrastructure for transport and distribution as well as of large-scale storage of hydrogen, and c) development of embedded hydrogen infrastructure enabling the transport of hydrogen over sea and in areas where pipelines cannot yet be deployed. Hy2Infra brings together market participants from all levels of the hydrogen supply chain in an integrated project with a single and coordinated focus and plan of action; it stimulates the deployment of hydrogen infrastructure that would not be realised through multiple independent and fragmented smaller projects.

(32) The underlying source of **negative externalities** is that undertakings do not always bear the full costs of the harm they impose on society. This leads to the use of more polluting solutions, with resulting pollutants, presenting thus a direct or indirect adverse environmental impact on society. The participating Member States consider that within the hydrogen value chain, negative externalities impact mainly the production of renewable and low-carbon hydrogen. To a certain extent, they however, also impact transport and storage of renewable and low-carbon hydrogen. Since the emissions and the subsequent consequences caused by the production and usage of fossil-based energy carriers are not fully reflected in the cost structure of these energy carriers, for renewable and low-carbon hydrogen a level-playing field is not given. The participating Member States

submit that the negative externalities addressed by Hy2Infra can be formulated as follows:

i. The current demand of hydrogen in industrial applications is supplied mainly by hydrogen produced from natural gas via steam reforming, producing large amounts of CO2 as a by-product. The negative effects of this CO2 are not fully accounted for in the market price and represent a strong negative externality.

ii. By substituting natural gas or coal as a feedstock in industrial processes with renewable and low-**carbon hydrogen, greenhouse gas ("GHG")** emissions and other pollutants resulting directly from the fossil fuels that is substituted can be avoided. As a rule of thumb 2 GW electrolyser capacity yielding approximately 150 – 200 kilotons **("kt") of renewable hydrogen** (depending on the realizable full load hours) will be necessary in order to fully replace a typical sized blast furnace in a steel facility. This would lead to CO2 reductions of about 4.5 to 6 million tonnes of CO2 annually. The total electrolyser installed capacity in Hy2Infra (3.2 GW) could thus account for emission savings of around 7 to 10 million tonnes of CO2 annually. However, also for steel, the negative effects of this CO2 are not fully accounted for in the market price and represent a strong negative externality.

iii. The participating Member States submit that the existing market and regulatory conditions do not provide sufficient incentives for potential hydrogen end users to implement new solutions to use renewable or low-carbon hydrogen and as such substantially reduce the CO2 emissions compared to current fossil-based solutions. CO2 emissions are only partially internalised via EU Emission Trading System ("ETS") ([31]). The participating Member States submit that from current developments and modelling of the transition of hard to abate industries to hydrogen as fuel and feedstock it is apparent that the current cost trajectories of the ETS are not sufficient currently to, on their own, trigger the types of investments proposed under Hy2Infra.

iv. In the regulated market for gas infrastructure, environmental factors are currently not being considered in the calculation of grid tariffs. In particular, the life cycle emissions of natural gas (e.g. methane leakage, flaring, leakage from fracking, LNG-Transport) are not accounted for properly and internalised in the natural gas prices. State aid to promote the development of renewable and low-carbon hydrogen infrastructure could help lower the price for clean alternatives compared to fossil energy sources.

(33) The individual projects under Hy2Infra will address negative environmental externalities for instance by:

([31]) Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a system for greenhouse gas emission allowance trading within the Union and amending Council Directive 96/61/EC (OJ L 275, 25 October 2003, p.32).

i. Upscaling mass production of electrolysers, which will enable the industrial production of renewable hydrogen to replace fossil-based hydrogen;

ii. Developing solutions to transport the produced hydrogen to the consumption centre; and

iii. Making steady supply of renewable hydrogen available to more end users thanks to large-scale storage facilities able to compensate for the variability and seasonality of renewable hydrogen production, lifting one condition hindering the transition of industrial and mobility end users from fossil fuels to hydrogen.

(34) **Positive externalities** occur when positive effects of the projects are not fully internalised in the renewable and low-carbon hydrogen prices. Where individual projects may provide benefits to society that are not fully captured by the undertakings, the undertakings' private rate of return may not be sufficiently attractive for each project to be funded fully privately, even though the overall benefits of that project justify the investment from a societal perspective. This leads to the underinvestment in hydrogen infrastructure, from the social perspective, which justifies the need for State intervention. State aid may help bridge this gap and ensure a level of investments in renewable hydrogen infrastructure closer to a socially optimal level.

(35) The investments for an open-access hydrogen infrastructure within Hy2Infra will enable the market access of further market participants and benefit Europe as a whole.

(36) Without regulatory intervention and appropriate funding, first movers establishing hydrogen production infrastructure might have to bear a higher financial load. This is because they might for instance finance the hydrogen infrastructure to a larger extent than the hydrogen production facilities connecting later on and benefitting directly from an already deployed and largely financed network. Indeed, the first users of the pipeline and storage infrastructures would be required to cover the full costs of these infrastructures in the first years of operation, while future end users will benefit from these infrastructures at lower costs because of a larger base of clients with whom to share the costs.

(37) The first large scale projects will most likely also entail a steep learning curve and will generate operation experience that will benefit to further market participants.

(38) The participating Member States indicate that the aid will address positive externalities for instance by reducing the financial burden that first movers will need to bear, and by bringing them closer to costs and prices that next generations of users would bear.

2.2. Objectives of Hy2Infra

(39) By participating in Hy2Infra, the participating Member States have agreed to follow a collaborative approach to establish the first regional clusters ([32]) and

([32]) In this decision, the term regional "cluster" is used to refer to a group of local hydrogen production or consumption centres interconnected by pipelines and possibly comprising a large-scale storage facility.

interconnections for hydrogen supply across several Member States in the EU. Hy2Infra aims at kick-starting the development of an integrated and open infrastructure. It offers a starting point in establishing the centrally required components to enable the market ramp-up of hydrogen supply in the EU.

(40) As first steps of the European hydrogen infrastructure, Hy2Infra will serve as a substantial basis for further growth. Hy2Infra will establish regional clusters as a basis and complement to PCI developed under the TEN-E Regulation. Furthermore, as also highlighted by the EU Hydrogen strategy, Hy2Infra seeks to ensure interoperability of hydrogen markets from the start to facilitate future interconnections between clusters and across borders. It encompasses also several cross-border connections.

(41) Together, the participating undertakings in Hy2Infra will therefore pursue the following sub-objectives:

- kick-start the ramp-up of a reliable supply chain for renewable and (to a more limited extent) low-carbon hydrogen in Europe;
- focus on interconnection of the infrastructure between the direct participants to establish a functional, open and non-discriminatory network; and
- generate knowledge through hands-on experiences during the process to contribute to a shared standardisation framework across EU Member States.

(42) To achieve these goals, the participating undertakings have set quantitative objectives with reference to Hy2Infra, established in the Chapeau document, namely to:

- install large-scale electrolyser capacity of 3.2 GW to produce 0.3 megaton **(“Mt”)** per year of renewable hydrogen;
- build 1,063 km of new pipeline and repurpose 1,607 km of pipeline for hydrogen transport;
- unlock 9,120 tonnes of hydrogen storage capacity; and
- develop port infrastructure and LOHC infrastructure capable of handling 6 kt per year of renewable hydrogen.

(43) The participating Member States submit that Hy2Infra seeks to – inter alia – contribute to attaining the specific goals of the EU Hydrogen Strategy as well as **the Union’s general objectives in reaching its decarbonisation targets, in** particular the European Green Deal and the REPowerEU Plan and that it will address the market failures described in section 2.1.3.

2.3. Hy2Infra in the context of previous IPCEI on Hydrogen

(44) Hy2Tech, Hy2Use and Hy2Infra are to an extent complementary concerning their general structure, objectives, and their contributions to the major goals of the European strategies. The three IPCEI address the different steps of the hydrogen value chain, targeting similar general common objectives, which are closely

linked to the EU climate and energy strategies. The three IPCEI are nevertheless distinct.

(45) In Hy2Tech, the participating undertakings will carry out R&D&I and FID activities related to the hydrogen value chain, in four areas: development of hydrogen generation technologies; development of fuel cell hydrogen technologies; development of technologies for storage, transportation and distribution of hydrogen; and development of hydrogen technologies for a selection of end users (in particular, the mobility sector).

(46) In Hy2Use, the participating undertakings will carry out R&D&I and FID activities in the development of hydrogen technologies for industry applications and develop hydrogen generation in several Member States as well as transport infrastructure in one Member State.

(47) Hy2Tech aims at pushing forward technological innovation in hydrogen production, transport and storage equipment, such as generating breakthrough innovation in electrolyser technology. It does not aim at deploying hydrogen infrastructure but will ensure that more efficient electrolysers are available for hydrogen producers.

(48) Hy2Use follows and complements Hy2Tech and focuses on projects not covered by Hy2Tech. Hy2Use for instance includes R&D&I projects for the use of hydrogen in the industrial sector, which is not the focus of Hy2Tech. Hy2Use also encompasses hydrogen production.

(49) Unlike Hy2Tech and Hy2Use, Hy2Infra does not entail R&D&I and FID activities. Hy2Infra includes infrastructure projects exclusively. The infrastructure projects of the Hy2Infra exceed the context of Hy2Use. By means of installation of large-scale storage capacities and the handling of embedded hydrogen / port infrastructure and the deployment or repurposing of pipeline infrastructure connecting to large scale electrolysers and storage facilities, Hy2Infra, as a whole, provides the first development step for a future wider European hydrogen network.

2.4. Overview of the Hy2Infra as integrated project

2.4.1. Structure of Hy2Infra

(50) The participating Member States present Hy2Infra as a European integrated infrastructure project, as defined in points 13 and 25 of the IPCEI Communication ([33]), focussing on hydrogen infrastructure. It contains 33 individual projects.

(51) The participating Member States further explain that Hy2Infra integration is based on two Pillars described in more details below (i.e. the deployment of the infrastructure and the collaboration for interoperability and common standards) **and four workstreams (“WSs”). Each WS** corresponds to a different type of infrastructure:

([33]) Communication on the criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of IPCEIs (OJ C 528, 30.12.2021, p. 10–18).

- WS1: Installation of hydrogen production capacity;
- WS2: Installation of hydrogen transmission and distribution via pipelines / technical grid infrastructure;
- WS3: Installation of large-scale hydrogen-storage facilities; and
- WS4: Handling of embedded hydrogen / port infrastructure.

(52) The participating Member States submit that the four WSs of Hy2Infra are complementary and significantly add value to meet the objectives of each WS separately and of Hy2Infra as a whole.

(53) The tasks of the direct participants in Hy2Infra within each WS and across WSs are structured around the two Pillars aimed at achieving the objectives described in recitals (39) to (43):

- **Pillar 1**: Deployment of first regional clusters and their links to increase certainty on hydrogen developments in an emerging market with a coherent and joint approach on project level. Tasks under Pillar 1 involve both (i) cross-cutting cooperation between different WSs at regional cluster level (e.g. physical interconnection, planning alignment) and (ii) WS-specific quantitative and qualitative objectives (e.g. overall installed electrolyser capacity for WS1).
- **Pillar 2**: The different regional clusters aim at interconnecting in the future. To this end, Pillar 2 involves a collaboration for interoperability and common standards to facilitate future interconnection between regional and national clusters and to prevent technical barriers by establishing a transparent framework for market entry and ramp-up. Tasks under Pillar 2 involve both (i) cross-cutting cooperation between different WSs, most particularly the common agreement on interoperability, and (ii) WS-specific collaborations (e.g. contribution to the development of standards and guidance specific to a given infrastructure type).

(54) Both Pillars are crucial for a subsequent development of a wider European hydrogen network. While the deployment of first regional hubs and their links is necessary to overcome current market failures for large-scale hydrogen infrastructure projects (step 1), the establishment of interoperability and common accessibility (step 2) will ensure further development of the open-access hydrogen infrastructure established by the Hy2Infra. The participating Member States observe that this two-step approach is explicitly foreseen in the EU Hydrogen Strategy. Therefore, the integration of Hy2Infra is based on these two fundamental and complementary Pillars.

(55) Following the two-Pillar approach, the participating Member States submit that **the significant added value to the achievement of the Union's objective (European** Hydrogen Strategy and REPowerEU) and the complementarity of the individual projects consist of:

- The **common objectives and quantitative targets within each WS** (section 2.2);

- the **physical interconnections** to be realised within Hy2Infra or expected to be realised with other projects beyond the scope of this IPCEI (section 2.4.3); and

- a common agreement on key technical parameters to facilitate **interoperability** and prevent the establishment of technical barriers and a common contribution to the development of European **standards** in the hydrogen sector to facilitate the development of technical operational rules (section 2.4.5).

2.4.2. *The participating undertakings in Hy2Infra (aid beneficiaries)*

(56) This section briefly describes the participating undertakings involved in Hy2Infra. The individual projects of each participating undertaking ([34]) are described in more details under sections 2.4.3 and 2.4.5.

- AIR LIQUIDE Deutschland GmbH

Air Liquide Deutschland GmbH ("ALD") (Germany) is part of the Air Liquide Group. ALD operates a hydrogen pipeline system in the Rhine-Ruhr area and manages the complete hydrogen value chain from production and transport to industrial and mobility applications.

- AquaDuctus Pipeline GmbH

AquaDuctus Pipeline GmbH, a subsidiary of GASCADE Gastransport GmbH ("GASCADE") (Germany), will carry out the project AquaDuctus, part of this IPCEI. GASCADE operates a high-pressure gas pipeline network connecting Germany to other European countries. GASCADE is active also in several specific onshore and offshore hydrogen projects.

- Creos Deutschland Wasserstoff GmbH

Creos Deutschland Wasserstoff GmbH ("Creos") (Germany) is a 100% owned subsidiary of Creos Deutschland GmbH, a regional gas distribution network operator in the Saarland and Rhineland-Palatinate region. The subsidiary will focus on hydrogen infrastructure, by operating a pipeline system.

- Energie Salentine

Energie Salentine (Italy) is a Special Purpose Vehicle ("SPV"), whose shareholders are EN.IT, an industrial group active in renewable energy, and Green Value S.p.A, a company expert in the implementation and structuring of investments in the environment and energy sectors. It qualifies as an SME. The company focuses on investing in the development, construction, and management of infrastructure and plants for the production, distribution, and storage of hydrogen, generated through the electrolysis of water, powered by renewable energy sources.

([34] These undertakings will participate in Hy2Infra with separated individual projects implemented by the different legal entities, bringing the total number of individual projects to 33.

- ENERTRAG Elektrolysekorridor Ost GmbH & Co. KG

ENERTRAG Elektrolysekorridor Ost GmbH & Co. KG (Germany), is a SPV set up by ENERGTRAG SE for the purpose of carrying out a project in the framework of Hy2Infra. ENERTRAG SE is a producer of renewable energy. The company has expertise in the development, financing, construction, plant operations and grid design/operations for wind, solar, green hydrogen, and Power to X **("PtX")** ([35]) projects across Europe and globally.

- Eustream, A.S.

Eustream (Slovakia) is an operator of high-pressure natural gas transmission infrastructure in Slovakia. Its main activity is the transmission of natural gas to EU markets.

- EWE HYDROGEN GmbH

EWE HYDROGEN GmbH ("EWE HY") (Germany) was founded in 2022 for the purpose of developing, constructing and operating electrolysis plants for hydrogen production. As a subsidiary of the EWE Group, it is currently managed by the Business Unit Hydrogen of the EWE Group. EWE HY will build up its own resources in the future.

- EWE GASSPEICHER GmbH

EWE GASSPEICHER (Germany), part of the EWE Group, is a gas storage facility operator in the German and European gas market. The company is active also in the field of hydrogen for large-scale storage and renewable hydrogen production with water electrolysis systems.

- EWE NETZ GmbH

EWE NETZ (Germany), part of the EWE Group, owns and operates networks, including electricity and natural gas networks in Germany. The company has experience in operational management, maintenance and expansion of the network infrastructure. EWE NETZ GmbH is also active in the field of hydrogen for the future distribution of hydrogen.

- Gasnetz Hamburg GmbH

Gasnetz Hamburg GmbH ("GNH") ([36]) (Germany) owns and operates **Hamburg's gas grid. The grid consists of 7,900 km of high-**, medium- and low-pressure pipelines as well as 600 pressure regulator stations supplying energy to private and commercial grid customers.

([35]) PtX is a technology which converts electric power – typically surplus electric power generated from renewable energy sources during periods when generation exceeds load – to another form of energy (such as hydrogen, methane or methanol) for storage and reconversion to electric power, to an alternative form of energy (such as gas or synthetic fuel), or to another useful product (such as ammonia or other chemical feedstocks).

([36]) **GNH will merge with Stromnetz Hamburg ("SNH")**, the distribution system operator for electricity in Hamburg, in 2024. The merger will have no impact on the IPCEI project.

- Gasunie Deutschland Transport Services GmbH

Gasunie Deutschland Transport Services GmbH ("Gasunie") (Germany) is a subsidiary of N.V. Nederlandse Gasunie, an energy infrastructure company, managing networks and storage facilities. Gasunie is a regulated ownership unbundled TSO. Gasunie is responsible for the management, operation, and expansion of an approximately 4,200 km long pipeline network in North-Western Germany.

- GHS 2 GmbH (APEX Group)

GHS 2 (Germany) is part of the APEX Group. APEX Group, headquartered in Rostock-Laage, is a project developer of hydrogen power plant solutions. These solutions cover three main areas: real estate solutions, mobility solutions, and industrial solutions. Projects are based on a supply of renewable energy, hydrogen production, development and operation of own certified hydrogen storage systems and the supply of hydrogen fuelling stations. GHS 2 will realise and operate the project part of this IPCEI.

- Hamburg Green Hydrogen GmbH & Co. KG (i.G.)

Hamburg Green Hydrogen GmbH & Co. KG i.G. ("HGH") (Germany) has been incorporated by Hamburger Energiewerke and Luxcara in 2023, for the sole purpose of carrying out the electrolyser project taking part in Hy2Infra.

- Hevo Portugal Unipessoal Lda

Hevo Portugal Unipessoal Lda ("Hevo") (Portugal) is a SPV of Fusion Fuel Group, set up for the development and scale-up of the electrolyser project, taking part in Hy2Infra. The company qualifies as a micro, small and medium-sized enterprise ("SME") ([37]). Fusion Fuel is a developer of electrolysers and designed among others an electrolyser that can produce grid-independent renewable hydrogen.

- Hydrogenious LOHC Infra Bavaria GmbH

Hydrogenious LOHC Infra Bavaria GmbH ("Hydrogenious") (Germany) is a subsidiary company of Hydrogenious LOHC Technologies GmbH. The company qualifies as an SME. Based on its proprietary LOHC technology with benzyltoluene as the carrier medium, Hydrogenious LOHC Technologies transports and supplies hydrogen to consumers in industry and mobility sectors.

- HydroHub Fenne GmbH

HydroHub Fenne GmbH ("HydroHub") (Germany) is a wholly-owned subsidiary of Iqony Energies GmbH, part of the STEAG group. The main activities of HydroHub are the construction and operation of an electrolyser plant. The STEAG group is active in the energy markets – including power

([37]) As defined in the Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises (OJ L 124, 20.5.2003, p. 36–41).

generation, trading and district heating – with Iqony GmbH and its subsidiaries focussing on renewable and developing markets, such as hydrogen and decarbonized district heating.

- Lhyfe S.A.

Lhyfe (France) was founded in 2017. It focuses on the development, construction, and operation of hydrogen production plants at industrial scale. The company qualifies as an SME.

- Linde GmbH

Linde GmbH ("Linde") (Germany) is part of the Linde plc, global player in the industrial gases and engineering sectors. Linde is an experienced gas specialist and an important hydrogen supplier in Germany. Linde's expertise covers the entire value chain from generation and liquefaction of renewable hydrogen to solutions for transport and storage to refuelling solutions.

- Lingen Green Hydrogen GmbH & Co. KG

Lingen Green Hydrogen GmbH & Co. KG ("Lingen") (Germany), is a 100% subsidiary of BP Europa SE, an entity of BP p.l.c. group ("BP group"). BP group is active in various energy sectors including oil, gas, renewables, and conventional power. BP group's expertise includes engineering, developing, constructing, managing and operating complex and industrial scale projects, refinery operations and transport, and marketing of liquid and gaseous fuels. Lingen focuses on the development, construction, and operation of a hydrogen electrolysis plant in Lingen, Germany.

- Nowega GmbH

Nowega GmbH ("Nowega") (Germany) is a gas TSO which operates high-pressure gas pipelines in Germany.

- ONTRAS Gastransport GmbH (two projects)

ONTRAS Gastransport GmbH ("ONTRAS") (Germany) is a gas TSO based in Leipzig. ONTRAS operates Germany's second-largest gas transmission system, with approximately 7,700 km of pipelines and about 450 interconnection points. The main activities of ONTRAS are the establishment, operation, maintenance, expansion, acquisition, marketing and use of gas network systems and other gas transport and distribution systems.

- Open Grid Europe GmbH

Open Grid Europe GmbH ("OGE") (Germany) is a European gas TSO operating a natural gas pipeline network with a total length of around 12,000 km, transporting natural gas, notably in Germany. With its location in Central Europe, the pipeline system is one of the central connections for natural gas flows in the internal European market.

- Polenergia H2Silesia sp. z o. o.

Polenergia H2Silesia sp. z o. o. ("Polenergia H2Silesia") (Poland) is a part of Polenergia Group and subsidiary of Polenergia S.A.. It is an entity dedicated to the realisation of the project taking part in the IPCEI. Polenergia S.A. is a vertically integrated energy group specialized in renewable energy sources development and operation. Polenergia is developing 3500 MW of renewable energy sources in Poland – including offshore wind farms on the Baltic Sea, developed via a joint venture with Equinor. […].

- Puglia Green Hydrogen Valley Srl

Puglia Green Hydrogen Valley Srl ("PGHyV") (Italy) is a joint venture established by Edison SpA, Sosteneo Fund 1 HoldCo S. à r.L, and Saipem SpA. The **joint venture's** objective is to develop, construct and operate two hydrogen production plants, in the Puglia region, powered by renewable electricity.

- rostock EnergyPort cooperation GmbH

rostock EnergyPort cooperation GmbH ("REPCO") (Germany) is a joint venture between Rostock Port GmbH, Rheinenergie AG, EnbW Erneuerbare Energien AG and RWE Generation SE. The company is headquartered within the Rostock **seaport using an existing energy infrastructure basis. REPCO's primary** objective is to plan, build and operate an electrolysis plant at the seaport of Rostock for the production of renewable hydrogen, as part of the IPCEI.

- RWE Gas Storage West GmbH

RWE Gas Storage West **("RWE Gas Storage") (Germany) develops and** operates underground salt cavern natural gas storages. On an existing natural gas storage site, RWE Gas Storage plans to construct and operate a hydrogen storage as part of the GET H2 initiative.

- RWE Nukleus Green H2 GmbH

RWE Nukleus Green H2 GmbH ("RWE") (Germany) is a newly founded operating company, currently incorporated as subsidiary of RWE Generation SE ("RWEG"), which in turn is a 100 percent subsidiary of RWE AG. RWE Group is one of the leading European operators of renewable energies. RWEG generates electricity from gas, hard coal, hydropower and biomass.

- Snam S.p.A.

Snam S.p.A. (acronym for Società Nazionale Metanodotti) (Italy) is a company operating mainly in the transport, storage and regasification of methane. Snam manages over 38,000 km of pipelines in Italy. Snam promotes the use of fully decarbonized gases like biomethane, bio-LNG, and hydrogen.

- Thyssengas GmbH

Thyssengas GmbH **("Thyssengas")** (Germany) is a TSO, which operates a gas-pipeline-network of about 4,400 km. It is specialised in the operation, maintenance, and servicing of gas-networks.

- VNG Gasspeicher GmbH

VNG (acronym for Verbundnetz Gas) **Gasspeicher GmbH ("VGS") (Germany)** is a fully owned subsidiary of the VNG AG. Headquartered in Leipzig, VNG AG is a group of companies active in the gas and gas infrastructure sector with about 20 subsidiaries in Germany and Europe. The activities of VGS comprise operation and maintenance of the storage units, project management, and trading of storage capacity. Currently, VGS offers storage capacity in four locations **with connectivity to some of Europe's trading markets.**

- <u>Vopak New Energies B.V.</u>

Vopak New Energies B.V. ("Vopak**")** (Netherlands) enables storage and handling of bulk liquids and gases, in particular chemicals, oil products, LNG, gases, or biofuels for its customers. Vopak does not normally own nor trade products, it facilitates trade flows for multiple customers, often via open-access terminal infrastructure.

- <u>Winpower S.A.</u>

Winpower (Portugal) is a public limited company, not part of a group or joint venture. The company qualifies as an SME. Its main activities are the development, studies, design, and operation and maintenance in energy projects. It aims at developing, in particular, hydrogen and e-fuels projects.

2.4.3. Integration of Hy2Infra within the WSs (Pillar 1 and Pillar 2)

(57) Under Pillar 1, the timely execution of individual projects will help (i) achieve the overarching objective of kick-starting and ramping-up hydrogen supply chains at EU-level and (ii) deliver the quantitative objectives of each WS, each one adding value in their contribution towards the achievement of the European Hydrogen Strategy. Each WS involves WS-specific quantitative objectives and common requirements described more in detail in this section. Furthermore, pursuing the objectives of Pillar 2, it is key that the energy infrastructure planned to be implemented in the four WS across different regions in Europe is designed in a way that allows for a seamless integration of the clusters into a future European hydrogen network. In this respect collaboration on interoperability and on contribution to standards is pursued by participating undertakings both within WSs and across WSs. Contribution to the cross-WS tasks of Hy2Infra under Pillar 2 are described in section 2.4.5. while WS-specific actions under Pillar 2 are described in this section for each WS.

(58) Sub-sections 2.4.3.1 to 2.4.3.4 provide a summary description of the added value of the projects participating in each WS and their contribution to the WS-specific quantitative objectives and common objectives under Pillar 1 as well as a summary of the WS-specific contribution under Pillar 2 (described in more details under section 2.4.5.3).

2.4.3.1. Significant added value and complementarity of the individual projects for the achievement of the goals of WS1

(59) WS1 focuses on the supply of renewable hydrogen by ensuring the construction of large-scale electrolyser capacities in front runner regions in five participating Member States (Germany, France, Italy, Poland, Portugal). The 16 individual

projects in WS1 are expected to contribute towards the following overarching objectives:

(60) ***Under Pillar 1***, the participating undertakings in WS1 will install an estimated electrolyser capacity of about 3.2 GW by mid-2028 at the latest, thus contributing to the overall European goal of about 40 GW hydrogen capacity to be created by 2030 (see section 2.4.3.1). The participating undertakings in WS1 pursue the joint objective of supplying renewable hydrogen ([38]) by installing and operating large-scale electrolysers based on volatile renewable energy.

(61) ***Under Pillar 2***, the participating undertakings in WS1 will contribute to the joint definition of recommendations for the development of standards. They will present guidance regarding the operability of the installations based on intermittent renewable electricity, the use of by-products (e.g. oxygen, heat), and the environmental standards for electrolysis plants (see section 2.4.5.3.1). Based on their experience, they will make recommendations in view of accelerating and improving permitting and licensing procedures (see also section 2.4.5).

(62) To achieve the aforementioned objectives, all the projects in WS1 will need to overcome the market failures already described under section 2.1.3 (negative externalities; coordination with transport and storage; lack of harmonised technical specifications) as well as additional challenges. Several of these **challenges are the result of projects in WS1 being of first movers' nature: so far,** no large-scale hydrogen industrial application exists and there is hardly any experience in managing large-scale electrolysers commercially. The set-up of hydrogen production capacities taking place in an insecure market environment (the legal framework is still in the making; the customer basis is prospective only and not yet firmly established) and being cost intensive, create further challenges. Finally, the participating undertakings in WS1 face the challenge of matching renewable electricity generation, which is inherently variable, with hydrogen demand.

(63) WS1 involves 16 individual projects by 16 participating undertakings: Elektrolysekorridor Ost GmbH & Co. KG (DE03), GHS 2 GmbH (DE32), Air Liquide Deutschland GmbH (DE33), RWE Nukleus Green H2 GmbH (DE34), Lingen Green Hydrogen GmbH & Co. KG (DE38), EWE HYDROGEN GmbH (DE43a), Hamburg Green Hydrogen GmbH & Co. KG (DE45), HydroHub Fenne GmbH (DE54), Linde GmbH (DE63), rostock EnergyPort cooperation GmbH (DE64), Lhyfe S.A. (FR23), Energie Salentine (IT02), Puglia Green Hydrogen Valley Srl (IT49), Polenergia H2Silesia sp. z o. o. (PL01), Winpower S.A. (PT11), and Hevo Portugal Unipessoal Lda (PT25).

(64) The following table lists the individual projects in WS1 and their contribution under Pillar 1.

([38]) Only one project in WS1 will produce, alongside renewable hydrogen, electricity-based low-carbon hydrogen (up to 20%), meaning, according to the definition in the Hydrogen and Decarbonised gas package, hydrogen the energy content of which is derived from non-renewable sources, which meets the greenhouse gas emission reduction threshold of 70% compared to the fossil fuel comparator for renewable fuels of non-biological origin set out in the methodology adopted according to Article 29a(3) to Directive (EU) 2018/2001.

Project	**Capacity (MW)**	**Planned end of construction ("eoc")**
DE03 – Eco EG	185	Q4 2027
DE32 – Green Hydrogen from Rostock	100	Q1 2028
DE33 – GreenMotionSteel	120	Q4 2026
DE34 – RWE Nukleus Green H2 GmbH	300	Q2 2027
DE38 – LGH2	100	Q3 2026
DE43A – Clean Hydrogen Coastline H2 supply	370	Q4 2027
DE45 – HGHH	100	Q1 2027
DE54 – HydroHub Fenne	52	Q3 2027
DE63 – Green Hydrogen Leuna	100	Q1 2026
DE64 – HyTechHafen Rostock	100	Q2 2028
FR23 – DecarbHyndustry	200	Q4 2027
IT02 – Hydrogen – H2-4D-PugliaValley	452	Q4 2027
IT49 – Apulia Green Hydrogen Valley	160	Q2 2027
PL01 – H2Silesia	105	Q4 2026
PT11 – PtX Sines	160	Q1 2027
PT25 – Hevo Portugal	630	Q4 2027
Total	**3,234**	N/A

Table 1: Contribution of the projects in WS1 under Pillar 1

(65) The participating Member States submit that all participating projects in WS1 qualify as energy infrastructure within the meaning the TEN-E Regulation and that in particular they fulfil the following criteria: (i) the electrolysers have at least 50 MW capacity; (ii) they achieve at least 70% GHG emission savings and (iii) they have a network-related function (i.e. electrolysers function as a demand sink in times of renewable energy oversupply, thereby supporting both the integration of renewable energy and the stability of the power grid) ([39]). In addition, the participating Member States submit that all electrolyser projects in WS1 contribute to sustainability, security of supply, enabling flexibility services as referred to in Article 4(3)(d) of the TEN-E Regulation and corresponds to one

([39]) Point 4 of Annex II of the TEN-E Regulation.

of the energy infrastructure categories listed in Annex II of the TEN-E Regulation.

(66) The paragraph below provides a description of the significant added value, under Pillar 1 of the each of the WS1 individual projects in WS1:

DE03 – Elektrolysekorridor Ostdeutschland ("Eco EG")

ECo EG is a large-scale renewable hydrogen production project put forward by ENERTRAG within its project company ENERTRAG Elektrolysekorridor Ost GmbH & Co.KG. The project consists of two electrolysers in Eastern Germany, namely in Mecklenburg-Vorpommern and Brandenburg. The two electrolysers form a single, coordinated project with a nameplate capacity of 185 MW. The project also involves an on-site storage tank and a related trailer station. From 2027 onwards, renewable hydrogen will be produced and distributed via the "doing hydrogen pipeline" (DE61, included in Hy2Infra) and hydrogen trailer filling stations, to the transport sector. It is estimated that ECo EG will avoid greenhouse gas emissions of approximately 112,500 tonnes carbon dioxide equivalent per year over 20 years of operation.

DE32 – Green Hydrogen from Rostock

With the project "Green Hydrogen from Rostock", GHS 2 aims to build 100 MW electrolysis capacity in Rostock-Laage. From 2028 onwards, the plant will enable an annual production of approximately 7,843 tonnes of renewable hydrogen. The project also includes an on-site storage tank. The hydrogen produced will be fed into a new hydrogen pipeline, to be built by ONTRAS (DE61, included in Hy2Infra).

DE33 – GreenMotionSteel

ALD intends to build, between 2023 and 2026, a 120 MW water electrolysis plant to produce renewable hydrogen in the Emscher-Lippe region. A large share of the hydrogen produced is planned to be delivered to industrial customers (mainly steel and chemical industries), the remaining hydrogen production volume will be used to supply the mobility sector. The hydrogen will be fed into ALD's existing private hydrogen infrastructure system and into the yet-to-be-built European hydrogen network via the DE49 pipeline (included in Hy2Infra) to enable delivery to customers in the Rhine-Ruhr region or at any exit point of the European hydrogen system. In addition, hydrogen can be distributed via the existing or a new filling centre to any interested customer.

DE34 – RWE Nukleus Green H2 GmbH

The target of the project is the build-up, by 2027, of an electrolysis plant with a capacity of 300 MW of renewable hydrogen, in Lingen, Lower-Saxony. The build-up will be separated in three 100 MW stages, with the first 100 MW to be operational by 2025. The second and third 100 MW will follow in 2026 and 2027, respectively. The RWE Nukleus Green H2 GmbH project will be connected to the publicly accessible GetH2 hydrogen transport infrastructure (DE56, part of Hy2Infra) from Lingen to the Ruhr region as well as to the Dutch border and to Salzgitter (by 2030 at the latest), to link production, storage and industrial usage of renewable hydrogen.

DE38 – Lingen Green Hydrogen project ("LGH2")

LGH2 aims to develop, install and operate a 100 MW electrolyser to produce renewable hydrogen in Lingen, Germany. Operations are planned to start in 2026. The electrolyser system will aim at producing 10 kt of renewable hydrogen per year. The main off-takers will be refineries and industrial end users such as companies operating in steel, cement and chemical sectors. The expected CO2 emissions reduction amounts to approximately 87 kt CO2 per year.

DE43a – Clean Hydrogen Coastline H2 supply

The project consists of two sub-projects for the supply of renewable hydrogen in the Northwest of Germany to be developed by EWE HY. The first sub-project consists in the installation of water electrolysis systems at the locations of (i) Bremen (50 MW) and (ii) Emden (320 MW) for the usage in industry (in particular steel mill) and transport (heavy duty). Both projects have a planned start of operation in 2027.

DE45 – Hamburg Green Hydrogen Hub ("HGHH")

HGHH will be carried out by the joint venture, Hamburg Green Hydrogen GmbH & Co. KG. The project aims to install and operate a 100 MW electrolyser to produce renewable hydrogen on the site of the former Hamburg Moorburg hard coal power plant. Existing infrastructure components are to be maintained and additional installations for the distribution of the renewable hydrogen are to be built. Construction is intended to start in 2024, testing and start of commercial operation is planned at the beginning of 2027. The project also involves a buffer (on-site) storage tank and a related trailer station. The renewable hydrogen produced is intended both, to contribute to the regional decarbonisation of the economic area Hamburg Harbour and to be one of multiple sources for the emerging pan-European market for renewable hydrogen. Physical connection will be realised via the local hydrogen grid HH-WIN (DE23) and its connection to the project Hyperlink (DE40), taking part in Hy2Infra.

DE54 – HydroHub Fenne

The HydroHub Fenne project by Iqony GmbH plans to build a 52 MW electrolyser at an existing coal plant site in Völklingen-Fenne, to produce renewable hydrogen. The regional steel industry will initially be the main off-taker, but other industrial, mobility and fuelling companies in the region could be candidate buyers of the renewable hydrogen as well. Construction will begin in 2025 and the plant is expected to be operational by the third quarter of 2027, producing 4,950 tonnes of renewable hydrogen per year. The project plans to be connect to the pipeline project DE28, part of Hy2Infra.

DE63 – Green Hydrogen Leuna

With its project, Linde is planning to build and integrate a 100 MW electrolyser system nearby or at the Leuna site, to produce renewable hydrogen. The project is planned to be completed in 2026. The hydrogen will be used by third parties, for instance in Leuna refinery for subsequent use in mobility & industrial applications, or for the production of methanol and other RFNBO. Additionally, connected through a Linde-owned pipeline, more than 20 hydrogen users, currently using conventional hydrogen, will have the opportunity to use the produced renewable hydrogen. Furthermore, the electrolyser will also be connected to the Ontras Green Octopus pipeline DE61, part of Hy2Infra.

DE64 – HyTechHafen Rostock project

The HyTechHafen Rostock project will be realised by rostock EnergyPort cooperation GmbH. The project will build and operate a 100 MW electrolyser in Rostock at the site of an existing coal-fired power plant (brownfield approach), producing around 6,300 tonnes of renewable hydrogen per year. The plant will also include an intermediate hydrogen storage tank and trailer filling station. Potential off-takers include steel plants, refineries, chemical producers, and mobility providers. The plant is planned to go into a test operation phase in the third quarter of 2026, awaiting its connection to the grid scheduled for mid-2028. It will connect to pipeline project DE61, part of Hy2Infra.

FR23 – DecarbHyndustry

With DecarbHyndustry, Lhyfe will design, build, and operate two electrolysers to produce renewable and low-carbon hydrogen with a capacity of 100 MW each. The share of low-carbon hydrogen will be maximum 20% of the production of the electrolysers. The two plants are located in the area of Le Havre, Normandie and Ingrande-sur-Vienne, Nouvelle Aquitaine. They are planned to be commissioned in Q4 2027. The two plants represent a total electrolysis capacity of 200 MW, corresponding to about 25 kt per year of hydrogen production. On-site hydrogen storage tanks will be installed as well as a trailer station. The main off-takers of the produced renewable hydrogen will be industrial end users (green ammonia and green methanol producers) and other end users (such as public and private transport companies, or logistic platforms).

IT02 – Hydrogen – H2-4D-PugliaValley

With this project, Energie Salentine will build a renewable hydrogen production plant in Puglia with a total electrolysis capacity of 452 MW (400 MW in Taranto and 52 MW in Brindisi), with an expected production of more than 40,000 tonnes per year; the electrolysers will be partially connected directly to PV plants to be installed in the area. The project also involves an on-site storage facility. The IT02 project will contribute to the region's decarbonization efforts by offering supply of renewable hydrogen to all potential off-takers. Moreover, a share of electrolysis plant capacity will provide grid flexibility services to Terna. Renewable hydrogen production is expected to start in last quarter of 2027. For the supply of the hydrogen to off-takers, the electrolysers will connect to a hydrogen network under development by Snam (IT21).

IT49 – Apulia Green Hydrogen Valley

The project that will be carried out by Puglia Green Hydrogen Valley Srl will be located in the Puglia region. It consists in the construction of two renewable hydrogen production plants, in Brindisi (60 MW) and Taranto (100 MW), powered by renewable electricity partially produced by dedicated photovoltaic ("PV") plants. The produced hydrogen will be made available to off-takers mainly through a hydrogen network under development by Snam (project IT21, part of Hy2Infra), contributing to the decarbonization of the nearby industrial sites of Brindisi (including petrochemical industry and power stations) and Taranto (including energy intensive industries such as a steel-making plant and refineries). The project is currently scheduled to become operational by 2027.

PL01 – H2Silesia

H2Silesia is a renewable hydrogen production installation project developed by Polenergia H2Silesia. H2Silesia Project is planned to be located in [...] the Upper Silesia region. It consists of PEM electrolysers, hydrogen storage facility for supply stability purposes, and hydrogen trailers filling stations. The project considers the construction of a 105 MW capacity electrolysis plant, which enables renewable hydrogen production at the average level of up to 10,300 tonnes per year. The project also includes an on-site storage and a trailer station. The main off-takers of the produced renewable hydrogen will be industrial and mobility end users. It is assumed that the project will be ready for operation by the end of 2026.

PT11 – **Winpower's PtX Sines**

Winpower will install large scale renewable hydrogen generation capacity, with 160 MW electrolysis, for a 23,000 ton/year production of hydrogen. The project also involves an on-site storage facility. The project will deliver its production to (i) the Sines Hydrogen backbone ring, a hydrogen pipeline to be installed by the Portuguese gas TSO, Redes Energéticas Nacionais, and (ii) the compressed storage transportable racks, to deliver directly to mobility/transport or industrial applications. PT11 is located in the Sines Industrial and logistics zone. The electrolysis capacity will be made available in two stages; the full operation is intended to be in place in 2028.

PT25 – Hevo Portugal

The Hevo-Portugal project consist of the construction of a 630 MW PEM-electrolyser in Sines, capable of generating 62,000 tonnes per year of renewable hydrogen. Like PT11, Hevo-Portugal project will connect to the Sines Hydrogen backbone ring. The project is anticipated to be fully operational by the end of 2027.

2.4.3.2. Significant added value and complementarity of the individual projects for the achievement of the goals of WS2

(67) WS2 focuses on the installation of hydrogen transmission and distribution infrastructure via pipelines and technical grid infrastructure in three participating Member States (Germany, Italy, Slovakia). The 12 individual projects in WS2 are expected to contribute towards the following overarching objectives:

(68) ***Under Pillar 1***, the participating undertakings in WS2 will build 1,063 km of new pipelines and repurpose ([40]) approximately 1,607 km of existing natural gas pipelines into pipelines for the transport of hydrogen in Germany, Italy and Slovakia contributing to the emergence of open-access transmission and distribution systems.

(69) ***Under Pillar 2***, based on their experience, the participating undertakings in WS2 will (i) contribute to the development of technical standards for hydrogen pipelines, (ii) share knowledge on the construction and operation of hydrogen pipelines, and (iii) share recommendations regarding approval procedures and environmental impact assessment (see section 2.4.5.3.2).

(70) To achieve these objectives, the individual projects in WS2 will need to overcome the market failures already described under section 2.1.3 (insecure economic viability of hydrogen transport; coordination with hydrogen supply; lack of technical standards) as well as additional challenges relating to (i) the lack of experience with the transport of renewable hydrogen; (ii) shortage of skilled employees and (iii) a regulatory framework in the making.

(71) WS2 involves 12 individual projects by 11 participating undertakings: Creos Deutschland Wasserstoff GmbH (DE28), Eustream, A.S. (SK04), EWE NETZ Gmbh (DE07), AquaDuctus Pipeline GmbH (DE29), Gasnetz Hamburg GmbH (DE23), Gasunie Deutschland Transport Services GmbH (DE40), Nowega GmbH (DE56), ONTRAS Gastransport GmbH (DE61 and DE71), Open Grid Europe GmbH (DE49), Snam S.p.A. (IT21), Thyssengas GmbH (DE26).The following table lists the contributions of the individual projects in WS2:

([40]) **'Repurposing' means the technical upgrading or modification of existing natural gas infrastructure in** order to ensure that it is dedicated for the use of pure hydrogen (TEN-E regulation, Article 2 (18)).

Project	Segment ([41])	Repurposed [km]	Newly built [km]	Planned eoc
DE07 – CHC - H2 infrastructure	Distribution	28	22.5	Q1 2027
DE23 – HH-WIN	Distribution	-	40	Q2 2027
DE26 – GETH2	Transmission	61	11.9	Q1 2027
DE28 – MosaHYc	Distribution	22.5	18.5	Q3 2027
DE29 – Aquaductus	Transmission	-	295	Q4 2029
DE40 – Hyperlink	Transmission	354.05	53	Q4 2026/29
DE49 – GETH2	Transmission	42.5	34.9	Q4 2026
DE56 – GETH2	Transmission	142	15.6	Q4 2026
DE61 – Doing hydrogen	Transmission	176.1	441.5	Q2 2029
DE71 - Green Octopus Mitteldeutschland – GO!	Transmission	195.5	105.9	Q1 2029
IT21 - H2 Valley Puglia	Transmission	85	24	Q4 2027
SK04 - H2I-TR	Transmission	500	-	Q4 2029
Total	**N/A**	**1,607**	**1,063**	**N/A**

Table 2: Contribution of projects in WS2 under Pillar 1

(72) The projects share the common objective to provide open and non-discriminatory access to pipelines for the large-scale transport of hydrogen. The hydrogen transport infrastructure to be built in WS2 is a key connecting element of Hy2Infra as it links production and storage as well as port infrastructure with each other and with downstream consumers of hydrogen. The transport infrastructure in WS2 constitutes the basis for the long-term development of an EU-wide

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([41]) According to the text of the provisional agreement between the Parliament and the Council on the **"Hydrogen and decarbonised gas market package"** (see footnote 10):

'hydrogen transmission network' means a network of pipelines for the transport of hydrogen of a high *grade of purity, in particular, networks which include hydrogen interconnectors, or which are directly connected to hydrogen storage, hydrogen terminals or two or more hydrogen interconnectors or which primarily serve the purpose of transporting hydrogen to other hydrogen networks, hydrogen storages or hydrogen terminals. Such networks may serve the purpose of supplying directly connected customers.*

'hydrogen distribution network' means a network of pipelines for the local or regional transport of *hydrogen of a high grade of purity, which primarily serve the purpose of supplying directly connected customers, and do not include hydrogen interconnectors, and are not directly connected to hydrogen storage or to hydrogen terminals, unless the network in question was a natural gas distribution system on [entry into force of this Directive] and has been partially or fully repurposed for the transport of hydrogen, or to two or more hydrogen interconnectors.*

hydrogen network: these projects provide the groundwork for the interregional and cross-border exchange of hydrogen, that will be consolidated through further hydrogen pipelines projects. In this respect, there are examples of projects with significant cross-border relevance under WS2 include:

- Projects reaching up to a cross-border point: DE40 and DE26 will both reach the German-Dutch border and DE61, the German-Polish border.

- Transit pipelines: SK04 will stretch from the Slovak-Ukrainian border to two connection points at the Slovak-Austrian border and the Slovak-Czech border.

- Projects that are part of cross-border regional clusters: DE28 will deploy the German section of the MosaHyc project, an initiative connecting France, Germany, and Luxembourg.

- Off-shore pipelines: DE29 will enable both off-shore renewable hydrogen on the national Exclusive Economic Zone as well as interconnections with other hydrogen subsea pipelines, making imports from other countries located around the North Sea possible.

(73) The participating Member States submit that the individual projects in WS2 correspond to one of the energy infrastructure categories of Annex II to the TEN-E Regulation, i.e. they are "pipelines for the transport, mainly at high pressure, of hydrogen, including repurposed natural gas infrastructure, giving access to multiple network users on a transparent and non-discriminatory basis". They further submit that they contribute significantly to hydrogen market integration or to security of supply or to competition in the hydrogen market by allowing access to multiple supply sources and network users on a transparent and non-discriminatory basis.

(74) The paragraph below provides a description of the significant added value, under Pillar 1, of the each of the individual projects in WS2:

DE07 – Clean hydrogen coastline H2 Infrastructure

EWE NETZ is planning the infrastructural connection of an electrolyser in Emden (EWE Gasspeicher, DE43a) and of a hydrogen cavern storage facility in Huntorf (EWE Gasspeicher, DE43b), to the planned H2 long-distance network (from Gasunie Deutschland, DE40). It forms part of the "Clean hydrogen coastline H2 Infrastructure" initiative ("CHC"). A total of 28 km of natural gas pipelines will be converted and a further 22.5 km of hydrogen pipelines will be newly constructed. One of the possible off-takers of the transported hydrogen will be steelworks in Bremen connected within the CHC-H2-infrastructure project. The work on the pipelines is scheduled to be completed by the first quarter of 2027.

DE23 – HH-WIN

The scope of GNH's project HH-WIN is establishing a 40 km long hydrogen transport and distribution infrastructure for Hamburg's main industry (steel, aluminium, refineries), logistics and heavy transport cluster. The entire HH-WIN will be connected to the supra-regional transport infrastructure via

Hyperlink (DE40), as well as to hydrogen production sites (like the 100 MW electrolyser, DE45), both participating in Hy2Infra. The infrastructure contains a length of 40 km. GNH plans to reach the full initial scope of the project by June 2027.

DE26 – GETH2

DE26 concerns the development of a pipeline section by Thyssengas GmbH within the GetH2 initiative. It entails 72.93 km of hydrogen-dedicated pipelines. 11.1 **km concerns Thyssengas' share of a new pipeline constructed between** Dorsten and Hamborn (jointly with OGE, project DE49), 0.7 km concerns **Thyssengas' share in the construction of a new pipeline between Frensdorfer** Bruchgraben and Frenswegen (jointly with Nowega, DE56) and 61 km concerns the conversion of natural gas pipelines between the cross-border connection in Vlieghuis (connected to the network of Gasunie/HyNetwork Services in the Netherlands) and Ochtrup. The GetH2 network will be located in the North-Western part of Germany bordering the Netherlands and connecting renewable hydrogen producers, hydrogen storage providers and industrial hydrogen consumers including steel producers in the industrial Rhine-Ruhr area in North Rhine-Westphalia. The cross-border connection to the Netherlands will enable the import and export of hydrogen. The 61 km converted pipelines will be ready for operation in 2025. The Dorsten-Hamborn pipeline will be ready for operation in 2027. The pipeline network will initially have a transmission capacity of 0.42 GW, increased to 0.6 GW by 2028, enabling up to 0.8 GW with additional investments in the Dutch system.

DE28 – mosaHYc

Creos plans the implementation of the cross-border German / French high pressure hydrogen network mosaHYc to be commissioned in 2027. The project area is the border region of the Land Saarland and the Lorraine area in France, a **part of the Interreg "grande region". The total length of pipelines to be** converted on the German side is around 22 km, and approximately 18 km of additional pipelines will be built. Renewable hydrogen will be transported first to industrial end users (such as steel factory). Other consumers may decide to use renewable hydrogen and will be connected in the timeframe between this proposal and the commissioning. Initially, the electrolyser of the HydroHub Fenne (DE54) and Gazel Energy on the French side will feed the network, additional electrolysers are likely to get connected.

DE29 – AcquaDuctus

The project AquaDuctus, carried out by AquaDuctus Pipeline GmbH, is an offshore hydrogen pipeline of 295 km located in the German part of the North Sea. The project encompasses the plan to build a 20 GW-scale offshore **hydrogen pipeline in the German Exclusive Economic Zone ("EEZ") with a** transport capacity of approximately 20 GW and interconnection points to link neighbouring European hydrogen infrastructures. This pipeline will provide non-discriminatory access to several network users (e.g. producers of green hydrogen from offshore wind farms). By 2029, AquaDuctus will connect the hydrogen wind farm site SEN-1 located in the German EEZ northwest of Heligoland via offshore pipeline to the German mainland (Wilhelmshaven) and from thereon via onshore pipeline to Bunde (overall lengths ca. 300 km) and the downstream onshore hydrogen infrastructure (in particular, to Hyperlink (DE40) to European consumers. In addition, AquaDuctus will be of high importance for stakeholders aiming for hydrogen imports to Germany via the offshore North Sea route (e.g. Norway, United Kingdom, the Netherlands etc.) as they will be able to connect other offshore pipelines to AquaDuctus. DE29 is included as PCI in the first PCI/PMI list.

DE40 – Hyperlink

Hyperlink is a hydrogen pipeline project of Gasunie Deutschland Transport Services GmbH. The pipelines will have a total length of 407 km. In total 354 km of hydrogen pipelines will be converted from existing natural gas pipelines, whereas 53 km concerns the construction of new pipelines to fill remaining gaps. The hydrogen pipelines will be located in the northern part of Germany from the border with The Netherlands via Bremen and Hamburg to Hannover. The project will connect green hydrogen producers, hydrogen storage providers and industrial hydrogen consumers including steel producers in the Bremen, Hamburg and Hannover industrial areas. The cross-border connection to the Netherlands will enable the import and export of hydrogen. Phase one of the project (HPL 1, Dutch border to Hamburg) will be ready for operation in 2026. Phase two (Hamburg to Hannover, HPL 2) will be ready for operation in 2029. The pipelines will have a transmission capacity of up to 7.2 GW.

DE49 – GET H2

Open Grid Europe's role in this project, in close cooperation with the other participating German TSOs Nowega and Thyssengas, is to convert parts of the existing natural gas pipeline system to hydrogen, as well as to build new hydrogen pipelines and thus enable the hydrogen transport from the source to the sink with the integration of hydrogen salt cavern storage facilities in Gronau-Epe operated by RWE Gas Storage West (DE24). This pipeline system will offer the basis for several subsequent expansions of the infrastructure (not included in Hy2Infra). In the framework of the Hy2Infra timeline, it will offer the possibility to connect additional customers to the new hydrogen grid as of the end of 2026. GET H2 will initially connect a RWE electrolyser in Lingen (DE34), and a refinery operated by BP in Gelsenkirchen (2025). Until 2026 the pipeline grid will be extended to allow for transport of hydrogen from a new connection point to the Netherlands to a steel mill operated by Thyssenkrupp Steel Europe as well as a hydrogen storage facility to be operated by RWE Gas storage West (DE24). The project consists of the conversion of three pipeline segments, new construction of three pipeline segments, a new pressure regulation and metering station, and a purification unit located primarily in northern North Rhine-Westphalia with total length of 140 km together with the other GET H2 partners. Within the above outlined time frame the transported hydrogen volumes will increase from 80 MW to a total of 660 MW across all customers and routes. Construction will start in 2023 and will be finalized at the end of 2026.

DE56 – GET H2

Nowega will set-up a 157.6 km-long hydrogen transport infrastructure by 2026, within the GET H2 initiative to create a connection from Lingen to Marl. Out of the 157.6 km, 142 km will be conversion of natural gas pipelines into hydrogen pipelines and 15.6 km will be newly constructed pipeline sections. A further expansion of this network by 2030 would correspond to approximately 453 km and would enable – inter alia – a connection to Salzgitter (outside of Hy2Infra).

DE61 – Doing hydrogen

ONTRAS Gastransport GmbH aims to provide part of a hydrogen transport infrastructure in East Germany. "Doing hydrogen" brings together innovative producers, gas network operators and end users with the aim to establish a European hydrogen cluster in East Germany from 2027 onwards and, in the medium term, an interconnected hydrogen system with connection points to Western Germany, Poland, the Baltic Sea region, as well as Central and Eastern European countries. Within the project DE61, ONTRAS will establish a transport infrastructure for hydrogen with a total length of 618 km from Rostock to Leipzig in East Germany by repurposing existing pipelines for natural gas and building new pipelines. Specifically, ONTRAS will repurpose 176 km and construct 442 km of pipeline. The commissioning will start in 2027, depending on the section of the pipeline infrastructure. Full operation will be achieved in 2029.

DE71 – Green Octopus Mitteldeutschland – GO!

ONTRAS Gastransport GmbH plans to extend the hydrogen nucleus being **created in the 'Bad Lauchstädt Energy Park' northward, traversing Saxony-**Anhalt with its industries and finally reaching the steel mills in Salzgitter, Lower Saxony and connecting to a pipeline towards the North Sea and Benelux. In the South of Germany, DE71 will fan out into three individual pipeline strings embracing the Leipzig metropolitan area from the north and from the south. One of these pipelines connects as well with pipeline project DE61. The infrastructure will have a length of 302 km pipelines, based on 196 km repurposed and 106 km newly built pipelines. The pipelines will support a flexible arrangement of entry and exit points for injecting or withdrawing hydrogen, enabling a non-discriminatory third-party access. The commissioning will start in 2027 depending on the section of the pipeline infrastructure. Full operation will be achieved by 2029. There will be a close collaboration with the **'Green Octopus Storage' project DE18, the storage is directly connected to** DE71 and needed to stabilize fluctuations of demand and supply.

IT21 – H2 Valley Puglia

Snam's project aims to establish a hydrogen transport infrastructure, linking planned hydrogen generation sites in Apulia (IT49 by PGHYV and IT02 by Energie Salentine) to key end-user districts, primarily in the steelmaking, refining and chemical sectors. In particular, the project involves the realization and operation of a hydrogen transport pipeline (up to 94.5 kt per year capacity) from the Brindisi area to the Taranto area. This includes a) the repurposing of the Palagiano - Brindisi natural gas pipeline (about 77 km length) and part of the pipeline towards Brindisi (about 7 km) to transport hydrogen, b) construction of pipeline connections to enable the injection of hydrogen from the partner

projects' production sites (about 7 km), and c) construction of a new pipeline to serve the Taranto industrial area (about 17 km). The pipelines should be in operation by the end of 2027.

SK04 – H2I-TR

The scope of the H2I-TR project, carried out by Eustream, includes repurposing a 500 km long natural gas pipeline for pure hydrogen cross-border transmission and construction of two compressor stations by the end of 2029. The future hydrogen pipeline will reach to the Ukrainian border on the eastern side and to the border with Czechia and Austria on the western side. **Eustream's pipeline** would prepare the ground not only for renewable hydrogen imports from Ukraine but also result in a bidirectional interconnection between the EU and Ukraine. The reverse H2 flow to Ukraine has potential to contribute to the **country's recovery efforts to be in line with the green transition** and the Memorandum of Understanding ([42]) between the EU and Ukraine on a Strategic Partnership on Biomethane, Hydrogen and Other Synthetic Gases. Eustream has signed a Cooperation Agreement on the H2EU+Store ([43]) project with several parties including the Austrian TSO Gas Connect Austria and the Ukrainian producer ECO-Optima. The H2EU+Store aims to develop hydrogen imports from Ukraine through Slovakia, Austria and Germany through Bavaria. The SK04 repurposed pipeline will have a capacity of 9.1 GWh/h / 2.02 Mt per year at the Ukrainian and Slovak border and 6 GWh/h / 1.33 Mt per year at Czech and Slovak as well as the Austrian and Slovak borders from 2030. SK04 is also expected to be connected via a local distribution network with the three largest **hydrogen consumers in Slovakia, the steel plant in Košice, fertilizer plant in Šaľa and refinery in Bratislava.** Construction will take place between January 2027 and June 2029 (2.5 years). The project will repurpose one pipeline between the Ukrainian border (Border Delivery Station Ruská), the Czech border (Brodské – **Lanžhot) and** the Austrian border (Vysoká pri Morave – Baumgarten).

2.4.3.3. Significant added value and complementarity of the individual projects for the achievement of the goals of WS3

(75) WS3 focuses on the installation of hydrogen large-scale storage facilities in in three locations within Germany. The three individual projects in WS3 are expected to contribute towards the following overarching objectives:

(76) ***Under Pillar 1***, the participating undertakings in WS3 will deploy large-scale storage sites with a capacity of 9,120 tonnes of hydrogen in three locations (see section 2.4.3.3). They are all deployed in underground salt caverns that were so far unused or used to store natural gas and which would be repurposed.

(77) ***Under Pillar 2***, based on their experience, the participating undertakings in WS3 will (i) contribute to the development of technical standards for hydrogen storage

([42]) See: https://energy.ec.europa.eu/system/files/2023-04/MoU_UA_signed.pdf.

([43]) See: https://www.h2euplusstore.com/en/project/project-description-and-goals.html.

facilities, and (ii) develop joint recommendations hydrogen infrastructure systems balancing rules (see section 2.4.5.3.3).

(78) WS3 involves three individual projects by the participating undertakings: VNG Gasspeicher GmbH (DE18), RWE Gas Storage West GmbH (DE24), and EWE GASSPEICHER GmbH (DE43b). The following table lists the contribution of the WS3 individual projects.

	Capacity in tonnes of hydrogen	**Capacity in GWh (44)**	**Planned eoc**
DE18 – Green Octopus Central Germany – GO!	4,494	177	Q4 2028
DE24 – RGSW Gronau-Epe	3,420	135	Q4 2026
DE43B – Clean Hydrogen Coastline – H2 storage	1,500	60	Q4 2027
Total	**9,120**	**372**	

Table 3: Contribution of the projects in WS3 under Pillar 1

(79) The participating Member States submit that the individual projects in WS3 correspond to one of the energy infrastructure categories listed in Annex II to the TEN-E Regulation. In this regard, the large-scale storage projects of WS3 will (i) allow to store excess capacity of hydrogen, (ii) ensure industrial customers with a constant and uninterrupted supply of hydrogen; (iii) give the pipeline grid operators the possibility to control the flows of hydrogen; (iv) help to handle the growing complexity of the balancing of supply and demand with the growth of the hydrogen network. All storage projects declare to comply with principles of open and non-discriminatory access to the infrastructure and non- discriminatory pricing and network operation.

(80) The participating undertakings in WS3 describe the following benefits of their project at system level:

i. Storage will help mitigate the high seasonality in hydrogen production and enable WS1 participating undertakings to invest in additional production capacity.

ii. Storage can guarantee a constant supply of hydrogen to industrial process that so require, facilitating end **users' decision to switch to renewable and** low-carbon hydrogen or to increase its consumption.

iii. WS3 projects will provide pipeline operators with more possibilities to control flows and meet hydrogen demand. This can be particularly helpful **at the early stages of the hydrogen system development, when the grid's** flexibility might be not sufficient due to the small size of the network.

(44) Conversion to GWh considering the high heating value of hydrogen of 39,39 kWh/kg.

iv. The scale-up of the system, with a variety of customers and production sites of different scales, will increase storage demand in absolute terms.

v. Storage will contribute to preserve security of supply in case of disruptions.

vi. Storage sites connected to a wide network can help boost hydrogen production in regions where underground storage is not available.

(81) The participating Member States claim that, to achieve these objectives, all the WS3 individual projects will need to overcome the market failures already described under section 2.1.3; as well as additional challenges relating to e.g. (i) the technical complexity of the storage of hydrogen and (ii) a regulatory framework in the making.

(82) The paragraph below provides a description of the significant added value, under Pillar 1, of the each of the individual projects in WS3:

<u>DE18- Green Octopus Central Germany – GO!</u>

With this project, VNG Gasspeicher GmbH proposes the conversion of an existing natural gas storage cavern for the storage of gaseous hydrogen, with a capacity of 4,494 tonnes of hydrogen (177 GWh). The cavern storage facility is located in Bad Lauchstädt, about 30 km west of Leipzig, close to future consumers in the Central German Chemical Triangle. The planned hydrogen storage facility is at a point where five long-distance pipelines of the planned European hydrogen network come together. The proposed hydrogen storage facility - in interaction with other projects - creates an effective balance between hydrogen supply and demand. VGS assumes that the plant will be ready for operation at the end of 2025 and will be available for the first filling of the cavern from summer 2026 when the brine emptying plant is ready for operation. From 2029, the hydrogen storage facility will go into regular operation.

<u>DE24 – Get H2</u>

RWE Gas Storage West's ("RGSW") project aims to develop two salt caverns for the storage of renewable hydrogen at the RGSW site in Gronau-Epe, Germany. The storage plant will have a capacity of 135 GWh. The storage plant will be capable to inject and withdraw 50,000 Nm^3/h (approx. 4,500 kg/h) of hydrogen and to store up to 38 million Nm^3 (3,420 tonnes) of hydrogen working gas volume in two salt caverns. The caverns are expected to be commissioned by Q1 2027. The main off-takers will be refineries and companies operating in industrial sectors such as that of steel. The project plans to have a cross-border connection to the Dutch hydrogen backbone.

<u>DE43B – Clean Hydrogen Coastline H2 Storage</u>

This project, carried out by EWE GASSPEICHER GmbH, has the objective to establish secure and open access hydrogen storage of up to 1,500 tonnes capacity for cross-sector applications in the Northwest of Germany, by the end of 2027. DE43B will provide large-scale underground storage capacity for hydrogen in the North-West of Germany by retrofitting a natural gas cavern into a hydrogen storage cavern in Huntorf. The main off-takers will be selected following an open-season process and a subsequent open auction process.

2.4.3.4. Significant added value and complementarity of the individual projects for the achievement of the goals of WS4

(83) WS4 focuses on the handling of hydrogen embedded in LOHC and the related port infrastructure in two participating Member States (Germany and the Netherlands). LOHC offers high flexibility of hydrogen transport by using mobile transport modes like ships, trains and trucks that can move large amounts of hydrogen over very long distances. These transport modes are flexible in their route (and scale) and can therefore connect different sources and off-takers. They still require infrastructure to bind the hydrogen to the organic carrier and then release the hydrogen again, as well as handling equipment. Besides pipeline connections, it is thus possible to use other means of transport to secure hydrogen supply across Europe. Especially when it is not feasible to construct pipeline connections for technical or economic reasons, transport options involving embedded (LOHC) hydrogen can be used for the interconnection of production and off-take.

(84) The two individual projects in WS4 are expected to contribute towards the following overarching objectives:

(85) ***Under Pillar 1***, the participating undertakings in WS4 will deploy a hydrogen transport infrastructure based on LOHC terminals connecting regions with high **renewable energy sources ("RES") potential with high energy demand (e. g. the** Netherlands, Germany) in the short-term. More precisely, WS4 will deploy terminals with a capacity to handle 6,000 tonnes of renewable hydrogen per year.

(86) ***Under Pillar 2***, based on their experience, the participating undertakings in WS4 will (i) contribute to the development of technical standards for LOHC handling terminals (e.g. modes of hydrogen transport, hydrogen quality derived from LOHC, loading and unloading stations) (see section 2.4.5.3.4).

(87) The participating Member States claim that, to achieve these objectives, the WS4 individual projects will need to overcome the market failures already described under section 2.1.3 as well as additional challenges relating to the highly complex technology.

(88) WS4 involves two individual projects by the participating undertakings: Hydrogenious LOHC Infra Bavaria GmbH (DE59) and Vopak New Energies B.V. (NL57).

Project	**Handling capacity (in tonnes per day ("tpd")**	**End of construction**
NL57 – Northern Green Crane	12 tpd (release)	Q4 2028
DE59 – Green Hydrogen @ Blue Danube	5 tpd (storage/release)	Q2 2027

Table 4: Contribution of projects in WS4 under Pillar 1

(89) The participating Member States submit that the individual projects in WS4 qualify as energy infrastructure, as they fulfil the conditions of the TEN-E

Regulation. In this regard, the LOHC handling terminal projects of WS4 will enable the development of hydrogen maritime trade routes within the EU and potentially from third countries. The reception terminals plan a connection to an open-access hydrogen network in their respective locations. All WS4 projects declare to comply with principles of open and non-discriminatory access to the infrastructure and non- discriminatory pricing and network operation.

(90) Project NL57 enables a complete supply chain by receiving LOHC by maritime transport from other European countries in Rotterdam and distributing it from there onwards. Project DE59 enables a local hydrogen transport chain within Germany, with the possibility to further develop a hydrogen value chain along the Danube-river. Both projects thus aim at developing cross-border hydrogen value chains. Both receiving terminals will be connected to the hydrogen network: NL57 plans to connect to the Dutch Hydrogen backbone and DE59 to the HyPipe Bavaria pipeline.

(91) The paragraph below provides a description of the significant added value, under Pillar 1, of the each of the individual projects in WS4:

DE59 – Green Hydrogen @ Blue **Danube ("GH@BD")**

Project GH@BD, conceived by Hydrogenious LOHC Infra Bavaria GmbH, aims at developing a blueprint for the establishment of import routes for renewable hydrogen from south-eastern Europe and supply it to customers in southern Germany and in the transnational Interreg Danube region and the TEN-T corridors to Southern. At the same time, the construction of LOHC dehydrogenation plants and the supply to regional customers will also prepare the market for imports and use of green hydrogen. DE59 is planning to build a 5 **tpd dehydrogenation unit (**'release plant'**) in Bavaria, Germany and a hydrogenation unit (**'storage plant'**) with a capacity of 0.5 tpd in Bavaria,** Germany. The released hydrogen could be used at the refinery in Neustadt an der Donau and/ or could be fed into **the future hydrogen grid 'HyPipe Bavaria'**. The LOHC can also be transported from Rotterdam (NL57).

NL57 – Northern Green Crane

For the project NL57**, Vopak's scope consists in operating a 12 ton** per day **release/dehydrogenation plant provided by Hydrogenious at Vopak's premises** in Rotterdam (Europoort terminal). For this project alone, Vopak may also act as trader, buying the LOHC and injecting the hydrogen (extracted from the LOHC) into the national hydrogen backbone in order to deliver it to contracted off-takers (commercial conversations are ongoing with large industrial players). The supply chain also envisages non-IPCEI-related steps, such as LOHC shipping, performed by a traditional shipping company, and storing the imported LOHC in Rotterdam (approximately 9500 m3 of tank capacity): storing will be done by an existing Vopak terminal company which will not directly participate in the IPCEI application, but only charge fees to the NL57 project company.

2.4.4. *Significant added value and complementarity of Hy2Infra clusters and their links (integration under Pillar 1)*

(92) Most of the projects in Hy2Infra will directly connect physically to each other within regional clusters ([45]) in different participating Member States in functional, open, and non-discriminatory networks, which will form the basis for the future development of a European hydrogen infrastructure. In line with the objectives set out in Pillar 1, within a cluster, the build-up of electrolyser capacities (WS1) will be coordinated along with the realisation of projects for transport and distribution (WS2), storage (WS3) and/or the handling of embedded hydrogen / port-infrastructure (WS4). Most clusters already include connection points to hydrogen customers, which, acting as initial hydrogen consumers, underpin the economic feasibility of Hy2Infra (taking into account the planned public support).

(93) Some of the projects selected by the participating Member States, while being part of a local or regional hydrogen value chain, do not directly connect physically to any other project within Hy2Infra. These projects are designated as **"nuclei** projects" (NL57, DE59, FR23, PL01, and SK04). These individual projects are part of Hy2Infra, as they represent important focal points in different participating Member States necessary for a subsequent development of regional clusters, and national and trans-national hydrogen infrastructures. In addition, the incorporation of these nuclei in Hy2Infra ensures knowledge transfer between nuclei and clusters. With this approach, specific technical conditions of all participating Member States can be integrated in the framework of the common agreement for interoperability and the common deliverables on standardisation and operational rules. Furthermore, the alignment of different European regions will not only help to develop domestic infrastructure but will also pave the way for important trans-European hydrogen transmission routes. Nuclei projects are described below within the cluster they are expected to connect to at an earlier stage.

(94) While Hy2Infra clusters and nuclei do not form a single continuous network and serve primarily a local or regional purpose, they are expected to be either directly connected to another Hy2Infra cluster or indirectly connected to another Hy2Infra cluster via complementing projects outside the Hy2Infra sphere. Such complementing projects are typically projects of common interest in energy as defined in the TEN-E regulation that have been included first list of PCIs and **Projects of Mutual Interest ("PMIs")** ([46]) as hydrogen infrastructure projects or projects included in Hy2Use. In one instance (in Portugal), the complementing project is an initiative the participating Member State has mandated the local TSO to carry out.

(95) In line with the European Hydrogen Strategy, regional clusters and nuclei within Hy2Infra contribute to the gradual emergence of an EU-wide hydrogen network evolving from a regional focus at the initial stages to cross-border networks in the

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([45]) In the context of Hy2Infra, a cluster is defined by the physical connection of projects involving at least two different steps of the hydrogen value chain, i.e. projects included in at least two different WSs.

([46]) The Union list of PCI and PMI is accessible here: https://energy.ec.europa.eu/system/files/2023-11/Annex%20PCI%20PMI%20list.pdf.

longer-term while ensuring interoperability of markets for pure hydrogen (see recital (10)).

(96) In the figures shown throughout this section, PCI/PMI are depicted in bold grey. PCI are designated by the code assigned to them in the PCI data collection process ([47]). These codes follow the naming HYD-N-XXX. The name of the project is indicated between parentheses. Other local developments showing a high level of maturity stemming, for example, of a mandate given by competent authorities to a local operator to develop such infrastructure are shown in light grey. Where relevant, some other infrastructure developments taking place over the longer-term or showing less maturity have also been included explicitly in certain figures to illustrate the potential for future interconnections between Hy2Infra projects.

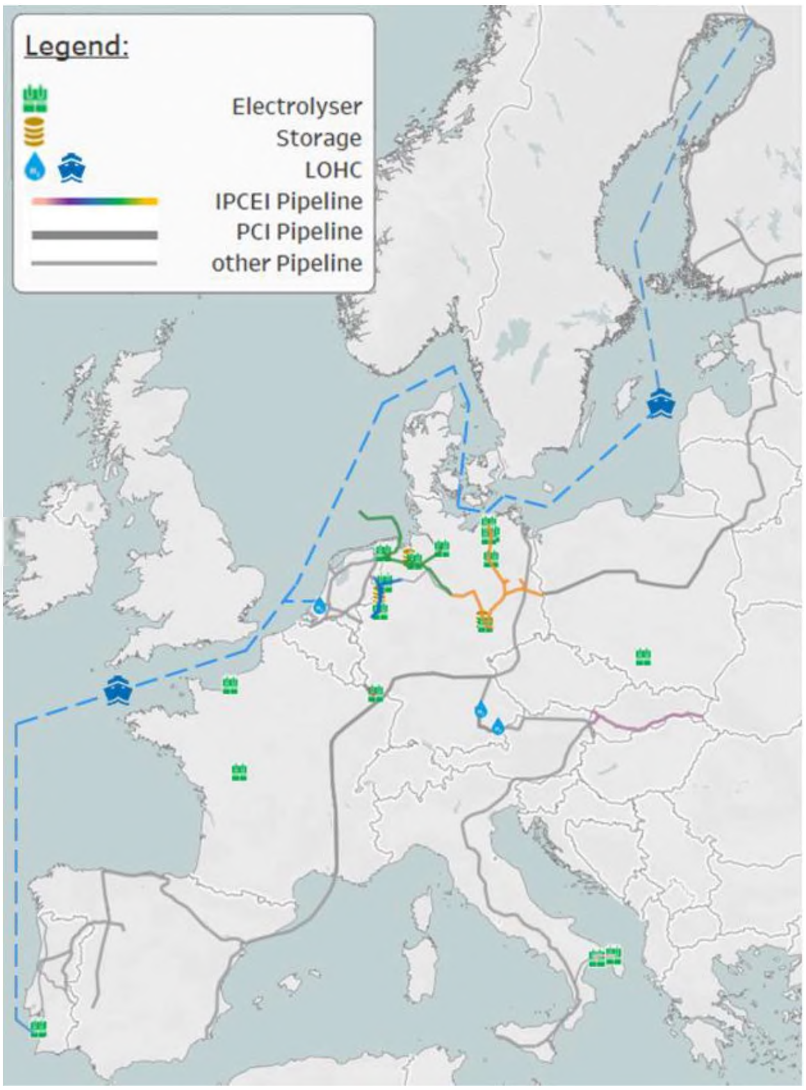

Figure 1: Projects and Clusters Overview Hy2Infra

([47]) The full list of projects and their corresponding code can be found here: https://www.entsog.eu/sites/default/files/2023-09/ENTSOG_TYNDP_2022_Annex_A_Project_Details_230411.xlsx.

(97) Considering the physical connections or logistic chains that will be effectively achieved within the scope of Hy2Infra, the participating Member States have grouped the individual components into the following clusters:

Cluster Name	Project ID	Company	WS	Capacity	Planned eoc
East Germany	DE03	ENERTRAG Elektrolysekorridor Ost GmbH	1	185 MW	Q4 2027
	DE18	VNG Gasspeicher GmbH	3	~ 4,494 t	Q4 2028
	DE32	GHS 2 GmbH & Co. KG	1	100 MW	Q1 2028
	DE61	ONTRAS Gastransport GmbH	2	~ 618 km	Q2 2029
	DE63	Linde GmbH	1	100 MW	Q1 2026
	DE64	rostock EnergyPort cooperation GmbH	1	100 MW	Q2 2028
	DE71	ONTRAS Gastransport GmbH	2	~ 302 km	Q1 2029
North-West Germany	DE07	EWE NETZ GmbH	2	~ 50 km	Q1 2027
	DE23	Gasnetz Hamburg GmbH	2	~ 40 km	Q2 2027
	DE29	AquaDuctus Pipeline GmbH	2	~ 300 km	Q4 2029
	DE40	Gasunie DT GmbH	2	~ 400 km	Q4 2026 /29
	DE43A	EWE Hydrogen GmbH	1	370 MW	Q4 2027
	DE43B	EWE GASSPEICHER GmbH	3	~ 1,500 t	Q4 2027
	DE45	Hamburg Green Hydrogen GmbH & Co. KG	1	100 MW	Q1 2027
West Germany	DE24	RWE Gas Storage West GmbH	3	~ 3,420 t	Q4 2026
	DE26	Thyssengas GmbH	2	~ 70 km	Q1 2027
	DE33	Air Liquide Deutschland GmbH	1	120 MW	Q4 2026
	DE34	RWE Nukleus Green H2 GmbH	1	300 MW	Q2 2027
	DE38	Lingen Green Hydrogen GmbH & Co. KG	1	100 MW	Q3 2026
	DE49	Open Grid Europe GmbH	2	~ 77 km	Q4 2026
	DE56	Nowega GmbH	2	~ 158 km	Q4 2026
South-	DE28	Creos Deutschland Wasserstoff	2	~ 41 km	Q3 2027

West Germany		GmbH			
	DE54	HydroHub Fenne GmbH	1	52 MW	Q3 2027
Portugal	PT11	Winpower	1	160 MW	Q1 2027
	PT25	Hevo Portugal	1	630 MW	Q4 2027
Italy	IT02	Energie Salentine	1	452 MW	Q4 2027
	IT21	Snam S.p.A.	2	~ 109 km	Q4 2027
	IT49	PGHYV	1	160 MW	Q2 2027
Nuclei for future clusters	FR23	Lhyfe	1	200 MW	Q4 2027
	PL01	Polenergia H2Silesia sp. Z o.o.	1	105 MW	Q4 2026
	SK04	eustream, a.s.	2	~ 500 km	Q4 2029
	NL57	Vopak New Energies B.B.	4	12 tH_2/day	Q4 2028
	DE59	Hydrogenious LOHC Infra Bavaria GmbH	4	5 tH_2/day	Q2 2027

Table 5: Hy2Infra clusters

(98) The following sections describe the composition, purpose and the added value of each regional cluster.

2.4.4.1.1. Cluster North-West Germany

(99) The individual projects DE07, DE23, DE29, DE40, DE43A, DE43B, and DE45 will integrate all relevant value chain steps for a secure hydrogen supply in the Cluster North-West Germany. The main end-use sectors targeted by this cluster are the steel industry and the transport sector. Figure 3 shows the individual projects which are part of the Cluster North-West Germany.

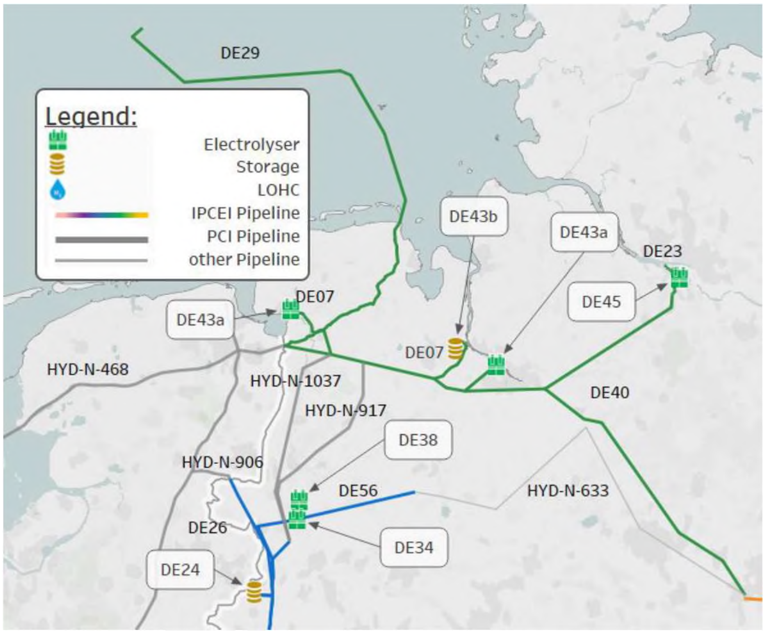

Figure 2: Cluster North-West Germany

(100) The 400 km-long transmission pipelines of DE40 contributes significantly to the cohesion of this cluster and its connection to a future EU-wide network. In the Western part of the cluster, **DE43A's large**-scale hydrogen production (370 MW) **and DE43B's storage facilities** (1,500 t) connect to DE40 via pipelines deployed by project DE07 (50 km). In addition, DE29 (300 km of pipeline), which is connected to DE40, enables access to offshore hydrogen production capacities and imports from third countries in the North Sea area. DE40 connects as well DE23, which will establish a hydrogen network in the city of Hamburg, via a pipeline of 40 km and with connections to further production projects such as DE45 (100 MW).

(101) DE40, in addition will connect at the Dutch border to the Dutch hydrogen network into which NL57 will feed, creating thus the possibility to import hydrogen from the Netherlands into Germany and through Rotterdam from other locations (for example Finland or Portugal, see in this respect recital (107)).

(102) As indicated in table 6, all the projects are aligned timing-wise. It is expected to complete the infrastructure deployment by 2026 or 2027 with the exception of DE29, envisaged to be completed by 2029. As shown in figure 2, DE29 will bring access to offshore renewable hydrogen production from the start of its operational phase and to hydrogen imports from neighbouring countries in North Sea from the late 20**40's onwards**. The completion of DE29 requires that the other projects in the cluster be deployed first, in particular DE40.

Cluster Name	Project ID	Company	WS	Capacity	eoc
North-West Germany	DE07	EWE NETZ GmbH	2	~ 50 km	Q1 2027
	DE23	Gasnetz Hamburg GmbH	2	~ 40 km	Q2 2027

	DE29	AquaDuctus Pipeline GmbH	2	~ 300 km	Q4 2029
	DE40	Gasunie DT GmbH	2	~ 400 km	Q4 2026 /29
	DE43A	EWE Hydrogen GmbH	1	370 MW	Q4 2027
	DE43B	EWE GASSPEICHER GmbH	3	~ 1,500 t	Q4 2027
	DE45	Hamburg Green Hydrogen GmbH & Co. KG	1	100 MW	Q1 2027

Table 6: Cluster North-West Germany

2.4.4.1.2. Cluster West Germany

(103) The individual projects DE24, DE26, DE33, DE34, DE38, DE49, and DE56 will create a holistic hydrogen infrastructure in the Cluster West Germany. Regarding the end-use sector, DE26 and DE49 will provide access to customers in the steel sector, refineries and other consumers in North Rhine-Westphalia and Lower-Saxony. Figure 3 shows the individual projects part of the Cluster West Germany.

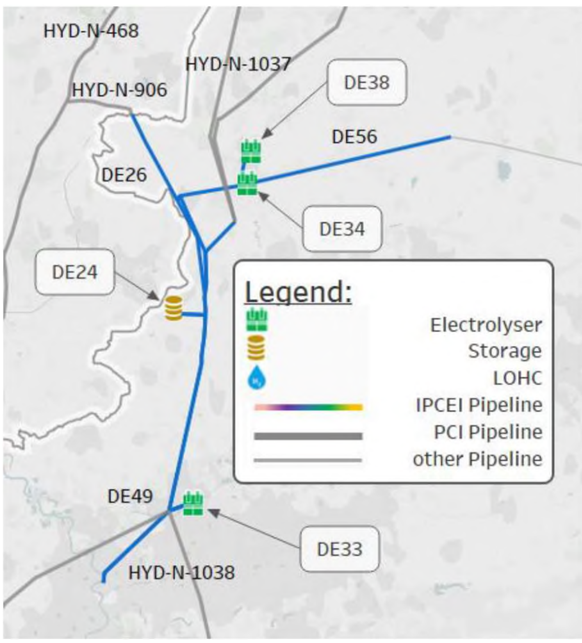

Figure 3: Cluster West Germany

(104) The participating undertakings in the cluster have put forward an integrated approach for hydrogen infrastructure in the Rhine-Ruhr area. Projects DE33, DE34, and DE38 will provide large-scale electrolysers, with the respective capacity of 120 MW, 300 MW, and 100 MW. They will connect to the future EU-wide hydrogen network via pipeline projects DE26, DE49, and DE56, with the respective length of 70 km, 85 km, and 160 km. In addition, pipeline projects **DE56 and DE49 will enable access to DE24's storage facility of** 3,420 t.

(105) As indicated in table 7, all projects expect to enter operation between the end of 2026 and the end of 2028 at the latest, their timing is thus aligned.

Cluster Name	Project ID	Company	WS	Capacity	eoc
West Germany	DE24	RWE Gas Storage West GmbH	3	~ 3,420 t	Q4 2026
	DE26	Thyssengas GmbH	2	~ 70 km	Q1 2027
	DE33	Air Liquide Deutschland GmbH	1	120 MW	Q4 2026
	DE34	RWE Nukleus Green H2 GmbH	1	300 MW	Q2 2027
	DE38	Lingen Green Hydrogen GmbH & Co. KG	1	100 MW	Q3 2026
	DE49	Open Grid Europe GmbH	2	~ 77 km	Q4 2026
	DE56	Nowega GmbH	2	~ 158 km	Q4 2026
Related nuclei	FR23	Lhyfe	1	200 MW	Q4 2027
	NL57	Vopak New Energies B.B.	4	12 tH_2/day	Q4 2028

Table 7: Cluster West Germany and related nuclei projects

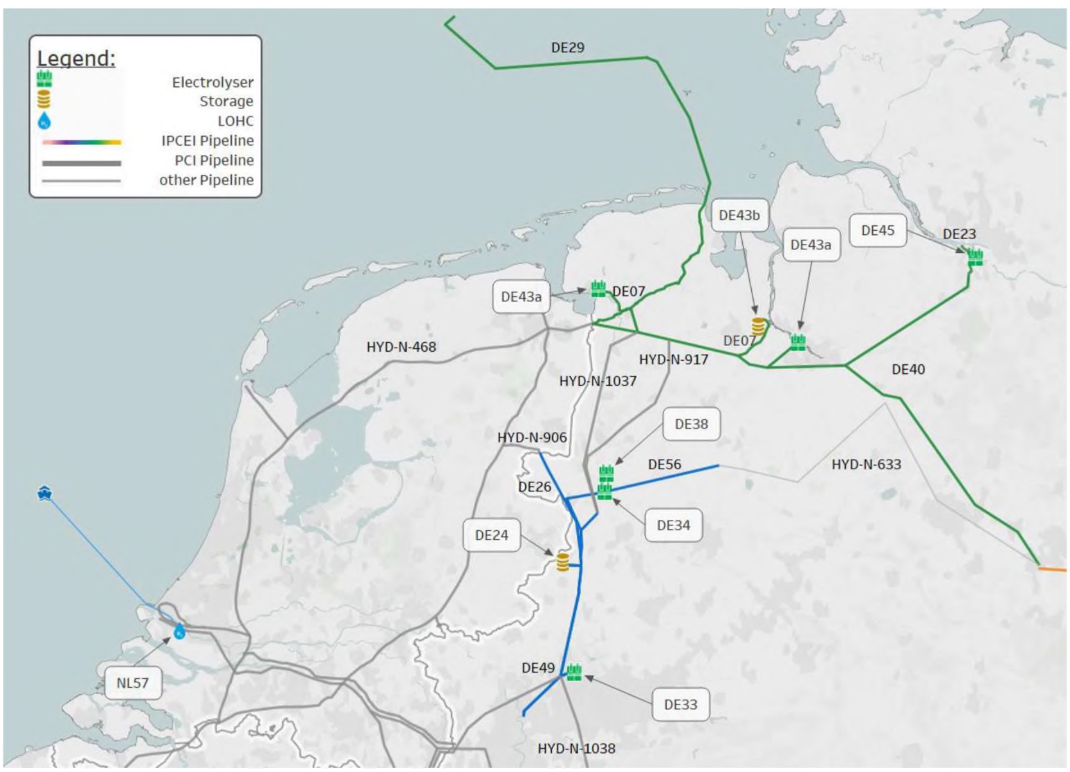

Figure 4: Future cluster connections in North-West Germany and The Netherlands

(106) In terms of connections with other clusters, Cluster West Germany will connect to Cluster North-West Germany Cluster via the PCI HYD-N-1037 (H2Ercules North). This expansion – beyond the scope of Hy2Infra – of DE56 would link Lingen to the Hanover area, enabling a connection to Cluster Northwest Germany

via DE40. As for the cross-border dimension, towards the West, HYD-N-906 (Vlieghuis-Ochtrup) provides a connection between DE26 and HYD-N-468 (Dutch National H2 Backbone) and therefore project NL57. Project DE40 will also connect to the Dutch network. The PCI status of great part of the Dutch National H2 Backbone in NL reinforces the integration between the Dutch projects and the German core network.

(107) As a related nuclei project, NL57, located in Rotterdam, will implement hydrogen transport chains based on LOHC. LOHC storage tanks in these chemical plants can help cover short-term storage needs. NL57 (with a capacity of handling 12 tpd) will connect LOHC transport routes to support complex hydrogen supply chains towards the hinterland and areas with less extensive hydrogen grids. At the same time, NL57 will connect to the Dutch National H2 Backbone, planned outside Hy2Infra. The Dutch H2 network will be connected to Clusters North-West Germany and Cluster West-Germany via projects DE40 and DE26 respectively. As potential sources of renewable hydrogen and locations for the corresponding LOHC storage terminal, NL57 has signed letters of intent with project FI08 ([48]) from the IPCEI Hy2Use and with project PT11 in Cluster Portugal.

(108) Another nuclei related to this cluster is project FR23, which will deploy two large-scale electrolysers in the French areas of Le Havre (Normandie) and Ingrande-sur-Vienne (Nouvelle Aquitaine) (France) supplying initial customers by tube-trailers among others. Lhyfe is investigating further transport connections with GRTgaz, one of the main French TSOs, indirect partner of DE28 as well. In addition, FR23 has considered proximity to existing transport infrastructure and potential developments of the EU-wide hydrogen network when choosing their locations. FR23 will be commissioned by the end of 2027, generally aligned with the rest of Hy2Infra.

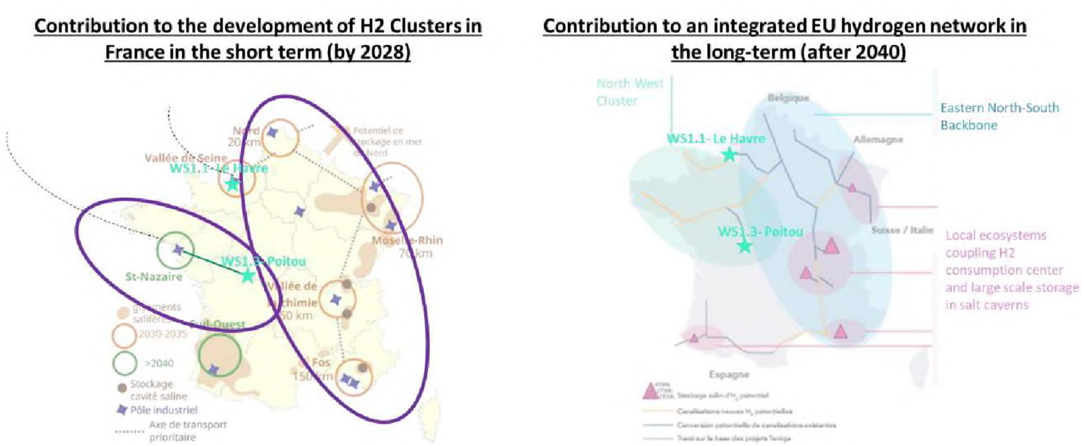

Figure 5: hydrogen network developments within France connecting FR23 project locations in the short and long-term

([48]) The project FI08 (Green Reindeer), is part of Hy2Use. It foresees the installation of two electrolysers, of 20MW and 50MW respectively.

Figure 6: Map of the project Green Octopus

(109) FR23 expects to be linked to the projects implemented by participating undertakings in Hy2Infra through the Franco-Belgian H2 corridor (Belgian part of project Green Octopus included in Hy2Use) and through the Hyfen H2 corridor (internal hydrogen infrastructure in France connecting to Germany, included in the first PCI/PMI list), both planned by 2030 in the 2022 version of the Ten-Year **Network Development Plan** ("TYNDP") ([49]). The figure above shows the potential connections between FR23 electrolysers and the French hydrogen network by 2040.

2.4.4.1.3. Cluster South-West Germany

(110) The individual projects DE54 and DE28 form the cluster called Cluster South-West Germany, as illustrated in figure 7.

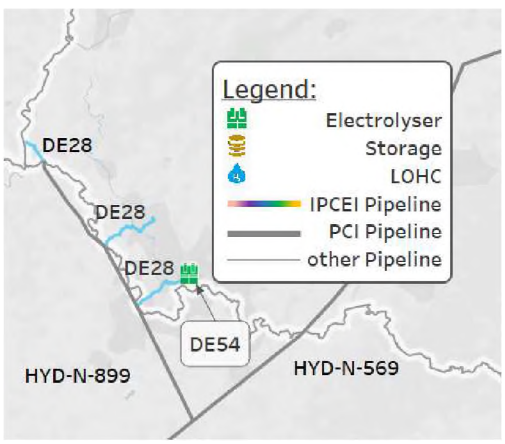

Figure 7: Cluster South-West Germany

([49]) The Ten-Year Network Development Plan ("TYNDP") provides an overview of the European gas infrastructure and its future developments, and it maps the integrated gas network according to a range of development scenarios. The TYNDP also includes a European supply adequacy outlook and an assessment of the network resiliency. Gas Regional Investment Plans (GRIPs) led by TSOs with ENTSOG assistance complement the TYNDP by focusing on issues of particular regional importance. EU Gas Regulation (EC) 715/2009 requires ENTSOG to develop the TYNDP on a biennial basis.

(111) The cluster of South-**West Germany is also known as the 'Grande Region Hydrogen' initiative. DE54 plans to install 52MW capacity that will feed** renewable hydrogen into the pipeline network of 41 km developed by DE28. The French TSO GRTgaz that will complete – outside the IPCEI scope- the network between the French region Lorraine, Saarland and Luxemburg. Therefore, the Cluster South-West Germany will create the foundation for a cross-border infrastructure in this region.

(112) The timing of the two projects is aligned: DE54 and DE28 expect to be completed by 2027 (see table 9).

Cluster Name	Project ID	Company	WS	Capacity	eoc
South-West Germany	DE28	Creos Deutschland Wasserstoff GmbH	2	~ 41 km	Q3 2027
	DE54	HydroHub Fenne GmbH	1	52 MW	Q3 2027

Table 8: Cluster South-West Germany

2.4.4.1.4. Cluster East Germany

(113) Projects DE03, DE18, DE32, DE61, DE63, DE64 and DE71 are intended to build a value chain comprising hydrogen production and distribution. The main end-use sectors targeted by this cluster are the steel, refining, chemical industry, as well as the transport sector. Figure 8 shows the individual projects part of the Cluster East Germany.

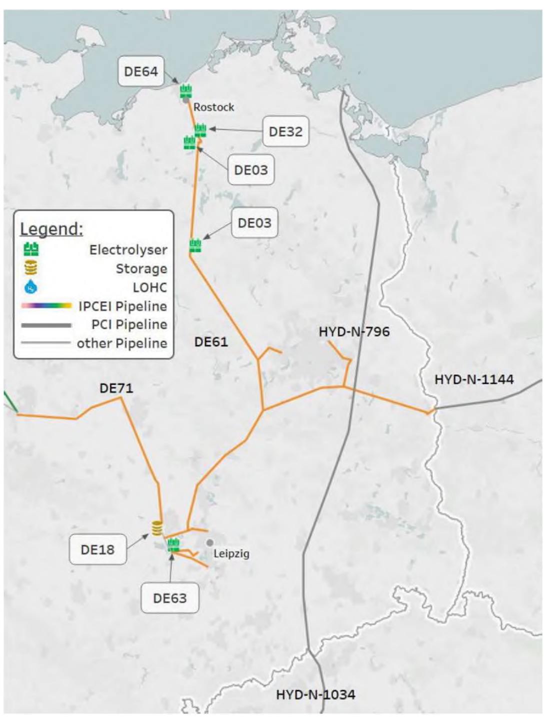

Figure 8: Cluster East Germany

(114) The individual projects in WS1, DE03, DE32, DE63 and DE64 will ensure sufficient hydrogen production to initiate this cluster, providing a total

electrolysis capacity of 485 MW. The individual project in WS3, DE18, will further increase the security of supply for hydrogen consumers by providing hydrogen storage in Bad Lauchstaedt; with a capacity of 4,494 t. The individual projects in WS2, DE61 and DE71, for hydrogen transport will connect production and storage facilities, and end users. DE61 will establish a pipeline connection of 618 km between Rostock and Leipzig, integrating several projects in the cluster (DE03, DE32, DE64). DE71 will implement a connection of 302 km between the Western and Southern parts of Germany and the area around the city of Leipzig. This cluster will be highly internally connected, as illustrated in figure 2 and table 6. It also provides options to connect to other clusters from an early stage, in particular to the Western part of Germany and the Netherlands (connection to DE40 envisaged outside of Hy2Infra). DE61 project includes a pipeline reaching the border between Germany and Poland (see figure 8).

(115) As indicated in table 6, the timing of the individual projects of the cluster is aligned and they will be completed between 2026 and 2029. Project DE63 will come into operation earlier than the rest of the cluster, serving an existing hydrogen network. By 2029, it will connect with the rest of cluster via DE71. By 2027, DE03, DE61 and DE71 will achieve interconnection, while other parts of DE71 will be operational by 2028 (northern parts of Saxony-Anhalt connecting hence with DE32 and DE64) and by 2029 (Lower Saxony).

Cluster Name	Project ID	Company	WS	Capacity	eoc
East Germany	DE03	ENERTRAG Elektrolysekorridor Ost GmbH	1	185 MW	Q4 2027
	DE18	VNG Gasspeicher GmbH	3	~ 4,494 t	Q4 2028
	DE32	GHS 2 GmbH & Co. KG	1	100 MW	Q1 2028
	DE61	ONTRAS Gastransport GmbH	2	~ 618 km	Q2 2029
	DE63	Linde GmbH	1	100 MW	Q1 2026
	DE64	rostock EnergyPort cooperation GmbH	1	100 MW	Q2 2028
	DE71	ONTRAS Gastransport GmbH	2	~ 302 km	Q1 2029
Related nuclei	PL01	Polenergia H2Silesia sp. Z o.o.	1	105 MW	Q4 2026
	DE59	Hydrogenious LOHC Infra Bavaria GmbH	4	5 tH_2/day	Q2 2027

Table 9: Cluster East Germany and related nuclei projects

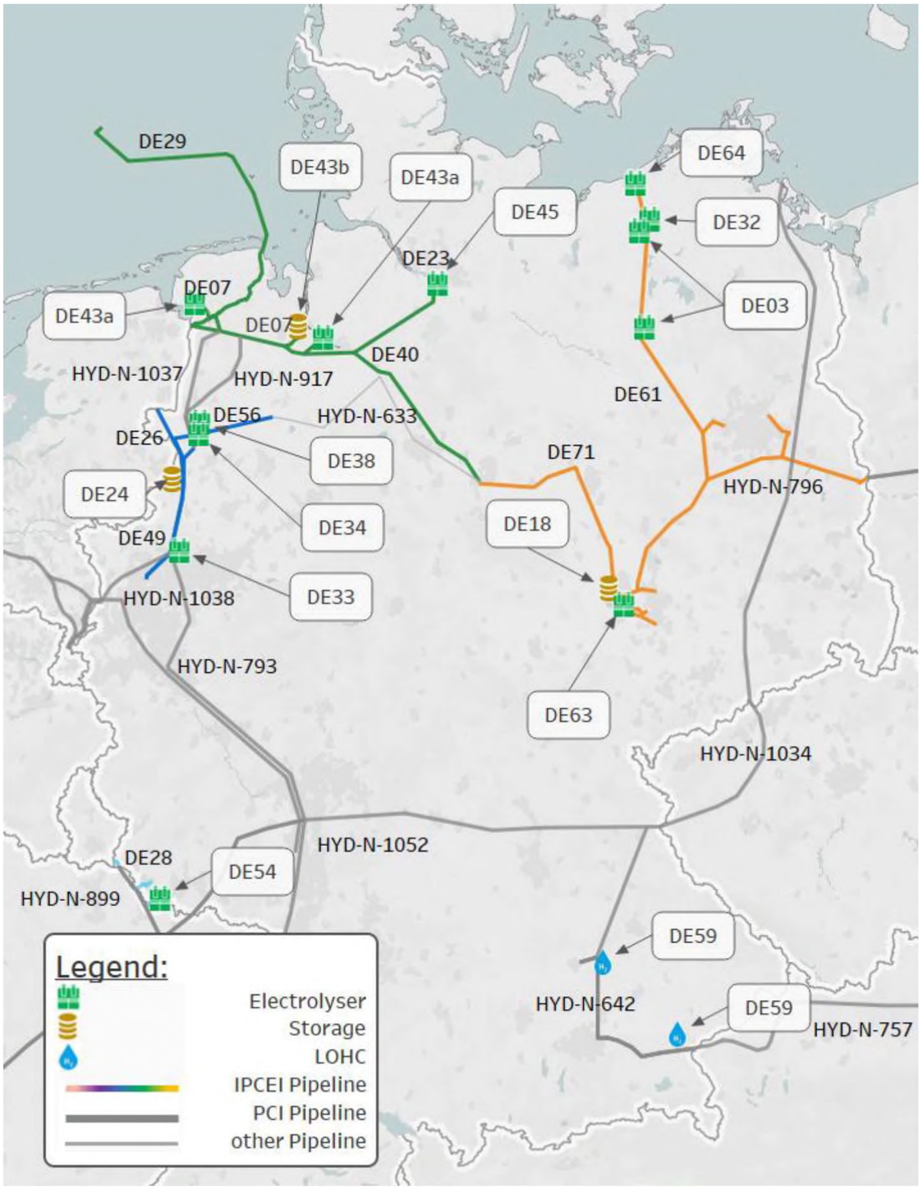

Figure 9: Future cluster connections within from Germany towards East and South

(116) Projects DE71 and DE40 will join their networks, following the progressive and planned development of the German core network, will take place outside the Hy2Infra scope, by 2029. This connection ensures the future integration of Cluster North-West Germany and Cluster East Germany.

(117) In addition, HYD-N-1038 (H2ercules Network West) will link Cluster West Germany with HYD-N-1052 (H2ercules Network South), which also connects to HYD-N-569 (HY-FEN, internal hydrogen infrastructure in France connecting to Germany and part of the Corridor Portugal – Spain – France – Germany) and indirectly to HYD-N-899 (Hydrogen valley in France to the German border, known as mosaHYc) and, hence, to DE28 and DE54.

(118) As a related nuclei project, DE59 will implement hydrogen transport chains based on LOHC, including the necessary chemical plants to embed hydrogen into LOHC and to release it from LOHC. LOHC storage tanks in these chemical

plants can help cover short-term storage needs. DE59 will set up a first transport chain within Bavaria, which will enable future hydrogen import routes via the Danube (from Austria for instance) into Southern Germany, with a capacity of 5 tpd. Additionally, project DE59 foresees the possibility to connect with the HyPipe Bavaria pipeline – included in the first PCI/PMI list – around Ingolstadt.

(119) Another related nuclei project, PL01, will establish large-scale hydrogen production capacities in the region of Upper Silesia, Poland, to supply off-take projects. Interconnections to an EU-wide network are possible but would be established with parallel planning outside of Hy2Infra and the PCI sphere (see figure 10). PL01 will be commissioned by the end of 2026, generally aligned with the timeline of the rest of Hy2Infra.

Figure 10: Location of PL01 with respect to pipeline developments in Poland

(120) Within Poland, project PL01 is about 40 km from the planned Polish Hydrogen Backbone Infrastructure (project HYD-N-983), which considers repurposing an existing gas pipeline for hydrogen by 2040. Such connection would grant PL01 access to an EU-wide hydrogen infrastructure, linking eventually to the Nordic-Baltic Hydrogen Corridor (HYD-N-1144) and hence meeting, Cluster East Germany (DE61) at the German-Polish border.

2.4.4.1.5. Cluster Italy

(121) Cluster Italy is composed of three projects: IT02, IT21, and IT49 for hydrogen production and transport for the supply of different customers in the Southern part of Italy, in the Puglia region (figure 11).

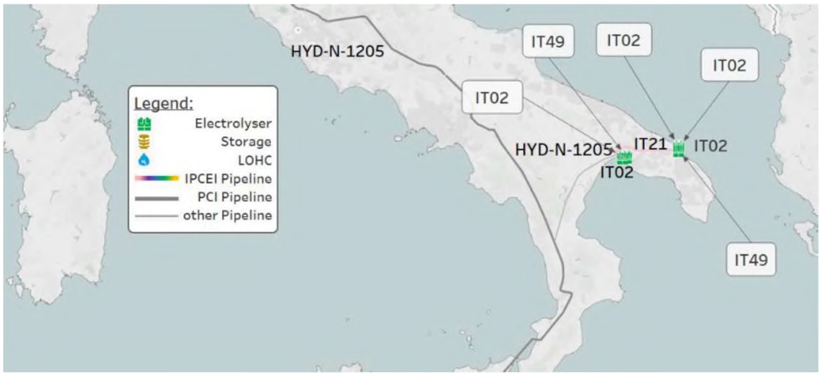

Figure 11: Cluster Italy

(122) IT02 and IT49 will establish large-scale hydrogen production capacities in the area of Taranto and Brindisi, with respective capacities of 452MW and 160MW. The projects also entail the construction of a hydrogen distribution infrastructure serving the port authorities and the industrial areas of Taranto and Brindisi (such as Acciaierie d'Italia steel plant and the members of the respective Industrial Development Area associations, ("ASI")). Project IT21 aims to deploy an infrastructure for the transmission and distribution of hydrogen of 109 km. between all projects in the Cluster Italy (IT02, IT49) with a pipeline connection from Taranto to Brindisi.

(123) Projects IT02, IT21 and IT49 will be finalised by 2027 and SK04 by 2029.

Cluster Name	Project ID	Company	WS	Capacity	eoc
Italy	IT02	Energie Salentine	1	452 MW	Q4 2027
	IT21	Snam S.p.A.	2	~ 109 km	Q4 2027
	IT49	PGHYV	1	160 MW	Q2 2027
Related nuclei	SK04	eustream, a.s.	2	~ 500 km	Q4 2029

Table 10: Cluster Italy and related nuclei projects

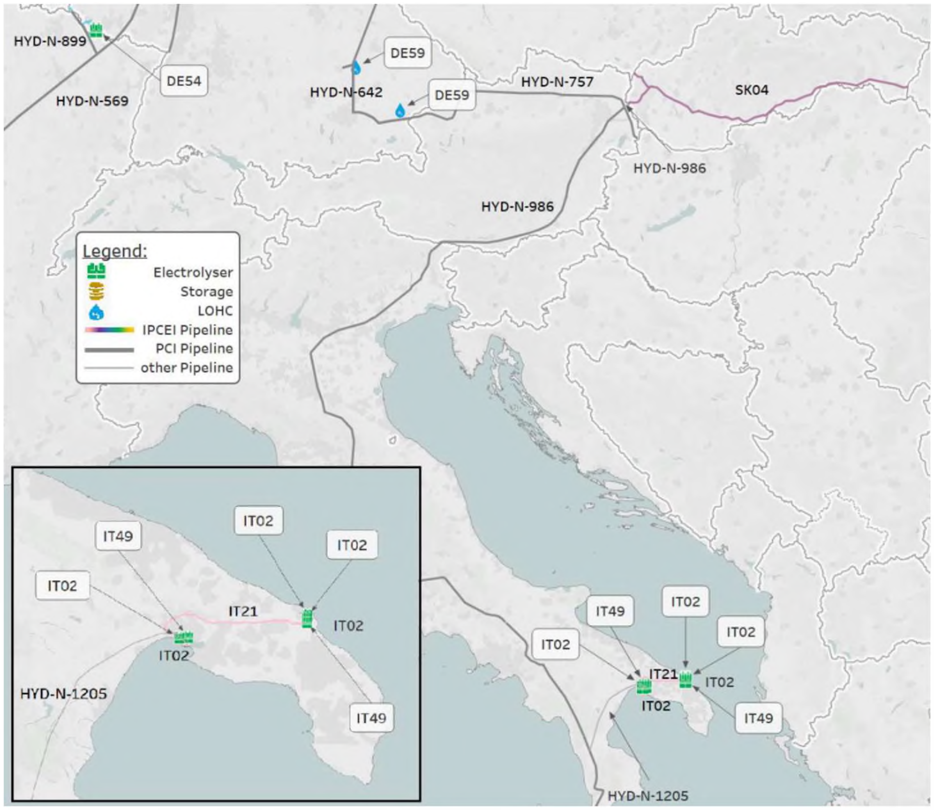

Figure 12: Italy-Austria-Germany Corridor

(124) The PCI 'Hydrogen corridor Italy-Austria-Germany', (HYD-N-1205, HYD-N-986 ([50]), HYD-N-757, and HYD-N-642, also known as SouthH2 Corridor), consists in construction of new pipelines and the repurposing of many existing ones along Italy, Austria and Germany and would connect to the German core network via the H2ercules Network South. The main sources of renewable hydrogen for the SouthH2 Corridor are expected to be developed in Algeria and Tunisia.

(125) The connection of this PCI corridor with IT21 would require the completion of an additional section between Taranto and Tarsia which is not part of the PCI selection or the IPCEI scope but that was submitted in the TYNDP process as part of the project HYD-N-1205. The above-mentioned PCI corridor is expected to enter the operational phase by 2030.

(126) A connection between project SK04 and other Hy2Infra projects could occur with the repurposing of 2.5 km of an existing gas pipeline between Baumgarten ([51]) and the border between Slovakia and Austria. This repurposing is not part of the

([50]) The description of this project in the TYNDP data collection states: "*The project consists in the repurposing for 100% hydrogen transport of 1 out of 3 existing pipelines of TAG's system, with all related facilities, along its full length between the Slovakian-Austrian border to the Austrian-Italian border with entering into full operation for 2030.*"

([51]) Baumgarten is a gas network interconnection point operated by Gas Connect Austria in Lower Austria and one of the largest gas hubs in Europe. It consists of gas reception, metering and testing facilities, and a compressor station.

SouthH2 Corridor but already planned within project HYD-N-986. It is, however, part of the H2EU+Store initiative (see the project description of SK04 in section 2.4.3.2). The project SK04 would lay the foundation for a hydrogen infrastructure in Slovakia by repurposing a 500 km long gas transmission pipeline for hydrogen transport. SK04 could over time establish a European transmission route connecting three Member States (Slovakia, Austria, and the Czech Republic) to production potential in Ukraine, when the situation allows. In addition, it paves the way for connecting local hydrogen demand in Slovakia. SK04 will be commissioned by the end of 2029 in a similar timeframe to DE29.

2.4.4.1.6. Cluster Portugal

(127) Production projects PT11 and PT25, with respective capacities of 160MW and 630MW, can serve as important cluster for the domestic development of a hydrogen infrastructure and market, targeting initially ammonia exports towards Rotterdam, and domestic hydrogen supply. They will deploy first large-scale hydrogen production capacities for the domestic supply of customers in the Sines area. Both projects will connect to a hydrogen network around Sines by 2025 which the Portuguese TSO, REN, has been mandated to build ([52]).

(128) In general, Portuguese authorities expect hydrogen export projects to develop in Sines thanks to its deep-water port and modern specialized terminals, and the emerging hydrogen ecosystem in the area, which will also contribute directly and indirectly to the interconnection of the Hy2Infra projects. A working group has been set up between Portugal and the Netherlands to examine the possibility to develop a sea route between Sines and Rotterdam. In this respect, project NL57 is cooperating with PT11 on a potential LOHC route from Sines to Rotterdam, for which both parties have signed a letter of intent.

(129) Furthermore, the Portuguese authorities foresee the deployment of a hydrogen national backbone that would connect hydrogen valleys within Portugal with international hydrogen flows via the H2Med initiative ([53]).

([52]) The mandate can be found in the Official Journal of the Republic of Portugal https://diariodarepublica.pt/dr/detalhe/resolucao-conselho-ministros/78-2023-215647923.

([53]) This project corresponds to the announcement made on the 20th of October 2022 in Brussels by the President of France, Emmanuel Macron, the President of the Government of Spain, Pedro Sánchez, and Prime Minister of Portugal António Costa. The three leaders agreed in the creation of a hydrogen interconnection between Portugal and Spain connecting Celorico da Beira (Portugal) with Zamora (Spain) and to develop a maritime pipeline connecting Barcelona (Spain) with Marseille (France). Part of the initiative is included in the PCI Corridor Portugal – Spain – France - Germany.

Cluster Name	Project ID	Company	WS	Capacity	eoc
Portugal	PT11	Winpower	1	160 MW	Q1 2027
	PT25	Hevo Portugal	1	630 MW	Q4 2027
Related nuclei	NL57	Vopak New Energies B.B.	4	12 tH2/day	Q4 2028

Table 11: Cluster Portugal

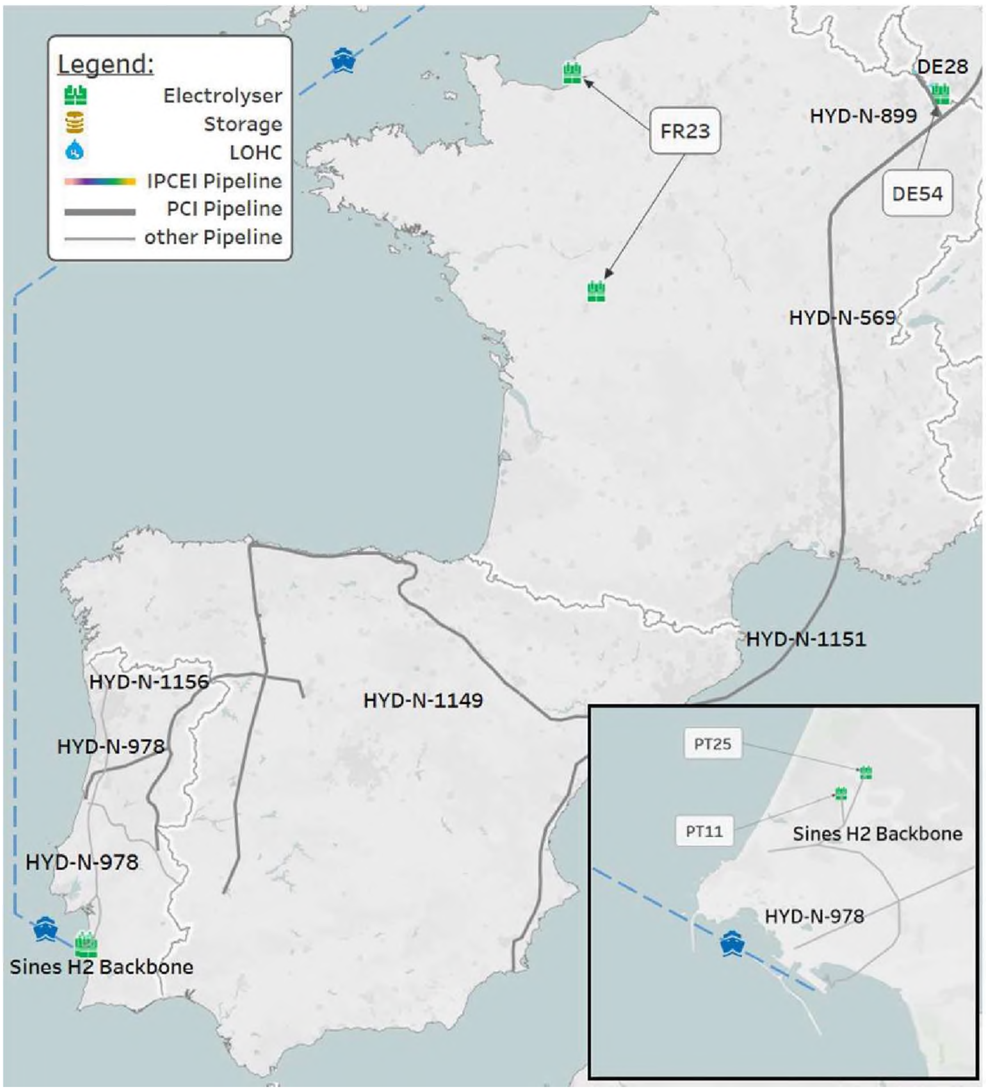

Figure 13: PCI and IPCEI pipelines in South West Europe

(130) Part of the Portuguese hydrogen backbone (HYD-N-978) has been selected as PCI, together with the rest of the Corridor Portugal – Spain – France – Germany (HYD-N-1156, HYD-N-1149, HYD-N-1151 and HYD-N-569). An additional

connection between Cantanhede and Sines is planned but not part of the IPCEI or the PCI scope ([54]).

(131) Furthermore, project NL57 is cooperating with PT11 on a potential LOHC route from Sines to Rotterdam (see also recital (107)).

2.4.5. Interoperability and contribution to standards (Integration under Pillar 2)

(132) While the deployment of the first regional clusters and their interconnection is meant to overcome current market failures for large-scale hydrogen infrastructure projects, the establishment of common technical and operational principles will facilitate further development of the open-access hydrogen infrastructure established by the Hy2Infra. With that aim, Hy2Infra direct participants will cooperate under Pillar 2 to reach an agreement on key interoperability parameters. They will also work together on common deliverables in relation to standards and operational rules.

2.4.5.1. Common agreement for interoperability

(133) The EU Hydrogen Strategy identifies "common quality standards (e.g. for purity and thresholds for contaminants) or cross-border operational rules" as essential to ensure interoperability of hydrogen markets and prevent the emergence of technical barriers for future interconnections.

(134) In terms of hydrogen purity, participating undertakings in Hy2Infra will work together to define common requirements for hydrogen purity at interconnection points within the first six months after the start of Hy2Infra with the aim of avoiding diverging criteria leading potentially to increased quality treatment costs. Subsequently, participating undertakings in Hy2Infra will complete, develop and implement further standards related to measurement, control and quality assurance at customer level and project level (see section 2.4.5.2).

(135) In addition, Hy2Infra participating undertakings will work together to define common requirements for pressure level at interconnection points within the first six months since the start of Hy2Infra.

2.4.5.2. Common deliverables as contribution to standards and operational rules

(136) Participating undertakings will work together to contribute to the adoption of national and European rules and standards for hydrogen infrastructure operations within Hy2Infra.

(137) The European Clean Hydrogen Alliance ([55]) has published a roadmap on Hydrogen Standardization ([56]) that provides a comprehensive overview of the

([54]) As part of the project RET-N-1049, the plans of REN, the Portuguese TSO only foresee the retrofitting of the pipeline connecting Cantanhede and Sines for allowing hydrogen blends up to 15% by 2030. The project was not selected as PCI.

([55]) The European Clean Hydrogen Alliance was set up in July 2020 to support the large-scale deployment of clean hydrogen technologies by 2030. It brings together renewable and low-carbon hydrogen relevant standards across the hydrogen value chain, including existing knowledge gaps and their priority. The document reflects a broad consensus among European hydrogen stakeholders and can be used to guide the work of Hy2Infra in relation to common standards. Participating undertakings in Hy2Infra have identified the gaps in the roadmap their projects can help address.

(138) Participating undertakings in Hy2Infra will use the experience and knowledge generated in the projects to support standardisation processes within the relevant bodies, such as European Committee for Standardization (**"CEN"**) ([57]), which are ultimately responsible for the adoption of technical standards. Participating undertakings in Hy2Infra will not develop singular solutions for their projects but bring their cumulated experience into existing standardisation and regulatory processes.

(139) The following table lists some of the standardisation gaps that can be addressed by Hy2Infra. The topics are grouped by the round tables ("RT") of the European Clean Hydrogen Alliance.

Topic / Horizontal aspect	Description	Status of the standardisation project ([58])
RT1 Production		
Gas quality aspects	Hydrogen and gas quality control and measurement methodologies purity of hydrogen impurities like inert gases	Under revision
Electrolysers	Electricity grid connection for ancillary services by electrolysers and regarding power quality requirements – standardisation (other than regulation on system operation at national level) of procedures for testing, inspection and certification of facilities and performance; Measurement and assessment of power quality characteristics of grid connected	To be identified

production, demand in industry, mobility and other sectors, and hydrogen transmission and distribution. Its members come from industry, public authorities, civil society, and other stakeholders. https://single-market-economy.ec.europa.eu/industry/strategy/industrial-alliances/european-clean-hydrogen-alliance_en.

([56]) The roadmap on hydrogen standardisation is accessible here: https://ec.europa.eu/docsroom/documents/53721.

([57]) CEN, the European Committee for Standardization, is an association that brings together the National Standardization Bodies of 34 European countries.

([58]) The status of each standardisation project corresponds to the one indicated in the roadmap of the European Clean Hydrogen Alliance:

- *in place*: standard published; Hydrogen standardisation topic is already covered;
- *under revision*: an existing standard will be revised to address the hydrogen standardisation topic;
- *in preparation*: standardisation topic is addressed; preliminary project; new project; or
- *to be identified*: no standardisation project has started yet and no committee has been identified.

	electrolysers	
	Control strategies for integrating electrolysers with intermittent renewable energies (mapping operational boundaries)	To be identified
	Electrolyser – frequency, voltage control and other grid service requirements of grid operators – technical oriented	To be identified
Safety aspects	Odorisation of hydrogen – choice of odorants	In preparation
RT2 Transmission and Distribution ("T&D")		
Gas quality aspects	Adaptation of gas analysis methods – purity analysis and treatment of purity data	In preparation
	Hydrogen quality in industry	To be identified
	Hydrogen quality in pipelines	In preparation
	Standards for hydrogen purity and gas quality handling,	In preparation
Gas/hydrogen infrastructure	Pressure regulation stations (Functional requirements)	In preparation
	Pressure regulation installations on service lines (functional requirements)	In preparation
	Pressure testing, commissioning ad decommissioning of hydrogen/gas network	In preparation
	Transmission pipelines for maximum operating pressure over 16 bar including non-metallic pipelines and including or complemented by the method of conformity assessment for Hydrogen service	Under revision
	Standards and technical rules linked to retrofitting/blending ([59]) and repurposing of new pipelines, underground gas storages and LNG terminals	In preparation
	Storage in aquifers including methodology for analyzing the interactions between Hydrogen and the reservoir rock, the cap rock, microbiological effects underlying and the leaks.	In preparation
Components/	Pressure regulators for the use with hydrogen	To be identified

([59]) Blending is out of the scope of Hy2Infra.

equipment	Measuring systems (functional requirements)	In preparation
	Safety shut-off devices	To be identified
RT3 Industry Heating		
Gas quality aspects	Purity of hydrogen/ impurities like inert gases/Wobbe index from repurposed infrastructure	In preparation
	Gas quality measurement devices	To be identified
RT5 Energy		
Gas quality aspects	Purity of hydrogen/ impurities like inert gases/Wobbe index from repurposed infrastructure	In preparation
Gas/hydrogen infrastructure	Design and stress calculation of the line pipe containing pure Hydrogen	In preparation
RT7 Cross-Cutting		
Energy / hydrogen carrier	Definition and standards for certifying low carbon and renewable hydrogen as well as liquid hydrogen – either as an end product or for logistics reasons	To be identified
	Quality of LOHCs reliable operation of the plants – purity of LOHC	To be identified
	Standards for all possible modes of hydrogen transport/storage (carrier) to ensure clarity in this part of the value chain. – LOHC, LIHC (60) – LH2 (61) – gaseous hydrogen – others	To be identified

Table 12: Hydrogen standardisation gaps to be addressed by Hy2Infra

(140) Some of the topics in table 14 are relevant for all WSs, other for only one or two WS. The participating Member States have submitted a compilation of the most relevant standardisation activities by each WS and project. In addition, the participating Member States have submitted the list of standardisation activities per project, where standardisation gaps have been identified systematically in accordance with the list of topics of the European Clean Hydrogen Alliance standardisation roadmap. For each of those gaps, direct participants have indicated whether they are ready to commit to respond to the call for experts in the relevant CEN/CENELEC (62) technical committees in the framework of the

(60) Liquid Inorganic Hydrogen Carriers.

(61) Liquid hydrogen.

(62) The European Committee for Standardization (CEN) is one of three European Standardization Organizations (together with CENELEC and ETSI) that have been officially recognized by the European Union and by the European Free Trade Association (EFTA) as being responsible for developing and defining voluntary standards at European level. Technical Committees (TC) are

corresponding standardisation process (see Annex II). The following table presents an overview of cross-cutting standardisation activities where several WSs and participating projects contribute. In addition, section 2.4.5.3 describes the main areas of collaboration around technical standards at WS level. In total, participating undertakings have committed 234 positive replies to call for experts, of which 78 relate to cross-cutting topics, 66 to WS1 specific topics, 42 to WS2, 30 to WS3, and 18 to WS4. All participating undertakings have committed at least one positive reply.

Topic	Corresponding WS	RT group	Contributing project(s) in RT groups
Safety aspects	WS 1	RT1	FR23, IT49
		RT5	DE32, DE64
		RT7	DE32, DE33, DE34, DE38, DE54, DE64, FR23, IT02, IT49
	WS2	RT1	IT21
		RT2	DE26, DE49, DE56, DE61, DE71, IT21
		RT7	IT21
	WS4	RT4	DE59, NL57
Gas quality aspects	WS 1	RT1	DE34, DE43A, DE54, FR23, IT02, IT49
		RT2	DE54, IT49, DE43A, DE43B
		RT6	DE54
	WS2	RT2	DE07, DE23, DE26, DE40
	WS3	RT2	DE43B
	WS4	RT2	DE59, NL57
Sustainability and origin	WS1	RT1	DE45
		RT3	IT02
		RT7	DE33, DE34, DE64, FR23, IT02, IT49, PL01
	WS4	RT4	DE59, NL57
		RT7	DE59
Energy /	WS1	RT3	PT11

established with precise titles and scopes, to prepare CEN deliverables (see https://boss.cen.eu/technicalstructures/pages/tc/).

hydrogen carrier		RT7	DE32, DE34, DE43A, DE64, IT02, IT49, PT11
	WS3	RT7	DE43B
	WS4	RT4	DE59, NL57
		RT7	DE59, NL57
Qualification and training	WS1	RT7	DE33, DE54, DE64, FR23, IT49
	WS4	RT7	DE59, NL57
Metrology	WS2	RT7	DE61, DE71
	WS4	RT7	DE59, NL57

Table 13: Cross-cutting topics across the WSs

(141) In the European electricity and gas markets, EU-wide operational rules ensuring a well-functioning operation of interconnected and highly integrated energy infrastructures are well known and established. These rules, known as network codes ([63]) or guidelines, are legally binding European Commission implementing Regulations.

(142) Until network codes for hydrogen are in place, Hy2Infra participating undertakings will jointly adapt the operation rules of gas network codes to hydrogen infrastructure as far as possible and in coordination with standard and public processes such as the European Gas Regulatory Forum (Madrid Forum) and the work of ACER ([64]), ENTSOG ([65]) and the planned ENNOH ([66]) in the framework of the hydrogen and decarbonised gas market package.

(143) In addition, participating undertakings of Hy2Infra will collaborate to contribute to the harmonisation and adoption of national and European rules for hydrogen infrastructure operations within Hy2Infra. In particular, participating undertakings of Hy2Infra will use their experience to make joint and concerted proposals for the development of operational rules as concrete deliverable of Hy2Infra. In doing so, participating undertakings will -where applicable- take account of national rules and standards as well, given that ([67]), for example, hydrogen quality standards remain a competence of the relevant national authorities. In this regard, the following topics will be considered as relevant to work on:

([63]) List of gas network codes: https://www.entsog.eu/network-codes-and-guidelines.

([64]) European Union Agency for the Cooperation of Energy Regulators.

([65]) European Network of Transmission System Operators for Gas.

([66]) European Network for Network Operators of Hydrogen.

([67]) According to recital 42 of the Regulation on the internal markets for renewable and natural gases and for hydrogen, "*while ensuring a harmonised approach on gas quality for cross-border interconnection points, Member States' flexibility as regards the application of gas quality standards in their domestic natural gas systems should be maintained*". Recital 58 of the same regulation points to a similar approach towards hydrogen quality: "*The quality of hydrogen transported and consumed in Europe can vary depending on its production technology and transport specificities. Therefore, a harmonised approach at Union level to hydrogen quality management at cross-border interconnectors should lead to the cross-border flow of hydrogen and to market integration.*"

a. Aspects for interoperability

i. Rules for Flow Control across the interconnection point (controllable, accurate, predictable, and efficient gas flow)

ii. Measurement principles for gas quantity and quality (measurement standards at the interconnection point)

iii. Rules for the matching process (Nomination and re-nomination rules with harmonised information exchange)

iv. Rules for the allocation of gas quantities

v. Communication procedures in case of exceptional events

vi. Communication rules for common set of units (pressure, temperature, volume, gross calorific value, energy, and other physical properties)

b. Aspects on gas balancing

i. Rules on balancing actions

ii. Rules on nomination procedures

iii. Rules on imbalance charges and provisions on operational balancing

iv. Rules on settlement processes

c. Aspects on capacity allocation mechanisms

i. Rules on harmonised auctions

ii. Standardisation on communication

iii. Rules on capacity calculation and maximisation

iv. Standard for allocation methodology

v. Standard capacity product

d. Aspects on transmission tariff structures

i. Rules on the application of reference price methodology

ii. Rules on associated consultation and publication requirements

iii. Rules on calculation of reserve prices for standard capacity products.

(144) The above aspects are primarily taken from the field of transmission pipelines and will address in the first place the operation of pipelines (WS2). However, all relevant steps of the value chain included in Hy2Infra must be considered, as they

are all connected via the pipeline network. Hence the input from participating undertakings from the other WSs will be needed. As an example, the experience of the participating undertakings regarding the interaction of the individual value chain steps will be of specific added value, e.g. for balancing dynamic and fluctuating hydrogen production and relatively constant demand. In this context, participating undertakings in Hy2Infra will continuously communicate these developments to the public via the reports.

(145) Participating undertakings inHy2Infra partners will not develop singular solutions for Hy2Infra but will bring their experience into the established standardisation and network code drafting process. The final development and decision on standardisation and network codes is the responsibility of bodies such as CEN, the ENTSOG or the ENNOH, with the involvement of the broad stakeholder community. As first movers, participating undertakings in Hy2Infra have a high level of interest in finding solutions and will provide support for it. They also commit to laying the ground for a swift implementation of network codes and adoption of standards across regional clusters and nuclei as soon as they are in place.

2.4.5.3. Collaborations within Hy2Infra with respect to the relevant WS

(146) This section describes collaborations taking place under Pillar 2 for WS-specific topics. The announced deliverables will be publicly reported on a yearly basis from 2024 to 2029 (see recital (184)).

2.4.5.3.1. Collaborations within WS1

(147) Participating undertakings in WS1 have defined three objectives under Pillar 2.

(148) The **first objective** is contributing to the development of joint standards. Joint standards will be crucial for interoperability within Hy2Infra, but also for interconnections with other clusters and projects outside of Hy2Infra. All projects in WS1 will exchange information relevant for the elaboration of standards for installation and on-site integration of large-scale electrolysers to establish best practices regarding operation and maintenance of installations in terms of e.g. advanced, digitalised management and control systems.

(149) All participating undertakings in WS1 will engage in exchanges over the use of by-products (oxygen, heat) and on common environmental standards. Together with standardization authorities, they will work on harmonising physical, chemical and technical standards to facilitate trading of hydrogen in entry-exit systems ([68]).

(150) As a deliverable, WS1 will produce recommendations by the end of 2029 incorporating up to four years of operational experience for the development of standards through the established harmonisation processes as described in section 2.4.5.4. As examples of relevant standardisation topics addressed by WS1 and

([68]) **'entry-exit system' means the aggregation of all transmission and distribution systems to which one** specific balancing regime applies.

included in the European Clean Hydrogen Alliance's Roadmap for Hydrogen standardisation the following are highlighted:

- Standardisation for electricity grid connection of electrolysers
- Standardisation for control strategy of integrated electrolyser systems
- Standardisation for a safe operation of electrolyser systems

(151) The **second objective is the analysis of electrolysers' grid services and flexible** operation. WS1 will propose a set of stabilisation services that electrolysers could deliver to the electricity grid. WS1 will conduct an analysis of the impact of large-scale electrolysers on the electricity network in terms of system integration performance for the whole electricity system under different operating conditions.

(152) To achieve a better integration of renewable energy into the system, WS1 will examine the potential for flexibility enhancement by aligning operational parameters of electrolysers, connected pipelines and storage capacities.

(153) As a deliverable, participating undertakings in WS1 will present guidance by the end of 2029 for operating large-scale electrolysers under volatile renewable energy supply over. Further market participants, grid operators and by manufactures can use this guidance to lower cost and improve the services electrolysers provide to the electricity system.

(154) The **third objective** is to conduct an analysis of permitting and licensing processes. Acceleration of permitting procedures is an enabling factor for an efficient market ramp-up. Electrolyser project promoters need to plan, implement and operate new concepts for the next MW and GW scale. In this context, especially with the permitting and building of such large-scale systems, EU companies and approving authorities should exchange knowledge.

(155) Identifying the required environmental and safety measures to obtain a permit, especially for installations with a capacity well above the 50 MW threshold in the Industrial Emissions Directive ([69]), will be a great step towards confirming the total cost of an operational facility. Participating undertakings in WS1 will analyse existing permitting procedures and identify weak points that could be clarified and standardised, especially regarding cross-border projects.

(156) As a deliverable, based on the experience of the first hydrogen production projects, the participating undertakings of WS1 will produce recommendations by the end of 2025 for the adaption of permitting and licensing with a view to improve and accelerate project feasibility and applicability.

2.4.5.3.2. Collaborations within WS2

(157) Participating undertakings in WS2 have defined three objectives under Pillar 2.

([69]) Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control).

(158) The **first objective** is contributing to the development of joint standards. While there are extensive experiences with the large-scale and cross-border transport of methane and natural gas, the development of a hydrogen transport network is subject to several technical and operational challenges, including characteristics of existing and future pipelines' materials and the entire process of hydrogen transport by pipeline.

(159) All participating undertakings in WS2 will help develop technical, commercial and operational standards (regarding safety rules, hydrogen quality, repurposing, interconnections, pressure levels etc) for hydrogen by providing operational results within the public reports (see section 2.4.5.4) and the relevant CEN/CENELEC technical committees.

(160) Participating undertakings in WS2 will exchange with stakeholders across the hydrogen value chain (e.g. pipeline manufacturers, production projects from WS1, downstream hydrogen consumers, storage facilities) to foster the development of joint technical standards.

(161) As a deliverable, participating undertakings in WS2 will provide recommendations by the end of 2029 for the development of standards for hydrogen pipelines through the established harmonisation processes as described in section 2.4.5.4. As examples of relevant standardisation topics addressed by WS2 and included in the European Clean Hydrogen Alliance's Roadmap for Hydrogen standardisation the following are highlighted:

- Standardisation for gas analysis method in pipeline systems
- Standardisation for transmission pipelines above 16 bar
- Standardisation for safety shut-off devices.

(162) The **second objective** is to elaborate best-practices for construction and repurposing of hydrogen pipelines and knowledge transfer.

(163) Since an integrated large-scale hydrogen network does not exist yet, hydrogen is currently used throughout Europe only in specific industrial applications and generally produced on-site from natural gas (see recital (28)). Therefore, knowledge on large-scale construction and repurposing of hydrogen pipeline networks is limited. Key findings in relation to repurposing can be, for example, material suitability or the testing of material properties of existing pipelines. Furthermore, measures to establish the suitability of existing pipelines for the use of hydrogen can be an important finding that is shared via the reports. With regard to new construction, the main differences to the construction of natural gas pipelines will be the most important findings. The projects use the reports to share the deviations that arise during construction and the measures that need to be taken in response (e.g. welding of pipeline elements). As a deliverable, participating undertakings in WS2 will publish a final report by the end of 2026 on experiences and best practices for the construction and operation of hydrogen pipelines. Furthermore, Hy2Infra transport projects face the challenge of recruiting employees with an adequate skill level in the field (see recital (70)). This challenge is reinforced by the general skills shortage in Europe. To overcome this obstacle, participating undertakings in WS2 will collaborate on

strengthening and developing professional networks in cooperation with **universities and the research community regarding industries' needs and offers.**

(164) The **third objective** relates to environmental impact assessment and permits. Approval procedures, including the necessary environmental assessments, account for a significant proportion of the project duration and therefore the costs of pipeline projects. In the case of hydrogen pipelines, an additional challenge arises because the approval authorities and the TSOs have little or no experience with the approval processes for hydrogen pipelines.

(165) Participating undertakings in WS2 will acquire important experiences on permitting processes including environmental impact assessment and develop good practices to accelerate approval processes while minimising the environmental impact caused by the construction of hydrogen pipeline networks.

(166) As a deliverable, participating undertakings in WS2 will derive recommendations by the end of 2025 from their experiences in regard of approval procedures and environmental impact assessment. Sharing these recommendations with relevant approval authorities can accelerate further projects beyond Hy2Infra.

2.4.5.3.3. Collaborations within WS3

(167) Participating undertakings in WS3 have defined two objectives under Pillar 2.

(168) The **first objective** is contributing to the development of joint standards. The development of technical and operational standards is highly relevant to enable investments decisions and gain a critical mass of facilities. Participating undertakings in WS3 will support the development of these standards based on their existing knowledge from their current or former business, i.e. storing natural gas and the practical experience from operating hydrogen storage infrastructure **with distinct technical characteristics in different locations. Hy2Infra's** collaborative approach on standards between the participating undertakings facilitates elaborating common recommendations, which participating undertakings in WS3 will pass on to relevant standardisation bodies.

(169) Participating undertakings in WS3 will analyse existing technical standards for hydrogen on a national and European basis and identify weak points, deviations and possible barriers. Based on this, they will work on necessary technical standards for hydrogen storage facilities. Similarly, Hy2Infra storage operators will align with transmission system operators on necessary standards to connect infrastructure, e.g. expected pipeline pressure, pressure at system entry and exit points, hydrogen purity and acceptable trace components.

(170) Participating undertakings in WS3 will collaborate with associations (e.g. Marcogaz, GIE ([70]), GSE ([71]), ENTSOG, Hydrogen Europe) to assist the development of joint technical and operational standards by identifying requirements for new safety standards (e.g. distances, materials, pressure levels, etc) and building on lessons learnt from re-purposing existing infrastructure.

([70]) Gas Infrastructure Europe.

([71]) Gas Storage Europe.

(171) As a deliverable, participating undertakings of WS3 will provide recommendations for the development of standards for hydrogen pipelines through the established harmonisation processes as described in section 2.4.5.4. As examples of relevant standardisation topics addressed by WS3 and included in **the European Clean Hydrogen Alliance's Roadmap for Hydrogen standardisation** the following are highlighted:

- Standardisation for retrofitting of gas storage facilities
- Standardisation for new build hydrogen storage facilities
- Standardisation for safe operation of hydrogen storage facilities.

(172) The **second objective** relates to balancing intermittent consumption with stable demand. WS3 will provide initial storage capacity in three regional clusters that can match intermittent supply with constant demand, facilitating hydrogen consumers to enter the market. WS3 projects will balance supply and demand and stabilise the grids while they grow. By turning unstructured supply of renewable and low-carbon hydrogen into structured commodities that are available on demand, storage sites in WS3 act as key enablers.

(173) WS3 will support the development of a non-discriminatory access regime to hydrogen storage facilities with clear terms and conditions for hydrogen producers, shippers and consumers. WS3 will develop and prove short (within-day, daily), and midterm (weekly, monthly) balancing strategies and methodologies. The feedback from connected projects will enable WS3 to analyse if these products and services fit market requirements and to adapt them accordingly. Equally, WS3 will investigate implications between hydrogen imports and storage.

(174) As a deliverable, participating undertakings in WS3 will develop joint recommendations by the end of 2029 for hydrogen infrastructure systems balancing rules, which will be presented to different stakeholders and authorities via the Hy2Infra reports and different events.

2.4.5.3.4. Collaborations within WS4

(175) The participating undertakings in WS4 have defined one objective under Pillar 2: contributing to the development of joint standards.

(176) LOHC conversion and reconversion systems and the associated port infrastructure can be standardised from a technical as well as from a safety point of view.

(177) Regarding the integration of renewable energies, the interface between electrolysers and conversion systems can be standardized from a technical point of view (e. g. purity, pressure) as well as from a safety point of view. In order to help the adoption of common standards, WS4 will combine the work with WS1.

(178) Finally, WS4 will address the topic of bulk ships capable to transport LOHC and LH2 with a view to establish technical and safety requirements.

(179) Participating undertakings in WS4 will work with responsible authorities (e. g. CEN, Deutsches Institut für Normung ("DIN")) to transfer the outcomes to

European and national standards. In addition, a major goal of WS4 is to enable the bulk transport of renewable hydrogen via ocean or river going vessels to connect regions with high-RES potential with regions of a surplus of energy demand. Currently, there are no ships transporting LOHC. Therefore, participating undertakings WS4 will work together with the responsible authorities such as the International Maritime Organization ("IMO") to contribute to the regulatory framework to regulate these types of maritime transport.

(180) As a deliverable, participating undertakings in WS4 will provide recommendations for the development of technical and safety standards through the established harmonisation processes as described in section 2.4.5.4. As examples of relevant standardisation topics addressed by WS4 the following are highlighted:

- Standardisation for all possible modes of hydrogen transport
- Standardisation for hydrogen quality derived from LOHC
- Standardisation for loading and unloading stations.

2.4.5.4. Public reporting as common deliverable

(181) The relevant results of the entire IPCEI Hy2Infra, especially common agreements on interoperability and standards must be made available to the public. The same applies to lessons-learned regarding regulatory constraints, which participating undertakings will acquire during the implementation of the projects, or to best-practice for commercial operating methods, developed through participating undertakings' interaction. To ensure an open access to this information, Hy2Infra participating undertakings will develop and publish joint reports on an annual basis as a concrete Hy2Infra deliverable during the implementation phase.

(182) The structure of the reports will follow the concrete and common deliverables of Hy2Infra:

a. Current state of Hy2Infra: the reports will present the current state of the construction phase of each component and, therefore, inform of the progress towards the common goal of achieving physical connections within Hy2Infra clusters. Reports will make clear which projects are in operation or will go into operation soon, which will help stakeholders to align further projects to Hy2Infra.

b. Current state of interconnections between Hy2Infra clusters on the national and European level. By presenting projects beyond Hy2Infra, the reports will deliver a complete picture of the development of the European hydrogen infrastructure.

c. Common agreement on interoperability: the reports will inform further market participants about common interoperability and connection requirements of the initial hydrogen infrastructure. As explained in section 2.4.5, participating undertakings will address hydrogen quality and pressure level standards as a priority. Therefore, first reports published will include the defined parameters for:

i. Hydrogen quality standard within Hy2Infra

ii. Hydrogen pressure level at connection points of Hy2Infra.

d. In addition, participating undertakings in Hy2Infra will share their view on standards and lessons-learned regarding their implementation or – when applicable – about lacking standards. Relevant standardisation bodies, such as CEN, will be able to use this information as technical recommendations. Examples of these standardisation topics are:

i. WS 1 (Production):

1. Electricity grid connection of electrolysers

2. Control strategy of integrated electrolyser systems

3. Safe operation of electrolyser systems

ii. WS 2 (Transmission grid):

1. Gas analysis method in pipeline systems

2. Transmission pipelines above 16 bars

3. Safety shut-off devices

iii. WS 3 (Storage):

1. Retrofitting of gas storage facilities

2. New build hydrogen storage facilities

3. Safe operation of hydrogen storage facilities

iv. WS 4 (Handling of transport modes):

1. All possible modes of hydrogen transport

2. Hydrogen quality derived from LOHC

3. Loading and unloading stations.

e. To further ensure interoperability with potential new market participants, participating undertakings in Hy2Infra will publish their solutions for operational rules. In accordance with the list provided in 2.4.5.2, participating undertakings will include different aspects for operating hydrogen infrastructures in the report:

i. Interoperability (flow control, measurement principles, allocation principles etc.)

ii. Balancing (balancing auctions, nomination procedures, communication standards, etc.)

iii. Capacity allocation (allocation methodology, capacity product etc.)

iv. Transmission tariffs structures (application of reference price methodology, associated consultation and publication requirements, etc.).

f. Lessons-learned in the context of regulatory framework: the reports will present lessons-learned and challenges which participating undertakings in Hy2Infra partners come across as early adopters of the regulatory framework.

(183) The reports will only present the overarching topics and common deliverables of Hy2Infra which are relevant for third parties. These topics are derived from Hy2Infra WSs and from interlinks between the individual projects within and across the WSs.

(184) All participating undertakings in Hy2Infra will contribute to the reports within the governance structure described in section 2.7. Reports will be issued on an annual basis over the construction phase of Hy2Infra ending with most projects already in their commercial phase by the end of 2029. Depending on the start of Hy2Infra, participating undertakings will publish at least six reports for the years 2024, 2025, 2026, 2027, 2028 and 2029. In addition, all participating undertakings in Hy2Infra can use the content and common results of the reports at public events or other occasions to ensure positive spillover effects.

2.5. Positive spillover effects generated by Hy2Infra

2.5.1. Positive spillover effects induced by the objectives of Pillar 1 – Network effects

(185) The participating Member States submit that a growing hydrogen network, consisting of producers (WS1), storage facilities (WS3, WS4), hydrogen transport (WS2, WS4) and consumers, developing from initial regional clusters, creates positive network effects ([72]) that further stimulate the growth of the hydrogen market.

(186) Given the open access commitment (see section 2.4.5.1) potential newcomers, be they suppliers of hydrogen, consumers of hydrogen, suppliers of storage or transport services will be able to connect to the different clusters. Any potential newcomer will benefit, when connecting to Hy2Infra from the existence of an already connected network with already a series of available facilities without the need to bear ramping up costs of the network. For Suppliers, this means access to an already existing number of consumers. For the off-takers it means access to an already series of connected suppliers, etc.

(187) As more hydrogen consumers, for instance, connect to the hydrogen network and as the network grows, a pull effect occurs, which leads to increased hydrogen production and lower commodity costs. Moreover, the increasing availability of transport via pipelines will enhance flexibility and efficiency in transporting

([72]) A positive network effect or externality exists if the quantity of a good demanded by a consumer increase in response to an increase in purchases by other consumers (source Lancaster University).

hydrogen from regions with production surplus to high demand regions. The increased numbers of users will help reduce transport fees as regulated network costs are shared among a larger pool of users. Network effects do not only benefit hydrogen producers and other infrastructure operators but also end users by increasing security of supply and facilitating an earlier switch to hydrogen.

2.5.2. Positive spillover effects induced by the objectives of Pillar 2 – Active contribution to standardisation

(188) As described in section 2.4.5.2, participating undertakings in Hy2Infra will collaborate to facilitate harmonisation and adoption of national and European standards. Without standards supporting technologies and processes in Hy2Infra, any interoperability efforts could be compromised because of the lack of market-wide adoption. Thus, the time to market would be longer and the associated costs higher.

(189) Standardisation efforts will also play an important role in the framework of the dissemination and exploitation activities as a crucial element of confidence building. The innovative nature of the projects requires the definition of standards and the development of international regulations. Standardisation activities increase the impact of projects and facilitate the exploitation and dissemination of results into the market. Indeed, one of the main benefits of standardisation activities is to facilitate technological cooperation and knowledge transfer. Hy2Infra participating undertakings will share their deliverables on interoperability, standardisation, and operational rules in open discussion among all stakeholders.

(190) As described in recital (140), all participating undertakings have committed to respond positively to call for experts within the corresponding CEN/CENELEC Technical Committees for the standardisation topics identified as relevant for their respective project.

2.5.3. Positive spillover effects induced by the objectives of Pillar 2 – Dissemination spillovers

(191) Hy2Infra will mainly disseminate knowledge acquired during the implementation of their respective individual projects that is not protected by IP-rights, such as contribution to conferences, trainings and learning events or participation in hydrogen fora, and to a lesser extent also by the dissemination and spillover of IP-protected results.

(192) Each direct partner will participate in the dissemination activities until the end of its individual project's lifetime. In general, knowledge that is not protected by IP-rights benefits from broad-spectrum dissemination across various communicative channels as detailed in section 2.5.3.1. These include conferences, publications, trainings, participation in hydrogen associations, cooperation with research and technical organisations.

(193) The dissemination and spillover of IP-protected results requires to respect the relevant legal consideration as detailed in section 2.5.3.4. Access to IP-protected results related to the technology of the participating undertakings in Hy2Infra will be granted under non-exclusive FRAND ("fair, reasonable, and non-discriminatory") terms. Based on estimations of IP-value, exploitation of IP-

protected results will be possible through a mix of lump sums, maintenance fees, milestone fees and royalties.

(194) Participating undertakings commit to support research facilities by funding and co-funding of PhD and M.Sc. theses over the course of Hy2Infra. The following table presents a cumulative overview of dissemination spillovers, a vast majority of which will take place in the EU.

	Tools		Target number without IPCEI	Target number with IPCEI
Publications	Peer-reviewed journals	N° of articles	7	58
	Professional and engineering magazines and journals	N° of articles	27	174
Academic support	Funding of Master/PhD studies	N° of candidates	29	115
	Funding of University Chairs	N° of chairs	2	8
Targeted events	Contribution to events like conferences as presentator/contributor	N° of presentations	98	402
	Organized workshops/webinars	N° of workshops	26	121
		N° of webinars / training	15	89
Collaboration with academia	Collaboration with academia and research organisations	N° of cooperations	17	82

Table 14: Dissemination spillover activities by participating undertakings with and without the IPCEI

(195) Each participating undertaking will participate in dissemination activities until, and including, the final year of its individual project. A member of the Facilitation Group (see section 2.7) will be designated as key contact for the implementation of the dissemination and spillover commitments.

2.5.3.1. Conferences and trainings

(196) Participating undertakings in Hy2Infra will take part in conferences and public presentations in the framework of established international events in several Member States including Austria, Belgium, Denmark, France, Germany, Hungary, Italy, the Netherlands, Portugal, and Spain, aiming for wide geographic coverage, beyond the participating Member States.

(197) These events are attended by actors active in several different sectors, such as steel industry, chemical industry, automotive, mobility, transport, materials, recycling, energy storage, and electrolysers, among others. They go largely beyond the sector in which the respective participating undertakings operate and will therefore aim for a wide sector coverage.

Conference Title, **Location** (73)	**Participating undertakings**	**Main topics addressed by participating undertakings (examples)**
E-world energy & water, Germany	DE03, DE29, DE32, DE33, DE40, DE61, PT25, DE64	- H_2 Netz 2030/2040 - Hyperlink and the EU collaboration with other Direct and Indirect Partners - AquaDuctus and the EU collaboration with other Direct and Indirect Partners - Doing hydrogen
BDEW Jahreskongress, Germany	DE03, DE24, DE28, DE29, DE38, DE40, DE23, DE64	Hydrogen market design and regulations
DVGW Kongress – H2-Sicherheit, online	DE24, DE28, DE29, DE33	GreenMotionSteel and its influences on hydrogen safety, norms and standards
Grande Region Hydrogen EEIG conference	DE28, DE54	Hydrogen economy in the Grande Region (Saarland, Lorraine, Luxembourg)
European Hydrogen Conference, Austria	DE33, DE45, DE63, FR23, DE23, PT25	Hydrogen production, hydrogen storage, handling and distribution, Cross-cutting topics like Safety, Environment and Training, Standards, Commercialization and markets strategies
Hydrogen Europe	DE38, DE40, DE63, IT21 PT25	- Codes and standards for H_2 transportation Infrastructure - Moving from gas transportation to hydrogen transportation, new common standards, specifications and rules have to be developed

(73) If no location of an event is mentioned, the location is either changing each time, online or not (yet) defined etc.

BeyondGas, Germany	DE07, DE29, DE40, DE56, DE32	Hydrogen as a future energy system
Hannover Messe / Hydrogen + Fuel cells Europe, Germany	DE23, DE32, DE33, DE40, DE59, FR23, PT25, DE64	- Combination of hydrogen Electrolysis (PEM) and Mobility Solutions - Value Chain of Green hydrogen in Germany
Hydrogen dialogue, Germany	DE59, DE64, PT25	- Company presentation - presentation and information of current projects (IPCEI)
H2 Forum, Spain	DE18, DE59, DE61, DE63, DE64, DE71, PT25	Green Octopus Mitteldeutschland: project intentions, status (included/associated partners, associated projects, new developments, possible expansions)
Gas Infrastructure Europe, Hungary	DE24, DE29, DE61, SK04	H_2 impact on existing infrastructure, design of system components testing, design of particular devices optimization, security of operation
International Renewable Energy Agency (IRENA) Conference, Portugal	DE63, PT11, PT25	Techno-economic and practical learnings from all aspects of the project - expect to attend at least 2 editions of these conference series
World Hydrogen Congress	DE24, DE59, NL57	Challenges in producing hydrogen from renewable to supply a H_2 liquefaction plant, large-volume and long-distance hydrogen transportation with LOHC
European Clean Hydrogen Alliance	DE03, DE23, DE24, DE29, DE38, DE63, DE61, DE71	- Technical best practices in hydrogen pipeline infrastructure, especially customer transition process from natural gas to hydrogen and operation of infrastructure - Commercial best practices in operation of discrimination free hydrogen infrastructure
f-cell, Germany	DE33, DE59	- Company presentation - presentation and information of current projects (IPCEI)
HyVolution, France	DE33, FR23	Large scale operations of PEM Electrolysers, Safety and Certification
International Conference on Hydrogen Production and Storage ICHPS, Switzerland	IT49, PL01	Presentation of plans and initial results related to hydrogen storage and balancing of the plant
NATIONALES WIRTSCHAFTSFOR	DE18, DE61,	Poster on Doing hydrogen and Green Octopus

UM WASSERSTOFF, Germany	DE64, DE71	Mitteldeutschland: project intentions, status

Table 15: List of conferences to which at least two participating undertakings will contribute

(198) Additionally, participating undertakings in Hy2Infra have committed to organise educational, academic and social dissemination through dedicated training of personnel.

(199) To keep and maintain competitiveness in the field of hydrogen, strengthening the skill base of employees is a crucial factor and a permanent task for the participating undertakings. Hence, new and existing training programmes on hydrogen related topics will be offered to different employee groups. Furthermore, several participating undertakings are planning to launch new training and lifelong learning events and to establish or intensify apprenticeship as well as student programmes. The envisaged activities within Hy2Infra cover a broad range of formats, such as regular series of lectures, technical trainings, hydrogen academies, e-learning platforms, exchange programs and internships.

(200) Besides the focus on internal education and in-house training options, participating undertakings will develop programmes in collaboration with external entities from academia and industry. Several participating undertakings plan engagements such as continuous lectures at university chairs, summer schools, site-visits, and scholarships aimed to improve competence in the hydrogen sector. In addition, there will be a strong cooperation with other professionals, customers, start-ups, and other stakeholders. For example, training in software applications, innovation labs, conferences, exhibitions as well as forums on hydrogen will engage these groups. Finally, educational activities for the public are considered, for example amongst others virtual tours and open days for local non-professionals.

(201) The following paragraphs present examples of participating undertakings' envisaged activities.

(202) DE28: Creos will participate in events that are open to the public (e.g. "Woche des Wasserstoffs Süd") to allow citizens to discuss their questions or concerns and educate themselves regarding hydrogen technology and its advantages and possibilities. Creos as member of the initiative "Grande Region Hydrogen" (GRH) will further organise and participate in educational events and conferences hosted by the GRH.

(203) DE33: Related to the project GreenMotionSteel, ALD plans to organize dissemination events itself for different target groups (industry, policy makers, students, scientists) in addition to publications and conferences and workshops organized by third parties. The actions include scientific days for students and young academics, conferences for practical experts in the field at the site, as well as company visits and open days for the public and celebratory events for the people and companies involved in the construction of the electrolysis plant.

(204) DE63: Linde will offer school graduates the opportunity to gain experience with environmentally friendly hydrogen technologies during their studies by combining theory and practical work experience. For this purpose, measures are planned both on the scientific side (integration in university teaching, theses) and

on the economic side (integration in training programs). Furthermore, Linde will organize open days for the interested public: an end-of-project commissioning conference will be held for Green Hydrogen Hub (target is six months after start of operations. Linde will invite attendees from government, industry, and interested public.

(205) DE03: ENERTRAG will hold open days for the public at the electrolyser sites to foster engagement with the local communities and make the use of hydrogen tangible and visible.

(206) PL01: Polenergia – **in collaboration with TU Gdańsk/TU Szczecin will organise a** presentation of the installation to students and other scientific employees.

2.5.3.2. Collaborative RDI ecosystems

(207) The participating Member States have submitted for each participating undertakings in Hy2Infra the list of collaborations with academia and research organisation. Participating undertakings in Hy2Infra commit to disseminate IP-unprotected results acquired in the framework of their projects to the scientific community, particularly, by collaborating with academia and research organisation and other indirect partners.

(208) Participating undertakings will contribute as well to the creation or development of university and school chairs to train future European scientists, engineers, technicians, and operators.

(209) The table below provides examples of collaborations between participating undertakings and research organisations.

Institution	**Direct Partner(s)**	**Scope of the collaboration**	**Country**
Danmarks Tekniske Universitet (DTU)	FR23	Assessment of relevant grid-services and how these could be obtained with electrolysers. Testing facility available to test and validate different control systems for providing these services	Denmark
French Institute for Sustainable Development	FR23	Assessment of the benefits of injecting oxygen into the oceans. As of today, the oceans have lost an important fraction of their oxygen with so-called dead-zones. This also means the oceans have lost capacity to absorb CO_2. With large-scale offshore hydrogen production it will be possible to re-inject oxygen back into the oceans	France
Fraunhofer IZFP	DE28	Creos is collaborating with Fraunhofer IZFP to develop a security monitoring system for hydrogen networks	Germany
Helmholtz association	DE23, DE59,	Technological research complemented by systems analysis and socio-	Germany

	DE63	economic perspectives	
University in Prag (Service agreement)	DE24	Cooperation with RWE Gas Storage CZ for material testing - suitability of existing installed components and materials for the utilisation with H_2	Germany
Technical University Clausthal	DE26, DE29	How electricity from nearby wind turbines can be converted into H_2 via a large-scale electrolyser	Germany
University of Rostock	DE03, DE32	Collaboration with University chairs	Germany
Real-world laboratory (Reallabor) Element Eins (Germany), Gasunie, Tennet, Thyssengas	DE07, DE43A, DE43B	System analytics for integration of green hydrogen production at systemic locations within the Real-world laboratory „Element Eins“	Germany
Friedrich-Alexander Universität Erlangen-Nürnberg	DE59	Development of innovative process designs, research of new catalysts, research of innovative LOHC applications	Germany
DBI Gas- und Umwelttechnik GmbH	DE18, DE61, DE71, DE23	Scientific cooperation in H_2 projects (e.g. Reallabor Energiepark Bad Lauchstädt) H_2 material compatibility, welding processes, separation techniques	Germany
Zentrum für Brennstoffzellen-Technik GmbH (ZBT), Max-Planck-Institute for coal-research	DE26	HyCleanUp Project: A project to develop a methodology for purification and testing of the quality of H_2 after transport by converted pipelines.	Germany
Fraunhofer Institute	DE32, PL01	Development of pressure tanks: production planning, material testing regarding hydrogen permeation; Providing proposals of market standards for hydrogen technologies, development of techno-economical models for new hydrogen-based business models	Germany
Leibniz Institut für Katalyse e.V	DE32	Chemical storage of hydrogen, catalyst development, new processes for efficient storage and generation.	Germany

Polytechnic University of Bari, DICATECh Department	IT02	The DICATECh includes the following scientific sectors (SS): Chemistry SS, dealing with Risk assessment and Pollution monitoring.	Italy
TU Warsaw	PL01	Collaboration - co-firing of hydrogen in CCGT units, possibility of R&D activities on installation	Poland
Wroclaw University of Science and Technology	PL01	Collaboration - hydrogen pipelines and storage of hydrogen	Poland
IMP PAN (Fluid Flow Machinery Institute of Polish Academy of Science)	PL01	Collaboration - integration of hydrogen installation (production, storage, distribution, electricity connection)	Poland
ISQ - Instituto de Soldadura e Qualidade	PT11	Collaboration in "DST-H2 Project" to provide data and information to decision support for planning and operation of the assets repurposed from natural gas to hydrogen	Portugal
HyLAB	PT25	Enable the Portuguese swift implementation of green hydrogen production, storage, transport and utilisation at competitive costs.	Portugal
Technical University Košice (TUKE)	SK04	Joint research in the field of complex material characterisation. Funding of a PhD thesis regarding infrastructure repurposing.	Slovak Republic

Table 16: Collaborations with research organisations (indicative and non-limitative list)

2.5.3.3. Publications

(210) In addition, over the course of Hy2Infra, several participating undertakings have committed to disseminate their project results in peer-reviewed articles or through articles in professional and engineering magazines and journals. The following paragraphs present some examples of such publication commitments.

(211) Within WS1, DE43A commits to publish up to 10 peer-reviewed articles on the following topics:

i. Impact of technical and economic aspects on systemic operation of water electrolysis systems.

ii. Systemic integration of water electrolysis systems and impact on RES deployment.

iii. Impact of cell degradation on overall performance and operating strategy.

iv. Operation strategies for integration of waste heat usage and balancing energy market.

v. Systemic influence of several electrolyser plants which are operated close to each other.

(212) Similarly, IT02 will disseminate knowledge through five publications in specialized magazines or scientific publications covering the following topics:

i. Grid peak balancing services with hydrogen production

ii. Transition from fossil-fuel derived hydrogen to green hydrogen

iii. Techno-economic analysis of hydrogen production

iv. Hydrogen production and distribution challenges

v. Decarbonization strategies for hard-to-abate industries

(213) IT49 commits to publish a peer reviewed article describing the electrolyser performances in continuous and discontinuous mode; including the impact on efficiency, maintenance, and energy demand of hydrogen production.

(214) Within WS2, DE29 commits to publish two articles on technical experiences, economic and legal considerations from the first large-scale hydrogen offshore pipeline Aquaductus. SK04 will publish two peer reviewed articles a year on the progress of the project in the Periodical of the Slovak Chamber of Commerce and Industry and two articles a year in the professional magazine Slovgas. The project will create valuable for other TSOs considering repurposing of pipelines with similar technical parameters, built in line with standards in the former Eastern Bloc European countries.

(215) Within WS3, DE43B commits to publish up to 10 peer-reviewed articles on the following topics:

i. Impact of RFNBO-compliant hydrogen production on storage operations.

ii. Influence of underground hydrogen storage on hydrogen quality.

iii. Optimisation of storage operation for storing RFNBO-compliant hydrogen.

iv. Transformation of natural gas storage facilities to hydrogen storage.

(216) Within WS4, DE59 will publish peer-reviewed articles on the following topics:

i. Improved hydrogenation process through development of novel hydrogenation reactor concepts

ii. Development of a dedicated LOHC hydrogen purification system for large scale installations

iii. An innovative heat transfer solution for utilising the exothermic heat generated by LOHC hydrogenation.

2.5.3.4. Spillover Effects in IP-protected results

(217) Most participating undertakings Hy2Infra will not generate IP-protected results during their activities since the focus of Hy2Infra lies in the construction of an integrated infrastructure and not in RDI or FID. However, in case of the creation of results which might be applicable for IP-protection, each direct partner will disseminate results that are subject to registered and unregistered intellectual property (IP) individually. Participating undertakings will use several ways for disseminating IP-protected results, which will in turn increase the visibility, attractiveness, and impact of their technologies. By default, the use of protected IP and license fees will be defined in cooperation contracts between the participating undertakings, customers and other partners. To make the results accessible to the European hydrogen industry, the licenses related to the technologies of the Participating undertakings, which are planned to be developed, will be under non-exclusive FRAND terms.

(218) Most of the participating undertakings in WS1 will not generate results of intellectual property rights. However, technology providers, e.g. electrolysis manufacturers, may gain potentially patentable technological expertise. The Union-wide exploitation of the electrolysis technology lies with and will be ensured by the electrolysis manufacturers, complemented by dissemination activities of the WS1 participating undertakings regarding operational best practices. The dissemination of technological improvements will promote the targeted cost reduction of large-scale electrolysers and, consequently, help lower market-entry barriers for additional participants. Existing agreements of the participating undertakings in WS1 with key-contractors will not constitute a barrier to sharing knowledge and results of this project with other participating undertakings.

(219) IP is – generally – only applicable in a limited way to participating undertakings in WS2 since pipeline projects aim at the large-scale implementation of infrastructure that is already technologically viable (although with limitations, e.g. regarding the operating pressure in the pipeline). In any event, all participating undertakings in WS2 share a long-term vision of a mature hydrogen backbone used by as many users as possible, for which intellectual property could be obstructive. Consequently, participating undertakings in WS2 are interested in sharing knowledge with relevant stakeholders (e.g. via relevant working groups in ENTSOG and – in the future – ENNOH or (in Germany) in DVGW or FNB Gas).

(220) Individual projects in WS3 do not foresee any major IP-protected results. **However, during the project's operational phase, participating undertakings may** gain technological expertise leading to potential patents. The Union-wide dissemination of technological improvements in WS3 will promote the targeted cost reduction of large-scale storage units and, consequently, contribute to lowering market-entry barriers for additional participants. Under Hy2Infra, the aim is to pave the way for a hydrogen backbone and, therefore, at this stage participating undertakings do not foresee any specific patents or IP protected results requiring a specific distribution strategy of corporate insights.

(221) Each participating undertakings in WS4 will develop technological building blocks and use cases to develop a European renewable and low-carbon supply chain. For example, some of the inventions of DE59 in the scope of Hy2Infra will be IP-**protected typically through filing patents. Hydrogenious, DE59's** technology developer, commits to offer FRAND licensing conditions for all patents resulting from the project, in line with the requirements of Hy2Infra. DE59 facilitates the development of LOHC chains in Europe and building experience with this technology by market players. Many third parties are involved in the construction of the LOHC systems. Hydrogenious will be forming partnerships, joint venture for specific applications of hydrogen within the scope of Hy2Infra. The FRAND licensing commitment of Hydrogenious will hold for DE59 project and the IP created. In addition, Hydrogenious will interact with several universities and RTOs in the scope of Hy2Infra for developing its projects, overcoming technological challenges for large-scale LOHC systems, and disseminate its IP-protected results.

2.6. Compliance of Hy2Infra with the principle of "do no significant harm" ("DNSH")

(222) The participating Member States have conducted an a priori assessment of their individual projects and submit that each of them complies with the environmental objectives set out in Article 9 of Regulation (EU) 2020/852 ([74]) **("Taxonomy Regulation").**

(223) The six environmental objectives covered by the Taxonomy Regulation are: climate mitigation, climate change adaptation, use and protection of water and marine resources, circular economy, including waste prevention and recycling, pollution prevention and control, and protection and restoration of biodiversity and ecosystems.

(224) First, regarding **climate change mitigation**, the participating Member States submit that:

(225) All hydrogen production projects are based on water electrolysis and aim at producing hydrogen in such a way as to significantly exceed the minimum GHG emission savings threshold of 70%, compared to a fossil fuel comparator of 94 g CO2e/MJ (i.e. CO2 equivalent per megajoule) by reference to the methodology set out in the second delegated act ([75]) of the REDII. In fifteen of these projects only hydrogen qualifying as RFNBO within the meaning of the RED II and its first delegated act ([76]) will be produced. One project envisages to produce essentially RFNBO as well as a limited share of low-carbon hydrogen ([77]) complying with the minimum GHG emission savings threshold of 70%, by reference to the methodology set out in the second delegated act of the REDII. If part of the hydrogen will be transported by trailers, ship or train, the participating

([74]) Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment (OJ L 198, 22.6.2020, p. 13).

([75]) See footnote 13.

([76]) See footnote 12.

([77]) See footnote 38.

Member States explain how the production of hydrogen complies with the minimum GHG emission savings threshold of 70% by reference to the methodology set out in the second delegated act of the REDII.

(226) Projects consisting in the installation of hydrogen transmission and distribution infrastructure via pipelines consist in pipelines dedicated to hydrogen only. Furthermore, the participating Member States submit that measures will be taken to prevent hydrogen leaks.

(227) All large-scale hydrogen-storage facilities projects in WS3, as well as on-site storage facilities forming part of the large-scale electrolyser projects in WS1 are only dedicated to hydrogen. Two out of the three large-scale hydrogen-storage facilities projects relate to the conversion of existing underground natural gas storage facilities into facilities dedicated to hydrogen storage. The third one relates to an unused cavern, which will be prepared and equipped for hydrogen storage. In addition, the participating Member States submit that measures will be taken to prevent hydrogen leaks and/or potential fugitive emissions and damage.

(228) For the two projects concerning the handling of LOHC, the emissions linked to the liquefaction / LOHC conversion and the transport remain limited so that the supplied hydrogen still complies with the minimum GHG emission savings threshold of 70% and qualifies as RFNBO within the meaning of the REDII. For these projects, the participating Member States submit that measures will also be taken to prevent potential hydrogen leaks and/or fugitive emissions and damage. The participating Member States further confirm that for these projects, by design, LOHC technology has a very low risk of hydrogen leaks, given that it is mainly handled in the form of LOHC along its supply chain.

(229) Second, regarding **climate change adaptation**, the participating Member States submit that the notified projects are not expected to lead to an increased adverse impact of the current climate and the expected future climate, on the notified projects themselves or on people, nature or assets. In this respect, the participating Member States specifically confirm the following:

(230) Hydrogen production projects setting up large scale electrolysers are not expected to have a negative impact on water availability in the regions concerned. For the projects located in areas subject to water stress, the participating Member States submit that sufficient mitigating measures will be taken to avoid that the electrolyser increases water stress in the region where it will be located. In particular, all these projects concerning large scale electrolysers will be subject to an environmental impact assessment. Moreover, their water needs are covered from sources with no significant impact on water availability in the regions concerned (treated wastewater, desalinized water or industrial water available from treated wastewater, desalinated water or meteoric catchment basin). Also for a series of other projects concerning large scale electrolysers located outside of areas suffering from water stress, water needs are covered by treated wastewater and industrial water, or treated water from surface sources (canals, rivers), for which the participating Member States submit there is no significant impact on water availability in the regions concerned. A limited number of projects concerning large scale electrolysers use drinking water from the network, but either they explore alternative water sources (e.g. using purified wastewater from local sewage treatment plant), or the participating Member States confirm there is

no significant impact on water availability in the concerned region as the regions concerned benefit from abundant water resources.

(231) Hydrogen storage facilities and transmission and distribution infrastructure via pipelines are not expected to lead to an increased adverse impact on the current climate and the future climate (as currently expected). The participating Member States confirm that a climate screening will be or has been conducted for several projects. The participating Member States explain that in any event, as the pipelines are placed underground, they are unlikely to be impacted by increasingly severe weather events like heavy rain or storm.

(232) The participating Member States submit that LOHC projects are unlikely to adversely affect water availability in the concerned regions, as the handling of LOHC itself does not require intensive use of water.

(233) Third, regarding the **sustainable use and protection of water and marine resources**, the participating Member States submit that the projects are not expected to be detrimental to the good status or the good ecological potential of bodies of water, including surface water and groundwater, or to the good environmental status of marine waters. Almost all projects have already been subject to or will be subject to an environmental impact assessment within the meaning of Directive 2011/92/EU ([78]). Where no environmental impact assessment will be conducted, the participating Member States explain that an environmental impact assessment was not considered necessary following a preliminary screening as part of the national permitting legislation, or the project sufficiently justified why it is not detrimental to the good status of water bodies and marine resources and therefore why there is no need to subject it to an environmental impact assessment (in particular because it does not make use of water and does not release any substance or untreated waste-water in water bodies). Furthermore, the participating Member States provide details on how wastewater would be handled for the different projects. Wastewater will either be treated by the project developer before returning to the environment or be channelled to a wastewater system operated by a third-party taking care of the treatment of the wastewater. Wastewater may not require any treatment if it is of same quality as river- or seawater. In particular, when the project releases brine the participating Member States indicate that the brine could only be released in the sea if environmental authorities confirm that this is without negative impact on marine resources. Furthermore, two large scale storage facilities projects will use the brine as feedstock instead of discharging it.

(234) Fourth, regarding the **transition to a circular economy**, including waste prevention and recycling, for all large-scale underground hydrogen storage facilities projects and LOHC projects, the participating Member States submit that a waste management plan will be put in place that ensures maximal reuse, remanufacturing or recycling at end of life of equipment and components, including through contractual agreements with waste management partners. Moreover, the participating Member States highlight that a series of projects

([78]) Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (OJ L 26, 28.1.2012, p. 1).

significantly contribute to circular economy. In this respect, several projects setting up large scale electrolysers found ways to use the waste heat and the oxygen by-produced from water electrolysis or intend to, respectively give priority to equipment that can easily be repaired and/or recycled or composed of subparts that can be refurbished. Also, some projects setting up large scale electrolysers will be built on sites on which activities have been or will be decommissioned. Where possible, some of the existing facilities will be reused (cables, pipes, water treatment facilities, etc.). Furthermore, projects concerning the repurposing of pipelines of existing natural gas pipelines into high-pressure pipelines for the transport of hydrogen positively contribute to the circular economy by reusing the asset.

(235) Fifth, regarding **pollution prevention and control**, the participating Member States submit that the projects are not expected to lead to a significant increase in the emissions of pollutants into air, water or land. They confirm that the projects lead to emissions of pollutants that are within or lower than the emission levels associated with best available techniques ranges set out in the latest best available techniques conclusions for the activity concerned, and they do not relate to the manufacturing or use of the substances listed in the Appendix C to the Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 ([79]) **("Taxonomy Delegated Regulation"). Furthermore, the Member States confirm** that:

a. Projects concerning large scale hydrogen-storage facilities and LOCH projects comply with Directive 2012/18/EU of the European Parliament and of the Council ([80]). Moreover, LOCH projects use energy efficient equipment (high energy efficiency label class).
b. Projects consisting in the installation of hydrogen transmission and distribution infrastructure via pipelines, fans, compressors, pumps and other equipment used (covered by Directive 2009/125/EC ([81])), comply, where relevant, with the top-class requirements of the energy label, and with implementing regulations under that directive and represent the best available technology.

(236) Sixth, regarding the **protection and restoration of biodiversity and ecosystems**, the participating Member States submit that the projects are not located in natural protected areas. Furthermore, almost all projects have already been subject to or will be subject to an environmental impact assessment, where required by EU and national environmental legislation, or to an environmental permit and the

([79]) Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives (OJ L 442, 9.12.2021).

([80]) Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (OJ L 197, 24.7.2012, p. 1)

([81]) Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (OJ L 285, 31.10.2009, p. 10).

conclusions of the environmental impact assessment will be implemented. In those cases where an environmental impact assessment will not be conducted, the participating Member States explain that an environmental impact assessment was not considered necessary following a preliminary screening as part of the national permitting legislation or the project justified why it was not detrimental to the biodiversity and ecosystems. In general, this is due to the fact that the facilities will be established on already existing industrial sites (hence do not involve any removal of trees); also, the activities concerned do not imply emissions that are damaging for ecosystems.

2.7. Governance of Hy2Infra

(237) A governance structure of the IPCEI will be set up, with several governing bodies to implement successfully Hy2Infra. The governance structure is summarized in the following table:

IPCEI Supervisory Board ("SB")		
Public Authority Board ("PAB")	Facilitation Group ("FG")	Commission (guest status)
IPCEI General Assembly ("GA")		

Table 17: Hy2Infra governance structure

(238) Hy2Infra's SB is composed of:

- The PAB, with representatives appointed by the participating Member States in Hy2Infra, each having one vote;
- The FG, with the chair and the deputy of Hy2Infra and the coordinators of the WSs; and
- Three representatives of the Commission as observers and advisers, i.e. additional company representatives or advisors, without voting rights, which may be invited by the SB.

(239) The SB oversees the implementation and the monitoring of Hy2Infra and ensures the compliance with the annual reporting obligations to the Commission required under the IPCEI Communication (point 52), based on the information provided by the FG. The focus of the implementation of Hy2Infra is on the technical advancements of the projects and on the spillover activities that the direct participants committed to undertake. The SB informs the GA of the progress of the Hy2Infra once per year. It should also inform the GA of any modification of the Hy2Infra.

(240) In principle, the SB meets twice per year, possibly by means of teleconferencing or videoconferencing. The SB may also meet in extraordinary session to discuss any event relating to Hy2Infra, such as, for instance, the potential entry of a new participating undertaking or the exit of an existing participating undertaking.

(241) At its first meeting, the members of the SB will agree upon the key performance indicators ("KPIs") demonstrating the effectiveness of Hy2Infra's functioning. The SB will monitor these KPIs during the course of Hy2Infra.

(242) The GA meets once a year. It gathers all direct participants, the representatives of the participating Member States, and the three representatives of the Commission (as observers). At its first meeting, to be held within six months after the Commission's decision approving Hy2Infra, the members of the GA (excluding the representatives of the participating Member States) elect the members of the FG (see recital (243)). Each direct participant has one vote, and the decisions of the GA are adopted by a two-thirds majority. It designates a participating undertaking that is a member of the FG, as key contact for the implementation of the spillover commitments. The GA takes note of any exit decision of a direct participant from Hy2Infra. As from its second meeting onwards, the GA shall be organised alongside an annual public IPCEI conference.

(243) The FG is composed of:

- the chair and the deputy of Hy2Infra;
- the coordinators of the WS (one per WS) and their substitutes; and
- additional undertaking's representatives or advisors assuming other missions related to the FG duties.

(244) The FG oversees WS coordination, annual reporting, communication, preparation of events, etc. It drives the overall progress of the WS on a non-confidential basis and establishes a permanent interface between private and public stakeholders with the goal of highlighting Hy2Infra's role and impact.

(245) The FG is responsible for organising and fostering collaboration and communication within Hy2Infra and vis-à-vis third parties who can potentially benefit from the results of Hy2Infra but who are not participating undertakings. For this, the FG implements two instruments: the annual Hy2Infra meeting and a Hy2Infra website.

(246) A Hy2Infra meeting takes place once a year, in the context of the IPCEI Hydrogen meeting. The IPCEI Hydrogen meeting will be held jointly with all IPCEI Hydrogen waves. It will start in December 2023 with Hy2Tech and Hy2Use. Hy2Infra will participate for the first time in the meeting following the clearance decision. The meeting will consist of a dedicated session for the participating Member States, the Commission, and the participating undertakings and depending on the advancement of projects a public conference open to any interested party, during which the participating undertakings will present the main results of their work.

(247) The already launched IPCEI Hydrogen website hosts public information about all IPCEI Hydrogen waves and the participating undertakings. The website serves as the dissemination and interaction channel of Hy2Infra engaging thus entities other than the participating undertakings. To achieve this, the website will list all spillover activities to which the participating undertakings have committed (see section 2.5). This information is likely to be presented in the form of an "Events

Calendar" with the concrete dates and a brief description of the activity. The interested community will have the opportunity to register to participate in the activities directly with the participating undertaking who will be in charge of the specific activity. The website serves also as a basis for the annual reporting on the delivery of the committed activities. The FG of each wave collects qualitative and quantitative information on each activity. In addition to the joint presence on the IPCEI Hydrogen website, each wave presents itself with its own section. It may also foresee a restricted area for the participating undertakings to organise the implementation of Hy2Infra.

(248) The members of the FG will change over time to take into consideration the end of participation of the participating undertakings according to their respective individual projects.

(249) **As regards national governance, the participating undertakings' individual** projects are governed by funding agreements to be concluded with the relevant funding authority within each participating Member State. Such funding agreements impose requirements and obligations towards the administration of any individual project according to the rules set up by the funding authority. The national funding authorities are in possession of the commitments of all participating undertakings. As such, the PAB will be responsible for monitoring the completeness of the listings and announcements of the committed spillover activities and knowledge dissemination.

2.8. Description of the aid measures

2.8.1. Total eligible costs in Hy2Infra

(250) The participating Member States indicate that the individual projects of Hy2Infra consist of infrastructure projects within the meaning of point 25 of the IPCEI Communication (see recitals (50), (65), (73), and (79)).

(251) They also submit that the total Hy2Infra eligible costs ([82]) will amount to EUR 11.51 billion.

2.8.2. Aid amounts per participating undertaking and per participating Member State

(252) The participating Member States have submitted the amounts of State aid under the measures that will be provided to the participating undertakings ([83]), together

([82]) Eligible costs are only those costs of the individual projects, which comply with the requirements of the Annex to the IPCEI Communication. They, however, do not represent all costs required to conduct the individual projects concerned. The remaining portion of the costs required to conduct those activities, which are not considered eligible for public financing, will be absorbed by the participating undertakings.

([83]) The aid is capped in nominal terms by the eligible costs. Participating Member States will also ensure that the discounted value of the aid for each participating undertaking (using the relevant weighted average cost of capital ("WACC") as the discount factor) will not exceed the notified funding gaps. The amounts shown under the funding gap column are expressed in discounted or present value terms. In some cases, the notified State aid (in discounted terms to be comparable to the funding gap) does not fully cover the funding gap of the respective individual projects. In those cases, it is expected that with the individual eligible costs and funding gaps. The funding gaps submitted by the participating Member States are calculated as the difference between the positive and negative cash flows over the lifetime of the investment, discounted to their current value ([84]) on the basis of an appropriate discount rate reflecting the rate of return necessary for the beneficiary to carry out the project, notably given the risks involved.

(253) All participating Member States intend to disburse State aid in several instalments over a certain period of time during the lifespan of a project. In such cases, aid payable in the future, including aid payable in several instalments, is discounted **using the weighted average cost of capital ("WACC") as the discount rate.**

(254) The main parameters for determining the State aid level are expressed in the Table 18 to Table 24 in nominal and in discounted (i.e. net present value ("NPV")) terms.

Project - undertaking	*EUR million*			
	Eligible costs (nominal)	**Funding gap (discounted)**	**State aid (nominal)**	**State aid (discounted)**
FR23 - Lhyfe S.A.	[400-500]	[300-400]	305.87	[200-300]

Table 18: France – State aid in EUR million

Project – undertaking	*EUR million*			
	Eligible costs (nominal)	**Funding gap (discounted)**	**State aid (nominal)**	**State aid (discounted)**
DE03 - ENERTRAG Elektrolysekorridor Ost GmbH & Co. KG	[200-300]	[100-200]	214.73	[100-200]
DE07 - EWE NETZ GmbH	[50-60]	[10-20]	17.67	[10-20]
DE18 - VNG Gasspeicher GmbH	[90-100]	[50-60]	61.16	[50-60]
DE23 - Gasnetz Hamburg GmbH	[170-180]	[100-200]	126.41	[100-200]
DE24 - RWE Gas Storage West GmbH	[200-300]	[100-200]	127.55	[100-200]
DE26 - Thyssengas GmbH	[50-60]	[10-20]	18.73	[10-20]
DE28 - Creos Deutschland Wasserstoff GmbH	[60-70]	[30-40]	44.15	[30-40]
DE29 - AquaDuctus Pipeline GmbH	[1000-2000]	[700-800]	1.177.59	[700-800]
DE32 - GHS 2 GmbH	[200-300]	[100-200]	167.38	[100-200]
DE33 - AIR LIQUIDE Deutschland GmbH	[200-300]	[100-200]	177.99	[100-200]
DE34 - RWE Nukleus Green H2 GmbH	[700-800]	[300-400]	492.40	[300-400]
DE38 - Lingen Green Hydrogen GmbH & Co. KG	[300-400]	[100-200]	125.10	[100-200]
DE40 - Gasunie Transport Services GmbH	[400-500]	[100-200]	144.79	[100-200]

the participating undertakings will proceed with the individual projects, as additional sources of funding may be sought.

([84]) The valuation year assumed for the discounting of nominal cash flows and aid instalments is the first year in which project-related cash flows occur.

Project – undertaking	*EUR million*			
	Eligible costs (nominal)	**Funding gap (discounted)**	**State aid (nominal)**	**State aid (discounted)**
DE43A - EWE HYDROGEN GmbH	[600-700]	[400-500]	447.45	[300-400]
DE43B - EWE GASSPEICHER GmbH	[70-80]	[40-50]	44.98	[30-40]
DE45 - Hamburg Green Hydrogen GmbH & Co. KG	[300-400]	[100-200]	154.13	[100-200]
DE49 - Open Grid Europe GmbH	[100-200]	[30-40]	40.29	[30-40]
DE54 - HydroHub Fenne GmbH	[100-200]	[90-100]	102.43	[90-100]
DE56 - Nowega GmbH	[70-80]	[40-50]	37.96	[30-40]
DE59 - Hydrogenious LOHC Infra Bavaria GmbH	[70-80]	[50-60]	74.91	[50-60]
DE61 - ONTRAS Gastransport GmbH	[1000-2000]	[300-400]	447.03	[300-400]
DE63 – Linde GmbH	[100-200]	[70-80]	74.60	[60-70]
DE64 - rostock EnergyPort cooperation GmbH	[200-300]	[100-200]	199.80	[100-200]
DE71 - ONTRAS Gastransport GmbH	[300-400]	[100-200]	157.02	[100-200]

Table 19: Germany – State aid in EUR million

Project – undertaking	*EUR million*			
	Eligible costs (nominal)	**Funding gap (discounted)**	**State aid (nominal)**	**State aid (discounted)**
IT02 - Energie Salentine Srl	[700-800]	[500-600]	574.47	[500-600]
IT21 - SNAM S.p.A.	[80-90]	[30-40]	46.27	[30-40]
IT49 - Puglia Green Hydrogen Valley - PGHyV Srl	[500-600]	[300-400]	370.17	[300-400]

Table 20: Italy – State aid in EUR million

Project – undertaking	*EUR million*			
	Eligible costs (nominal)	**Funding gap (discounted)**	**State aid (nominal)**	**State aid (discounted)**
NL57 - Vopak New Energy BV	[100-200]	[60-70]	86.36	[60-70]

Table 21: The Netherlands – State aid in EUR million

Project – undertaking	*EUR million*			
	Eligible costs (nominal)	**Funding gap (discounted)**	**State aid (nominal)**	**State aid (discounted)**
PL01 - Polenergia H2Silesia Sp. z o.o.	[200-300]	[100-200]	142.77	[100-200]

Table 22: Poland – State aid in EUR million

Project – undertaking	*EUR million*			
	Eligible costs (nominal)	**Funding gap (discounted)**	**State aid (nominal)**	**State aid (discounted)**
PT11 - Winpower S.A.	[200-300]	[80-90]	81.06	[60-70]
PT25 - HEVO PORTUGAL. UNIPESSOAL LDA	[600-700]	[200-300]	257.50	[100-200]

Table 23: Portugal – State aid in EUR million

Project – undertaking	*EUR million*

	Eligible costs (nominal)	Funding gap (discounted)	State aid (nominal)	State aid (discounted)
SK04 - eustream. a.s.	[400-500]	[200-300]	364.70	[200-300]

Table 24:– Slovakia – State aid in EUR million

	EUR million			
	Eligible costs (nominal)	**Funding gap (discounted)**	**State aid (nominal)**	**State aid (discounted)**
All projects	11 509	5 750	6 905	5 475

Table 25: Total – State aid in EUR million

(255) The overall notified State aid is thus EUR 6 905 million in nominal terms and EUR 5 475 million in discounted terms.

(256) The participating Member States submit that the durations of the individual projects of the participating undertakings differ. The eligibility period corresponds to the period during which the costs, which the undertakings can claim as eligible, should be incurred, which is until the end of the construction phase and the infrastructure is commissioned.

2.8.3. The aid instruments

(257) The aid to be granted by all the participating Member States will take the form of direct grants.

2.9. Granting of the aid under the notified measures

(258) All the Member States participating in Hy2Infra have subjected the implementation of State aid to the prior approval of the Commission.

(259) Pursuant to point 10 (a) of the IPCEI Communication, the participating Member States have further confirmed that the participating undertakings are not undertakings in difficulty as defined in the Guidelines on State aid for rescuing and restructuring non-financial undertakings in difficulty ([85]).

(260) The participating Member States have furthermore committed to suspend the granting of the notified aid if the beneficiary still has at its disposal earlier unlawful aid that was declared incompatible by a Commission Decision (either as individual aid or aid under an aid scheme having been declared incompatible), until that beneficiary has reimbursed or paid into a blocked account the total amount of unlawful and incompatible aid and the corresponding recovery interest, pursuant to point 10 (b) of the IPCEI Communication.

(261) The participating Member States have also confirmed that aid under Hy2Infra will not be granted to the participating undertakings if it constitutes by itself, by virtue of the conditions attached to it or of its financing method, a non-severable

([85]) Guidelines on State aid for rescuing and restructuring non-financial undertakings in difficulty (OJ C 249, 31.7.2014, p. 1).

violation of Union law, pursuant to point 10 (c) of the IPCEI Communication, in particular:

- granting of aid that is subject to the obligation for the beneficiary to have its headquarters in the Member State concerned or to be predominantly established in that Member State,
- granting of aid that is subject to the obligation for the beneficiary to use nationally produced goods or national services.

(262) Finally, the participating Member States have indicated that cumulation with other aid will be allowed to cover the same eligible costs, provided that the total amount of public funding granted in relation to the same eligible costs does not exceed the most favourable funding rate laid down in the applicable rules of Union law, pursuant to point 35 of the IPCEI Communication.

2.10. Claw-back mechanism

(263) In order to further ensure that the aid is kept to the minimum necessary, the participating Member States have in their notification committed to introduce a claw-back mechanism, pursuant to point 36 of the IPCEI Communication. The basis for the claw-back mechanism will be ex-post financial figures, which have been subject to annual approval by an independent auditor. For this purpose, separate analytical accounting will be required from the participating undertakings in the relevant Member State. The detailed conditions of the claw-back mechanism are explained in Annex I to this Decision.

(264) The claw-back mechanism is applied to the individual project of a participating undertaking only when during the project's lifetime a surplus arises, i.e. when the NPV (calculated with the WACC of the individual project as the discount rate) of the actual cash flows of the project (including the actual State aid disbursements, all costs and revenues and any additional public financial contributions) is strictly positive. The claw-back mechanism then triggers an obligation for the beneficiary to repay to the relevant Member State 70% of the surplus.

(265) The claw-back mechanism will apply to all individual projects of participating undertakings irrespective of the aid amount notified for a project. It will apply during the entire period for which financial projections were made in the notified funding gap calculation for a project. A project's terminal value will also be taken into account. The application of the claw-back mechanism may end before the end of the period for which financial projections were made only when a participating undertaking has become subject to a regulatory framework which precludes the further emergence of surplus cash flows due to allowed revenues being cost-reflective. In that case, the concerned Member State will request the end of the application of the claw-back mechanism to the Commission, accompanied by an explanation of the regulatory framework and a demonstration that the framework precludes the emergence of further surplus cash flows. The repayment (if any) to the relevant Member State required on the basis of the claw-back mechanism will then be calculated at the moment the claw-back mechanism ceases to apply.

(266) The participating Member States commit to report to the Commission on the implementation of the claw-back mechanism each year by the end of September until the end of a project's lifetime.

2.11. Transparency

(267) The participating Member States have in their notification committed to comply with the transparency and publication requirements of points 48 and 49 of the IPCEI Communication. In particular, the participating Member States have committed to publish in the Commission's transparency award module or on a comprehensive State aid website, at national or regional level, the full text of the individual aid granting decision and its implementing provisions or a link to it, as well as all related information as specified in point 48 of the IPCEI Communication ([86]).

3. Assessment of the measures

3.1. Presence of State aid pursuant to Article 107(1) TFEU

(268) Pursuant to Article 107(1) TFEU, "any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods shall, in so far as it affects trade between Member States, be incompatible with the internal market".

(269) To qualify as State aid under Article 107(1) TFEU, the following cumulative conditions must be met: (i) the measure must be imputable to the State and financed through State resources; (ii) it must confer an advantage on its recipient; (iii) that advantage must be selective; and (iv) the measure must distort or threaten to distort competition and affect trade between Member States.

(270) The public support measures of the participating Member States will be financed with funds stemming from the respective State budgets. The measures therefore involve State resources and are imputable to the relevant States.

(271) The aid measures in the form of direct grants to the participating undertakings will relieve them from costs that they would have had to bear themselves under normal market conditions. By contributing to the financing of their infrastructure projects with funds that would not have been obtained under normal market conditions, the aid measures confer an economic advantage on the aid beneficiaries over their competitors. These measures are granted only to the aid beneficiaries chosen by the participating Member States and listed in section 2.4.2 on the basis of their individual projects. It is not available to all undertakings

([86]) The participating Member States have notified the following websites for this purpose: for France: https://www.europe-en-france.gouv.fr/fr/aides-d-etat; for Germany: https://webgate.ec.europa.eu/competition/transparency/public; for Italy: https://www.rna.gov.it/sites/PortaleRNA/it_IT/home; for the Netherlands: https://webgate.ec.europa.eu/competition/transparency/; for Poland: https://www.gov.pl/web/klimat/wiadomosci; Portugal: https://portaldiplomatico.mne.gov.pt/en/about-us/management-and-transparency/legal-documents; Slovakia: https://semp.kti2dc.sk/.

active in the same sectors or competing with the undertakings listed in section 2.4.2 for the same activities or products. The aid measures are therefore selective.

(272) The aid beneficiaries involved in the relevant WSs described above in section 2.4.2, operate in different sectors along the hydrogen value chain, namely, hydrogen production, hydrogen transport and distribution via pipelines, large-scale hydrogen-storage, handling of LOHC to transport hydrogen over sea or to areas not yet connected through pipelines. These are economic sectors open to intra-EU trade (both in terms of supply and demand). Therefore, the measures are liable to distort or threaten to distort competition and intra-Union trade, since they improve the competitive position of the beneficiaries compared to other undertakings with which they compete.

(273) In light of the foregoing, the Commission considers that the public support granted to the beneficiaries in the form of direct grants, as described within the framework of Hy2Infra, qualifies as State aid within the meaning of Article 107(1) TFEU.

3.2. Legality of the aid measures

(274) The participating Member States submit that they shall not grant State aid to any of the individual projects before notification of the Commission's decision approving the notified aid measures. The granting of State aid will be governed by national funding agreements that are expected to be concluded following the Commission's decision (see recital (249)). By notifying the measures before putting them into effect, the participating Member States have fulfilled their obligations under Article 108(3) TFEU.

3.3. Assessment of the aid measures

3.3.1. Applicable legal basis for assessment

(275) In derogation from the general prohibition of State aid laid down in Article 107(1) TFEU, aid may be declared compatible by the Commission if it can benefit from one of the derogations enumerated in Article 107(2) and (3) TFEU.

(276) The Commission will assess the compatibility of the notified measures pursuant to Article 107(3), point (b) TFEU, which concerns aid to promote the execution of an IPCEI. The criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of IPCEI are laid down in the IPCEI Communication. The Commission will examine whether Hy2Infra satisfies the conditions laid down in the IPCEI Communication in the subsequent sections, following the structure of the IPCEI Communication.

3.3.2. Eligibility criteria

(277) In order to be eligible for aid under Article 107(3), point (b) TFEU, the notified measures must involve a project. That project must be of common European interest, and it must be important. These three criteria are considered below.

3.3.2.1. Integrated project

(278) Pursuant to point 13 of the IPCEI Communication, the Commission may consider eligible an "integrated project", that is to say, "a group of single projects inserted in a common structure, roadmap or programme aiming at the same objective and based on a coherent systemic approach. The individual components of the integrated project may relate to separate levels of the supply chain but must be complementary and significantly add value in their contribution towards the achievement of the important European objective" (see section 3.3.2.2.1.1).

(279) The participating Member States, as explained in section 2.4, consider the notified IPCEI Hy2Infra to constitute an integrated project with individual components ([87]).

(280) The Commission finds that Hy2Infra is designed in such a way as to contribute to the common objectives, formulated by the participating Member States and participating undertakings, as described in section 2.2. As mentioned therein, the main aim of Hy2Infra is to initiate the development of an integrated and open hydrogen infrastructure by (i) kick-starting a reliable supply chain for renewable hydrogen in Europe, (ii) interconnecting the infrastructure to be built by the participating undertakings within the regional clusters and preparing the ground for future interconnections between clusters to establish a functional network with non-discriminatory access; and (iii) sharing experience acquired during the process to contribute to shared hydrogen related standards across EU Member States.

(281) The Commission considers that Hy2Infra integrates 33 individual projects based on a coherent systemic approach. The presence of this coherent systemic approach is illustrated by the fact that the participating Member States prepared a common structure described in the Chapeau document:

(282) In particular, the Commission notes that the common structure established in the Chapeau document includes the definition of overall objectives at the level of Hy2Infra (see section 2.2), articulated in specific objectives at the level of the four WSs (see section 2.4.3), to be implemented and monitored under a common governance structure (see section 2.7). Furthermore, the organisation and work plan of the four WSs is divided into two Pillars (see recital (53)), each of which consists of different components and ultimately actions as well as common tasks to be implemented by projects belonging to a given WS. The individual projects are also grouped into different geographic clusters (see section 2.4.4). As overall common objectives of Hy2Infra, the Commission notes that, under Pillar 1, the participating undertakings in Hy2Infra pursue the common objective of establishing functional hydrogen networks with open and non-discriminatory access, in different regional clusters and the common technical and operational principles will facilitate the interconnection of the clusters and the further development of the hydrogen infrastructure (see section 2.4.4). Under Pillar 2, all participating undertakings in Hy2Infra collaborate to ensure interoperability and

([87]) The Commission notes that, as is apparent from, in particular, Sections 2.2, 2.3, 2.8.1, and 2.8.2 each of the individual projects that make Hy2Infra has well-defined objectives, quantitative and qualitative deliverables in terms of infrastructure, and funding needs.

to contribute to common standards to facilitate future interconnection (see section 2.4.5).

(283) As described in section 2.4.3, each individual project is complementary to the other projects in several manners and significantly adds value in its contribution **to the achievement of Hy2Infra's objectives** and the achievement of the European Hydrogen Strategy (see sections 2.4.4 and 2.4.5).

(284) In this respect, the Commission notes the following:

(285) In the framework of WS1, the participating Member States set the objective to install an estimated electrolyser capacity of about 3.2 GW by 2027 to produce renewable hydrogen (Pillar 1, see recital (60)**). This represents 8% of the Union's** target for 2030 of 40 GW (see recital (60)) or 14 times the current installed capacity of 228 MW (see recital (23)), which the Commission considers to be a significant contribution to the achievement of that target. In addition, the participants highlight that the sources of the renewable electricity will be mainly new sources, in line with the EU Hydrogen Strategy and REPowerEU. The projects complement each other, as they are located in five different Member States, tapping into the renewable energy potential of different locations.

(286) Under WS2, the participating Member States have set the objectives to build 1,063 km of new pipelines and repurpose 1,607 km of existing natural gas pipelines (Pillar 1). Each of the projects add value to the other by connecting additional sources of hydrogen with additional demand centres, or creating import possibilities, in line with the vision of the EU Hydrogen Strategy and REPowerEU.

(287) In WS3, the participating Member states aim at installing large-scale underground storage facilities with an estimated capacity of 9,120 t (Pillar 1). They offer initial storage possibilities in larger clusters, offering cyclical storage, enabling a more stable supply of large volumes of hydrogen produced from intermittent sources. The clusters in which each facility will initially be located are planned to be connected over time providing more stakeholders access to these storage facilities.

(288) Finally, in WS4, the participating Member states set the objective to install LOHC handling terminals, with an aggregated capacity of 6,000 tonnes per year (Pillar 1). This infrastructure makes it possible to import hydrogen from additional Member States over the sea (in particular, potentially Finland or Portugal) to Rotterdam and from there, via the Dutch hydrogen backbone to clusters West Germany and North-West Germany thanks to projected interconnections with DE26 and DE40. This alternative mode of transporting hydrogen makes it possible to connect over sea areas with large hydrogen potential with areas with significant demand. In addition, they enable transport of LOHC to reach additional areas of consumption where no pipeline will be deployed or much later deployed (see recital (83)) as the technology functions similar to a virtual pipeline. The EU Hydrogen Strategy identifies this technology as an alternative mode of transporting hydrogen ([88]) compared to pipelines. In that sense, these

([88]) See for example, page 14 of the EU Hydrogen Strategy.

projects add value to Hy2Infra for the achievement of the Union's objectives under the EU Hydrogen Strategy and REPowerEU Plan (see recitals (307) and (308)).

(289) In terms of complementarity, the Commission notes that the integration of Hy2Infa is achieved (i) by the complementary contribution of each individual projects to the quantitative and qualitative objectives of the different WSs in Hy2Infra, (ii) by the physical interconnections of the individual projects within the regional clusters, (iii) by the expected connections between clusters and nuclei based on complementary projects and above all the cross-WSs collaborations on interoperability and standards that will ensure interconnectability in the future. In this respect, the Commission notes in particular the following:

(290) There is a strong complementarity between electrolysers, pipelines and storage facilities from a sector coupling perspective (see recital (334)), as their collaboration will provide significant flexibility to balance intermittent and seasonal hydrogen production with stable demand from end users.

(291) This complementarity is particularly strong within the clusters as projects will be directly interconnected among each other and coordinated in time in order to allow for a timely supply of initial demand centres (see section 2.4.4).

(292) Integration and complementarity will be further achieved via the connection between clusters (see section 2.4.4), which will form the basis for the future development of a European hydrogen infrastructure. Projects included in the regional clusters represent important focal points in different participating Member States, which are necessary for a subsequent development of national and trans-national hydrogen infrastructure that will progressively achieve physical integration in an EU-wide hydrogen network thanks to complementary projects outside the Hy2Infra sphere, such the PCIs and PMIs.

(293) As introduced in recitals (72) and (89), there are several regional clusters projects in Hy2Infra with a significant cross-border dimension:

- projects reaching up to a cross-border point in the Netherlands (DE40 in Cluster North-West Germany and DE26 in Cluster West Germany),
- a project reaching up to the border with Poland (DE61 in Cluster East Germany),
- a transit pipeline opening the possibility to import renewable hydrogen from Ukraine (SK04);
- a cross-border regional cluster with France and Luxembourg (DE28 in Cluster South-West Germany);
- an off-shore pipeline opening potential imports through the North Sea from Norway, the United Kingdom and Denmark (DE29 in Cluster North-West Germany);
- LOHC reception terminal projects enabling by maritime transport of hydrogen within the EU and potentially from third-countries (NL57 with plans to import from Finland or Portugal and possibly third countries to

Rotterdam and from there into Germany, Belgium, and France (as hydrogen would be injected into the Dutch hydrogen network which will itself be connected to the Belgian hydrogen network, while the Belgian hydrogen network will be connected to France through the project Green Octopus included in Hy2Use) (see recital (109)); or more local supply in areas where pipeline connections will develop at a later stage (DE59 with potential connections to Austria via the Danube);

- and projects with potential for establishing maritime routes for hydrogen (PT11).

(294) Such cross-border relevance is further underlined by the inclusion of some projects in the PCI/PMI list (e.g. DE29), by being located along the same corridors (e.g. SK04, see recital (124)) and by the interlinks between Hy2Infra and PCIs in general (see section2.4.4). The Commission observes that this cross-border dimension contributes significantly to the integrated character of Hy2Infra as an IPCEI.

(295) Under Pillar 2, planned activities and objectives further reinforce the likelihood of the future physical integration, as they aim to prevent the emergence of technical barriers and facilitate future interconnections, by:

- reaching a common agreement on key interoperability requirements ([89]) (e.g. hydrogen purity and pressure, see section 2.4.5.1), and preventing the establishment of technical barriers: this will facilitate future interconnectivity between clusters through other envisaged projects, in particular PCI projects included in the first PCI/PMI list;

- a common contribution to addressing existing standardisation gaps as identified by European Clean Hydrogen Alliance (see recitals (137) to (140));

- contributing to the development of common operational rules on interoperability, gas balancing, and capacity allocation mechanisms (see recitals (141) to (144); and

- technical collaborations and concrete objectives of significant added value within the different WSs (see section 2.4.5.3).

(296) Participating undertakings in Hy2Infra will report publicly and regularly on the progress of all planned deliverables under Pillar 1 and 2 as described in section 2.4.5.4, which encourages a coordinated approach among participating undertakings in Hy2Infra and strong stakeholder involvement.

(297) By combining infrastructure deployment under Pillar 1 and common deliverables under Pillar 2, Hy2Infra is aligned with the gradual approach of the EU Hydrogen Strategy, which recognizes that a full interconnection between all emerging regional infrastructure elements from an early stage is neither possible nor

([89]) Without prejudice to provisions in article 39 (Cross-border coordination on hydrogen quality) of the Directive in the Hydrogen and decarbonised gas market package.

necessary but that it is important to ensure interoperability of markets through common standards and cross-border operational rules ([90]).

(298) Furthermore, to ensure the coherent implementation of Hy2Infra, the participating Member States will establish a common governance structure, as described in section 2.7, under a SB, which will have the task of reviewing the progress and the results of Hy2Infra and propose changes if necessary, giving specific attention to the benefit for the European society. The Commission will be represented in the SB as an observer. The Commission considers that Hy2Infra's common governance structure will ensure that by joining their forces in the integrated Hy2Use, the participating Member States will be incentivised to implement and report as planned on their individual projects, establish the planned collaborations and enable the dissemination of spillover effects in a timely manner, without jeopardising the achievement of the common objectives.

(299) In view of the above, the Commission concludes that Hy2Infra qualifies as an integrated project in the meaning of point 13 of the IPCEI Communication, as its individual projects and WSs are inserted in a common structure, aiming at the same objectives and based on a coherent systemic approach. Furthermore, the individual projects and WSs are complementary and significantly add value in their contribution towards the achievement of the important common objective of establishing an emerging EU-wide hydrogen infrastructure in the Union.

3.3.2.2. Common European Interest

(300) In order to establish that a project qualifies as being of common European interest, the IPCEI Communication sets out general cumulative criteria (section 3.3.2.2.1), as well as general positive indicators (section 3.3.2.2.2). In addition, the IPCEI Communication sets out certain specific criteria depending on the type of project (section3.3.2.2.3).

3.3.2.2.1. General cumulative criteria (Section 3.2.1. of the IPCEI Communication)

3.3.2.2.1.1. Important contribution to the Union's objectives

(301) Pursuant to point 14 of the IPCEI Communication, the project must represent a concrete, clear, and identifiable important contribution to the Union's objectives or strategies and must have a significant impact on sustainable growth, for

([90]) For example, the EU Hydrogen Strategy stresses that "Local hydrogen clusters, (…) will develop, relying on local production of hydrogen based on decentralised renewable energy production and local demand, transported over short distances. (…) In this phase, the need for an EU-wide logistical infrastructure will emerge, and steps will be taken to transport hydrogen from areas with large renewable potential to demand centres located possibly in other Member States. (…) By 2030 the EU will aim at completing an open and competitive EU hydrogen market, with unhindered cross-border trade and efficient allocation of hydrogen supply among sectors. (…) In the second phase, local hydrogen networks would emerge to cater for additional industrial demand. With increasing demand, the optimisation of the production, use and transport of hydrogen will have to be secured and is likely to require longer-range transportation (…). To ensure interoperability of markets for pure hydrogen, common quality standards (e.g. for purity and thresholds for contaminants) or cross-border operational rules may be necessary."

example by being of major importance among others for the European Green Deal, the New Industrial Strategy for Europe and its update, the Next Generation EU, the new European Research Area for research and innovation, or the Union's objective to become climate neutral by 2050.

(302) The Commission notes the important role that Hy2Infra is expected to play in reaching the decarbonisation targets of the EU. The European Climate Law ([91]) presents a legally binding, EU-wide, economy-wide GHG emissions reduction target by 2030 compared to 1990 of at least 55%, a target endorsed by the European Council in December 2020 ([92]). Further, the Commission has adopted a communication presenting its long-term vision for a climate-neutral economy by 2050 ([93]). The development of clean and innovative technologies, the deployment of renewable sources of electricity and alternative sustainable fuels, the integration of low and zero-emissions mobility and transport solutions, and the move towards a circular economy to reduce GHG emissions are set to be the main technological pathways to reach carbon neutrality. The Union views in this regard hydrogen as an important enabling technology to achieve carbon neutrality. In its Hydrogen Strategy, the EU targets the deployment of at least 40 GW of renewable hydrogen electrolysers in the EU by 2030.

(303) Furthermore, the RRF supports investments in flagship areas, such as hydrogen. Hy2Infra will be partly funded by the RRF (see recital (18)).

(304) In addition, on 18 May 2022, the Commission presented the REPowerEU Plan, in response to the hardships and global energy market disruption caused by Russia's invasion of Ukraine. The REPowerEU Plan includes the implementation of a 'Hydrogen Accelerator', which sets a target of 10 million tonnes of domestic renewable hydrogen production and 10 million tonnes of renewable hydrogen imports by 2030, as well as foresees supporting the development of an integrated gas and hydrogen infrastructure, hydrogen storage facilities and port infrastructure.

(305) All the above initiatives supplement the Commission's Communication that sets out a European Green Deal. The aim is to transform the EU into a climate-neutral society where economic growth is decoupled from resource use ([94]).

([91]) Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021, establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'), (OJ L 243, 9.7.2021, p. 1). See also Communication from the Commission, to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *Stepping up Europe's 2030 climate ambition – Investing in a climate-neutral future for the benefit of our people*, COM(2020) 562 final, 17.9.2020.

([92]) European Council meeting (10-11.12.2020) – Conclusions, 11.12.2020, EUCO 22/20, point 12.

([93]) Communication from the Commission, to the European Parliament, the European Council, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, *A Clean Planet for all – A European strategic long-term vision for prosperous, modern, competitive and climate neutral economy*, COM(2018) 773 final, 28.11.2018.

([94]) See also, Communication from the Commission, to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *A new Circular Economy Action Plan For a cleaner and more competitive Europe*, COM(2020) 98 final, 11.3.2020.

(306) The Commission considers that Hy2Infra will contribute to fulfilling the objectives laid down in the various EU initiatives mentioned:

(307) Hy2Infra will deliver substantial volumes of renewable hydrogen enabling the decarbonisation of industrial and mobility users; it will enable substantial CO2 emissions savings at the level of the users by substituting fossil fuel-based hydrogen or other conventional energy carriers (like coal, natural gas, oil) with renewable hydrogen (and to a limited extent with low-carbon hydrogen). By bringing about 3.2 GW of generation capacity for renewable hydrogen, Hy2Infra will facilitate increasing the hydrogen generation capacity and storage. As such, Hy2Infra will deliver 8**% of the Union's objective to reach 40 GW of renewable** hydrogen electrolysers in the EU by 2030 under European Hydrogen Strategy (see recital (302)). Hy2Infra also includes the transport infrastructure make it possible to supply the generated hydrogen to initial centres of consumption (industry mainly and mobility to a more limited extent), as well as storage facilities and LOHC infrastructure.

(308) At the same time**, Hy2Infra will contribute to decreasing the Union's dependency** on fossil energy imports and to supporting the efforts of the EU to diversify energy imports of Member States. In particular, by deploying first-of-a-kind port infrastructure allowing the conversion and handling of embedded hydrogen (LOHC), which is recognised in the REPowerEU plan and the Hydrogen and decarbonised gas market package as a possible means of importing hydrogen, Hy2Infra will provide import-ready port infrastructure from within the EU and outside the EU using LOHC. In addition, in terms of import capabilities, one individual project (SK04), while being at an early stage, prepares the ground to potential imports over time from Ukraine ([95]) and the project DE29 gives access to offshore renewable hydrogen production and opens a potential import route to hydrogen imports from neighbouring countries in North Sea (see recital (102)).

(309) Finally, through the planned infrastructure, Hy2Infra will serve different dimensions of the Energy Union: i) energy security, solidarity and trust; ii) a fully integrated European energy market; and iii) decarbonising the economy.

(310) Hy2Infra will contribute to develop hydrogen skills in Europe. Since the hydrogen market is at its nascent stages, the projects will face the challenge of recruiting skilled employees with an adequate skill level in the field of hydrogen (production, transport, storage, handling of embedded hydrogen). The projects of Hy2Infra will thus create a need for new skills and operating practices to ensure safe and efficient handling of the product. The partners will share training materials and approaches to ensure a consistent approach; they will collaborate on the strengthening of professional networks and will develop new ones; they will exchange and joint cooperation with universities or scientific/research institutes **regarding industries' needs and offers** (199).

(311) Hy2Infra will help complete missing or lacking European technical standards for **the hydrogen economy identified in the European Clean Hydrogen Alliance's** Roadmap for Hydrogen standardisation (recital (137)).

([95]) Depending on the evolution of the war.

(312) In alignment with the European Hydrogen Strategy, Hy2Infra will, from an early stage, ensure interoperability by including a common agreement on key requirements such as minimum hydrogen purity and pressure, thereby preventing the emergence of technical barriers and facilitating the future interconnection of regional clusters (recital (134)). In addition, Hy2Infra will deliver best practice recommendations, based on hands-on experience, for the development of cross-border operational rules, such as network codes (recital (141)).

(313) Based on the foregoing, the Commission concludes that Hy2Infra contributes, in a concrete, clear and identifiable manner, to several Union's objectives and has in particular a significant impact on sustainable growth and value creation across the EU and more largely the European Economic Area ("EEA"), in accordance with point 14 of the IPCEI Communication.

3.3.2.2.1.2. Important market failures

(314) Point 15 of the IPCEI Communication foresees that the project must demonstrate that it is designed to overcome important market or systemic failures, preventing it from being carried out to the same extent or in the same manner in the absence of the aid, or societal challenges, which would not otherwise be adequately addressed or remedied. Point 20 of the IPCEI Communication also foresees that the positive effects of a project in addressing important market or systemic failures or societal challenges that could not otherwise be addressed are in all cases subject to individualised assessment.

(315) The Commission's assessment of important market failures has been performed at each level of the value chain and per individual project, focusing on identifying the existence of a market failure as such. This allowed the Commission to define the overarching market failures specific to Hy2Infra. In a second step, the Commission examined how Hy2Infra as a whole and each project in particular address such failure specifically. Through this methodology, the Commission identified three market failures affecting the development of the European hydrogen infrastructure that Hy2Infra can address: coordination problems (recitals (28) to (31)), negative environmental externalities (recitals (32) to (33)) and positive externalities (recitals (34) to (38)).

(316) First, the integrated, coordinated and simultaneous nature of the individual projects in Hy2Infra is expected to address **coordination problems** in the development of hydrogen infrastructure, by aligning the incentives of multiple actors along a value chain, thereby enabling simultaneous investments.

(317) Coordination problems may arise when the profitability of various projects is conditional on their ability to coordinate and invest simultaneously. The Commission observes that there is a lack of economic incentive for the hydrogen market players to initiate alone the development of an open-access European hydrogen infrastructure. This lack of coordination has resulted in the market players not initiating expensive and risky large scale and open-access infrastructure projects, with the EU lagging behind the 2024 objective enshrined in the European Hydrogen Strategy in terms of production capacity (see recitals (29) and (30)). The integrated, coordinated and simultaneous nature of Hy2Infra allows the market failure to be addressed. For instance, in the regional clusters, participating undertakings are coordinating the planning and deployment of their

infrastructure (see for example Cluster North-West Germany, recital (102)), so that when the electrolyser will be ready to produce hydrogen, the pipeline projects will also be completed to transport the produced hydrogen. This coordinated planning and deployment is possible in the framework of Hy2Infra, as the IPCEI tool provides certainty as to the projects selected and as to the timeframe in which they will receive State aid.

(318) These coordination failures are not addressed by other instruments or tools. For instance, while the TEN-E framework (see recital (20)) can certainly help to ensure interconnections, and system integration, the specific criteria on cross-border relevance and the identified priority corridors may limit the scope of eligible projects and by assessing each project separately, the TEN-E framework does not aim at addressing coordination problems between different steps of the value chain in the integrated and comprehensive manner an IPCEI can achieve and would therefore not entirely address this market failure.

(319) Second, the Commission observes that the individual projects in Hy2Infra will contribute to addressing a market failure in the form of **negative environmental externalities**, by developing the hydrogen infrastructure. The underlying source of negative externalities is that undertakings do not always bear the full cost of the harm they impose on society, which leads to the use of more polluting technologies, with resulting pollutants, presenting thus a direct or indirect health hazard to society. The role of policy intervention is to reinforce the incentives to shift towards the use of less polluting production processes Hydrogen is identified as an important technological solution to reduce GHG emissions in hard-to-abate sectors (recitals (11) and (12)). To achieve this goal, the EU Hydrogen Strategy and the REPower EU Plan define targets for the hydrogen production (recital (14)). In addition, using hydrogen as an alternative to fossil fuels cannot meet end users' needs without the development of hydrogen infrastructure and hydrogen production capacity. The Commission examined the claim made by the participating Member States that the current cost trajectories of the ETS are not sufficient to, on their own, trigger the types of investments proposed under Hy2Infra (recital (32)(iii)). The Commission observes that this is confirmed by the funding gap calculations submitted by the participating undertakings and by the cost simulations provided by several participating undertakings for the production of fossil-based hydrogen. They show that the costs of fossil-based hydrogen remain significantly lower than the costs of renewable hydrogen, even taking ETS costs into account (recital (258) and section 3.3.3.1.2). Without State aid, undertakings would likely not have the incentive to invest in the necessary hydrogen infrastructure (recital (27)).

(320) The individual projects under Hy2Infra will address negative environmental externalities by decreasing the economic and technological gap between the renewable hydrogen production (and to a lesser extent low-carbon hydrogen) and distribution and more polluting alternative technologies.

(321) This is to happen by enabling large-scale production of renewable hydrogen to replace fossil-based hydrogen (recital (32)) as well as its transport.

(322) In addition, Hy2Infra will address negative environmental externalities by making steady supply of renewable hydrogen available to more end users thanks to large-scale storage facilities able to compensate for the periodicity of renewable

hydrogen production, lifting one condition hindering the transition of industrial and mobility end users from fossil fuels to hydrogen (recital (32)).

(323) Third, the individual projects in Hy2Infra are expected to address **positive externalities** of the development of the hydrogen infrastructure, not fully internalized by the beneficiaries, through dissemination of knowledge on operation experience to other market participants, including those beyond the **beneficiaries' own sectors of activities (recital** (35)). In other words, undertakings will share the stock of knowledge with other undertakings without being directly compensated for it. This is further reinforced in the case of commitments to open-access hydrogen infrastructure within Hy2Infra.

(324) The individual projects under Hy2Infra will also address positive externalities for instance by:

- stimulating regional employment and the local economy linked to the hydrogen value chain but also beyond (recitals (37)); and
- supporting the higher costs linked to the nascent nature of the hydrogen value chain – allowing future undertakings of the hydrogen value chain to benefit from these infrastructures at lower costs (recital (36)).

(325) The Commission has assessed each project on an individual basis with respect to the identified important market failures. All projects address at least coordination failures due to the coordinated and simultaneous nature of IPCEI Hy2Infra or negative environmental externalities. As for projects in WS1, they all address both coordination failures and negative externalities. In addition, some projects also address positive externalities.

(326) Based on the above, the Commission concludes that the eligibility condition of points 15 and 20 of the IPCEI Communication is fulfilled.

3.3.2.2.1.3. Member States involved

(327) Point 16 of the IPCEI Communication requires that at least four Member State shall ordinarily be involved. Hy2Infra involves seven Member States, i.e.: France, Germany, Italy, the Netherlands, Poland, Portugal, and Slovakia. The Commission therefore concludes that the eligibility condition regarding the minimum number of Member States is fulfilled.

3.3.2.2.1.4. Open procedure for Member States

(328) On 17 December 2020, 23 EU Member States plus Norway signed a joint manifesto in which they committed to launch IPCEI on hydrogen. In line with point 17 of the IPCEI Communication, the signatory Member States invited all other interested EU and European Free Trade Association ("EFTA") Member States to join this initiative, open to countries willing to participate in the design of IPCEI on hydrogen. Therefore, the Commission concludes that the eligibility condition of ensuring a genuine opportunity for all interested Member States to participate in the IPCEI has been fulfilled.

3.3.2.2.1.5. Positive spillover effects

(329) Point 18 of the IPCEI Communication requires that an IPCEI must benefit the European economy or society via positive spillover effects. In particular, the benefits of the project must not be limited to the undertakings or to the sector concerned but must be of wider relevance and application to the economy or society in the Union through positive spillover effects (such as having systemic effects on multiple levels of the value chain, or up- or downstream markets, or having alternative uses in other sectors or modal shift) which are clearly defined in a concrete and identifiable manner.

(330) The IPCEI Communication requires for spillover effects to be identified at all the following levels: beyond the participating **Member States ("economy or society in the Union"); beyond the aid beneficiaries ("not be limited to the undertakings");** and **beyond the sector(s) in which the aid beneficiaries are active ("[…] or to the sector concerned").**

(331) Under Pillar 1, section 2.5.1 describes how the projects in Hy2Infra will create positive network effects beyond the participating undertakings and sectors. In particular, given the open access commitment, the Commission expects that the deployment of infrastructure will encourage additional stakeholders, both from the production, the infrastructure, and the end-use side, to join an already existing network and benefit from the already interconnected facilities and further expand it. **Hy2Infra's open** access wave design, its regional clusters and nuclei form a critical mass allowing the network effect to gain traction and to spread benefits to hydrogen actors beyond the participating undertakings. Stemming from the requirement to deploy an open infrastructure with non-discriminatory access, Hy2Infra projects will offer their non-booked production, network and storage capacities to third parties, thereby creating a pull effect for stakeholders to join the established network. Increased production and demand will stimulate eventually the expansion of hydrogen infrastructure. The increased numbers of network users will help reduce transport fees as regulated infrastructure costs are shared among a larger pool of users. For example, additional production facilities connecting to one of the clusters will directly have access to the already connected end users and storage facilities. Conversely, additional end users will directly benefit from already alternative sources of hydrogen connected to it. In addition, clusters have already planned future connections among themselves ([96]), increasing alternatives for both the supply- and the demand-sides. It is also expected that the increased demand for hydrogen will decrease commercial risks for new production and infrastructure projects thanks to the access to an established value chain and a large customer base for their products or services. Finally, the performance of hydrogen production, transportation and end-use projects will also be significantly improved by the knowledge and experience to be acquired and shared.

(332) A further positive spillover effect generated by Hy2Infra is the security of supply it will provide. End users will benefit from an increased security of supply from

([96]) For instance, DE71, a pipeline project in Cluster East Germany contains the options to connect to other clusters from an early stage, in particular to the Western part of Germany and the Netherlands, via the pipeline project DE40, part of the Cluster North-West Germany.

the clusters as they offer already alternative sources of supply or the combination of supply and storage, facilitating an earlier switch to hydrogen and its adoption not only in sectors traditionally using hydrogen, produced from fossil fuels, such as fertilisers, but also in other sectors such as steel making or the production synthetic fuels for the transport sector. In addition, clusters have already planned future connections among themselves, increasing the security of supply they can offer.

(333) Hy2Infra is also a strong enabler for the green transition of hard-to-abate sectors: by connecting to the transmission or distribution pipelines deployed in Hy2Infra, end users will have access to renewable hydrogen, enabling them to engage into decarbonisation. This will lead to lower carbon emissions at the level of end users in France, the Netherlands. Portugal, Germany, Italy, Poland and indirectly Belgium and Luxembourg.

(334) From a sector coupling ([97]) perspective, Hy2Infra projects and clusters will provide significant flexibility to balance the inherent intermittency and seasonality of renewable energy and, hence, of renewable hydrogen production with the relatively stable demand profiles of end users, contributing to the overall energy system efficiency, thanks to the link that Hy2Infra establishes between hydrogen and electricity networks and between diverse end-use sectors. Such flexibility is underpinned by the physical interconnection between production facilities, pipelines and storage sites, and LOHC handling terminals, which facilitates a secure and reliable system operation in line with TEN-E criteria, (see section 3.3.2.2.3). In particular, WS1 projects will have a network-related function (e.g. acting as a demand sink in times of renewable energy oversupply, thereby supporting both the integration of renewable energy and the stability of the power grid) (see recital (65)). In addition, WS3, by enabling the storage of the hydrogen, reinforces the network-related function of the large-scale electrolysers included in Hy2Infra. Beyond the general demand sink that electrolysers can provide, in certain geographic zones suffering from network congestion, electrolysers can also reduce significantly the level of curtailment of renewable electricity plants. This is the case three WS1 projects located in areas suffering from frequent curtailment of renewable electricity production: DE45 (Hamburg), DE63 (Leipzig), DE64 (Rostock). In addition, two individual projects (FR23 and IT02) already plan to offer structured grid balancing services and participate to grid service markets (see recital (380)), while several other projects will examine whether participation in grid service markets is possible. Finally, the vast majority of electrolyser projects will stimulate the deployment of new renewable electricity generation assets as they plan to conclude power purchase agreements with new (additional) renewable electricity generation capacity ([98]).

([97]) Sector coupling referred primarily to the electrification of end-use sectors like heating and transport, with the aim of increasing the share of renewable energy in these sectors (on the assumption that the electricity supply is, or can be, largely renewable) and providing balancing services to the power sector. The concept of sector coupling has broadened to include supply-side sector coupling. Supply-side integration focuses on the integration of the power and gas sectors, through technologies such as power-to-gas.

([98]) The other electrolyser projects (DE34, DE63 and DE64) expect to be exempted from the additionality requirements in the REDII due to their commissioning date but indicated that they will likely connect to additional capacity nevertheless.

(335) Under Pillar 2, in view of the commitments for spillover effects as submitted by the participating Member States for each individual project and the common work referred to in section 2.5.2, the Commission observes that the cooperation of participating undertakings in Hy2Infra with the relevant external stakeholders and technical bodies such as CEN/CENELEC, the ENTSO-G and the ENNOH, on interoperability, standardisation, and operational rules will facilitate the exploitation and dissemination of results into the market, technological cooperation and knowledge transfer. The consolidation of that knowledge in European standards and eventually network codes, ensures spillover effects beyond the participating Member States, undertakings, and sectors.

(336) Furthermore, the Commission takes note of the collaborations and deliverables described in section 2.4.5.3, which aim at addressing their respective specific-WS challenges and opportunities:

(337) WS1-specific deliverables are related to: (i) recommendations for the development of electrolysers related European standards (e.g. electricity grid connection, control strategy of integrated electrolyser systems, and safe operation of electrolyser systems); (ii) guidelines on grid services and flexible operation; and (iii) recommendations on permitting and licensing (see heading (a) in section 2.4.5.3). The Commission notes in this respect, in particular, the value of sharing experience on how to operate large scale electrolysers running on intermittent electricity: based on the **participating undertakings'** early experience, providing useful insights to undertakings not participating in Hy2Infra. As experience with large-scale electrolysers is quite limited, this will reduce learning costs of future operators of large-scale electrolysers.

(338) WS2-specific deliverables are related to: (i) recommendations for the development of pipeline related European standards (e.g. gas analysis methods, transmission pipelines above 16 bar, safety shut-off devices), (ii) best-practices for construction and repurposing of hydrogen pipelines; and (iii) recommendations on approval procedures and environmental impact assessment (see heading (b) in section 2.4.5.3). The Commission further notes in this respect that participating undertakings of WS2 will develop and share knowledge on how to build new gas pipelines or to repurpose gas pipelines for hydrogen use (in particular, measures to establish the suitability of existing pipelines for the use of hydrogen), which will de-risk further similar projects by undertakings outside Hy2Infra.

(339) WS3-specific deliverables are related to: (i) the contribution to the development of technical standards for hydrogen storage facilities (e.g. retrofitting of gas storage facilities, new build hydrogen storage facilities, safe operation of hydrogen storage facilities), and (ii) joint recommendations for hydrogen infrastructure systems balancing rules (see heading (c) in section 2.4.5.3). The Commission further notes in this respect that participating undertakings of WS3 will develop and prove short- (within-day, daily), and midterm (weekly, monthly) balancing strategies and methodologies (see recital (172)). The dissemination of this know-how (on how to operate storage with cyclical withdrawals and injections and how to repurpose natural gas caverns) will enable further stakeholders to engage into hydrogen storage and reduce the technical entry barriers by sharing useful insights into a technical area in which experience is particularly scarce to date.

(340) WS4-specific deliverables are related to contributing to the development of technical standards related to LOHC (e.g. hydrogen quality derived from LOHC, loading and unloading stations) (see heading (d) in section 2.4.5.3). The Commission notes that part of hydrogen imports into the EU will take place via maritime routes through a varied range of technologies, among which LOHCs are one of the most relevant alternatives next to ammonia and liquid hydrogen. The Commission considers that Hy2Infra helps to de-risk and escalate LOHC technologies.

(341) In addition, the Commission recognises the significant effort undertaken by the participating undertakings to spread and share knowledge in conferences and trainings, through collaborative RDI ecosystem – including links with the academic world via collaborations for the implementation of Hy2Infra, a significant sponsorship of PhD and master of science degrees and university chairs related to technologies developed under Hy2Infra – publications in peer-reviewed journals and dissemination of IP-protected results (see section 2.5.3). These commitments will contribute to the dissemination of the knowledge, skills and results obtained through the IPCEI in the sense that participation in these events is typical of all key actors (undertakings, RTOs, universities, etc.) of the hydrogen value chain, as they provide an opportunity to exchange on the specific results produced by each individual project and the technological advancements **achieved and to ensure that the knowledge and individual project's results of** Hy2Infra are transmitted to the next generations.

(342) Based on the description of the positive spillover effects generated by Hy2Infra as presented in section 2.5, the Commission considers that the benefits of Hy2Infra are clearly defined in a concrete and identifiable manner and the participating Member States have adequately shown how Hy2Infra benefits interested parties beyond those directly involved in Hy2Infra and beyond the sectors concerned. In addition, the Commission notes that, at both integrated and national governance levels, Hy2Infra will monitor the correct implementation of the committed dissemination activities and spillovers of the participating undertakings (see section 2.7) in compliance with the provisions of the IPCEI Communication and the national funding agreements.

(343) In view of the above, the Commission considers that this eligibility condition is satisfied, in accordance with point 18 of the IPCEI Communication.

3.3.2.2.1.6. Co-financing by the aid beneficiaries

(344) As required by point 19 of the IPCEI Communication, the project must involve important co-financing by the beneficiaries. The amount of State aid per undertaking/project is provided in ***Table 18: France – State aid in EUR million*** to ***Table 24:– Slovakia – State aid in EUR million*** The Commission estimates that the co-financing by the beneficiaries for the implementation of the projects is EUR 5.41 billion in total ([99]). This corresponds to 44% of the financing need of

([99]) Co-financing is calculated as the financing need of a project which is not covered by the total nominal aid for the project. The financing need of a project is defined as the most negative cumulative nominal cash flow **over the project's forecast period (i.e.** the period for which detailed yearly financial projections have been submitted in the **project's** funding gap calculation).

the projects notified by the participating Member States for Hy2Infra. The Commission considers this co-financing as important.

(345) In view of the above, the Commission considers that this eligibility condition is satisfied, in accordance with point 19 of the IPCEI Communication.

3.3.2.2.1.7. Principle of DNSH

(346) Point 20 of the IPCEI Communication requires Member States to provide **evidence as to whether the project complies with the principle of 'do no significant harm' within the meaning of Article 17 of** the Taxonomy Regulation, or other comparable methodologies.

(347) **Article 17 of the Taxonomy Regulation defines what constitutes 'significant harm' for the six environmental objectives covered by the Taxonomy Regulation,** taking into account the life-cycle of the products and services provided by an economic activity including evidence from existing life-cycle assessments:

- an activity is considered to do significant harm to climate change mitigation if it leads to significant GHG emissions;
- an activity is considered to do significant harm to climate change adaptation if it leads to an increased adverse impact of the current climate and the expected future climate, on the activity itself or on people, nature or assets;
- an activity is considered to do significant harm to the sustainable use and protection of water and marine resources if it is detrimental to the good status or the good ecological potential of bodies of water, including surface water and groundwater, or to the good environmental status of marine waters;
- an activity is considered to do significant harm to the circular economy, including waste prevention and recycling, if it leads to significant inefficiencies in the use of materials or in the direct or indirect use of natural resources, or if it significantly increases the generation, incineration or disposal of waste, or if the long-term disposal of waste may cause significant and long-term harm to the environment;
- an activity is considered to do significant harm to pollution prevention and control if it leads to a significant increase in emissions of pollutants into air, water or land, as compared with the situation before the activity started; and
- an activity is considered to do significant harm to the protection and restoration of biodiversity and ecosystems if it is significantly detrimental to the good condition and resilience of ecosystems, or detrimental to the conservation status of habitats and species, including those of Union interest.

(348) In order to assess compliance with point 20 of the IPCEI Communication, the Commission requires Member States to provide evidence that demonstrates that the individual projects comply with the above-mentioned six environmental

objectives of the Taxonomy Regulation, by reference in particular to the screening criteria developed in the Taxonomy Delegated Regulation for determining whether the activity implied by the project and consisting of the production of hydrogen, the transport of hydrogen and its storage causes no significant harm to any of the environmental objectives.

(349) The Commission assessed the environmental impact of all of the individual projects against the six environmental objectives set out in Article 9 of the Taxonomy Regulation by reference in particular to the screening criteria set out in the Taxonomy Delegated Regulation for determining whether the concerned activities (hydrogen production, hydrogen storage, hydrogen transport) cause no significant harm to any of the environmental objectives. For all individual projects included in the Hy2Infra the Commission finds the following:

(350) The Commission considers that the participating Member States have demonstrated that the activities considered in Hy2Infra will not do significant harm to ***climate change mitigation***, as:

(351) All hydrogen production projects setting up large scale electrolysers aim at significantly exceeding the minimum GHG emission savings threshold of 70%, compared to a fossil fuel comparator of 94 g CO2e/MJ by producing renewable electricity-based hydrogen qualifying as RFNBO within the meaning of the REDII and its first delegated act. The lifecycle GHG emissions have been computed in accordance with the methodologies set out in the second delegated act of REDII. For 15 out of the 16 projects the entire hydrogen production will 100% qualify as RFNBO. The Commission notes that one project envisages to produce RFNBO as well as a limited share of low carbon hydrogen complying, however, also with the minimum GHG emission savings threshold of 70%. When projects involve trailer stations, the Commission also verified that the emissions from trailer transport would be taken into account for the purpose of ensuring compliance with the minimum GHG emission savings threshold of 70% (see recital ((225)).

(352) Projects consisting in the installation of hydrogen transmission and distribution infrastructure via pipelines are dedicated to hydrogen only (see recital (226)) and therefore comply with the DNSH screening criterion for climate change mitigation applicable to the transport of low carbon gases.

(353) All large-scale hydrogen storage facilities projects, as well as on-site storage facilities which are part of the large-scale electrolyser projects are only dedicated to hydrogen. In addition, measures will be taken to prevent hydrogen leaks and/or potential fugitive emissions (see recital (227)).

(354) For LOHC projects, the emissions linked to the LOHC conversion and the transport remain limited so that the supplied hydrogen still complies with the minimum GHG emission savings threshold of 70% and qualifies as RFNBO within the meaning of the REDII despite potential emissions from the transport of LOHCs by ship or barge. All LOHC projects will use electricity for the release process via renewable power purchase agreements ("PPA"). In addition, measures will be taken to prevent hydrogen leaks and/or potential fugitive emissions and damage (see recital (228)).

(355) Concerning ***climate change adaptation***, the Commission finds that no negative effects are foreseeable from the individual projects. While several projects already conducted a climate screening or will carry out such screening and usual climate hazards will be taken into account in the design of the projects, the Commission examined in particular whether large-scale electrolysers were at risk of triggering water stress in the regions where they would be located. For these projects, however, the participating Member States confirm that they are not expected to have a negative impact on water availability in the regions concerned. For all the projects located in regions suffering from water stress, the participating Member States submit that the projects have been or will be subject to an environmental impact assessment with special attention to water, commit to implement their results, and confirm that sufficient mitigating measures will be taken. More specifically, based on the participating Member States' submissions, the water needs of projects located in areas where water is less abundant are covered from sources with no significant impact on water availability for other purposes in the regions concerned. They will use treated wastewater, desalinized water or industrial water that originates from treated wastewater, desalinized water or water from meteoric catchment basin, and which so far was not used for other purposes). For the other projects (not located in regions subject to water stress), they will be subject to an environmental impact assessment or to preliminary screening under the national permitting legislation with special attention to water stress. The Commission notes that for one project no environmental impact assessment will be conducted but based on the participating Member States' submissions, the project sufficiently justified why it is not detrimental to the good status of water bodies. In addition, the Commission notes that based on the participating Member States' submissions, projects using drinking water from the network either explore alternative water sources (e.g. using purified wastewater from local sewage treatment plant), and/or the participating Member States confirm no significant impact on water availability in the concerned region. None of these projects are located in regions suffering from water stress (see recitals (230)(231)(232)).

(356) The Commission considers that, concerning the ***sustainable use and protection of water and marine resources***, the participating Member States demonstrate that the projects are not expected to be detrimental to the good status or the good ecological potential of bodies of water, including surface water and groundwater, or to the good environmental status of marine waters. Most projects have already been subject or will be subject to an environmental impact assessment where required by EU or national legislation, or to an environmental permit containing specific requirements on water, and the results of the environmental impact assessment will be implemented. The Commission notes that, based on the participating Member States' submissions, where no environmental impact assessment will be conducted, an environmental impact assessment was not considered necessary following a preliminary screening as part of the national permitting legislation, or the Member States sufficiently justified that the project would not be detrimental to the good status of water bodies (in particular because it does not make use of water and does not release any substance or untreated waste-water in water bodies). Furthermore, concerning wastewater, the Commission notes based on the participating Member States submissions that wastewater will either be treated by the project developer before returning to the environment or be channelled to a wastewater system operated by a third-party taking care of the treatment of the wastewater or does not require treatment

(because of same quality as river- or seawater). In addition, when the project releases brine, the participating Member States confirmed that the brine could only be released in the sea if environmental authorities confirm that this is without negative impact on marine resources. Furthermore, two large scale storage facilities projects will use the brine as feedstock instead of discharging it (see recital (233)).

(357) The Taxonomy Delegated Regulation on climate change mitigation does not contain any technical screening criteria for determining the conditions under which an economic activity involving the production of hydrogen or transmission and distribution pipelines causes no significant harm to the circular economy objective and deems circularity as not applicable. However, many projects contribute to the ***circular economy*** by paying particular attention to the choice of the equipment used and giving priority to equipment that can easily be repaired and/or recycled or composed of subparts that can be refurbished (like the stacks). Also, the production of hydrogen through electrolysis generates heat and oxygen and several projects found ways or investigate the possibility to reuse the waste heat and the oxygen (e.g. by feeding the off-heat into the local district heating system, by using the oxygen at a refinery for oxy-firing to replace combustion air at a fired heater, or by injecting the oxygen into the existing oxygen grid on-site). Some individual projects will be built on existing industrial sites and reuse part of the facilities already present (in particular cables, pipes, water treatment), reducing the need to build entirely new facilities. The majority of the transport pipelines projects imply the repurposing of pipelines of existing natural gas pipelines into high-pressure pipelines for the transport of hydrogen, reducing the need to build new pipelines. For all large-scale hydrogen-storage facilities projects and LOHC projects a waste management plan will be put in place that ensures maximal reuse, remanufacturing or recycling at end of life, including through contractual agreements with waste management partners ((see recital (234)).

(358) The Commission verified that the development of hydrogen technologies and systems under Hy2Infra does not lead to a significant increase of ***pollution to air, water or land***. The participating Member States confirmed that the projects do not involve any of the substances listed in Appendix C to the Taxonomy Delegated Regulation on climate change mitigation. Furthermore, where required by the EU and national environmental legislation, projects have already been subject to or will be subject to an environmental impact assessment or to environmental permit. For projects concerning large scale hydrogen-storage facilities above five tonnes, they all committed to comply with Directive 2012/18/EU of the European Parliament and of the Council ([100]). As regards projects concerning the installation of hydrogen transmission and distribution infrastructure via pipelines, the participating Member States confirmed that projects will make use of fans, compressors, pumps and other equipment complying, where relevant, with the top-class requirements of the energy label, and represent the best available technology. Concerning LOHC projects, the Commission notes they committed to comply with Directive 2012/18/EU of the European Parliament and of the

([100]) Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC Text with EEA relevance, OJ L 197, 24.7.2012, p. 1–37.

Council, and use energy efficient equipment (high energy efficiency label class) ((see recital (235)).

(359) Finally, the Commission considers that it is unlikely that the activities carried out under Hy2Infra will have a significant negative impact on the ***protection and restoration of biodiversity and ecosystems***. No project will be located in a protected area and most projects will be located in existing industrial areas. Furthermore, projects have already been subject to or will be subject to an environmental impact assessment, where required by EU and national environmental legislation, or to environmental permit. Projects closer to natural areas will implement additional nature protection measures (see recital (236)).

(360) In view of the above, the Commission concludes that the participating Member States have sufficiently demonstrated compliance with point 20, including footnote 20 of the IPCEI Communication ([101]).

(361) Therefore, based on all of the above considerations, the Commission considers that the general cumulative criteria for eligibility of the notified Hy2Infra for aid under Article 107(3), point (b) TFEU are met.

3.3.2.2.2. General positive indicators (section 3.2.2. of the IPCEI Communication)

3.3.2.2.2.1. Involvement of the Commission in the design

(362) The Commission facilitated the emergence of Hy2Infra and helped enhance coordination between Member States in the project by having participated and contributed during the period preceding the pre-notifications from January 2021 to August 2021 in several technical meetings with open invitations for all Member States interested in participating in Hy2Infra. The Commission takes a positive note of it consistently with point 21(a) of the IPCEI Communication.

3.3.2.2.2.2. Involvement of the Commission in the governance

(363) As described in detail above under section 2.7, the governance structure of Hy2Infra involves the Commission through participation into the SB. The Commission takes a positive note of it consistently with point 21(c) of the IPCEI Communication.

3.3.2.2.2.3. Important collaborative interactions

(364) The participating Member States provided detailed information (see section 2.4.5.3) describing how each individual project creates important collaborative

([101]) Insofar as individual projects under this Decision fall under a measure of a national RRP, this conclusion is without prejudice to the assessment of the Commission in the context of the RRF Regulation, of the satisfactory fulfilment of any related milestones and/or targets, as established in the respective Council Implementing Decisions approving the RRPs.

interactions within clusters to ensure a timely physical interconnection but also across clusters in relation to interoperability, operational rules, and standards.

(365) With regard to collaborative interactions of the individual projects within the regional clusters, the Commission notes that such interactions are not only required to achieve the overall quantitative objectives under Pillar 1 (see recital (284)) but also to deploy interconnected and cross-border relevant hydrogen infrastructure within the clusters (as in cluster North-West Germany, see section 2.4.4.1.1) that enables emergence of a Union-wide network for the transport and storage of hydrogen and fosters market integration, security of supply and competition and cross-border value chains between participating undertakings (e.g. between NL57 and PT11, see recital (128)) .

(366) With regard to the collaborative interactions of the individual projects across clusters and nuclei, the Commission notes that collaborations under Pillar 2 (see recital (291)) on interoperability, standardisation, operational rules, and WS-specific deliverables help significantly to facilitate not only the interconnection between clusters and nuclei but more broadly between Hy2Infra projects and future infrastructure developments (e.g. including PCIs and PMIs).

(367) Additional collaborations are formed on more specific topics within each WS (see section 2.4.5.3) as, for example, the collaborations in WS1 to deliver guidance on flexibility services provided by electrolysers (see recital (151)), or in WS2 to elaborate best-practices for construction and repurposing of hydrogen pipelines (see recital (162)), or in WS3 around short, and midterm balancing strategies and methodologies (see recital (172)), or in WS4 concerning standardisation of hydrogen quality derived from LOHC (see recital (175)).

(368) The Commission takes positive note of the above consistently with point 21(d) of the IPCEI Communication.

3.3.2.2.2.4. Co-funding or co-financing from a Union fund

(369) The Commission acknowledges that some participating Member States will be using for some of their projects co-funding or co-financing from the RRF. The inclusion of co-funding or co-financing of individual projects within Hy2Infra is consistent with point 21(e) of the IPCEI Communication.

3.3.2.2.2.5. Significant strategic dependency

(370) **The Commission acknowledges Hy2Infra's furthering of the EU's policy to** decrease its dependency on fossil energy imports and provide energy security (see recitals (307) and (308)). The Commission takes positive note of it consistently with point 21(g) of the IPCEI Communication.

(371) In view of all of the foregoing, the Commission considers that on grounds of section 3.2.2 of the IPCEI Communication, five out of seven general positive indicators, in accordance with point 21 of the IPCEI Communication are met.

3.3.2.2.3. Specific criteria for infrastructure projects

(372) Point 25 of the IPCEI Communication provides that infrastructure projects in the environmental, energy, transport, health or digital sectors, to the extent that they are not covered by points 22 and 23 of the IPCEI Communication, must be of great importance for the environmental, climate, energy (including security of energy supply), transport, health, industrial or digital strategies of the Union or contribute significantly to the internal market, including, but not limited to those specific sectors, and can be supported for the period until becoming fully operational following construction. Point 45 of the IPCEI Communication provides that "projects involving the construction of an infrastructure must comply with principles of open and non-discriminatory access to the infrastructure and non-discriminatory pricing and network operation, including **those laid down in Union law"** ([102]).

(373) In order to establish whether they can be viewed as infrastructure projects and can be deemed of great importance for the environmental, climate, energy (including security of energy supply), transport, health, industrial or digital strategies of the Union within the meaning of point 25 of the IPCEI Communication, the Commission has examined the contribution of the individual components of Hy2Infra and of their collaborations to the environmental, climate and energy strategies of the Union referred to in recitals (10) to (20). Given the features of these projects, the Commission assessed, in particular, their contribution to the European Hydrogen Strategy.

(374) In addition, the Commission considers as a positive indicators of great importance the fact that the projects address already identified needs, rest on open access principles, are aligned with objectives of the EU energy policy (see in particular the criteria established in Article 4 (3) (d) the revised TEN-E Regulation, which stress the importance for energy infrastructure to contribute to market integration, security of supply and competition).

3.3.2.2.3.1. Specific criteria for electrolyser projects

(375) All projects within WS1 involve the deployment of large-scale electrolysers. Against this background, the Commission has verified first whether, the electrolysers to be built in the framework of those projects can be viewed as energy infrastructure. To that end, it has verified whether they qualify as one of the energy infrastructure categories listed in Annex II of the TEN-E Regulation.

(376) More specifically, the Annex II of the TEN-E Regulation identify three relevant criteria that electrolysers must meet to be viewed as energy infrastructure complying with the general policy objectives: (i) a capacity of at least 50 MW, which implies that they can have an impact of European relevance; (ii) generate

([102]) Footnote 34 of the IPCEI Communication foresees that "where the project involves an energy infrastructure, it shall be subject to the tariff and access regulation and to the unbundling requirements where required by internal market legislation". At the time of the adoption of this decision, the provisional agreement of the Parliament and the Council on the Hydrogen and decarbonised gas package was not yet formally adopted. In terms of unbundling, the Commission assessed that gas transmission network operators are not engaged in production activities (WS1).

hydrogen in a way that ensures high savings of GHG emissions; and (iii) have a network-related function, specifically for the electricity and hydrogen networks.

(377) With regard to the first TEN-E criterion for electrolysers, related to capacity, the Commission notes that all of the individual electrolyser projects within WS1 plan to reach capacities of at least 50 MW and in some cases much larger (see section 2.4.3.1). The total estimated capacity covered by these projects could reach approx. 3.2 GW (see recital (60)).

(378) With regard to the second TEN-E criterion for electrolysers, related to the environmental impact, the Commission has verified that all projects within WS1 will comply with life-cycle GHG emissions savings of at least 70 % relative to a fossil fuel comparator of 94 g CO2eq/MJ. This TEN-E criterion exactly corresponds to one of the requirements under the DNSH principle as applied **under the Taxonomy Regulation and, therefore, the Commission's assessment of** compliance of all individual projects within Hy2Infra with the general eligibility criterion of compliance with the DNSH principle (see recital (351)) enables it to conclude that the electrolyser projects of WS1 are in line with that specific TEN-E criterion.

(379) With regard to the third TEN-E criterion for electrolysers, concerning their network-related functions, the Commission examined in particular the relevant **projects' contributions to the electricity networks.**

(380) Concerning the electricity networks, the Commission notes that the large-scale electrolysers to be built in the framework of the individual projects within WS1 will all be connected to the electricity network and be designed to operate in a flexible manner so that they can facilitate system integration of high amounts of RES whilst reducing concurrently downstream electricity grid congestions (see section 3.3.2.2.1.5 on spillover). Furthermore, several individual projects plan to offer grid balancing services and participate to grid service markets. This will allow them to contribute to secure, efficient, and reliable operations of the electricity systems. The Commission therefore concludes that the large-scale electrolyser projects included in Hy2Infra can all be viewed as energy infrastructure within the meaning of point 25 of the IPCEI Communication.

(381) The Commission observes that, together, electrolyser projects included in WS1 contribute to an overall capacity of 3.2 GW of renewable hydrogen, which amounts to 8% of the 40 GW target by 2030 in the European Hydrogen Strategy. The Commission considers this to be a significant contribution towards this objective, in particular, since the projects concerned will go into operation at the end of 2027 at the latest, thus before 2030.

(382) In addition, these projects can, beyond the quantitative contribution, also contribute significantly to the energy policy objectives of sustainability, including by reducing GHG emissions and enhancing the deployment of renewable or low-carbon hydrogen; and security of supply, including by contributing to secure, efficient, and reliable electricity system operation, or by offering flexibility solutions.

(383) In addition, the Commission also examined to what extent the individual projects in WS1 address already identified needs and will contribute to large-scale supply of renewable hydrogen.

(384) In this respect, the Commission finds it important to verify that the electrolyser projects can show the existence of prospective off-takers but, at the same time, that they are not exclusively dedicated to one off-taker. Indeed, while supplying exclusively one off-taker may have important benefits in terms of decarbonisation for one specific production plant, the Commission considers that such projects do not comply with principles of open and non-discriminatory access as required by point 45 of the IPCEI Communication and lack the scope and ambition required for being deemed of great importance for the relevant Union strategy or contribute significantly to the internal market, as required by point 25 of the IPCEI Communication ([103]).

(385) Nevertheless, the Commission also notes that many large-scale initiatives in an emerging sector such as that of hydrogen, in which large parts of the expected demand still need to materialise, may require so-called 'anchor' or 'launching' customers which can commit to a predictable demand for hydrogen in the initial phase of operation of the electrolysers and thus provide investors with reasonable expectations of sufficient financial returns justifying the risks involved in building electrolysers of such large scale. This is the case for example in industrial sectors, such as steel-making, and refineries; and in transport sectors, in particular, heavy-duty or long-haul services.

(386) To ensure that the role of such initial customers does not put into question the open nature of the projects and their ability to contribute effectively to achieving Union's objectives in relation to the emerging hydrogen market, the Commission has verified that all of the individual projects within WS 1 have concrete and realistic plans to supply several customers, notably in terms of available hydrogen production capacities, technical characteristics of the electrolysers, and localisation close to areas and regions where large hydrogen demand is forecasted during the lifetime of the individual project.

(387) In addition, WS-specific deliverables under Pillar 2 are also a significant contribution (see recital (337)).

(388) Furthermore, the Commission assessed the feasibility the individual projects within WS1 to ensure from a technical point of view that they can deliver the expected results and thus contribute effectively to achieving the Union's objectives in the energy sector.

(389) Following the assessment against the relevant factors listed above, the Commission considers that all projects within WS 1 qualify as energy infrastructure and are aligned with the Union's objectives and will contribute significantly to their implementation and to the achievement of their targets.

([103]) In alignment with Commission Decision on an Important Project of Common European Interest on Hydrogen Industry (Hy2Use), see recital (262).

3.3.2.2.3.2. Specific criteria for pipeline projects

(390) All projects within WS2 involve the deployment of pipelines for the transport of hydrogen, which qualifies them as energy infrastructure.

(391) To verify whether the infrastructure is of great importance for the EU Hydrogen Strategy and EU objectives in terms of hydrogen deployment, the Commission notes that participating undertakings in WS2 will contribute 1,063 km of new pipelines and repurpose approximately 1,607 km of existing natural gas pipelines into pipelines for the transport of hydrogen. The Commission further recognizes that while there is no quantitative target in the European Hydrogen Strategy in terms of the length of pipelines to be deployed, the strategy recognises the need to deploy medium- and long-range transport infrastructure for (renewable) hydrogen, including through the repurposing of natural gas pipelines. The Commission observes further that the deployment of transport infrastructure in WS2 is indispensable for the technical and economic feasibility of the vast majority ([104]) of projects in WS1 and WS3 as it makes the link between hydrogen production, storage infrastructure, and hydrogen end-use sectors (see recital (394)). **In addition, the REPowerEU Plan states "to facilitate the import of up to** 10 million tonnes of renewable hydrogen, the Commission will support the development of three major hydrogen import corridors via the Mediterranean, the **North Sea area and, as soon as conditions allow, with Ukraine".** In this respect, projects DE29 and SK04 are contributing to such developments in the North Sea area and with respect to Ukraine. Therefore, the Commission regards the deployment of pipeline infrastructure in WS2 as significantly contributing to the Union's energy and climate strategies.

(392) In addition, the Commission notes that the pipelines are exclusively built or repurposed for the transport of hydrogen (see also point (3) (a) of Annex II of the TEN-E Regulation), in line with the European Strategy Hydrogen, which stresses the importance of having pipelines in which only hydrogen is transported. All projects in WS2 comply with these principles.

(393) Furthermore, the Commission has assessed whether pipelines in WS2 contribute significantly to at least one of the following criteria: market integration, security of supply and competition (see recitals (373) to (374)).

(394) Most individual projects in WS2 are integrated in regional clusters which also include production projects under WS1 and, except for Cluster Italy, also storage facilities under WS3. Therefore, the Commission notes that they contribute significantly to market integration by facilitating the emergence of a Union-wide hydrogen network, as well as to security of supply and flexibility by paving the way for the interconnection of regional clusters and nuclei in a gradual approach aligned with the European Hydrogen Strategy and ensuring interoperability (see recital (297)). The links that projects in WS2 establish between hydrogen production facilities in WS1 and storage facilities in WS3 enable sector coupling and the balancing of hydrogen production inherent seasonality (see recital (334) and facilitates flexibility services offered by WS1 projects (see recital (380)).

([104]) With the exception of projects PL01 and FR23 acting as nuclei and PT11 and PT25, which rely on pipelines to be deployed outside the scope of Hy2Infra.

(395) The Commission notes further that project SK04 establishes a European transmission route within Slovakia, reaching the borders of two other Member States (Austria ([105]), and the Czech Republic) as well as the border with Ukraine, laying the ground for future imports from Ukraine (see recital (124)). The Commission also notes the ongoing cooperation between Eustream and Gas Connect Austria in the framework of the H2EU+Store initiative (see the project description of SK04 in section 2.4.3.2).

(396) In addition to market integration and security of supply, the Commission has verified that all projects in WS2 foster competition by allowing access to multiple supply sources and network users on a transparent and non-discriminatory basis in line with point 45 of the IPCEI Communication. All projects in WS2 fulfil that requirement (see recital (72)).

(397) Moreover, the Commission has verified that pipeline projects address actual needs. To that end, the Commission has examined the projected capacity bookings and their likelihood, the likelihood to connect to production projects, storage facilities, and demand centres. While all pipeline projects face the challenge of an initial ramp-up phase, all projects present a sufficient utilisation rate over the longer-term, enabling the recovery of their costs without disproportionate burden to network users, while the remaining capacity ensures access to further network users, ensuring flexibility and fostering competition.

(398) Furthermore, the Commission has assessed the feasibility of the individual projects in WS2 to ensure from a technical point of view that they can deliver the **expected results and thus contribute effectively to achieving the Union's** strategies in the energy sector.

(399) In addition, WS-specific deliverables under Pillar 2 are also a significant contribution (see recital (338)).

(400) Following the assessment against the relevant factors listed above, the Commission considers that all projects within WS 2 qualify as energy infrastructure and **are aligned with the Union's objectives and will** contribute significantly to their implementation and to the achievement of their targets.

3.3.2.2.3.3. Specific criteria for large-scale storage facilities projects

(401) All projects in WS3 involve the deployment of large-scale underground storage facilities for hydrogen, which qualifies them as energy infrastructure.

(402) To verify whether the infrastructure is of great importance for the EU Hydrogen Strategy and EU objectives in terms of hydrogen deployment, the Commission notes that the participating undertakings in WS3 will deploy large-scale storage sites with a capacity of 9,120 tonnes in three locations (see section 2.4.3.3). While there is no quantitative target in the European Hydrogen Strategy in terms of installed hydrogen storage capacity, the European Hydrogen Strategy recognises

([105]) As discussed in recital (126)**, a connection between SK04 and the PCI "**Hydrogen corridor Italy-Austria-**Germany"** could be carried out by repurposing 2.5 km of an existing gas pipeline.

the importance of cyclical or seasonal storage to secure hydrogen supply and allow electrolysers to operate flexibly, while the REPowerEU Plan recognises the importance of storage for an accelerated hydrogen deployment (see recital (26)). The deployment of storage infrastructure in WS3, which involves eligible costs of around EUR 410 million, is indispensable for the technical and economic feasibility of the projects in WS1 in clusters North-West, West and East Germany as it enables sector coupling and the balancing of hydrogen production depending on the season (see recital (334)) and facilitates flexibility services offered by WS1 projects (see recital (380)), which the Commission considers of great importance.

(403) In addition, the Commission assessed whether the storage facilities are exclusively dedicated to renewable or low-carbon hydrogen (see also point (3) (b) of Annex II of the TEN-E regulation), in line with the European Strategy Hydrogen, which stresses the importance of having storage facilities dedicated to hydrogen. All projects in WS3 comply with this principle.

(404) The Commission assessed whether storage facilities in WS3 contribute significantly to at least one of the following criteria: market integration, security of supply and competition (see recitals (373) to (374)).

(405) All projects in WS3 foresee a connection to a pipeline project in WS2 of their regional clusters, hence, not only addressing local needs but also contributing significantly to the emergence to the market integration by facilitating the emergence of a Union-wide hydrogen network, as well as to the security of supply and notably to the flexibility and sector coupling, as discussed in recital (394).

(406) In addition to market integration and security of supply, the Commission verified that all projects in WS3 foster competition by allowing access to multiple supply sources and network users on a transparent and non-discriminatory basis, in line with the TEN-E criteria, and whether in line with point 45 of the IPCEI Communication, they offer non-discriminatory pricing and network operation, which all projects in WS3 fulfil (see recital (79)).

(407) Furthermore, the Commission verified that storage projects address local needs by examining the projected capacity bookings, the likelihood to connect to production projects, pipelines, and demand centres. While all storage projects face the challenge of an initial ramp-up phase with relatively low booking levels, all projects present a sufficient utilisation rate over the longer-term, enabling the recovery of their costs without disproportionate burden to network users, should these costs be regulated under the applicable national framework, while the remaining capacity ensures access to further network users, ensuring flexibility and fostering competition.

(408) Furthermore, the Commission assessed the feasibility the individual projects within WS3 to ensure, from a technical point of view, that they can deliver the **expected results and thus contribute effectively to achieving the Union's** strategies in the energy sector.

(409) In addition, WS-specific deliverables under Pillar 2 are also a significant contribution (see recital (339)(339)).

(410) Following the assessment against the relevant factors listed above, the Commission considers that all projects in WS3 qualify as energy infrastructure and are aligned with the Union's objectives and will contribute significantly to their implementation and to the achievement of their targets.

3.3.2.2.3.4. Specific criteria for LOHC projects

(411) All projects in WS4 involve the deployment of facilities for the handling of hydrogen embedded in other chemical substances, specifically in LOHC, with the long-term goal to develop maritime hydrogen transport, intra-EU or for imports. The Commission views them as energy infrastructure within the meaning of point 25 of the IPCEI Communication. In annex II to the TEN-E Regulation, only reception facilities for the release of the embedded hydrogen and its injection into the hydrogen network can be considered as an eligible infrastructure category. While project NL57 focuses on the reception-side, project DE59 includes a so-called storage facility as well, which also constitutes a fixed asset, for the process of embedding hydrogen into LOHC (hydrogenation process). The Commission observes however that the reception and storage facilities function together. Together they enable the transport of hydrogen from point to point or from point to multiple points, functioning like a virtual pipeline. The Commission notes that the projects under WS4 encompass fixed assets only (the terminals) but not movable assets used in between to carry the LOHC (ships, barges, trucks). The Commission therefore considers that both the reception and the storage facilities together can be seen as an infrastructure within the meaning of point 25 of the IPCEI Communication.

(412) To verify whether the infrastructure is of great importance, the Commission notes that while there is no explicit objective in the European Hydrogen Strategy in terms of installed LOHC handling storage capacity, the REPowerEU Plan sets a target of 10 million tonnes of hydrogen imports by 2030, part of which will need to be imported via maritime routes through a varied range of technologies. The Commission considers that Hy2Infra helps to de-risk and escalate LOHC technologies. In addition, the Commission notes the potential of LOHC technologies to enable renewable hydrogen maritime and fluvial routes within the EU and imports from third countries, which are a significant component of the REPowerEU Plan.

(413) The Commission further examined whether the LOHC handling facilities are exclusively dedicated to renewable or low-carbon hydrogen, which is the case, contributing therefore directly to the achievement of the targets of the European Hydrogen Strategy.

(414) Furthermore, the Commission assessed whether life-cycle GHG emissions savings of at least 70 % relative to a fossil fuel comparator of 94 g CO2eq/MJ (see recital (354)).

(415) In addition, the Commission observes that the LOHC handling facilities in WS4 contribute significantly to at least one of the following criteria: market integration, security of supply and competition (see recitals (373) to (374)).

(416) All release terminals in WS4 foresee a connection to a pipeline included in the first PCI/PMI list (see recitals (107) and (119)), hence enabling an indirect

connection to Hy2Infra regional clusters, and therefore contributing to the emergence to market integration by facilitating the emergence of a Union-wide hydrogen network, as well as to security of supply and flexibility.

(417) In addition to market integration and security of supply, Commission observes that all projects in WS4 foster competition by allowing **user's** access to multiple supply sources on a transparent and non-discriminatory basis. In line with point 45 of the IPCEI Communication, they offer non-discriminatory pricing and network operation (see recital (89)).

(418) Furthermore, the Commission verified that LOHC handling facilities in WS4 address local needs not only by the future connection to an EU-wide hydrogen network but also due to their vicinity to demand centres in the Rotterdam area and around Ingolstadt (see projects descriptions in recital (91)).

(419) Furthermore, the Commission assessed the feasibility the individual projects within WS4 to ensure from a technical point of view that they can deliver the **expected results and thus contribute effectively to achieving the Union's** strategies in the energy sector. The Commission notes the collaboration between NL57 and projects FI08 and PT11 as potential renewable hydrogen suppliers (see recital (107)).

(420) In particular, the key expected technical results of the projects in WS4 and the corresponding contribution of the participating undertakings according to the proposed objectives are the following:

- Under Pillar 1, the participating undertakings in WS4 will deploy handling terminals with a capacity to handle 6,000 tonnes of renewable hydrogen per year (see section 2.4.3.4).

- In addition, WS-specific deliverables under Pillar 2 are also a significant contribution.

(421) Following the assessment of the relevant factors listed above, the Commission considers that the projects in WS4 correspond to energy infrastructure within the meaning of point 25 of the IPCEI Communication and are aligned with the Union's objectives and will contribute significantly to their implementation and to the achievement of their targets.

3.3.2.2.3.5. General conclusion on point 25 of the IPCEI Communication

(422) Based on the findings described under sections 3.3.2.2.3.1 to 3.3.2.2.3.4, the Commission considers that all the individual projects in Hy2Infra qualify as infrastructure projects and that together they constitute an integrated infrastructure project of great importance for the relevant Union strategy, in particular the European Hydrogen Strategy, as complemented by the REPowerEU Plan, in line with point 25 of the IPCEI Communication.

3.3.2.3. Importance of Hy2Infra

(423) According to point 26 of the IPCEI Communication, in order to qualify as an IPCEI, a project must be important quantitatively or qualitatively. It should be particularly important in size or scope or imply a very considerable level of technological or financial risk, or both. As demonstrated below, Hy2Infra is **particularly large in size and scope and Hy2Infra's individual projects face a very** considerable level of strategic and financial risks.

(424) The Commission considers Hy2Infra to be an ***important project*** meeting the quantitative and qualitative requirements set out in section 3.3 of the IPCEI Communication, based on the following:

(425) Hy2Infra represents an ***important contribution to Union's objectives*** (see section 3.3.2.2.1.1) and is of ***great importance for the energy strategy*** of the Union (see section 3.3.2.2.3.5): the Commission notes in particular that the project will on its own deliver 8**% of the Union's objective under European** Hydrogen Strategy to reach 40 GW of renewable hydrogen electrolysers in the EU and already connect these production sites with various consumption sites, developing regional clusters. It represents thus the deployment of already an important part of the needed enabling storage (see section 3.3.2.2.3.3) and pipeline infrastructure (see section 3.3.2.2.3.2). It also contributes to scaling-up and de-risking hydrogen import related technologies such as LOHC. In terms of size, it can already be viewed as important. It is also important in scope as it covers four complementary types of infrastructure, seven Member States, 32 undertakings with 33 individual projects and mobilizes sizable investments (more than EUR 11.5 billion of eligible costs – see section 2.8.1).

(426) Hy2Infra is designed to overcome ***important market failures*** (see section 3.3.2.2.1.2): in particular it contributes to overcome coordination problems which significantly hamper the development of the renewable hydrogen ecosystem that is however needed to enable decarbonisation of hard-to-abate sectors.

(427) Hy2Infra generates ***positive spillover effects*** (see section 2.5): the already interconnected and open infrastructure will offer other stakeholders the possibility to connect to an already existing and functioning infrastructure. This will thus stimulate further hydrogen-suppliers' projects and enable further decarbonisation projects in different end-use sectors of the participating Member States (such as the steel industry, the mobility sector) but also in other Member States given the complementarity with PCI projects and national initiatives. Besides positive network effects, Hy2Infra produces significant spillovers by disseminating the knowledge generated in the projects and by helping complete missing or lacking European technical standards for the hydrogen economy. Finally, Hy2Infra involves important collaborative interactions (see section 2.5.3.2).

(428) Hy2Infra addresses a significant ***strategic dependency*** as it enables a transition to hydrogen away from the dependency on fossil fuel imports (such as natural gas and coal) (see also section 3.3.2.2.2.5).

(429) **Hy2Infra complies with the principle of 'do no significant harm' (see** section 3.3.2.2.1.7).

(430) All Member States were given the opportunity to participate in Hy2Infa (see section 3.3.2.2.1.3).

(431) The Commission was involved in the design of Hy2Infra (see section 3.3.2.2.2.1) and will be involved in its governance (see section 3.3.2.2.2.2).

(432) In addition, the Commission acknowledges the considerable level of (i) strategic and organisational risks, (ii) financial risks, (iii) technological risks and (iv) human resources risks, for the individual Hy2Infra projects.

(433) The participating undertakings will face **strategic and organisational risks**.

(434) As it is the case in the energy sector, different hydrogen infrastructures are present all along the hydrogen value chain. Each stakeholder has to be integrated/interoperable with the others, to ensure the good functioning of a connected network. To overcome these coordination problems in the deployment of the hydrogen infrastructure (see recital (30)), the participating undertakings of Hy2Infra plan to cooperate on integration and interoperability issues. However, this high degree of integration and interoperability also results in the risk that the failure of one project may affect the entire hydrogen value chain. Integrated infrastructure projects are based on interdependencies between generation, transport and consumption. Especially in the ramp-up phase of these new infrastructures, which tend to be small clusters with few to no short-term switching options, the failure of one partner can become a significant risk for all other partners involved in the construction of the infrastructure. For instance, in a given cluster, if a pipeline project (linking an electrolyser to its off-takers), would fail, this could highly endanger the electrolyser project which will need to find an alternative means to transport the hydrogen to its customers.

(435) In addition, the participating undertakings will be confronted with high **financial risks**, since the large-scale deployment of hydrogen infrastructures in Europe is unpreceded so far ([106]). In this regard, the Commission notes the following.

(436) First, implementing a European hydrogen network including hydrogen storage and transport technologies bears a high risk for first movers, due to the lack of redundancies. Conventional commodity markets with highly networked infrastructures offer a high number of redundancies that are available, for example, in the event of system failure or mismatches between supply and demand to ensure a continued secure supply. These default risks must be contractually taken into account by the participating undertakings and addressed, for example, through compensation payments to their customers. These compensation payments represent a considerable financial risk that can only be reduced by liquid markets and reliable redundant infrastructures, for which Hy2Infra can be a first step.

(437) Second, the projects within this IPCEI are likely to run over many years (see recital (64)), during which changes of the operating conditions are very likely to occur. Projects could be exposed to risks that are not all identifiable and

([106]) In September 2023, only 228 MW of electrolyser capacity was installed in Europe compared to the 3,234 MW that Hy2Infra plans to deploy.

quantifiable from the start. The nominal objectives may not always be achieved on their initial target date; there may also be unexpected events affecting some parts of the value chain, which may create delays in the overall deployment. Therefore, the fulfilment of the initial schedule, as well as on the construction and operational costs are subject to some degree of uncertainty. Each year of delay generally induces significant additional costs. A close and constant follow-up of the project should take place, but a certain risk still remains.

(438) Finally, more than in many other sectors, the price of renewable hydrogen is highly dependent on the cost of renewable electricity, which constitutes the main operating cost component for hydrogen production. For the moment, such costs remain uncertain and exposed to general volatility in energy prices, increasing the level of financial risks of the projects.

(439) The level of **technological risks** of the Hy2Infra projects is important.

(440) First, the individual projects of Hy2Infra will act as first mover projects in the relevant value steps of renewable hydrogen production via electrolysis systems, transporting hydrogen in newly build and repurposed pipelines, hydrogen storage in new build and repurposed gas storage facilities as well as hydrogen handling with LOHC. Although first market-ready technologies are available, the products still lack market maturity and market experience. By the time the participating undertakings will complete the installation of the infrastructure, there will be hardly any experience in the way to operate the infrastructure, whether for electrolysers, pipelines, large-scale storage facilities or embedded hydrogen. There is also a lack of market maturity and experience regarding the lifetime of single components and the operation of the entire systems (e.g. the dynamic operation mode of the electrolysis plants for RFNBO compatibility, reduced lifetimes or a complete failure of systems as a result of the dynamic operating mode). Moreover, infrastructure must also meet safety standards. While some standards for hydrogen safety (coming from the conventional fossil-based hydrogen sector) exist, they are not widely adopted. There is not much experience in implementing them and they might need to evolve over time or be adapted as identified in the European Clean Hydrogen Alliance standardisation roadmap, e.g. for repurposed pipelines (see recitals (137) to (140) and Annex II for a complete list of standardisation topics that the hydrogen sector needs to address) .

(441) Second, project implementation at an early market stage within Hy2Infra entails the risk of being overtaken by technological developments beyond Hy2Infra. The intention of Hy2Infra is to kick-start the development of a pan-European infrastructure and thus to contribute to the development of the hydrogen market (spillover effect). This means that technologies can develop and make systems obsolete that have already been implemented. For example, improved electrolysis systems with higher efficiency or a longer lifetime could become established. There is also the possibility that other carrier methods besides LOHC will be established for handling hydrogen. There is therefore a risk that accelerated technological developments could make the projects of Hy2Infra obsolete.

(442) Finally, Hy2Infra will face **human resources risks**, because of the current lack of competent human resources at each stage of the value chain within the EU. Training of staff and development of competence centres in the new technical fields, particularly when it comes to safety concerns in the handling of hydrogen

(for example, certain surface installations in pipeline systems (metering stations) or electrolyser sites (balance of plant, intermediate storage), will be needed to overcome this risk. If the European public is to accept the transformation into an energy system in which hydrogen is an important part, accidents must not occur, which in turn requires a well-trained workforce in this new field.

(443) All the above-mentioned risks with which the participating undertakings are confronted during the implementation of their individual projects, demonstrate the importance of Hy2Infra as a whole, in line with section 3.3 of the IPCEI Communication. The Commission considers that Hy2Infra is designed in a way to enable the participating undertakings to overcome or at least minimise those risks.

3.3.2.4. Conclusion on the eligibility of Hy2Infra

(444) In view of the above, the Commission concludes that Hy2Infra meets the eligibility criteria of the IPCEI Communication.

3.3.3. Compatibility criteria

(445) When assessing the compatibility with the internal market of an aid to promote the execution of an IPCEI on the basis of Article 107(3), point (b) TFEU, point 27 of the IPCEI Communication requires the Commission to take into account a number of criteria, as elaborated below in the present section. Moreover, point 28 of the IPCEI Communication also requires the Commission to carry out a balancing test to assess whether the expected positive effects outweigh the possible negative effects.

(446) The Commission analysed the compatibility criteria at the level of aid beneficiaries and per individual project.

3.3.3.1. Necessity and proportionality of the aid measures

3.3.3.1.1. Necessity of the aid measures

(447) Pursuant to point 30 of the IPCEI Communication, "[t]he aid must not subsidise the costs of a project that an undertaking would anyhow incur and must not compensate for the normal business risk of an economic activity. Without the aid, the realisation of the project should be impossible, or it should be realised in a smaller scale, with a more narrow scope, or not with sufficient speed, or in a different manner that would significantly restrict its expected benefits." According to footnote 26 of the IPCEI Communication, the application for aid must precede the starts of the works. Point 31 of the IPCEI Communication states that the "Member State must provide the Commission with adequate information concerning the aided project, as well as a comprehensive description of the counterfactual scenario, which corresponds to the situation where no aid is awarded by any Member State."

(448) The Commission has verified that all participating undertakings submitted their applications for aid to the relevant Member States before the start of the works on their individual projects included in Hy2Infra. Therefore, the formal incentive effect criterion, as required by the IPCEI Communication (footnote 26) is met.

(449) The participating Member States submitted information demonstrating that the aid has a substantive incentive effect for all aid beneficiaries, i.e. that the aid will induce the beneficiaries to change their behaviour by enabling them to engage in their individual projects in their full ambitious scope and in the time span as notified.

(450) More specifically, the participating Member States have presented the situation without the aid, where each of the aid beneficiaries demonstrated that, without public financing for Hy2Infra, they would either: (i) not undertake their individual projects or, (ii) if the beneficiaries would develop alternative projects, they would undertake that with significant time-lag, which would not be compatible with the European Hydrogen Strategy objectives.

(451) In view of the above, the Commission notes that the information provided by the participating Member States shows that, the participating undertakings would not undertake their individual projects under Hy2Infra in the absence of aid and hence that the aid is not **subsidising** "the costs of a project that an undertaking would anyhow incur". Indeed, there is no evidence showing that the participating undertakings had considered such projects in their internal decision-making at the time of taking the decision to apply for the public support. Furthermore, the funding gap calculated for each individual component of Hy2Infra (see recital (254)), shows that without the aid the project would not be possible. Thus, the absence of aid would jeopardise the materialisation of Hy2Infra.

(452) The Commission notes that in a limited number of cases the discounted aid amount would not cover the full funding gap. The Commission however observes that the remaining gap is not large. In any event, where the aid would not cover the funding gap, it would still induce a **change of the aid beneficiaries' behaviour,** either because the difference is very small or because aid beneficiaries can be expected to obtain additional funding if needed, as the State aid make their project financially stable.

(453) Also, in its assessment of the eligible costs, the Commission verified that the list of submitted costs would not include costs that an undertaking would have incurred in any event, and the undertaking would have had to support those costs, even without Hy2Infra.

(454) In light of the above, the Commission considers that the participating Member States have sufficiently demonstrated that the aid measures do not subsidise the costs of projects that the participating undertakings would have incurred in any event and do not compensate for their normal business risks, in line with point 30 of the IPCEI Communication.

(455) Since the aid measures enable the participating undertakings to pursue ambitious projects, which would not have been pursued in the absence of Hy2Infra, the Commission concludes that the notified aid measures are necessary to induce a **change in the aid beneficiaries' behaviour.**

3.3.3.1.2. Proportionality of the aid measures

(456) Pursuant to point 32 of the IPCEI Communication, in the absence of an alternative project, the Commission will verify that the aid amount does not exceed the minimum necessary for an aided project to be sufficiently profitable,

for example by making it possible to achieve an internal rate of return corresponding to the sector- or firm-specific benchmark or hurdle rate. According to point 33 of the IPCEI Communication, the maximum aid level is determined with regard to the identified funding gap and to the eligible costs. The aid could cover all the eligible costs, provided that the discounted value of the notified aid amounts does not exceed the notified funding gap (which itself is expressed in discounted terms) and that their nominal value does not exceed the eligible costs (as reported in section 2.8.1).

(457) The participating Member States have submitted, for all participating undertakings, detailed calculations of the eligible costs for their individual projects as well as detailed funding gap calculations.

3.3.3.1.2.1. Assessment of the eligible costs

(458) In its assessment of the eligibility of the costs, for every individual project, the Commission verified that the eligible costs fall within the categories listed in points (a) to (h) as set out in the Annex to the IPCEI Communication. The Commission also verified that, for every individual project, the nominal State aid amount does not exceed the eligible costs.

(459) For every individual project participating in Hy2Infra, the Commission verified that the eligible costs were necessary for and exclusively related to the construction of the infrastructure until the infrastructure becomes fully operational, as set out in point 25 of the IPCEI Communication. With regard to the operational expenditures (points (a), (d), (e), (f), and (h) of the Annex to the IPCEI Communication), only the costs incurred during the construction period were considered eligible. Hence, costs related to the operation of the infrastructure, such as costs of supplies or of maintenance, were excluded from eligible costs. With regard to the capital expenditures (points (b) and (c) of the Annex to the IPCEI Communication), only depreciation costs that will be **incurred during a project's forecast period** ([107]) and which relate to capital expenditures incurred during the construction period were considered eligible. **Hence, any residual value of project assets at the end of a project's forecast period** is excluded from eligible costs. When the commissioning of an infrastructure occurs in several phases, the Commission also verified that the costs are allocated by phase and assessed the eligibility of these costs consistently with the commissioning date associated with the different phases.

(460) The Commission also verified that beneficiaries estimated eligible costs in a credible manner by requiring adequate justification and supporting evidence such as supplier quotations, external benchmarks or calculations based on justified assumptions. Where possible, the Commission also compared the information provided by different projects that are part of the same WS to verify the relevance of claimed costs and benchmark the claimed level of similar costs.

(461) In sum, the Commission has assessed the cost information provided by the participating Member States for each participating undertaking as summarised in

([107]) The forecast period is the entire period for which detailed yearly financial projections have been submitted in the respective funding gap calculations.

Table 18: France – State aid in EUR million to ***Table 24:– Slovakia – State aid in EUR million*** under recital (254)(255), and concludes that it meets the conditions set out in the Annex to the IPCEI Communication. As further elaborated on in these tables, the total nominal State aid amount for each project is not exceeding the eligible costs of the project.

3.3.3.1.2.2. Assessment of the funding gaps

(462) The Member States must demonstrate for each individual project that the discounted value of the State aid amounts requested for a project does not exceed the funding gap (both expressed in discounted terms based on the same valuation year). The Commission reviewed in detail the funding gap calculations provided by the participating Member States for each individual project and verified the main assumptions underlying those calculations, as explained below.

(463) The Commission analysed whether point 34 of the IPCEI Communication is applicable, i.e. whether the beneficiary faced a clear choice between carrying out either an aided project or an alternative one without aid (counterfactual scenario). For the counterfactual scenario, the participating undertakings reported that there was no alternative project but the possibility to deploy the project much later or no alternative project at all and no perspective to develop the project at a later stage. In very limited number of cases, either a project but with a smaller scope or lower level of environmental ambition was reported. Where participating undertakings put forward an alternative project, the Commission analysed whether the alternative project was sufficiently specific, credible, and substantiated. However, due to the lack of sufficient substantiation in the form of relevant recent company documents (e.g. internal reports or decision-making documents, board presentations or minutes illustrating the choice between the different scenarios which the company considered at the time of deciding on the project that would participate in Hy2Infra), the Commission concluded, for each of the projects concerned, that the information provided on the counterfactual scenarios was not specific and reliable enough to apply point 34 of the IPCEI Communication. As a result, the Commission did not compare the expected NPV of the investments in the aided project to that of the counterfactual projects for the purposes of determining the proportionality of aid. Consequently, the Commission applied point 32 of the IPCEI Communication.

(464) In the absence of a credible, sufficiently substantiated alternative project, the funding gap is equal to the difference between the positive and negative cash flows over the lifetime of the investment, discounted to their current value on the basis of an appropriate discount factor reflecting the rate of return necessary for the beneficiary to carry out the project (see point 33 of the IPCEI Communication). The cash flows are discounted at the WACC of the aid beneficiary ([108]).

(465) Consequently, the Commission assessed for each project the funding gap assumptions for the factual scenario. It verified that calculations were carried out correctly, that estimates were properly explained and justified, and that the

([108]) The valuation year assumed for the discounting of nominal cash flows and aid instalments is the first year in which project-related cash flows occur.

necessary evidence was provided to substantiate the cost and revenue assumptions. It also benchmarked similar projects belonging to the same WS with regard to key financial parameters influencing the funding gap calculation.

(466) More specifically, the Commission assessed whether the financial projections for each individual project included all of the revenues that a project is expected to generate. The Commission also verified that the revenue streams were comprehensive, were in line with the technical characteristics of each individual project and accrued over the entire expected lifetime of the respective project. The Commission also reviewed the calculations and assumptions (e.g. prices and volumes) underlying the projected revenues.

(467) **Concerning capital expenditure, the Commission verified that beneficiaries'** estimates were credible by requiring adequate justification and supporting evidence such as supplier quotations, external benchmarks or calculations based on justified assumptions (see also recital (460)).

(468) Furthermore, the Commission examined the operational expenditures, such as costs of supplies, energy, maintenance or personnel, by reviewing the underlying calculations and assumptions (e.g. full-time equivalent estimations and cost per employee, contractual price with suppliers or market indices, etc.). It verified that all calculations were properly explained and justified.

(469) Specifically for hydrogen production projects (WS1), particular scrutiny was applied to the electricity cost and hydrogen price assumptions, and the related margin. Both assumptions are critical for the profitability of the hydrogen production business since electricity is usually the main cost and hydrogen sales constitute the main revenue. The Commission ensured that the electricity and hydrogen prices were properly justified and substantiated by the participating undertakings and in line with independent market benchmarks and forecasts. The Commission also ensured that the margins resulting from both price assumptions were reasonable, as the acceptable hydrogen price range depends on local conditions and the availability and cost of (renewable) electricity. To do so, margin levels have been benchmarked between projects.

(470) Specifically for hydrogen transportation projects (WS2), particular scrutiny was applied to the revenue calculation and its relationship with existing regulatory frameworks. The tariffication of natural gas transport is regulated, and it is expected that the tariffication of hydrogen transport will at some point be regulated as well in the participating Member States ([109]). However, the specific regulated framework which will apply to each project is as of the date of the present decision not known. Therefore, the Commission consistently examined for all participating undertakings in WS2 a regulated scenario providing reasonable tariff and revenue ranges, based on an as-realistic-as-possible assumption on the application of a regulated framework. Regulated frameworks in this context usually ensure that regulated revenues lead to an acceptable internal rate of return for the company. For example, in the case of Germany, the assumptions are compared to the Wasserstoffnetzentgeltverordnung

([109]) See article 31 of the Directive within the Hydrogen and decarbonised gas package.

("WasserstoffNEV") ([110]), in particular in terms of tariffication methodology and return on capital. Subsequently, the Commission verified that all participating undertakings in WS2 justified their claim that a lack of demand in the first years of their project due to the nascent nature of the hydrogen market would not allow them to reach the specific hydrogen volume or transport tariff assumed under the regulated scenario. To that end, all participating undertakings in WS2 provided evidence for either a transported hydrogen volume ramp-up or a prohibitive **tariffication (constrained by customers' willingness**-to-pay) in order to justify their funding gap. In the former case, the undertakings showed for example that their ramp-up was in line with projections of hydrogen use; in the latter case, undertakings provided evidence of price negotiations with customers.

(471) The Commission verified moreover for each individual project that a terminal **value, capturing a project's** value creation beyond the period for which financial projections were provided, was calculated and that the underlying assumptions were properly justified.

(472) The Commission also verified for each individual project that the WACC, which **is used to discount a project's cash flows, corresponded to the aid beneficiary's** company WACC. Deviations from this rule were assessed on a case-by-case basis. In particular, the Commission accepted that projects corresponding to a regulated activity (such as pipelines) employ a calculation based on parameters set by the regulation. It also verified that the WACC was calculated by applying the formula

$$WACC = \frac{E}{D+E} \times \left(r_f + \beta * ERP\right) + \frac{D}{D+E} \times \left(r_f + DP\right) \times (1 - T)$$

where E = equity, D = debt, r_f = risk-free rate, $\boldsymbol{\beta}$ = equity beta, ERP = equity risk premium, DP = debt premium and T = tax rate, and that all of these parameters were provided, together with their sources and the methodology to determine **them. Furthermore, the Commission also checked that individual projects'** WACC and the assumptions on the underlying parameters were in line with external benchmarks ([111]).

(473) Finally, the Commission assessed the methodology applied by each individual project to compute taxes on profits to ensure a consistent approach across projects. Tax effects did not increase the funding gap in an unjustified or disproportionate manner.

(474) Upon verification of compliance with each of the above elements for each of the individual projects, the Commission concludes that all participating undertakings have calculated their funding gap in line with point 33 of the IPCEI Communication, and that for all projects the notified discounted aid amount (in discounted terms) does not exceed the funding gap (as reported in section 2.8.2).

([110]) Verordnung über die Kosten und Entgelte für den Zugang zu Wasserstoffnetzen vom 23. November 2021 (BGBl. I S. 4955)

([111]) The benchmarks identified by the Commission reflect the country and industry risks of the individual projects.

3.3.3.1.2.3. Claw-back mechanism

(475) Pursuant to point 36 of the IPCEI Communication, the participating Member States submitted a mechanism (which is described in section 2.10 and of which the text is in Annex I) which provides an additional safeguard to ensure that the State aid remains proportionate and limited to the minimum necessary.

(476) The claw-back mechanism enables the participating Member States to reclaim a share of the surplus which arises when a project turns out to be more profitable than initially projected in the respective notified funding gap calculation. In particular, the claw-back mechanism notified by the participating Member States will apply only to those projects with investments that reach, based on the ex-post cash flow results (including State aid disbursements), a rate of return that exceeds **the respective beneficiaries' cost of capital, set equal to their** notified WACC (see Annex I), due to the emergence of a surplus as described in recital (264).

(477) **The share of a project's surplus profits which** participating Member States can claw back is set at 70% of the surplus. As such, the Commission considers that the claw-back mechanism notified by the participating Member States ensures, as required by point 36 of the IPCEI Communication, a balanced distribution of additional gains between the participating Member State and the beneficiaries when the project turns out to be more profitable than forecast, while maintaining **strong incentives for beneficiaries to maximise their projects' performance** as a share of any potential surplus will remain with the respective undertakings. By returning surplus profits of a project to the relevant Member State in question, the claw back mechanism also helps to ensure that the aid granted under Hy2Infra actually **does not exceed what is necessary to achieve Hy2Infra's objectives.**

(478) The Commission notes that the claw-back mechanism will The Commission also notes that the mechanism will apply during the entire period for which financial projections have been submitted in the respective funding gap calculations **("forecast period"), and that at the end of these respective forecast periods, projects' respective terminal values will be taken into account. These elements** ensure a maximum scope of application for the claw-back mechanism.

(479) The Commission notes that the claw-back mechanism may only cease to apply to **a project before the end of the project's forecast period when the project's** beneficiary becomes subject to a regulatory framework that by construction precludes the further emergence of surplus profits ([112]) and when the Commission agrees to a participating **Member State's request to end the application of the** claw-back mechanism based on an adequate justification (see recital (265)). Such a situation may arise in particular for projects belonging to WS2 (see recital (470)). In that case, the amount (if any) to be repaid to the relevant Member State will be calculated at the moment the claw-back mechanism ceases to apply. Given

([112]) Such regulated frameworks may set rules for the calculation of revenues depending on a regulated cost base and a regulated rate of return. Under such frameworks, the level of regulated tariffs is automatically adjusted so that the regulated rate of return is not exceeded and surplus profits cannot occur. One important check to be performed is whether the regulated rate of return is consistent with the WACC assumed in the funding gap calculations for the respective projects.

these safeguards, the Commission does not consider this provision to weaken the effectiveness of the claw-back mechanism.

3.3.3.1.2.4. Cumulation

(480) In addition, the Commission observes that, where the notified aid would be cumulated with other aid under other measures to cover the same eligible costs, the participating Member States have confirmed that the total amount of public funding granted in relation to the same eligible costs will not exceed the most favourable funding rate laid down in the applicable rules of Union law ([113]). This ensures compliance with point 35 of the IPCEI Communication.

3.3.3.1.2.5. Conclusion

(481) Taking into consideration the assessment of eligible costs and of funding gaps, as well as the existence of the claw-back mechanism to ensure a balanced distribution of additional gains, the Commission concludes that the aid to be granted by the notifying Member States is proportionate.

3.3.3.2. Prevention of undue distortion of competition and balancing test

3.3.3.2.1. Appropriateness

(482) Pursuant to point 42 of the IPCEI Communication, the Member States must provide evidence that the proposed aid measure constitutes the appropriate policy instrument to address the objective of the project. Point 40 of the IPCEI Communication provides that "[t]he choice of the aid instrument must be made with a view to the market failure or other important systemic failures which it seeks to address. For instance, where the underlying problem is lack of access to finance, Member States should normally resort to aid in the form of liquidity support, such as a loan or guarantee (32). Where it is also necessary to provide the undertaking with a certain degree of risk-sharing, a repayable advance should normally be the aid instrument of choice. Repayable aid instruments will generally be considered as a positive indicator."

(483) The participating Member States submit that State aid is the appropriate policy instrument to support Hy2Infra. In their view, due to the scale of the investments included in Hy2Infra and the coordination it requires from the various participating undertakings, Hy2Infra could not be achieved without the support of the participating Member States involved in the financing of Hy2Infra. The participating Member States explain that, among other public policy instruments, the use of regulation to implement Hy2Infra would not attain the objectives of Hy2Infra. Because of the technological risks and uncertainties weighing on the upscaling of integrated systems, as well as costs and level of investments required to implement the individual projects, a regulation could not efficiently impose the development of such infrastructure without a financial intervention. In particular, the PCI tool is not an appropriate instrument to ensure a coordinated and aligned

([113]) In most cases, the most favourable funding rate is achieved when aid is granted to fully cover a project's funding gap.

deployment of the infrastructure, as it assesses projects on an individual basis. In addition, only cross-border relevant projects can receive the PCI status. Therefore, PCI is not the most suitable tool to deploy initial regional clusters within Member States but is a complementary tool to the IPCEI tool ([114]).

(484) The participating Member States further argue that the payment of direct grants constitutes the appropriate State aid instrument in view of the high risks of Hy2Infra in strategic, economic, technological, and human resources terms (see recitals (433) to (442)). The market failures which the State aids aim to address are neither a problem of access to finance nor a problem of risk sharing. As such, a public soft loan, a state guarantee, or a repayable advance are not appropriate in Hy2Infra. The grant is intended to compensate for the low profitability of the project without State aid. The simulation of a repayable advance in the business **plan can only have a marginal impact on the project's profitability: public** funding is received but then reimbursed including interests in the nominal scenario of success. Only a direct grant has the potential to have the profitability reach the **company's hurdle rate by filling the funding gap**. In addition, it is considered further that the use of direct grants limits the potential financial losses in case of project failure. Also, the participating Member States submit that direct grants address the coordination problems and encourage the participating undertakings to commit to their projects for the achievement of common objectives.

(485) The Commission shares the views of the participating Member States that given the level of risks and ambitions pursued by Hy2Infra, its size, the public support through the notified State aid measures constitutes the appropriate policy instrument to address the objectives of Hy2Infra. In the view of the Commission, the use of a loan or a guarantee does not constitute an appropriate aid instrument in cases such as the one at hand, as the State aid does not aim to address a problem of access to finance. Similarly, the use of a repayable advance does not constitute an appropriate aid instrument in cases such as the one at hand, as the State aid does not aim to address a problem of risk sharing. Even more so in a context whereby the hydrogen industry is nascent, while the success of individual projects depends to a large extent on the evolution of the hydrogen market as a whole and of the coordinated actions of all of the participating undertakings. Considering the market failures identified, (see section 2.1.3), in particular the negative externalities (see recital (32)) and taking into account the level of risk and uncertainty (see recitals (432) to (442)), the Commission considers the use of direct grants to be appropriate, pursuant to point 40 of the IPCEI Communication.

3.3.3.2.2. Identification of the potential risks of distortion of competition

(486) According to point 43 of the IPCEI Communication, aid can be declared compatible if the negative effects of the aid in terms of distortions of competition and impact on trade between Member States are limited and outweighed by the positive effects in terms of contribution to the objective of common European interest. The assessment of the potential negative effects of the aid under the IPCEI Communication needs to consider, in particular, the effects on competition between undertakings in the markets concerned, including up- or downstream

([114]) Some individual projects of Hy2Infra such as DE29 and DE40 also received the PCI status.

markets, the risk of overcapacity, as well as risks of market foreclosure and dominance (points 44 and 45 of the IPCEI Communication).

(487) The participating Member States submit that the European renewable hydrogen sector is at a nascent stage (see recital (22)). In addition, the Commission notes that the installed water electrolysis capacity in Europe grew at a high rate in the last years, with a compound annual growth rate ("CAGR") of 25% between 2017 and September 2023, when it reached 228 MW compared to the target of 6 GW by 2024 in the European Hydrogen strategy ([115]). Electrolysis capacity is expected to continue to expand more significantly in the years to come: based on the number of projects announced, they should reach a total production capacity of 85 GW by 2030, 73% of them in early development (concept or feasibility study stage) ([116]). As a result of the will of the participating Member States to replace the current grey hydrogen production by renewable hydrogen and further extend its use in other hard-to-abate sectors, there will remain ample opportunities to develop business for the competitors of the participating undertakings on the hydrogen market. Indeed, Hy2Infra represents 8% of the EU target of 40 GW for 2030 (see for instance recital (285)). While Hy2Infra represents a significant contribution to the achievement of that target, there remains ample scope for other market participants.

(488) Hy2Infra involves a large number of participating undertakings ([117]), each with an actual or future presence across the hydrogen value chain. The assessment of potential distortions to competition was carried out taking into account the particularities of the relevant WS and the participating undertakings involved.

(489) In assessing the likelihood of significant competition distortions in the present case, the Commission identified the market segments that could potentially be affected by the aid measures. The Commission then assessed the position of these undertakings in the relevant segments, to determine if there is a risk of dominance, or of customer or input foreclosure.

(490) More precisely, as a first step, the Commission identified the segments that could be potentially affected by the State aid in the present case. These include: hydrogen production; renewable hydrogen production; hydrogen transport; and hydrogen storage liquefied hydrogen storage. In addition, the Commission collected information for the related segments, where some of the participating undertakings are already active. These included the manufacture of gas; gas transport; gaseous gas transport; liquefied gas transport; gas distribution; gas distribution to industrial off-takers; gas distribution to retail off-takers; gas trade; gas storage; manufacture of electrolysers; manufacture of alkaline electrolysers; manufacture of polymer electrolyte membrane electrolysers; electricity production; electricity production from renewable energy sources; electricity transmission; electricity distribution; electricity trade.

([115]) See Figure 2.9 of the Clean Hydrogen Monitor 2023, from Hydrogen Europe, accessible here: https://hydrogeneurope.eu/wp-content/uploads/2023/10/Clean_Hydrogen_Monitor_11-2023_DIGITAL.pdf.

([116]) See Figure 2.13 of the Clean Hydrogen Monitor 2023, from Hydrogen Europe.

([117]) Hy2Infra involves 32 companies.

(491) Furthermore, the Commission requested and received data on the past turnover (2018-2022) and projected future turnover (2023-2030) at the level of the participating undertakings and at the level of the total respective segments and subsegments, at EU- and national level. In addition, for each segment and geographic level, the Commission requested and received data on the five main competitors of each participating undertaking. Based on this information, the Commission assessed whether undertakings are currently active in the segments in which they intend to develop the infrastructure, as a result of the aid measures at hand and the estimated share of the respective undertakings based on turnover in the relevant segments, at EU- and national levels.

(492) Considering that Hy2Infra encompasses projects at different levels of the supply chain, with distinct market features in its competition assessment, the Commission took into account factors relevant to each WS.

(493) In a second step, having identified the relevant segments, the Commission identified individual projects, where there might be risks of high market power, or of foreclosure by the strengthening or the maintaining of substantial market power by the aid beneficiaries.

(494) With regard to hydrogen production (WS1), the Commission considers that the position of the participating undertakings in the relevant segments does not raise concerns, either because of the estimated shares of these undertakings are low, or because there are competitors that can restrain the ability of participating undertakings to distort competition. Moreover, the dynamic nature of the hydrogen market, which is expected to grow significantly in the years to come is also taken into account. Finally, in assessing the individual project portfolios, the Commission ensured that in each of them, the aided electrolysers would not be dedicated to only one or few customers (see recital (385)) and that non-discriminatory conditions would be applied by the owner of the infrastructure when contracting with third parties in the upstream or downstream levels.

(495) With regard to pipeline infrastructure (WS2), the Commission notes that pipeline networks may exhibit characteristics of natural monopolies. They also often fall under regulated activities. The competition assessment considered first whether alternatives to the pipelines to be supported for the transport of hydrogen existed and the Commission observes that as far as the projects in WS2 are concerned, several alternatives exist for the transport of hydrogen, such as trailers and alternative transport technologies (LOHC) and participating undertakings in WS1 also use trailers to a certain extent to transport hydrogen to customers. In addition, in some cases alternative pipeline routes will also exist with Hy2Infra (in particular within cluster West Germany and cluster East Germany. Second, the Commission identified that the competitors of the participating undertakings are other grid operators or hydrogen suppliers that are also able to build hydrogen pipelines for the supra-regional transportation network. Third, the Commission also took into account the current and prospective regulatory framework, in which participating undertakings would be active, aims at ensuring non-discriminatory conditions for third parties to access the relevant assets.

(496) More precisely, at EU level, the recently revised Hydrogen and decarbonized gas market package includes a proposal for a Directive of the European Parliament and of the Council on common rules for the internal markets in renewable and

natural gases and in hydrogen ([118]). The proposed Directive provides for common rules in relation to the transport, supply and storage of hydrogen using the hydrogen system. It lays down the rules relating to the organisation and functioning of this sector, access to the market, the criteria, and procedures applicable to the granting of authorisations for networks, supply and storage of hydrogen and the operation of systems. The proposed directive requires Member States to ensure regulated third-party access to hydrogen networks based on published tariffs and applied objectively and without discrimination between any hydrogen network users ([119]).

(497) Furthermore, a proposal for a Regulation of the European Parliament and of the Council on the internal markets for renewable and natural gases and for hydrogen provides for non-discriminatory rules for access to natural gas and hydrogen systems (including harmonised principles for tariffs, or the methodologies underlying their calculation, for access to the natural gas network, the establishment of third-party access services and harmonised principles for capacity-allocation and congestion-management, the determination of transparency requirements, balancing rules and imbalance charges, and the facilitation of capacity trading).

(498) It follows that despite any current differences in national legislation across Member States, participating undertakings in WS2 expect the rules described above (including non-discriminatory conditions for third party access to pipeline networks) to be transposed into their respective national legal orders in due course. As a result, the pipelines to be supported, irrespective of the participating Member State in which they are located, will all be regulated in the near future, both in terms of third-party access and in terms of tariffs.

(499) In any event, pending this transposition, in assessing the individual project portfolios, the Commission verified that, in each of them, the participating undertaking has committed to offer interested stakeholders open and non-discriminatory access to its transport infrastructure(see recital (396)).

(500) Based on the above, the Commission considers that even if indicative shares in the relevant segments may be significant, these would not raise concerns on market foreclosure or other negative effects on competition.

(501) With regard to storage facilities (WS3), the Commission first assessed the estimated position of the participating undertakings in the relevant segment, noting however, that also in this segment, significant growth is expected in the years to come (see recital (487)). Similarly, the Commission observes that the proposal for a Directive of the European Parliament and of the Council on common rules for the internal markets in renewable and natural gases and in hydrogen, requires regulated third-party access to hydrogen storage, while it sets tariffs, or the methodologies underlying their calculation, under the approval of the competent national authorities (120). In addition, in assessing the individual

([118]) See footnote 10.

([119]) Idem, Article 32.

([120]) Idem, Article 33.

project portfolios, the Commission verified that all participating undertakings in WS3, commit to offer open and non-discriminatory access to potential customers (see recital (406)). Finally, the Commission also considered that the connections established by the different networks planned between the clusters of Hy2Infra will also allow interested stakeholders to access different storage facilities.

(502) With regard to the handling of hydrogen embedded in LOHC (WS4) the Commission took into account that this is a relatively new activity, which intends to provide alternatives to the transportation of large amounts of hydrogen over long distances. The Commission examined the estimated position of the participating undertakings and confirmed that in any possible delineation of the relevant segment, the shares attributed to the participating undertakings were very low. In addition, the Commission confirmed that all projects in WS4 comply with principles of open and non-discriminatory access to the infrastructure and non-discriminatory pricing and network operation (see recital (89)).

(503) On this basis, the Commission was able to conclude that the granting of aid in the context of Hy2Infra will not give rise to specific concerns of market dominance or market foreclosure.

(504) The Commission furthermore assessed the potential risk of overcapacity. In view of the hydrogen sector's nascent state and the expectation of its significant expansion (see recital (487)), the Commission considers that the risk of overcapacity is limited in the present case. In addition, the Commission's assessment shows that the aid granted under the Hy2Infra is limited in scope in relation to the current economic activity of the undertakings and the overall hydrogen-based economic activities. In particular, while projects under WS1 are expected to lead to the creation of approximately 3.2 GW of new electrolyser capacity, the target goal outlined by the Commission in the EU Hydrogen Strategy is to reach 40 GW of renewable hydrogen electrolysers in the EU by 2030 (see recital (14)).

(505) Moreover, there is no risk of crowding out effects. Crowding out effects can occur when public sector spending reduces or eliminates private sector spending in a particular industry. Instead, Hy2Infra aspires to lay down the foundation for a hydrogen network in Europe, which in turn, will increase the reach of renewable hydrogen and encourage private investment.

(506) The Commission also assessed the risk of a subsidy race between Member States, which may arise in particular with respect to the choice of location pursuant to point 46 of the IPCEI Communication. It must be noted in this regard that the national calls launched for preselecting potential projects (see recital (2)), as well as the demonstration of an open procedure for Member States to participate in Hy2Infra (see recital (328)), have mitigated any such risk. It follows from the above that the open and non-discriminatory procedure designed by the notifying Member States for the preselection and final selection of the participating undertakings in Hy2Infra enabled all interested undertakings active in the relevant markets and segments thereof, to join the Hy2Infra IPCEI, thereby minimising any potential risk of competition distortions.

(507) Finally, the Commission notes that the participating Member States confirmed in their notifications that their respective aid measures are not conditional on the

relocation of a production activity or any other activity of the beneficiary from another Contracting Party to the EEA Agreement to the territory of the Member State granting the aid, pursuant to point 47 of the IPCEI Communication. Therefore, no harm to the internal market occurs in this regard.

(508) Following the assessment described above, the Commission has undertaken a balancing test to assess whether the expected positive effects of the aid outweigh its possible negative effects. The positive effects of the aid considered in the balancing test included concrete contributions of the individual projects under Hy2Infra to addressing well-defined market failures (see section 3.3.2.2.1.2), as well as the objectives of the common European interest (see recitals 3.3.2.2.1.1).

(509) The analysis of the detailed information available to the Commission, therefore, leads to the conclusion that the risks of foreclosure, dominance and overcapacity are likely to be outweighed by the positive effects of Hy2Infra (see recital (425)).

3.3.3.3. No breach of any relevant provision of Union law

(510) Under point 10(a) of the IPCEI Communication, aid shall not be granted to undertakings in difficulty as defined in the Guidelines on State aid for rescue and restructuring non-financial undertakings in difficulty.

(511) In addition, under point 10(b) of the IPCEI Communication, aid shall not be granted to undertakings that are subject to an outstanding recovery order, following a previous Commission decision declaring an aid illegal and incompatible with the internal market.

(512) Moreover, under point 10(c) of the IPCEI communication, State aid cannot be declared compatible with the internal market, if the supported activity, the aid measure, or the conditions attached to it entail a violation of relevant Union law ([121])

(513) The Commission examined these conditions and based on the information submitted by the participating Member States, the Commission has no reason to consider that Hy2Infra would involve aid to undertakings in difficulty (see recital (259)), or to undertakings that are subject to an outstanding recovery order (see recital (260)), or that it would involve any breach of Union law (see recital (261)).

(514) In light of the above, the Commission considers that Hy2Infra does not infringe relevant Union law, and that the conditions of points 10 (a), (b) and (c) of the IPCEI Communication are fulfilled.

3.3.3.4. Transparency

(515) The transparency requirements, specified in section 4.3 of the IPCEI Communication, are fulfilled (see recital (267)).

([121]) See also, judgement of 31 January 2023, European Commission v Anthony Braesch and Others, C-284/21 P, EU:C:2023:58, paragraph 96.

3.3.4. Conclusion on compatibility

(516) Based on the assessment under the IPCEI Communication, the Commission concludes that the notified aid measures are compatible with the internal market pursuant to Article 107(3), point (b) TFEU.

3.3.5. Reporting obligations

(517) According to point 52 of the IPCEI Communication the execution of the project must be subject to regular reporting.

(518) As notified by the participating Member States, the execution of Hy2Infra will be subject to annual reporting by the participating undertakings and the participating Member States. This reporting is three-fold:

- first, the participating undertakings will report annually the execution of their activities, as regards the advancements of their individual projects, the individually committed spillovers and the compliance with the DNSH principle to the national funding authorities. The reporting period will ideally reflect the participating **Member States' annual reporting obligation** towards the Commission;

- second, the participating Member States will provide a summary report on an annual basis about **the participating undertakings' execution of their** activities to the Commission. In accordance with the participating Member **States' notifications, a template will be created by the FG during its first** meeting and evaluated by the Commission. The reporting will be scheduled based on the annual FG meetings. A detailed description on the reporting mechanisms will be defined after the initial FG meeting, as well as the respective reporting period; and

- third, the SB, which has the role of supervising the monitoring and implementation of Hy2Infra as a whole (see recital (239)), will report to the Commission on an annual basis about the progress of Hy2Infra (including through KPIs) with respect to progress in Pillars 1 (deployment of clusters and their links) and 2 (interoperability, standards, operational rules and other WS specific objectives) as described in section 2.4.5.4. The reporting period should ideally follow the reporting of the participating Member States to the Commission.

(519) Further, the concerned Member States have agreed to report to the Commission on the application of the claw-back mechanism (see Annex I).

(520) The Commission therefore considers that the reporting obligation on the execution of Hy2Infra is fulfilled.

4. CONCLUSION

The Commission has accordingly decided not to raise objections to the State aid measures on the grounds that they are compatible with the internal market pursuant to Article 107(3), point (b) of the Treaty on the Functioning of the European Union.

If this letter contains confidential information which should not be disclosed to third parties, please inform the Commission within fifteen working days of the date of receipt. If the Commission does not receive a reasoned request by that deadline, you will be deemed to agree to the disclosure to third parties and to the publication of the full text of the letter in the authentic language on the Internet site: https://competition-cases.ec.europa.eu/search?caseInstrument=SA.

Your request should be sent electronically to the following address:

European Commission,
Directorate-General Competition
State Aid Greffe
B-1049 Brussels
mailto:Stateaidgreffe@ec.europa.eu

Yours faithfully,

For the Commission

Margrethe VESTAGER
Executive Vice-President

Annex I

Claw-back mechanism

1. A claw-back mechanism is introduced as an additional safeguard to ensure that the State aid remains proportionate and limited to the necessary and to ensure a balanced distribution of additional gains when a project is more profitable than forecasted in the notified funding gap analysis. In principle, the aid is capped in nominal terms by the notified and actual eligible costs. The Member State will also ensure that the value of the aid discounted to the year in which the first project-related cashflow occurs (using the notified WACC as a discount factor) does not exceed the notified funding gap. To reduce the risk of overcompensation in case of unexpected positive developments going beyond the current forecasts, the Member States committed to put in place a claw-back mechanism covering the entire lifetime of each participating project.

2. This claw-back mechanism applies to each project within Hy2Infra for the project's entire lifetime, i.e., the period for which financial projections were made in the notified funding gap analysis, and also takes into account the terminal value.

3. The application of the claw-back mechanism may end when a beneficiary has become subject to a regulatory framework, which excludes the emergence of surplus cash flows as admitted revenues are cost-reflective. In this case, the Member State has to request the end of the application of the claw-back mechanism to the European Commission services. The request has to be accompanied by an explanation of the regulatory framework coming into force, demonstrating that the emergence of surplus cash flows is excluded. The final secured amount, referred to in recital 12 below, will then be calculated at the moment the claw-back mechanism ceases to apply and has to be transferred to the Member State at that time.

4. The claw-back mechanism will entail a comparison of the project's negative and positive cash flows (including the actual State aid disbursements). The basis for such verification will be ex post figures, which have been subject to annual approval by an independent auditor. For this purpose, the beneficiary will be required to submit separate analytical accounting.

5. Every year, from the start of the project until the end of the project's lifetime ("end date" (122)), a surplus (denoted $Surplus_i$ for year i) will be computed. The $Surplus_i$ is calculated as the sum of the actual (positive or negative) *ex post* audited post-tax cash flows CF_k from the year of project start (s) to year "i", whereby the cash flows are interest-adjusted to year "i" (using the notified *WACC* as an interest-adjustment factor). The cash flows CF_k take into account all costs and revenues (123), all State aid

(122) "End date" is defined as the last year of the forecast period in the notified funding gap analysis. In the event of delays in the implementation of the individual projects compared to the notified schedule, the "end date" will be extended accordingly.

(123) Including additional revenues (for example relating to future sales of electrolysis by-products like oxygen and waste heat or remuneration for grid services, or free ETS allowances) and including additional cost savings or synergies (for example the use of waste heat from electrolysis in one of the company's other production processes if such waste heat previously had to be purchased from an

payments and any additional public financial contributions ([124]) in relation to the same eligible costs of the individual project, and exclude financing cash flows. ([125])

6. As a formula, the surplus would be represented as follows:

$$Surplus_i = \sum_{k=s}^{i} CF_k \times (1 + WACC)^{(i-k)}$$

7. For costs and revenues where a market price can be computed, evidence must be provided by the company to duly justify the gap between the market prices and the figures of the project if the ex post figures of the project, which have been subject to annual approval by an independent auditor, significantly differ from the market prices. Such evidence can be a long-term contract signed by the company earlier after a sourcing process transparent to the Member States authorities. In case of insufficient evidence, the relevant market prices must be used to compute the surplus of the project.

8. For sales to and purchases from related companies or partner companies (both according to EU definition ([126])), market prices should be used. In particular:
   - for hydrogen at least market prices have to be taken into account in the cash flow,
   - for the purchase of electricity, at most market prices for the purchase of electricity can be taken into account in the cash flow.

9. The market prices must be proven or justified by the beneficiary.

10. The claw-back mechanism only applies if the $Surplus_i$ is positive. The $Surplus_i$ will be multiplied by a repayment ratio (*RR*) of 70%. Thus, the potential clawback in year *i* is defined by:

$$= \max(RR \times Surplus_i; 0)$$

11. A letter of credit (by a reputable financial institution having investment grade rating from a first-rank rating agency) should cover the repayment obligation at the end of **the project's lifetime by the aid beneficiary, from the point on, when a surplus has** been established for the first time. ([127])

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external supplier, or the use of the supported equipment for other activities) that were not included in the notified funding gap analysis but which directly result from the individual project.

([124]) This includes any other public funding, irrespective of whether it qualifies as State aid or not.

([125]) The terminal value shall be accounted for in the post-tax cash flow of the last year of the forecast period in the notified funding gap analysis. In principle, it should be determined according to the method used in the notified funding gap analysis. In justified individual cases, another method may be chosen with the consent of the participating Member State. The terminal value has to be approved by an independent auditor. The terminal value shall not be negative.

([126]) As defined in Article 3 of Annex I of the Commission Regulation (EU) No 651/2014

([127]) Alternatively, the participating Member State may opt for an account-based system instead of the letter of credit system described above. This system will apply exclusively if the two following conditions are both met: a) the account to be used for the purpose of applying the claw-back mechanism is not under the control of the aid beneficiary; and b) computations and transfers to/from the account by the aid beneficiary must take place once every year until the end date.

12. The secured amount guaranteed by the above-mentioned letter of credit should be at least equal to an amount ensuring that the two following principles are fulfilled:
    1) The secured amount must never be negative (initial balance equal to zero);
    2) The amount secured must be equal to the lower of the following values each year if positive:
        - the $Clawback_i$ in year i;
        - the sum of the actual State aid disbursements between year of project start and year i minus repayments made. For all the disbursements SA and repayments (128) RP before year i, the interest-adjustment factor will be the notified WACC.

13. As a formula, the secured amount A_i should be at least equal to

$$A_i = \max\left[0; \min\left[Clawback_i; \sum_{k=s}^{i}(SA_k - RP_k) \times (1 + WACC)^{(i-k)}\right]\right].$$

14. An amount equal to the final secured amount has to be transferred to the Member **State following the last application at the end of the project's lifetime, or at the** moment when the claw-back mechanism ceases to apply (as approved by the European Commission services) if a beneficiary has become subject to a regulatory framework which excludes the emergence of surplus cash flows.

15. The application of the claw-back mechanism will be reported by the Member State to the European Commission by the end of September each year until the end of the **project's lifetime.**

(128) The beneficiary can make (partial) repayments to the relevant Member State at any time, which are taken into account when calculating the repayment obligation. Instead of a letter of credit, the beneficiary may also pay the amount to be secured to the relevant Member State. Grants repaid in this way cannot be granted again at a later stage.

Annex II

Standardisation gaps per workstream

Workstream 1

Topic identification in European Clean Hydrogen Alliance roadmap			WS1 information
contribution by	**issue / topic horizontal aspects**	**standardisation gap details / description**	**Project(s) available to respond to the relevant call for experts (yes/no)**
RT1 Production	Electrolyser	- control strategies for integrating electrolysers with intermittent renewable energies (mapping operational boundaries) - key performance indicators - electricity grid connection for ancillary services by electrolysers and regarding power quality requirements - standardisation (other than regulation on system operation at national level) of procedures for testing, inspection and certification of facilities and performance; Measurement and assessment of power quality characteristics of grid connected electrolysers; EU harmonised protocols for testing of low temperature water electrolysers, JRC 2021 - electrolyser - frequency, voltage control and other grid service requirements of grid operators – technical oriented - electrolyser - development of measurement methods and test procedures for electrolyser performance – single cells, stacks and systems testing protocols - electrolyser - development of measurement methods and test procedures for electrolyser performance dedicated to the needs of ancillary service requirements - Electrolyser – harmonisation of requirements	DE03, DE33, DE34, DE45, DE54, DE63, DE64,FR23, IT02, IT49, PL01, PL04, PT11
	Safety aspects	- gas grid connection devices & assemblies, materials, measurement equipment, operational issues, etc. - Compatibility of materials in devices and operational matters in both production and transmission systems (and also in the mixing station) must be considered, for hydrogen and natural gas requirements. - Requirements for design modular hydrogen systems - Gas detection and explosion risk assessment	FR23, IT49
	Electrolysers metrology	- electrolyser - development of measurement methods and test	DE63, DE38

		procedures for electrolyser performance – single cells, stacks and systems testing protocols	
	Sustainability and origin	environmental management for concrete and concrete structure; definition for calculation of efficiency, key performance indicators (KPI), GHG emissions, certification of origin	DE45
	Gas quality aspects	- Electrolyser - oxygen quality - Hydrogen and gas quality control and measurement methodologies. Purity of hydrogen. Impurities like inert gases Wobbe index from repurposed infrastructure - Material testing standards	DE63
RT2 T&D	Components/Equipment	- measuring systems (functional requirements) - steel pipe for pipeline transportation systems - compressors - safety shut-off devices - Pressure regulators for the use with hydrogen	IT02, DE64
	Gas quality aspects	- sensors for concentration monitoring H2 and H2NG - methodologies for analysis and measurement of impurities in Hydrogen, norms for quality of hydrogen to all utilization - adaptation of gas analysis methods – purity analysis and treatment of purity data - Standards for hydrogen purity and gas quality handling	DE54, IT49
	Gas/hydrogen infrastructure	- technical standards for infrastructure planning, infrastructure operation and infrastructure maintenance - standards needed for the handling of hydrogen and derivatives when injecting into the hydrogen grid to avoid issues at interconnection points	DE64, IT49, PL04
RT3 Industrial applications	Sustainability and Origin	- ammonia production metrology for determining GHG emissions	IT02, DE63
	Combustion quality aspects	- Rate of change of hydrogen content. - Flame temperatures. - Flame radiation. - Oxygen level in gas - adaptative combustion controls	PT11
	Energy/Hydrogen Carrier	Labelling of renewable/low-carbon ammonia	PT11
RT5 Energy	Safety aspects	- Explosion protection for plant - fire protection for plant - plant safety concept - plant ventilation concept - exhaust system and related equipment design for safe operation - purging concept - O&M guidelines - operation safety of compressors - machine room access control	DE32, DE64
	Power plants	- Plant certification	DE32, DE54

		- Plant safety concept	
RT6 Building – residential application	Gas quality aspects - purity	- Purity	DE54, DE64
RT 7 Cross-cutting	Energy carriers	- Standards for all possible modes of hydrogen transport/storage (carrier) to ensure clarity in this part of the value chain. - LOHC, LIHC - LH2 - gaseous hydrogen – others - Definition and standards for certifying low carbon and green hydrogen as well as liquid hydrogen - either as an end product or for logistics reasons	DE32, DE64, IT02, DE34, DE43A, PT11
	Safety aspects	-Basic safety levels and measures appropriate graded for users (risk assessment and safety requirements) for: 1.Process industry (large plants, specially trained personnel including hydrogen safety) 2.Commercial use (small plants, trained personnel without special knowledge of hydrogen) 3.Installations and facilities for public use (user without training and knowledge, children) - requirements for design modular hydrogen systems 1. Reliable interface functions between the modules, safety-related functions 2. Tightness of the interfaces 3. Decoupling concepts (see also Protective systems) 4. Concepts and requirements for exceeding critical thresholds (5 t or 50 t according to RL 2018/12/EU) - requirements for design and functioning of cyber security for hydrogen plants - requirements for dynamic operating regimes of electrolysis plants (Dynamic Mode Operation, DMO)	DE33, DE34, DE38, DE54, DE64, FR23, IT02, IT49
	Digitalisation and cyber security	- Sensor networks, digital certificates, machine readable certificates	DE43A, DE54, DE64
	Qualification and training	- Specific training and qualification for operation and maintenance of hydrogen related equipment. - training about the safety aspects of hydrogen/H2NG	DE33, DE54, DE64, FR23, IT49
	Sustainability and origin	- Definition of standards for certifying hydrogen following its carbon intensity - emission factors for carbon footprint calculation / GHG emission savings increasing transparency and comparability for hydrogen production technologies - standards for guarantees of origin and Certificates - definition of production system boundaries, including electrolysers and other technologies of production of hydrogen and other equipment (BOP) as basis for efficiency calculation and key performance indicators (KPI) and also all emissions (scope 1-4) and impact	FR23, IT02, IT49, PL01, DE33, DE64

		categories attributable to upstream, for the purposes of certification of origin - guarantee of origin of hydrogen and its blends with natural gas or biomethane - benchmark system for different types of low carbon H2 production based on emissions - carbon footprint benchmarks. Technologies for production of low-carbon hydrogen production and co-production: fossil with CCS, waste to hydrogen, a.o.	
	Safety aspects - leakage	- leakage related safety risks (safety, leakage related hydrogen characteristics) - large H2 releases - leakage related safety risks (safety, leakage related hydrogen characteristics) - validation models	DE38, DE64

Workstream 2

Topic identification in European Clean Hydrogen Alliance roadmap			**WS 2 information**
contribution by	**issue / topic horizontal aspects**	**standardisation gap details / description**	**Project(s) available to respond to the relevant call for experts (yes/no)**
RT1 Production	Gas/hydrogen infrastructure	Material testing standards	SK04
	Safety aspects	- Gas grid connection devices & assemblies, materials, measurement equipment, operational issues, etc. - Compatibility of materials in devices and operational matters in both production and transmission systems (and also in the mixing station) must be considered, for hydrogen and natural gas requirements.	IT21
RT2 T&D	Gas quality aspects	- Hydrogen quality in pipelines - Adaptation of gas analysis methods - purity analysis and treatment of purity data - H2 quality in industry - Standards for hydrogen purity and gas quality handling - Need for standardised hydrogen quality in (transmission and distribution) pipelines	DE07, DE23, DE26
	Gas/hydrogen infrastructure	- Pressure regulation stations (Functional requirements) - Safety Management System (SMS) and Pipeline Integrity Management System (PIMS) for hydrogen and gas infrastructure - Transmission pipelines for maximum operating pressure over 16 bar including non-metallic pipelines and including or complemented by the method of conformity assessment for Hydrogen service.	DE23, DE29, DE49, DE56, DE61, DE71, IT21, SK04

		- welding of steel pipework used for hydrogen and its blends with natural gas. - welding of steel pipework used for hydrogen - hydrogen injection facilities - installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations [EN 15001-1/-2] - standards and technical rules linked to retrofitting/blending and repurposing of new pipelines, underground gas storages and LNG terminals - technical standards for infrastructure planning, infrastructure operation and infrastructure maintenance - Materials for metallic industrial piping used for hydrogen and its blends with natural gas, particulary the related requirements of prevention of brittle fracture at low temperatures and including the evaluation of compliance for hydrogen service of the existing or new pressure equipment and links for the selection of proper material testing standards for hydrogen service. This standard should be updated to include non-metallic pipes.	
	Components/equipment	- pressure regulators up to 100 bar for the use with hydrogen and its blends with natural gas/biomethane - Measuring systems (functional requirements) - Equipment and devices installed in the gas chain – pipeline valves - Pressure regulators for the use with hydrogen	DE23, DE29, DE61, DE71, IT21
	Components/equipment gas measurement	- measuring systems (functional requirements)	DE26, DE49, DE56, DE61, DE71
	Components/equipment - pipes	- steel pipe for pipeline transportation systems	DE61, DE71, IT21
	Components/equipment – safety aspects	- Safety shut-off devices	DE61, DE71
	Components/equipment - valves	- performance requirements and tests for valves for hydrogen/gas transportation in pipelines	DE61, DE71, IT21
	Safety aspects – material compatibility	- Suitability assessment of the existing gas infrastructure for hydrogen - grid corrosion	DE26, DE49, DE56, DE61, DE71, IT21
	Safety aspects	- grid corrosion - corrosion of metals and alloys - sealings and connections in piping systems [EN 549]	IT21
RT4 Mobility	Road vehicles Installation Safety heavy duty / road vehicles - installation - safety	sensors for leak detection of H2 and H2NG	IT21

RT5 Energy	Gas/hydrogen infrastructure	design and stress calculation of the line pipe containing pure Hydrogen or H2NG blend [EN 1594]	IT21, SK04
RT7 cross-cutting	Safety aspects - leakage	leakage related safety risks (safety, leakage related hydrogen characteristics) - validation models	IT21

Workstream 3

Topic identification in European Clean Hydrogen Alliance roadmap			**WS3 information**
contribution by	**issue / topic horizontal aspects**	**standardisation gap details / description**	**Project(s) available to respond to the relevant call for experts (yes/no)**
RT2 T&D	Gas quality aspects	- Standards for hydrogen purity and gas quality handling - Adaptation of gas analysis methods - purity - Analysis and treatment of purity data.	DE24, DE43B
	Gas quality aspects - purity	- hydrogen quality in pipelines - Purification of hydrogen fuel gases divers aspects e.g. pressure swing absorption - Standards for hydrogen purity and gas quality handling, including blending	PL04, DE24
	Gas/Hydrogen infrastructure	- Standards and technical rules linked to retrofitting / blending and repurposing of new pipelines, underground gas storages and LNG terminals - Pressure regulation stations (Functional requirements) - Technical standards for infrastructure planning, infrastructure operation and infrastructure maintenance - Storage in solution-mined salt cavities including methodology for analyzing the interactions between H2 and the salt cavern, the effects of the pressure variations and leak - Underground storage surface facilities including requirements for each type of components: piping, valves, burners, compressors, treatment technology - pressure testing, commissioning ad decommissioning of hydrogen/gas network – Compressor stations (de-sign, con-struction, operation of new stations) – Safety Management System (SMS) and Pipeline Integrity Management System (PIMS) for hydrogen/gas infrastructure	DE18, DE43B, DE24
	Gas/Hydrogen infrastructure - storage	- storage in solution-mined salt cavities including methodology for analyzing the	DE18, PL04

		interactions between H2 and the salt cavern, the effects of the pressure variations and leak - underground storage surface facilities including requirements for each type of components: piping, valves, burners, compressors, treatment technology	
	Components/equipment – pressure regulators	Pressure regulators for the use with hydrogen and its blends with natural gas/biomethane Components are regularly available, but dimensions for using in H2 underground storage facilities are different in pressure and size.	DE24
	components/ equipment - compressors	Compressors for serval hydrogen applications are regularly available, but dimensions (pressure/size) and operational aspects (range of control and suction/discharge pressures, dynamic operation) for use in H2 underground storage facilities are different.	DE24
	Components/equipment – gas measurement	- Measuring systems (functional requirements)	PL04, DE24
	gas/hydrogen infrastructure - hydrogen storage	Missing construction/building norms for H2 storage in gaseous and liquid form.	DE24
	gas/hydrogen infrastructure - storage	Storage in solution-mined salt cavities including methodology for analyzing the interactions between H2 and the salt cavern, the effects of the pressure variations and leak.	DE24
	safety aspects	Equipment and devices installed in the gas chain - Safety devices for protection against excessive pressure.	DE24
	safety aspects - material compatibility	- Grid corrosion - Sealings and connections in piping systems	DE24
	Components/equipment - valves	- Equipment and devices installed in the gas chain - pipeline valves	PL04, DE24
	Gas/Hydrogen infrastructure	- Underground storage surface facilities including requirements for each type of components: piping, valves, burners, compressors, treatment technology	DE43B
RT5 Energy	Storage - pressure vessels - safety aspects	- design, stress calculation, material selection of pressure vessels and material testing of station piping system (underground storage)	DE18
	qualification and training	Specific training and qualification for operation and maintenance of hydrogen related equipment.	DE24
	safety aspects	Create public acceptance.	DE24

	safety aspects - leakage	Leakage related safety risks (safety, leakage related hydrogen characteristics) - large H2 releases.	DE24
	Safety aspects - potential explosive atmosphere	- A special risk assessment procedure for assemblies like compressors intended for use in hydrogen applications.	DE24
	Energy/Hydrogen Carrier	- Definition and standards for certifying low carbon and green hydrogen as well as liquid hydrogen - either as an end product or for logistics reasons.	DE43B
	hydrogen production - safety aspects	Requirements for design and functioning of cyber security for hydrogen plants. Storage-sites for natural gas have to fulfill the regerminations for critical infrastructure for the OT-installations. No standards/thresholds are given up to know for hydrogen storages	DE24

Workstream 4

Topic identification in European Clean Hydrogen Alliance roadmap			**WS4 information**
contribution by	**issue / topic horizontal aspects**	**standardisation gap details / description**	**Project(s) available to respond to the relevant call for experts (yes/no)**
RT2 T&D	Gas quality aspects	Standards for hydrogen purity and gas quality handling, including blending	DE59, NL57
RT4 Mobility	Heavy duty / road vehicles – safety aspects – leakage	Safety topics for the use of alternative hydrogen carriers e.g. LOHC or metal hydride	DE59, NL57
	Sustainability and origin-emissions / GHG-energy / hydrogen carriers	Missing well-to-wheel standard for GHG emissions measurement - ISO TS 19870 is a new GHG methodology standard for H2 currently under development	DE59, NL57
	Maritime – energy / hydrogen carrier	Safety of LOHC in maritime transport, storage and use	DE59, NL57
RT7 Cross-cutting	Energy / hydrogen carrier	- Quality of LOHCs reliable operation of the plants - purity of LOHC - Standards for all possible modes of hydrogen transport/storage (carrier) to ensure clarity in this part of the value chain.	DE59, NL57
	Qualification and training	Training about the safety aspects of hydrogen/H2NG	DE59, NL57
	Metrology	Adaptation of gas analysis methods – reference conditions	DE59, NL57
	Metrology - certification	Energy content and metering of hydrogen in LOHC	DE59, NL57
	Sustainability and origin	Definition / role for LOHC under Guarantees of Origin scheme need to be defined in EN 16325	DE59, NL57
	Terminology / definitions	Definition of the term and use of LOHC	DE59, NL57