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Issues Impacting the Future of Hydrogen

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PART I - INTRODUCTION

Climate change and environmental considerations are at the top of the European political agenda. A key demonstration of this was the December 2019 unveiling by European Commission (Commission) President Ursula Von der Leyen of the European Green Deal¹ (Green Deal) in her first 10 days in office. The Green Deal is Europe's strategy towards achieving carbon neutrality² by 2050. The plan integrates a variety of medium- and long-term policies designed to make Europe a global climate leader, support the transition for regions reliant on fossil fuels, and relaunch investments and competitiveness in the bloc. Following that announcement, the Commission launched its ambitious Hydrogen Strategy on 8 July 2020. Taken together, the Green Deal and the Hydrogen Strategy set Europe on a path to be a global leader in the development of a hydrogen economy.

¹ European Commission (2019), "The European Green Deal," Communication from the Commission to the European Parliament and the European Council, COM (2019) 640 final, Brussels, available at https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf.

² In other parts of the text, it can appear as climate neutrality. Climate neutrality can be achieved if CO₂ emissions are reduced to a minimum and all remaining CO₂ emissions are offset with climate protection measures.

I. Hydrogen in Light of the Green Deal

Taking into account the Green Deal's overarching objectives, it is clear that the energy industry will play a pivotal role in the EU's transition to climate neutrality. The energy industry can contribute significantly to reducing greenhouse gas emissions to ensure a sustainable future for the next generation. Importantly, Europe sees hydrogen as one of the top priorities in its energy transition.

Currently, hydrogen is mostly produced from fossil fuels such as gas and coal and is used to generate industrial heat or as feedstock, resulting in the release of 70 to 100 million tonnes CO₂ annually in the European Union. Against this backdrop, the EU hydrogen strategy has called renewable the “most compatible option with the EU's climate neutrality goal in the long term,” as it is produced using mainly wind and solar energy.

II. Five Key Planks of the Green Deal

Five key planks of the Green Deal could facilitate hydrogen's potential in Europe's decarbonization:

A. The Strategy for Energy System Integration³

The Strategy for Energy System Integration creates better links in the EU's energy system across different sectors like gas, electricity, transport, buildings,

and industry through (1) electrification; (2) greater use of renewable and decarbonized gases and fuels; and (3) a more circular energy system, in order to accelerate the decarbonization of harder-to-abate sectors, such as transport, buildings, parts of industry, and agriculture. Importantly, the strategy will allow new low-carbon energy carriers, such as green hydrogen, to emerge and facilitate the progressive decarbonization of the economy, including the gas sector. This is because green hydrogen can be used in areas where higher costs may prevent direct heating or electrification.

Moreover, the strategy also facilitates carbon capture, storage, and use, for two reasons: (1) the inability even in an integrated energy system to completely eliminate CO₂ emissions from all parts of the economy; and (2) the fact that there will not be adequate volumes of green hydrogen produced to meet the growing demand.

To this end, the strategy highlights the role of hydrogen in an integrated energy system. Hydrogen infrastructure can help integrate large shares of variable renewable generation by offloading grids in times of abundant supply and providing long-duration storage to the energy system. Overall, the strategy emphasizes that setting an efficient policy framework around green hydrogen is central to the Hydrogen Strategy (discussed below), which it complements.

³ European Commission (2020), “Powering a climate-neutral economy: An EU Strategy for Energy System Integration,” Communication from the Commission to the European Parliament and the European Council, COM (2020) 299 final, Brussels, available at https://ec.europa.eu/energy/sites/ener/files/energy_system_integration_strategy_.pdf.

B. The Industrial Strategy⁴

The Industrial Strategy sets a goal to mobilize industry for a clean and circular economy. The Green Deal underlines the critical role emerging technologies play in achieving its ambitious 2050 decarbonization target. These technologies include clean hydrogen, carbon capture and storage, fuel cell, energy storage, and alternative fuels. The Industrial Strategy notes that Europe needs “climate and resource frontrunners” to develop the first commercial applications of these types of breakthrough technologies in key industrial sectors by 2030. Importantly, it also announced the development of the European Clean Hydrogen Alliance, which will bring together stakeholders and identify technology needs, investment opportunities, regulatory barriers, and enablers to build a clean hydrogen ecosystem in the European Union.

C. A Potential Carbon Border Adjustment Mechanism

In the context of the Green Deal, strict climate policies on the reduction of carbon emissions can cause a significant increase in carbon prices and lead to carbon leakage. This occurs when production is transferred from the European Union to other countries with lower goals for emissions reduction or when EU products are replaced by more carbon-intensive imports. To this end,

the Green Deal puts forward a carbon border adjustment mechanism (CBAM) for selected sectors to reduce the risk of carbon leakage if differences persist in levels of commitment by non-EU nations to reduce carbon emissions. This would ensure that the price of imports reflects more accurately their carbon content and that non-EU companies importing goods into the European Union face the same costs of emissions as their European counterparts. In fact, the Commission⁵ is currently consulting on a CBAM that can take the form of: (1) a carbon tax on selected products applicable on both imported and domestically produced products; (2) a new carbon customs duty or a tax on imports; or (3) the extension of the EU Emissions Trading Scheme (EU ETS) to imports. In particular, the Commission will evaluate whether the CBAM is complementary with the EU ETS. This stresses that any new measure should be in line with the internal EU carbon price. Concerning hydrogen in particular, the Hydrogen Strategy (discussed below) points out the need to provide incentives to produce green hydrogen, while taking into account the risk for carbon leakage for hydrogen production and industries using hydrogen. Even though this risk could be tackled by reducing the price difference between grey and green hydrogen, the Commission reiterates its commitment to propose a CBAM in 2021, with the view of potential implementation in 2023.

⁴ European Commission (2020), “A New Industrial Strategy for Europe,” Communication from the Commission to the European Parliament and the European Council, COM (2020) 102 final, Brussels, available at https://ec.europa.eu/info/sites/info/files/communication-eu-industrial-strategy-march-2020_en.pdf.

⁵ European Commission (2020), “Carbon border adjustment mechanism Inception Impact Assessment,” Ref. Ares (2020)1350037, Brussels, available at <https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12228-Carbon-Border-Adjustment-Mechanism>.

D. The Forthcoming Offshore Renewable Energy Strategy⁶

Europe has considerable offshore renewable energy potential (more than 250 gigawatt (GW) of installed offshore wind anticipated by 2050) and covers the North Sea, Baltic Sea, Black Sea, Mediterranean Sea, and the Atlantic Ocean. Notably, offshore renewable energy can be used to produce green hydrogen via electrolyzers in a comprehensive, integrated, and cost-efficient manner. Moreover, hydrogen can be used to facilitate long-duration storage for otherwise renewable resources.

E. The Circular Economy Action Plan⁷

The production of hydrogen from renewable or low-carbon sources requires a large amount of raw materials. The Circular Economy Action Plan (Action Plan) prioritizes reducing Europe's dependency on foreign materials by preventing waste, increasing recycling, and using secondary raw materials. The Action Plan, inter alia, envisages the uptake of material resources from recycled products and recovered materials, thus saving primary raw materials from being extracted. Taking into account Europe's dependence on raw materials imports, securing these materials for the production of low-carbon innovations should be looked at both in light of the circular economy and the upcoming Action Plan on Critical Raw Materials.



⁶ European Commission (2020), "Offshore Renewable Energy Strategy Roadmap," Ref. Ares (2020)3757650, Brussels, available at <https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12517-Offshore-renewable-energy-strategy>.

⁷ European Commission (2020), "Circular Economy Action Plan," Brussels, available at https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf.

PART II - THE COMMISSION'S DEDICATED HYDROGEN STRATEGY

Hydrogen is not only an intrinsic element in Europe's decarbonization journey, but can also account for 24 percent of final energy demand and 5.4 million jobs by 2050.⁸ In other words, hydrogen is a green growth engine, which has the potential to transform how the European Union generates, distributes, stores, and consumes energy. On 8 July 2020, the Commission launched its Hydrogen Strategy⁹ with the goal of creating a full-fledged hydrogen ecosystem in the European Union.

⁸ Fuel Cells and Hydrogen 2 Joint Undertaking, (2019), "Hydrogen Roadmap Europe: A sustainable pathway for the European Energy Transition," Brussels.

⁹ European Commission (2020), "A hydrogen strategy for a climate-neutral Europe," Communication from the Commission to the European Parliament and the European Council, COM (2020) 301 final, Brussels, available at https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf.

The Commission takes the view that Europe needs the Hydrogen Strategy because:

- Hydrogen accounts for less than 2 percent of Europe's energy consumption and is still largely produced from fossil fuels.
- The production of green hydrogen is still considerably more expensive than the conventional highly carbon-intensive methods. In fact, conversion of renewable electricity to hydrogen is currently not as efficient as direct consumption of renewable electricity.
- There are barriers such as lack of production, infrastructure, high cost, and low efficiency hindering the development of a hydrogen ecosystem.
- An effective instrument is needed to avoid the risk of uncoordinated action by member states' fragmented regulatory approaches and industry initiatives towards hydrogen.



PART III -

THE TIMELINE OF

HYDROGEN DEPLOYMENT

The priority for the European Union is to develop hydrogen production from renewable electricity, which aligns with its zero-carbon footprint target.

Green hydrogen is produced using renewable sources of energy. Blue hydrogen is produced from fossil fuels where greenhouse gas emissions from the production process are captured. The Commission acknowledges that green and blue hydrogen are not as competitive as grey hydrogen, which is produced from fossil fuels but without any capture of greenhouse gas emissions.¹⁰

The Commission's ultimate goal is the development of green hydrogen, while it expects that both green and blue hydrogen will be cost-competitive against grey hydrogen from 2030. The Commission acknowledges that other forms of low-carbon hydrogen, such as blue hydrogen, are needed in the short to medium term, primarily to rapidly reduce emissions from existing grey

and blue hydrogen production and to support the parallel and future uptake of green hydrogen.

Therefore, the Commission underscores that the hydrogen ecosystem will be developed gradually across the European Union and foresees three main phases:

I. Phase 1 (2020–2024)

The strategic objective is the decarbonization of existing hydrogen production. This translates into the installation of at least 6 GW of green hydrogen electrolyzers, the production of up to 1 million tonnes of green hydrogen, and the retrofitting of existing hydrogen production plants with carbon capture and storage technologies. Because the Hydrogen Strategy envisions that these electrolyzers would ideally be powered directly from local renewable electricity sources, local production will hold a key role. The policy focus is to establish a well-functioning regulatory framework for hydrogen and appropriate state aid rules to incentivize both supply and demand.

¹⁰ Idem.



II. Phase 2 (2025–2030)

Hydrogen use will be expanded to new industrial applications, including steel making, trucks, rail, and some maritime transport. The Hydrogen Strategy provides for the installation of at least 40 GW of green hydrogen electrolyzers by 2030 and the production of up to 10 million tonnes of green hydrogen in the European Union. The ultimate objective of this period is to develop large logistical infrastructure and international trade.

III. Phase 3 (2030–2050)

The Commission envisages a mature and cost-competitive hydrogen ecosystem. At this stage, green hydrogen technologies should be deployed at large scale to reach difficult sectors, including those more challenged to decarbonize. In this phase, hydrogen and hydrogen-derived synthetic fuels can be used as an alternative fuel for a wider range of sectors such as aviation and shipping.

PART IV –

THE MAIN PILLARS OF THE EU HYDROGEN STRATEGY

I. A Strong Hydrogen Investment Agenda

To help deliver its ambitious hydrogen roadmap, the Commission has put forward the following initiatives.

A. The European Clean Hydrogen Alliance¹¹

The European Clean Hydrogen Alliance (Alliance) is a public-private partnership that aims to (1) contribute to the deployment of green and low-carbon hydrogen in terms of supply, demand, and distribution; and (2) build up a clear pipeline of viable investment projects along the hydrogen value chain, which will be structured around six industrial pillars (hydrogen production, transmission distribution, the energy sector, industrial applications, mobility, and residential applications). On a practical level, the Alliance will deliver 6 GW of green hydrogen electrolyzer

capacity by 2024 and 40 GW of green hydrogen electrolyzers by 2030. It is worth noting that the estimated costs to achieve the 2024 target range between €5 and €9 billion, while the 2030 target will cost between €26 and €44 billion.¹²

B. The Sustainable Finance Regulatory Framework

The renewed sustainable finance strategy to be adopted by the end of 2020 and the EU sustainable finance taxonomy will guide investments in hydrogen across key economic sectors by promoting carbon-neutral activities and projects.

C. COVID-19 Recovery Instruments

In light of COVID-19, the European Union has reshaped parts of the European Green Deal into a recovery package, with significant support for hydrogen. More concretely, the Hydrogen Strategy asserts that investments will be supported through (1) the ReactEU instrument of €47.5 billion, a top up to the broader cohesion policy for the years 2020–2022;

¹¹ European Clean Hydrogen Alliance Declaration (2020), available at <https://ec.europa.eu/docsroom/documents/42603>.

¹² European Clean Hydrogen Alliance Factsheet (2020), available at https://ec.europa.eu/commission/presscorner/detail/en/fs_20_1297.

(2) the Strategic European Investment Window of InvestEU¹³; and (3) the ETS Innovation Fund, which for the period 2020-2030 may amount to about EUR 10 billion, depending on the carbon price.¹⁴

D. The Strategic Forum for Important Projects of Common European Interest (Strategic Forum)

Important Projects of Common European Interest (IPCEIs) comprise innovative research projects that often entail significant risks and require joint, well-coordinated efforts and transnational investments by public authorities and industries from several member states. The Strategic Forum will be tasked with the identification of cross-border hydrogen projects that may benefit from state aid. Furthermore, the Hydrogen Strategy underlines that the Alliance will simultaneously facilitate cooperation in a range of hydrogen-related IPCEIs.

The Hydrogen Strategy Investment Agenda	
Investment Areas	Estimated Costs (based on the Hydrogen Strategy figures)
Scaling up solar and wind energy production capacity to the electrolyzers to 80–120 GW	€220 billion to €340 billion by 2030
Investments in retrofitting half of the existing plants with carbon capture and storage	Around €11 billion
Investments in electrolyzers	€24 billion to €42 billion by 2030
Development of hydrogen transport, distribution and storage, and refueling stations	€65 million
Investments in hydrogen production capacities	€180 billion to €470 billion by 2050
Transformation of an end-use sector, transport	400 small-scale hydrogen-refueling stations could require between €850 million and €1 billion

¹³ The new strategic European investment window will focus on building stronger European value chains in line with the strategic agenda of the European Union and the New Industrial Strategy for Europe, as well as supporting activities in critical infrastructure and technologies.

¹⁴ European Commission, ETS Innovation Fund, available at https://ec.europa.eu/clima/policies/innovation-fund_en.

II. Scaling Up Production and Boosting Demand

The Commission acknowledges that kicking off the hydrogen market requires a full value chain approach to ensure cost-competitive hydrogen production. Currently, the costs of fossil-based hydrogen are estimated to be around €1.5 per kg, while the costs for green hydrogen vary between €2.5 and €5.5 per kg. Indeed, costs for green hydrogen are rapidly decreasing. Electrolyzer costs have already been reduced by 60 percent in the past 10 years and are predicted to decline from €900/KW to €450/KW or less in the period after 2030, and €180/KW after 2040. In this regard, the Hydrogen Strategy will focus on the following areas.

A. Strengthening the EU ETS

The EU ETS is a “cap and trade” system, which works by capping overall greenhouse gas emissions of all participants in the system. The EU ETS legislation creates allowances, which are essentially rights to emit these emissions equivalent to the global warming potential of 1 tonne of CO₂ equivalent. In line with this, based on a benchmarking approach, it allocates some free allowances. In other words, purchasing allowances is contingent on whether there is a gap between a company’s free allocation and its measured emissions.

- Hydrogen production falls under the scope of the EU ETS, which means

that hydrogen producers should purchase allowances for each ton of CO₂ emitted.

- Hydrogen producers of clean hydrogen will purchase less quotas as its production emits significantly less CO₂.
- A potential extension of the EU ETS scope to the aviation and maritime sectors can incentivize cost-effective decarbonization in all its covered sectors through carbon pricing.
- In the upcoming revision of the EU ETS, the Commission may consider how the production of green and low-carbon hydrogen could be further enhanced while taking due account of the risk for sectors exposed to carbon leakage.

B. The Revision of the State Aid Framework

The state aid guidelines for energy and environmental protection, predicted to be revised in 2021, will enable decarbonization. These guidelines will include hydrogen.

C. Market and Carbon Contracts for Difference

The main barrier for large blue and green hydrogen production is that currently markets are not willing to pay the higher production cost of very low-carbon materials. In Europe, the EU ETS carbon price is considerably low to permit these technologies to compete with cheaper “high carbon” alternatives.¹⁵

¹⁵ Sustainable Development and International Relations, SciencesPo (2019), “How Carbon Contracts-for-Difference could help bring breakthrough technologies to market,” Oliver Sartor, Chris Bataille, available at [https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue Iddri/Etude/201910-STO619-CCfDs_0.pdf](https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue%20IdDri/Etude/201910-STO619-CCfDs_0.pdf).

To increase the production of green and blue hydrogen, the Hydrogen Strategy sets forth a tendering system of carbon contracts for difference (CCfD) providing investment or operating aid. Carbon contracts for difference would pay hydrogen projects the difference between the price of an EU carbon permit and the actual cost of reducing CO₂. In essence, they provide investors with a strike price (also known as a fixed price) for emissions reductions compared to grey hydrogen. These contracts can contribute substantially to the decarbonization of the industrial sector, without having to wait, until the European Union accepts much higher EU ETS carbon prices or international carbon border adjustments are implemented.¹⁶ Importantly, the Commission envisages the application of a pilot scheme for CCfD to (1) accelerate the replacement of existing hydrogen production in refineries and fertilizer production, low carbon, circular steel, and basic chemicals; (2) support the deployment in the maritime sector of hydrogen and derived fuels such as ammonia; and (3) assist the deployment of synthetic low-carbon fuels in aviation.

The Commission emphasizes that measures to promote the use of hydrogen should also target the demand side. It is estimated that clean hydrogen could meet 24 percent of global energy demand by 2050, with annual sales in the range of €630 billion.¹⁷ To this end, the Hydrogen Strategy indicates

that two particular sectors (industrial applications and transportation) can play an important role in scaling up the production of hydrogen.

Nevertheless, the Commission notes that the higher costs of hydrogen technologies are a key limiting factor for the use of hydrogen in industrial applications and transport. Carbon prices in the range of €55 to €90 per tonne of CO₂ would be needed to make fossil-based hydrogen with carbon capture competitive vis-à-vis fossil-based hydrogen currently used.^{18,19} For this reason, the Commission suggests the introduction of quotas and minimum shares as mechanisms to stimulate hydrogen demand in a targeted way.

Hydrogen presents significant potential to be used as a fuel in the transport sector (such as local city buses, taxis, specific parts of the rail network, and heavy-duty road vehicles). In the longer-term, it can help in the decarbonization of the aviation and maritime sector, through the production of liquid synthetic kerosene or other synthetic fuels. In the industrial sector, it can reduce and replace the use of carbon-intensive hydrogen in refineries, the production of ammonia, for new forms of methanol production, or to partially replace fossil fuels in the production of steel.

In light of the above, the Hydrogen Strategy emphasizes the importance of creating a taxonomy, which will provide clarity and certainty on (1) the hydrogen

¹⁶ Idem.

¹⁷ See note 8.

¹⁸ Idem. It refers to fossil-based hydrogen produced through a variety of processes using fossil fuels as feedstock, mainly the reforming of natural gas or the gasification of coal. This represents the bulk of hydrogen produced today.

¹⁹ Idem.

production technologies that need to be developed in Europe; and (2) the definition and categorization of green and blue hydrogen. This explanatory framework can be set out in either the Renewable Energy Directive or the EU ETS Directive and will consist of the following:

- A common low-carbon threshold/standard for the promotion of hydrogen production installations based on their full life-cycle greenhouse gas performance.
 - A comprehensive terminology and European-wide criteria for the certification of green and low-carbon hydrogen. One way to determine hydrogen's contribution in the decarbonization of the energy system is via Guarantees of Origin (GO), a credit-based chain-of-custody system that enables consumers to know what percentage of their energy supply comes from renewables. GOs are already widely used to guarantee that the source of electricity is renewable.
 - » The legislative framework upon which hydrogen standardization will be based is the Renewable Energy Directive, which extended the scope of GOs to hydrogen.
 - » The Renewable Energy Directive stipulates that the greenhouse gas emission savings from the use of renewable liquid and gaseous
- transport fuels of non-biological origin excluding recycled carbon fuels shall be at least 70 percent as of 1 January 2021.
 - » At this stage, the Hydrogen Strategy leaves many open questions around the development of a hydrogen GO scheme, such as (1) the type and origin of the gas, including hydrogen; (2) the system for generating, auditing, tracking, and exchanging GOs; and (3) how it will fit in a nascent hydrogen market.
 - » In this vein, the Council of the European Energy Regulators emphasized that pursuant to the Renewable Energy Directive's definition of a "renewable energy source," decarbonized gases (such as hydrogen) that are derived from natural gas through steam methane reforming or thermal methane pyrolysis "would not be considered as renewable gas but could be included in the national GOs systems as decarbonized gas, thereby making transparent to gas customers the low-carbon nature of this gas."²⁰
 - » In Europe, there are already some hydrogen certification schemes in place, such as CertiHy²¹ and ERGaR.²²

²⁰ Council of European Energy Regulators (2019), "Regulatory Challenges for a Sustainable Gas Sector," Public Consultation Paper, Ref: C18-RGS-03-03, available at <https://www.ceer.eu/documents/104400/-/-/274b3146-afb5-8c96-436e-4056f3636b31>.

²¹ CertiHY, available at <https://www.certifyhy.eu/>.

²² See: <https://www.entsog.eu/certification-green-gases/>; and <http://www.ergar.org/>.



- » The Commission is expected to present a methodology to better account for the share of renewable electricity used in hydrogen production using equipment connected to the grid by 31 December 2021.

III. Designing an Infrastructure Framework and Market Rules

Meeting the increased supply and demand needs for hydrogen in the near term requires an efficient energy infrastructure. Hydrogen can be transported via pipelines, but also via non-network-based transport options such as trucks or ships. In this regard, the increase of the availability of energy

infrastructure at a regional, local, and supranational level to satisfy the demand for hydrogen can be achieved through the following options.

A. Review of the Trans-European Networks for Energy (TEN-E) Regulation²³

The recast framework will foster the deployment of innovative technologies and infrastructure, such as smart grids, hydrogen networks or carbon capture, storage and utilization, and energy storage, also enabling sector integration. The Commission also contemplates the review of the Trans-European Transport Network²⁴ (TEN-T), which will contribute to meeting the transport demands through a network of fueling stations.

²³ The TEN-E Regulation identifies priority corridors and thematic areas of trans-European energy infrastructure and provides guidelines for the selection of Projects of Common Interest (PCIs). The main objective of this assignment was to provide an independent evaluation of the TEN-E Regulation and PCI framework. The evaluation focused on the distinct assessment criteria and evaluation questions and provided evidence especially in those aspects in which the PCI framework had not been delivering as expected.

²⁴ The TEN-T policy addresses the implementation and development of a Europe-wide network of railway lines, roads, inland waterways, maritime shipping routes, ports, airports, and railroad terminals. https://ec.europa.eu/transport/themes/infrastructure/ten-t_en.

B. Use of Existing Gas Transportation Systems to Transport Hydrogen

Taking into account that demand for natural gas will decline after 2030, repurposing may provide an opportunity for a cost-effective energy transition in combination with the newly built, hydrogen-dedicated infrastructure. For instance, the Hydrogen Strategy mentions that a hydrogen network in Germany and the Netherlands may consist of up to 90 percent of repurposed natural gas infrastructure. However, the key challenge of repurposing natural gas pipelines lies in the fact that existing pipelines are owned by network operators that may not be allowed to own, operate, and finance hydrogen pipelines. To this end, the Commission recommends the review of the internal gas market legislation for competitive decarbonized gas markets, integrating two main objectives: (1) facilitating third-party access to liquid markets on a nondiscriminatory basis for new producers and customers; and (2) removing barriers for efficient hydrogen infrastructure development (via repurposing of pipelines).

C. Blending of Hydrogen in the Natural Gas Network

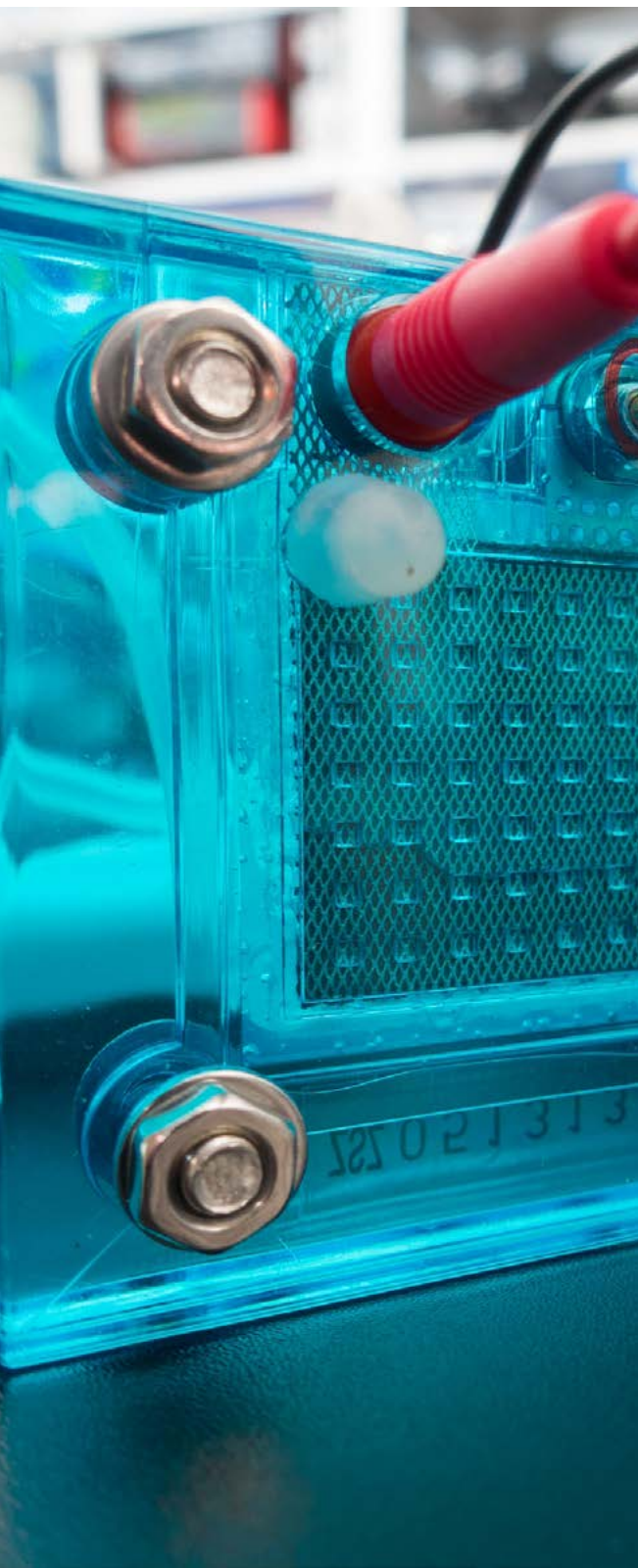
The Commission indicates that blending of hydrogen into natural gas pipelines at a limited percentage may enable decentralized green hydrogen production in local networks in a transitional phase. However, the Commission also notes that it may be less efficient and diminishes the value of hydrogen. It also can cause differentiation in gas quality in the internal European natural gas market,

particularly if neighboring member states accept different levels of blending and cross-border flows are hindered.

IV. Promoting Research and Innovation

The Hydrogen Strategy recognizes that ensuring a full hydrogen supply chain demands further research and innovation. Even though Europe has been undertaking research efforts for many years, decarbonization calls for hydrogen deployment at large scale. The Hydrogen Strategy provides for the following:

- Scaling-up of larger size and more efficient production capacities. As a first step, a call for proposals for a 100 MW electrolyzer will be launched in Q3 2020.
- Support for large-scale, high-impact projects across the entire hydrogen value chain, such as green ports and airports.
- Further development of infrastructure to distribute, store, and dispense hydrogen at large volumes and possibly over long distances.
- Under the research and innovation framework program, Horizon Europe, establishment of a Clean Hydrogen Partnership focusing on supporting research and development of green hydrogen.
- Improved and harmonized safety standards.
- Targeted support to build the necessary capacity for preparation of financially sound and viable hydrogen



projects. This translates into the development of local hydrogen clusters, such as remote areas or islands, or regional ecosystems, the “Hydrogen Valleys.”

V. International Cooperation with Fast-Accelerating Hydrogen Markets

The Commission stresses that “hydrogen diplomacy” is a top priority of its external energy policy agenda. Cooperation should focus on research and innovation, regulatory policy, direct investments, and fair trade in the hydrogen sector. The European Union could also benefit from an enhanced collaboration on hydrogen with its international partners, including Ukraine, the African Union, the Western Balkans, and neighboring countries of the Mediterranean. As Europe strives to be one of the central hubs of a new hydrogen marketplace, the Commission suggests the development of a benchmark for euro-denominated hydrogen trades by 2021. However, many industry executives point out that a single currency for hydrogen trades is less important than a directed, massive rollout of green hydrogen production and use.²⁵

²⁵ S&P Global (2020), “EC plans euro-based hydrogen benchmark by 2021: draft EU strategy,” Siobhan Hall, available at <https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/062320-ec-plans-euro-based-hydrogen-benchmark-by-2021-draft-eu-strategy>.

PART V - THE REGULATORY OUTLOOK OF THE HYDROGEN STRATEGY

The Hydrogen Strategy does not set forth any legally binding measures. The Commission notes that the Hydrogen Strategy in its current form is a roadmap for engagement with institutional and private-sector stakeholders. Against this backdrop, potential actions will take the form of both:

- Non-legislative measures; and
- Legislative measures to be further developed in the context of the June 2021 legislative proposals on energy and climate to enable more ambitious climate action.

It is important to note that any initiative will be complementary to those identified in the Strategy for Energy System Integration and reinforced by the work of the Alliance. With regard to any

legislative initiatives, although no timeline of implementation is provided, they will undergo a 12-week consultation of interested parties before the Commission submits them for review to the European Parliament and the Council. Forthcoming proposed legislative actions include the following:

- **Revise the Energy Tax Directive scheduled for 2021.**

The goal is to align the taxation of energy products and electricity with EU environment and climate policies, ensure a harmonized taxation of both storage and hydrogen production, and avoid double taxation. The Commission is already consulting on the energy tax directive (ETD) review and considering a number of policy options, such as (1) minimum excise rates, taking into account energy content and linkages to greenhouse gas emissions; (2) sectoral tax differentiation, taking into account existing differentiation between motor and heating fuel and focusing on tackling fossil fuel subsidies; and

(3) product coverage, taking into account that the use of hydrogen, among other new energy products, is currently discouraged because it can be taxed in the same manner as traditional energy products.

- **Ensure that the revision of the state aid framework supports the cost-effective decarbonization of the economy where public support remains necessary by 2021.**

The State aid Guidelines²⁶ for environmental protection and energy (EEAG) 2014–2020 define energy from renewable energy sources as:

“Energy produced by plants using only renewable energy sources, as well as the share in terms of calorific value of energy produced from renewable energy sources in hybrid plants which also use conventional energy sources, and it includes renewable electricity used for filling storage systems, but excludes electricity produced as a result of storage systems.”

Neither hydrogen nor low-carbon gases are specifically covered under the EEAG. However, national subsidies to carbon capture and storage are permissible under the EEAG and

could, under certain circumstances, favor blue hydrogen. In light of the above, it is evident that the revised EEAG will have to reflect the EU policy objectives addressing market barriers to the deployment of clean energy products, such as green hydrogen.

- **Review the legislative framework to design a competitive decarbonized gas market, fit for renewable gases, including empowering gas customers with enhanced information and rights by 2021.**

Initially, a review of the Third Gas Directive was scheduled for 2020 and then replaced by the Energy Sector Integration Strategy. In practice, the Energy Sector Integration Strategy introduces “sector coupling” of the gas and electricity sectors. Sector coupling occurs when “the EU electricity and gas sectors, both in terms of their markets and infrastructure” are linked.²⁷ Further, the Commission points out the potential for linkage between the supply chains for hydrogen, methane, and natural gas, for instance, by blending of hydrogen or synthetic methane with natural gas, or competition for storage between hydrogen, methane, and CO₂.²⁸

Apart from the Commission’s strong commitment to embed hydrogen in Europe, many member states (including

²⁶ European Commission (2014), “Communication from the Commission Guidelines on State aid for environmental protection and energy 2014–2020,” (2014/C 200/01), Brussels, available at [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0628\(01\)&from=EN](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0628(01)&from=EN).

²⁷ European Commission (2019), COWI consortium (Frontier Economics, CE Delft, and THEMA Consulting Group): “Potentials of sector coupling for decarbonization: Assessing regulatory barriers in linking the gas and electricity sectors in the EU,” Final Report December 2019, available at <https://op.europa.eu/en/publication-detail/-/publication/60fadfee-216c-11ea-95ab-01aa75ed71a1/language-en>.

²⁸ Idem.

the Netherlands, Germany, and Portugal) have an interest in advancing the hydrogen agenda.

Notably, Germany, which unveiled its national Hydrogen Strategy before the Commission, is expected to push the Hydrogen Strategy while holding the Presidency of the Council of the European Union until the end of 2020. Unsurprisingly, its Presidency program²⁹ underscores that it wants to win “partners for green energy imports.” Portugal, which will hold the Presidency of the Council of the European Union in the first half of 2021, is also expected to push for a pro-hydrogen policy, having recently launched its ambitious hydrogen plans.

The European Parliament already has been working on its own initiative on the development of a hydrogen economy. Some days before the official launch of the Hydrogen Strategy, Members of the European Parliament of the Committee on Industry, Research and Energy (ITRE) endorsed a report³⁰ proposing ways to step up energy storage solutions, including hydrogen. The report, prepared by rapporteur Claudia Gamon (*Austria/Renew Europe*), concludes that there are serious regulatory barriers, which interfere with the swift exploitation of the European Union’s energy potential.

Specifically, as regards hydrogen, the report:

- Highlights the potential of green hydrogen and urges the Commission to continue supporting research into and development of a hydrogen economy.
- Emphasizes that support measures are needed to reduce the cost of production of green hydrogen, while calling on the Commission to assess if retrofitting gas infrastructure to transport hydrogen is possible.
- Underscores that Europe needs to become a leader in the green hydrogen sector. The report mentions that green hydrogen can (1) provide significant flexibility to the electricity system; (2) capture a significant market share of the 15 metric tonnes of hydrogen used worldwide in refineries; and (3) be used as fuel for cars.
- Highlights the need for developing a hydrogen market.
- Calls for clear rules to avoid market distortion.

Interestingly, it is clear that the deployment of hydrogen has many allies in the EU policy arena, and there appears to be a high degree of consensus on the strategic priorities and future direction of the EU hydrogen economy.

²⁹ German Presidency Program (2020), available at <https://www.eu2020.de/eu2020-en/programm>.

³⁰ European Parliament (2020), “Draft Report on a comprehensive European approach to energy storage,” (2019/2189(INI)), Brussels, available at https://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/ITRE/PR/2020/06-29/1198854EN.pdf.

PART VI - HYDROGEN FUNDING OPPORTUNITIES

The European Commission estimates that the total capital expenditures for hydrogen production technologies could range between €140 and €400 billion by 2050.³¹ Similarly, investments in green hydrogen in Europe could be up to €180 to €470 billion by 2050, and in the range of €3 to €18 billion for low-carbon fossil-based hydrogen.

³¹ The European Commission's science and knowledge service (2019), "Hydrogen use in EU decarbonisation scenarios," Brussels, available at https://ec.europa.eu/jrc/sites/jrcsh/files/final_insights_into_hydrogen_use_public_version.pdf.

Funding Program	Program Description
InvestEU³²	<ul style="list-style-type: none"> • The InvestEU builds on the successful model of the Investment Plan for Europe, the Juncker Plan. • The InvestEU program will provide crucial support to companies and ensure a strong focus of investors on Europe's medium- and long-term policy priorities, such as the Green Deal. • The InvestEU will mobilize public and private investment through an EU budget guarantee of €75 billion that will back the investment projects of implementing partners such as the European Investment Bank Group and others and increase their risk-bearing capacity.
The Strategic Investment Facility³³	<ul style="list-style-type: none"> • The Commission added a fifth investment window in the InvestEU, the "Strategic European Investment Window," via the new Strategic Investment Facility. The new Strategic European Investment Window will focus on building stronger European value chains in line with the strategic agenda of the European Union and the New Industrial Strategy for Europe, as well as supporting activities in critical infrastructure and technologies. • It will generate investments of up to EUR 150 billion in boosting the resilience of strategic sectors, notably those linked to the green and digital transition, and key value chains in the internal market. • It will invest in technologies, which are key for the clean energy transition, such as, among other things, clean hydrogen, carbon capture and storage, and sustainable energy infrastructure. As such, the industry holds that it offers the most potential for hydrogen development.³⁴

³² European Commission (2020), "Questions and Answers: The proposed InvestEU Programme," available at https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_947.

³³ European Commission Factsheet (2020), "An enhanced InvestEU Programme and new Strategic Investment Facility to help kick-start the economy," available at <https://ec.europa.eu/info/sites/info/files/economy-finance/investeu-factsheet.pdf>.

³⁴ Hydrogen Europe (2020), "Hydrogen in the EU's Economic Recovery Plans," available at https://hydrogeneurope.eu/sites/default/files/Hydrogen_Europe_EU_Recovery_Plan_Analysis_FINAL.pdf.

Funding Program	Program Description
<p>Just Transition Mechanism</p> <p>It aims to facilitate the energy transition for those regions heavily reliant on fossil fuels. The identification of these territories will be carried out through a dialogue with the Commission.</p> <p>All investments under the Just Transition Mechanism will need to be implemented based on member states' territorial just transition plans.</p> <p>The Just Transition Mechanism is expected to mobilize at least €150 billion of public and private green investments.</p>	<p>The Just Transition Mechanism consists of three financing pillars:</p> <ul style="list-style-type: none"> <p>The Just Transition Fund.³⁵ The overall budget of the Just Transition Fund is €17.5 billion. The funding of the Just Transition Fund will be used to alleviate the socioeconomic impacts of the green transition in the regions most affected, by supporting the re-skilling of workers, helping subject matter experts to create new economic opportunities, and generally investing in the future of the most affected regions. Access to the Just Transition Fund will be limited to 50 percent of national allocation for member states that have not yet committed to implement the objective of achieving climate neutrality, the other 50 percent being made available upon acceptance of such a commitment.</p> <p>A dedicated just transition scheme under InvestEU. It will mobilize up to €45 billion of investments. It will seek to attract private investments, including in sustainable energy and transport, that benefit those regions and help their economies find new sources of growth.</p> <p>The public sector loan facility.³⁶ The facility will be jointly implemented by the Commission and the European Investment Bank. It is expected to mobilize up to between €25 and €30 billion of public investment to the benefit of areas such as energy and transport infrastructure, district heating networks, public transport, energy efficiency measures, social infrastructure, and other projects that can directly benefit the communities in the affected regions and reduce the socioeconomic costs of the transition.</p>

³⁵ European Commission (2020), "Proposal for a Regulation of the European Parliament and the Council establishing a Just Transition Fund," COM/2020/22 final, Brussels, available at <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020PC0022>.

³⁶ European Commission (2020), "Proposal for a Regulation of the European Parliament and of the Council on the public sector loan facility under the Just Transition Mechanism," COM (2020) 453, Brussels, available at <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020PC0453>.

Funding Program	Program Description
Connecting Europe Facility³⁷	<ul style="list-style-type: none"> • It supports the development of high-performing, sustainable, and efficiently interconnected trans-European networks in the fields of transport, energy, and digital services. It offers financial support through grants, guarantees, and project bonds. • The Innovation and Networks Executive Agency runs the Connecting Europe Facility, with €4.6 billion dedicated for energy and €23.7 billion for transport. • The Connecting Europe Facility will be harnessed to fund dedicated infrastructure for hydrogen, repurposing of gas networks and carbon capture projects, and finance hydrogen refueling stations.
Important Projects of Common European Interest (IPCEI)³⁸	<ul style="list-style-type: none"> • They are designed to bring together public and private sectors to undertake large-scale disruptive and ambitious research and innovation projects. • To receive funding from member states, an IPCEI should fulfill the following requirements: <ul style="list-style-type: none"> » Contribute to EU objective(s) and have a significant impact on competitiveness, sustainability, or value creation across the European Union. » Involve more than one member state. » Have positive spillover effects on the Single Market, whereas benefits should not be limited to participating member states and companies. » Involve co-financing by the project beneficiaries. » For research and innovation projects, the projects must be of a major innovative nature or of important benefit in light of the state of the art in the sector. If the project entails the first deployment of technology or innovations in industry, it should facilitate the deployment of either: (1) a new product of high research and innovation value; or (2) a fundamentally innovative production process.

³⁷ Innovation and Networks Executive Agency, "Connecting Europe Facility," available at <https://ec.europa.eu/inea/en/connecting-europe-facility>.

³⁸ European Commission (2014), "Communication on Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest" (2014/C 188/02), Brussels, available at [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014XC0620\(01\)#:~:text=This%20communication%20gives%20guidance%20on,common%20European%20interest%20\(IPCEIs\).&text=They%20are%20designed%20to%20bring,the%20Union%20and%20its%20citizens.](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014XC0620(01)#:~:text=This%20communication%20gives%20guidance%20on,common%20European%20interest%20(IPCEIs).&text=They%20are%20designed%20to%20bring,the%20Union%20and%20its%20citizens.)

Funding Program	Program Description
Projects of Common Interest³⁹	<ul style="list-style-type: none"> • Projects of common interest are key cross-border infrastructure projects that link the energy systems of at least two member states. • They are regulated by the TEN-E Regulation, which is currently reviewed to ensure consistency with the climate neutrality objective of the Green Deal. To this end, the revision of the TEN-E Regulation might expand its scope to energy infrastructure projects other than electricity and gas. • The TEN-E Regulation lays out the conditions for identifying projects of common interest that will be eligible for EU funding under the Connecting Europe Facility.
Innovation Fund⁴⁰	<ul style="list-style-type: none"> • The Innovation Fund is one of the first EU funding instruments tangibly supporting the vision for climate-neutral Europe by 2050. It is about unleashing low-carbon investments in all member states. • The revenues for the Innovation Fund come from the auctioning of 450 million EU Emissions Trading System allowances from 2020 to 2030, as well as any unspent funds coming from the NER300 program. The Fund may amount to about €10 billion, depending on the carbon price. • There is currently an open call of projects, which will be assessed based on (1) greenhouse gas emission avoidance; (2) degree of innovation; (3) project maturity; (4) scalability; and (5) cost efficiency.

³⁹ European Commission, "Projects of Common Interest," available at https://ec.europa.eu/energy/topics/infrastructure/projects-common-interest/key-cross-border-infrastructure-projects_en.

⁴⁰ European Commission, "Innovation Fund," available at https://ec.europa.eu/clima/policies/innovation-fund_en.

Funding Program	Program Description
European Regional Development Fund (ERDF) and the Cohesion Fund⁴¹	<ul style="list-style-type: none"> • It aims to redress the main regional imbalances in the European Union. • It benefits from a top-up in the context of the new initiative React-EU to support the green transition. • Financial instruments co-funded by the ERDF can potentially be used for all investment priorities outlined in the ERDF operational programs of the member states and regions, provided that they address an identified market gap. • The ERDF consists of a range of financial instruments: loans, grants, equity, microcredit, and guarantees.
European Agricultural Fund for Rural Development (EAFRD)⁴²	<ul style="list-style-type: none"> • The EAFRD is the funding instrument of the Common Agricultural Policy that supports rural development strategies and projects. • The Commission has allocated in the EAFRD €77.85 billion. • Rural areas will have a vital role to play in delivering the green transition. • The EAFRD is co-managed by the Commission and member states, while funding is provided through the Rural Development Programs designed by member states.
Fuel Cells and Hydrogen Joint Undertaking⁴³	<ul style="list-style-type: none"> • It is a public private partnership supporting research and technological development in fuel cell and hydrogen energy technologies in Europe. It launches open calls for grants annually. The call for 2020 is currently closed.

⁴¹ European Commission, "The European Regional Development Fund Financial instruments," available at https://www.ficompass.eu/sites/default/files/publications/ERDF_The_european_regional_development_fund_EN.pdf.

⁴² European Commission (2020), "Questions and Answers on the EU budget: the Common Agricultural Policy and Common Fisheries Policy," available at https://ec.europa.eu/commission/presscorner/detail/en/QANDA_20_985.

⁴³ Fuel Cells and Hydrogen Joint Undertaking, "2020 Call for Proposals launched: EUR 93 million available for 24 topics," available at <https://www.fch.europa.eu/news/2020-call-proposals-launched-%E2%82%AC93-million-available-24-topics>.

Funding Program	Program Description
<p>Recovery and Resilience Facility⁴⁴</p> <p>It comprises a €672.5 billion budget consisting of:</p> <ul style="list-style-type: none"> • €360 billion loans; and • €312.5 billion grants. 	<ul style="list-style-type: none"> • It aims to support investments and reforms essential to a lasting recovery, to improve the economic and social resilience of member states, and to support the green and digital transitions. • Member states will have to prepare national recovery and resilience plans setting out a reforms and investments agenda for 2021–23. The plans will be reviewed and adapted as necessary in 2022. • The plans are presented by member states and should be consistent with the challenges and priorities identified in the European Semester, with the national reform programs, the national energy and climate plans, the just transition plans, and the partnership agreements and operational programs adopted under the European Union funds. • The grants and loans will be disbursed in installments upon completion of milestones and targets as defined by member states in their recovery and resilience plans.

⁴⁴ European Commission (2020), “Questions and Answers on the EU budget for recovery: Recovery and Resilience Facility,” available at https://ec.europa.eu/commission/presscorner/detail/en/QANDA_20_949.

GLOSSARY EUROPEAN UNION

CBAM	carbon border adjustment mechanism
CCfD	carbon contracts for difference
EAFRD	European Agricultural Fund for Rural Development
EEAG	Environmental and Energy State Aid Guidelines
ERDF	European Regional Development Fund
ETD	Energy Tax Directive
EU ETS	EU Emissions Trading Scheme
GO	Guarantees of Origin
GW	gigawatt
IPCEI	Important Projects of Common European Interest
ITRE	Committee on Industry, Research and Energy
KW	kilowatt
MW	megawatt
PCIs	Projects of Common Interest
TEN-E	Trans-European Networks for Energy
TEN-T	Trans-European Transport Network

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The background is a deep blue with a complex, abstract pattern. It features several large, semi-transparent spheres that appear to be made of a fine, woven mesh. These spheres are arranged in a way that creates a sense of depth and movement. The background also has a subtle, repeating grid or scale-like pattern, reminiscent of a globe or a microscopic view of a material. The overall effect is futuristic and high-tech.

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