European Liberal Forum
PAPERS

RESEARCH PAPER
No 2 | July 2021

Clean Hydrogen and the Future of Energy:

Investing in a Sustainable Growth for the EU

Abstract:

The paper describes the path set for using hydrogen in the context of European decarbonisation and sustainability projects. Although hydrogen can be used as a feedstock, fuel, energy carrier, and storage in several sectors such as transport, energy, building, and industry, it still represents only a small part of the energy mix. Nonetheless, its use remains a priority in the context of the EU Green Deal and transitions objectives. The paper also considers the technical and regulatory aspects and challenges of large-scale deployment and use of hydrogen in the EU. As the authors point out, there is a need for more investments in the sector, while liberal values are claimed to be essential to ensure that this market is free, open, and with strong participation of the private sector.

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Introduction

The European Union is inexorably moving towards transformative transitions: societal, economical, digital, and ecological, among others. One of these transitions, the shift to non-polluting fuels for energy needs, is transversal to several sectors. This will play a crucial role in the development of new solutions for end users, the creation of market opportunities, and environmental protection. As in other significant moments of change, there is a need for bold vision, adjusted and sustainable objectives, smart investments, and the involvement of multiple stakeholders. For that, the best technical solutions and policies need to be implemented. Liberal concepts of economic systems—capital markets, competition, entrepreneurship, and free markets—can play an important role in assisting lawmakers and politicians to find the most successful way to navigate these challenges.

The International Energy Agency predicted at the end of 2019 that global energy demand would continue to increase by possibly 25% to 30% until 2040.[1] If these needs continue to be supported by the utilisation of coal and oil, there will be a continuous release of greenhouse gases into the atmosphere. The European Commission has proposed, alongside a provisional agreement with the European Parliament and Member States,[2] a reduction in the emissions of these gases by at least 55% by 2030.[3] This aim would have the Union reach a climate neutral economy by 2050, fulfilling its commitments derived from the Paris Agreement.[4] To make this happen, there is a need to integrate energy networks for smarter, more cohesive, and optimised systems, aiming for the full decarbonisation of industries and economies.[5] To achieve this, hydrogen production will play a key role. Therefore, the Commission has adopted a hydrogen strategy for climate-neutral Europe[6] that includes investment plans, roadmaps, policy frameworks, guidelines for research, innovation, and operational needs, and the know-how to develop an international dimension. The development of comprehensive, smart, and economically viable hydrogen strategies, both at the central level and in Member States, will be crucial to keeping European economies competitive and sustainable. In addition, these initiatives will allow the European Union to assume

1 International Energy Agency, "World Energy Outlook 2019", https://www.iea.org/reports/world-energy-outlook-2019 (accessed 20 April 2021).
2 Council of the European Union, "European climate law: Council and Parliament reach provisional agreement", (21 April 2021), https://www.consilium.europa.eu/e3n/press/press-releases/2021/04/21/european-climate-law-council-and-parliament-reach-provisional-agreement/ (accessed 30 May 2021).
3 European Commission, "2030 Climate Target Plan," https://ec.europa.eu/clima/policies/eu-climate-action/2030_ctp_en (accessed 20 April 2021).
4 European Commission, "2050 long-term strategy", https://ec.europa.eu/clima/policies/strategies/2050_en (accessed 20 April 2021).
5 European Commission, "EU strategy on energy system integration" (8 January 2021), https://ec.europa.eu/energy/topics/energy-system-integration/eu-strategy-energy-system-integration_en (accessed 20 April 2021).
6 European Commission, "Communication from the Commission to the Parliament, the Council, the European Economic and Social Committee and the Committee of Regions. A hydrogen strategy for a climate-neutral Europe" (8 July 2020), https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf (accessed 20 April 2021).

a trans-European, and trans-continental, leadership role in a new global market while guaranteeing energy security and environmental protection.

> Renewable electricity is one answer but is not fit for all purposes. It needs to be complemented by investments in clean hydrogen value chains.

Among the solutions receiving attention in search of "the best of both worlds" is having sources of energy that are useful for multiple needs, and in different fields, without causing harmful emissions to the environment. Renewable electricity is one answer but is not fit for all purposes. It needs to be co-mplemented by investments in clean hydrogen value chains. For the moment, hydrogen production is not yet a fully clean option for energy needs. More than 95% of supply is based on natural gas steam reforming or coal gasification, leading to the production of what is labelled as "grey" hydrogen,[7] produced from natural gas, and "black" hydrogen, derived from coal.[8] However, this causes the release of carbon dioxide (CO2). Most of these emissions, up to 95%, can be captured for storage or use: a solution called Carbon Capture and Storage (CCS).[9] Hydrogen production from natural gas through methane steam or autothermal reforming with CCS is known as "blue" hydrogen. Another approach is methane pyrolysis, splitting methane into two parts: a solid, carbon, and a gas, hydrogen. This technique, labelled "turquoise" hydrogen production, is still in the pilot stage.[10] As both pyrolysis and gas reforming can be performed using renewable sources, they are therefore solutions for avoiding the release of CO2 or reaching negative emissions. Finally, there is "green" hydrogen, produced via water electrolysis using electricity generated by renewable sources. While still an uncompetitive option due to the associated costs and only making up a small share of the global supply, green hydrogen is widely seen to be on the cusp of a virtuous circle of policy-assisted growth, economies of scale, learning, and cost declines. It furthermore enjoys favoured status as an option for a sustainable, environmentally-friendly energy transition.

Naturally, there are considerable costs associated with developing this technology and making it "scale to fit". Presently, the production of hydrogen from low- or zero-CO2 emissions is an expensive endeavour. However, positive signs abound: those costs in the production of electricity from renewable sources are decreasing,

7 International Renewable Energy Agency, "Green hydrogen. A guide to policy making" (2020), https://www.irena.org/publications/2021/May/Green-Hydrogen-Supply-A-Guide-To-Policy-Making (accessed 20 April 2021).

8 U.S. Department of Energy Hydrogen Program, "DOE H2A Analysis", https://www.hydrogen.energy.gov/h2a_analysis.html (accessed 20 April 2021).

9 European Commission, "Carbon Capture and Geological Storage", https://ec.europa.eu/clima/policies/innovation-fund/ccs_en (accessed 20 April 2021).

10 Cedric Philibert, "Methane splitting and turquoise ammonia", Ammonia Energy Association (14 May 2020), www.ammoniaenergy.org/articles/methane-splitting-and-turquoise-ammonia (accessed 20 April 2021).

and they will continue to do so in the future.[11] Still, investments in the European Union to create a sustainable hydrogen market by 2030 are between €24 and €48 billion for electrolysers, with €220 to €340 billion to be invested to scale up and connect 80–120 GW of solar and wind energy for conversion into electricity for electrolysers. There is also the need to adapt end-use sectors. Around €160 to €200 million are required to convert a steel factory in the European Union to be hydrogen compliant. Some €850 million to €1 billion would be needed to create 400 small-scale refuelling stations for land transport.[12] Adding to that, €65 billion in investments are anticipated for developing hydrogen transport, distribution, storage, and refuelling stations.[13] This projection should be thought of, naturally, as a "best case scenario". In recent years, investments have been stable—in the vicinity of around €505 billion—but total energy investments are set to increase.[14]

The path towards a European hydrogen economy

Policy decisions regarding the mass production of environmentally-friendly hydrogen, as well as strategies for the development and implementation of clean hydrogen value chains, will influence the pace of the energy transition. Tasks ahead include identifying high-value applications to create immediate benefits and to assist the scaling up of markets. It will also be important to replace hydrogen that causes carbon emissions with renewable hydrogen in industrial settings, for example, in the refining and production of methanol and ammonia. To account for these needs, the European Commission has launched the European Clean Hydrogen Alliance,[15] which is to play a decisive role in facilitating and implementing the actions proposed in the New Industrial Strategy[16] as well as generate investments to scale up production and develop the conditions for increased demand. Until 2030, around €430 billion are estimated to be applied in these projects.[17] Equally vital are the recommendations of the Strategic Forum for Important Projects of Common Interest regarding joint actions and investments within Member States, as well as the development of a transnational hydrogen supply chain.[18] This is particularly important when some EU countries

11 Max Roser, "Why did renewables become so cheap so fast? And what can we do to use this global opportunity for green growth?", Our World in Data (1 December 2020), https://ourworldindata.org/cheap-renewables-growth (accessed 20 April 2021).
12 European Commission, "A hydrogen strategy for a climate-neutral Europe".
13 European Commission, "Hydrogen Roadmap Europe. A Sustainable Pathway for the European Energy Transition", Fuel Cells and Hydrogen Joint Undertaking (January 2019), https://www.fch.europa.eu/sites/default/files/Hydrogen%20Roadmap%20Europe_Report.pdf (accessed 20 April 2021).
14 International Energy Association, "World Energy Investment 2020. Key findings", https://www.iea.org/reports/world-energy-investment-2020/key-findings (accessed 20 April 2021).
15 European Commission, "European Clean Hydrogen Alliance", https://ec.europa.eu/growth/industry/policy/european-clean-hydrogen-alliance_en (accessed 20 April 2021).
16 European Parliament, "New EU industrial strategy: the challenges to tackle", (17 December 2020), https://www.europarl.europa.eu/news/en/headlines/economy/20201112STO91445/new-eu-industrial-strategy-the-challenges-to-tackle (accessed 20 April 2021).
17 European Commission, "European Clean Hydrogen Alliance".
18 European Commission, "Strengthening Strategic Value Chains for a future-ready EU Industry",

(like the Netherlands, Poland, and France) have put hydrogen production at the heart of their strategy for dealing with climate, energy, and economic growth,[19] while others have presented "vision documents" (Portugal)[20] or are developing national hydrogen plans (Austria, Denmark, Italy).[21] The desired synergies (some exist already)[22] between Member States will result in a hub, the Hydrogen Energy Network.[23] Finally, it is also important to mention the European Regional Development Fund[24] and the Cohesion Fund[25] in the context of the REACT-EU initiative for the green transition.[26]

The path on which carbon-free hydrogen will become the best option for a more sustainable EU industry and economy, as suggested by the Commission,[27] is composed of three phases. The first one spans the years 2020 to 2024. In this period, the objectives are installing a minimum of 6 GW of renewable hydrogen electrolysers and producing one million tons of clean, green hydrogen. It will also include creating regulatory frameworks for a hydrogen market, developing conditions to generate supply and demand, and prioritising the production of renewable energy and low-carbon hydrogen. Investments will be evaluated by the European Clean Hydrogen Alliance, with an Important Project of Common European interest (IPCEI) providing potential national subsidy schemes based on special exemptions attributed by the Directorate General for Competition. However, other funding instruments will also support these kinds of investments, e.g., funds like Next Generation EU,[28] InvestEU,[29] Strategic European Investment,[30] and the Energy Trading System.[31]

https://ec.europa.eu/docsroom/documents/37824/attachments/2/translations/en/renditions/native (accessed 20 April 2021).

19 Simon Frédéric, "EU countries agree to 'rapidly upscale' hydrogen market", Euroactiv (15 December 2020), https://www.euractiv.com/section/energy-environment/news/eu-countries-agree-to-rapidly-upscale-hydrogen-market (accessed 20 April 2021).

20 Portuguese Presidency of Council of Ministers, "Resolução de Ministros n.º63/2020. Aprova o Plano Nacional de Hidrogénio" (Lisbon: 4 August 2020), https://dre.pt/application/conteudo/140346286 (accessed 20 April 2021).

21 International Renewable Energy Agency, "Green hydrogen. A guide to policy making",

22 Government of the Netherlands, "Portugal and the Netherlands strengthen bilateral cooperation on green hydrogen" (23 September 2020), https://www.government.nl/latest/news/2020/09/23/portugal-and-the-netherlands-strengthen-bilateral-cooperation-on-green-hydrogen (accessed 20 April 2021).

23 European Commission, "Hydrogen" (11 December 2020), https://ec.europa.eu/energy/topics/energy-system-integration/hydrogen_en (accessed 20 April 2021).

24 European Commission "European Regional Development Fund", https://ec.europa.eu/regional_policy/en/funding/erdf/ (accessed 20 April 2021).

25 European Commission, "Cohesion Fund", https://ec.europa.eu/regional_policy/en/funding/cohesion-fund/ (accessed 20 April 2021).

26 European Commission, "REACT-EU", https://ec.europa.eu/regional_policy/en/newsroom/coronavirus-response/react-eu (accessed 20 April 2021).

27 European Commission, "A hydrogen strategy for a climate-neutral Europe".

28 European Commission, "Recovery plan for Europe. NextGenerationEU", https://ec.europa.eu/info/strategy/recovery-plan-europe_en#nextgenerationeu (accessed 20 April 2021).

29 European Union, "InvestEU", https://europa.eu/investeu/home_en (accessed 20 April 2021).

30 European Commission, "An enhanced INVEST EU programme and New Strategic Investment Facility to help kick-start the economy" (2020), https://ec.europa.eu/info/sites/info/files/economy-finance/investeu-factsheet.pdf (accessed 20 April 2021).

31 European Commission, Innovation and Networks Executive Agency, "Innovation Fund"(4 April 2021), https://ec.europa.eu/inea/en/innovation-fund (accessed 20 April 2021).

A second phase is set in the window from 2025 to 2030, during which hydrogen "needs to become part of an integrated energy system",[32] installing a minimum of 40 GW of electrolysers and ramping up production to six million tons per year. By the end of this period, carbon-free hydrogen is expected to become cost-competitive. Still, demand-side stimuli—such as carbon contracts for difference (CCfD)—will be the ultimate driver of industrial sectors' decarbonisation (e.g., clean steel). Another expected result from this period is the emergence of "hydrogen valleys", regions with local green hydrogen production with the help of decentralised renewable energy systems. Apart from distribution to satisfy local demand, there should be investment in regional transportation within the European Union.[33] That will eventually lead to larger scale transportation, including between Member States, facilitating the transfer of hydrogen from countries which have optimal conditions and use renewable sources for its production to others. The plan is to develop a pan-European energy grid for hydrogen and to have a complete, open, and competitive hydrogen market by 2030. This target of the Commission seems, however, overly optimistic. As a reference point, established energy markets like natural gas have taken considerably more time to mature. There will also be the need to develop partnerships to overcome trade barriers and distortions and to assure equal access even among countries with different plans and approaches.[34] Apart from maritime and long-distance land transport, there is also the option of utilising existing gas pipelines with even better transport capabilities after retrofitting.[35] Furthermore, adjusting the gas distribution grid and heating equipment could be done in a way to accept higher shares of hydrogen, up to a 50% distribution in 2050 and 70% in 2070.[36] Although heating appliances may be technically able to handle such blends, it has been proposed that the investment tipping point is at 20% of the TSO/DSO level. This means that it makes more sense financially for the required investments to be moved towards dedicated hydrogen transport.[37]

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32 European Commission, "A hydrogen strategy for a climate-neutral Europe".
33 Ibid.
34 Ibid.
35 Kira Taylor, "MEPs back natural gas as a 'bridge' to 100% renewable hydrogen", Euroactiv (27 January 2021), https://www.euractiv.com/section/energy-environment/news/meps-back-natural-gas-as-a-bridge-to-100-renewable-hydrogen (accessed 20 April 2021).
36 European Commission, In-depth Analysis in Support of the Commission Communication COM(2018) 773 (28 November 2018), https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf (accessed 20 April 2021).
37 Marcogaz, "Overview of available test results and regulatory limits for hydrogen admission into existing natural gas infrastructure and end use" (October 2019), https://ec.europa.eu/info/sites/

By the third phase, until the year 2050, it is expected that the technology to produce hydrogen with electrolysers, using electricity from renewable energies, will reach maturity. Along with that, an easier transition to environmentally-friendly energy would be able to take place in hard-to-decarbonise economic sectors, or ones that must pay a high cost to achieve this. This will happen thanks to the progressive decarbonisation of Europe's electricity mix and the increasing availability of 100% clean-hydrogen, neutral electricity on the grid. On the other hand, fossil-based hydrogen will face increasing pressure from stringent CO2 limits and pricing that will impact the (limited) carbon emissions associated with blue hydrogen. However, a note of caution is needed here. Regardless of all the plans and roadmaps, it is important to keep in mind that until the European Union can reliably depend on the production of carbon-free hydrogen, low-carbon emissions hydrogen will continue to be part of the energy mix.[38] Natural gas is expected to serve as a "bridge" to zero-carbon hydrogen resulting from renewable sources.[39] However, hydrogen in the broader, systemic decarbonisation context must be seen as a helpful tool rather than a goal. Direct electrification via clean power sources and digital solutions remains—by far—the most effective driver of systemic efficiency. It is equally necessary to account for the kick-start effect of a hydrogen economy supported by a blue/green blend on the market. This will also have the benefit of letting renewable electricity contribute to direct electrification, where this makes the most sense.

Points of concern

Two points are necessary to consider: one is technical, and the other is related to policy choices, namely when observed through a liberal lens, which we will tackle later. In the third phase mentioned above, it is expected that a significant share of renewable electricity will be used for hydrogen production. Some estimations point to an increase of 25%.[40] This means a need for massive energy production from renewable sources. The principle of "energy additionality"[41] applies in this case. In situations where there are more productive uses for electricity generated by renewables, this energy should not be diverted to produce hydrogen. As electrification rates rise, this will incentivise natural gas-based electricity production to provide for the growing gap in electricity supply. Here again, blue hydrogen can work as a solution, since it is cheaper to produce than green hydrogen. Clean hydrogen should only be produced from additional renewable energy when supply exceeds the volume commissioned for direct electricity consumption. This includes industry, light transportation, and the electrification of energy grids. This is critical to a successful energy transition and effectively removing carbon-based fuels[42] from the energy mix. The source of

default/files/energy_climate_change_environment/events/documents/02.c.03_mf33_background_-_marcogaz_-_infographic_hydrogen_admission_-_j_dehaeseleer_g_linke.pdf (accessed 20 April 2021).

38 Kira Taylor, "MEPs back natural gas as a 'bridge' to 100% renewable hydrogen".

39 Ibid.

40 European Commission, "A hydrogen strategy for a climate-neutral Europe".

41 International Renewable Energy Agency, "Green hydrogen. A guide to policy making".

42 Ibid.

this additional energy needs to be documented, and this can be performed via power purchase agreements (PPAs) or certifications of origin.

The European Commission is aware of this need, as presented in a 2018 Directive addressing the use of energy from renewable sources: "The Commission should develop, by means of delegated acts, a reliable Union methodology to be applied where such electricity is taken from the grid. That methodology should ensure that there is a temporal and geographical correlation between the electricity production unit with which the producer has a bilateral renewables power purchase agreement and the fuel production".[43] The "temporal correlation" refers to the timing of hydrogen production via electrolysis with the utilisation of low carbon electricity—or, in the case of green hydrogen, zero carbon emissions—and the "geographical" is the grid connection to hydrogen production, for example, via a shared electricity network. It is good to remember that hydrogen operations should not come at the expense of direct electrification.[44]

Sectors where hydrogen adds maximum value should be given priority. This will prevent competition with other, more immediate solutions for decarbonisation. Once clean hydrogen becomes a more viable and accessible energy vector, these priorities can shift. By then, the renewable electricity-generating capacity will have to have scaled up to the point of enabling both increased direct electricity consumption and increased green hydrogen production. The market will also be a force for change as businesses and enterprises lead the way in emissions reductions. Plans are already being introduced by private companies, including in the power and industrial sectors, to increase the role of renewable energy.[45] Evidence suggests that companies are increasingly aware of the growing concern about environmental protection and thus adapting their decisions to consumer requests for a sustainable transition in Europe[46] and elsewhere.[47]

In many sectors, electricity from renewable energy will be a more expedient and cost-effective replacement for unabated fossil fuels than clean hydrogen.[48] This especially applies to road passenger transportation: with a decline in electric vehicle costs, battery technology developments would allow for longer driving ranges and improved charging capability, making this kind of vehicle a

43 The European Parliament and the Council of the European Union, "Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources", Official Journal L328/95 (12 December 2018), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=fr (accessed 20 April 2021).

44 Bellona Europa, "Hydrogen from Electricity – Setting Sustainability Standards to Meet Innovation, Deployment and Climate Action" (July 2020), https://network.bellona.org/content/uploads/sites/3/2020/07/Hydrogen-From-Electricity-Setting-Sustainability-Standards.pdf (accessed 20 April 2021).

45 European Commission, In-depth Analysis in Support of the Commission Communication, COM(2018) 773.

46 European Commission, "Study on Incentives Driving Improvement of environmental Performance of Companies", Ecorys (8 May 2012), https://ec.europa.eu/environment/pubs/pdf/Incentives_Ecorys.pdf (accessed 20 April 2021).

47 Adam Butler, "Do Customers Really Care About Your Environmental Impact?", Forbes (21 November 2018), https://www.forbes.com/sites/forbesnycouncil/2018/11/21/do-customers-really-care-about-your-environmental-impact/?sh=10dcbf03240d (accessed 20 April 2021).

48 International Renewable Energy Agency, "Green hydrogen. A guide to policy making".

This could be one of the main functions of green hydrogen: to serve as a storage medium for electricity.

preferred option. It applies to the trucking segment, as well, because hydrogen is widely seen as having a future in this important road transport sub-sector. Because electrification is not an option for large marine vessels or aircrafts over longer distances, these sectors are therefore strong candidates for hydrogenization. The more wind and solar power generation capacity being built, the more challenging it will become to match electricity supply and demand. There may be periods of considerable excess generation capacity, thus calling for curtailment if there are no means to store the electricity and/or causing severe electricity price volatility. This could be one of the main functions of green hydrogen: to serve as a storage medium for electricity.

The need for investments

To make the contribution of clean hydrogen to a carbon-free economy a reality, investments are needed and will call for the use of European Union funds, contributions from the European Investment Bank, and private financing. The involvement of investors from the private sector should start as soon as possible in order to create a clear picture of these projects and their targets, technologies, and strategic decisions. Private-public partnerships can work as a primary engine for the development of solutions to obstacles regarding the implementation of clean hydrogen plans and roadmaps. This should also include investments in research and development, which will eventually contribute to a decrease in the costs associated with production and utilisation. This joint work will generate know-how and sharing of information between stakeholders, which is advantageous for technological development, consensus creation, the definition of strategies and market priorities, activity coordination, integrated growth, the development of good practices, and organisational success. This will also contribute to risk reduction in the early phases, facilitating the transition from demonstration to commercialisation and allowing companies to build experience while reaping the benefits of participating in initial market developments.[49] Optimally, the main goal of these partnerships, as well as general plans and roadmaps, is to reach a point where public financing can be discontinued. There are precedents for this kind of model being successful. In 2002, the European Union developed the High-Level Working Group on Hydrogen,[50] Optimally, the main goal of these partnerships, as well as general plans and roadmaps, is to reach a point

49 International Renewable Energy Agency, "Green hydrogen. A guide to policy making".

50 European Commission, "Hydrogen Energy and Fuel Cells. A vision of our future", Fuel Cells and Hydrogen Joint Undertaking (2003), https://www.fch.europa.eu/sites/default/files/documents/hlg_vision_report_en.pdf (accessed 20 April 2021).

where public financing can be discontinued. There are precedents for this kind of model being successful. In 2002, the European Union developed the High-Level Working Group on Hydrogen,[51] which led to the 2004 establishment of the Fuel Cell Technology Platform that created the Fuel Cells and Hydrogen Joint Undertaking.[52]

The revision of the "State aid Framework" in 2021[53] will allow for the creation of a comprehensive model of support systems for the implementation of the European Green Deal while limiting competitive advantages and adverse effects within Member States. On the demand side, the European Commission is set to apply minimum shares, or quotas, for clean hydrogen or derivatives in certain end-use sectors, like the chemical and transport industries. These should be based on the performance of green hydrogen as a market solution and should also include the contribution of blue and turquoise hydrogen. Since there is still a high level of uncertainty around demand for clean hydrogen, support should target hard-to-abate sectors such as marine and air transportation and high-temperature industrial processes[54] by addressing the cost gap between renewable hydrogen and its fossil-fuel alternatives. The creation of tendering systems for "carbon contracts for difference" (CCfD) or contracts with public counterparts will help to incentivise investment by paying the difference between the carbon "strike price" (a set price for negotiations of derivate contacts) and the real one. Equally, a fixed amount per avoided ton of greenhouse gases emissions could be set, thus bridging the cost gap with conventionally produced products.[55] CCfDs should also be made available for blue hydrogen production, at a different strike price, covering the relative funding gaps for each technology. Blue hydrogen will be able to deliver similar environmental protection at 95% decarbonisation rate compared to green hydrogen projects. It is expected that the grid mix will only reach 32% renewable electricity by 2030. In such an event, the average decarbonisation rate of green hydrogen will be well below the blue hydrogen potential, putting the 2030 greenhouse gases reduction target at risk.

The creation of a so-called "liquid market", based on green hydrogen supply and demand, would increase the number of producers and the size of markets, facilitating integration with other energy markets. This will increase investments and help develop smarter strategies for hydrogen production via electrolysis with renewable energies, considering technological developments, geographical solutions, storage, and distribution means.[56] European Commission, "EU Emissions Trading System.[57] as with the Next Generation EU fund and the 2030 Climate

51 European Commission, "Deployment Strategy", European Hydrogen & Fuel Cell Technology Platform (August 2005), https://www.fch.europa.eu/sites/default/files/documents/hfp_ds_report_aug2005.pdf (accessed 20 April 2021).
52 European Commission, "Deployment Strategy".
53 European Commission, "A hydrogen strategy for a climate-neutral Europe", p.10.
54 International Renewable Energy Agency, "Hydrogen from renewable power. Technology outlook for the energy transition" (September 2018), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Sep/IRENA_Hydrogen_from_renewable_power_2018.pdf (accessed 20 April 2021).
55 European Commission, "A hydrogen strategy for a climate-neutral Europe", p.13.
56 European Commission, "A hydrogen strategy for a climate-neutral Europe".
57 European Commission, "EU Emissions Trading System. EU ETS" (20 April 2021), https://ec.europa.eu/

Target Plan,[58] for the creation of financial support towards initiatives aiming at the sustainable recovery of the European economy. Emissions trading systems have been a point of interest among academics and policymakers alike.[59] In addition, the European Union is set to implement measures to protect industries against carbon leakage with a Carbon Border Adjustment Mechanism (CBAM).[60]

Liberal view of (new) market growth

Adding to the work done by the European Commission, the European Parliament is also leading the way in creating frameworks for change to happen. This includes the "phasing-out of hydrogen" production based on the utilisation of fossil fuels, the certification of hydrogen imports, and the avoidance of carbon leakage that is associated with the production and transportation of hydrogen. Notably, the Parliament will closely follow the implementation of incentives to generate demand for this new source of energy, as well as to "create a European hydrogen market and fast deployment of hydrogen infrastructure".[61] However, it is interesting to note that, according to the position of the Committee on Industry, Research and Energy, and also in the European Parliament, low-carbon hydrogen will be recognised to serve as a bridging technology in the short and medium term.[62]

Regardless of what funding mechanisms are made available, including European funds, it is important that financial or fiscal supports are direct and transparent. This applies to hydrogen markets and the generation of electricity from renewable sources, including flexibility of services, increased renewable energy production, and more incentives for exploring renewable sources as carbon-free hydrogen production moves on to the third phase of implementation. During that period, there should be competitive market growth, both on the supply and demand sides. Direct financial incentives, either central (European Union) or local (Member States), should be discontinued, privileging private capital for hydrogen production and delivery to end-point users.

From the outset of this new ambitious EU undertaking to preserve the environment for future generations—while still maintaining European economies'

clima/policies/ets_en (accessed 20 April 2021).

58 European Commission, "2030 Climate Target Plan".

59 Rikard Forslid, "Carbon Adjustments and Climate Clubs in the EU context" (Brussels: European Liberal Forum 2020), https://www.liberalforum.eu/publications/border-carbon-adjustments-and-climate-clubs-in-the-eu-context/ (accessed 20 April 2021).

60 Karl Mathiesen & Paola Tamma, "Europe's plan to tax the world into climate ambition" (21 April 2021), https://www.politico.eu/article/europes-plan-to-tax-the-world-into-climate-ambition-joe-biden-frans-timmermans/?utm_medium=Social&utm_source=Twitter#Echobox=1619115166 (accessed 30 May 2021).

61 European Parliament, "Renewable hydrogen: what are the benefits for the EU?" (17 May 2021), https://www.europarl.europa.eu/news/en/headlines/society/20210512STO04004/renewable-hydrogen-what-are-the-benefits-for-the-eu (accessed 30 May 2021).

62 European Parliament, "Report on a European Strategy for Hydrogen", Committee on Industry, Research and Energy (April 2021), https://www.europarl.europa.eu/doceo/document/A-9-2021-0116_EN.pdf (accessed 30 May 2021), p.12.

competitiveness and sustainability by leading the way in producing a (new) market for carbon-free hydrogen—liberal values are essential to ensure that this market is free, open, and with strong participation of the private sector. European Union and Member States' initial investments and regulations are vital. However, as the phases progress towards the massification of production, distribution, and utilisation of clean hydrogen, the market should have the opportunity to regulate itself to the benefit of not only end users but also industry. This is particularly important because some EU Member States that already have optimal conditions to garner energy from renewable sources will have to break from the tradition of excessive governmental intervention combined with poor planning and execution. However, the conditions are set for an auspicious start and, hopefully, a more sustainable and prosperous future.

Author bio

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About ELF

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A liberal future in a united Europe

DOI: 10.53121/ELFRP2

ISSN: 2736-5816

Cover image: AdobeStock

This publication was co-financed by the European Parliament. The European Parliament is not responsible for the content of this publication, or for any use that may be made of it.

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