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COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Towards a hydrogen economy in Europe: a strategic outlook

1. INTRODUCTION – WHY CLEAN HYDROGEN MATTERS FOR A CLIMATE NEUTRAL ECONOMY [DG ENER, DG CLIMA, DG GROW, DG RTD]

- Hydrogen: what it is and how it is produced. Green, blue and grey hydrogen: definitions and compared life cycle emissions.
- Spell out what is meant by 'clean' hydrogen in the title of the strategy, and our objectives (in the context of decarbonisation, clear priority on green hydrogen asap, accepting that blue hydrogen will play a role in the transition, no grey hydrogen).
- A bit of history: the initial attempts to use hydrogen as a fuel. Previous waves of interest for hydrogen, soon fading off. Apollo space program triggered expectations of large-scale hydrogen applications (1961) / Oil crisis, creation of IEA Hydrogen (1977) / Hydrogen car (late 90s/early 00s). Why they failed.
- This time could be different: For the first time, there is solid demand and request from industry. Share of renewable electricity projected to increase significantly and costs going down.
- Why Hydrogen is central to the European Green Deal - key to achieve carbon-neutral economy for 2050 and 50/55 GHG reduction for 2030. Hydrogen is one of the enablers in the context of the Green Deal for decarbonising sectors like chemical industry, steel industry and transport. This Strategy contributes to the 2030 climate plan (due September 2020) and to the June 2021 legislative package on increased climate ambition. Green hydrogen also important for storage and flexibility of the energy system.
- Hydrogen can help the economic recovery post-COVID-19 – sector's turnover could increase from 2 bn euro to 140 bn euro, creating 140 000 jobs by 2030.
- Hydrogen represents a limited share in EU energy mix – share of green and blue. A rapid acceleration is needed after 2030 – quantify what we are aiming for (share of green, blue, grey hydrogen in the energy mix by 2030, 2040, 2050), time to lay the foundations for this rapid acceleration and industrial leadership is now.
- Problem definition: when green hydrogen will become price competitive? Relative prices today compared to blue hydrogen and to other carriers. Projections of future price trends and factors that drive down costs.
- To facilitate the taking-off of green hydrogen in the next years, we need strong policy steer at EU level to complement market and private investment. Policy actions would aim at enabling green hydrogen to arrive at close to competitive price levels already in a couple of years. This will be possible as soon as integrated green hydrogen factories at gigawatt scale go into production.
- A growing interest at Member States level - national strategies being adopted. Risk of uncoordinated, fragmented development. Need for a European approach now, also to protect the Single Market and global competitiveness. Rapid developments in other global partners, China, Japan, South Korea, US.
- EU strategy must follow a value chain approach, looking at the entire ecosystem from upstream, how to speed up production to downstream – how to boost demand through developing efficient and liquid markets and to put in place the necessary infrastructure to transport significant quantities. Need for policy coherence in the use of different EU policy instruments.
- Purpose of the Communication is to set out such an integrated strategy for building a hydrogen economy in Europe, based on a whole value chain approach (demand, production, infrastructure, market rules). Central role of the Clean Hydrogen Alliance,

Strategy and Alliance meant to be mutually reinforcing. Note that the Alliance is formally launched simultaneously with this Strategy.

- Link to the Strategy for Energy System Integration and how hydrogen complements other options such electrification, direct renewable use in end use sectors or waste heat reuse.

2. GETTING THE RIGHT SIZE: BOOSTING DEMAND FOR AND SCALING UP PRODUCTION OF CLEAN HYDROGEN [DG GROW, DG MOVE AND DG ENER]

Production:

- Current H2 production in Europe – 9.8 million tons (out of 74 million globally). Only 4% is green and X% is blue. Barriers to further expansion. Why scaling up volumes is key to lower prices and ensure uptake of hydrogen.
- The main booster has to be a significant increase in volumes to bring down the price/kg to a range of 1-2 €/kg as quickly as possible.
- Current initiatives: 2x 40 GW initiative: outline the need for magnitude (commodity like) roll-out of green hydrogen production, mainly in dedicated green hydrogen factories with integrated solar or wind renewable facility.

End-use applications:

- End use applications in industry and transport: focus on the sectors and end-uses that have no (or only expensive) alternatives to decarbonise.
- Hydrogen as a fuel for aviation, shipping, trains, heavy duty transport – either as Hydrogen or as renewable fuel based on Hydrogen
    - Hydrogen is the most promising low emission fuel for transport with heavy polluting emissions such as heavy duty vehicles, busses, coaches and special purpose vehicles
    - Extension to non-electrified train routes and ships
    - Aviation sector, possibly with eFuels
    - Deployment of a refuelling infrastructure (HRS) along main transit routes but also for captive fleets in public transport and in ports
    - Regulatory support measures and facilitation for taxes and fees and usage regimes
- Boost green hydrogen demand in industry: fertiliser, steel, chemical and cement industry.
    - Reaching required large commodity-like quantities in a cost efficient way
    - supporting commercial viability trough temporary grant schemes for kick-start
    - Implementing supporting framework measures as outlined in the Energy-Intensive Industries (EII) Master Plan.
- Hydrogen in the electricity sector (notably, dispatchable power, large-scale and seasonal storage, CHP applications, and turbines)
- Hydrogen in the heating sector (eg CHP, hydrogen appliances, industrial heat)

Local vs long-range production and demand:

- Production: Balance of local domestic production, hydrogen transport networks, or imports. Hydrogen has to be produced in places best suited for these technologies (e.g. PV in the south of the EU, wind off-shore in the North).
- Demand: explain difference in demand in different sectors, proportion of local vs. long-range demand, and how this will evolve over time.
- Concept of 'hydrogen valleys', qualify how prominent this will be in our approach
- Europe is well positioned to develop the necessary economies of scale for green hydrogen: Green hydrogen needs significant amounts of renewable electricity.
- Renewable electricity is available, but needs to rapidly scale up and investments to provide the necessary electricity to produce green hydrogen. Quantify how much renewable energy is needed to reach our hydrogen goals by 2030, 2040, 2050. Opportunity also to import renewable hydrogen (see later) and to develop partnerships.
- Already, industry initiatives to produce blue hydrogen (CCUS, pyrolysis) in the transition phase. In parallel, support the deployment of green hydrogen, avoidance of lock-in

Hurdles and possible way forward:

- To meet projected increase in demand, need to scale up production. Build up a sustainable industrial ecosystem: Strengthen a skilled workforce, industrialise key components, scale-up technologies for multiple-businesses, and create a circular economy within the sector. The Strategic Forum and its recommendations. Ensure global leadership for EU industry, notably for electrolysers.
- More concrete support for SMEs should be provided through EEN and the EIC as well as the renewed JU. Potentially specific calls for phase 2 project could be launched.
- Hydrogen Alliance will play a crucial role in facilitating and implementing these actions. It will have 6 separate technology based sectorial CEO round tables representing the pillars of the hydrogen value chain (production, transmission, mobility, industry, energy, heating in the EIC).

Some possible key actions:

- Kick-starting the Clean Hydrogen Alliance to scale up and roll out the production and use of hydrogen across the EU
- Delivering on the Strategic Forum Recommendations
- Clean Steel Programme
- Contracts for difference program: support Gigawatt-sale production of clean hydrogen, industrial plants for the production of low carbon and circular steel, cement and basic chemicals
- Role of hydrogen in the planned Sustainable and Smart Mobility Strategy

3. DESIGNING AN ENABLING REGULATORY FRAMEWORK FOR HYDROGEN: MARKET RULES AND INFRASTRUCTURE [DG ENER, DG MOVE]

Market rules

- Need to design an open and competitive green hydrogen market ensuring efficient allocation of resources. Potentials within the EU differ. The market should be designed based on the following principles: (i) unrestricted cross-border trade, (ii) unrestricted access for all market players to the relevant infrastructure, (iii) network owners to operate based on the unbundling principles, Need to keep the integrity of the internal market. Need to cater for local solutions. Solid price signals for carbon needed, but not sufficient.

Creating an enabling regulatory framework

- Elements for an enhanced regulatory framework for upscaling green hydrogen production (in coordination with the Strategy for Energy System Integration):
    - Common classification/taxonomy for clean hydrogen, and associated minimum GHG reductions standards (and sustainability criteria)
    - Robust certificates/guarantees of origin, system to support consumer information and the trade of "green" quality
    - Methodology to count green (i.e. renewable) hydrogen towards EU renewables' targets, ownership of assets,
    - Incentivising demand of green hydrogen for example through targets on certain end-use sectors and by selectively supporting the green hydrogen supply in combination with our general climate policy instruments.
    - Blending as a transitional possibility where needed to kick start production and re-use existing infrastructure.
    - Treatment of Hydrogen for large scale storage

Infrastructure

- Infrastructure needs: what types are available, what types are needed, what are the phases for creating new infrastructure, what are the obstacles, what is the cost.
- Infrastructure is a key element for roll-out and scale-up since transportation cost are very high relative to production cost.
- Repurposing of existing gas infrastructure for transport of clean energy in the form of H2 may provide an opportunity for a cost-effective energy transition. But: need to avoid the risk of stranded assets and lock-in effect.
- On the other hand, the cost of creating a brand new infrastructure has to be carefully assessed to minimise its impact on consumers and competitiveness.
- In both cases (repurposing vs brand new) the cost of the infrastructure cannot be an obstacle to cross-border trade.
- How hydrogen will be transported will depend on patterns of production (decentralised/centralised; source of hydrogen) and demand (industrial clusters/transport/buildings) Depending on distance and conditions, transport can be made by pipeline or through shipping (ships, trucks). Cross-border approach.
- Since initially the (dedicated) pipeline network will be rather limited and supply also to remote locations necessary, in particular refueling stations, transportation will need to be assured also by other means.
- Refuelling infrastructures, in particular for heavy duty.

- A likely first phase of repurposing of gas infrastructure creating H2 local systems to cater in particular to industrial demand, then connected through backbones.
- A specific strategy to reach transport demand through a network of refuelling stations for heavy-duty vehicles This challenge will require a sound infrastructure planning approach across sectors: connecting electricity and gas grids (for P2G) and catering for all demand sectors
- Long-term storage is key in the overall role of H2. Technical challenges, research still needed. Salt caverns are an existing solution but limited in volume, other longer-term solutions to be investigated.

Some possible key actions:

- Provide a classification of various types of hydrogen and adopt a methodology for the calculation of the minimum life-cycle GHG emission savings of renewable hydrogen (and recycled carbon fuels) (as part of the June 2021 legislative package. Specify which legislative text would be revised to do that – REDII?).
- Adopt a methodology for the full accounting as renewable of hydrogen produced from electricity and used, including additionality requirements (by June 2021. Specify which legislative text would be revised to do that – REDII?).
- Enhancing the regulatory framework for hydrogen in coordination with the Strategy for Energy System Integration via upcoming legislative reviews of energy legislation by June 2021. Specify which legislative text(s) would be revised to do that – REDII? Gas directive?. This could include inter alia the following elements:
    - Additional incentives to support hydrogen in specific end-use sectors, through specific quotas.
    - Comprehensive terminology and robust certification.
    - Ensuring access to markets and customers for hydrogen producers on a level playing field
    - Fostering the deep integration of a hydrogen market with other energy markets
    - Ensure that the EU infrastructure policy promotes the development of hydrogen infrastructure, including at cross-border level, and takes it fully into account in infrastructure planning.
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4. PROMOTING RESEARCH AND INNOVATION IN CLEAN HYDROGEN TECHNOLOGIES [DG RTD, ENER, CLIMA, JRC]

- Decades of research and innovation in the hydrogen sector in the EU has brought the technology to a level of maturity that now makes industrial scale deployment possible. Other technologies are still under development.
- Need to improve the scale, efficiency, durability, operational flexibility and reliability of electrolysers, as well as reducing their capital cost (e.g. substitution of

critical/costly materials). Need to reduce cost, improve efficiency and upscale end use applications, in particular fuel cells for transport (e.g. MW scale for maritime applications), but also for power and heat production (being fuel cells or even turbines).

- Coordinated EU research and innovation action is needed to create value/supply chains through support for large-scale high-impact projects that include large scale electrolysers (100 MWs), clean electricity production (e.g. offshore) and the development of sustainable industrial areas as well as ports and airports that can use the produced Hydrogen as a climate-neutral energy carrier and source of feedstock – first example is the Green Deal call
- Horizon Europe and the Strategic Energy Technologies plan can be used to coordinate MS and industrial partners and promote cooperation through joint calls in Horizon Europe
- The Fuel Cells and Hydrogen Joint Undertaking – its achievements. The Clean Hydrogen Joint Undertaking covering the entire value chain but with a clearer focus on renewable hydrogen production, infrastructure and storage.
- R&I partnerships with industry that create demand, in particular shipping, aviation, fertiliser, clean steel, chemicals;
- The envisaged European Partnership for Clean Hydrogen will gather together knowledge, technological and financial resources available across public and private stakeholders through a coordinated pan-European approach.
- New emerging technologies in particular for renewable hydrogen production should also figure on the research agenda, e.g. artificial photosynthesis, but also pyrolysis with solid carbon.

(Outline actions?)

Ensure that the partnership on Clean Hydrogen is contributing fully to the Hydrogen economy in Europe

5. THE INVESTMENT CHALLENGE [DG ENER, CLIMA, TAXUD, GROW, RTD]

- The size of the investment challenge. Need to develop value streams. Role of the Alliance. How much from the private and the public sector?
- EU lags behind in terms of public support to hydrogen per capita: China – 4 euro pc; Japan 3 euro pc; US 0.75 euro pc; EU 0.5 euro pc.
- Which EU instruments can contribute?: Horizon Europe, Innovation Fund, Connecting Europe Facility, InvestEU, Structural funds.
- Need to ensure coherence and create links between instruments, e.g. from Horizon Europe to the Innovation Fund to scale-up rapidly
- State aid – on-going revision of the IPCEI and Energy and Environmental Aid. EEAG to provide a level playing field and avoid distortions in competition coming from possibly different national support strategies.
- Guidelines, hydrogen producers as electro-intensive industries.
- Impact of the carbon price
- Energy taxation – setting the right incentives

Some possible key actions:

- Establish hydrogen as strategic supply chain for Europe (possibly IPCEI (tbc))
- Set up dedicated window for hydrogen under Innovation Fund
- Use Recovery instrument and sustainability requirements in financial support to create a market pull for hydrogen use (e.g. shipping such as cruise ships, aviation using hydrogen or hydrogen-based renewable fuels)
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6. THE INTERNATIONAL DIMENSION [DG ENER,DG NEAR, DGDEVCO, DGRTD]

- The geopolitics of hydrogen – who are the main actors;
- Promote clean hydrogen in bilateral energy dialogues and in international cooperation fora globally - Japan, South-Korea and US (common taxonomy), Clean Energy Ministerial – Hydrogen initiative - Commission leading with Netherlands, US, Japan and Canada, supported also by the International Energy Agency and the International Renewable Energy Agency. Cooperation under G20.
- International partnership for the Hydrogen Economy (IPHE) - Mission Innovation
- Use Hydrogen to exploit RES potential and promote investments as part of the neighbourhood policy and to promote a low carbon economy globally. Cooperation with Norway and neighbouring countries, promoting investments and replacing gradually fossil fuel imports with green hydrogen imports (incl. Morocco, Ukraine, Algeria, Egypt)
- Hydrogen and security of supply. Possible impact on relations with third countries which have natural gas pipelines to/LNG contracts with the EU.
- EU-Africa development cooperation
- The trade dimension for clean hydrogen: with neighbouring countries, but also with the US, South Africa, Australia.
- The international role of the euro – establishing a benchmark for euro denominated hydrogen transactions.

Some possible key actions:

- Strengthen EU lead role in international fora, notably on setting common definitions for clean hydrogen and methodologies to determine greenhouse gas emissions from hydrogen production, distribution and storage
- In a multi-lateral context (G20, IEA, CEM) the EU will work with international partners to secure open rule-based free trade in hydrogen, including based on clear sustainability criteria.
- Set out a cooperation with the African Union on hydrogen under the Climate Change and Sustainable Energy Partnership
- Set up cooperation with Maghreb countries and Neighourhood on hydrogen
- Develop a benchmark for euro denominated transactions in hydrogen
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7. CONCLUSIONS

- Building a hydrogen Economy to contribute to longer-term objective of decarbonisation of energy system – potential for innovation, job creation, growth.
- What Hydrogen could represent for the energy system of the future – scenarios
- Member States plans for hydrogen resulting from NECPs – need for EU policy steer.
- The role of the Alliance
- Strengthen HyNet cooperation with MS.
- Call on European Parliament, Council, and Member States to discuss these ideas. Follow up legislative proposals in June 2021 will follow better regulation principles.