Energy system coupling, Electricity and Hydrogen

Vision and Challenges

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Role of Hydrogen in Net Zero Goals

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37 Coutries sigend a Declaration of Intent During COP28

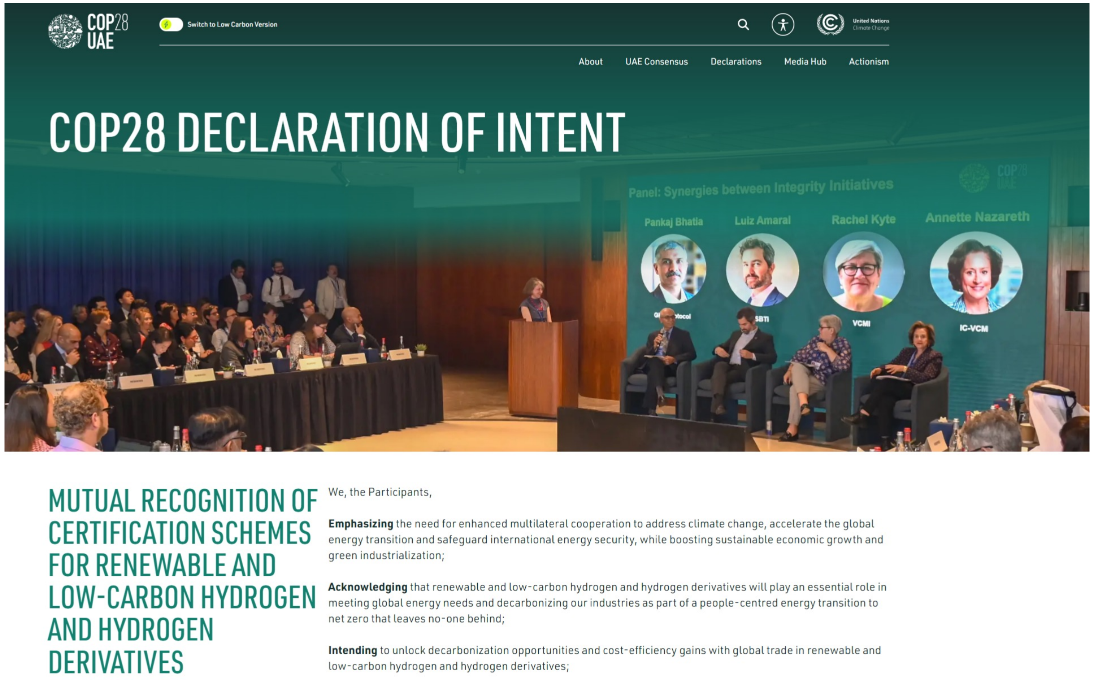
1. In order to pave the way for development of a global market renewable and low-carbon hydrogen and hydrogen derivatives, the Participants seek to work towards mutual recognition of their respective certification schemes;

2. The Participants seek accelerated development of technical solutions to enable mutual recognition of their certification schemes, including through cooperation of the Participants with and under the framework of the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) and the Hydrogen Technology Cooperation Programme (Hydrogen TCP);

3. The Participants seek to, where possible, nominate government experts to IPHE and Hydrogen TCP to facilitate the development of relevant solutions for mutual recognition of their certification schemes for renewable and low-carbon hydrogen and hydrogen derivatives;

4. The Participants may consider further steps to support the process of mutual recognition of certification schemes, including by taking into account the adoption of or consistency with globally recognised standards, such as the ISO methodology for determining the GHG emissions associated with the production and transport of hydrogen;

5. The Participants intend to monitor progress on cooperation towards mutual recognition of certification schemes on an annual basis.



H2 will be a pivotal contributor to abate global carbon emissions by supporting heavy industries to become carbon neutral

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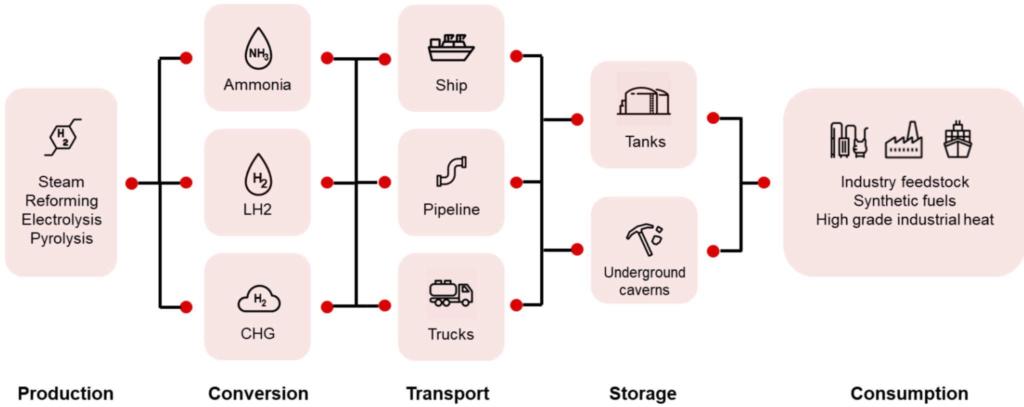
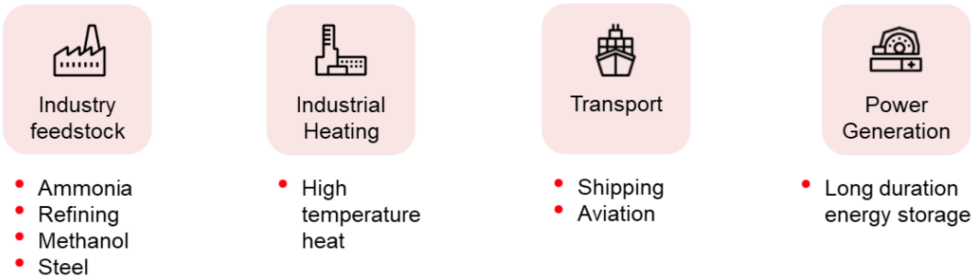
Previous Works and Findings

From C1.48 Work

- As feedstock, green hydrogen is expected to be heavily used in ammonia production, methanol production, refining operations, steel production; as a fuel for industrial process heat at high temperature and for mobility in shipping and aviation
- Use of CO2-free electricity (typically solar and wind) in electrolyzers located as close as possible to the final consumption is the most efficient and economic option for having CO2-free hydrogen (concept of Hydrogen Valleys). This requires enough available physical space, grid expansion, which are less likely to be accessible in the vicinity of the large urban and industrial centers. Therefore, the deployment of a hydrogen system shall also rely on hydrogen transportation and storage, i.e. a new dedicated logistic infrastructure
- Electrolyzers can become a source of flexibility for both shortand
- long-term flexibility needs, providing:
- – Short term flexibility: Grid balancing and frequency control
- – Long term flexibility: Power to Gas (P2G) and subsequent Gas-to-Power (G2P)

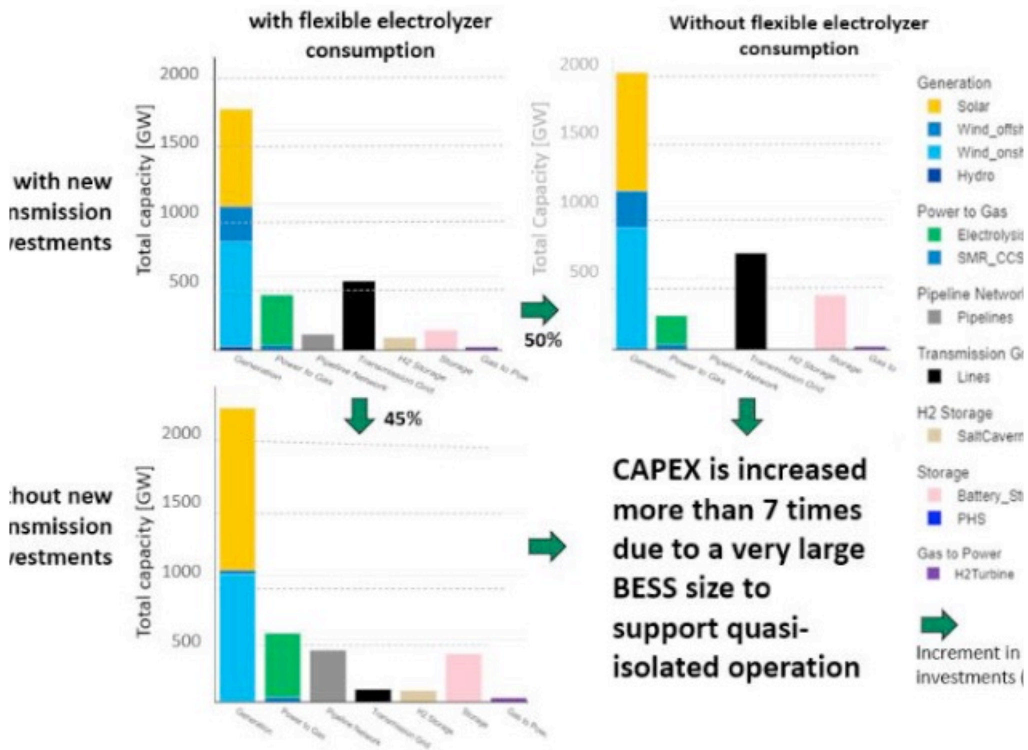




Previous Works and Findings

From C1.48 Work

- The presence of hydrogen flexibility reduces the power load on wind energy and better utilizes the fluctuating solar energy.
- Hydrogen flexibility will play a crucial role in limiting the CAPEX. In this scenario, electrolyzers systemic function requires suitable forms and amounts of remuneration, which are currently not being considered in the business plans by private industrial developers.
- Due to the high cost of hydrogen transport, production of hydrogen should be closer to the end-use points. Without the expansion of electrical transmission grid, the importance of hydrogen network and flexibility to achieve zero emissions and energy demand increases.
- bulk and long distance energy transport, especially if marine paths are involved, hydrogen transport can be cheaper than marine electric cable, especially if done through repurposing existing gas pipelines; repurposing could also be widely applied into inland gas networks, thus changing the comparison of the economics of electric/molecule transport modes



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C1.50 WG - Hydrogen Global Trade

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Objective is to perform a quantitative pre-feasibility study of a global power system including electricity and green hydrogen by 2050.

This pre-feasibility study shall explore the economic costs and benefits:of interactions between electricity and hydrogen supply chain including production, conversion, transport, and storage

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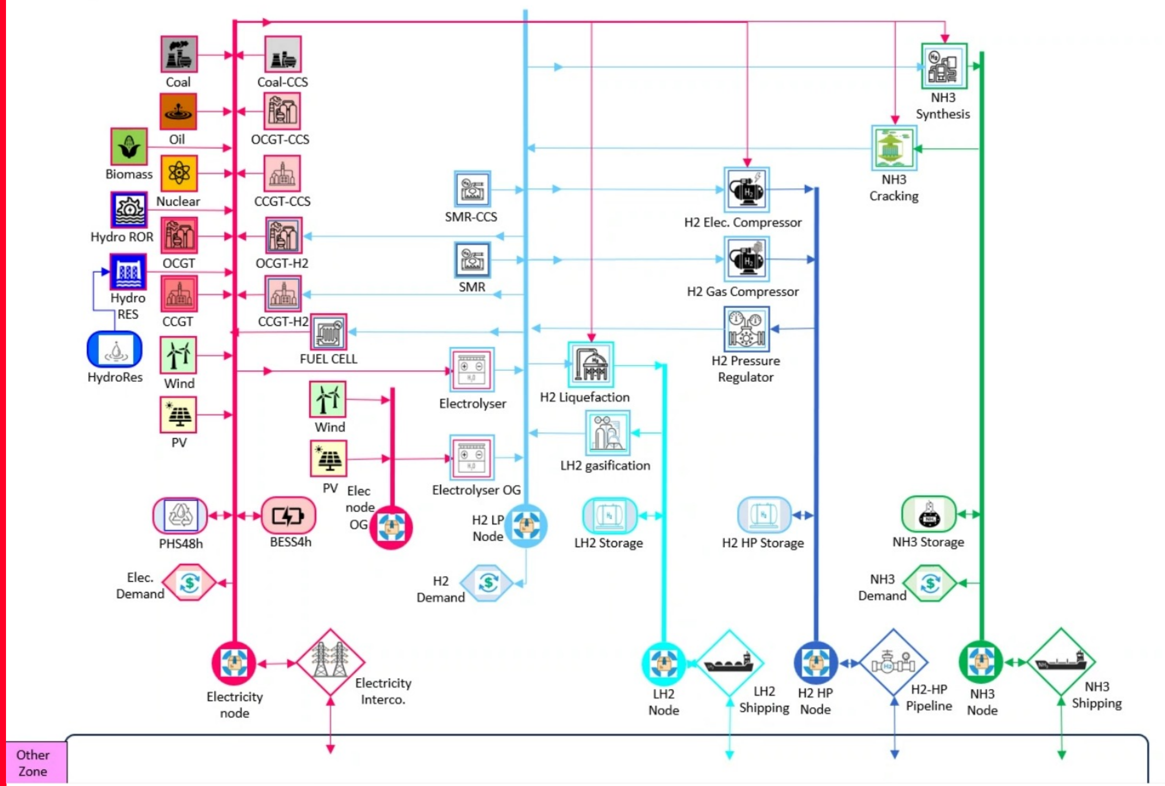
Hydrogen Supply Chain – Complex Game

Forecast and map hydrogen demands in each region and corresponding amount of renewable electric energy supply and installed capacity.

Develop and apply a methodology for modelling hydrogen layer on a global scale including potentials of production, conversion, transport, and storage.

To run the model and to identify the costs and benefits of synergies between electricity and hydrogen in a global power mix system.



CCS: Carbon Capture Storage
H2: Hydrogen
HP: High Pressure
LH2: Liquefied H2
LOHC: Liquid Organic Hydrogen Carrier
LP: Low Pressure
NH3: Ammonia
O-g: Offgrid
SMR: Steam Methane Reforming

Electricity, the backbone of energy transition – A complex game

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Challenges

Power Quality

Green Electricity

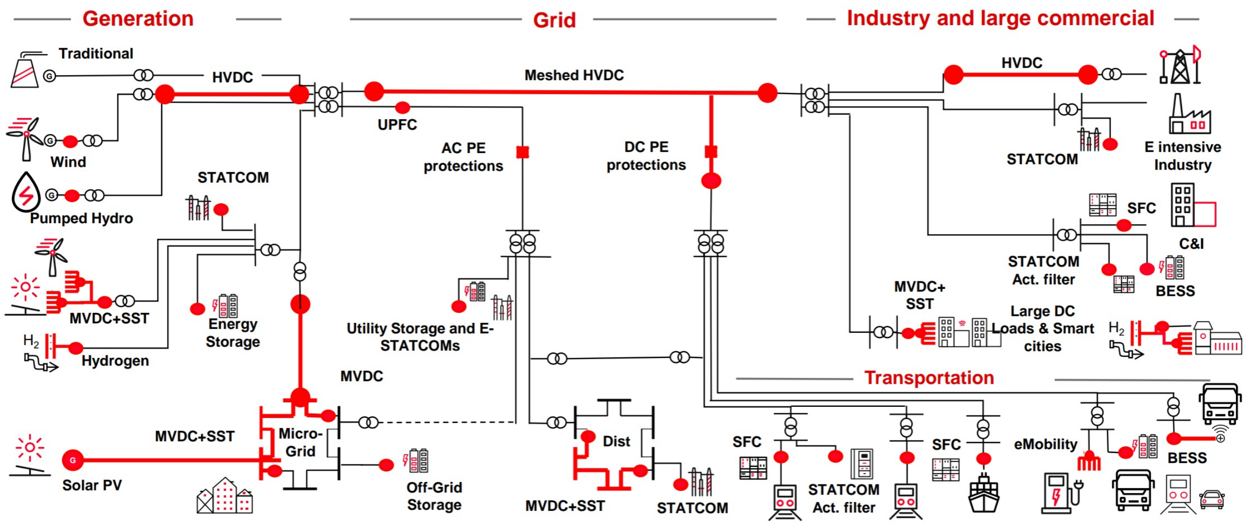
Grid congestion

Grid stability

Grid strength

Availability

Energy intermittency



Services

Grid Forming

Energy and Capacity

- Economic Dispatch

Operating Reserves

- Frequency Response
- Regulating Reserve
- Contingency Reserve
- Ramping Reserve

Other Essential Reliability Services

- Voltage Support
- Black Start Capability

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NC DC - Impact on Scale-up of Hydrogen Economy

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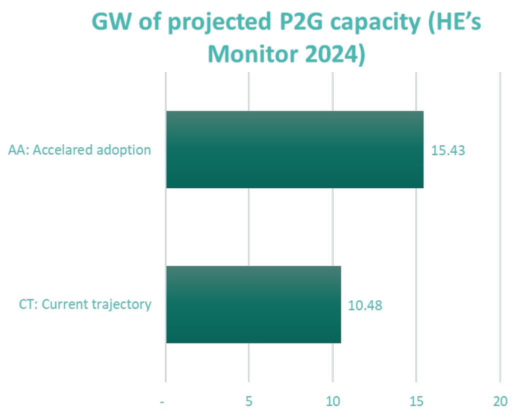
- **Detailed Modelling Requirements:** TSOs require detailed modelling to prove that electrolyzer can fulfill the FRT requirements. This modeling is highly complex for electrolyzer. Multidisciplinary work is required to detailed the dynamic of the plant including the balance of plant, balance of stack and chemical process (up- and down-stream)
- **Long Planning Times:** Electrically, the technology is available to comply with the FRT requirement at the expenses of additional investment. However, the electrolysis technologies necessary to comply with FRT might have require various design changes resulting in various years of development and test before it can become a market service/grid requirements.
- **Decline in FIDs:** The overall impact on the electrical infrastructure in conjunction with the electrolysis technology development will increase the overall investment cost and affect European competitiveness, as investors reduce investment capital due to uncertainty and increase in costs.
- **Impact on Existing Plants:** Planned expansions could be halted due to new grid connection standards
- **Tender Participation Risks:** The lack of certainty about whether electrolyzer can meet the new requirements will impact participation in tenders.
- **Regulation:** New test procedures will need to be developed to ensure all electrolyzer are treated fairly and are in compliance with the new standards



Source: Hydrogen Europe upcoming Clean Hydrogen Monitor, November 2024

The proposed amendment could have significant impact into the market development, slowering the growth and delaying the corresponding investment plans to cope with the netzero goals

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Next Steps

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Complete and implement the functional scheme and interaction among the various regions

Identify and forecast the various economical parameters for the different segment on the functional scheme

Implement and execute the preliminary simulations in Plexus

cigre
For power system expertise

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