IRENA INNOVATION WEEK 2020

SUMMARY OF KEY INSIGHTS FROM SESSION 3: GREEN HYDROGEN: ELECTROLYSIS, AMMONIA AND OTHER E-FUELS

(Organized in partnership with the Hydrogen Council)

SESSION OVERVIEW

The 3rd IRENA Innovation Week took place online between 5-8 October 2020 under the theme **'Renewable solutions for transport and industry**'. Green hydrogen allows large amounts of renewables to be conveyed to end-uses which would otherwise be difficult to be decarbonised. Following Members' call for a continuous dialogue on green hydrogen at IRENA's ministerial roundtable in January 2020, IRENA established the Collaborative Framework on Green Hydrogen in June 2020. Building on findings from previous IRENA's reports on green hydrogen and Reaching Zero with Renewables report that discusses both hydrogen and e-fuels, this session will present findings from IRENA's recent analysis and explore with key partners from government, industry and international organisations insights on recent developments in electrolyser technologies and e-fuels, the potential for cost reduction and the next steps for its successful scale-up in industry and transport sectors.

2 Panels	14 Expert speakers	638 Participants

SUMMARY OF KEY INSIGHTS

Session 3 discussed opportunities for the scale-up production of hydrogen and its derivatives and highlighted key priorities whilst exploring what is needed to sufficiently accelerate innovation across different dimensions (e.g. technological, regulatory, political, economic) to produce these energy carriers in a cost-competitive way and in turn help to accomplish the goal of decarbonizing the end-use sectors of industry, transport and buildings by mid-century. The key points from the discussion were:

- As electrolyser size increases continuously, this leads to a decrease in the total system cost due to economies of scale (p.eg. a same balance of plant can be used for different stacks, among others). In this respect, the standardisation of processes, materials and system elements is important
- Electrolysers have been long in operation, yet the technology is still evolving. R&D initiatives are essential to reduce costs by technology learning at the pace needed for the envisioned energy transition
- Efficiency is decreasing with higher current density, so there is a need to standardise the definition of efficiency at rated power based on AC input to the plant. Besides, project developers should be transparent regarding the plant efficiency for different operation levels which also depends on the specific project application and setup
- Investment and the elaboration of the required supporting schemes are required in order to unlock the full potential of renewable hydrogen
- Integrated design of e-fuels production processes could mitigate renewable variability and minimize the cost of ammonia or methanol
- Green hydrogen definition based on carbon content and certification schemes are key elements in hydrogen and hydrogen-based e-fuels production
- Absence of a liquid market for hydrogen and its derivatives poses a significant offtake risk that requires underwriting. Ensuring long-term off-takers is essential at the current early stages of the market

SCENE SETTING

The opening to the first panel delivered by **Emanuele Taibi,** responsible for **Power Sector Transformation Strategies** at **IRENA,** focused on providing some context on the relevance of green hydrogen for the energy transition as well as IRENA's work (to date and upcoming) in the space of hydrogen. Attendees could learn how the overall costs of green hydrogen behave for different values of renewable power and electrolyser investments. Besides, it touched upon the main elements of green hydrogen facilities that see the best potential to be improved to reduce costs further, as a preview of the upcoming IRENA report on electrolysers for green hydrogen production.

PANEL I: ELECTROLYSIS PRODUCTION

The main objective of this session was to discuss the most promising innovative technological pathways, as well as regulatory and market solutions to produce cost-competitive green hydrogen. Panellists evaluated the potential of different technology options, identified their deployment challenges, weighed their pros and cons, and closed the panel discussion with their vision on what solution is more likely to succeed. The panel was moderated by **Tim Karlsson, Executive Director, IPHE** and the following **panellists** joined the discussion:

- **Armin Schnettler**, Executive Vice President, New Energy Business, Siemens Energy
- **Eiji Ohira**, DG, Fuel Cells and Hydrogen Technology Group, NEDO, Japan
- **Thorsten Herbert**, Director for Market Development and Public Affairs, NEL
- **Denis Thomas**, Global Business Development Leader, Water electrolysis, Cummins-Hydrogenics
- **Jan-Justus Schmidt**, Co-founder, Enapter

Highlights from the discussion:

» The **size of electrolysers is increasing continuously**, bringing the **total system cost down due to economies of scale which, jointly with the technology learning, should further significantly reduce the costs of green hydrogen along the upcoming years.**
» For mobility and hub stations, a 10-20 MW size of electrolysers is becoming more frequent.
» Not only investment costs of electrolysers are important when assessing the economics of green hydrogen, but also the **balance of plants** and **service availability.**
» Countries with different national contexts have acknowledged green hydrogen as a key part of COVID-19 recovery plans, illustrated by the European Momentum with the European Commission that came up with a **new Hydrogen strategy** in July 2020.
» It is essential for the industry to coordinate in the most efficient way in order to utilize funding schemes.
» It is key to have **balance of stacks** and to **partner with EPC** companies who have the know-how.
» The main challenge for the industry is to bring down the cost of hydrogen and make it cost-competitive like fossil fuels. To do so, **standardizing commodities** is key.

SCENE SETTING

The opening to the second panel delivered by **Michele Azalbert, CEO, Hydrogen Business Unit, Engie,** representing the **Hydrogen Council** - the **partner organisation for this session** - focused on how ammonia and e-fuels can be used in the future to decarbonise the energy sector and how these power fuels can be produced from green hydrogen by illustrating it with some real projects. The presentation also highlighted the key activities by which the Hydrogen Council has supported the development of the sector.

PANEL II: AMMONIA AND OTHER E-FUELS

E-fuels, whether hydrogen-based fuels obtained from syngas, derived through biomass gasification or by synthesizing green hydrogen with a source of carbon (CO and CO2 captured from emission streams, biogenic sources or directly from the air) or with nitrogen (in the case of ammonia) represent an attractive direct replacement of their fossil fuel-based counterparts, which is particularly relevant for applications that are hard to electrify e.g. shipping and aviation.

E-fuels' storage, distributions and consumption are possible with existing infrastructure without the need to adapt it. But according to the IRENA's analysis, green ammonia, green methanol and synthetic oil products have production costs that are two to three times higher than fossil-based products. To realise the benefits of e-fuels, some challenges need to be overcome including high electrolysers costs and the need for a cheap and clean carbon source.

This session discussed the key challenges of ammonia and e-fuels production, as well as the main barriers to overcome to scale-up their production. The panel was moderated by **Fernando Gomez, Head, Chemical and Advanced Materials Industry, World Economic Forum** and the following **panellists** joined the discussion:

- Badr Ikken, Director General, IRESEN, Morocco
- Kilian Crone, Team Lead, International Cooperation Hydrogen and Powerfuels, DENA
- Karan Bagga, Chief Engineer, Thyssenkrupp Green Hydrogen & Chemicals Technology
- Dan Feldman, Partner, Shearman & Sterling LLP

Highlights from the discussion:

» **Ammonia** is used today mainly for **fertilizers** production (80-90%) but in the future it could be used for **electricity generation** (co-generation or in coal power plants) or **mobility** (via fuel cells).

» **E-fuels** will be useful mainly to fully **decarbonise the transport sector**, including shipping, aviation, rail and freight transport.

» Countries are working together to build hydrogen and hydrogen-based fuels markets; however, **investment and the elaboration of the required supporting schemes** are required to unlock the full potential of renewable hydrogen, ammonia and e-fuels.

» As an example, countries like **Morocco have plans to become front-runners in exporting hydrogen and its derivatives, while replacing imports of hydrogen-based commodities such as Ammonia,** and plan to develop a technological ecosystem based on green molecules.

» One of the main challenges in ammonia and e-fuels production is that while electrolysers can deal with the variability of solar and wind (at a cost), chemical synthesis processes cannot do it. This can be mitigated by **integrated design from power to electrolysis and then to chemical synthesis**. By optimising so, the whole system costs can be minimised.

» Another key element in e-fuels production is **green definition based on the entire chain carbon content and certification**, especially after hydrogen production: there is a need for additional green electricity for producing ammonia (i.e. powering the Haber-Bosch synthesis), to compress or liquify hydrogen for transport, to power direct-air-capture facilities where carbon is required, etc. There is no consensus on the need for this electricity to be renewable to be able to call the hydrogen green, and this needs to be addressed to create a global market.

» **Absence of a liquid market for hydrogen and its derivatives** like ammonia poses a significant offtake risk that requires underwriting (e.g., what if an off-taker goes bankrupt? Who will buy the product and at which price? However, **there is a global market for methanol**, which limits the power of policies and regulations in providing a green premium for green methanol, as it is a tradeable commodity which competes in a global market (currently, in absence of a global carbon price). Nevertheless, ensuring long-term off-takers for hydrogen-based commodities is essential.