Clean Hydrogen Partnership

Summary of the opinions collected from the wider scientific community on the work Programme of the Clean Hydrogen JU

November 2021

In 2021, during the preparation of the SRIA, the JU made the first attempt to collect the opinions of the wider scientific community via a workshop organised on 30/11/2021 in two sessions, during the second day of the European Hydrogen Week 2021. The JU presented an overview of its planned multi-annual research and innovation (R&I) priorities, covering the whole hydrogen value chain. A particular emphasis was given to the necessary synergies with other end-use partnerships, collaboration with whom will be critical to achieve its goals.

All sectors, including the wider scientific community, were invited to discuss these priorities and ways to bridge the gaps between ready-to-market technology and large-scale uptake, while continuing the efforts to improve and diversify the technological options. A number of relevant points were made during the session discussions, as well as collected through a Q&A application, which are summarised below:

1. There was a general consensus that the partnership approach – including the setting of priorities - followed by its predecessor FCH JU, between the public, private and research sectors, was exemplary. This is proven by the good R&I results of the partnership (and its projects), with the steadily increasing participation of industry and research and the third continuation of FCH JU in its succeeding Clean Hydrogen Partnership.

2. There was also a strong support for the Clean Hydrogen JU to fund activities along the whole hydrogen value chain and across technology readiness levels (TRL). The latter is particularly important, as on one hand early demonstrations are necessary to provide feedback on the developed technologies, while on the other hand low TRL research is essential to provide the next generation of technologies and products.

3. Particular emphasis was given to the need to improve manufacturing capacity and strengthen the capability for mass production, through joint efforts of research with the industry, as this is critical for the envisaged scale up.

4. The activities of the Clean Hydrogen Partnership should also consider the aspect of regional particularities, as optimal production and distribution solutions depend a lot on the local specificities. Here activities such as the hydrogen valleys are considered extremely important (more on the point below).

5. Hydrogen valleys, following an ecosystem approach, should be a priority area. They showcase how the hydrogen economy could work on a local level, but also help identify and resolve issues associated with their operation (and associated business model). Such issues could range from technical ones to purely administrative (e.g. associated with permitting procedures). For a more effective implementation of hydrogen valleys, the idea of creating a sandbox for such projects was proposed. This is in line with the proposal imbedded in the Gas Decarbonisation Package published on 15 December 2021[72].

In terms of specific scientific priorities, a number of priority areas were proposed by the participants, as follows:

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A. **Hydrogen Production**

A.1 Electrolysis

All electrolysis technologies should be addressed in order to achieve their intended large scale deployment in the short-term, but also to find the winning combination of performance, durability and cost in each case. Focus should also be on the system integration. The three main technologies on the market have not the same level of maturity and face different technological challenges.

Low temperature electrolysis

Alkaline technology is mature and already in a scaling-up phase. It is not suitable for dynamic operation. PEM is more efficient than alkaline and adapted to all types of applications (industry, mobility and grid balancing).

PEM technology is getting mature, but research & innovation is still needed to reduce cost and increase durability (especially for HDV applications). Higher efficiency means an increase in current density from 2.2 SoA up to 3 to 4 A/cm^2 in 2030 without affecting degradation rate and durability. The reduction of Critical Raw Materials (CRM) / PGM is a priority, and the ultimate goal is to find alternative catalysts.

High temperature electrolysis

SOEL is a less mature technology, it has the great advantage of not using noble catalysts (though some rare earths and Cobalt). It has the best electrical efficiency thanks to its high temperature of operation. This technology is very relevant when heat is available (steam). Thanks to R&D and demo projects (like Multiplhy project, 2.4 MW in a bio-refinery), it is expected that this technology will become competitive with PEM and alkaline.

A.2 Other routes of hydrogen production

Organic wastes and residues, biogas, biomass, are alternatives to produce hydrogen through fermentation or reforming. The cost of these wastes is predictable and make these technologies competitive if the hydrogen produced is consumed on site. The possibility of blending the hydrogen in the natural gas network might be an option. If the hydrogen produced cannot be used on site, then additional transport costs should be considered. These decentralized sources of production are complementary of large scale production trough electrolysis.

B. **Storage and distribution**

To reach the EU target of 40% of RES in the energy mix in 2030, hydrogen will be the only solution to deal with the issue of the intermittent supply of wind and solar-generated electricity. To store large quantity of energy in hydrogen, large scale underground storage will have to be implemented.

There are already some examples of such storage in UK (salt cavern in Teesside) and Austria (20% H_2 and 80% of CH4 in porous rocks). Overall, it is estimated that there are more than 100 underground storage potential sites in Northern Europe, but there is a lack of knowledge on their long term behaviour. A few demonstration projects will be required, in different locations across EU applying different technologies, to highlight the readiness of hydrogen storage for integration within the overall EU energy system.

Regarding the transport and distribution of hydrogen, several pathways must be also considered, such as LH_2 carriers and pipelines.

C. **End uses**

Research on fuel cells for stationary applications in EU is at a very good level, scaling up will require new manufacturing processes to reduce the costs, especially for CHP in building applications. Electrification of the buildings sector (e.g. via heat pumps) can't achieve on its own EU's ambitious objectives and need to be complemented by other technologies, most notably hydrogen CHP, therefore research efforts should continue. The next step should be the development of CHP systems running on pure hydrogen.

In transport, due to the wide area of applications, the JU should be more focused, considering also international competition. Transport building blocks should be a priority for the JU, including MEA stacks, their membranes and the application of graphite to improve lifetime components. FCEVs will still play a role, especially in heavy duty transport. Here the JU should focus first on new applications and in parallel on platinum free catalysts solutions research which may take more time to lead to the desired results. Recycling aspects should be considered too. Finally, the use of LH_2 in aviation should be a priority.

D. **Cross-cutting activities**

Cross-cutting issues are very important and should not be ignored as they support the whole value chain. The partnership should make an important contribution to the development of skills, in particular to attract young researchers.