Final report

1. Project details

Project title	IEA Hydrogen TCP: Power to Gas arbejdsgruppe (Task 38)
File no.	64014-0516
Name of the funding scheme	EUDP-14_II
Project managing company / institution	DGC
CVR number (central business register)	12105045
Project partners	More than 60 persons representing 39 organisations from 17 countries around the world. Task 38 manager: CEA, France
Submission date	30 December 2020

2. Summary

Power to Hydrogen and Hydrogen to X

The "Power to hydrogen" concept means that hydrogen is produced via electrolysis – often supplied by low carbon and/or low-cost electricity. Electricity supply can be either:

- On Grid
- Off grid
- On grid + Renewable Energy Source connection

With particular attention devoted to:

- Provision of services to the grid
- Characterization of hydrogen relevance for energy storage

"Hydrogen to X" implies that the hydrogen supply concerns a large portfolio of applications:

- **Transport** (hydrogen for fuel cells, biofuels, synthetic methane for transport, etc.)
- **Natural gas grid** (blending H_2 directly with natural gas or synthetizing CH_4 and injecting into the natural gas grid)
- **Re-electrification** through hydrogen turbines or fuel cells
- **General business** of merchant hydrogen for energy or industry, especially refinery, steel industry, ammonia, etc.

- Various **ancillary services and balancing** to the electric power grid

Specific regulations seem to be lacking for several pathways. The specificity of hydrogen being a versatile energy carrier seems often disregarded: only few countries are implementing legal frameworks facilitating diverse hydrogen applications. In addition, the potential benefits of hydrogen production via water electrolysis in contributing to the electric system stability and greater integration of variable renewables seem neglected as well.

The review of the role of hydrogen in the global energy scenarios shows that energy systems models have traditionally not been good at representing the fine details, such as temporal variability, hampering the representation of flexibility options like hydrogen systems.

A main objective of this work is to provide an updated and updatable long-lasting database on Hydrogen technologies allowing improved modelling, understanding and decision making. Additionally, to establish a closer collaboration between the Hydrogen TCP, the ETSAP analysis community and the IEA.

Dansk sammenfatning

Power to Hydrogen og Hydrogen to X

Konceptet "Power to hydrogen" betyder, at brint produceres via elektrolyse – ofte baseret på VE- og/eller billigt elektricitet. Elforsyning kan være enten:

- On Grid
- Off Grid
- On Grid + VEe-tilslutning

Med mulighed for:

- Balanceringsydelser til el-nettet
- Energilagring i form af brint

"Hydrogen to X" indikerer, at brint har en stor portefølje af applikationer:

- Brændstoffer (brint til brændselsceller, biobrændstoffer, syntetisk metan til transport osv.)
- Naturgasnet (blanding af H_2 direkte med naturgas eller syntetisering til CH_4 og afsætning til gasnettet)
- Re-elektrificering via fx brint-gasturbiner eller brændselsceller
- Generel anvendelse af brint til energi- eller industriformål, fx raffinaderi, stålindustri, ammoniak osv.
- Forskellige net-ydelser til balancering til elnettet

Anvendelige og specifikke regler og forskrifter for brint i energisystemet synes i mange tilfælde at mangle og kun få lande implementerer juridiske rammer, der letter introduktionen af forskellige brintapplikationer. Derudover mangler der synliggørelse af PtX teknologiens fordele i form af net-balancering og integration af variable vedvarende energikilder.

Gennemgangen af brintens rolle i de globale energiscenarier viser, at energisystemmodeller traditionelt ikke er gode til at repræsentere detaljer som fx tidsmæssig variation, hvilket hæmmer synligheden af brintteknologiernes fleksibilitet. Det er derfor vigtigt at brintteknologiernes muligheder via ”Power to Hydrogen og Hydrogen to X” synliggøres for at få det fulde udbytte af brint i det fremtidige energimiks.

Et hovedmål med dette arbejde er at levere en database om brintteknologier, der muliggør forbedret modellering og beslutningsgrundlag. Derudover at etablere et tættere samarbejde mellem Hydrogen TCP, ETSAP-analysesamarbejdet og IEA.

3. Project objectives

General Objectives of the project

- to provide a comprehensive understanding of the various technical and economic pathways for power-to-hydrogen applications in diverse situations
- to provide a comprehensive assessment of existing legal frameworks
- and to present business developers and policy makers with general guidelines and recommendations that enhance hydrogen system deployment in energy markets

A final objective was to give hydrogen visibility as a key energy carrier for a sustainable and smart energy system, for different time frames.

The work was scheduled to take place over a four-year period, and is structured in two phases:

- a general state of the art survey of existing studies on techno-economic and business cases, existing legal framework, and macro-economic impacts, including demo/deployment projects
- detailed specific cases studies, based on detailed targets defined during the first phase, together with elaboration of legal and regulatory conditions, policy measures, and general guidelines for business developers as well as public and private financial mechanisms and actors

Results and outline of the project report (Task 38 final report, 328 pages, Link at 8))

The project report first chapter elaborates on P2X pathway definitions with the aim to clarify terminologies that are often used but with different meanings which leads to misunderstanding.

Once the hydrogen pathways from the production step to the application are defined, the second chapter tackles the current hydrogen status. As numerous its energy applications are, hydrogen is mainly used today as a chemical component in industries like ammonia production and refineries. The energy related hydrogen pathways are currently mainly seen through demonstration projects. Hence, the second chapter of this document suggests a review of the P2X demos around the world. The challenges are mainly related to cost and regulatory issues.

In Chapter 3, a review of the incentives and regulatory barriers with regards to hydrogen deployment is proposed for several regions represented by Task 38 experts.

Chapter 4 addresses the techno-economic aspect of P2X pathways, starting with a review of studies tackling this issue, and then focusing on electrolyser cost projections assessing their impact on renewable hydrogen price settings. A fourth part of Chapter 4 also addresses the flexibility potential of electrolysis and the possibility to provide services to the grid, services that can help improve the profitability of hydrogen production.

Three kinds of stakeholders can influence the hydrogen deployment in a specific region:

- industries setting the hydrogen system price (that depends on its costs)

- policy makers that show ambition or not in hydrogen deployment and that act accordingly to make sure the regulatory framework is suitable
- and finally, academics and organizations running models and publishing energy system scenarios, so often used to enlighten industries and policy makers

Chapter 5 presents a review on the role of hydrogen in the renowned global energy scenarios analysing whether hydrogen is suitably presented or not, based on the available techno-economic data, but also conducting a deeper analysis to inspect whether hydrogen pathways are well presented in the models used to generate the scenarios. Some conclusions and best practices for scenarios development and hydrogen modelling are provided.

In Chapter 6, the case studies are conducted and analysed.

Finally, yet importantly, the final chapter of the results part proposes a set of recommendations regarding P2X development based on the expertise of Task38 members.

4. Project implementation

Project execution

The project was defined by the IEA Hydrogen TCP and organised as Task 38 with 5 subtasks and 4 task forces. The task participation has been successful with more than 60 members representing 39 organisations from 17 countries.

Task manager: CEA, France

Task Structure

Subtasks

1. Task management
2. Mapping and review of existing demonstration projects
3. Review
    a. Review and analysis of the existing techno-economic studies on PtH and HtX
    b. Review of the existing legal context and policy measures
4. Systemic approach - The curious case of conflicting roles of hydrogen in global energy scenarios
5. Case Studies

Task Forces:

- Power to Hydrogen and Hydrogen to X pathways: Clearing the Definitions from ambiguities
- EL Data State of the art CAPEX data for water electrolysers, and their impact on renewable hydrogen price settings
- Services to the Grid
- Data

Challengers and risks

The large number of participants is a challenge and a risk for the project, because large efforts and many resources must be allocated to coordination, administration, and data collection. In this case the project manager CEA had the “power” to run the project and at the same time the Hydrogen TCP ExCo was well engaged in the project management by the ExCo chair, who has been the mentor of the project.

Milestones

The project has almost been in accordance with the milestones, but there was a delay in the task definition phase, which did extend the project kick-off.

This is a general observation when initiating new tasks and within the Hydrogen TCP there is an ExCo work on procedures to limit the task definition phase, which often takes one to two year.

Unforeseen

During the reporting phase the Covid19 situation delayed the final report and did postpone the final task meeting and parts of the dissemination to 2021.

5. Project results

Objective and outcome

Based on the results of the Sub-Tasks and the Task Forces, a set of recommendations for easing the deployment of Power-to-X systems is developed.

Techno-economic, regulatory, and modelling related recommendations are addressed allowing to target a wide range of stakeholders: policy makers, industries and analysts (academic, research organizations, etc.). A global database of Power-to-X demonstration projects is developed and collaboration on standardization issues related to hydrogen is initiated with CEN.

The outcome of the project is very much in line with the project proposal worked out during the task definition phase.

Major project accomplishments

- Round table organization and participation at WHEC 2018: “The Role of Hydrogen in the Energy Policies”

  As part of the 22nd edition of the World Hydrogen Energy Conference (WHEC 2018), a round table co-organized by the IEA's Hydrogen TCP Task 38 and the Hydrogen Council and moderated by Paul Lucchese (Capenergies, France) brought together researchers and industry stakeholders to talk about the role of hydrogen in energy scenarios with an orientation towards modeling and data aspects.

- Workshop on Power-to-X demonstrations in Aix-en-Provence

  An international workshop on the analysis of Power-to-X demonstration projects was organized on November 20, 2018 in Aix-en-Provence, hosted at the National School of Arts and Crafts (Arts et Métiers) by Capenergies and sponsored by GRTgaz.

- Workshop on hydrogen in energy models in Bath

  In the framework of Task 38, a workshop on the theme “Energy system models and the role of hydrogen” was organized at the University of Bath on May 17th, 2017. Bringing together 40 participants, this workshop aimed to provide a forum for discussions on energy system models (objectives, specificities) and the potential role played (or not) by hydrogen in these models.

- Workshop on Hydrogen in the Mediterranean region in Puertollano

  In the framework of the Task38, a workshop dedicated to the potential of a Mediterranean hydrogen hub was held on September 26, 2019 in Puertollano (Spain), hosted by the National Hydrogen Center (CNH2), and co-organized by CNH2, Task 38 and Capenergies.

Papers

Five papers have been published in international journals, mainly in the International Journal of Hydrogen Energy, and one paper is still under review. A wide range of topics has been addressed: regulatory framework, demonstration projects, power to X systems modelling, electrolyser costs, etc. A list is available below:

- Z. Chehade, C. Mansilla, P. Lucchese, S. Hilliard, J. Proost. 2019, IJHE, Review and analysis of demonstration projects on power-to-X pathways in the world:

  https://www.sciencedirect.com/science/article/pii/S0360319919333142

- C. J. Quarton, O. Tlili, L. Welder, C. Mansilla, H. Blanco, H. Heinrichs, J. Leaver, N. J. Samsatli, P. Lucchese, M. Robinius and S. Samsatli. 2019, Sustainable Energy&Fuels, The curious case of the conflicting roles of hydrogen in global energy scenarios:

  https://pubs.rsc.org/en/content/articlelanding/2020/se/c9se00833k#!divAbstract

- Dolci, D. Thomas, S. Hilliard, C. Fúnez Guerra, R. Hancke, H. Ito, M. Jegoux, G. Kreeft, J. Leaver, M. Newborough, J. Proost, M. Robinius, E. Weidner, C. Mansilla, P. Lucchese. 2019, IJHE, Incentives and legal barriers for power-to-hydrogen pathways: An international snapshot:

  https://www.sciencedirect.com/science/article/pii/S0360319919309693

- J. Proost, 2019, IJHE, State-of-the art CAPEX data for water electrolysers, and their impact on renewable hydrogen price settings:

  https://www.sciencedirect.com/science/article/pii/S0360319918324157

- J. Proost, 2020, IJHE, Critical assessment of the production scale required for fossil parity of green electrolytic hydrogen:

  https://doi.org/10.1016/j.ijhydene.2020.04.259

Participation in conferences (WHEC, P2G, EEM, IAEE)

- P. Lucchese, A. Le Duigou, C. Mansilla, Power-to-Hydrogen and Hydrogen-to-X: System Analysis of the techno-economic, legal and regulatory conditions: A new task of the IEA Hydrogen Implementing Agreement, 21st World Hydrogen Energy Conference (WHEC 2016), Zaragoza, Spain, June 13-16, 2016. Oral Communication.

- R. Dickinson, F. Dolci, A. Le Duigou, P. Lucchese, N. Lymperopoulos, P. Mancarella, C. Mansilla, S. Samsatli, N.J. Samsatli, D. Thomas, M. Weeda, E. Weidner, O. Tlili, Power-to-Hydrogen and Hydrogen-to-X pathways: Opportunities for next energy generation systems, 14th International Conference on the European Energy Market (EEM15), Dresden, Germany, June 6-9, 2017. Oral Communication.

- M. Robinius, L. Welder, S. Ryberg, C. Mansilla, M. Balan, F. Dolci, R. Dickinson, R. Gammon, P. Lucchese, N.D. Meeks, A. Pereira, S. Samsatli, J. Simon, O. Tlili, S. Valentin, E. Weidner, Power-to-Hydrogen and Hydrogen-to-X: Which markets? Which economic potential? Answers from the literature, 14th International Conference on the European Energy Market (EEM15), Dresden, Germany, June 6-9, 2017. Oral Communication.

- J. Proost, State-of-the-art CAPEX data for water electrolysers, and their impact on renewable hydrogen price settings, European Fuel Cell conference & exhibition (EFC17), Naples, Italy, December 12-15, 2017

- P. Lucchese, C. Mansilla, F. Dolci, R. R. Dickinson, C. Funez, L. Grand-Clément, S. Hilliard, J. Proost, M. Robinius, M. Salomon, and S. Samsatli, Power-to-Hydrogen and Hydrogen-to-X: latest results of Task 38 of the IEA Hydrogen Implementing Agreement, European Fuel Cell conference & exhibition (EFC17), Naples, Italy, December 12-15, 2017.

- M. Robinius, J. Linssen, C. Mansilla, M. Balan, F. Dolci, R. Dickinson, C. Funez, L. Grand-Clément, S. Hilliard, H. Iskov, J. Leaver, A. Pereira, J. Proost, C. Quarton, S. Samsatli, O. Tlili, S. Valentin, E. Weidener, P. Lucchese, Techno-economic Potentials and Market Trends for Power-to-Hydrogen and Hydrogen-to-X based on a Collaborative and International Review, 22nd World Hydrogen Energy Conference (WHEC 2018), Rio De Janeiro, Brazil, June 17-22, 2018. Oral Communication.

Technology Briefs

Three technology briefs have been published on the IEA Hydrogen TCP website. A list is suggested below. A fourth brief will soon be available to address the participation of hydrogen to the electricity security market.

- S. Hilliard, R. Dickinson, P. Mancarella, C. Mansilla, 2017?, What services to the grid? What hydrogen can do?

- J. Proost, S. Saba, M. Müller, M. Robinius, D. Stolten, 2018, Electrolysis: What are the investment costs? State of the art and outlook.

- Dolci, D. Thomas, S. Hilliard, C. Fúnez Guerra, R. Hancke, H. Ito, M. Jegoux, G. Kreeft, J. Leaver, M. Newborough, J. Proost, M. Robinius, E. Weidner, C. Mansilla, P. Lucchese, 2019, Power-to-Hydrogen / Hydrogen-to-X: What are the incentives and legal barriers? Current status in Belgium, France, Germany, Italy, Japan, New Zealand, Norway, Spain, The Netherlands, and the UK.

6. Utilisation of project results

Power-to-X roadmap

An IEA Hydrogen TCP Power to X road map will be published in 2021 as a final output of Task 38.

Power-to-X global project database

One of the deliverables, the demo projects database, was extensively used in The IEA report "The future of Hydrogen", delivered to G20 summit in Japan in 2019.

The database will continuously be updated and be one of the main assets for the IEA Hydrogen TCP.

Task 41 Data and Modelling

Task 41 is a successor project to Task 38 (Power-To-Hydrogen and Hydrogen-To-X) and Task 30 (Global Hydrogen Systems Analysis). The task has four subtasks, each contributing to the overall goal of providing updated parameters describing Hydrogen technologies, as well as to develop knowledge of how to model Hydrogen in the value chain.

The main objectives of this task are to provide an updated and updatable long-lasting database on Hydrogen technologies allowing improved modelling, understanding and decision making. Additionally, the Task aims to establish a closer collaboration between the Hydrogen TCP and the ETSAP analysis community. The IEA is expected to be a major beneficiary of this task.

Results - Pathway specific recommendations

<u>Power to H_2</u>

Upstream, low-carbon hydrogen production requires low-carbon electricity. Energy policies should promote renewable energy penetration, or more generally low-carbon electricity. This is a win-win strategy since hydrogen production can serve as a measure to avoid curtailment of excess electricity, to adjust the power demand by providing grid balancing services, or even to allow more renewable electricity to enter new applications in the form of a green gas, green chemical and green fuel. Hydrogen business cases can become more profitable when hydrogen systems can participate in grid balancing or ancillary services and capacity mechanisms. Hence, acknowledging the PtX flexibility potential and regulating it is required. Further incentives can consider exempting electrolysis from paying electricity taxes for example, or subsidizing part of the electrolyser cost. Penalizing the fossil-based competitor is also crucial to trigger the market. At present, there is a lack of regulations or penalties being applied to conventional polluting methods of hydrogen production to make them more expensive and ease the transition to low-carbon hydrogen. Carbon pricing can be one of the important mechanisms to consider.

<u>H_2 to X</u>

Downstream, hydrogen system deployment can be fostered by sector-specific measures, via implementing standards and/or incentives during the transition.

<u>H_2 to Power</u>

The hydrogen to power pathway is still expensive today. It may have sense when considering peak hours as previously explained (techno-economic recommendations). However, in order to reach competitiveness, penalizing fossil peak electricity generation means is essential. In a world where fossil fuel means are forbidden, hydrogen may be the only way to produce electricity during peak hours and hence contribute to the stability of the electricity system during "stress" hours.

<u>H_2 to Gas</u>

The injection into natural gas networks will need government support to promote its market penetration. Acknowledging the actual greenhouse gas mitigation for gas applications by also accounting the contribution of methane leakages during processing and transport of natural gas (and implement the relevant incentives/penalties accordingly); a clear target for the hydrogen blending concentration into the gas grid could be set. This concentration currently varies a lot from one region to another. It can reach 10% (of the volume) like in Germany for example, while it does not exceed 6% in France and 0.1% in the UK A harmonization of the standards at the European level (but not only) is crucial to prepare a more suitable market penetration environment. Standards for natural gas pipeline systems, underground storage and use of gas mixtures in burners have generally been designed from the viewpoint of a few percent hydrogen in natural gas. In the years to come, if hydrogen gas becomes the norm, these standards need to be revised.

A system of Guarantees of Origin can be set for biogas and hydrogen as an appropriate measure to stimulate the use of renewable gases.

Additionally, to foster the development of "green" gas, feed-in tariffs may be implemented in the transition. Such schemes exist for bio-methane injection. Hydrogen or synthetic methane could be made eligible for similar support.

A quota system can also be discussed, to foster the H_2 to gas applications.

H_2 to Fuel

HtF-H_2

Regarding the mobility market segment, moving to the decarbonisation of the transport sector may go through the coexistence of the different technologies to be able to meet the GHG emissions reduction targets. Setting a pledge for the carbon emission reductions related to the transport sector is important but not sufficient since it does not clarify the prospects for each low-carbon mobility option. It is leading to the misconception of considering that these options will only compete against each other, while they can complement each other to achieve the targets. A clear strategic roadmap leading to the realization of the pledged targets is required. Incentives could also include, in the transition, grants to reduce the vehicle price paid by the consumer. It is then important to think beyond the sole light passenger duty vehicles (i.e. by including trucks, trains, maritime use), and incentivize the infrastructure development jointly with the vehicle purchase. Other financial support mechanisms include carbon pricing and carbon related taxation for vehicles, which allows penalizing the fossil-based alternatives and help hydrogen vehicles reach competitiveness. A system of tax and/or fees exemptions (example: registration fees and highway tolls) can also be considered to promote clean technologies, including hydrogen).

HtF-S (Syn fuel) and HtF-G (Gas fuels for transport)

The economy of E-fuels being partly based on the carbon price, setting a clear framework of carbon pricing can be one of the major political responsibilities to foster this market. Besides, setting quotas for fuel shares (for instance in aviation, shipping, other) can help boost the use of these synthetized fuels and initiate economies of scale.

H_2 to Industry

The existing industrial markets: Refineries together with H_2-to-Ammonia and H_2-to-Methanol are expected to continue to drive the hydrogen demand worldwide. However stronger environmental constraints (regarding the sulphur content or the carbon footprint of these industry activities) can play a major role in enhancing the hydrogen demand. As a matter of fact, according to, refineries will have to invest in larger capacities for hydrogen production to cope with the new environmental measures in the maritime sector. Promoting the use of low-carbon hydrogen in industry by implementing adequate certificates, subsidies and/or penalties; ensure a "level playing field" for products obtained with low-carbon hydrogen, which can foster the transition to low carbon hydrogen production via the development of electrolysis. Low carbon Hydrogen could help to revamp, or update potential “stranded” assets, like gas turbine, by replacing fossil fuels (e.g., natural gas) by hydrogen for example.

Commercialisation of Power-to-X technologies

Overall, to unleash the hydrogen potential, governmental support is needed. Private industrial initiatives cannot, alone, foster its development. Governmental and regional support can take different forms. It can be financial like granting subsidies, feed-in tariffs or premiums (which is already the case for the injection of biogas into the grid, and in some countries for EV). Or it can be setting standards or targets such as the concentration of hydrogen into the NG grid, or the modalities of a potential hydrogen participation to the electricity reserve market. Thus, relevant policies require a holistic approach, by proposing adequate measures for the industry and energy sectors (gas and power) adapted to the regional contexts.

Project results contributes to realise energy policy objectives

In 2015, when IEA Hydrogen TCP initiated Task 38 “Power to Hydrogen and Hydrogen to X” the concept Power-to-Gas was rather new and known as a potential technology to treat surplus of power.

Since then, a global focus on GHG reductions and renewable power production from wind and PV has transformed Power-to-Gas solutions to one of the most important future energy technologies, to phase out fossil fuels from power production, heating, and transport applications.

This has not happened because of the work of Task 38, but Task 38 has facilitated international collaboration and knowledge sharing on Power-to-Gas technologies and supported the IEA with data and analysis pointing out the potential of Power-to-Gas and hydrogen.

In the Danish Climate action plan energy islands is foreseen to be an important component in the future energy system, and if realised, Power-to-X is a key technology.

7. Project conclusion and perspective

The value chain for low-carbon hydrogen is not completely developed at commercial scale today. Depending on the PtX pathway and on the step of the supply chain, different stages of maturity are faced with specific technical challenges. As stated in the IEA Innovation report, unlocking the steps of the supply chain with the lowest maturity levels is essential to allow the deployment of the full pathway. To do so, further research, development, and innovation (R&D&I) is required as well as further demonstration projects.

This is not only the responsibility of research organizations or industries working on the specific related technologies, but also of governments and local authorities via the adequate R&D&I financing tools. Overall, improvements are still needed to ensure a high global efficiency of the pathway.

The use of critical materials is also problematic and further research should be dedicated to this issue. Enhancing the lifetime of certain technologies such as SOEC by improving the material stability is also one major research field to be supported. The Innovation IEA report details specific recommendations to foster innovation in Power-to-X field among other new technologies.

For more developed pathways, the challenges are different. The latter are rather addressing the economic viability of the Power-to-X systems, and the related technologies. Several technologies have reached the required maturity and the next step is to be deployed in the market. However, only relying on the market system will not allow these technologies to enter market, since these technologies are today not competitive compared with fossil-based solutions providing the same services.

The highlighted next step is upscaling. This will allow reducing the costs because of the economies of scale and the learning experience behind. When the demand is existent, one way to do it is by building on existing industries, and infrastructure. For instance, the IEA Hydrogen report highlights the importance of making industrial clusters the nerve centres for scaling up the use of clean hydrogen. This offers “the opportunity to create hubs that bring down the cost of low-carbon hydrogen pathways and kick-start new sources of demand”. In particular, the coastal industrial hubs, located near ports, can be attractive.

Beyond relying on the existing demand in industry to bring down the costs, benefiting from the existing infrastructure, when possible, can help prevent big expensive delivery infrastructure investments.

By relying on the existing industrial demand to scale up clean hydrogen technologies, and reduce the costs, the new demands can be fostered. However, this does not mean to focus on the industrial pathway only. The other pathways (HtF, HtG, HtQ) also need to be advanced to reach appropriate scale for competitive technologies.

One business case helping to improve the overall system cost is targeting different markets for the produced hydrogen as part of the sector coupling potential. This will help enhance the profitability of the electrolysers by increasing its utilisation rate, while helping to unlock new markets with lower hydrogen production costs.

Next to the economics of hydrogen systems, there is also the environmental impact. The interest in hydrogen is led by the environmental concern and the target to lower the global GHG emissions. For a specific service, the interest in substituting fossil-based technologies by hydrogen-based ones is conditioned by the carbon footprint of the hydrogen production.

Low carbon hydrogen production may not match big hydrogen demand hubs, geographically speaking. Hence, a need for international trading of hydrogen is foreseen. It will allow linking the regions with low carbon hydrogen production potential with regions where the demand is voluntarist but under low carbon production resource constraints. Hence kick-starting international hydrogen trade for ultimate global low-carbon market – (Asia Pacific, Middle East, North Africa, Europe) will be one of the next major steps to be taken.

Next steps and further use of project results

After closing the Task 38, further collaborations and events are also foreseen to ensure a continuity of the work, so that it would not be a “one shot” work effort.

Establishment of a joined IEA Secretariat/Hydrogen TCP Database on projects deployment

Based on the feedback of the database on Power-to-X demo projects, a reference database will be established in 2021 through a collaboration between the IEA Secretariat Paris and the Hydrogen TCP. This database will include information on all hydrogen production deployment projects. This database will be very useful for data modelling, statistic, tracking progress on hydrogen deployment and many IEA tools.

Collaboration with Task 41 Data and Modelling

Task 41 address the hydrogen data and modelling issues in details, addressing the representation of hydrogen in different sets and types of energy system models, including TIMES based models.

The main objectives of this task are to provide an updated and updatable long-lasting database on Hydrogen technologies allowing improved modelling, understanding and decision making. Additionally, the Task aims to establish a closer collaboration between the Hydrogen TCP and the ETSAP analysis community. The IEA is expected to be a major beneficiary of this task.

8. Appendices

- Add link to relevant documents, publications, home pages etc.

TASK 38 Final Report:

- Power-to-Hydrogen and Hydrogen-to-X: System Analysis of the techno-economic, legal, and regulatory conditions

  LINK: https://www.ieahydrogen.org/task/task-38-power-to-hydrogen-and-hydrogen-to-x/