

POWER-TO-HYDROGEN AND HYDROGEN-TO-X: LATEST RESULTS OF TASK 38 OF THE IEA HYDROGEN IMPLEMENTING AGREEMENT

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Abstract - Task 38 of the Hydrogen Implementing Agreement of the IEA is dedicated to the analysis of Power-to-Hydrogen and Hydrogen-to-X pathways, with a final objective of providing business developers and policy makers with recommendations to enable hydrogen as a key energy carrier for a sustainable integrated energy system. This paper offers an appraisal of the recent work, mostly dedicated to review and state-of-the-art analysis.

Index Terms – HIA, Power-to-Hydrogen, Power-to-X

I. INTRODUCTION

Energy systems are changing around the world due to a variety of factors [1]-[2]:

- Increasing demand for energy in the world due to globalization and emerging countries;
- Increasing renewable share in the energy mix, especially in the electricity mix;
- Greenhouse gas constraints and CO₂ emission reduction targets in the energy sector;
- Local pollution constraints;
- Deregulation in the energy system, allowing new challengers to enter the market;
- Energy security constraints, system reliability objectives;
- Decentralisation of energy production systems.

The balancing of the electricity grid is increasingly challenging as the installed renewable energy capacity is increasing. Solutions such as transmission super grids, smart

grids, energy storage, demand management, and back-up capacity implementation can contribute; but new measures that go beyond increasing transmission capacity and flexible generation or consumption will have to be introduced to manage the grid as the level of renewable energy sources is increased. Power-to-hydrogen (PtH) system components are clearly part of the broader picture [3]. Hydrogen production via electrolysis makes it possible to quickly adjust the power consumption: electrolyzers can reach full load operation in a few seconds [4]. They can also decrease demand in sub-seconds for providing frequency control services. As a result, hydrogen production can be an economically and technically attractive way to contribute to power systems management.

The “Power-to-hydrogen” concept means that, especially once hydrogen is produced from low-carbon electricity, a potentially large portfolio of uses is possible. Applications across diverse sectors include transport, green chemistry, electrification (i.e. power storage), blending with natural gas, and also the general business of merchant hydrogen for energy or industry. Providing ancillary services or grid services for the electricity grid, transport or distribution grid may also be considered. Indeed, hydrogen can provide flexible energy storage and carrier options which could help in managing the energy system. With these benefits in mind, a task of the Hydrogen Implementing Agreement (HIA) of the International Energy Agency (IEA) was approved in October 2015 by the 72nd HIA Executive Committee as “Task 38”, to examine

hydrogen as a key energy carrier for a sustainable integrated energy system. It is entitled: “Power-to-Hydrogen and Hydrogen-to-X: System Analysis of the techno-economic, legal and regulatory conditions”. This paper presents the Task and its latest achievements.

II. TASK DESCRIPTION

The general objectives of the Task are: i/ to provide a comprehensive understanding of the various technical and economic pathways for power-to-hydrogen applications in diverse situations, ii/ to provide a comprehensive assessment of existing legal frameworks, and iii/ to present business developers and policy makers with general guidelines and recommendations that enhance hydrogen system deployment in energy markets. A final objective will be to develop hydrogen visibility as a key energy carrier for a sustainable and smart energy system, within a 2 or 3 horizon time frame: 2030 and 2050, for example. The work is slated to take place over a four-year period, and is structured in two phases:

- 1/ a general state-of-the-art survey of existing studies on techno-economic and business cases, existing legal framework, including demo/deployment projects;

- 2/ 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.

Today, the task gathers over 50 experts of 37 organisations from 17 countries.



Fig. 1. Affiliations of the Task 38 members

III. LATEST ACHIEVEMENTS

The first phase involved several actions. To start with, the main PtH pathways and interconnections were identified in a way that overcomes the ambiguities inherent in the term “Power-to-Gas”. In turn, this aims at providing solid and easier to understand foundations for building legal and regulatory frameworks for new business opportunities [5].

Another part was dedicated to the compilation of state-of-the-art technical and economic data on large-scale water electrolyser systems, both for PEM and alkaline technology, from the major electrolyser manufacturers worldwide [6]. A workshop on PtH demonstrations will also help identify the

next steps towards commercialization.

An extensive literature review of the current PtH literature was undertaken [7]. The aim was to capture diversity within the current literature and draw some major conclusions from it. Over 200 documents were reviewed with a methodology developed to analyze the variety of studies considered. This reviewing effort relied on the participation of the members of Task 38, both to co-construct a database of existing studies on PtH and to review the works. The first step is almost complete and will be followed by in-depth analysis of the most relevant studies. A similar approach is being applied for the review of the regulatory and legal context for PtH, in a number of countries. Business cases will be assessed, building on this thorough review step.

Modelling is not neglected either. A workshop was organized by the University of Bath on energy system modelling and the role of hydrogen. Lively and productive debates dealt with the key issues and future avenues for hydrogen systems research. Data is a key issue in this context, to be addressed in a more global IEA HIA approach.

IV. CONCLUSION

Task 38 of the Hydrogen Implementing Agreement is dedicated to the analysis of PtH pathways, with a final objective of providing business developers and policy makers with recommendations to enable hydrogen as a key energy carrier for a sustainable integrated energy system. Recent work was mostly dedicated to review and state-of-the-art analysis. Building on this, next steps will also involve modelling to develop relevant recommendations.

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