

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

Alain Le Duigou - CEA

Christine Mansilla - CEA

Paul Lucchese, ExCo Father and Mentor of the Task - CEA



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

Scope of the Task 38

What?

The “**Power-to-hydrogen**” concept means that hydrogen is produced via low carbon electricity electrolysis

Electricity supply can be either:

- *Grid connected*
- *Off-grid*
- *or hybrid systems*

With particular attention devoted to:

- *Provisions of services to the grid*
- *Characterization of hydrogen’s relevance for energy storage.*

“**Hydrogen-to-X**” implies that the hydrogen supply concerns a large portfolio of uses:

- Transport : hydrogen for fuel cells;
- “Green” gas (either through methanation or not)
- Industry (refinery, steel, ammonia, synfuels, etc.);
- Re-electrification (towards the power grid or for remote areas).

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

Objectives of the Task 38

Why?

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**;

To provide business developers and policy makers with **general guidelines and recommendations** that enhance hydrogen system deployment in energy markets.

The overarching objective will be to develop hydrogen visibility as a key energy carrier / chemical intermediate for a sustainable and smart energy system, within a 2 or 3 horizon time frame: 2020, 2030 and 2050, for example.

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

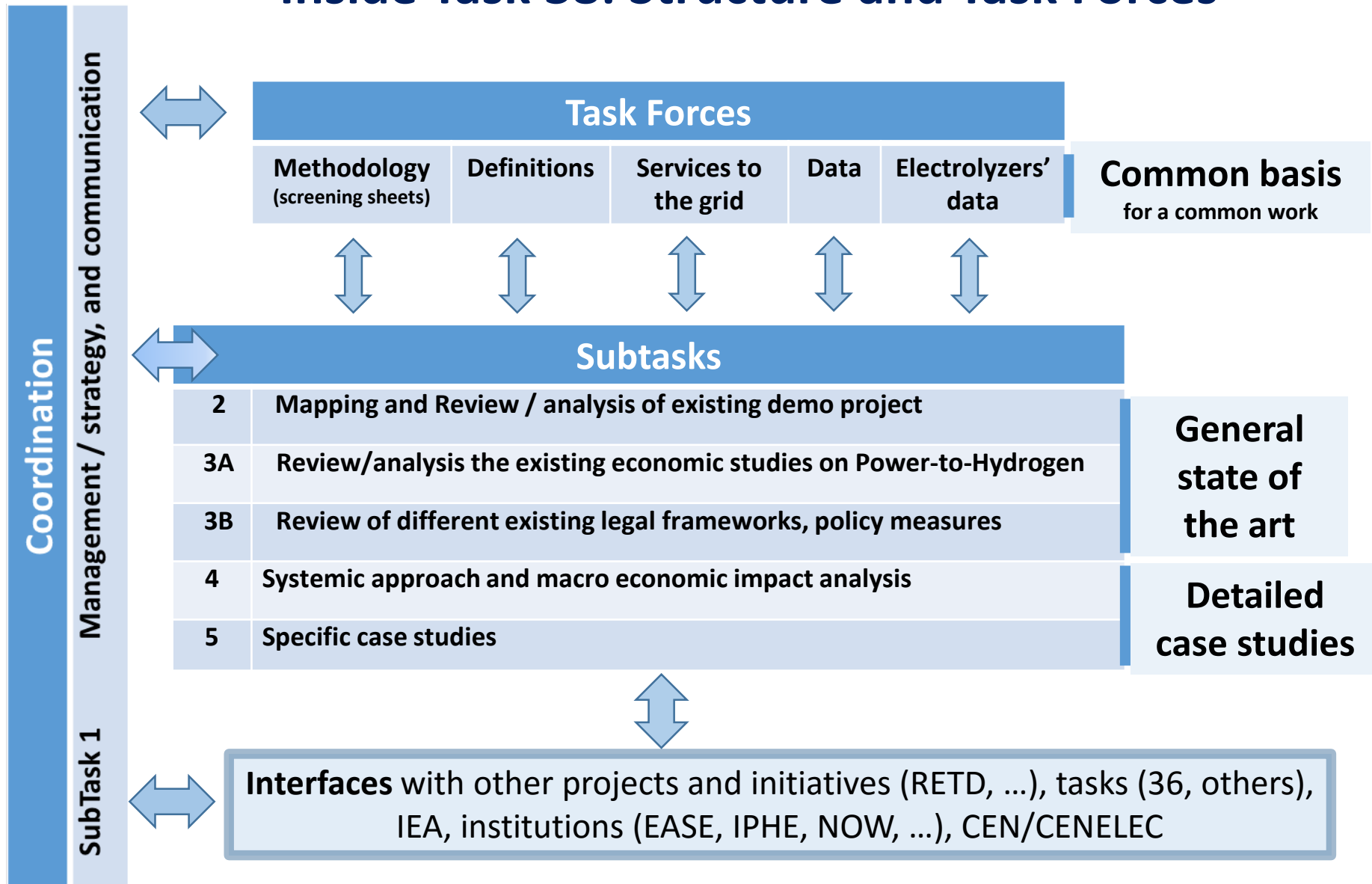
Four years / two phases

How?

1 - General state of the art survey of existing studies on techno-economic and business cases, existing legal frameworks and macro-economic impacts, including demo/deployment projects;

2 - Detailed specific case 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 and policy makers as well as public and private financial mechanisms and actors.

Inside Task 38: Structure and Task Forces



Task 38: major deliverables

Reference document (ST1)

Semi annual reports (ST1, with the help of the partners)

Intermediate Report on state of the art of demonstration projects (ST 2)

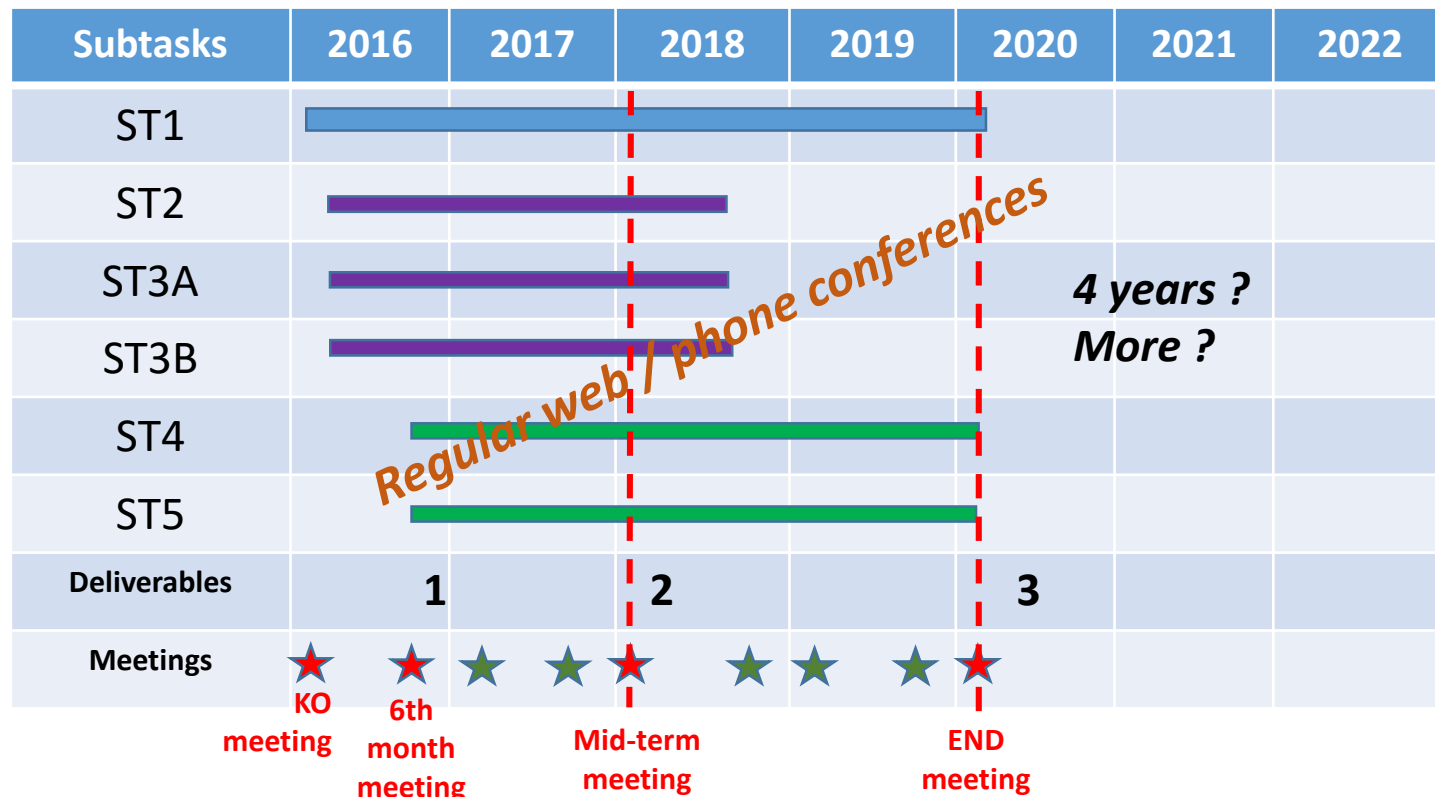
Intermediate Report on state of the art of techno-economic studies (ST 3A)

Intermediate Report on state of the art of legal framework (ST 3B)

Intermediate Report on selection of data base and case studies (ST4, ST5)

Global synthesis (ST1 / coordinators and all the partners): short summary and reference to the Intermediate Reports, results of the case studies, guidelines for business developers, recommendations for policy makers.

Task 38 preliminary timeline



★ Spring and Fall meetings

1 : organization / methodology / common vision of the Task

2 : general state of the art survey

3 : detailed specific cases studies

WORK IN PROGRESS ...

Subtask 1 / management and coordination

Management team today: Paul Lucchese and 2 co-Operating agents, Alain Le Duigou and Christine Mansilla from CEA laboratory I-tésé (Institute for Technico-economics of Energy Systems
(Support contract with French agency Ademe for at least 18 months)

Organization of the Kick-Off meeting in Paris on January 28th 2016

30 participants from 13 countries (today ca. 40 people involved)

- *To achieve a **common vision** of the Task objectives and structure*
- *First exchange on participants' role and subtask leaders*
- *Identify the next steps*
- *Schedule next meeting*

Discussions and debates about:

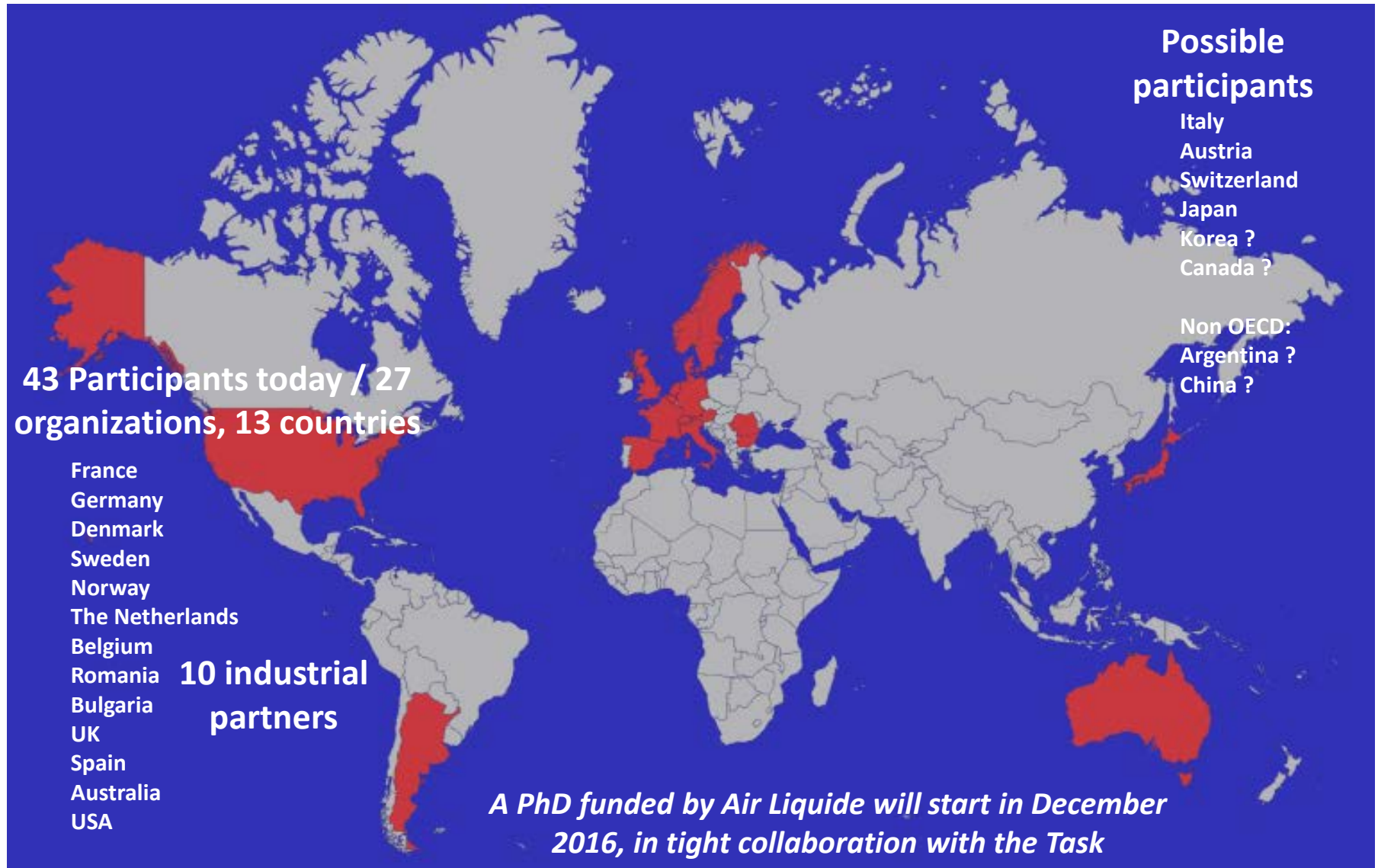
- *The scope and objectives of the Task*
(« low carbon », « power » to H2, H2 to « X », ...)
- *The issues, topics, markets to consider*



Creation (CEA) of a secured Internet site : *documents, data, minutes, forum, ...*

Launching of a « Reference Document » that describes the Task, the organization, and the SubTasks and Task Forces specifications

Participants and possible participants to the Task



Subtask 1 / management and coordination

First arrangement of the SubTasks and Task Forces contributors and leaders

| SubTask | | Contributors | Leader |
|---------|---|---|--------|
| 2 | Mapping and Review / analysis of existing demo project | UCL, ICSI, JRC, FCH JU, DGC, SWECO, HA, Hydrogenics, DBI, CEA, <i>IFE ?</i> | UCL |
| 3A | Review/analyse the existing economic studies on Power to Hydrogen | FZJ, CEA, Hydricity, Imperial College, ICSI, DMU, DGC, SWECO, HA, Hydrogenics, Air Liquide, Southern Company , <i>IFE ?</i> | FZJ |
| 3B | Review of different existing legal frameworks, policy measures | JRC, ICSI, Hydrogenics, Southern Company, CEA, BAS | JRC |
| 4 | Systemic approach and macro economic impact analysis | IC, Hydricity, Imperial College, ICSI, DMU, JRC, Air Liquide, <i>SWECO ?</i> | IC |
| 5 | Specific case studies | CEA, Hydricity, Imperial College, ICSI, UCL, HA, Air Liquide, FZJ, Pers-ee, Southern Company, <i>SWECO ?</i> | |

| Task Forces | | Contributors | Leader |
|-------------|----------------------|---|---------|
| M3A | Methodology ST 3A | FZJ, CEA, Hydricity, Imperial College, DMU, JRC, SWECO | FZJ |
| Def | Definitions | Hydricity, Imperial College, ICSI, CEA, <i>Engie ?</i> | IC |
| SG | Services to the Grid | CEA, DMU, Air Liquide, <i>Clean Horizon ?</i> , <i>AREVAH2Gen ?</i> , <i>ITM ?</i> | |
| D | Data | Imperial College, JRC, CEA, Pers-ee | Pers-ee |
| ED | Electrolysers' Data | UCL, Imperial College, Hydrogenics, AREVAH2Gen, Air Liquide, <i>IFE ?</i> , <i>JRC ?</i> , <i>ITM ?</i> | UCL |

Subtask 1 / interfacing

- Participation to the **CEN/CENELEC** hydrogen platform workshop (May 3-4)
Positive reception of the Task presentation
Possible cooperation on:
 - Task force: Definitions
 - ST3B (legal framework and policy measures)
 - ST2: database for demo/pilot plants
- Participation to the steering committee of the study "Renewable Power-to-Gas for non-individual transportation" for the **RETD** Implementing Agreement
- Participation to the **HIPS-NET** (European Network for “Establishing a pan-European understanding of admissible hydrogen concentration in the natural gas grid”) 3rd network meeting: 23rd of June 2016

Subtask 3A and 3B / already done

Objective: publish a reference document “labelled” Task 38

Support of Bulgarian Academy of Science : Marin Pandev (in Paris 2 Months late 2015)

Creation and work of a first methodology group (M 3A)

➡ Definition of a first methodology sheet for literature review

- *Proposal of a screening sheet as a common analysis grid of the studies to be discussed and agreed upon*
- *2 levels analysis grid: quick scan / thorough reading*
- *First Web Seminar in May / distribution of the studies among the participants and starting of the 1st level review*

➡ First list of studies gathered / *more than 200 documents today, including focus on native language studies*

Communication

First actions engaged: task summary, participation to the WHEC

IEA – HIA Task 38

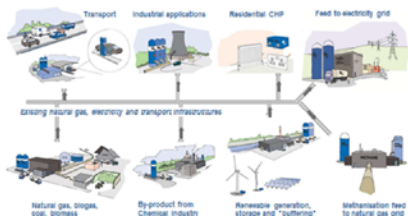
Power-to-Hydrogen and Hydrogen-to-X: System Analysis of the techno-economic, legal and regulatory conditions:

A new task of the Hydrogen Implementing Agreement of the International Energy Agency was proposed and approved by the Executive Committee as Task #38 - "Power-to-Hydrogen and Hydrogen-to-X: System Analysis of the techno-economic, legal and regulatory conditions".

The "Power-to-hydrogen" concept means that hydrogen is produced via electrolysis. "Hydrogen-to-X" implies that the hydrogen supply concerns a large portfolio of uses: transport (hydrogen for fuel cells, as well as synfuels); mixing with natural gas grid; industry (refinery, steel, ammonia, etc.); and re-electrification. Electricity supply can be either grid, off-grid or mixed systems, with particular attention devoted to resolution of electricity grid issues and characterization of hydrogen's relevance for energy storage.

The general objectives of the task are: 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 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: 2020, 2030 and 2050, for example.

Power-to-Hydrogen and Hydrogen-to-X concept



The work is slated to take place over a four (4) period, and will be 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.

Over 20 experts from more than 10 countries have already confirmed interest in this task. The companies and institutions involved are: FZJ (De), Hydricity (Aus), ECN (NL), Imperial College and ITM (UK), ICIT (Ro), FHA (Es), BAS (BG), UCL Louvain (Be), Proton On Site (USA), Hydrogenics (USA, Be), JRC and FCH JU (EU), ADEME, Air Liquide and CEA (Fr). Other companies from Germany (Siemens, OTH) and France (Engie, GRT Gaz) are expected to engage as well. Sweden likewise plans to support an expert for this task. Japan and Korea's participation are also foreseen. When its accession to the IEA HIA is complete, China may also participate. At least in-person meetings will be organized on a semi-annual basis.

This task will have a very large number of interfaces with other HIA Tasks, mainly Task 36, as well as IEA analysts, other Implementing Agreements and CEN/CENELEC.

The French CEA/I-tésé, supported by the French ADEME, will coordinate the Task.

WHEC – Dedicated IEA HIA Session

Under the topic "Countries Strategies/Associations/Assessments"

21st World Hydrogen Energy Conference 2016. Zaragoza, Spain. 13-16th June, 2016

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

P. Lucchese¹, A. Le Duigou² and C. Mansilla^{2*}

¹DRI, CEA, F-91191 Gif-sur-Yvette Cedex, France

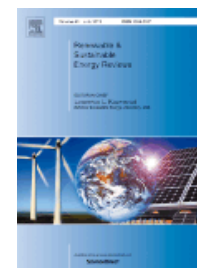
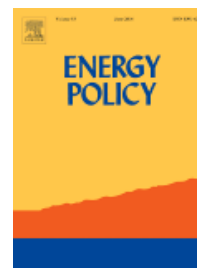
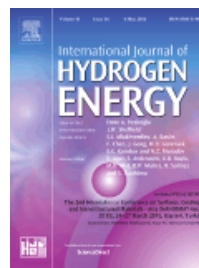
²I-tésé CEA, DEN, Université Paris Saclay, F-91191 Gif-sur-Yvette, France

(*) christine.mansilla@cea.fr

Semi-annual reports, project reports

Public internet site planned

Reviews for publications



Conferences communications

... and the current presentation !



