PURPOSE

The purpose of Task 24 is:

- to explore in detail all possible issues (technical, economic, social, environmental, market and legal) related to hydrogen production using electrolysis with wind energy; and
- to explore in detail possible applications for hydrogen produced using electrolysis with wind energy, with special emphasis on wind and hydrogen integration by means of hydrogen storage and electrical conversion that balances the original wind energy production.

STATUS OF THE TECHNOLOGY

STATUS OF THE TECHNOLOGY

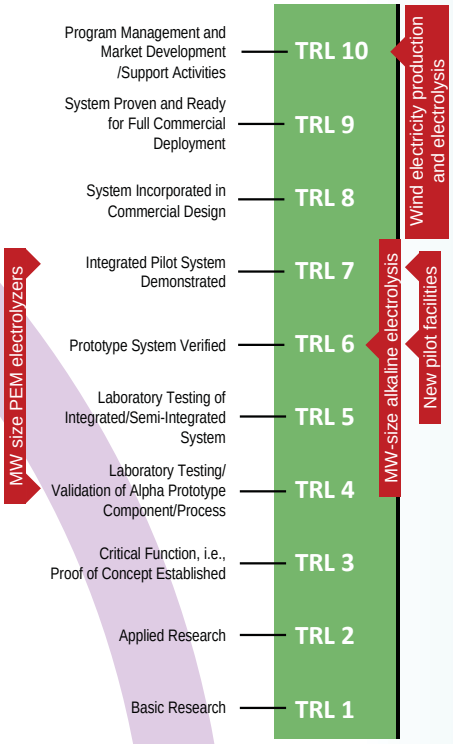
Wind turbines have reached a high level of technology maturity over the years. With turbines in excess of 6 MW being tested and even 10 MW size in sight, wind energy will definitely play a major role all over the world in the next decades. From the point of view of the electricity system (distribution and transport), the maturation of the technology represents an unprecedented threat not only to the stability of grid parameters but also for the economics itself, because the market price can be seriously affected by growing shares of non-dispatchable electricity.

The focus has turned to the role of the seasonal system-level size storage of surplus electricity, leaving the direct coupling of wind turbine to electrolyzers to a secondary market of isolated or stranded generation. In some countries that are strongly committed to the energy challenge, storage in general and hydrogen in special are again back in the debate.

In this respect, electrolysis total cost of ownership (including efficiency, capital expenditure and operation and maintenance) and massive storage means (geological underground storage) have become hot technology topics. Additionally, market studies on the economics of hydrogen as energy or raw material, along with the integration of such in the existing energy transport infrastructures – while not purely technological issues -- always contribute to the discussions.

TECHNOLOGY READINESS LEVEL (TRL)

When it comes to wind electricity generation in one hand and hydrogen production by electrolysis on the other hand, both technologies reached the maximum TRL (level 10, where program management and market development/ support activities are underway for proven systems in full commercial deployment) a long time ago.



TASK 24

WIND ENERGY AND HYDROGEN INTEGRATION

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VITAL STATISTICS

Term

Phase 1: 2006-2010

Phase 2: 2010-2011

Members

11 Participant countries

Expert Participants

21 Experts

2011 Meetings

26th - 27th of May

Grenoble, France

29th - 30th of September

Pamplona, Spain

Nonetheless, technology never stops improving, and megawatt-size alkaline electrolysis has stepped back for asbestos replacement to TRLs from a level of 10, the top level previously described, to the 4 to 7 range (between laboratory testing/component validation at level 4 to demonstration of an integrated Pilot System), depending on the source (novelty of materials used). Regarding the alternative PEM technology, recent announcements of major manufacturers unveiling the realization of 1 MW size electrolyzers, raise the TRL of PEM technology to 6, verification of a prototype system.

Finally, with respect to pilot experiences of wind electricity and hydrogen production, some new interest has showed up in the past years. Where previous projects as Utsira, Hari, or Sotavento have yielded interesting experience, new facilities as Enertrag near Berlin and a couple of new ongoing European projects promise to blow fresh air (TRL level 6, in slow transition to level 7) into the technology.

FRAMEWORK SUMMARY

SUBTASK A: STATE OF THE ART

Dr. Aaron Hoskin, Subtask leader

In this Subtask, the goal is to conduct an in-depth review of the current state of the art in the technology (wind turbines, electrolyzers, ancillary equipment), as well as a detailed review that includes the lessons learned relative to hydrogen production projects using wind energy. Feedback from the existing and finalized projects worldwide has been collected, thanks to the networking activity conducted by the members (some of them directly involved in such projects). Dr. Javier Pino took responsibility for depicting the state of the art for simulation tools.

SUBTASK B: NECESSARY IMPROVEMENTS & SYSTEM INTEGRATION. TECHNOLOGY DEVELOPMENT ON MAIN EQUIPMENT AND SYSTEM INTEGRATION CONCEPTS

Dr. Kevin Harrison, Subtask leader

In this part of the study, the scope is focused on the hydrogen production equipment, as the wind turbine has proved over the years to be a more mature technology upstream of the electrolyzer. (Rephrasing a representative of a notable wind turbine manufacturer in a conference, the only thing wind turbines nowadays cannot perform is to correct the wind.) Of note, the change of perspective during the evolution of Task 24 has shown a displacement of the focus from the isolated wind turbine, where the problem to solve was the regulation of the electrical output to the predicted one, to the hydrogen production side. The electrolyzer has occupied the center of the Task reflections, seen now as a controllable load offering much wider possibilities connected to the grid, and especially for the unbeatable seasonal storage performance of hydrogen. Also very valuable was the participation of three electrolyzer manufacturers in the expert meetings, which provided a deep insight into the technology as well as the evolution pursued in the future.

SUBTASK C: ECONOMIC ASPECTS OF WIND-HYDROGEN SYSTEMS

Dr. Klaus Stolzenburg, Subtask leader

Subtask C, formerly and still officially called "Business Concept Development," provides answers to the various questions as how wind-hydrogen systems can be categorized with regard to their main purpose and plant size, and which levels of costs current and completed demonstration projects provide. Lessons learned are derived from these projects. An insight into the regulations on electricity and on alternative fuels in various countries allows assessment of the possible opportunities and obstacles they may generate for hydrogen derived from wind energy. It also analyses relative to the potential that regulations could provide for wind-hydrogen systems.

SUBTASK C: APPLICATIONS. EMPHASIS ON WIND ENERGY MANAGEMENT

Dr. Raquel Garde, Subtask leader

In this subtask, near-term applications for the hydrogen produced have been studied with a special emphasis in wind energy management. The topic of wind energy management became a separate subtask given the noticeable synergy between hydrogen and wind energy regarding their integration for further development of inherently non-continuous renewable energy sources that are random nature. Investigation of the wind power situation in Europe and in some countries with high wind power penetration (as Spain, Germany, and Denmark) has led to challenges stemming from risks associated with management and stability of the electricity network in cases of wind power penetration.

It is important to note that hydrogen used as an energy storage system to manage wind energy has many other competitor technologies that can be used in a wide power and energy range and can cover several energy functions. Different energy storage systems that can compete with hydrogen in wind power management services have been identified and characterized. Finally, different strategies of wind energy management can lead to different optimal energy storage technologies.

MEMBERS

TASK MEMBER AND EXPERTS

Task Member and Expert Table

TASK 24	COUNTRY	EXPERT NAME (INDICATE IF SUBTASK LEADER)	INSTITUTION NAME
1	Spain	Luis Correas (Operagent Agent)	Aragon Hydrogen Foundation
2	Spain	Ismael Aso	Aragon Hydrogen Foundation (from 2011, CNH2)
3	Spain	Carolina Garcia	Spanish Hydrogen National Center (CNH2)
4	Canada	Aaron Hoskin (Subtask A Leader)	Natural Resources of Canada
5	USA	Kevin Harrison (Subtask B Leader)	NREL
6	Germany	Klaus Stolzenburg (Subtask C Leader)	Planet GbR
7	Spain	Raque Garde (Subtask D Leader)	CENER
8	UK	Rupert Gammon	Bryte Energy Ltd
9	Japan	Ken-ichiro OTA	Yokohama National University
10	Spain	Mila Rey	Gas Natural
11	Spain	Pablo Fontela	Endesa
12	Switzerland	Ernest Burkhalter	IHT
13	Greece	Eli Varkaraki	CRES
14	Spain	Javier Pino	Seville University
15	Spain	Salvador Suarez	ITC
16	Denmark	Allan Schroeder	RISO
17	Germany	Dennis Krieg	Juelich
18	Norway	Stein Trygve Briskeby	StatoilHydro
19	Germany	Raymond Schmid	Hydrogenics
20	France	Florence Lefebvre-Joud	CEA LITEN
21	Spain	Rafael Ben	Ariema

Comments on growth/changes in member and/or expert participant composition if applicable

One additional member, France, has added to the already 10 participant member countries.

Two additional experts have joined the working group, namely the French Commissariat à l'Energie Atomique (CEA) and the Spanish National Center for Hydrogen. Both research centers provide a deep knowledge in energy science, especially for renewable and hydrogen. Dr. Lefebvre-Joud is a very knowledgeable scientist, and member of the Scientific Committee of the European Fuel Cells and Hydrogen Undertaking.

ACTIVITIES AND RESULTS IN 2011

PROGRESS AND ACCOMPLISHMENTS

Subtasks A, C and D have produced their expected final reports during the year, validated during the final meeting. Subtask A has been split into two different approaches, one for the state of the art of the hardware and one for the simulation tools. Subtask B has partial results, among which the continuous exchange among the experts during the meetings has proved especially fruitful. Main conclusions will be complied by the Operating Agent for final report edition.

Last but not least, the finalization of the PhD thesis by some of the Experts is a well-deserved finish line after years of dedication. Dr. Javier Pino and Dr. Milagros Rey, directed by Dr. Raquel Garde, earned their PhDs during 2011 and beginning of 2012. This is another example of win-win cooperation within the Task.

An offspring of Task 24, the ELYGRID project (Improvements to Integrate High Pressure Alkaline electrolyzers for Electricity/H2 production from Renewable Energies to Balance the Grid), a European FCH-JU funded project, started in November 2011. ELYGRID aims to contribute to reduction of the total cost of hydrogen produced via electrolysis coupled to renewable energy sources, mainly wind turbines, and focusing on megawatt size electrolyzers (from 0.5 MW and up). The objectives are to improve the efficiency of the overall system by 20% and to reduce costs by 25%. The work will be structured in three (3) distinct parts, namely: cell improvements, power electronics, and balance of plant (BOP). Two scalable prototype electrolyzers will be tested in facilities which allow feeding with renewable energies (photovoltaic and wind).

SPECIFICALLY ADDRESS MILESTONES AND THEIR STATUS

When it comes to Task 24 milestones, the production of the final subtask reports, reached in October 2011, together with the celebration of the two last expert meetings (May 2011 hosted by CEA in Grenoble, France, and September 2011 hosted by CENER in Pamplona, Spain) constitute the final milestones for Task Expert Members. There remains one ultimate milestone -- the production of the final report by the Operating Agent during 2012. The fall 2012 ExCo meeting seems a proper date and venue for submission of this final report.

OUTREACH AND COMMUNICATION

Summary of Strategy and Activities

Strategy for Communication of this Task has always been the presence at the main venues for energy storage and especially hydrogen technology related. The lobbying capacity of their members has reinforced the Task outreach. A total of three publications in scientific and technical events, two communications in scientific conferences, and one participation in a roundtable during 2011 complete a large amount of communication activities.

The Operating Agent wants to thank the interest and effort of Dr. Harrison, Dr. Varkaraki, Dr. Garde, Dr. Hoskin, Mrs. Rey and Mr. Aso for their contribution.

Complete 2011 entry in Task Communication and Outreach Table, i.e., add on to table used for 2010 (see Other Specifications below and attached completed exemplar)

PUBLICATION / PRESENTATION NAME	PUBS	PRES	OTHER
NREL and XCEL Energy Collaboration on Wind-to-hydrogen (Wind2H2)	1		
Roundtable discussion			1
Activities of the IEA Hydrogen Implementing Agreement Annex 24 - Wind Energy and Hydrogen Integration	1		
Analysis of Wind Power and Hydrogen Sotavento Plant	1		
IEA-HIA Task 24 Wind Energy and Hydrogen Integration: Applications, Emphasis on wind energy management		1	
Wind-hydrogen Systems: opportunities and challenges		1	
TOTAL	**3**	**2**	**1**

Task websites

http://task24.hidrogenoaragon.org

FUTURE WORK

ACTIVITIES AND /OR TARGETS FOR 2012

The pending activity for 2012, the production of the Task final report, will be carried during the first half of the year by the Operating Agent, Dr. Luis Correas, with the ad hoc support of Subtask leaders. The target for accomplishing the activity is the fall ExCo meeting, where the OA will present the final conclusions to the ExCo members and other Task OAs.