INTRODUCTORY NOTE

IEA Wind Task 11 Topical Expert Meeting 106
June 5th, 6th, 7th 2023 2 to 5 PM CET Time (3 sessions)

On

HYDROGEN FOR 100% RENEWABLE ENERGY SYSTEMS
FROM VARIABLE TO INTEGRATED RENEWABLE ENERGIES

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1 Value for IEA Wind TCP

1.1 Background

Green hydrogen is recognised as a key enabler of a net zero energy system, and electrolysis is one of, if not the most cross-cutting renewable energy technology. It touches on electricity generation, energy storage, transport, systems integration, import/export, and others.

The role of green hydrogen will vary by sector, region, resource availability, development status, and the availability of existing infrastructure and is thus hard to define. At the same time costs continue to fall, technologies improve, and emissions reduction ambitions increase, creating new opportunities for green hydrogen and bringing with them new research potential.

With the role so difficult to define there is also an increased risk that researchers and developers cannot track the wider developments and potential synergies between their previously disparate sectors.

1.2 Motivation

The space related to the integration of hydrogen technologies with renewable energy is occupied by a large number of dispersed stakeholders, each with different priorities. The IEA promotes collaboration between the Technology Collaboration Programmes (TCPs) and such collaboration allows for knowledge sharing, avoids duplication of efforts, and can lead to greater outcomes overall.

1.2.1 Specific Value to IEA Wind

As we achieve higher shares of Variable Renewable Electricity (VRE) we begin to experience increased issues of constraint and curtailment, reducing the viability of development. VRE will also likely be the largest contributor to electrolysis energy demand importantly allowing it to affect emissions reduction outside of the electricity sector and have additional non-CO_2 environmental benefits. Other added benefits of converting wind energy to hydrogen include energy security and economic development, both promoted within the IEA Wind TCP.

The topic is also aligned with strategic objectives;

1. *Maximise value of wind in energy systems and markets, and*
4. *Foster collaborative research and the exchange of best practices and data*

Tasks 11, 25, 28, 37, 41, 50 and 53 would all benefit from research on green hydrogen generation from wind energy.

1.2.2 Collaboration between TCPs

The IEA promotes collaboration between the TCPs as they recognise interdisciplinary contributions add value, reduce risk, and in this case helps to address research priorities of Wind TCP ;

3. *Energy Systems with High Amounts of Wind, and*
4. *Social, Environmental, and Economic Impacts*.

There are several ongoing collaborations, workshops, and conferences in the area of PV, wind and hydrogen, along with numerous national and international projects. Though these tend to either examine the topic at a high-level and highlight potential areas of synergy or focus on a

particular technological niche without awareness of the wider system. These projects are financed either through dedicated funds for the development of hydrogen technologies (like the FCH-JU at EU level) or through funds related to the increased penetration of renewable energies in the mix.

This Topical Expert Meeting (TEM) will differ by trying to make independent players aware of one another's views and potential for mutual benefit. However, the normal benefits of providing an independent global forum for leading experts and researchers to leverage global government funding for international collaborative programmes will also apply. The Wind TCP has been in contact with the Hydrogen and PVPS TCPs and started discussions on defining their common interests and finding the best way to collaborate, while respecting their members' engagements and priorities. PVPS and Hydrogen TCP have had discussions with the IEA's Renewable Energy Division, who expressed an interest to participate and potentially coordinate a cross-cutting collaborative task on green hydrogen, especially to performances of the value chain.

2 Meeting Format and Goals

2.1 Objectives and Ideal Outcomes

The goal of the meeting is to lay the groundwork for a cross-cutting collaboration between the wind, PV and hydrogen TCPs managed by IEA Secretariat. The ultimate goal is to address the specific challenge of 100% renewable energy system and realise the IEA 2050 net zero scenario.

This TEM aims to narrow the scope of the discussion and move the conversation from broader awareness and siloed thinking to specific actions that can be taken. This will be achieved by encouraging focused debate on specific key issues, as opposed to technology status updates and introductions to individual research projects by members of the TCPs. There will be scope for members to familiarise themselves with each other's work in advance, but the focus will be concise and collaborative discussion giving rise to well-defined research aims.

As an ideal outcome, one or more briefs detailing the goals of a new task will be produced.

2.2 Tentative Programme

The first choice is to host this TEM online, with three sessions held across three different days. Preliminary surveys will allow us to amend the programme to best promote productive discussion based on attendee expertise and guide attendees to sessions where they can contribute most. Focusing on a few, well-defined issues, should produce the most focused collaboration. Broadly, the interconnectedness of green hydrogen, the potential constraints on development, recognition that optimisation lies beyond a single source of electricity, and the underlying economics are the topics to be discussed.

2.2.1 Online format

The success of the online TEM format lends itself well to replication and adaption. Online fora maximise the utility of attendee's time as they avoid the need for travel and allows attendees to be selective on which sessions they attend, though of course they will be welcome in multiple sessions. We can survey potential participants in advance, narrowing down the topics for discussion on the day, again maximising the effectiveness of the sessions.

Below is a high-level outline of how the TEM could be run, subject to input from the organising committee, and survey responses of the potential attendees.

Before the TEM:

- List of suitable attendees is created, updated often, wide variety of stakeholders
- Session moderators are appointed, each half-day being defined and under the responsibility of one of the following co-organisers.
- Potential points of discussion are generated for each session
- Attendee list is surveyed to identify most pertinent points of discussion
- Attendees produce a slide (5-10min video optional) on them and their work
- Access to slides and videos, plus survey results are shared with attendees

During the TEM:

- Each session has a brief 15-20min introduction, prepared by the moderator
- The session is broken into group of 6-8 to discuss the topics
- Each group has a chair and notetaker, nominated in advance
- Groups are brought back together where chairs lead a 30min group summary

After the TEM:

- The group summaries and subsequent discussions are used to detail new tasks
- Attendees are given a final summary and the new task brief is shared

2.2.1.1 Day 1: Direct Production or Systems Integration

Brief: *The source of electricity dictates the cost and sustainability of green hydrogen however, its role in the overall energy system must be considered. Producing directly from VRE guarantees the hydrogen is fully decarbonised and simplifies the supply chain, but may limit the capacity factor and opportunities for shared infrastructure, increasing the cost. Conversely, utilising grid electricity can increase the capacity factor and allow for the provision of grid services, but PPAs and/or Guarantees of Origin, which can also increase cost, are required to demonstrate sustainability, and it could be difficult to achieve the scales required.*

Potential Points of Discussion within this Session

- Autonomous green hydrogen production (no grid connection)
- Holistic comparison/synergies of biofuels and non-electric options to green hydrogen
- Optimised location and sizing of electrolysis for grid services provision
- Influence of end-user on decision making
- Influence of storage technologies and existing infrastructure
- Flexibility of electrolysis required to enable new opportunities
- Profitability of each configuration and their sensitivities
- Export from low-cost, high resources regions
- Proximity to demand and resulting effect on cost
- Factors that influence the choice between autonomous and integrated projects
- Principal of additionality
- Mitigating grid expansion and storage requirements with hydrogen

2.2.1.2 Day 2: Optimum Electricity Mix Considering Green Hydrogen

Brief: *Traditionally VRE is placed where resources are greatest, and efforts are made to accommodate the power on the electricity grid. This though is not optimal as the share of VRE increases. More recently there has been recognition that the timing and location of generation are factors in the actual value of electricity generated as they can mitigate*

the need for storage, grid expansion, and curtailment. Applying the same thinking to green hydrogen can help to optimise its production and hence, cost.

Potential Points of Discussion within this Session

- Co-locating multiple VREs with electrolysis
- benefits of integration with a single technology e.g. offshore wind
- Generator characteristics that optimise hydrogen price (e.g. low cut in speed WTGs)
- Role of storage (battery-electric and hydrogen)
- Trade-off of capacity factor and overall energy production
- Control strategies for optimisation of an integrated plant
- Influence of demand characteristics on optimal configuration
- Co-location with a hydrogen CCGT
- Integrated power electronics, avoid multiple DC/AC conversions
- Influence of forecasting on the optimisation
- Consuming surplus vs generating during lulls – Market context/system analysis

2.2.1.3 Day 3: Pricing Green Hydrogen

Brief: *Competing directly with fossil fuels is incredibly difficult, particularly while their externalities are not priced in, and they continue to be subsidised. Instead it is understood that in order to achieve comparable costs hydrogen requires a combination of subsidisation, targeted policy measures, monetising system benefits, and exemptions from certain taxes depending on usages. How exactly this is achieved is up for debate but all solutions should consider the consumer, encouraging competition and development, and sustainability.*

Potential Points of Discussion within this Session

- Protecting consumers from high energy prices and encouraging adoption
- Green Hydrogen usages
- Monetising the flexible consumption of electrolysis
- Sharing the costs, system benefits of electrolysis, social acceptance
- Protecting new supply chains from the Green Paradox
- Encouraging whole systems thinking (price signalling, technology subsidisation)
- Assessing the suitability of current policy and accelerating the opportunity
- Subsidising the demand (FCEVs), the production (kg of H_2), or both
- Successful policies and potential learnings
- Enabling cross border trade