IEA WIND TASK 61 - DANISH STAKEHOLDERS NEWSLETTER

VRE-HYDROGEN INTEGRATION

Issue 1, March 2026

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Emerging Challenges: system complexity, resource variability, safety, regulatory adaption, cybersecurity risks

RECENT ACTIVITIES

Welcome to the IEA Wind Task 61 Danish Stakeholder Group. The global site for IEA Wind Task 61 is available here: https://iea-wind.org/task-61/

The site for the Danish stakeholder group to post the recent updates and activities ongoing in Denmark is available here: IEA Wind Task 61: Danish Stakeholders

Green hydrogen, produced via Variable Renewable Energy (VRE) including wind and solar, is key to decarbonizing hard-to-electrify sectors like industry and transport. However, scalable, cost-effective VRE-hydrogen systems are needed to enable its full potential. It is critical to explore and identify current challenges in the design, control, and deployment of hybrid VRE-hydrogen plants. A comprehensive overview of VRE-hydrogen plant design, operation, and regulation will be analyzed across the 4-year project to develop:

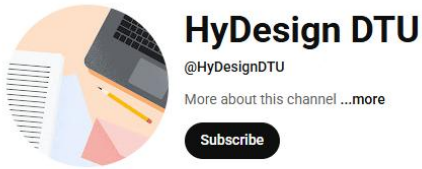
- state-of-the art activities in VRE-hydrogen plants
- reference VRE-hydrogen plants for different configurations
- recommendations for integration practices

Projects ongoing on VRE-Hydrogen

- **FLEXUM**, to investigate the flexibility and degradation of electrolyzers - Mission Green Fuels
- **SHIELD**, large-scale deployment of green hydrogen, IFD Indo-Danish project
- **H2BRIDGE**, Indo-Danish networking project on green hydrogen, hybrid energy plants and large-scale integration of H2, Global Innovation Network Program
- **VRE2H2**, proof-of-concept on control architectures and operational strategies for VRE-powered hydrogen production plants - Mission Green Fuels
- Alignment of IEA activities with IEC activities for the standardization of PtX systems - AU

Tools

- **HyDesign** - python-based, open-source software platform for design and operation of utility-scale hybrid power plants developed by DTU Wind.



- **dEMS** - a collection of tools to optimize the operation of a power generation system, consisting of fuel cells and batteries, including degradation developed by DTU Energy.

From ambition to action:
green hydrogen powers a safe, flexible path to net zero

PUBLICATIONS

1. Grandin, M., Gupta, M. and Leon, J.P.M., 2025. Optimizing eFuel Production in Hybrid Renewable Power Plants with Integrated Energy Storage. In Wind Energy Science Conference 2025. European Academy of Wind Energy.

2. Gupta, M., Baize-Roch, F. and Das, K., 2025. Hybrid Renewable Power Plants for Green Ammonia Production: Optimal Operation and Economic Assessment. In Wind Energy Science Conference 2025. European Academy of Wind Energy.

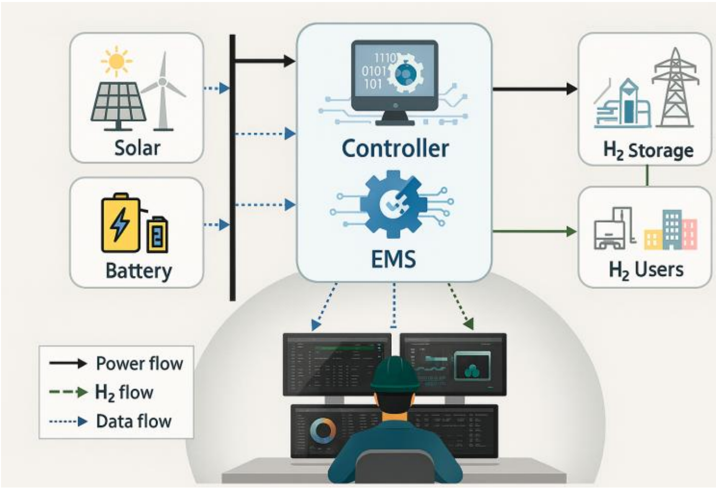
3. Li, R., Wu, J., Mosleh, S., Groth, K., Modarres, M., Lind, M., Ravn, O., & Zhang, X.(2025). Enhancing safety and operation of hydrogen fueling stations: A model-based method for complex failure scenario analysis. Process Safety and Environmental Protection,201, Article 107533.https://doi.org/10.1016/j.psep.2025.107533

RECOMMENDED PRACTICES FOR VRE-HYDROGEN INTEGRATION

During the WP3 meeting of IEA Task 61 on identifying recommended practices for VRE–hydrogen plants, a monthly seminar series is being conducted to facilitate knowledge exchange among participants from five countries. The discussions emphasized that safety standards and regulatory frameworks for VRE–hydrogen systems must comprehensively address the entire value chain - including renewable generation, electrolysis, hydrogen handling, storage, and associated infrastructure. Key international & regional frameworks identified are:

- UNECE Hybrid Renewable Electricity–Renewable Gas Framework
- European Union Hydrogen Frameworks
  - EU RenewableHydrogenCertification Framework
  - EU Hydrogen Infrastructure Regulation
  - EU Hydrogen Strategy (40 GW target)
- ISO Hydrogen Certification - National Hydrogen Frameworks with International Influence
  - Germany’s National Hydrogen Strategy
  - India’s Hydrogen Certification Schemes
  - United States (IRA-based Hydrogen Incentive Framework)
  - China’s Standards, Certification and Safety Regulation
  - Japan’s Hydrogen Society Promotion Act (2024)
  - Korea’s Hydrogen Economy Promotion and Hydrogen Safety Management Act

The conceptualization of the white paper is currently underway. Given the broad range of potential technologies and system configurations, task members have agreed to initially focus on a grid-connected VRE–hydrogen system. This reference configuration comprises co-located wind and solar generation with a common controller and energy



Grid-connected VRE–Hydrogen system with a common controller and EMS, integrated with multiple energy markets and an automation platform.

management system (EMS), and access to both electricity and hydrogen markets. The system includes energy storage options (battery and/or hydrogen) and an integrated automation platform. Additional configuration variants will be considered in subsequent phases.

The white paper will focus on:

Review

• Identify different integration and technical challenges in VRE-hydrogen plants in different countries

• Potential demand of hydrogen and its role in future energy systems

Grid services and flexibility

• Recommendations in terms of modeling and control for integration of VRE-hydrogen plant assets

• Modelling of MW scale electrolyzers for grid integration studies and grid compliance

Codes, Tests and standardization

• Recommendations for future codes, test methods and standardization of VRE-hydrogen plants for more universal adoption and comparison

• Regulation standards – experience of different countries

Energy storage options

• Explore potential choices

• Recommendations for safety standards and implementation challenges

Safety standards and automation

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UPCOMING EVENTS

- IEA Wind Task 61 Annual Danish workshop at the upcoming **Aarhus University PtX Symposium** on June 24-25, 2026.
- HFES Nordic: Rasmussen Redux, 21 April 2026, Copenhagen. Presenter - Jing Wu, Integrating Process Safety Principles into VRE–Hydrogen Systems
- Webinar in METASIS2026, 09 March 2026. Presenter - Rafael Nogueira Nakashima, High-temperature electrolysis for net-zero hydrogen: Bridging UK–Nordic research.