Hydrogen: missing link for a sustainable energy system

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Outline contents

- Introduction
  - International Energy Agency (IEA)
  - IEA Hydrogen Implementing Agreement (HIA)
  - IEA HIA Task28 – Large scale hydrogen delivery infrastructure
- Energy Challenges
- Energy storage technologies
- Vision Hydrogen
- Messages
International Energy Agency

Autonomous body within the Organization of Economic Cooperation and Development (OECD), founded in 1974 to carry out energy cooperation among member countries.
IEA Hydrogen Implementing Agreement

- A collaborative research and development (RD&D) program, created in 1977 on a task-shared, “bottom-up” basis


- **Vision:**
  A hydrogen future based on a clean sustainable energy supply of global proportions that plays a key role in all sectors of the economy

- **Mission:**
  To accelerate hydrogen implementation and widespread utilization to optimize environmental protection, improve energy security and promote economic development internationally, while establishing the HIA as a premier global resource for expertise in hydrogen

- **Strategy:**
  To facilitate, coordinate and maintain innovative research, development and demonstration (RD&D) activities through international cooperation and information exchange
HYDROGEN IMPLEMENTING AGREEMENT

IEA HIA Members

23 Contracting Partners

- Denmark
- Finland
- France
- Germany
- Greece
- Iceland
- Italy
- Lithuania
- Netherlands
- Norway
- Spain
- Sweden
- Switzerland
- Turkey
- UK
- EU
- Japan
- S. Korea
- UNIDO
- Unido
- Canada
- USA
- Australia
- New Zealand

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Current Task Portfolio

22. Fundamental & Applied H₂ Storage Materials Development
23. Small-Scale Reformers for On-Site H₂ Supply
24. Wind Energy and H₂ Integration
25. High Temperature Processes for H₂ Production
26. Advanced Materials for H₂ from Waterphotolysis
27. Near-Market Routes to H₂ by co-utilization of biomass with fossil fuel
28. Large Scale Hydrogen Delivery Infrastructure
29. Distributed and Community H₂
30. Global Hydrogen Systems Analysis
31. Hydrogen Safety

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IEA HIA Task 28

Scope:

Large Scale Hydrogen Delivery Infrastructure

- Production
- Transport
- Distribution
- End-use

- Mass market applications: cars, busses, light duty trucks
- Infra needed beyond current demonstration phase
- Scenarios with large scale intermittent sources; storage of hydrogen and greening of natural gas
Objectives

- Improve **understanding of infrastructure needed** to deliver projected hydrogen demands by sharing latest information, experiences/insights and lessons learned.

- Develop a common **state-of-the-art knowledge base** on concepts and components for delivery of hydrogen.

- Improve understanding of **available tools for modeling and analysis** of hydrogen delivery infrastructure (rollout) using case studies; approach, assumptions, ...

- Identify **knowledge gaps** regarding components and concepts for hydrogen delivery and delivery infrastructure deployment strategies.
IEA HIA Task 28

Task structure

Large-scale Hydrogen Delivery Infrastructure

Production → Transport → Distribution → End-use

Subtask A: FCEV & HRS Scenarios
Subtask B: HRS Assessment
Subtask C: Analysis H₂ Pathways
Subtask D: Large-scale Storage and Greening of Gas

Hydrogen as transport fuel
Hydrogen as integrating energy vector

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IEA HIA Task 28 Subtask D: Large-scale Storage and Greening gas

- Map studies, demo’s and initiatives about use of H₂ for buffering energy from intermittent sources and mixing of H₂ into the natural gas grid
- Evaluate data and results
- Identify knowledge gaps/research questions
Energy challenges

- Securing future energy supply
  - Reduce dependence on imports
  - Anticipate resource depletion

- Reducing air pollution
  - $\text{NO}_x$, CO, $\text{SO}_2$, VOC, PM$_{10}$/2.5

- Reducing greenhouse gas emissions
  - -20% in 2020
  - -80% in 2050
  - All sectors: power, industry, transport, …

Tool box:

- Energy saving
- Wind
- Solar
- Biomass
- Hydro
- Tidal & wave
- Geothermal
- Fossil/CCS
- Nuclear
- Fusion
Challenge: integration variable RES

Load curve and wind power in the Vattenfall grid

- Wind power 2008
- Estimated wind power 2030 (4 x 2008)
- Load 2008

Source: LBST 2010
Challenge: integration variable RES

Load curve and wind power in the Vattenfall grid

Source: LBST 2010

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Challenge: integration variable RES

Load curve and wind power in the Vattenfall grid

Source: LBST 2010

Impact of existing storage capacity

Pumped Hydro Goldisthal 8.48 GWh

CAES Huntorf 0.66 GWh

Σ Pumped Hydro Germany 40 GWh

1000 GWh

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Energy storage technologies

Source: Deutscher Verein des Gas- und Wasserfaches (DVWG), Mit Gas-Innovationen in die Zukunft!, 2011
Vision hydrogen: integrated energy system

Electricity grid

- Electrolysis water: Power-to-Gas (P2G)
- Fuel Cell systems, Engines, CCGT: Re-electrification
- H₂ as fuel for Fuel Cell Electric Vehicles
- H₂ as chemical feedstock for industry
- Methanisation: \(2H_2 + \text{“C”} = CH_4\)
- Admixing of H₂: “Greening of gas”

(Natural) Gas grid

- HYDROGEN storage, transport and distribution

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Large scale and small scale solution

- Integration RES in remote (rural, islands) energy systems (Task 29)
- Virtual hydrogen plants; local grids and filling stations

One of many examples: Utsira Hydrogen project
Performing Energy Alliance for H₂ from Wind

- Vattenfall, Enertrag, Total and Siemens
- Hybrid power plant in Prenzlau – start of production 2011
EU project hydrogen storage

**HyUnder**: Assessment of the potential, actors, and relevant business cases for large scale storage of renewable electricity by hydrogen underground storage in Europe

- 2 year project starting June 2012
- Project consortium:

Wide range of supporting partners

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AN IMPLEMENTING AGREEMENT OF THE INTERNATIONAL ENERGY AGENCY
**Take away messages**

- **Hydrogen one of only two zero-emission energy carriers**

- **Hydrogen and electricity are compatible:**
  - P2G: Electrolysis
  - G2P: Fuel cells, GT, engine

- **Hydrogen and electricity are complementary energy carriers:**
  - Major RES options are power producing options
  - Hydrogen is a gas: easy to transport and easy to store
  - Hydrogen turns “non-controllable” RES into dispatchable reserves

- **Hydrogen - fuel for transitions:**
  - At present, produced from hydrocarbons
  - Fits in CCS scheme: decarbonise hydrocarbons
  - Fully sustainable on the basis of water and renewable energy
  - Support integration variable RES: electricity, but also fuel and feedstock

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HYDROGEN IMPLEMENTING AGREEMENT

International Energy Agency Hydrogen Implementing Agreement

... A premier global resource for technical expertise in hydrogen research, development and demonstrations

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Thank you very much!