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HYDROGEN AS A KEY ELEMENT OF THE GERMAN ENERGY TRANSITION - THE NATIONAL HYDROGEN STRATEGY

EUPVSEC 2020 – Parallel Session XAL.2: New Trends in PV Applications - From Green Hydrogen to Solar Fuels, Hydrogen as the Missing Link in PV Mass Development?

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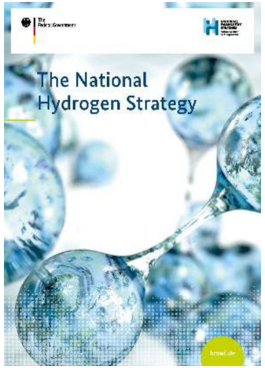
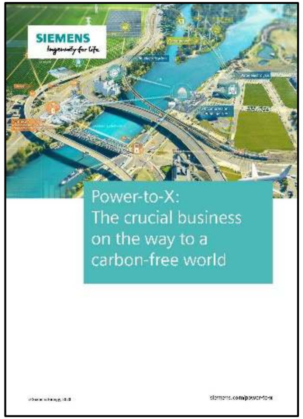
CONTENT



- The national Hydrogen Strategy
  - Political frame and Motivation
  - Funding programs
  - H2-Market in Germany: Status Quo and Expected development
- Industrial view
  - Siemens White Paper on Power-to-X



The National Hydrogen Strategy

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The Federal Government | Federal Ministry for Economic Affairs and Energy | Federal Ministry for the Environment, Nature Conservation and Nuclear Safety | Federal Ministry of Transport and Digital Infrastructure | Federal Ministry of Education and Research | Federal Ministry for Economic Cooperation and Development

- The Hydrogen Strategy of the German Federal Government
  - Published 10.06.2020 by the German Federal Ministry of Economic Affairs and Energy
  - Also significantly involved:
    - Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
    - Federal Ministry of Transport and Digital Infrastructure
    - Federal Ministry of Education and Research
    - Federal Ministry for Economic Cooperation and Development

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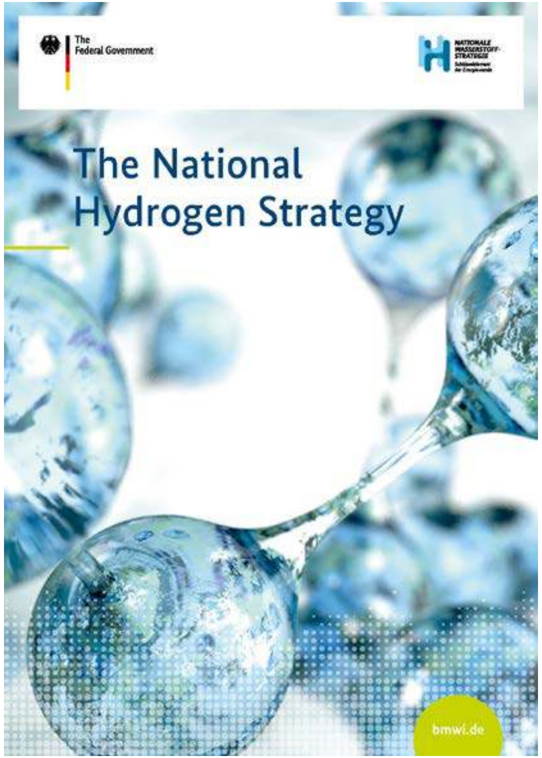
- Political framework
  - 2015: Paris Agreement
  - 2016: “Climate Action Plan 2050” (e.g. Greenhouse gas neutrality until 2050)
  - 2018: “European hydrogen Initiative” together with 27 other European nations.
  - 2019: “Climate Action Programme 2030”
  - 2020: “National Hydrogen Strategy”
- What the Strategy is about:
  - Establishing a national and global Hydrogen market
  - Path for green H2



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MOTIVATION

- Hydrogen will play a key role in the German Energy Transition
  - Energy Source
  - Energy Storage Medium
  - Key role for Sector coupling
  - Base substance (for chemical processes like ammonia production)
  - CCU (Carbon Capture and Utilization)
- On long term, only Green Hydrogen is considered to be sustainable, but the European and global market expected to form during the next years will also base on “blue” und “turquoise” Hydrogen.
- It is unlikely that the large quantities needed for the energy transition can be produced in Germany alone. Therefore fostering and intensifying international cooperation will be necessary

The National Hydrogen Strategy

HYDROGEN FUNDING PROGRAMS: STATUS QUO AND OUTLOOK

- National Innovation Program on Hydrogen and Fuel Cells:
  - 700 Mio. € (2006-2016)
  - 1.400 Mio. € (2016-2026)
- Energy and Climate fund:
  - 310 Mio. € (2020-2023) for practice oriented basic research on green hydrogen. Plans to add another 200 Mio. €.
- “Regulatory Sandboxes for the Energy transition”
  - 600 Mio. € (2020-2023)
    - >300 MW of Electrolysers will be built within several projects
- Decarbonisation programme
  - 1.000 Mio. € funding for investments in technologies which use hydrogen to decarbonize manufacturing processes (2020-2023)
- “Package for the Future”
  - 7.000 Mio. € for Hydrogen market rollout in Germany and
  - 2.000 Mio. € for fostering international partnerships

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HYDROGEN MARKET: STATUS QUO AND EXPECTED DEVELOPMENT

- H2 domestic consumption
  - Today: ~55 TWh
    - Material production (ammonia, methanol, conventional fuels,…)
  - 2030: 90-110 TWh
    - Industry: +10 TWh (conservative estimates)
    - Growing demand for fuel cell driven electric vehicles
    - On long term: other consumers like e.g. part of the heating sector
- Production today
  - Bulk: grey H2 (steam methane reforming)
  - ~7% (3,85 TWh) via electrolysis (chloralkali) process
  - By-product of other processes (e.g. catalytic reforming)

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HYDROGEN MARKET: OUTLOOK

- Additional need for electricity based energy sources
  - Different scenarios for 95% GHG reduction (against 1990 baseline) in 2050:
    - 110 TWh (*Klimaschutzszenarien* [Climate Action Scenarios] by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
    - ~ 380 TWh (*Klimapfade* [Climate Paths] by the BDI, the Federation of German Industries).
- Hydrogen as sustainable base material for industry
  - P2x: Air and maritime transport
  - Steel Industry: more than 80 TWh of H2 would be needed to switch to GHG neutral production (e.g. direct reduction of iron ore)
  - Refinery and ammonia production: ~22 TWh H2 needed
  - Huge potential for using green H2 -> One of the main factors speeding up market roll-out
- Transport and distribution infrastructure
  - Enhancing the existing gas infrastructure (net and storage)
  - Building and expanding a dedicated hydrogen network

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GOALS FOR GREEN HYDROGEN

- Electrolysers:
  - 2030: 5 GW (~14 TWh (4.000 full load hours and 70% efficiency)
    - green Hydrogen Production: 20 TWh RE needed
    - 2019: Wind: ~124 TWh; PV: ~42 TWh
  - 2035 (latest 2040): another 5 GW

- Domestic production will not be sufficient
  - 2030: 90-110 TWh demand vs. 14 TWh green H2 production
  - Intensifying coorperation with other EU Member states
    - North and Baltic Sea (Offshore Wind: High Availability)
    - Southern Europe (PV: Low Cost)
  - European Hydrogen Strategy necessary (economy, technology, legal and regulatory framework)

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- International Markets and global cooperation
  - Strong interest in the establishment of a global hydrogen market.
  - Use existing trade relations and supply chains:
    - Fossil fuel producers could become potential suppliers of hydrogen
    - attractive opportunities to convert their supply chains to the use of renewable energy and hydrogen
  - Ensure that local markets and a local energy transition in the partner countries are not impeded, but are fostered by the production of hydrogen.

Siemens White Paper

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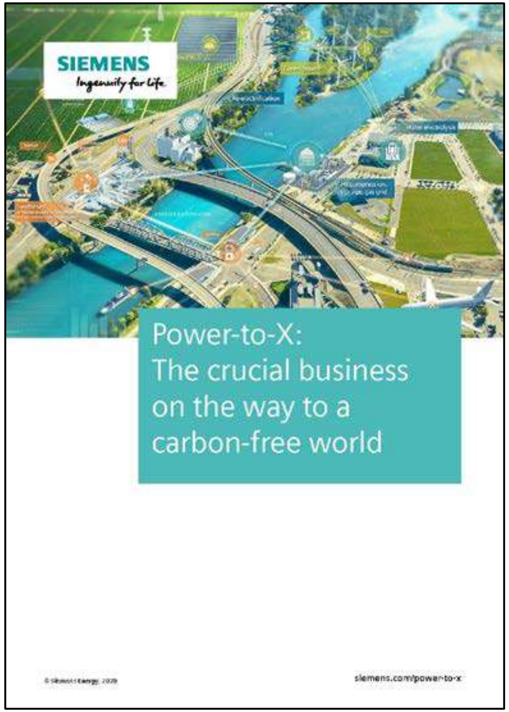
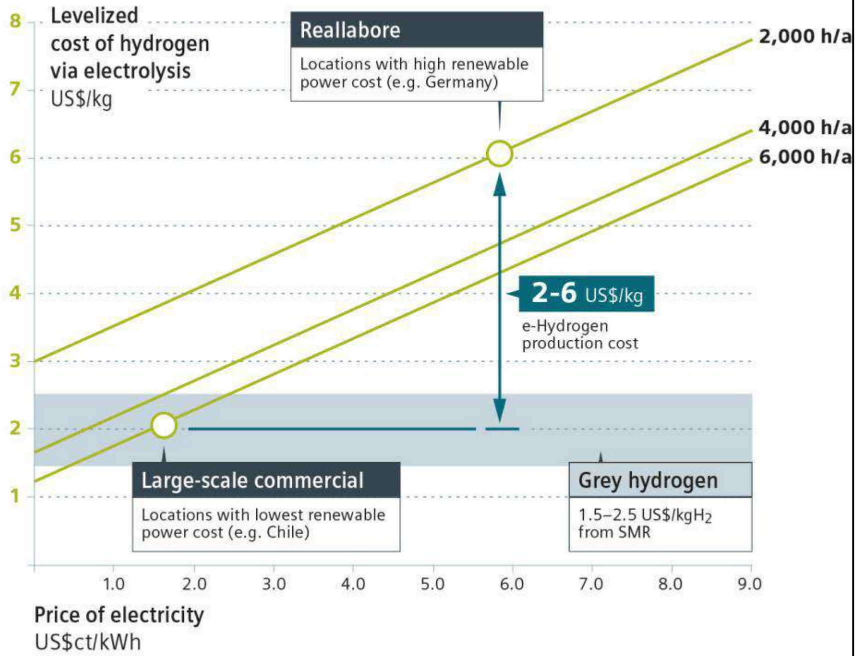
- „Power-to-X: The crucial business on the way to a carbon free world“
  - https://new.siemens.com/global/en/products/energy/technical-papers/download-power-to-x.html



Hydrogen from electrolysis becomes competitive

Highly available, low-cost renewable power already generates green e-Hydrogen at costs of conventional hydrogen from steam methane reforming (SMR).



Source: Siemens

Main impact by WACC; electrolyzer_ CAPEX, OPEX, electrolyzer efficiency, lifetime

SUMMARY

- Hydrogen will play a key role in the German energy transition
- Market rollout needs to start immediately to stay in pace with carbon goals
- German domestic green Hydrogen production will be far too low the cover consumption
- Renewables (especially PV+Wind) need to be the electricity source for green Hydrogen

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- **Grey hydrogen** is based on the use of fossil hydrocarbons. Grey hydrogen is mainly produced via the steam reforming of natural gas. Depending on the fossil feedstock, its production entails considerable carbon emissions.
- **Blue hydrogen** is hydrogen which is produced using a carbon capture and storage (CCS) system. This means that the CO2 produced in the process of making hydrogen does not enter the atmosphere, and so the hydrogen production can be regarded on balance as carbon-neutral.
- **Green hydrogen** is produced via the electrolysis of water; the electricity used for the electrolysis must derive from renewable sources. Irrespective of the electrolysis technology used, the production of the hydrogen is zero-carbon since all the electricity used derives from renewable sources and is thus zero-carbon.
- **Turquoise hydrogen** is hydrogen produced via the thermal splitting of methane (methane pyrolysis). This produces solid carbon rather than CO2. The preconditions for the carbon neutrality of the process are that the heat for the high-temperature reactor is produced from renewable or carbon-neutral energy sources, and the permanent binding of the carbon.

Siemens White Paper