STRATEGIC POLICY TARGETS AND THE CONTRIBUTION OF HYDROGEN IN A 100% RENEWABLE EUROPEAN POWER SYSTEM

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**INTEEVER-II:** Analysis of the integration of renewable energies in Germany and Europe, taking into account the security of supply and decentralized flexibilities

- 2018-2022
- Collaboration with the University of Stuttgart and Fraunhofer IEE

Source: Cao et al. (2021), 10.1002/ese3.891
Decarbonizing the energy system

Utilization of hydrogen?
- Crucial applications
- Flexibility option

Hydrogen source?
- Import
- Domestic production

Infrastructure
- What is needed?
- How much is needed?
- When does it need to be available?
METHODS
Modelling the decarbonization

Energy System Optimization Model REMix

$\min (C_{\text{exp}} + C_{\text{op}})$

Cost-optimal expansion and operation

Expansion cost
Operational cost
"Further decarbonising the energy system is critical to reach climate objectives in 2030 and 2050."

European Green Deal
- Zero CO₂
- Self-sufficiency
- Diverse electricity production
- Back-up capacity

National long-term strategies
- More independence from energy imports
- Diversity
- Secured capacity
Model setup

Region: Europe and Maghreb

Optimization model: REMix

Goal: Zero CO$_2$ emission in the power supply

Scenarios: with/ without H$_2$
+ additional policy targets

Base scenario: No strategic policy targets

Power plants: - Renewables
- Nuclear
- Gas turbines and fuel cells in H$_2$ scenarios
Setup – Scenarios with H₂
Setup – Scenarios without H₂

Political Restrictions
- Self-sufficiency
- Diversity
- Secured capacity

No H₂ demand
No H₂ reconversion

Decarbonization Restriction
- Zero CO₂

REMix
- Power
- RE power plants, storage, power grid
- Heat pump
- E-boiler
- Electric vehicles
- Heat
- Transport

RESULTS
System cost and feasibility

**System cost**

- System cost lower when hydrogen is considered in the power sector
- More policy targets can be implemented with hydrogen in the power sector

**Feasibility**

- Scenarios with hydrogen: 67%
- Scenarios without hydrogen: 15%

Source: Sasanpour et al. (2021), 10.1016/j.egyr.2021.07.005
Impact on the structure of the energy system

- **Secured capacity** → more flexible gas power plants, less batteries
- **Diversity** → CSP and wind offshore substitute PV and wind onshore
- **Self-sufficiency** → less electricity grid expansion
- **No H₂** → more biomass and nuclear power plants, more batteries

Source: Sasanpour et al. (2021), [10.1016/j.egyr.2021.07.005](10.1016/j.egyr.2021.07.005)
Power system with H$_2$ in Germany

- Without self-sufficiency: up to 60% of electricity demand imported
- With self-sufficiency: capacity doubled/tripled
- Hydrogen used for reconversion

Power plant capacities

- Electricity exchange
  - Wind offshore
  - Wind onshore
  - PV
  - RE-gas
  - Hydro

- Hydrogen exchange
  - H$_2$ exchange
  - H$_2$ domestic

Source: Sasanpour et al. (2021), 10.1016/j.egyr.2021.07.005
CONCLUSIONS
Summary and outlook

- Strategic policy targets influence structure of energy system on an overall and national level
- Fully decarbonized energy system profits from H₂ in the power sector
  - Total system costs lower
  - More flexibilities and long term storage available
  - More strategic policy targets can be implemented
- Required hydrogen transport and import infrastructures need further attention
- Resilience of different system designs with sector coupling has to be assessed
Topic: Strategic policy targets and the contribution of hydrogen in a 100% renewable European power system

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