At other countries' expense?

Sustainability dimensions for green hydrogen imports

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Main references

Working Paper: „Sustainability dimensions of imported hydrogen, Oeko-Institut Working Paper 8/2021 (in English)

Report: “Comparing sustainability of RES- and methane-based hydrogen“ (in English)

Hydrogen fact sheet – Gulf Cooperation Countries (GCC): Saudi-Arabia | Oman | United Arab Emirates | Qatar Kuwait | Bahrain; – North African Countries: Morocco | Algeria | Tunisia | Egypt | Mauritania; – Argentina

Report: „Die Wasserstoffstrategie 2.0 für Deutschland“ (in German)

Report: „Wasserstoff sowie wasserstoffbasierte Energieträger und Rohstoffe“ (in German)

Sustainable production of hydrogen needs action
Expected environmental and socio-economic impacts from production

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Water demand ~ 49 m. m³

Sea water desalination
- Pollution of coastal waters through the discharge of salt water
- Electricity consumption of desalination plants can cause GHGs
- Competition for desalination plant sites

Surface water and groundwater
- Local risks of exacerbation of water scarcity
- Potentially increasing water prices

Electricity demand ~ 255 terawatt hours

Power supply from the grid
- Increase in CO_2 emissions caused by additional electricity demand of hydrogen production
- Supplementary cost for integrating the electrolysis into the electricity system

Power supply from renewable energy sources
- Significant land requirements for solar and wind farms
- Competition for best sites for renewable electricity generation for local energy transition

Other sustainability risks
- Economic participation of exporting countries is not naturally given
- Human rights violations as part of social conflicts over land and other resources
- Ecosystem interventions and land-use change

Electrolysis

Transport
- Potential environmental risks through poisonous substances (e.g. ammonia)

~ 169 terawatt hours

Annual hydrogen imports in 2045 in scenario "Climate-neutral Germany 2045"

Comparison: Water demand

Necessary water supply
~ 49 m. m³

Water consumption in private households in Germany in 2016
3,700 m. m³

Water consumption for irrigation of Spanish agriculture in 2018
15,500 m. m³

Comparison: Electricity demand

Necessary annual electricity supply for the production of hydrogen
255 TWh (equivalent to ~85 GW at 3,000 full load hours)

Electricity generation from onshore wind in Germany in 2020
104 TWh (with 54 GW of installed capacity)

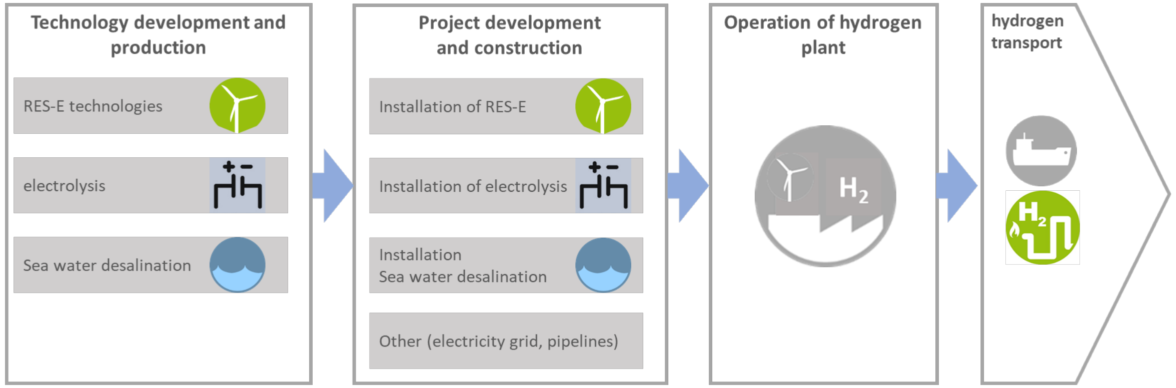
Electricity generation from onshore wind in Morocco and Egypt in 2020
~8 TWh (with ~3 GW of installed capacity)

Sustainability dimensions

- Environmental dimensions
  - GHG emissions
  - Water consumption and pollution
  - Biodiversity
  - Critical resources
  - CO_2 source
  - Air quality
  - Soil
- Socio-economic dimensions
  - community development
  - economic participation
  - labour conditions
  - respect and fostering of rights
- System level dimensions
  - Electricity system
  - Energy system
  - Economic system

Sustainability dimension:
Economic system perspective in exporting countries

- Hydrogen industry might be susceptible to Dutch disease and inhibit sustainable economic growth and equal economic participation (resource course hypothesis)
- Potentially create competition for infrastructure, financial and human resources with established extractive industries (e.g., oil, natural gas, copper) and business models



- Steering projects towards contributing to sustainable economic development on the country level is a challenge
  - Criteria are difficult to formulate and to operationalize, because they touch upon areas of national sovereignty and require cooperation on the international level.
  - Higher valued added and the export of hydrogen derivates (e.g., ammonia or methanol) can put pressure on business models and producers in the importing countries.
  - While shifting production to countries with large low-cost hydrogen production potentials can be very beneficial from a sustainability point of view (increasing energy and resource efficiency), economic and geopolitical motives of importing countries might prevent further value chain integration in exporting countries.

Potenial sustainability criteria

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Country specific		Project specific	

	Electricity	Water	Land use	Socio-economics
Minimum standard			• Exclude protected areas • Respect local (informal) land rights	• Comply with due diligence • Secure human rights • Prevent corruption and enable monitoring local economic participation (Transparency Initiative)
support of sustainable development			Enable co-benefits, for example: • Shading from "Agri-PV" • Local economic participation	• Capacity Building (R&D) • establishing and operating a local supply chain for technology • Secure a share of local work force

SWD: sea water desalination | RES-E: renewable energy sources electricity | "Additional", refers to the principle of additionality: In practice this needs further specifications such as developing a baseline projection and taking into account interference with other parallel developments.

Recommendations for next steps

- Countries with high potentials for low cost H_2 production show: regional or local water scaricity, political instability, weak civil society institutions, high shares of fossil fuel in the electrcity mix, long transport distances to demand centers
- So far, the political focus is on ensuring the green qualitiy of H_2 production but other sustainability dimensions are rather disregarded.
- Beyond „do no harm“ sustainable development should be supported. Publically funded projects could apply stricter criteria sets.
- Common sustainability criteria on the international level (IPHE, EU, etc.) are also important to create security of invesment and enable a market uptake
- The design and organization of certification systems should account for difference in energy markets and national regulations
- There is a need for an (industry)-initiative for socio-economic standards and transparency
- Deep bilateral exchange with the exporting countries is key
- There is need for a broad and open discurs about the location of key industries where economic interests, climate protection, and resilience of values chains from a complex conflict situation

Thank you for your attention!

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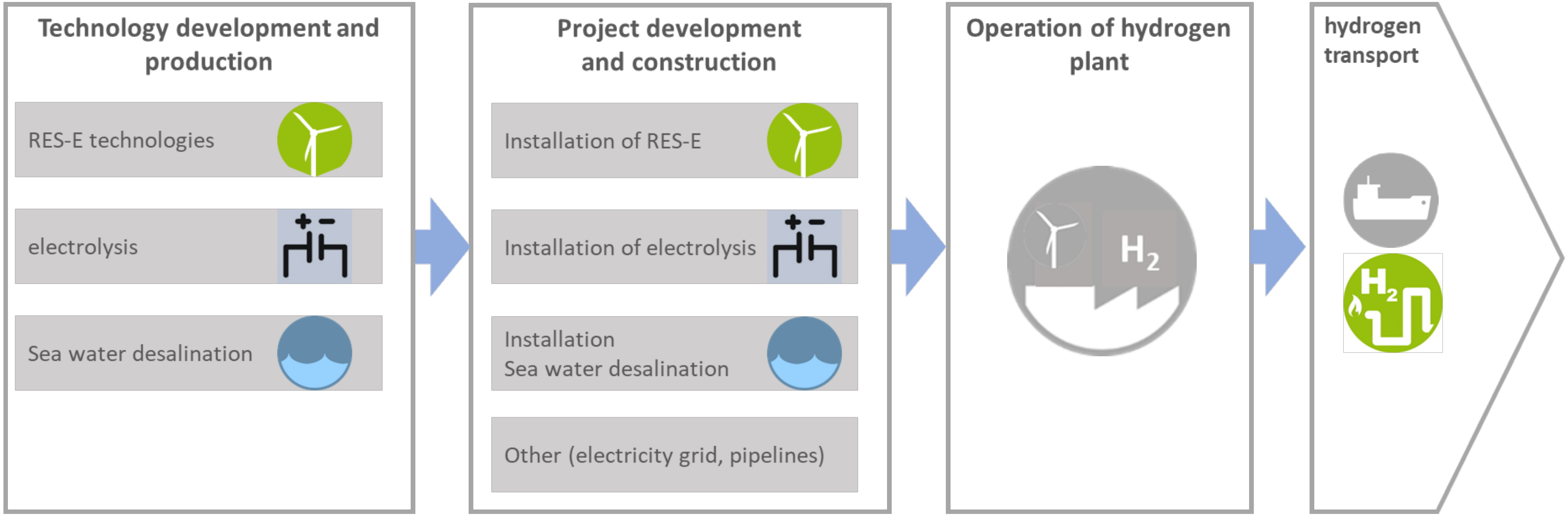
Back-Up slides

Dimensions covered by current schemes and regulations on hydrogen

		Hydrogen value chain							
Sustainability dimensions		CAPEX	Energy production	Transport of energy	hydrogen production	Sourcing of CO_2	hydrogen storage	production of derivatives	transport to destination
Environmental sustainability	GHG emissions								
	CO_2 source								
	Water								
	Air quality								
	Critical resources								
	Biodiversity								
	Soil								
Socio-economic sustainability	Community development								
	Economic participation								
	Labour conditions								
	Respect and fostering of right								
System level sustainability	Electricity system perspective								
	Energy system perspective								
	Economic system perspective								

Dimensions covered by current schemes and regulations on hydrogen

Value chain of hydrogen production based on electrolysis and RES-E



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Sustainability Dimensions

Sustainability dimensions

- Electricity supply
  - CO_2-emissions from electricity generation
  - Indirect effects on electricity grid due to new large scale demand
  - Competition for low-costs RES-E potentials
  - Need for additional RES-E production
  - Socio-economic and ecological impact
- Water supply
  - Scarcity of water
  - Brine disposal with low ecological impact (sea water desalination)
  - Electricity input for sea water desalination
- Land use
  - Land use competition
  - Ecological significance of land
  - Socio-cultural significance of land
- Socio-economic impacts
  - Human Rights
  - Potential for added-value in exporting country
  - Potential local effects on labour
- Transport
  - Labour standards and handling of hazardous goods
  - Land use and ecological issues
- Other
  - Sustainable CO_2 for hydrocarbons
  - Raw materials needed for RES-E plants and electrolysis

Sustainability dimensions in electricity supply

Sustainability dimensions that need to be considered	Electricity supply from the grid	Off-grid electricity supply
CO_2 footprint of hydrogen production due to specific CO_2 intensity of electricity	x	
Energy system integration of electrolysis	x	
Competition for low-cost RES-E potentials	x	x
Additionality of RES-E plants to cover demand for hydrogen production	x	x
Socio-economic and ecological footprint	x	x

- In operation: about 1.4 TWh of electricity required to produce 1 TWh of RES-E based hydrogen
- Electricity determines qualification as **"green" hydrogen and real GHG emissions**
- Competition for the use of **limited RES-E potentials** between hydrogen exports and national decarbonisation strategies
- Choice of location and type of generation technology governs further impacts on **socio-economic and environmental dimensions** of the hydrogen production

Sustainability dimensions in water supply

Sustainability dimensions that need to be considered	Groundwater / surface water	Seawater desalination
General scarcity of water	x	
Seasonality of water availability	x	
Additionality of water supply	x	x
Brine disposal harms maritime flora and fauna and contains chemicals		x
Electricity demand can lead to additional CO_2 emissions		x
Competition for input water (location)		x

- Current state of the art of electrolysis plants, require **fresh water** as input. Depending on the electrolysis technology, different qualities of water can be used
- Many location that have favorable RES potentials are already suffering from local water scarcity
- PV and CSP require additional water for cleaning and cooling; (0.03 m^2-4.3 m^2 per MWh of H_2) excluding cooling deamnd for electrolysis

Country specific

- National decarbonisation strategy (NDC) should include hydrogen production
- Perform a Strategic Environmental Assessment (SEA)
- Work towards Hydrogen strategy addressing sustainability dimensions (power, water, land-use, socio-economics, transport, CO2-feedstock)

Project specific

- Environmental Impact Assessment
- Sustainability Impact Assessment (SIA)
- Consultation of local stakeholders
- Grievance mechanisms
- No significant harm to SDGs (especially SDG 6 to 9)

Electricity

Minimum standard

- Exclude Biomass and Nuclear power plants
- If sourcing from direct connection to dedicated RES-E capacity:
    - RES-E should be additional
- If sourcing from electricity grid:
    - RES-E should be additional
    - Temporal correlation to RES-E
    - Geographical correlation to RES-E
- Address competition for RES-E sites between exports and local decarbonisation

support of sustainable development

- Additional RES-E capacity to decarbonize local energy system
- Provisions for additional (funds for) infrastructure
    - Flexibility
    - Grid

Water

Minimum standard

- Exclude surface and ground water in areas with regional water stress
- If sourcing from Sea Water Desalination (SWD):
    - SWDs should be powered by RES-E
    - SWDs water supply need to be additional
    - Compliance with yet to be developed international environmental standard for brine disposal
    - Monitoring and securing existing water prices

support of sustainable development

- Additional water production exceeding the needs for hydrogen production
- Improve existing water infrastructure

Land use

Minimum standard

- Exclude protected areas
- Respect local (informal) land rights

support of sustainable development

Enable co-benefits, for example:

- Shading from "Agri-PV"
- Local economic participation

Socio-economics

Minimum standard

- Comply with due diligence
- Secure human rights
- Prevent corruption and enable monitoring local economic participation (Transparency Initiative)

support of sustainable development

- Capacity Building (R&D)
- establishing and operating a local supply chain for technology
- Secure a share of local work force

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Options for placement of sustainability criteria

	Electricity	Water	Land Use	Human Rights	Economic effects	Transport	CO_2 for derivative
Renewable Energy Directive II	✓						✓
CertifHY	✓						
European Taxonomy	✓	✓					
atmosfair	✓	✓		✓			✓
IPHE Methodology	✓						

Which steps of the hydrogen value chain are considered in current schemes and regulations?

Scheme / Regulation	hardware	Energy production	Energy transport	Hydrogen production	Transport of hydrogen	supply
EU Taxonomy	None of the schemes and regulations include emissions from CAPEX					
RED-II						
IPHE Task Force						
CertifHy						
TÜV Süd CMS 70					for GreenHydrogen+	
LCFS						
China H_2 Alliance						
H2Global	No clear definition					