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International Partnerships

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Potential Role of Green Hydrogen in Just Transition

Identifying the export potential of African countries

Martin Kaltschmitt, Fabian Carels, Katharina Meinecke

International Partnerships

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2 Methodology

3 Exemplary results

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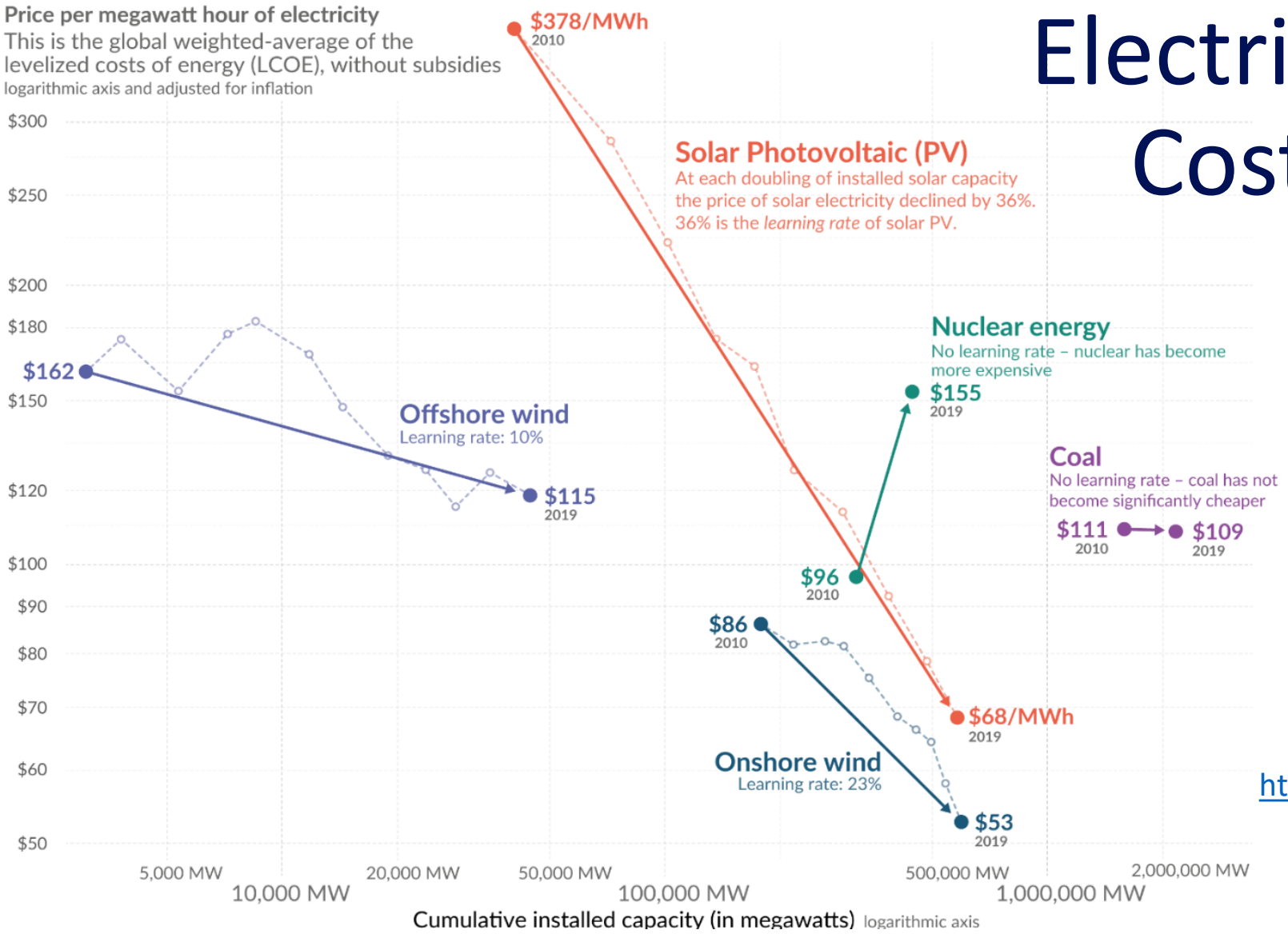
Electricity generation – Cost development



Source: Roser (2021) / IRENA (2020) / https://ourworldindata.org/cheap-renewables-growth

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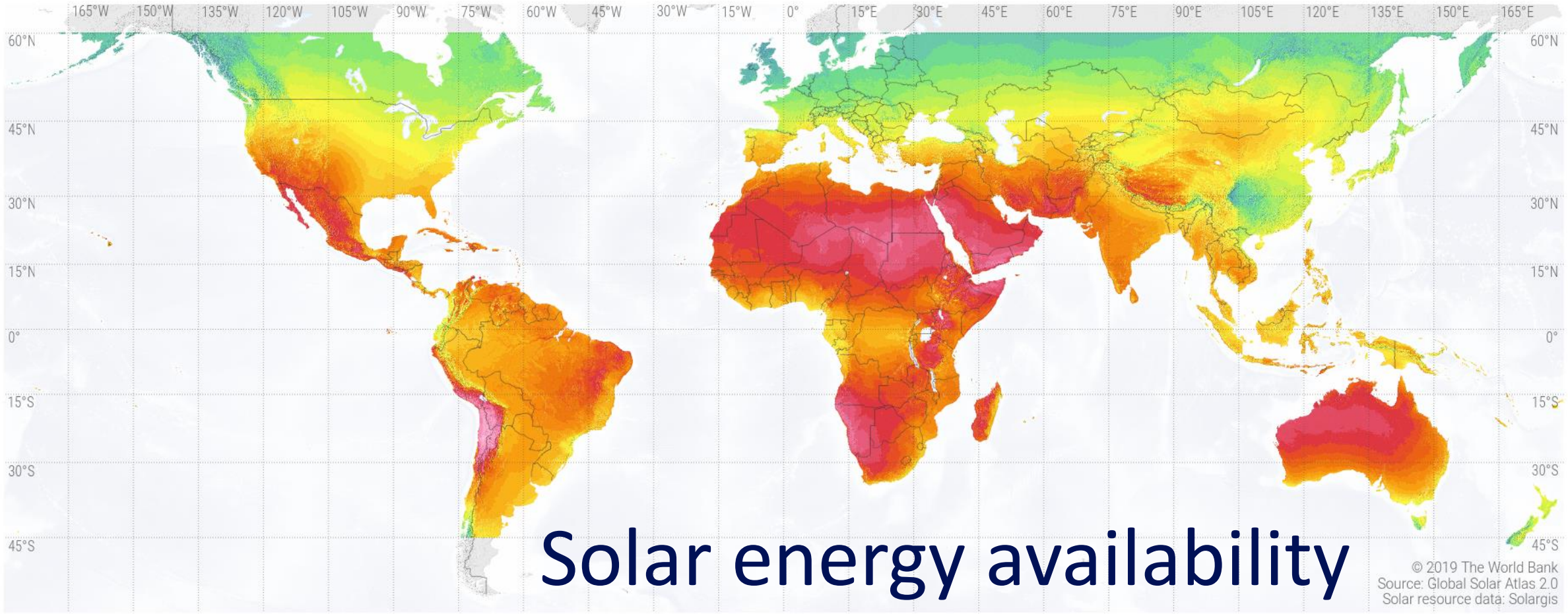
Source: The World Bank Group (2019) / https://globalsolaratlas.info/download/world

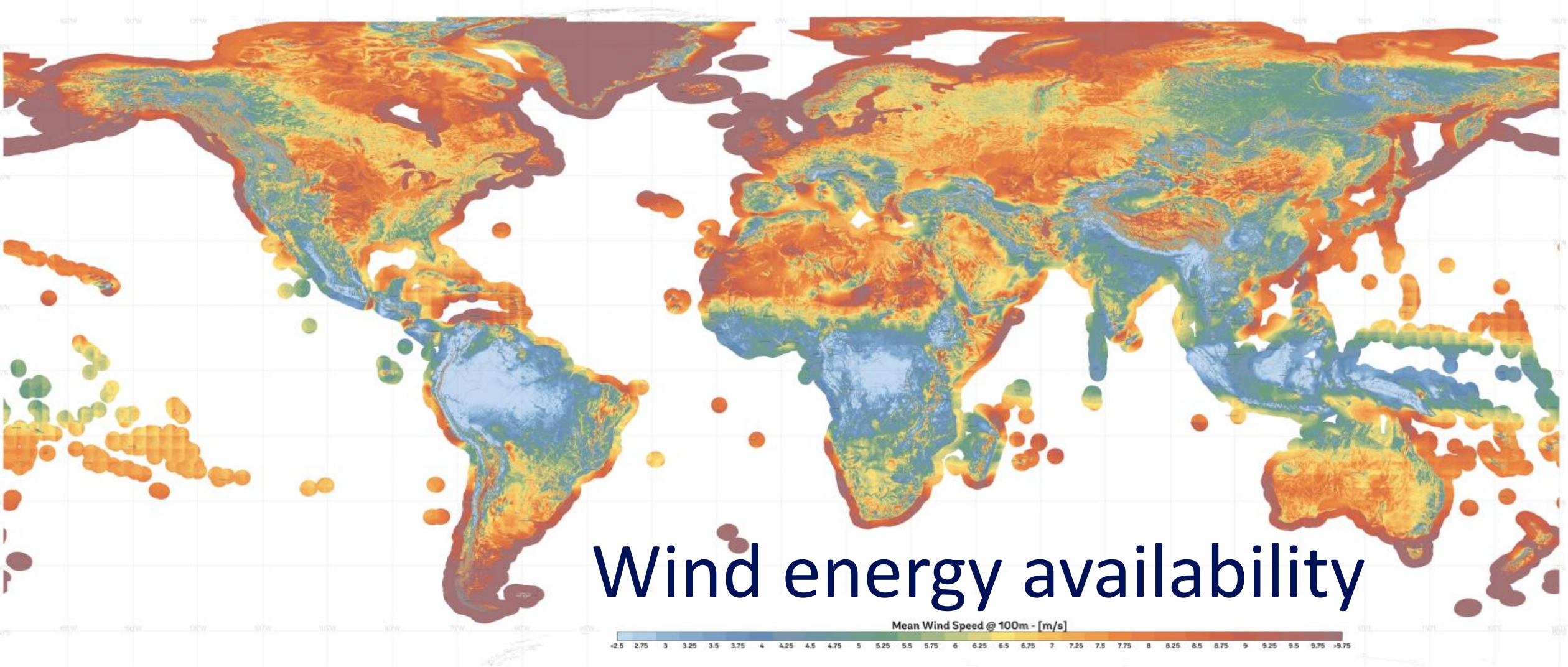


Solar energy availability

Long-term average of global horizontal irradiation (GHI)

Daily totals:	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4	5.8	6.2	6.6	7.0	7.4
														kWh/m²
Yearly totals:	803	949	1095	1241	1387	1534	1680	1826	1972	2118	2264	2410	2556	2702

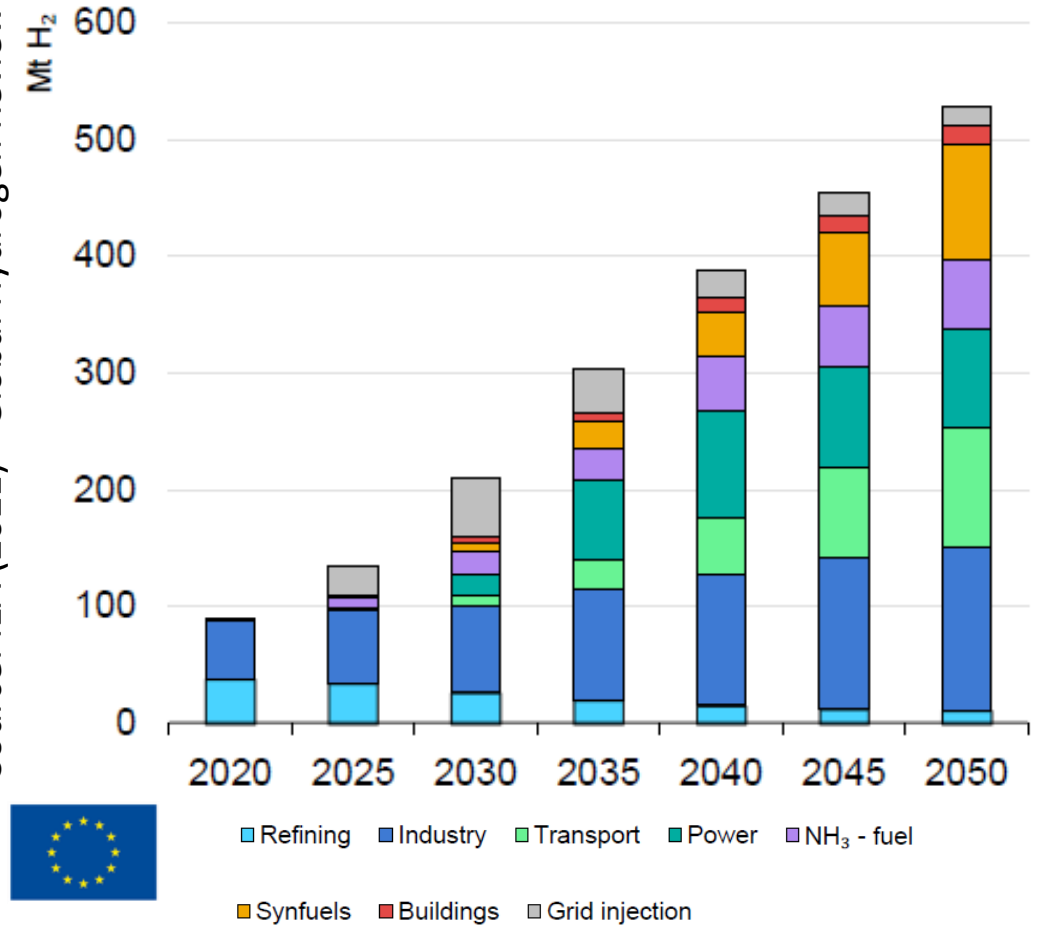
Source: Roser (2021) / IRENA (2020) / https://ourworldindata.org/cheap-renewables-growth

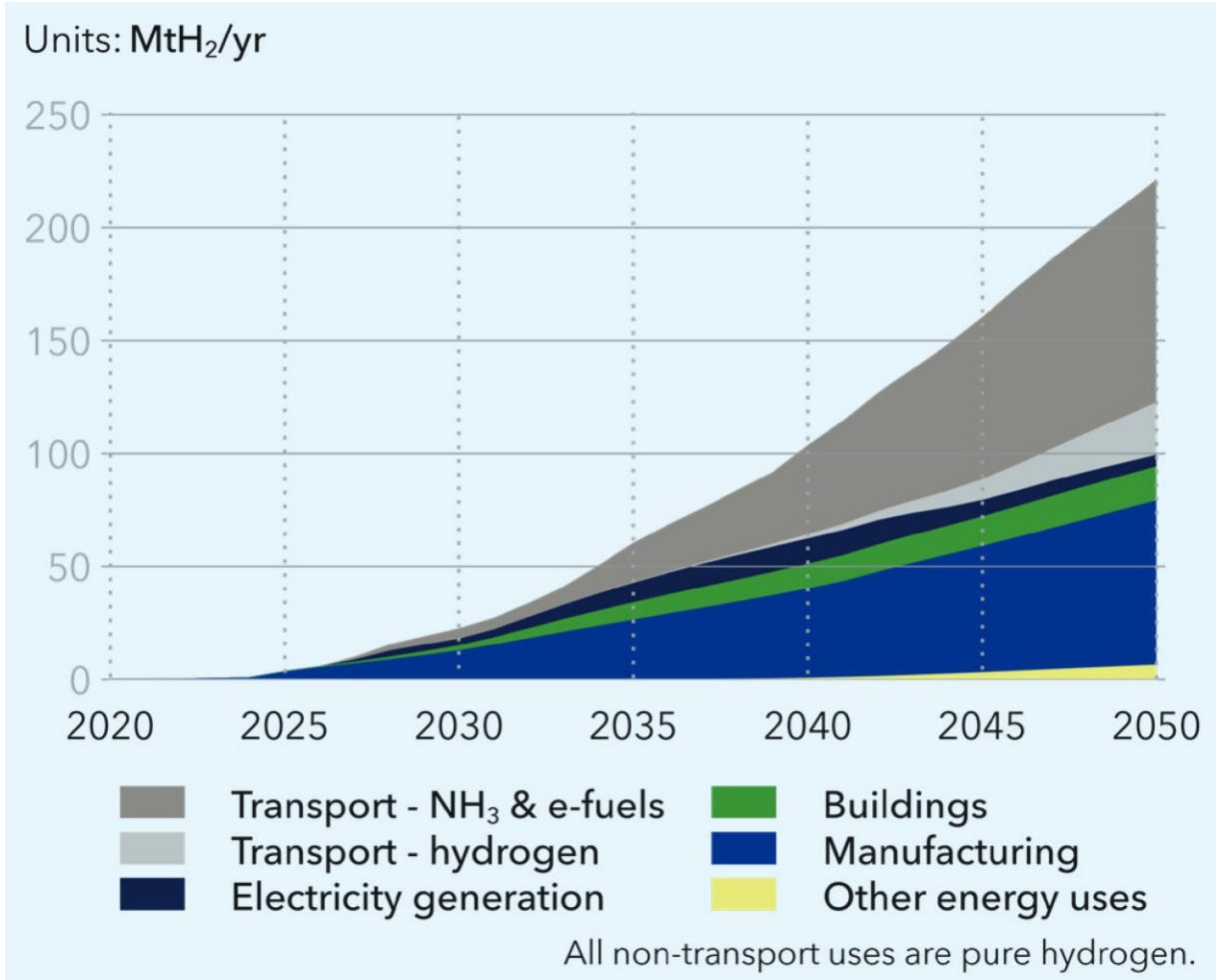


Wind energy availability

Projected global H_2 demand

Source: IEA (2021) - Global Hydrogen Review 2021



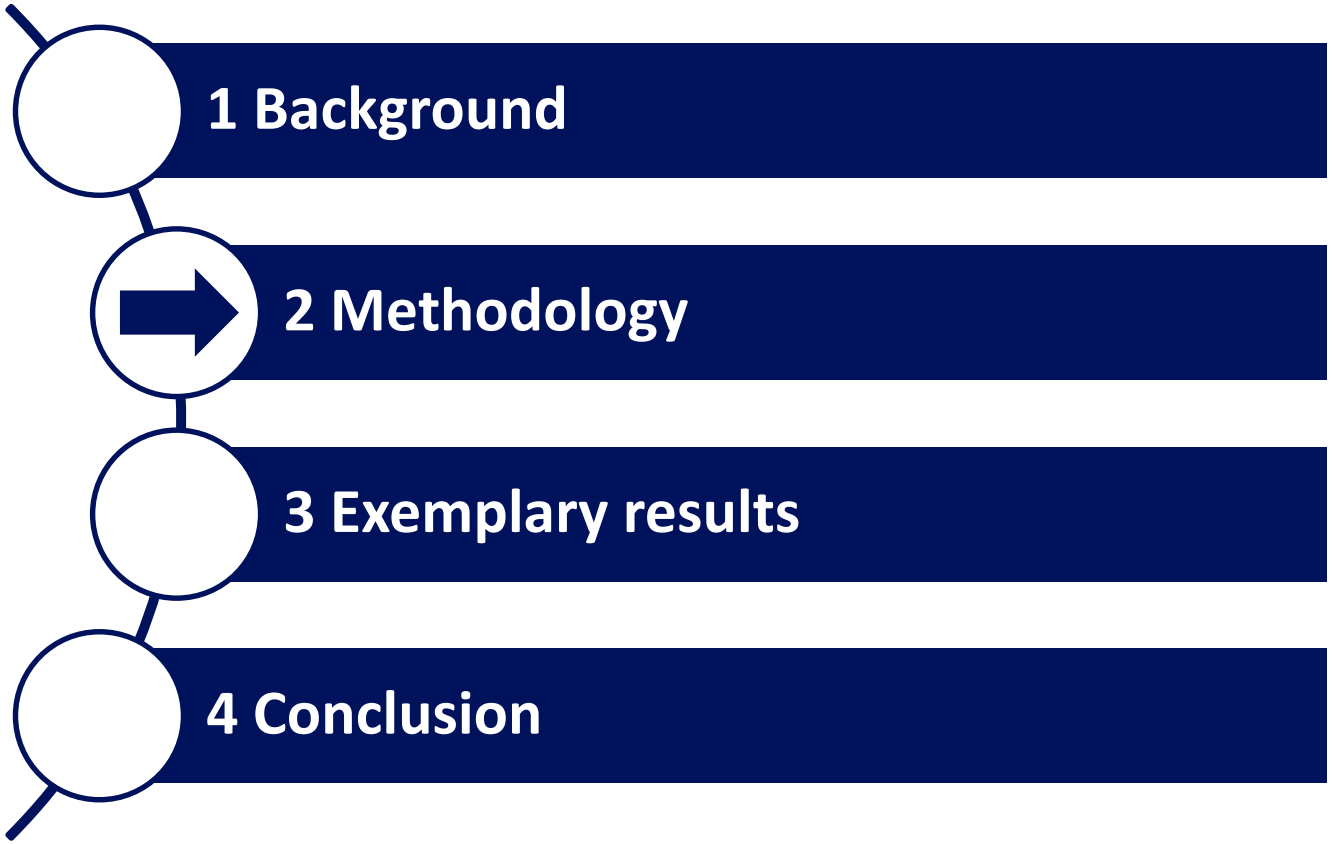


Source: DNV (2022) - Hydrogen Forecast to 2050

Key messages

- Only renewables – and in particular wind power and solar energy – promise a valid, robust, technological mature and economic viable solution for a GHG-neutral energy provision in the years to come.
- Unexploited potentials for electricity provision from wind power and solar energy are huge – but are not necessarily always in line with to the given energy demand, both in terms of location and time.
- Thus, to pave the road toward increasingly higher shares of renewable energies (a) a efficient storage option is needed and (b) a tradeable secondary energy carrier technologically easily provided from electricity is needed.
- Hydrogen seems to be one promising solution; i.e. the hydrogen demand is expected to increase clearly within the next decades, as green hydrogen and it's derivates (e.g. ammonia) provide a flexible solution for transport and storage of renewable electricity.

Agenda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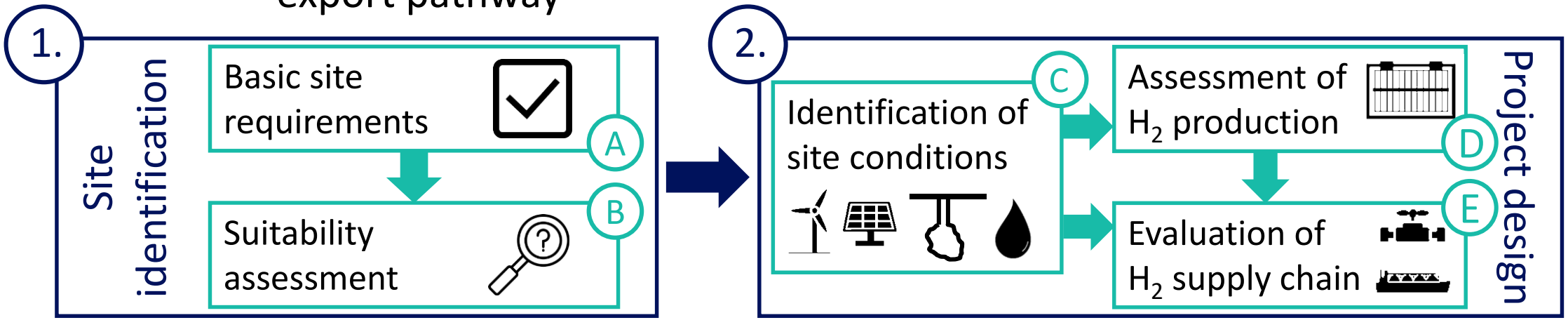
Methodology Overview

Overarching goals:

1. Identify favorable sites for the production and export of H_2
2. Conceptual design of potential projects, including production plant and export pathway



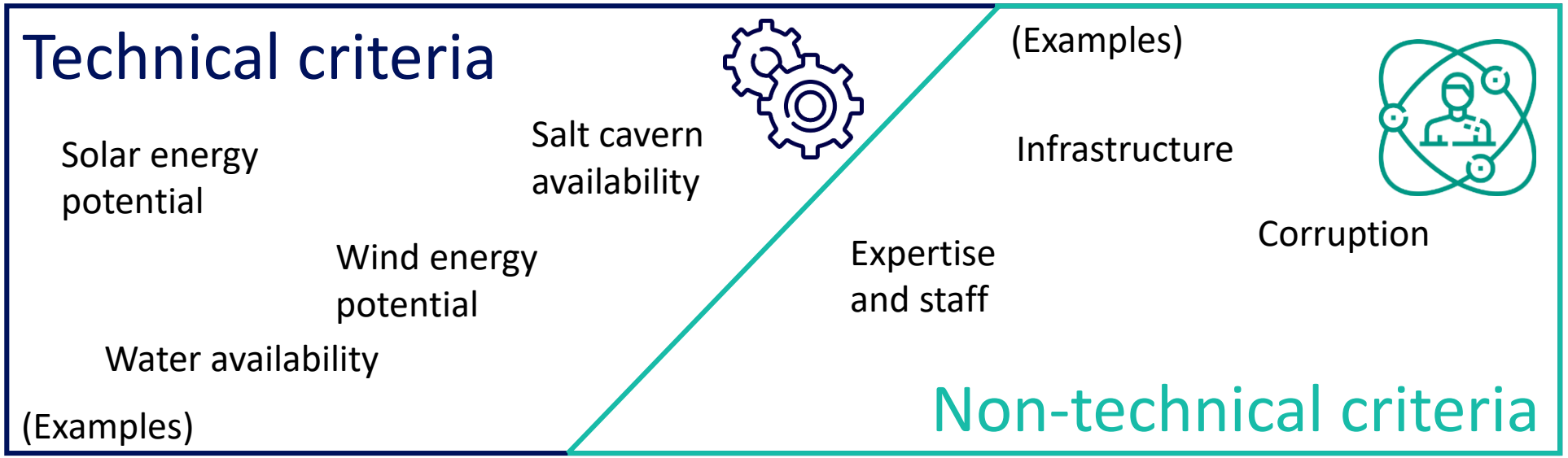
Step A: Basic site requirements

➡ Certain minimum requirements have to be met by sites to be considered in the assessment

1. Political stability
   - Enables successful realization of projects and reliable international cooperation
2. Costal access
   - Enables offering of H_2 or its derivatives on the world energy markets without having to pass through another country
3. Area availability
   - Availability of suitable areas (no settlements, nature conservation areas, etc.) is necessary for the successful realization of hydrogen projects

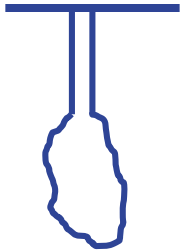
Step B: Suitability assessment

➡ A multi-criteria approach is used to select regions with especially good conditions for production and export of H_2.



Step C: Identification of site conditions

- Solar radiation and wind speed

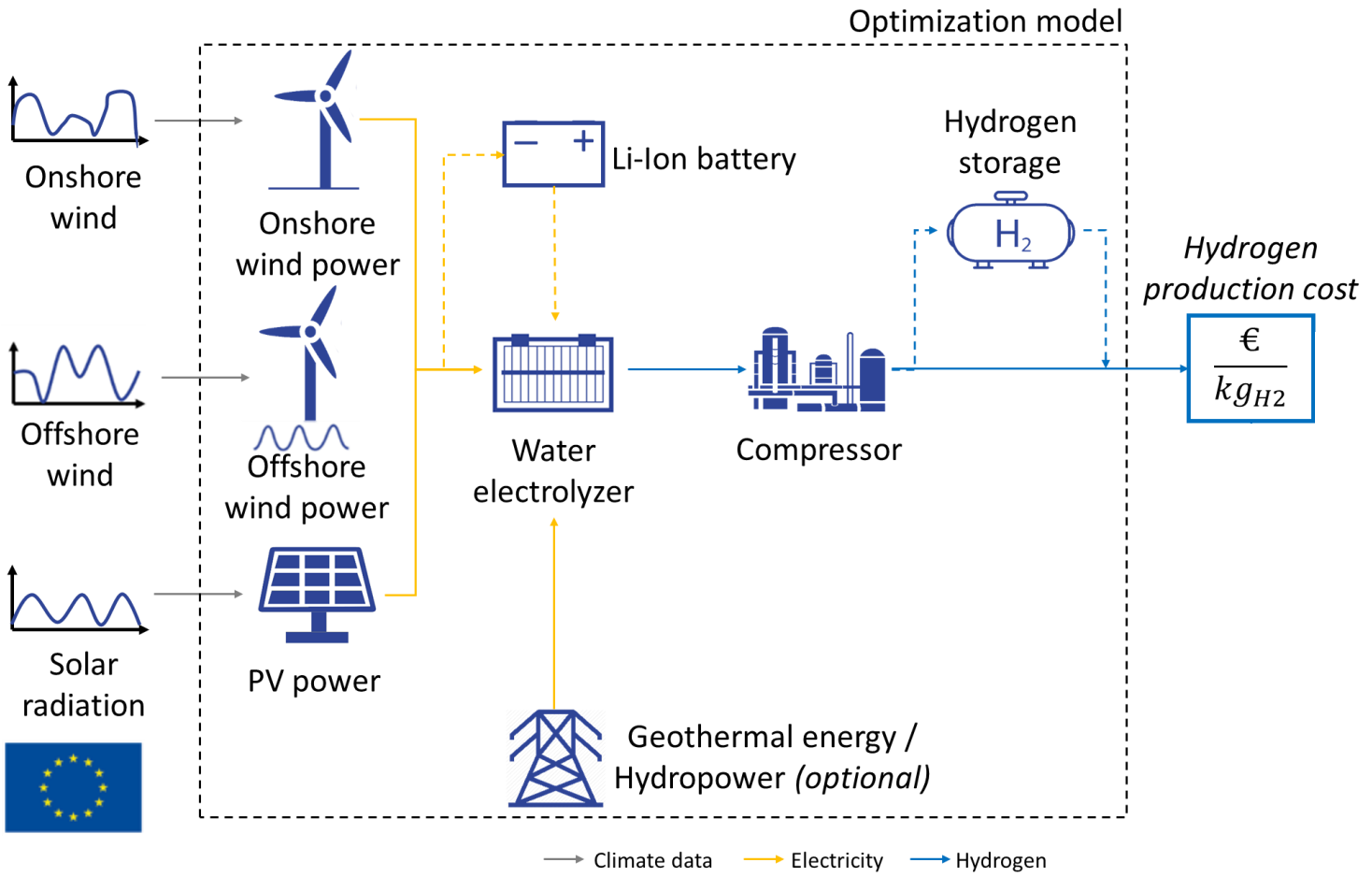


- Presence of salt caverns suitable for H_2 storage

- Constant availability of “green” grid electricity (e.g. geothermal or hydro-power)

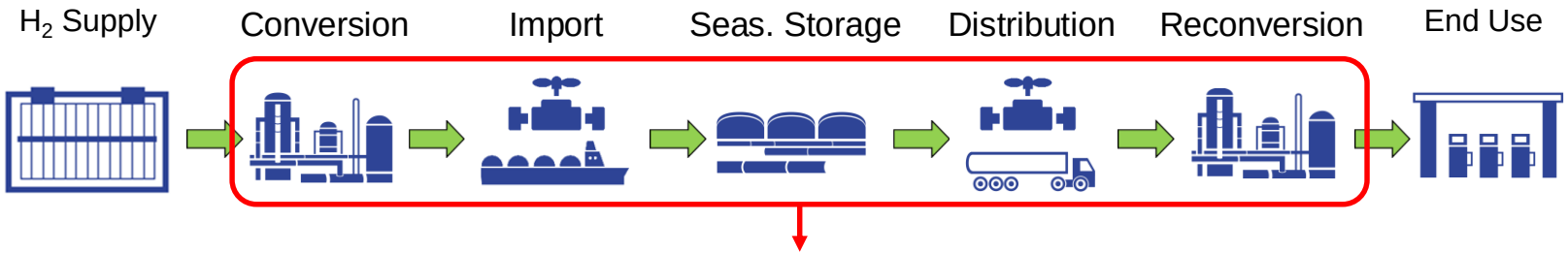
- Distance to sustainable water source (e.g. seawater for desalination)

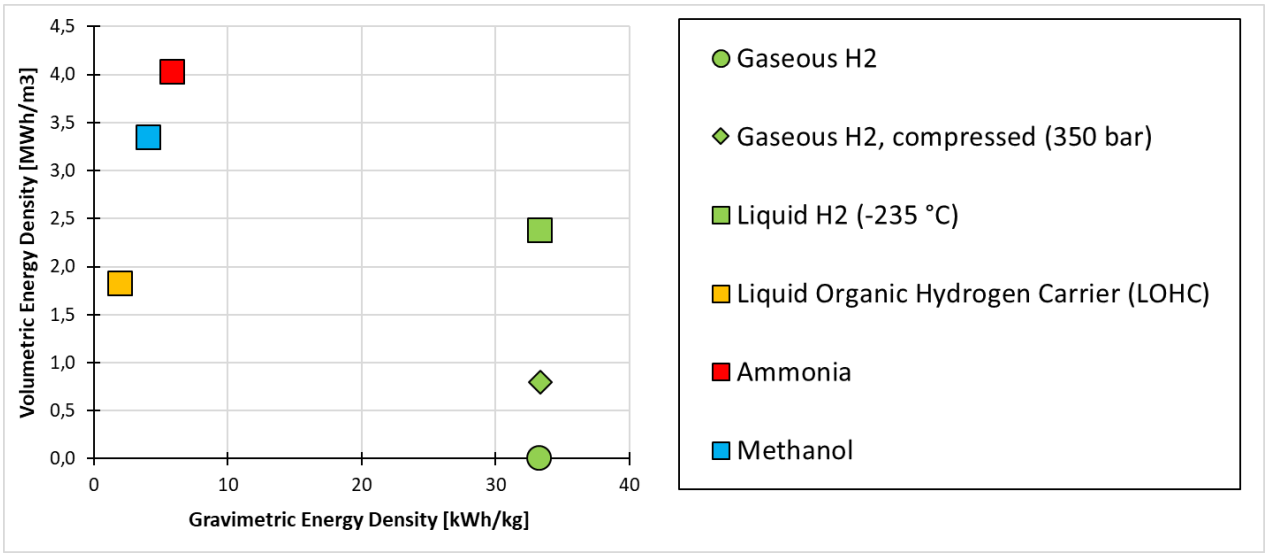
Step D: Assessment of H_2 production



Site-specific H_2 production costs are determined

Step E: Evaluation of H_2 supply chain





Various energy transport options are analyzed

Key messages

- The developed methodological approach is flexible to be adapted to various regions / areas / countries.
- The presented approach can help to identify the most promising concepts to allow for a subsequent much more target oriented planning phase.
- The shown assessment method is user-friendly and can be adapted easily by well-trained engineers.
- The results help to understand the pros and cons of such a hydrogen project for the national as well as the international markets.
- The approach can help to prepare in a transparent and easy to follow way the respective decisions.

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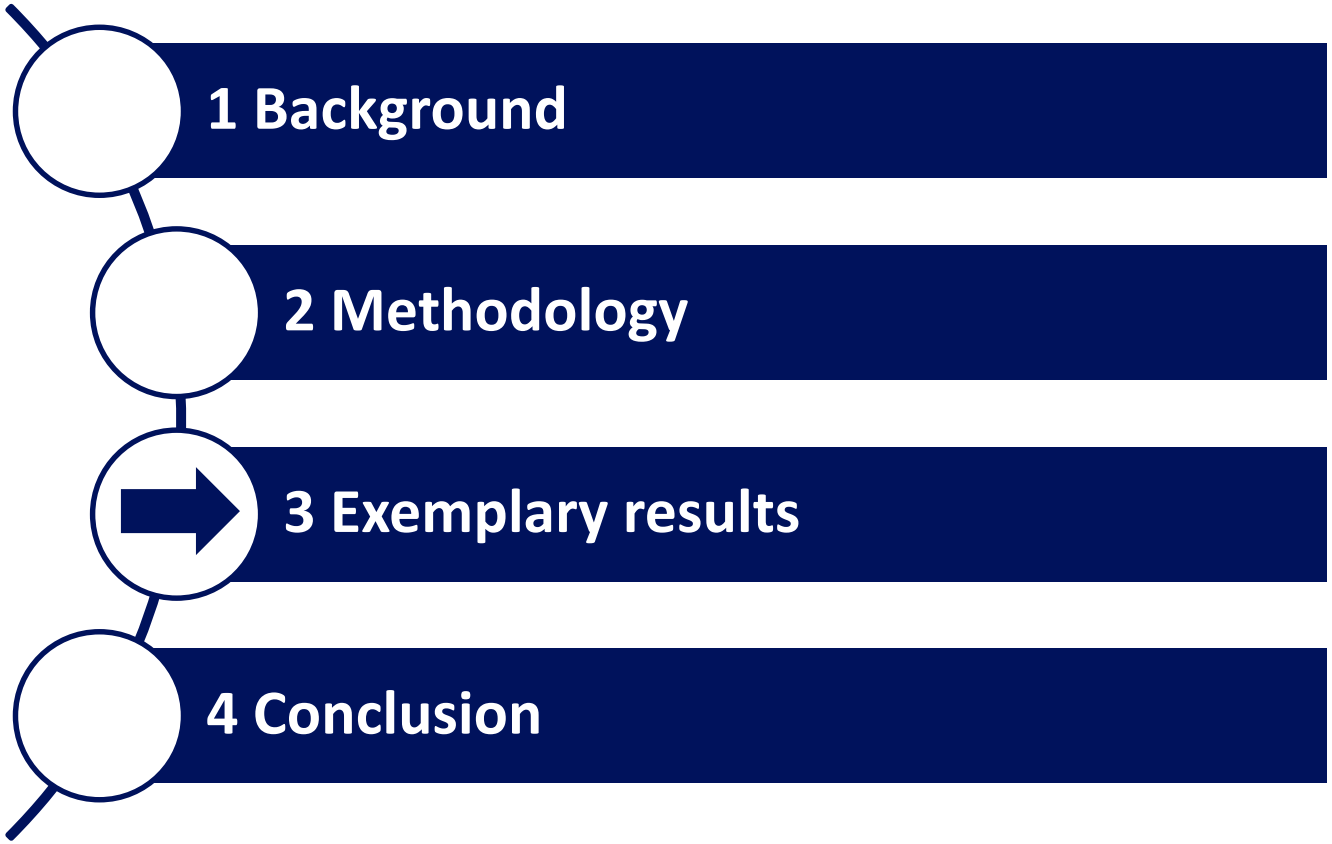
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Exemplary results

- Applying the methodology to the countries of North Africa

Step A: Basic site requirements

☐ Political Stability ☐ Costal Access ☐ Area Availability

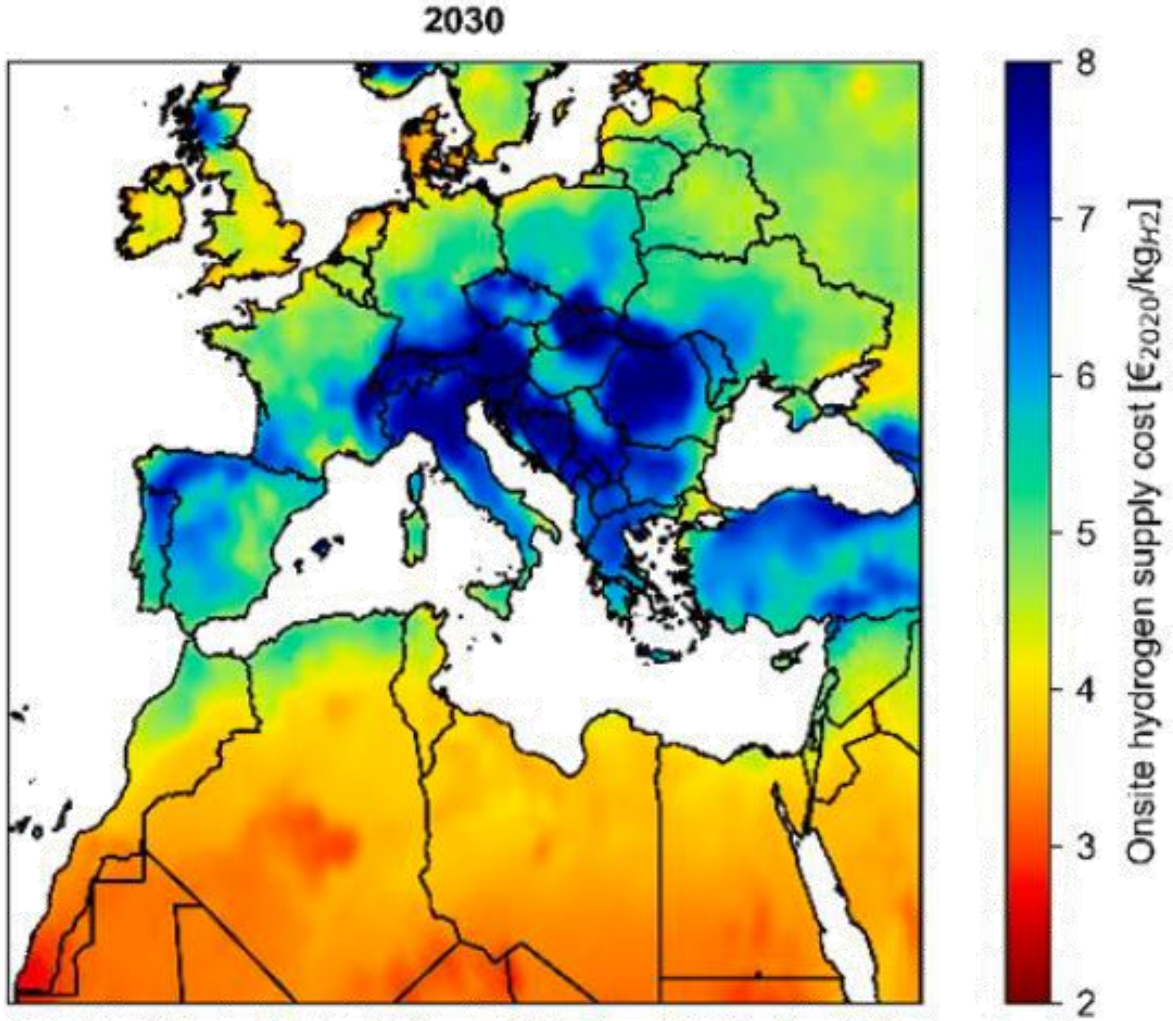
Step A: Basic site requirements

☐ Political Stability ☐ Costal Access ☐ Area Availability

Libya lacks political stability and is excluded from further assessment

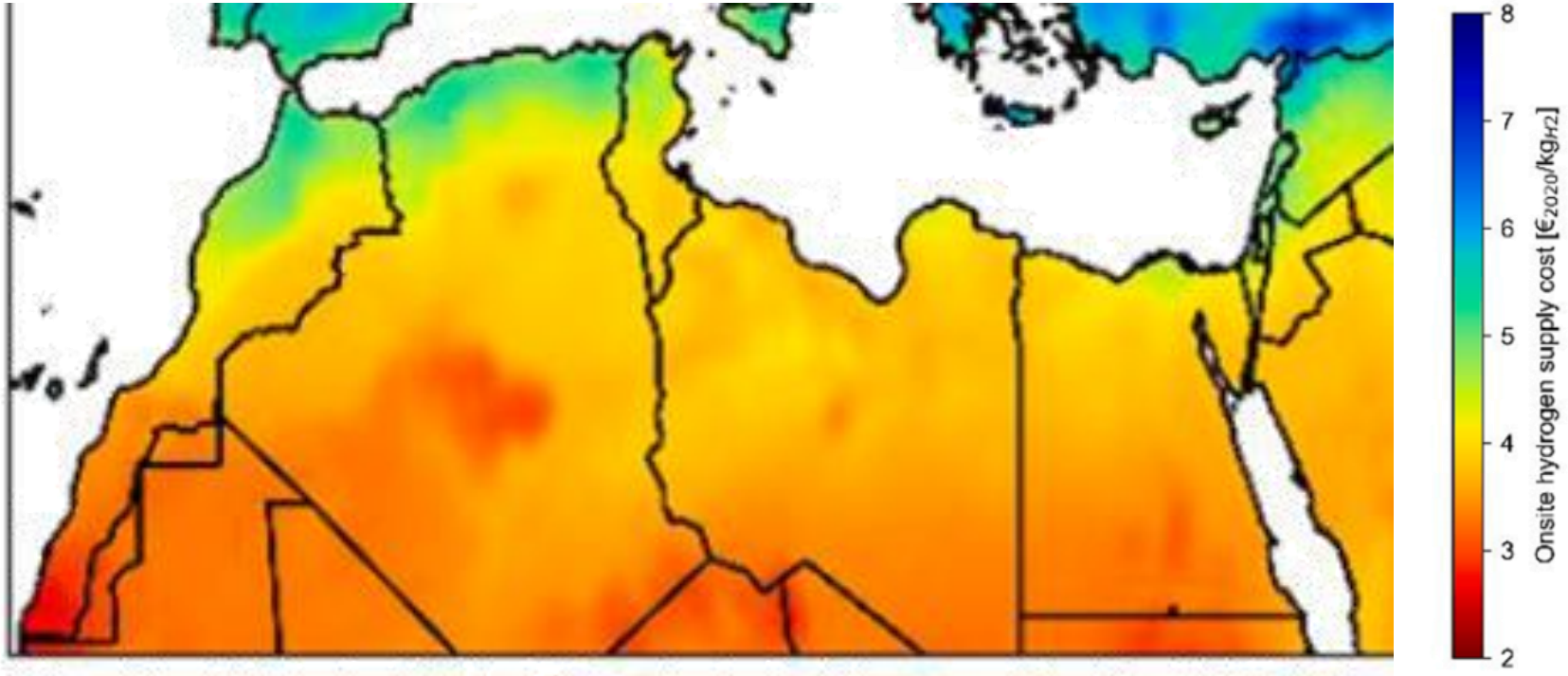
Step B: Suitability assessment

➡ Assessment of technical criteria shows regions with low onsite H_2 supply costs.



Step B: Suitability assessment

➡ Adding non-technical criteria to the assessment shows suitable regions for the production and export of H_2.



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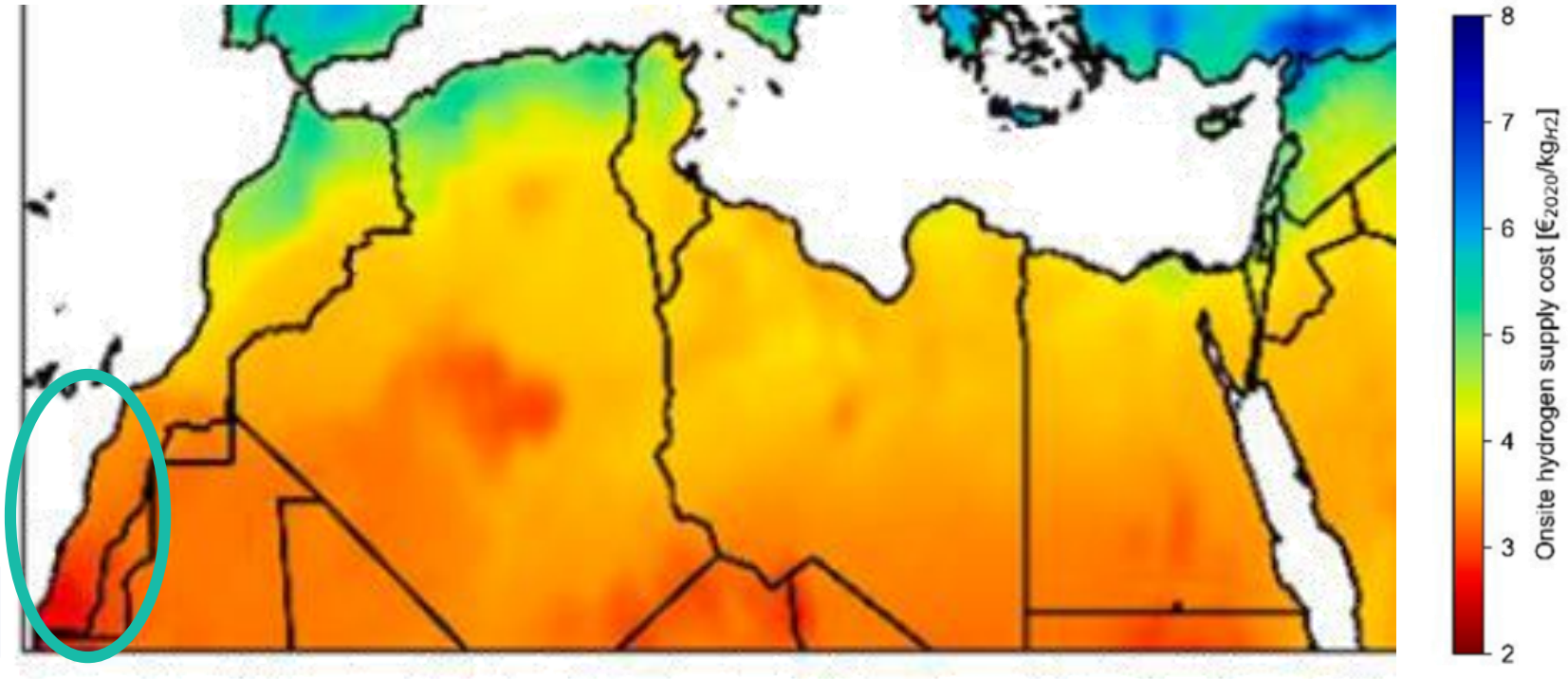

Morocco / Western Sahara

- Lowest onsite H_2 supply cost (< 3 €/kg_{H2})
- Direct coastal access for water supply and export

Step B: Suitability assessment

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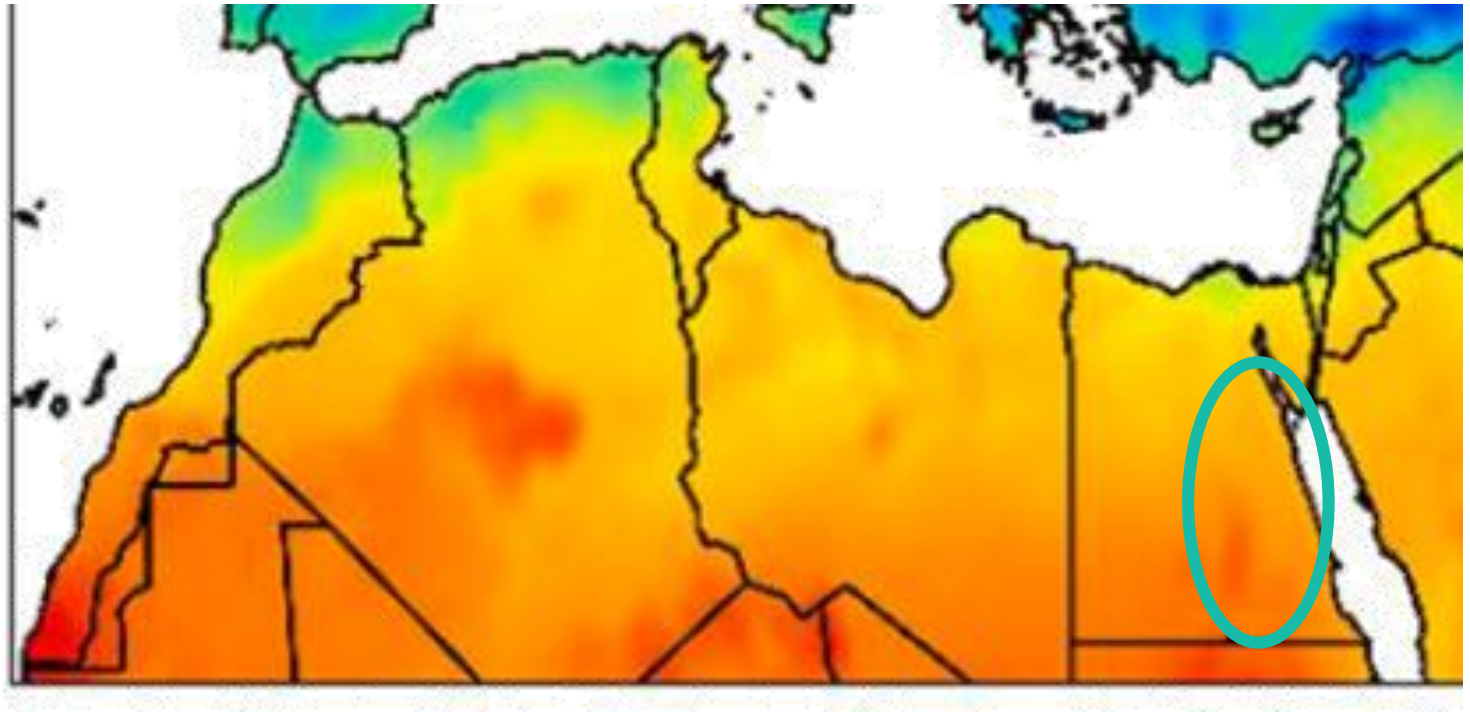
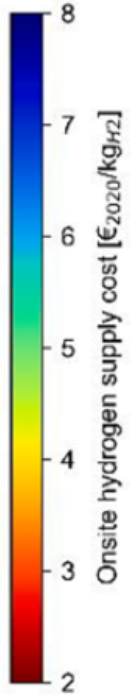


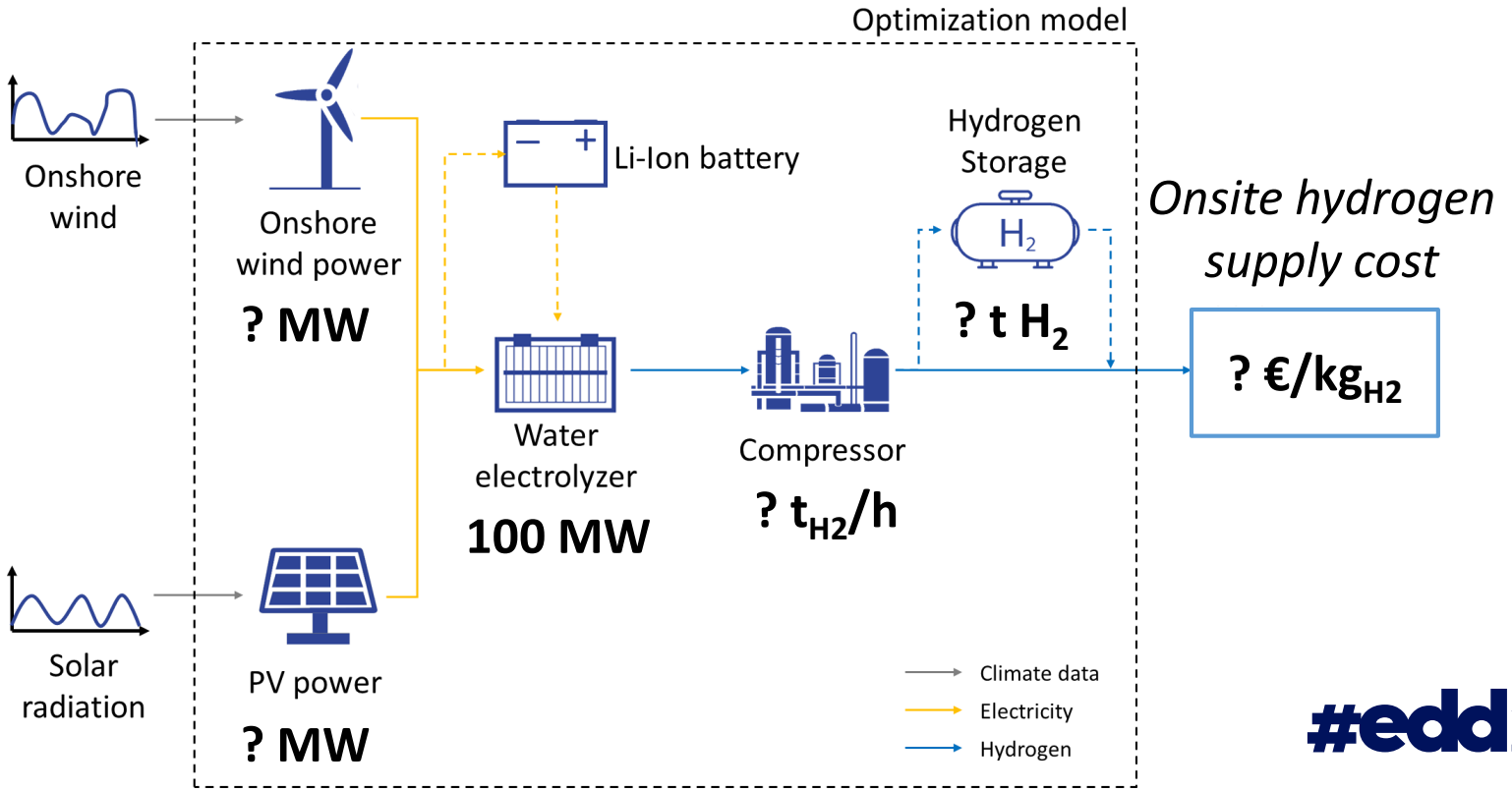


Southeast of Egypt

- Low onsite H_2 supply cost (< 3,5 €/kg_{H2})
- Good infrastructure available
- Additional green energy from hydropower possibly usable

Step C-E: Project design

➡ Exemplary design of an optimized plant for H_2 supply



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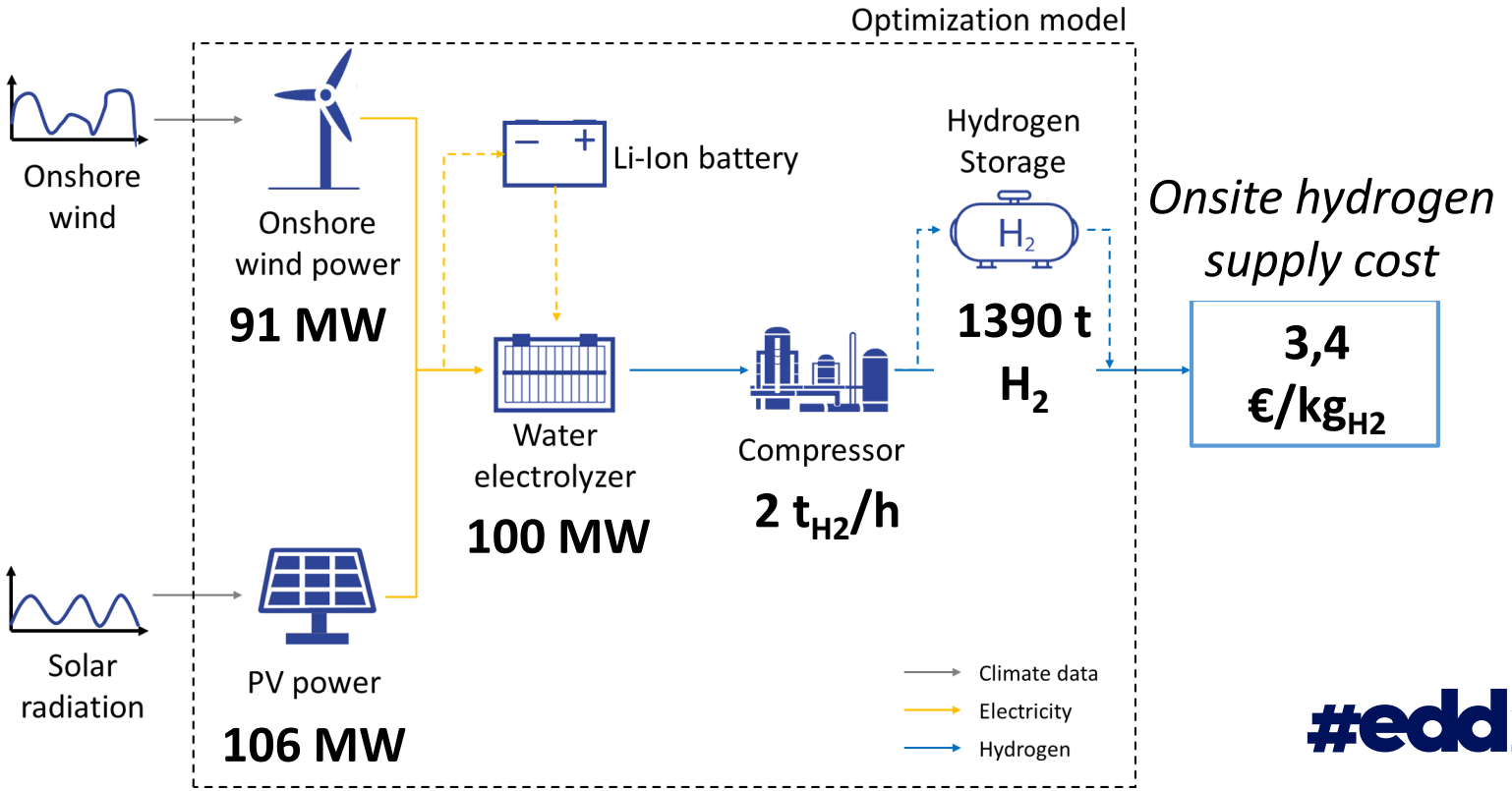
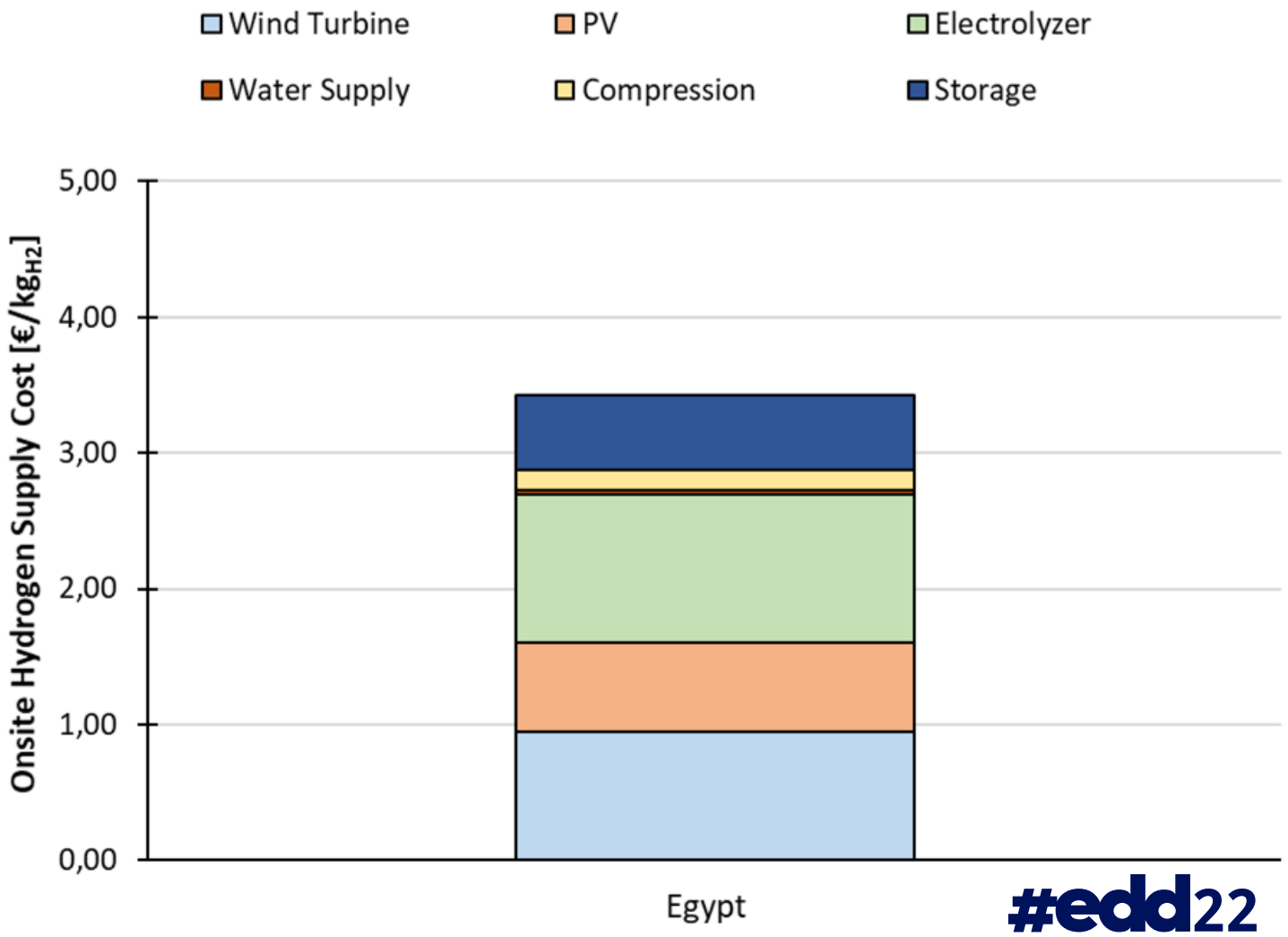


Step C-E: Supply chain assessment

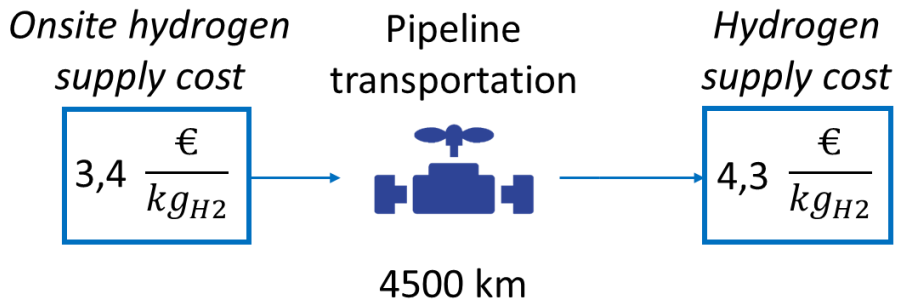
➡ Onsite H_2 supply cost

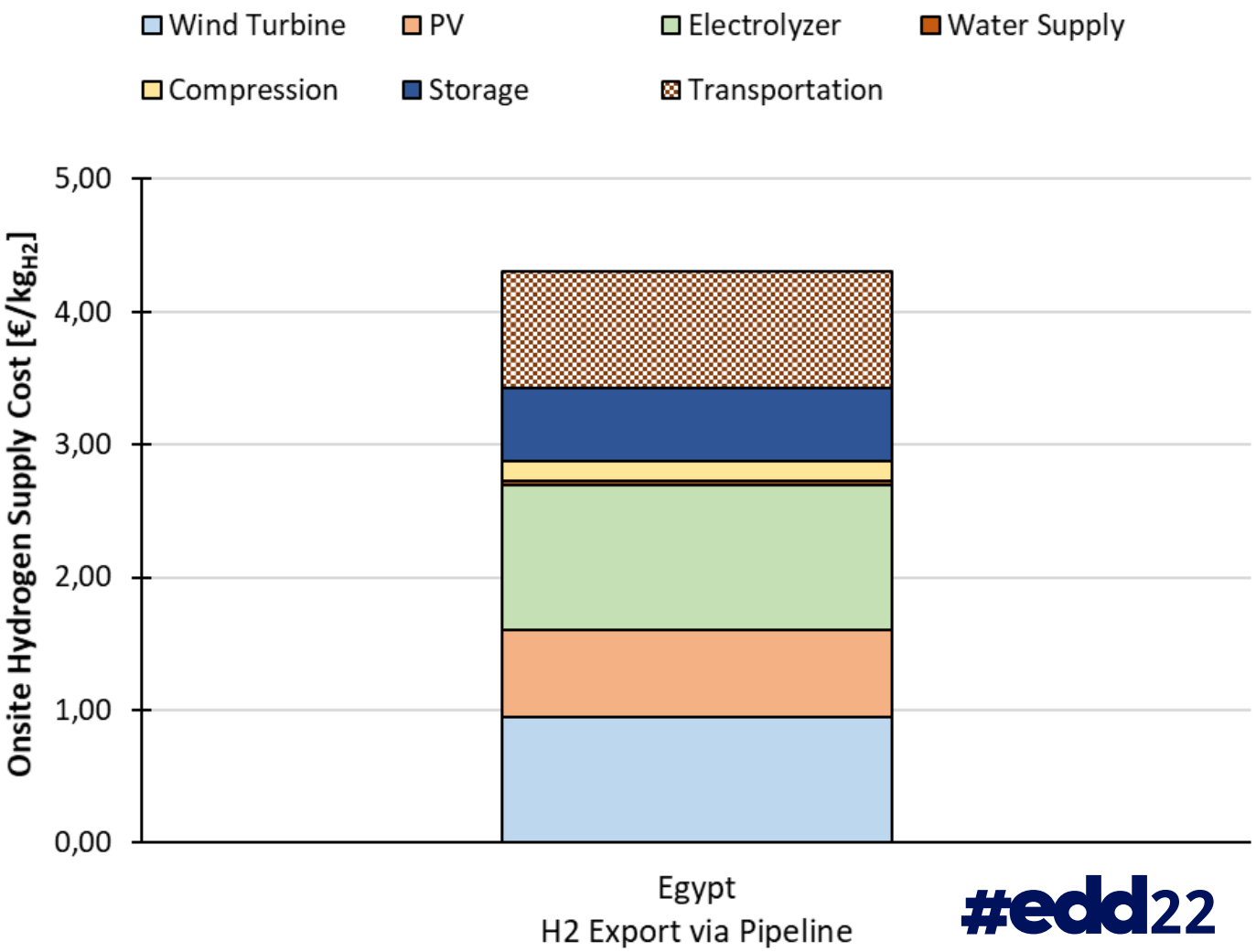
→ $3{,}4\ \frac{€}{kg_{H2}}$



Step C-E: Supply chain assessment

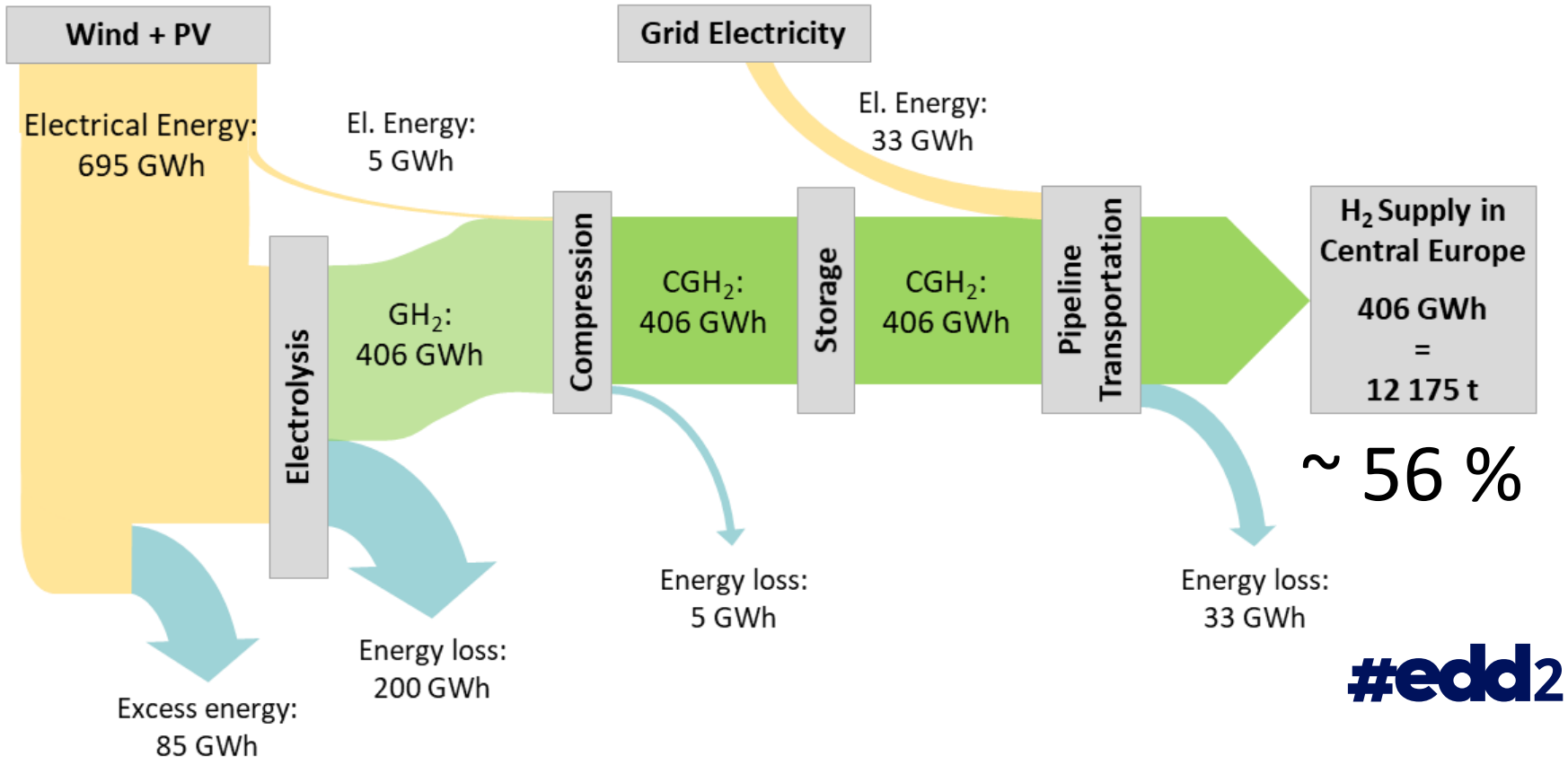
➡ H_2 supply cost for an export to Central Europe





Step C-E: Supply chain assessment

➡ Energetic efficiency



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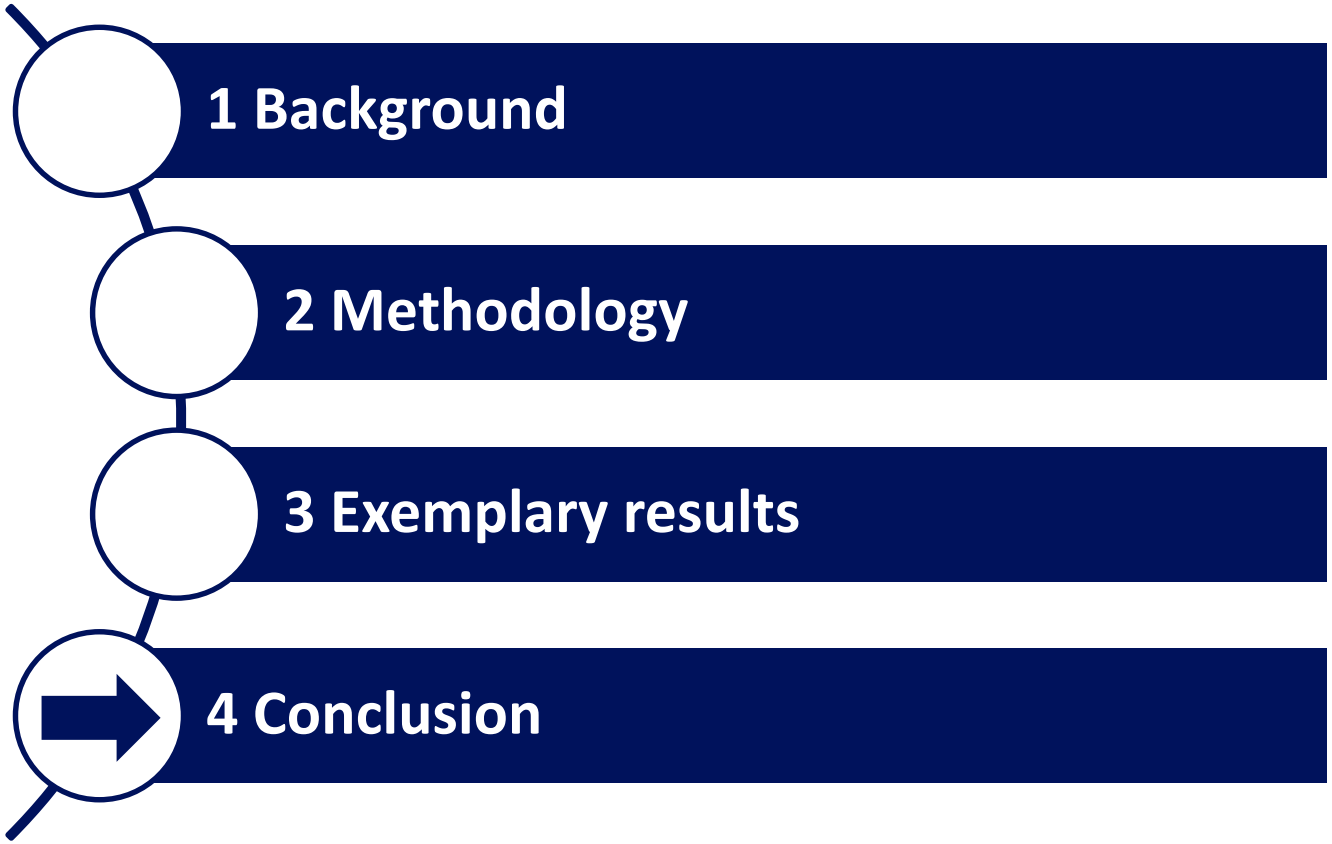
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Key messages

- A wide range of criteria must be taken into account when selecting suitable sites for the production of H_2.
- Several regions in North Africa show excellent conditions for the production of H_2 and its export.
- In 2030, onsite H_2 supply costs of 3 to 4 €/kg_{H2} can be achieved.
- This leads to H_2 supply cost of 4 to 5 €/kg_{H2} in Central Europe if pipeline transportation is considered.

Contact

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