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GREEN HYDROGEN DEVELOPMENT IN MOROCCO:

Promising Trends and Sustainability Impacts

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RCREEE

Regional Center for Renewable Energy and Energy Efficiency

المركز الإقليمي للطاقة المتجددة وكفاءة الطاقة

SUMMARY

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2. National H2 Context
3. PtX Potential in Morocco
4. National H2 Commission
5. Green Hydrogen Roadmap
6. Sustainability Concerns of H2

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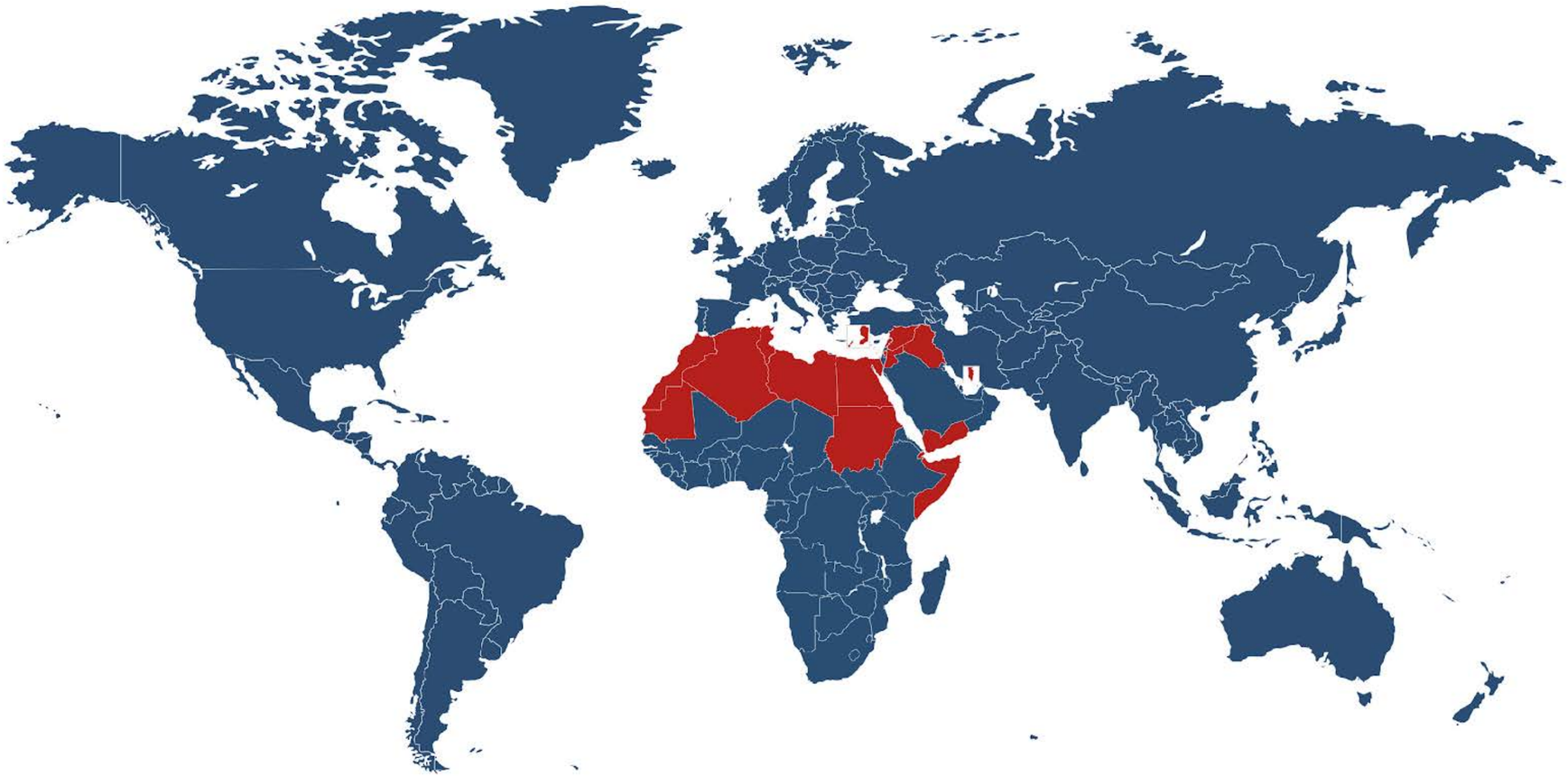
1. About RCREEE:



Work in the Pan-Arab Region… Know How to Navigate your Way

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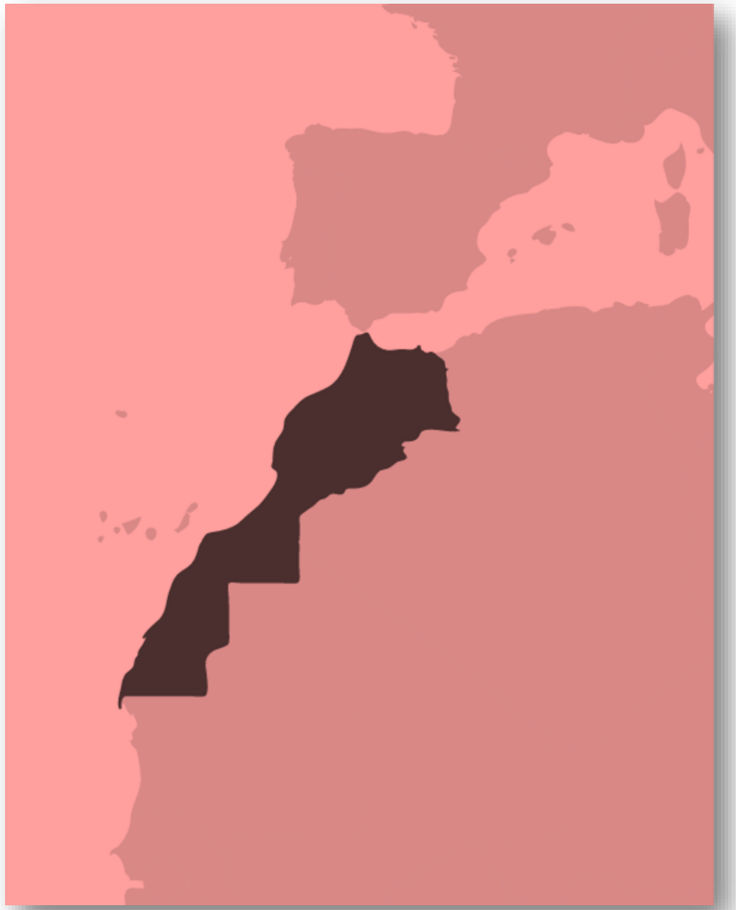
2. National H2 Context:



- Strong Solar Power potential especially for PV electricity:

+ 20000 GW

Solar Potential

- Highest Onshore Wind Energy potential:

+ 6000 GW

Wind Potential

- OCP & Fraunhofer partnership to produce synthetic Green Hydrogen & **Green Ammonia**

Private Sector Involvment

- 6 International **Maritime Harbors** equipped with infrastructure for energy exchange

Maritime Infrastructure

- Proximity to Europe & the **Maghreb – Europe Gas Pipeline** already in place in the northern part

Maghreb – EU Gas Pipeline

- Solid international partnerships lowering trade costs and barriers: (**Morocco-EU Free Trade Area**)

Trade Partnerships

3. PtX Potential:

Preliminary Studies on PtX Potential in Morocco:

- **Description:**

In partnership with **Fraunhofer IMWS** and **Fraunhofer ISI** , and with the support of the Moroccan-German energy partnership **PAREMA**, two preliminary studies were conducted during 2018 to explore the national PtX potential in Morocco:

- Study with Fraunhofer IMWS: **PtX Market and Technologies**

  With special focus on Electrolysis Technologies, Hydrogen and Ammonia

- Study With Fraunhofer ISI: **Opportunities and Potential for Morocco**

  With special focus on Grid Infrastructure, Export Infrastructure and Impacts.

- **Main Outcomes:**

  - ✓ « Morocco: a **Business Case** for **PtX**, given its potential of renewables … »
  - ✓ « **Electricity** stands for **60% to 75%** of the **Cost** of a Green Molecule … »
  - ✓ « Moroco **could capture around 2 to 4% of PtX world market** … »

  (Hydrogen Market~$100Bn, Ammonia Market ~$40 Bn, Methanol Market ~$50Bn)

  - ✓ « Need for **R&D** demonstration at a pilot scale … »
  - ✓ « Substantial **Impacts on the Economy**, creation of a dedicated Industrial Eco-System…»

4. National Commission:

National Commission for Green Hydrogen:

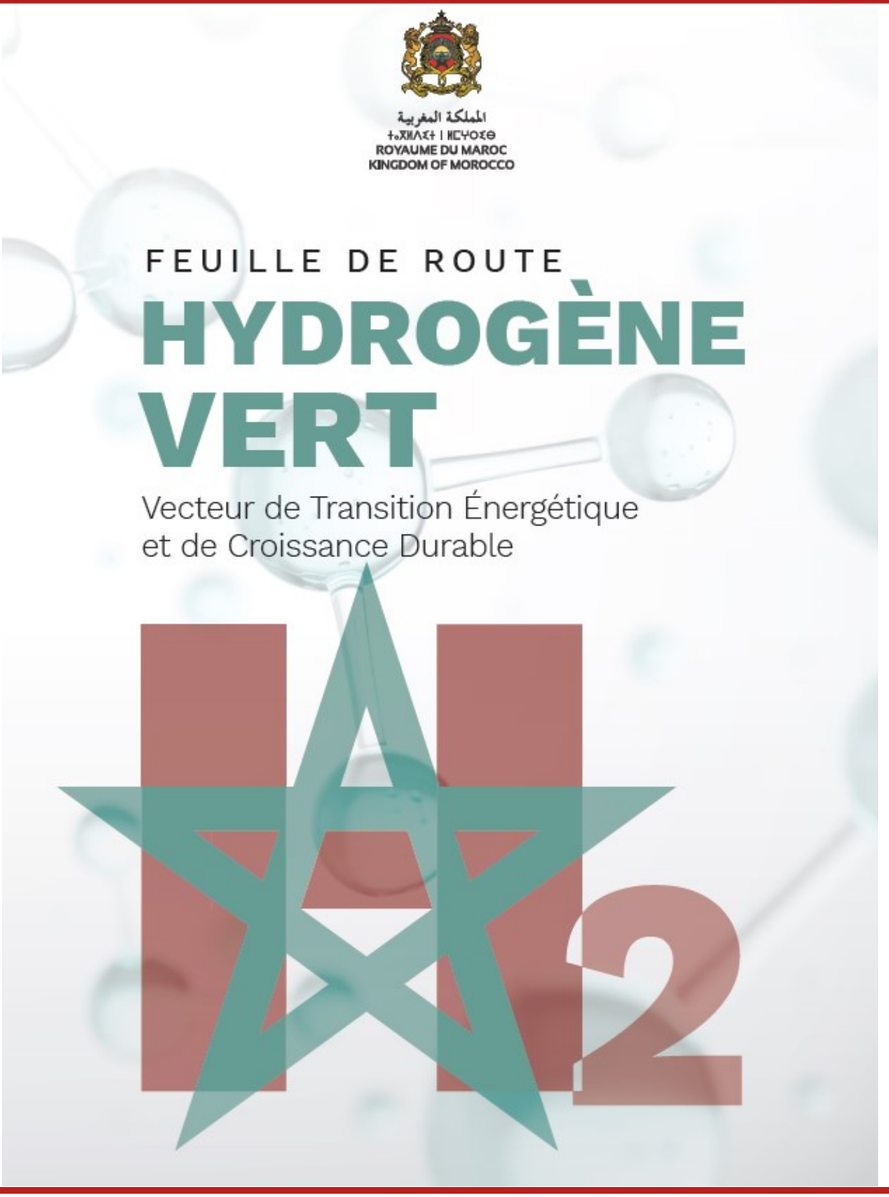
- **Description:**

Composed of the relevant Ministerial Departments (Energy, Finance, Transport, Higher Education, Industry…), ONEE, MASEN, IRESEN, CGEM and the Energy Federation…

- **Mission:**

Elaborate the National Green Hydrogen Strategy and a 3rd in depth study about PtX Roadmap in Morocco (2030 - 2050).

5. Green H2 Roadmap:



- **National Green Hydrogen Roadmap in Morocco :**

- **Description:**

Launched during the 1st meeting of the National Green Hydrogen Commission in October 2019, with the aim of conceiving a sectorial clear vision for green hydrogen opportunities and practices across the whole economy value chain.

- **Objectives:**

- Elaborate a sectorial roadmap for Green Hydrogen (2020 - 2050)
- Evaluate the socio-economic impact of the Green hydrogen economy
- Focus on the environmental impact of the Green Hydrogen industry
- Explore the R&D, Innovation and Industrial opportunities for Morocco

5. Green H2 Roadmap:

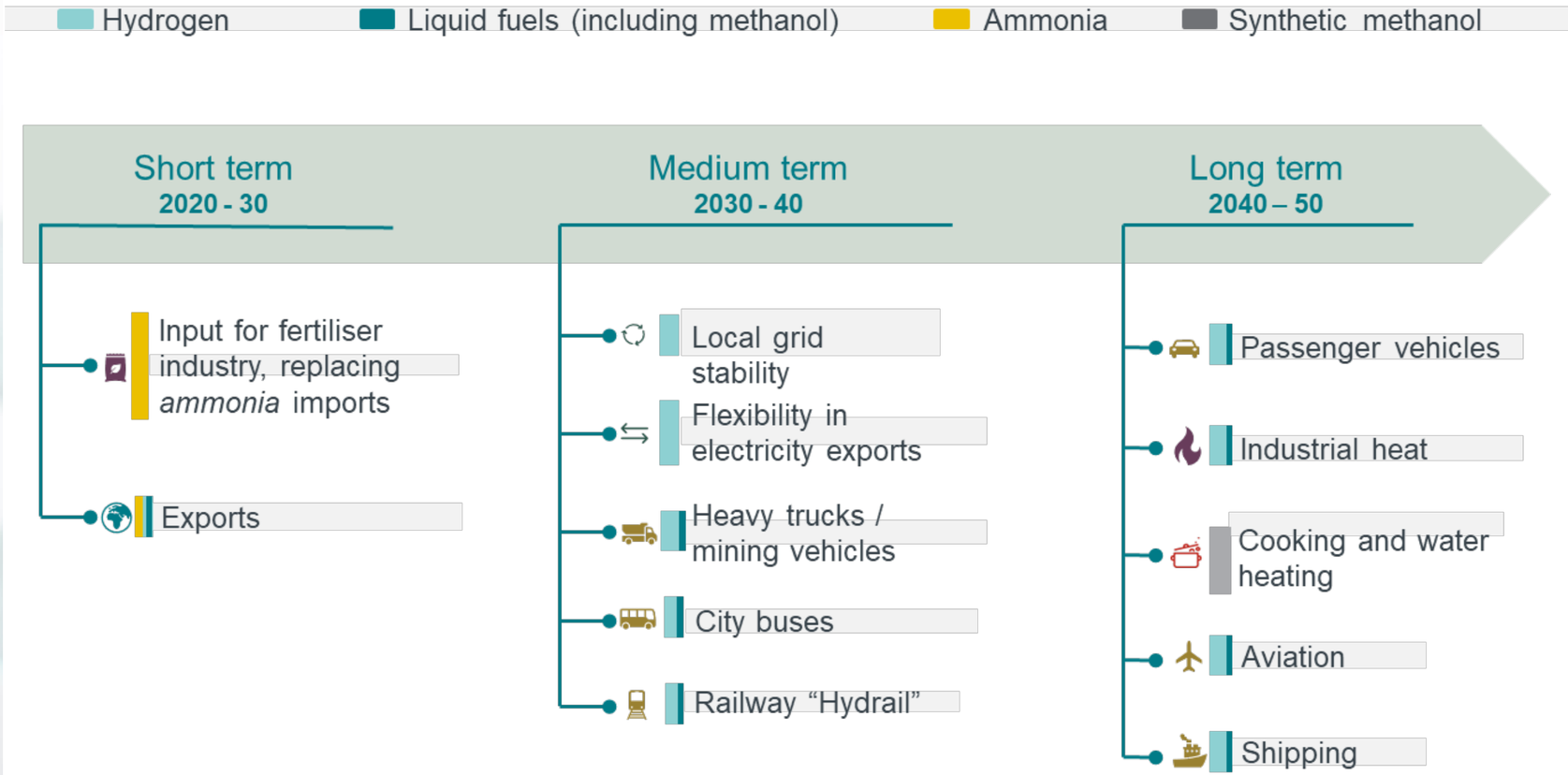
المملكة المغربية
ROYAUME DU MAROC
KINGDOM OF MOROCCO

FEUILLE DE ROUTE

HYDROGÈNE VERT

Vecteur de Transition Énergétique
et de Croissance Durable

Perspectives of a Green H2 Based Economy:



Green Ammonia presents a business case for the 1st phase of the roadmap implementation, tacking into account the ***ammonia imports (1.8 Mt in 2018 = 0.4% GDP)*** *to satisfy the fertilizers industry needs, and considering its increasing demand..*

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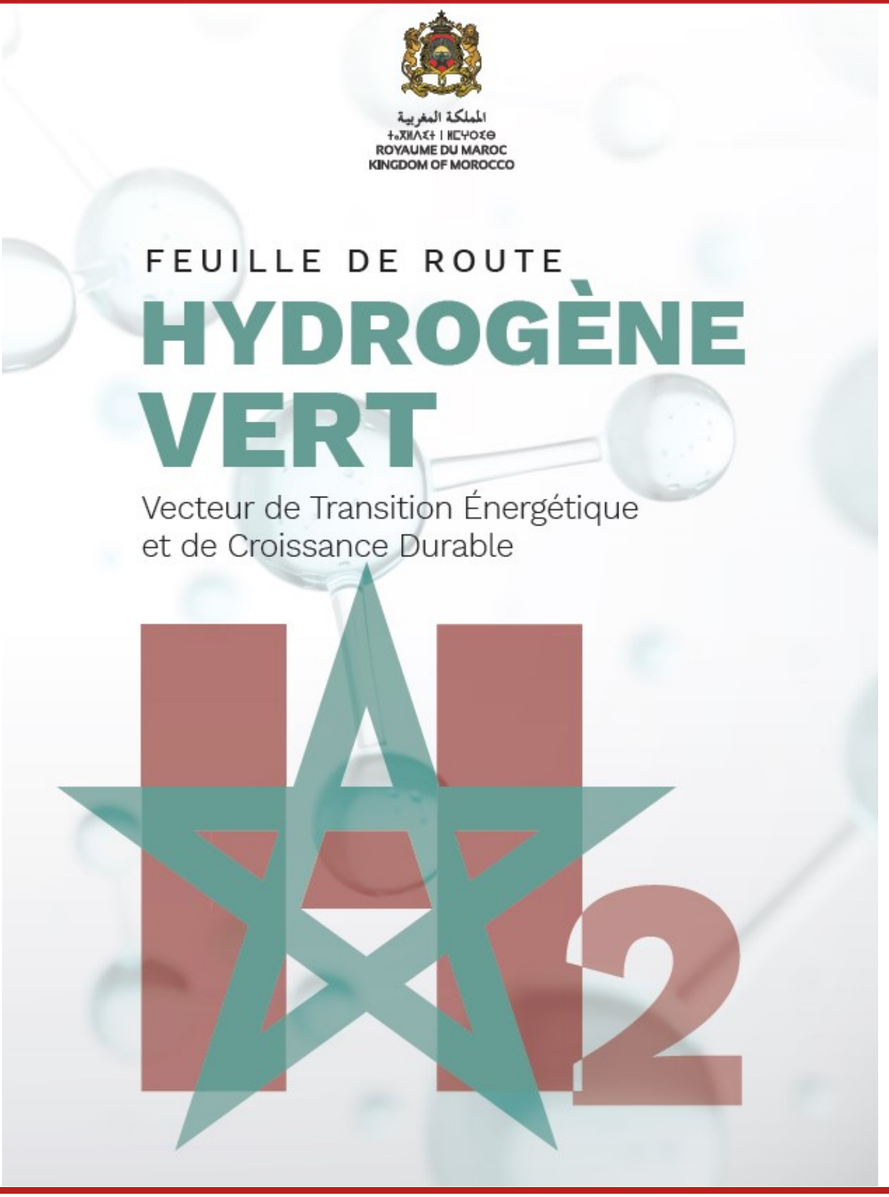
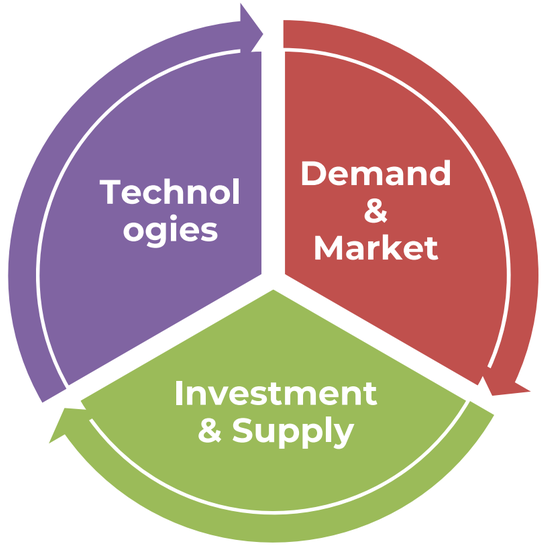
5. Green H2 Roadmap:



Green H2 Development Framework Pillars:



Green H2 Development Action Areas:

1. **Facilitating costs reduction** along the PtX value chain.
2. **R&D:** Setting-up a Moroccan and international research cluster.
3. Defining the relevant measures for **local content**.
4. Setting-up an industry cluster and develop related **infrastructure masterplan**.
5. **Securing financing to developing the PtX industry.**
6. Creating the **conditions for exporting PtX** products from Morocco.
7. **Assessing** in detail a **storage** plan for the electricity sector.
8. **Develop Domestic Market**

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6. Sustainability Concerns:

Additional Renewable Electricity Generation:

Additionality of the expansion of renewable energy sources is foreseen to produce the green hydrogen, which means more dedicated investments in wind and solar.

This will accelerate the achievements of RE national objectives, where the off-grid regions are particularly suitable (land availability, RE yield) as well as the regulatory uncertainties and costs which can be avoided (grid fees, connection procedures…)

- **Conclusion**:

The energy transition in the electricity sector and the Green H2 strategy will mutually diverge (synergy effects, economies of scale …).

6. Sustainability Concerns:

Irrigation & potable water supply in dry climate zones:

- Unlike the limited availability of potable water in the country, the access to the sea in Morocco provides the option to gain sweet water from desalination.

- Water availability is likely not a limiting constraint in Morocco since desalination plants can be built along the coastline, where RES-E potentials are promising, and where some of the existing RE plants are already located near to those seas.

- Morocco has started to build small-scale desalination plants since 1995 and has reached a capacity of 132 Mm3/year by 2016. In the 2015 National Water Plan, the country planned to increase this capacity to over 500 Mm3/ year out to 2030.

6. Sustainability Concerns:

- **Sustainable development in production countries:**

CO2 reduction measures in foreign countries are implemented in a manner that encourages sustainable economic development.

=> Criteria for sustainable development could include the requirement to make additional investment, reduce poverty levels, increase employment , local content and/or transfer new technologies/

=> It can be expected that successful economic development depends heavily on political and regulatory factors with along a strong industrial development policy.

6. Sustainability Concerns:

Sustainable use of space:

- Competition with the use of land for food production and with forested areas are of particular importance in this regard. Renewable facilities, synthetic fuel production plants and, as necessary, plants for obtaining water and CO2 all require space.

=> In Morocco, 12.25% of the land is dedicated to agriculture and 12.8% is forested. This suggests that nearly 75% of the territory could be used for green hydrogen generation or other purposes.

=> The estimations states that land needed for additional RES dedicated to the Hydrogen industry would be between 990 and 1,660 km2 . This is at most 0.36% of non-agricultural nor forested land in Morocco.

6. Sustainability Concerns:

Closed Carbon Loop:

The origin of carbon in case of synthetic energy carriers such as methane, syn-fuels, methanol.

- The production of 1TWh of synthetic methane requires 198 kt CO2 (Agora/Frontier Economics, 2018).
- The CO2 supply is limited in the long-term. Using CO2 from fossil processes is not sustainable. A true CO2 recycling process is required.
- The origin of the carbon will be the more an issue if Morocco becomes an exporter of PtX to countries with 95% reduction targets. It is difficult to envisage that those countries would import PtX based on non-sustainable CO2 sources.
- Direct Air Capture (DAC) appears as the main approach.

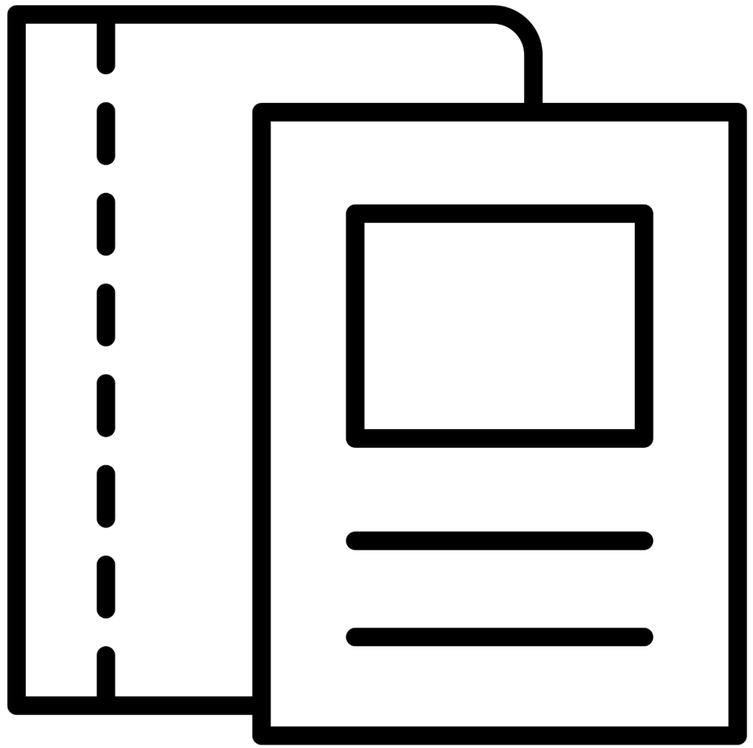
Sources:

- **Green Hydrogen Roadmap 2030:**
Ministry of Energy Transition and Sustainable development

- **H2 development in Morocco 2021 :**
Moroccan-German Energy Partnership (GIZ PAREMA)

- **Opportunities of PtX in Morocco 2019:**
IRISEN & GIZ PAREMA & Fraunhofer ISI

- **The Future of Hydrogen 2019:**
International Energy Agency (IEA)



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