H2 development and sustainability concerns in Morocco

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Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH



There are promising preconditions to develop a PtX industry in Morocco

Morocco has a strong RES-E potential and corresponding low costs prospects for PtX production

Morocco could cover its domestic demand more than **10 times** with its solar sources alone.¹

Morocco's RES-E technical potential²



Morocco appears to be in the lower cost range of PtX production worldwide.





Source:IEA (2019): The Future of Hydrogen

Its proximity to Europe and infrastructure partly already in place benefit PtX export prospects from Morocco



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Maghreb-Europe-Gas-Pipeline from the northern part of Morocco to Europe.



6 harbours with facilities for energy exchange.

Morocco has strong international partnerships that lower trade costs and innovation hurdles



Free trade area between EU and Morocco.



Involvement of industry and private sector



OCP engaged in inter-institutional alliances (including Fraunhofer, Germany) for PtA.



- ¹ Global Solar Atlas (2020)
- ² Iresen

Birth of Power-To-X in Morocco: Preliminary Studies

In 2018, two preliminary studies launched with the support of PAREMA on « Power-To-X » in Morocco



Results presented during a workshop chaired by H.E. Mr. A. RABBAH on Feb, 2019

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First Workshop on "Power-To-X" on Feb. 11th 2019

 \ll ... Morocco: a Business Case for PtX, given its potential of renewables... \ast

« Electricity stands for 60 to 75% of the Cost of a Green Molecule \dots »

« 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 Moroccan Economy, Creation of a dedicated Industrial Eco-System... »

- Decision:
 - \Rightarrow Creation of a 'National Commission of PtX
 - $\Rightarrow 3^{rd}$ study PtX RoadMap for Morocco







National Commission for Green hydrogen (February 2019)

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

- In charge of elaborating the H2 strategy
- Participation in the study trip to Germany in November 2019 to learn about the German experience in this field.





Power to X 2050 Roadmap for Morocco

- Launched on Octobor 2019 with support of PAREMA
 - Launch during the first meeting of the national commission of Hydrogen Morocco
 - A third more in-depth study is launched to:
 - Assess R&D, Innovation and Industrial opportunities for Morocco
 - Evaluation of the socio-economic impact of the PtX economy
 - · Focus on the environmental impact of the PtX industry
 - Elaborate a sectorial Roadmap for PtX in Morocco (2030 2050)





Ptx Roadmap: Hydrogen opportunities/applications



* Preconditioned by the plans of Morocco to resume operation of its current refinery "La Samir" or the vison to construct new refinery in the North of Morocco (Nador city) as was announced in 2018

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Ptx Roadmap: green ammonia production offers a business case to introduce the PtX industry



Source: Updated Agora/Frontier Economics (2018) calculator combined with Fraunhofer Haber-Bosch assumptions

Morocco already employs a significant amount of ammonia in its fertiliser industry

- 1.4 Mt imports represented 0.4% of Morocco's GDP in 2017.
- Between 2012 and 2017, ammonia imports had doubled.
- The OCP group reports 1.8 Mt ammonia procurement in 2018, with expectations of a sharply increasing demand in the future.

Phases to materialise this business opportunity

Short term	 Focus on pilot projects
until 2030	 Funding support to early projects
	 Electricity from the grid and other cheap electricity sources (for example, industrial waste), can enhance the business case.
Medium term 2030-2040	 Commercial projects could arise
	 Still, complementing RES with electricity from the grid and cheap sources would continue fueling the sector.
Long term 2040 – 2050	 Improving commercial cases for ammonia (rising conventional price and expanding

fertiliser industry)

Electricity procurement from RES-E only.



Ptx Roadmap: the Maghreb-Europe Gas Pipeline has a potential relevant role to export PtX to Europe

Maghreb-Europe Gas Pipeline (MEG)



Exploring this opportunity

To assess from a technical and cost-perspective •Hydrogen blending (5%-15%),

Pipeline reconversion to green hydrogen,Injecting green methane.

Commercial assessment

•MEG connects with the Iberian Peninsula. PtX aspirations of Portugal and Spain shape the economic viability of this option.



Ptx Roadmap : three pillars defining a sustainable framework to develop the PtX industry in Morocco and eight areas of action

3 pillars:

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savings,





Green H2 Cluster (launched on March 2021)

Vision => creation of the first national and regional (international) collaborative platform fully dedicated to the development of hydrogen/PTX industry, notably through collaborative innovation, industrial integration, capacity building, knowledge transfer and market development

Objectives:

- Create, develop and animate an efficient H2 ecosystem
- Strengthen the exchange and collaboration between actors
- Conduct business intelligence studies for collaborative purposes
- Contribute to the capacity building of the members of the H2 ecosys





Green H2 Cluster – Structure

Working Groups

- 1. R&D&I
- 2. Industry-ENR
- 3. Industry-Chemical
- 4. Project development
- 5. International Partnership
- 6. Transport of Energy



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Website: www.greenh2.ma





National H2 Commission vs Green H2 Cluster vs

POSITIONNEMENT STRATÉGIQUE DU CLUSTER H2



Summary of Important milestones



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The additionality of renewable electricity generation:

The production of green hydrogen presupposes additionality of the expansion of renewable energy sources.

- We assume that at least for the foreseeable future there will be a dedicated investments in wind and solar farms exclusively earmarked for PtX, as.
 - (i) this will make it easy to prove 100% RE,
 - (ii) off-grid regions are particularly suitable (land availability, RE yield) and
 - (iii) regulatory uncertainties and costs can be avoided (grid fees, connection procedures, etc.).
- We assume that the energy transition in the electricity sector and the PtX strategy will mutually benefit each other (synergy effects, economies of scale, learning curves) and will not lead to a slackening of momentum in the "electricity transition"



Sustainable use of space:

relates to competition between various land uses. Competition with the use of land for food production and with forested areas are of particular importance in this regard.

Renewable power 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 PtX or other purposes.

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

Existing potable water supply must not be used in dry climate zones:

Even though Morocco has limited availability of sweet water in the country, the access to the sea provides the option to gain sweet water from desalination.

- ⇒ it can be expected that 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.
- ⇒ 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.

Sustainable economic 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 andor 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.

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.



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