RES4Africa Foundation

Knowledge Platform

Assessing opportunities and challenges for Green Hydrogen in Africa: the case of Morocco

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Green Hydrogen in Africa: why

- Green Hydrogen is now considered a **key strategic component of energy transition, security and economic development pathways** – including for Africa, with a pioneering role for Morocco.
- Although global hydrogen production is by no means limited to Africa, the continent is attracting attention as well-placed for the development of a **green H2 economy** for the following key factors:

RE potential: Africa's vast and diverse wealth of natural resources and ever-growing solar and wind capacity point towards vast potential for competitive low-carbon, lower-cost and multi-purpose electricity production.

Diversify energy transition and industrialization strategy: Green H2 presents opportunity for new industries and markets as countries seek to leapfrog and avoid mistakes of the past when planning out the energy and industrial infrastructure of the future.

Support carbon neutrality targets and strategies: Global and African governments are setting energy transition targets and defining pathways on how to get there (NDCs, carbon-neutral goals by 2050)

Source: RES4Africa elaboration on IRENA, IEA

Green Hydrogen in Africa: Opportunities and Challenges

Opportunities

- Decarbonise hard-to-abate sectors and match local industrial demand to achieve carbon neutrality targets
- Improve energy security and diversify energy transition strategies
- Use the infrastructure for the production of hydrogen for other local needs (e.g. desalination)
- Grow and develop a hydrogen economy to unlock local value and long-term jobs
- Fast-track industrialization through hydrogen-related technologies and derivatives
- Foster capacity building and create Africa's competitive and technical skills of tomorrow

Challenges

- Local contexts and existing and supporting infrastructure
- Proximity between consumption and production pools in geographies, connect supply & demand
- Prioritise and size RE investments for access to electricity and then avail accompanying supply chain to support the green H2 ecosystem development
- Need for clear policy signals as a key driver for transparency and good governance following clear strategies and plans
- Environmental, resource (in particular water) and safety issues

Source: RES4Africa elaboration on IRENA, IEA, German Federal Ministry for Economic Cooperation and Development

Green Hydrogen in Africa: how

Integrate green H2 strategy as part of a comprehensive and holistic energy transition pathway: green H2 strategies and policies should be integrated in broader and country-specific energy strategies with the aim of benefiting energy access, accelerating RE deployment, maximizing social impact by enhancing job creation, environmental integrity, and efficient natural resources management.

Create a green H2 ecosystem and accompany new infrastructure with additional competitive RE and logistical value chains: As such H2 contributes to create local value chains and accelerate local just energy transitions.

Foster knowledge, technical and human capacities: tailored capacity building and training on green H2 can remove barriers for the participation of local communities, civil society and all relevant stakeholders, so as to drive and boost the development of the continent's green H2 future across Africa.

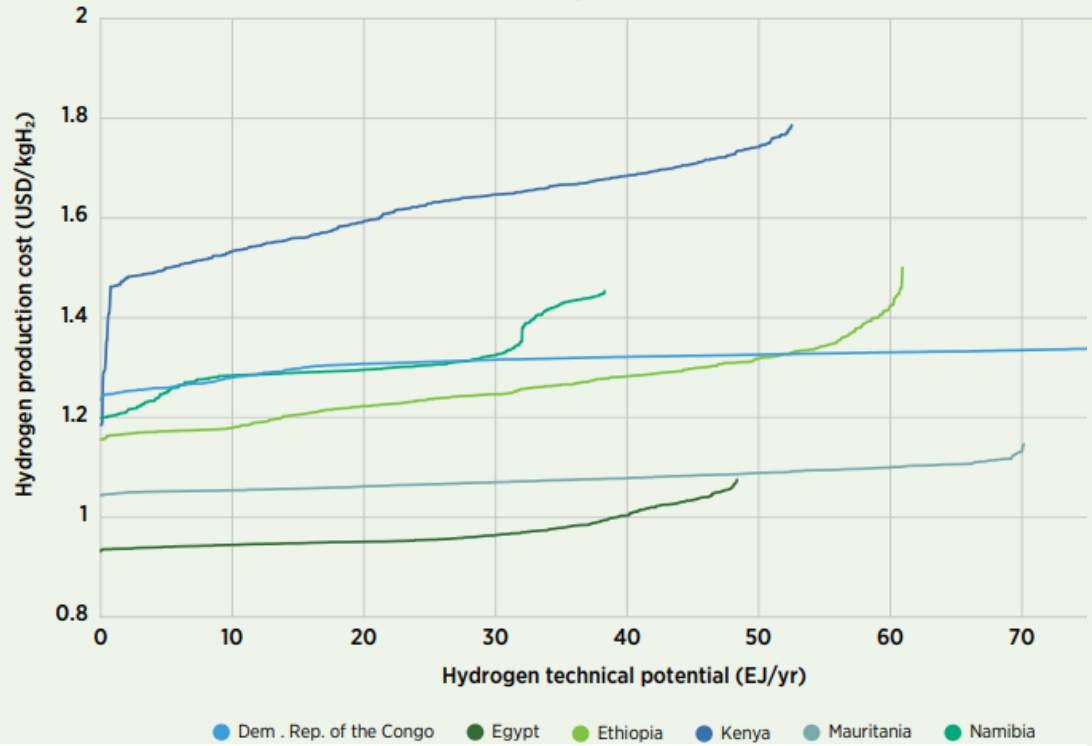
Enable multi-stakeholder win-win partnerships and domestic hubs/approaches to anchor projects: the inclusion of green H2 should involve local companies, associations, research centers, universities and ensure transparent governance for the development of green H2's value chain, as well as international partnerships and engagement.

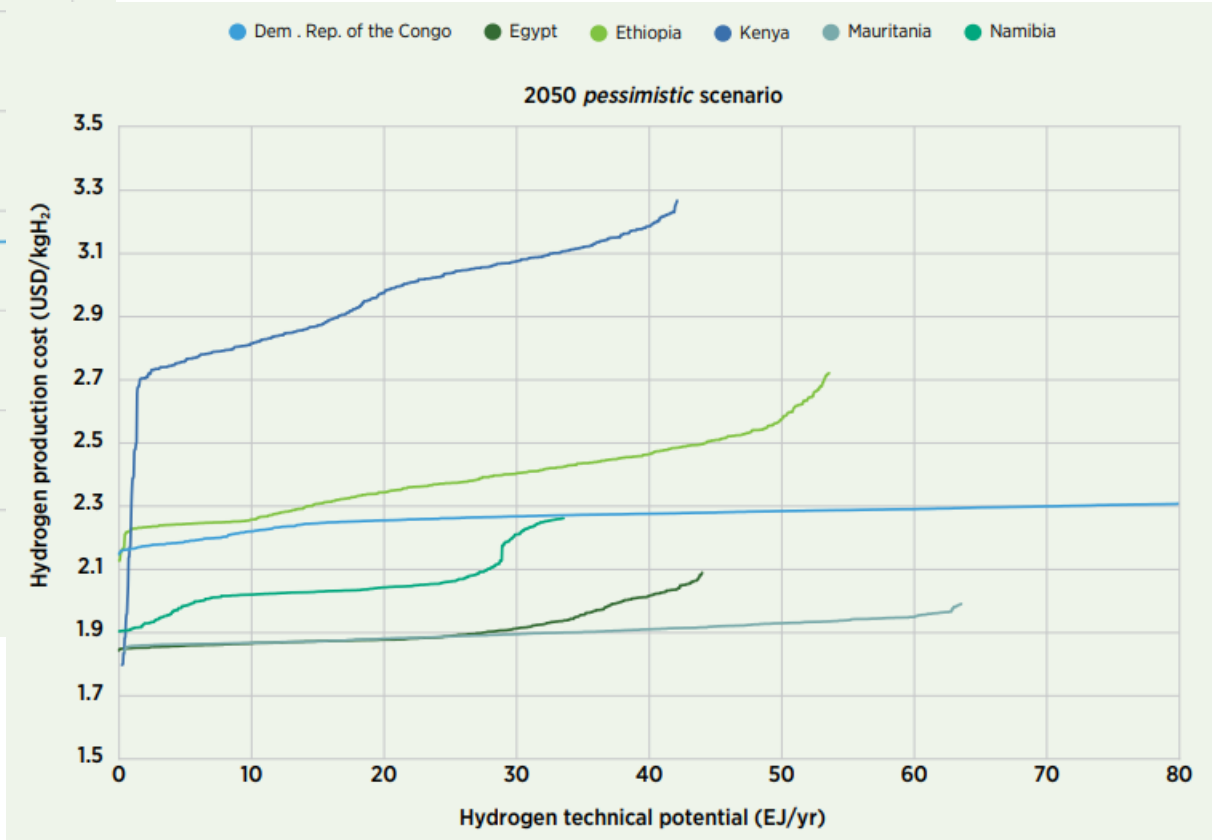
Prioritise environmental and safety impacts: minimize the burden on natural resources that are already under pressure and minimize the impact of new infrastructure, production and waste through standards and control, addressing also safety concerns.

Source: RES4Africa elaboration on IRENA, IEA, German Federal Ministry for Economic Cooperation and Development

Green Hydrogen in Africa: some numbers

FIGURE 3.9. Green hydrogen supply-cost curves for selected African countries in 2050





Source: IRENA (2022)

Green Hydrogen in Africa: existing initiatives

Cross-country

EU's "Hydrogen Strategy", "Hydrogen Europe", "Towards a Comprehensive Strategy" with Africa advocate for an increasing role for Africa in hydrogen production – accelerated in the current geopolitical and climate context.

African Hydrogen Partnership

A continent-wide African umbrella association solely dedicated to the development of green hydrogen, hydrogen based chemicals, fuel cell technology and related business opportunities in Africa.

National

In August 2021 Morocco published an ambitious national roadmap for the development of green hydrogen.

The Egyptian government is due to announce a $40bn national hydrogen strategy, which will include plans for a production capacity of 1.4GW by 2030. EU-Egypt agreed in June 2022 to collaborate strongly on green hydrogen, energy efficiency and renewables. In 2023 Egypt launched a GH strategy with EBRD.

Namibia announced in 2021 that a green hydrogen project will be based in the Tsau-Khaeb National Park, and ultimately produce around 300,000 tons of green hydrogen per year.

Mauritania and Charito will work on a potential 10 GW green hydrogen development known as 'Project Nour'. The project would spread over an onshore and offshore area of about 14,400 sq. km producing power from solar and wind resources for electrolysis to produce green hydrogen.

The South African government is moving towards hydrogen with the establishment of HySA (Hydrogen South Africa). In 2007, the South African government showed interest to explore its Green H2 potential in a variety of sectors. The country is currently developing feasibility studies to foster innovation along the value chain of green hydrogen and fuel cell technology, especially in platinum group metals, an area in which it is abundantly endowed.

Source: RES4Africa elaboration

Morocco National Hydrogen Roadmap: highlights

Estimated potential demand

Sectors in TWh	Reference scenario (2030)	Reference scenario (2050)	Optimistic scenario (2030)	Optimistic scenario (2050)
Export	10,3	114,7	21,7	229,5
Industry	3,1	20,7	6,8	21,4
Transport (Energy)	0,5	11,2	1,4	37,7
Industry (Energy)	0	5,4	0	14,4
Residential (Energy)	0	1,3	0	3,1
Energy storage	0	0,6	0,2	1
Total demand	**13,9**	**153,9**	**30,1**	**307,1**
Total demand (t)	**417 000**	**4 617 000**	**903 000**	**9 213 000**

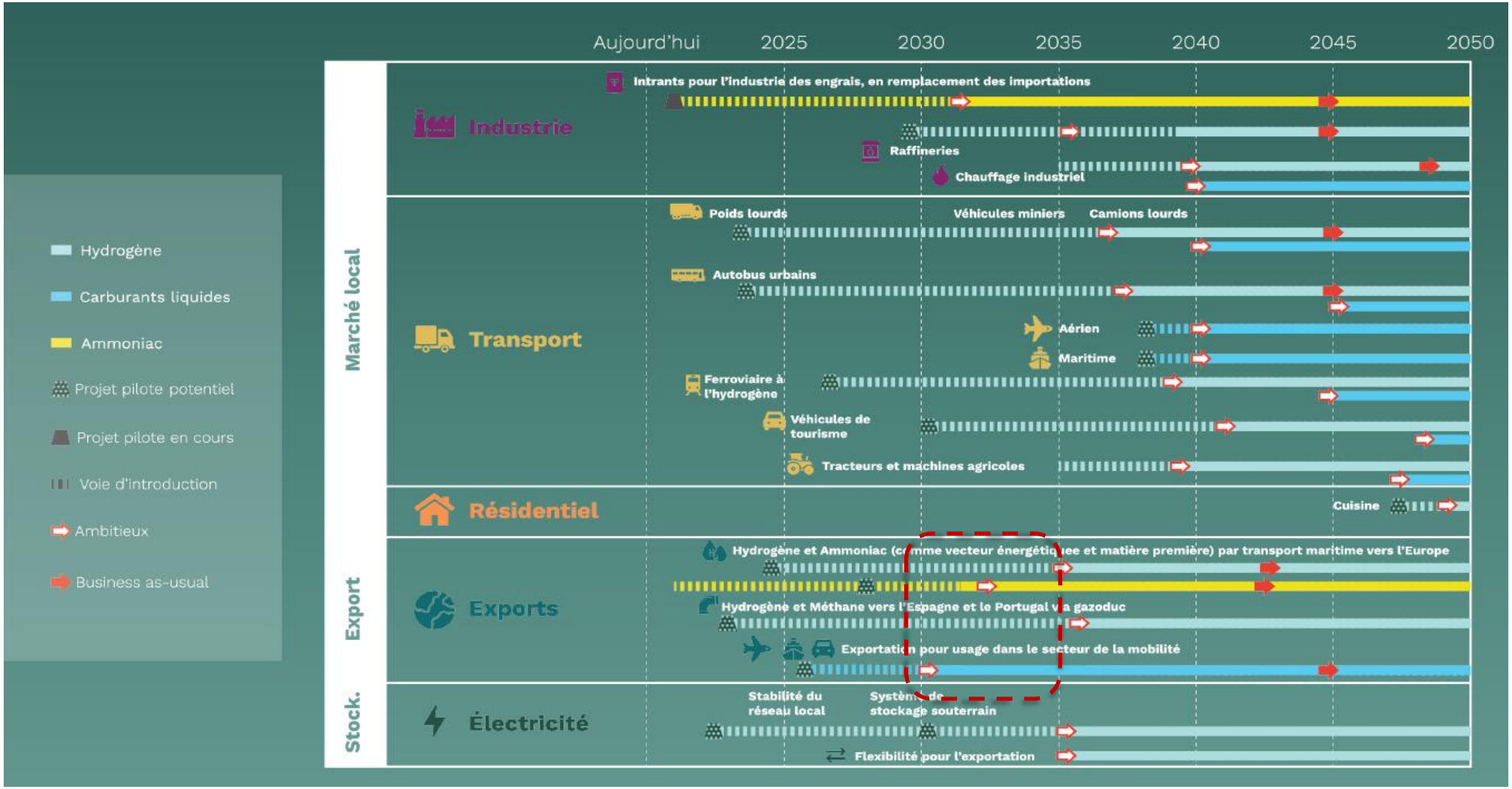
Estimated capacities needed

	Reference scenario (2030)	Reference scenario (2050)	Optimistic scenario (2030)	Optimistic scenario (2050)
RE (GW)	8	78,2	14,6	131,5
Electrolysers (GW)	2,8	31,4	5,2	52,8
Desalination plants (Mm3)	4,4	49,2	7	70,4
Conversion Power to Liquid Gas (Ptl) plants (GW)	0,4	5,3	0,8	11,6
Conversion Power to Ammonia (PtA) plants (GW)	1,1	10,7	2,4	19,2

Cost	RS (2030)	RS (2040)	RS (2050)	OS (2030)	OS (2040)	OS (2050)
Total investment (bln DRM)	90	289	382	143	380	502

Source: Morocco National Hydrogen Roadmap

Morocco National Hydrogen Roadmap: timeline



Source: Morocco National Hydrogen Roadmap

Morocco National Hydrogen Roadmap: Main actors

	National	International
Public policies support	Ministry of Energy, Ministry of Industry, ONEE, OCP, MASEN, ONHYM, ONDA, ANP, IMANOR, Local authorities: councils of municipalities and Regions.	Investment and development Banks, international IEC and ISO committees
R&D and innovation	Mohammed VI Polytechnique University, Green Energy Park, IRESEN, MedV University (Rabat), Cadi Ayad University (Marrakech), Hassan II University (Casablanca), Med1 University (Oujda) and MASCIR.	Fraunhofer IMWS/ IGB/ CBP, ECN-TNO, Cea-Tech, Université Halle Leipzig, Université de Jülich, Université d'Offenbourg, Université de Fribourg, Hypos, Hydrogen Europe and Centro National
Technological support and service for the industry sector	CGEM, Fédération de l'Energie, FIMME, FENELEC, FCP (Fédé. Chimie/Parachimie), FT (Fédération Transport), OCP, Masen, ONEE, JESA, CID, NOVEC, NAREVA, Afriquia, Somas, Maghreb Oxygène, SNTL, SNEP, ONDA, Royal Air Maroc, ONCF, Port Tanger MED, ANP and Startup/JV/Spin-Off	Siemens, Thyssenkrupp, Hydrogenics, McPhy, EDF, MAN Energy Solution, Engie, NEL, Air Liquide, Total, Climeworks, Sunfire, Airbus, Lufthansa, PSA, Proton Ventures, Port de Rotterdam, Vopak, Linde, Tractebel and VDA.
Capacity building and training	Moroccan universities cited above, Moroccan industries, OFPPT, IFMEREE and CERIM	International universities cited above, RENAC, Fraunhofer, INES and Hypos

National Hydrogen Commission

Green H2 Maroc

AMHYD

Source: Morocco National Hydrogen Roadmap

Challenges to the development of Green Hydrogen in Morocco

National strategy and policy framework	• **Unquantified targets in terms of production and usage, desalination and electrolysis capacity could hinder the routes to market for hydrogen and makes it difficult for investors to evaluate the process of implementation** • **Unclear priorities and objectives for the natural gas sector** could entail the duplication of costs and investments, which could not be financially sustainable, especially in the long term. Similarly, a more comprehensive strategy to decarbonize the industrial sector is not in place. • **Lack of a policy framework** compared to other competing countries and **unclear financial sources and support for the routes to market**
Production	• **RE generation cost still much higher** than other competing countries on the global hydrogen markets (such as Chile, Mexico, UAE, etc.) • **Morocco scarce water resources could hamper** the development of green hydrogen. The only viable solution is using desalinated water with associated cost, energy consumption and constraints in terms of location for production, impacting negatively on LCOH. • **Joint work of all stakeholders must be scaled up** to reduce the time lag between innovation and market uptake. • Although multiple partnerships with other countries are in place, it is important to mention that currently **the same countries have signed and demonstrated interest in other countries as well.**
Infrastructure	• **Few existing infrastructures dedicated to gas transport and storage in the country:** there is a significant disadvantage compared to other competing countries that have an established gas infrastructure and therefore could test H2 in blending and repurposing of existing infrastructure. • **High cost of transport for exports**. In the case of **pipelines** directed toward Europe, this would require **massive investments which Morocco might not be able to support by itself.** In the case of **shipping** (green shipping?), the country will lose some of the strategic advantages in terms of flexibility/reliability of supply over other competing countries because the **best sites will be located in the South of the country** and therefore ports and new logistics infrastructures may be required to be established in the Southern regions (knowing that transport by trucks is a high-cost option). • Currently, **norms, control and verification entities still need to be implemented** to handle **properly and safely** the transportation and storage of Green Hydrogen.
End uses	• According to the current configuration envisaged by the National Strategy (exports and feedstock) **the hydrogen market in Morocco will be strongly exposed to the conditions of the international Green Hydrogen market** and to the purchasing capacities of a large national industrial customer (OCP). • More generally, **measures to stimulate demand and incentives are still to be implemented** to promote the transition to green hydrogen (for instance, guarantees of origin)

Source: RES4Africa and PwC

Key measures to unlock Green Hydrogen potential in Morocco

With the publication of its Green Hydrogen national roadmap, Morocco has passed one of the first milestone in the development of this technology but there are still measures to implement in order to reach full potential

1

Strategic positioning

1. **Complete the country's national hydrogen roadmap by setting quantified and ambitious but feasible targets for the whole Green H2 value chain** (production, electrolyzers capacity, desalination plants, required transport infrastructure, costs of production and operations, R&D, etc.). Those targets should be accompanied also by **intermediate targets in the short to medium term, to facilitate monitoring and evaluation**.

2. **Set the country's priority in terms of Green H2 and its place in the energy strategy compared to other energy sources** (Oil, RES, Natural Gas, etc.) and infrastructure.

3. **Carefully evaluate the possible targets and the priorities in terms of local consumption and exports.** As stated by the Decarbonization Pathway for Morocco the priority is cutting the national greenhouse gas emissions and this should be taken into account. Upon these considerations, the routes to transport should be decided considering that **sector coupling is expected to be an important driver of decarbonization.**

4. **Study and analyze the option of developing the necessary technologies for the production and transportation of Green H2 locally or involving international actors** to meet the needs.

Source: RES4Africa and PwC

Key measures to unlock Green Hydrogen potential in Morocco

2 Implementation and support

5. **Design and implement a dedicated, integrated, and coherent policy and regulatory framework**. This would enable the creation of bankable contracts for off-takers and de-risk investments.

6. **Design clear and transparent financial support mechanisms** for market uptake and to close the price gap between Green H2 and substitutes. Various countries involved in the development of Green H2 initiatives have identified specific areas of support to be brought by the authorities, from direct support through grants/concessional loans to tax credits for specific uses of Green H2. In doing so, it is important to avoid market distortions and cross-subsidies.

7. **Setup certifications or guarantees of origins** that are in accordance with export countries' regulations and standards (in particular with the EU legislation, as the continent is considered as a major future destination for exports). Some kind of scheme to enable the labelling of hydrogen as "Green" is essential to provide transparency to consumers and create market pull for Green H2.

8. Setup the technical norms with a focus on **safety (in particular for transport and storage).**

3 Governance

9. **Create and operationalize clear governance** for the Green H2 market and sector development, identify the actors who will be involved, and **implement the necessary coordination and synergies between them.**

10. **Deploy and empower R&D** platforms with think tanks, national companies, and ministries to promote the continuous creation of research programs as soon as possible.

Source: RES4Africa and PwC

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