REPORT SERIES CLEAN HYDROGEN PROJECTS IN THE GLOBAL SOUTH

Opportunities for renewable hydrogen development in Africa:

Insights from an innovative country clustering analysis

H2Global Stiftung

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About this report

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Executive summary

Africa holds immense potential for low-cost renewable hydrogen production, as it benefits from abundant solar resources as well as significant wind and geothermal potential. This presents a transformative opportunity for the continent to develop a hydrogen economy and drive green industrialization. However, Africa's diversity means that countries have different starting points in this transition.

This report assesses which African countries are best positioned to establish a national hydrogen economy and advance towards green industrialization. It introduces a comprehensive framework to evaluate countries' readiness, incorporating five key dimensions: water (H2O) and renewable energy (RE) potential, national hydrogen commitment, domestic anchor demand, country risk, and export infrastructure. By integrating these factors, the report provides an alternative perspective that moves beyond the limitations of existing studies, offering practical insights for successful hydrogen market creation in Africa.

Through an innovative country clustering analysis, the report identifies three groups of countries with potential for hydrogen market creation: **front runners**, **momentum builders**, and **strong foundation**. Despite their differences, all clusters share two fundamental characteristics: medium to high water availability and renewable energy potential—a prerequisite for renewable hydrogen production—and the presence of domestic anchor demand, which is essential for kickstarting hydrogen projects. The key distinction among these groups lies in their level of national hydrogen commitment and country risk profile.

Africa holds immense potential for low-cost renewable hydrogen production. However, Africa's diversity means that countries have different starting points in this transition. This report identifies those countries well-suited to develop hydrogen economies in the region.

By linking the country clustering to concrete policy recommendations, the report supports policymakers, investors, and development partners in prioritizing actions that are tailored to the specific readiness levels and needs of each country group.

Front runners—Egypt, Kenya, Mauritania, Morocco, Namibia, South Africa, and Tunisia—are already advancing their hydrogen markets. These countries have published hydrogen strategies and initiated project development. To maintain their status, they should focus on implementing their hydrogen strategies, mitigating offtake risks, developing infrastructure, facilitating coordination among key government institutions and other relevant stakeholders, and investing in workforce capacity-building to accelerate progress.

Momentum builders—Algeria, Angola, Mozambique, Uganda, and Zimbabwe—have strong potential but require further action to sustain their momentum. With less mature policy frameworks and investment landscapes, these countries should prioritize publishing national hydrogen strategies, advancing early-stage projects, showcasing hydrogen sector potential, and addressing infrastructure gaps and investment risks to attract market interest.

Strong foundation countries—Cameroon, Nigeria, Senegal, and Tanzania—are at the earliest stages of hydrogen market development. While they have no announced hydrogen policy commitments, they possess favorable conditions such as low-to-medium country risk, strong renewable energy potential, and domestic anchor demand. To build on their potential, these countries should develop hydrogen strategies, support pilot projects, and leverage their stability to establish a solid foundation for long-term hydrogen market creation.

Africa’s vast hydrogen production potential

Africa has vast potential for low-cost renewable hydrogen production, with excellent solar resources and substantial wind and geothermal potential across multiple regions. This positions the continent as a potential future key player in renewable hydrogen, offering tremendous opportunities for socio-economic development. Renewable hydrogen could aid decarbonization, support green industrialization, spur economic growth, reduce dependence on global markets for essential commodities, and raise living standards across the continent.

Yet, hydrogen projects globally face several barriers due to the nascent nature of the market, including high investment costs, a lack of potential offtakers willing to pay a green premium, and regulatory uncertainty. Africa, in particular, grapples with additional obstacles: high perceived risks drive up capital costs and deter investment, while skill shortages and underdeveloped infrastructure hinder large-scale deployment. Moreover, most African countries still need to expand electrification to ensure energy access and decarbonize existing electricity systems as part of their energy transition.

Globally, as the sector remains nascent, hydrogen projects are advancing more rapidly in countries with substantial policy and financial support. The expected production from Africa’s announced renewable and low-carbon hydrogen projects accounts for only one-seventh of the total production from globally announced projects by 2030 (49 million tons per annum, Mtpa). As of 2024, only 7% of globally announced projects reached final investment decision (FID) or are under construction, casting doubt on full deployment by 2030.[1]

Figure 1: Renewable energy potential map[2].

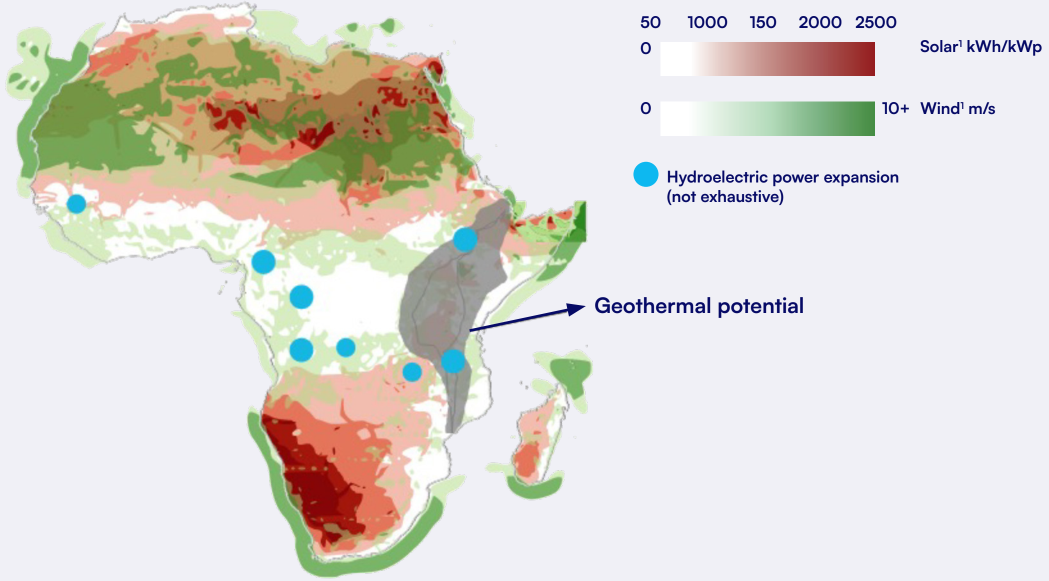
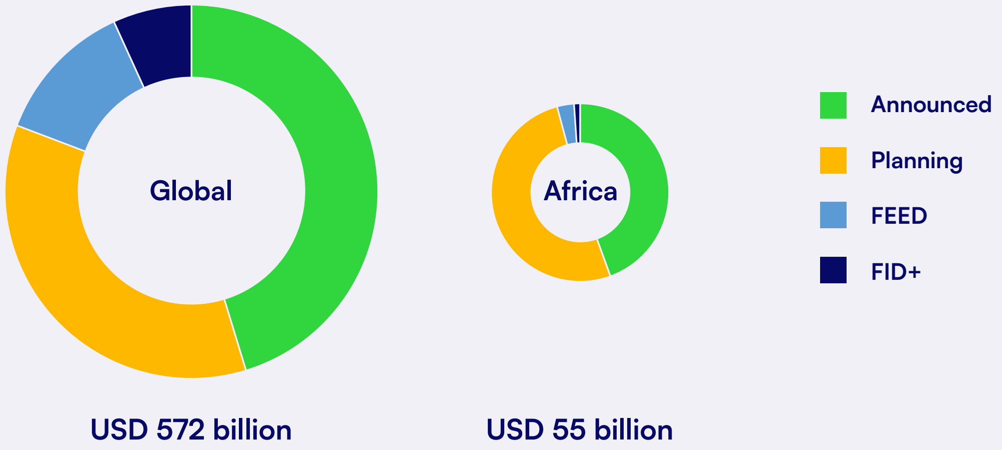


Figure 2: Announced direct investments into hydrogen projects through 2030[2].



Key conditions for a successful hydrogen economy

Africa is highly diverse, with countries at vastly different starting points for developing a hydrogen economy. The central research question guiding this report is: **Which African countries are well-positioned to build a national hydrogen economy and move towards green industrialization?**

Current analyses of African countries' readiness for renewable hydrogen production are often limited in scope. Existing studies primarily focus on modeling technically feasible hydrogen production potential using solar and wind energy or on evaluating announced hydrogen projects.[3] While these approaches provide valuable insights, they do not fully address key elements that determine which African countries are well-positioned to build their hydrogen economy and move towards green industrialization. This report addresses that gap by offering a more comprehensive framework to assess African countries' readiness (see Figure 3). The framework encompasses five key dimensions: water (H2O) and renewable energy (RE) potential, national hydrogen commitment, domestic anchor demand, country risk, and export infrastructure.

The H2O & RE potential dimension evaluates a country's technical potential for renewable energy production in areas with sustainable water sources, including low water-stress regions and locations where seawater desalination is feasible. This combined assessment of water availability and renewable energy potential forms a crucial foundation for sustainable renewable hydrogen production. Ensuring that hydrogen production does not exacerbate local water scarcity is essential. Quantitative data on renewable energy production potential was drawn from a detailed GIS analysis conducted by H2Global's research partners at Fraunhofer IEE,[4] and supplemented by additional data on hydropower[5] and geothermal power production.[6]

The national hydrogen commitment dimension assesses the country's commitment to developing a hydrogen economy, which is critical given the sector's nascent stage of development. It focuses on two aspects: the presence of a national hydrogen strategy,[7] and the existence and development status of renewable hydrogen projects.[8]

Figure 3: Definition of the five dimensions for the country clustering.

H2O & RE potential	Water stress	GIS analysis of wind & PV
	Sea access for desalination	Geothermal & hydropower
National hydrogen commitment	National hydrogen strategy	
	Planned renewable hydrogen projects	
Domestic anchor demand	Fertilizer production	Mining
	Crude steel production	
Country risk	Country-risk rating	
Export infrastructure	Terminals for NH3, MeOH, & LNG	

The domestic anchor demand dimension evaluates domestic offtake opportunities for renewable hydrogen by using quantitative indicators for three key industries: fertilizer production,[9] crude steel production,[10] and large-scale mineral extraction.[11] Additionally, it captures existing industrial know-how, providing a foundation for developing the skills needed to support the hydrogen economy.

The country risk dimension draws from OECD's ranking,[12] which assesses a country's political, financial, and economic stability in a single metric. This measure is crucial for attracting investment and ensuring the successful realization of long-term renewable hydrogen projects.

The export infrastructure dimension evaluates a country's port infrastructure for exporting hydrogen derivatives by analyzing the presence of terminals for ammonia, methanol, and liquefied natural gas (LNG)—the latter being relevant for exporting e-methane. Given high import demand and willingness to pay in regions like Northwest Europe, Japan, and South Korea, many planned projects prioritize exporting these derivatives.

By incorporating these dimensions, this report provides a holistic perspective that moves beyond the limitations of existing studies, offering actionable insights for the successful creation of hydrogen markets in Africa. The analysis considers both domestic hydrogen demand and export potential—recognizing that while many large-scale projects currently target international markets, domestic anchor demand plays a critical role in building a hydrogen economy. By linking the analysis to concrete policy recommendations, the report supports policymakers, investors, and development partners in prioritizing actions that align with the specific readiness levels across African countries.

Figure 4: Comparison of existing analytical focus and key factors for renewable hydrogen market creation.

Existing analyses focus on:

- ✓ **Planned renewable hydrogen projects**
- ✓ **Wind & PV potential**
- ✓ **Hydrogen production costs**
- ✓ **Export potential to Europe**

But successful renewable hydrogen market creation also depends on:

- ✓ **Water availability**
- ✓ **Political support & international collaboration**
- ✓ **High levels of national & international investment**
- ✓ **Existing domestic offtakers/markets**
- ✓ **Country stability for long-term project realization**
- ✓ **Strengthening of legal, regulatory, & institutional frameworks**

Methodology

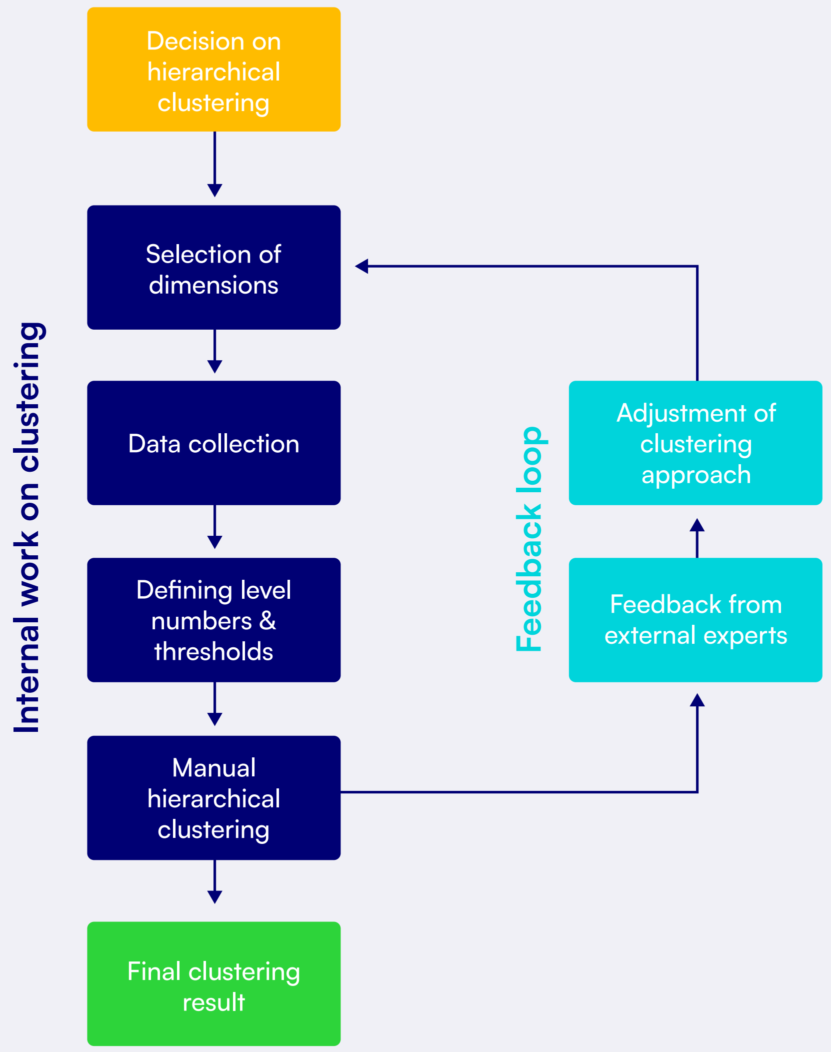
This report introduces an innovative approach to country clustering. Data was collected on a wide range of factors, so-called dimensions, which influence the successful creation of a hydrogen market. The number of dimensions was kept to a minimum—five in total—while ensuring that all critical factors for hydrogen market creation were covered. This targeted approach simplified the clustering process, making it more effective in identifying each country's hydrogen economy potential. The dimensions have been mentioned in the previous section. They are: H2O & RE potential, national hydrogen commitment, domestic anchor demand, country risk, and export infrastructure.

The analysis began with data collection for each key dimension across all African countries using publicly available sources. This data was then categorized into distinct levels, either binary (yes/no) or based on defined thresholds for multiple levels. Using the agglomerative hierarchical clustering method, countries with shared characteristics across the selected dimensions were clustered together. This iterative and flexible method allowed for manual adjustment of clusters throughout the process, accommodating the complexity of different dimensions without predefining weights or the number of clusters.

The preliminary clustering results were reviewed by external experts, whose feedback helped refine and adjust the approach. This feedback loop enabled continuous improvement, resulting in a meaningful, nuanced grouping of countries that reflects their varied starting points and potential.

For a detailed explanation of the clustering methodology and the five chosen dimensions, please refer to the Methodology Annex.

Figure 5: Methodology for the country clustering.



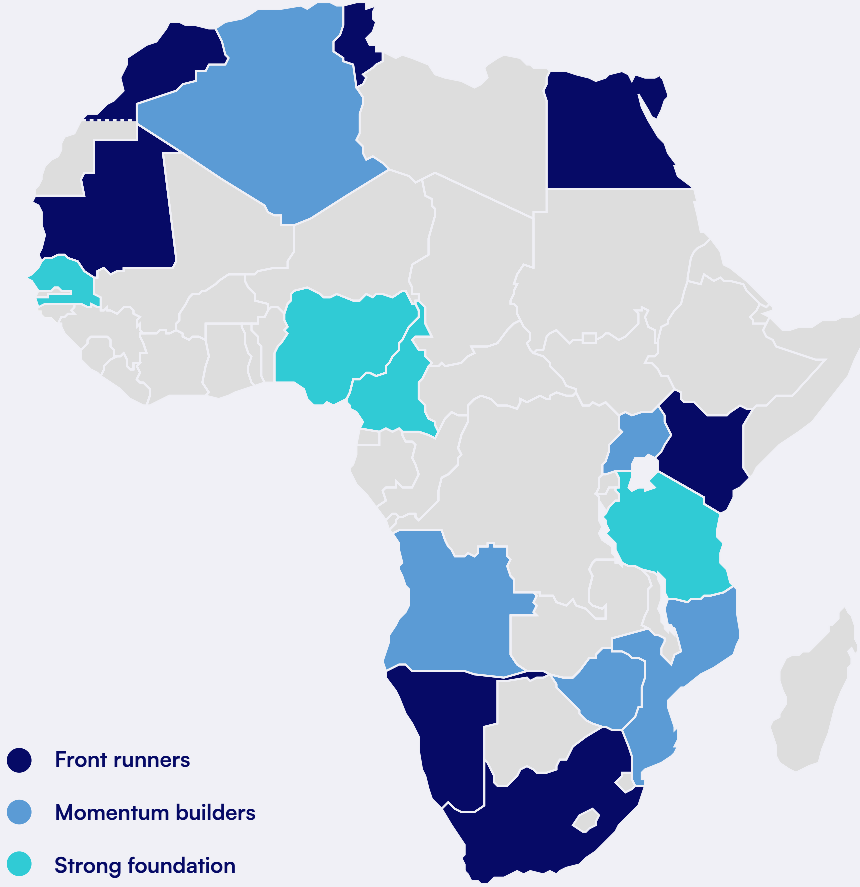
Results of the country clustering

The hierarchical clustering process identified three key groups of countries with promising potential for establishing a hydrogen economy, which the research team categorized as: front runners, momentum builders, and strong foundation.

All clusters share two essential characteristics: medium to high H2O & RE potential, a prerequisite for renewable hydrogen production, and the presence of domestic anchor demand, which is a critical stepping stone for the implementation of initial hydrogen projects. However, what differentiates these groups is their level of national hydrogen commitment and country risk profile.

The front runners demonstrate a high level of national hydrogen commitment, as they have published hydrogen strategies and have projects under development. The momentum builders show a medium level of commitment, reflecting a less mature policy framework and hydrogen investment landscape. In contrast, the strong foundation group consists of countries with no announced commitment to renewable hydrogen, medium to high H2O & RE potential and relatively low country risk. The latter is notable, as 32 out of 55 African countries are rated at the highest possible country risk level, according to the OECD.[13]

Figure 6: Results of the country clustering.



Front runners

Egypt, Kenya, Mauritania, Morocco, Namibia, South Africa, and Tunisia share several defining characteristics that position them as front runners in the burgeoning renewable hydrogen sector.All seven countries have substantial renewable energy potential and access to water resources—either through freshwater in regions without significant water stress or seawater desalination. A key factor distinguishing these countries is the presence of a national hydrogen strategy and at least one planned renewable hydrogen project that has advanced beyond the concept phase to the feasibility study stage or further, signaling a tangible commitment to the sector.

This group of front runners is also defined by potential domestic anchor demand, with industries such as fertilizer production, crude steel manufacturing, and mineral extraction creating opportunities for local hydrogen use and value creation.

Additionally, all these countries have sea access, which is crucial for potential hydrogen exports. Some countries, such as Egypt, Morocco, South Africa, and Tunisia, already have export infrastructure for hydrogen derivatives. Egypt has liquefied natural gas (LNG) terminals capable of exporting e-methane, along with facilities for ammonia and methanol; Morocco and Tunisia have ammonia terminals; and South Africa has both ammonia and methanol terminals. Kenya, Mauritania, and Namibia currently lack terminals for hydrogen derivatives, which could limit export opportunities in the short term.

Country risk profiles within this group vary significantly. While some enjoy moderate stability, others—such as Kenya, Mauritania, and Tunisia—face higher country risk ratings, which could hinder investment and complicate project execution.

Figure 7: Clustering results for the front runners group.

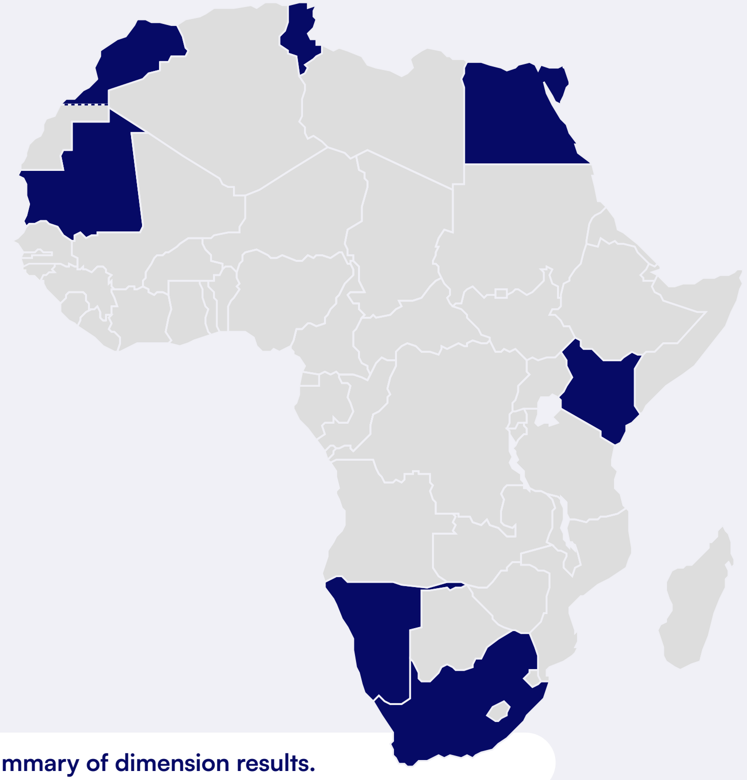


Figure 8: Summary of dimension results.

✪ High rating
✓ Medium rating
✗ Low rating

✪ ✓	H2O & RE potential
✪	National hydrogen commitment
✪	Domestic anchor demand
✪ ✓ ✗	Country risk
✪ ✗	Export infrastructure

Recommendations for the front runners

To capitalize on their strong potential and ambition for establishing a hydrogen economy, the front runners—Egypt, Kenya, Mauritania, Morocco, Namibia, South Africa, and Tunisia—need to address existing challenges and take strategic steps to reinforce their position as leaders in Africa's renewable hydrogen transition. By building on their shared strengths, these countries can create the necessary conditions for successful hydrogen market development.

A critical first step is strengthening legal, regulatory, and institutional frameworks to provide clear and consistent guidelines for project development as well as facilitating coordination among key stakeholders. While national hydrogen strategies are important starting points, they must be followed by concrete policy actions to ensure that targets translate into real impact. Establishing one-stop shops to streamline approvals and administrative processes is one such action that will further enhance efficiency and attract investment.

Supporting local hydrogen offtake is another priority, with a focus on industries like fertilizers and mining that are considered low-hanging fruit. This approach fosters immediate demand, creates local economic value, and contributes to advancing green industrialization.

Key risks must also be mitigated to reduce the often very high cost of capital, thereby encouraging investor confidence and improving project viability. Offtake risk can be addressed through mechanisms such as quotas, mandates, and contracts-for-difference, or the adoption of the H2Global double auction mechanism. High country risk ratings—particularly in countries like Kenya, Mauritania, and Tunisia—require targeted de-risking strategies, including political risk insurance, foreign investment guarantees, and partial credit guarantees.

Unlocking infrastructure investment will be essential to support hydrogen production, domestic demand, and export capabilities. Public-private partnerships (PPPs) can play a significant role in financing and developing key infrastructure, including pipelines, transmission grids, desalination plants, and export terminals. In parallel, faster permitting processes will be critical for accelerating project timelines.

Finally, investing in skill development and capacity building is crucial to developing a local workforce capable of implementing and maintaining hydrogen projects. Establishing training programs will not only support project realization but also create economic opportunities for local communities.

Figure 9: Clustering results for the front runners group.

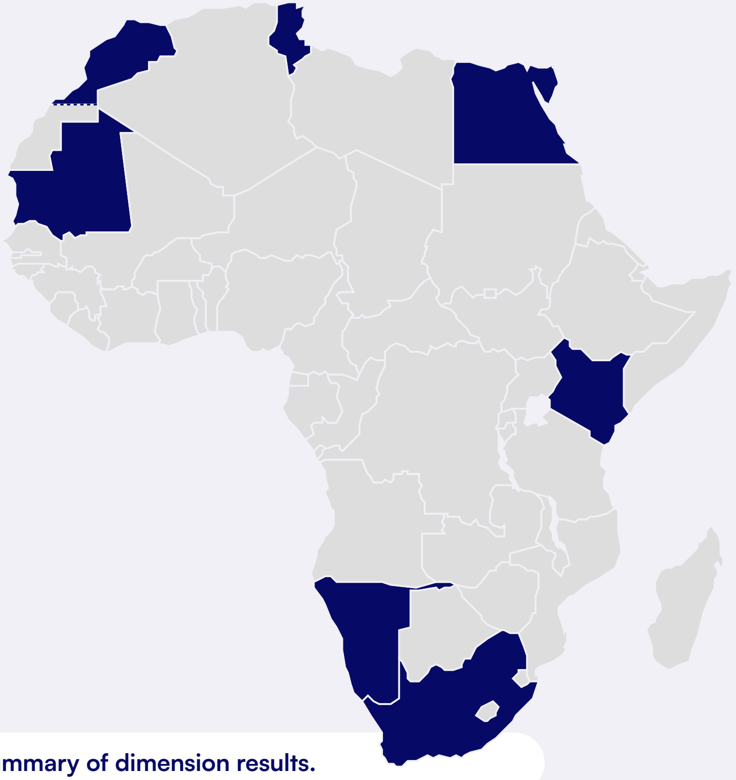


Figure 10: Summary of dimension results.

★ High rating
✓ Medium rating
✗ Low rating

★ ✓	H2O & RE potential
★	National hydrogen commitment
★	Domestic anchor demand
★ ✓ ✗	Country risk
★ ✗	Export infrastructure

Case study: Mauritania

Mauritania has significant potential for large-scale hydrogen production and is emerging as one of the front runners in the global renewable hydrogen economy.

Detailed GIS analysis shows that 2.2% of the country's land area is highly suitable for hydrogen production, with access to water, roads, and small cities—all within 100 kilometers. This corresponds to a renewable energy capacity of approximately 1,900 GW of solar photovoltaic (PV) and 500 GW of wind power.[14] As an arid country, Mauritania faces water challenges, with the Senegal River and groundwater serving as its primary sources. Annual water withdrawals amount to 1,350 Mm^3, with agriculture consuming the largest share.[15] Meeting hydrogen production targets will require 39 Mm^3 of purified water annually by 2030, rising to 229 Mm^3 by 2050, necessitating large-scale desalination.[16]

The Mauritanian government has demonstrated strong ambition to become a front runner in renewable hydrogen. In 2022, it published the Roadmap for a Low-Carbon Hydrogen Industry, targeting 1.2 Mt of hydrogen exports, 66,000 t of ammonium nitrate fertilizer, and feasibility studies for methanol and green steel projects by 2030.[17] In September 2024, the Green Hydrogen Code was ratified, introducing tax incentives and establishing the Mauritanian Agency for Green Hydrogen to oversee operations and streamline investment processes.[18] Several projects are already in the feasibility phase, with 20 GW of planned electrolysis capacity and 77 GW announced.[19]

Mauritania's mining sector, which accounted for 71% of its total export income in 2022, presents significant opportunities for hydrogen integration.[20] As Africa's second-largest iron ore exporter, Mauritania could use hydrogen to further process its iron ore into direct reduced iron (DRI) for export, unlocking substantial economic benefits. Hydrogen can also be used to decarbonize mining operations and provide reliable off-grid power. Another opportunity lies in fertilizer production. Currently dependent on imports, Mauritania could use renewable hydrogen to produce ammonia-based fertilizers, reducing reliance on external suppliers and enhancing food security. Exporting ammonia, methanol, or e-methane is also a possibility, but it will require significant investment in port infrastructure.

High perceived country risk, resulting in elevated capital costs, remains a key challenge to attracting the large-scale investments needed to realize these hydrogen projects. Addressing these barriers through financial mechanisms and strategic partnerships will be essential to unlocking Mauritania's potential and consolidating its position as a front runner in renewable hydrogen.

Figure 11: Overview of planned hydrogen projects and RE potential in Mauritania.

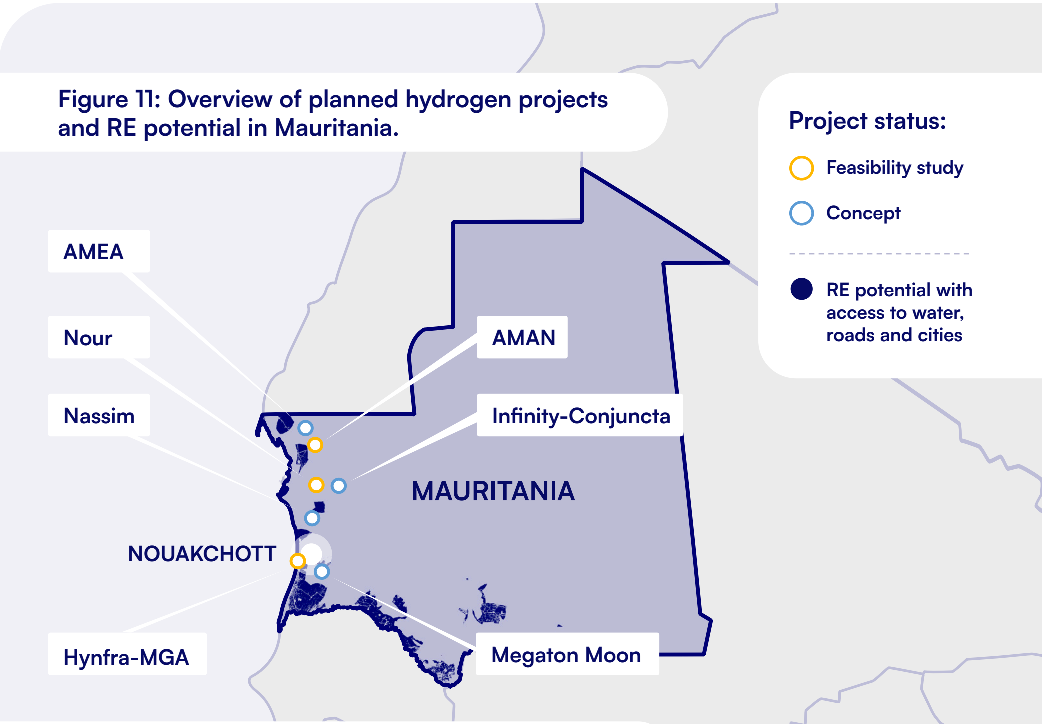


Figure 12: Summary of dimension results.

★	**H2O & RE potential**	PV: 23,015 km^2 Hydropower: 0 GW	Wind: 20,028 km^2 Geothermal: 0 GW
★	**National hydrogen commitment**	Published hydrogen strategy 3 projects in feasibility study phase 4 projects in concept phase	
★	**Domestic anchor demand**	No nitrogen fertilizer production No crude steel production Mineral production: 8,290,552 t/a	
✗	**Country risk**	High risk classification: 7/7	
✗	**Export infrastructure**	No LNG, ammonia, or methanol terminals	

★ **High rating** ✓ **Medium rating** ✗ **Low rating**

Momentum builders

Algeria, Angola, Mozambique, Uganda, and Zimbabwe are emerging as promising players in Africa's renewable hydrogen sector. These countries exhibit several characteristics that position them as momentum builders, reflecting their potential for future development in the renewable hydrogen economy.

All five countries possess significant renewable energy potential and access to water resources—either through freshwater sources or seawater desalination—providing a strong basis for renewable hydrogen production. In terms of national hydrogen commitment, these countries hold a medium rating, which sets them apart from the front runners with higher ratings. For example, Algeria has published a hydrogen strategy but does not have projects that have reached at least the feasibility study stage. Conversely, Angola, Mozambique, Uganda, and Zimbabwe have hydrogen projects in the concept or feasibility stages but lack a published national hydrogen strategy.

Each country in this group also benefits from some level of domestic anchor demand, with industries such as fertilizer production, crude steel manufacturing, and mineral extraction offering opportunities for local hydrogen use.

Country risk profiles within this group are mixed. Algeria enjoys a relatively low risk rating, while Angola and Uganda are classified as medium risk. In contrast, Mozambique and Zimbabwe face high country risk ratings, which could deter investment and complicate project development.

Export infrastructure also varies significantly across this cluster. Algeria, Angola, and Mozambique have LNG terminals, with Algeria being additionally equipped to handle ammonia exports. Uganda and Zimbabwe, as landlocked countries, depend on the export infrastructure of their neighbors. Zimbabwe primarily relies on South Africa and Mozambique's export infrastructure, while Uganda depends on Kenya's. These limitations in export capabilities could pose significant challenges to establishing a robust renewable hydrogen market in the near future.

Figure 13: Clustering results for the momentum builders group.

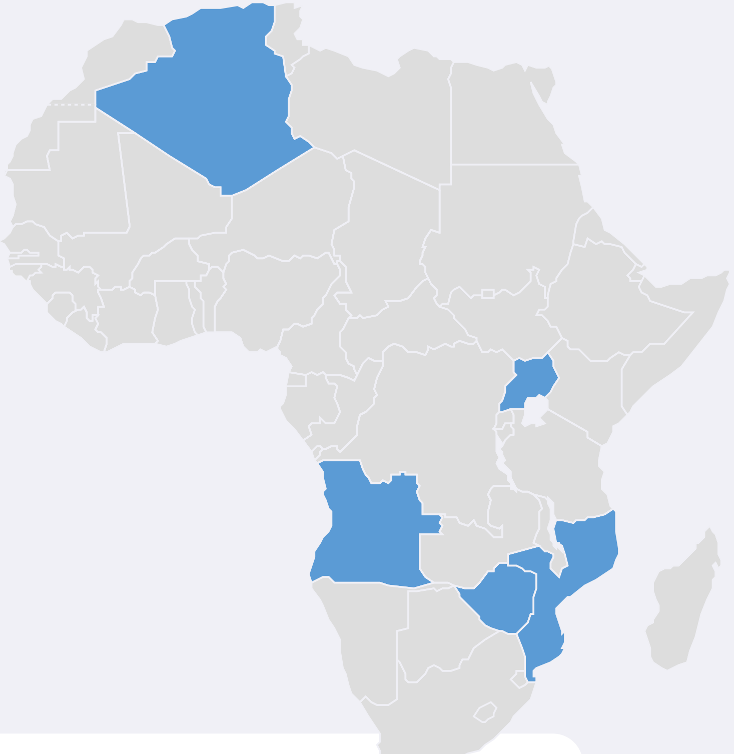


Figure 14: Summary of dimension results.

★ High rating
✓ Medium rating
✗ Low rating

★ ✓	H2O & RE potential
✓	National hydrogen commitment
★	Domestic anchor demand
★ ✓ ✗	Country risk
★ ✗	Export infrastructure

Recommendations for the momentum builders

To unlock their potential and make meaningful progress toward establishing renewable hydrogen economies, the momentum builders—Algeria, Angola, Mozambique, Uganda, and Zimbabwe—should focus on addressing foundational gaps and leveraging their strengths. While these countries share several characteristics with the front runners, the recommendations differ due to their earlier stage of hydrogen sector development.

This group includes a mix of countries: some have a national hydrogen strategy but no projects beyond the concept phase, while others have announced hydrogen projects but lack a formal strategy. For the latter—Angola, Mozambique, Uganda, and Zimbabwe—a critical first step is to publish a well-defined national hydrogen strategy. This would set national goals, provide clear direction, and demonstrate political commitment to international investors and stakeholders. Equally important is helping to support the advancement of existing announced hydrogen projects from initial concept to feasibility studies and, ultimately, implementation. Strengthening legal, regulatory, and institutional frameworks will be key to providing clear and consistent guidelines for project development.

Promoting private sector investment is another priority. By highlighting their strong renewable energy potential and initial hydrogen initiatives, these countries can enhance visibility, attract funding, and secure partnerships needed to develop more hydrogen projects.

Like the front runners, the momentum builders should focus on several key areas. First, they should support local offtake opportunities identified in the domestic anchor demand dimension. Second, they should mitigate offtake risk and address perceived high country risks through mechanisms like contracts-for-difference and political risk insurance. Third, identifying and investing in infrastructure gaps is essential for establishing the foundational facilities for hydrogen production, demand, and export. Finally, investing in skills development and capacity building will ensure a workforce capable of implementing and maintaining hydrogen projects, which will foster broader green industrialization.

Figure 15: Clustering results for the momentum builders group.

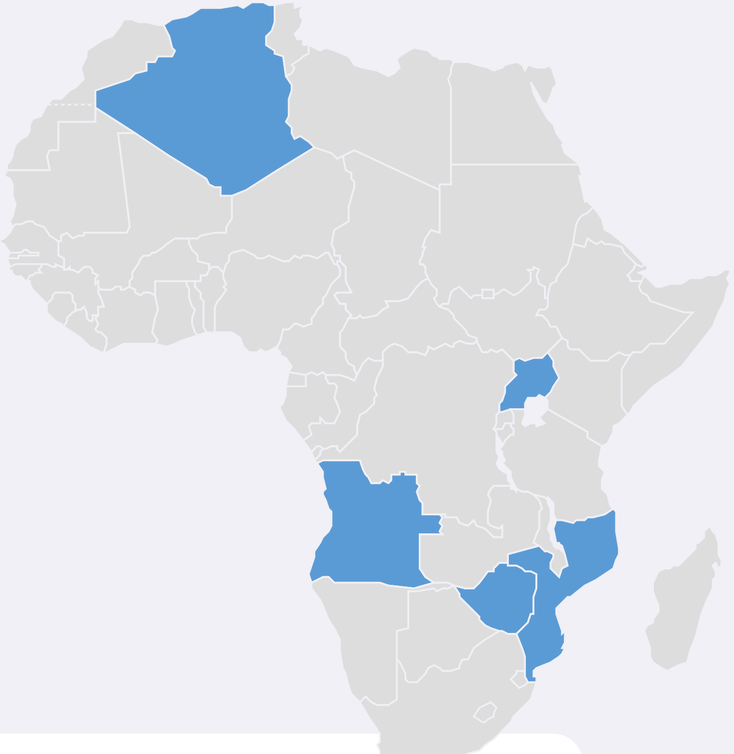


Figure 16: Summary of dimension results.

★	**High rating**
✓	**Medium rating**
✗	**Low rating**

★ ✓	**H2O & RE potential**
✓	**National hydrogen commitment**
★	**Domestic anchor demand**
★ ✓ ✗	**Country risk**
★ ✗	**Export infrastructure**

Case study: Angola

Angola has significant potential for large-scale hydrogen production and is emerging as a momentum builder in the global renewable hydrogen economy. Detailed GIS analysis indicates that 1.3% of the country's land area is highly suitable for hydrogen production, with proximity to water sources (such as open water bodies and seawater), road networks, and at least one small city, all within a radius of 100 kilometers. This translates into a renewable energy capacity of approximately 1,360 GW of PV potential.[21]

Hydropower is currently Angola's largest electricity source, providing 70% of generation in 2022, and significant untapped potential remains.[22] Water availability—a critical resource for hydrogen production—varies across the country. While southern regions face significant water scarcity, desalination near the coastline offers a viable alternative solution.

Although Angola has not yet published a national hydrogen strategy, the government announced a proposal in 2023 to transition from oil dependence to sustainable energy and decarbonization.[23] Two hydrogen projects are in the planning stage: a 400 MW project by Sonangol, and a 200 MW project planned at the Capanda Hydropower Plant.[24]

Angola's mining sector is predominantly focused on diamond extraction and oil production, with oil accounting for 95% of the country's export revenues.[25] The country has two steel plants—Aceria Angola Bengo Steel Plant and CSC Angola Plant—both of which offer opportunities for hydrogen integration in steelmaking to reduce emissions.[26] Additionally, Angola remains dependent on fertilizer imports, highlighting another opportunity for renewable hydrogen use in the domestic production of ammonia-based fertilizers.

In terms of export infrastructure, Angola has an LNG terminal in the north of the country, which could potentially be used to export e-methane or, with additional investment and modifications, be repurposed to handle renewable ammonia. While moderate country risk poses a challenge, Angola's hydropower, existing export infrastructure, and oil revenues provide a strong foundation. Strategic investments and partnerships will be key to unlocking Angola's potential and establishing it as a momentum builder in the global renewable hydrogen market.

Figure 17: Overview of planned hydrogen project and RE potential in Angola.

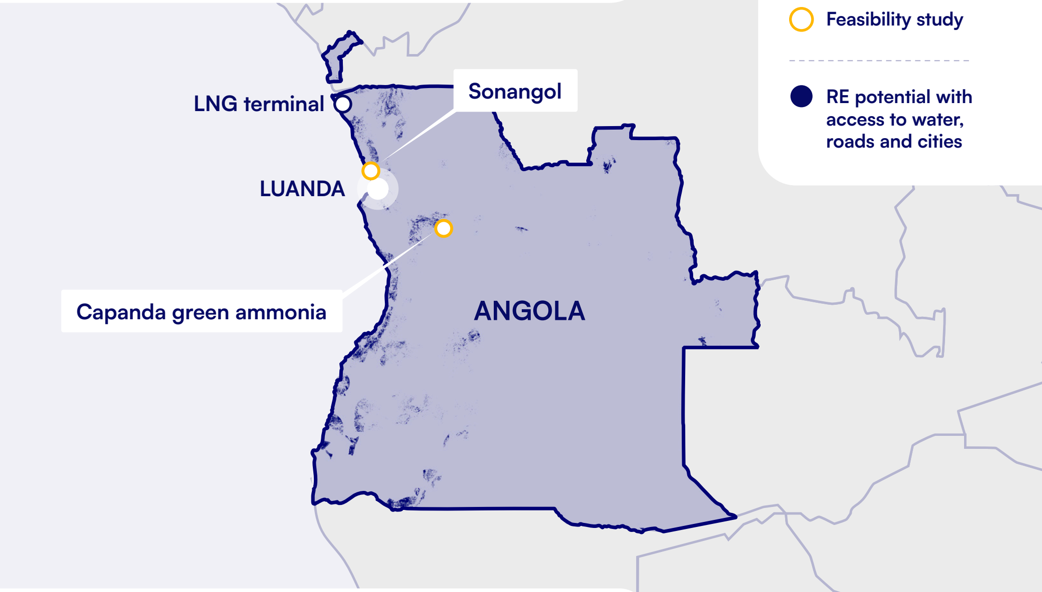


Figure 18: Summary of dimension results.

✓	**H2O & RE potential**	PV: 16,301 km² Hydropower: 110 GW	Wind: 0 km² Geothermal: 0 GW
✓	**National hydrogen commitment**	No hydrogen strategy 2 projects in feasibility study phase	
☆	**Domestic anchor demand**	No nitrogen fertilizer production Crude steel production: 500,000 t/a Mineral production: 270,212 t/a	
✓	**Country risk**	Medium risk classification: 6/7	
☆	**Export infrastructure**	1 LNG terminal No ammonia or methanol terminals	

☆ **High rating** ✓ **Medium rating** ✗ **Low rating**

Strong foundation

Cameroon, Nigeria, Senegal, and Tanzania are well positioned to emerge as key players in Africa's renewable hydrogen sector in the near to midterm future. Unlike the front runners and momentum builders, this strong foundation group is at an earlier stage of hydrogen market creation, with no publicly available national hydrogen strategies or planned hydrogen projects reported to date. However, they share several defining characteristics that provide a strong foundation for future growth, distinguishing them from many other African countries.

Two key advantages distinguish this group from other countries without hydrogen strategies or projects: existing domestic anchor demand and relatively low-to-medium country risk profiles. The low-to-mid-risk profiles of Cameroon, Nigeria, Senegal, and Tanzania make them more attractive to investors seeking long-term opportunities—particularly in a region where high-risk ratings are common—and position them favorably for the gradual creation of a hydrogen market.

All four countries exhibit potential domestic anchor demand for renewable hydrogen with industries such as fertilizer production, crude steel manufacturing, and mineral extraction. They also possess significant renewable energy potential, combined with access to water resources—through freshwater or seawater desalination—both of which are critical prerequisites for renewable hydrogen production.

Export infrastructure within this group is mixed. Cameroon and Nigeria stand out for their established LNG terminals, while Nigeria and Senegal have infrastructure capable of supporting ammonia exports. Tanzania, however, lacks dedicated export terminals, limiting its near-term potential to participate in the global hydrogen market.

Figure 19: Clustering results for the strong foundation group.

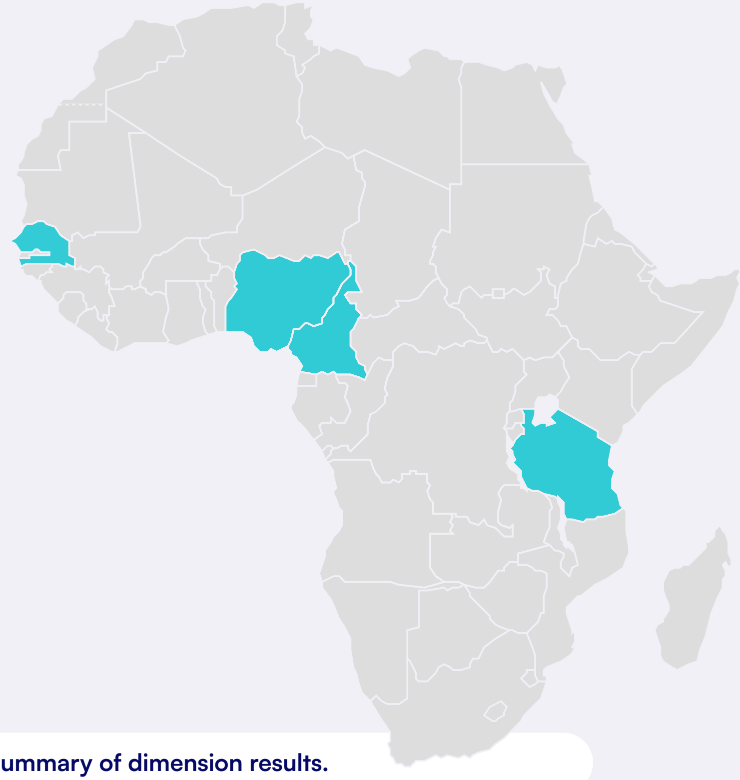


Figure 20: Summary of dimension results.

★ High rating
✓ Medium rating
✗ Low rating

✓	H2O & RE potential
✗	National hydrogen commitment
★	Domestic anchor demand
★ ✓	Country risk
★ ✗	Export infrastructure

Recommendations for strong foundation countries

To unlock their potential and take the first steps toward creating a renewable hydrogen market, the strong foundation countries—Cameroon, Nigeria, Senegal, and Tanzania—should focus on addressing foundational gaps while leveraging their favorable starting conditions. With their relatively low-to-medium-risk profiles, significant renewable energy potential, and domestic anchor demand, these countries are well positioned to initiate renewable hydrogen development through targeted actions.

Their most critical priority is to develop and publish a national hydrogen strategy. This would serve as a strong signal of political commitment, providing a roadmap for market creation and attracting both domestic and international investment. Equally important is supporting the planning of initial hydrogen projects, ensuring they are linked to both local and international offtake opportunities. These projects can act as early success stories to build confidence among stakeholders and demonstrate the feasibility of hydrogen initiatives in these countries.

Promoting private sector investment is essential to kickstart project development. Creating visibility of these countries' strong renewable energy potential and low-to-medium-risk profiles will help attract the funding and partnerships needed to support early-stage projects. Additionally, evaluating and implementing de-risking mechanisms tailored to local circumstances can significantly improve the investment environment. These mechanisms should address key challenges such as offtake risk and infrastructure gaps for hydrogen production, domestic demand, and export capabilities. By identifying and prioritizing critical infrastructure investments, these countries can establish a solid foundation to support a future hydrogen economy.

Finally, identifying the skills and capacity required to implement and sustain hydrogen projects will ensure that local workforces are prepared to participate in—and benefit from—this emerging sector.

Figure 21: Clustering results for the strong foundation group.

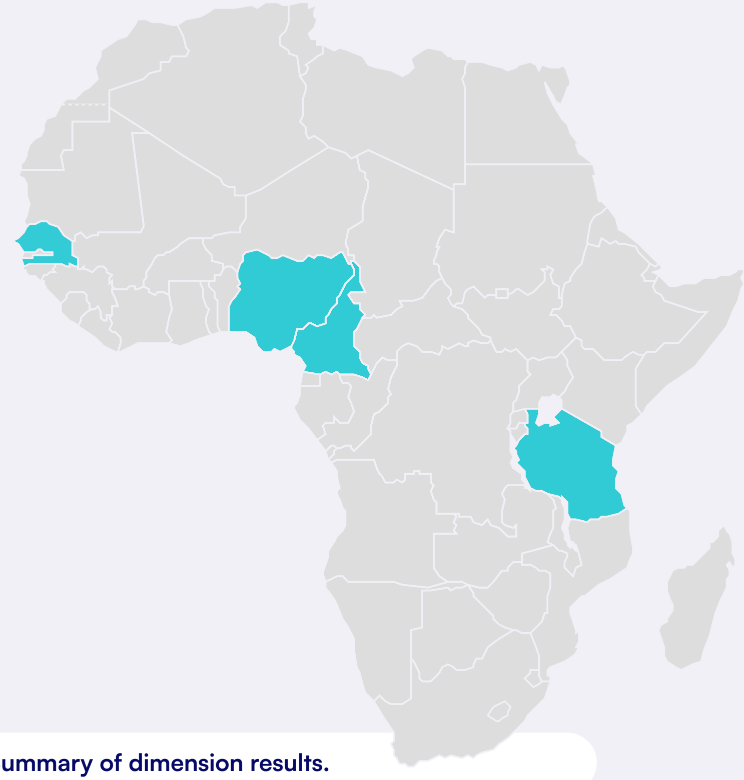


Figure 22: Summary of dimension results.

★ **High rating**
✓ **Medium rating**
✗ **Low rating**

✓	**H2O & RE potential**
✗	**National hydrogen commitment**
★	**Domestic anchor demand**
★ ✓	**Country risk**
★ ✗	**Export infrastructure**

Case study: Nigeria

Nigeria has significant renewable energy potential and is identified as part of the strong foundation cluster in the renewable hydrogen economy. The main source of renewable energy in Nigeria is hydropower, which accounted for 24% of the country's electricity generation in 2022 and has a vast untapped potential of 73 GW. Detailed GIS analysis shows that Nigeria has highly suitable land area for 85 GW of solar PV and 8 GW of wind energy for hydrogen production, with access to water, roads, and small cities within a 100-kilometer radius. Nigeria's water availability varies significantly across regions, with the north experiencing arid conditions and the south characterized by a humid tropical climate. Careful assessment of water resources is crucial for hydrogen projects in the north due to limited availability, while the south—facing no water stress—can also leverage its coastal access for desalination to preserve surface water supplies.[27]

Currently, Nigeria has no published hydrogen strategy or announced projects. The country's Energy Transition Plan (ETP), launched in 2021, targets 8 GW of solar PV capacity by 2030, but progress has been slow.[28] As of 2023, only 112 MW of PV had been installed, contributing just 0.3% of electricity generation.[29] While 11 PV projects with a combined capacity of 1,790 MW are in the planning phase, natural gas remains dominant, accounting for 76% of electricity generation in 2022.[30]

Nigeria's economy is heavily reliant on its oil and gas sector, which accounts for approximately 90% of export revenues.[31] The country has a large LNG terminal and an ammonia terminal, both of which could be leveraged for the export of hydrogen derivatives. Nigeria's fertilizer industry is well developed, featuring three urea production plants based on natural gas and 65 blending plants.[32] Partially converting these facilities to produce renewable hydrogen-based fertilizers could enhance agricultural sustainability while reducing emissions. With 3 billion tonnes of iron ore reserves and three crude steel plants, the steel sector also offers significant potential for hydrogen integration, though current production remains low.[33]

Nigeria is Africa's largest economy and, while it faces moderate country risk, this is still lower than in most African countries. Its vast oil and gas resources, large domestic market, and existing export infrastructure provide a strong foundation for investment. To support climate finance, Nigeria has strengthened its policy framework through initiatives such as the Nigerian Green Bond Market Development Programme. However, private climate financing remains limited, and the country faces high unemployment, with 33% of the workforce unemployed in 2022.[34] Addressing these challenges through policy reforms, skills development, and private sector engagement will be critical for Nigeria to build on its strong foundation and unlock its hydrogen potential.

Figure 23: Overview of RE potential in Nigeria.

Figure 24: Summary of dimension results.

✓	**H2O & RE potential**	PV: 1,018 km² Hydropower: 73 GW	Wind: 309 km² Geothermal: 0 GW
✗	**National hydrogen commitment**	No hydrogen strategy No projects announced	
☆	**Domestic anchor demand**	Fertilizer production: 6,400,000 t/a Crude steel production: 3,400,000 t/a Mineral production: 264,393 t/a	
✓	**Country risk**	Medium risk classification: 6/7	
☆	**Export infrastructure**	1 LNG terminal, 1 ammonia terminal, and no methanol terminal	

☆ **High rating** ✓ **Medium rating** ✗ **Low rating**

Pathways forward

The innovative country clustering analysis highlights three distinct groups of African countries—front runners, momentum builders, and strong foundation—that are well positioned to build a national hydrogen economy and advance toward green industrialization. Each group brings unique strengths, faces specific challenges, and requires tailored recommendations to fully realize its potential within the emerging renewable hydrogen economy.

The table on the right provides a summary of the recommendations for each group, reflecting their specific stages of development.

The front runners—Egypt, Kenya, Mauritania, Morocco, Namibia, South Africa, and Tunisia—are already making progress in hydrogen market creation. These countries should focus on implementing their national hydrogen strategies, supporting hydrogen project development, inter-institutional coordination, and further enhancing key enabling conditions such as mitigating offtake risk, developing infrastructure, and investing in workforce capacity building.

The momentum builders—Algeria, Angola, Mozambique, Uganda, and Zimbabwe—have significant potential but must take steps to ensure continued progress. Priorities include publishing national hydrogen strategies, supporting early-stage hydrogen projects, creating visibility of their hydrogen sector potential, and addressing key infrastructure gaps and risk-related barriers to attract investment and drive growth.

The strong foundation countries—Cameroon, Nigeria, Senegal, and Tanzania—are at the earliest stage of development toward a hydrogen economy but possess favorable conditions, including low- to-medium country risk, strong renewable energy potential, and domestic anchor demand. For these countries, the focus should be on developing national hydrogen strategies, supporting the launch of initial hydrogen projects, and leveraging their stability to build the groundwork for long-term hydrogen market creation.

This analysis underscores that all three groups have the necessary starting conditions to play a vital role in the global renewable hydrogen transition. With targeted action and collaboration, African countries can unlock their full potential, drive economic development towards green industrialization, and contribute meaningfully to global decarbonization efforts. By building on their individual strengths and following tailored recommendations, these countries can collectively help position Africa as a leader in the emerging hydrogen economy.

Figure 25: Summary of key recommendations for the three clusters.

Dimensions	○ Front runners	● Momentum builders	● Strong foundation
Develop & publish an H2 strategy	Completed	Ongoing	Pending
Support the planning of first H2 projects	Completed	Ongoing	Pending
Create visibility of hydrogen potential	Ongoing	Ongoing	Pending
Strengthen legal, regulatory, and institutional frameworks; implement one-stop shops	Ongoing	Pending	Pending
Support H2 projects by linking them to local offtake	Ongoing	Pending	Pending
Implement (financial) de-risking mechanisms	Ongoing	Pending	Pending
Invest in supporting infrastructure	Ongoing	Pending	Pending
Skills development and capacity building	Ongoing	Pending	Pending

Annex: Methodology

For the country clustering, the research team strategically defined five dimensions that were both representative and minimally correlated, ensuring a comprehensive analysis. The following tables present the identified levels for each dimension across all African countries.

The national hydrogen commitment dimension had three levels. Countries that lack both a national hydrogen strategy and any planned hydrogen projects were assessed as having a low level of commitment. Those that either have a national hydrogen strategy or one or more projects in the conceptual phase or beyond were considered to have a medium level of commitment. Countries with both an existing hydrogen strategy and at least one project in the feasibility study phase or beyond were classified as having a high level of commitment.

The data on national hydrogen strategies was sourced from Columbia University's National Hydrogen Strategies and Roadmap Tracker,[35] while the status of hydrogen projects was drawn from the IEA database and triangulated with announcements on company websites.[36]

The H2O & RE potential dimension assessed a country's renewable energy potential, considering only areas with sustainable water sources. The evaluation included onshore wind, PV, hydropower, and geothermal energy, with countries categorized into three levels based on predefined thresholds: 22 GW for hydropower, 748 GW for wind, and 3,876 GW for PV—representing the upper third percentile of potential among African countries.

A high level was assigned when both wind and PV potentials exceeded their respective thresholds. The medium level applied when at least one of the four energy sources (wind, PV, hydropower, or geothermal) exceeded its threshold. A low level was given when all RE sources fell below the thresholds.

The data for wind and PV potential was sourced from a high-resolution GIS analysis conducted by Fraunhofer IEE as part of the "H2Global meets Africa" research project. This analysis, with a 50x50 m grid resolution, applied strict exclusion criteria, filtering out areas such as urban zones and nature reserves. Additionally, it considered proximity to settlements and roads to ensure the practical feasibility of infrastructure and workforce availability.

Countries	National hydrogen commitment	H2O & RE potential	Export infrastructure	Domestic anchor demand	Country risk	Clustering result
Algeria	Medium	High	High	High	Low	Momentum builders
Angola	Medium	Medium	High	High	Medium	Momentum builders
Benin	Low	Low	Low	Low	Medium	-
Botswana	Low	Low	Low	High	Low	-
Burkina Faso	Low	Low	Low	Low	High	-
Burundi	Low	Low	Low	Low	High	-
Cabo Verde	Low	Low	Low	Low	Medium	-
Cameroon	Low	Medium	High	High	Medium	Strong foundation
Cen. Afr. Republic	Low	Low	Low	Low	High	Momentum builders
Chad	Low	High	Low	Low	High	-
Comoros	Low	Low	Low	Low	Medium	-
Congo	Low	Medium	Low	Low	High	-
Cote D'Ivoire	Low	Low	Low	Low	Low	-
Dem. Rep. Congo	Low	Medium	Low	High	High	-
Djibouti	Medium	Medium	Low	Low	High	-
Egypt	High	High	High	High	Medium	Front runners
Equatorial Guinea	Low	Low	High	Low	High	-
Eritrea	Low	High	Low	Low	High	-
Eswatini	Low	Low	Low	Low	Medium	-
Ethiopia	Low	High	Low	High	High	-
Gabon	Low	Medium	Low	High	High	-
Gambia	Low	Low	Low	Low	High	-
Ghana	Low	Low	Low	High	High	-
Guinea	Low	Low	Low	High	High	-
Guinea Bisseau	Low	Low	Low	Low	High	-
Kenya	High	High	Low	High	High	Front runners
Lesotho	Low	Low	Low	Low	Medium	-

Water availability was assessed through a multi-step approach:

- Coastal areas were included regardless of water stress levels, given the viability of seawater desalination.
- In inland regions, areas with medium to high water stress were excluded, while low-stress areas were only included if located near surface water bodies.[37]

The hydropower assessment focused on untapped potential, calculated by subtracting existing installed capacity (based on IRENA data[38]) from each country's total hydropower potential, as identified in a detailed study by TU Delft.[39] Geothermal potential was assessed using data from the Geothermal Atlas for Africa,[40] which provides a detailed and region-specific evaluation of viable geothermal resources.

While this assessment did not explicitly account for competing uses of RE for improving domestic electricity access and decarbonizing national energy systems, the applied thresholds were sufficiently high to suggest that, where they were met, countries are likely to have enough potential to support both hydrogen production and electricity system development. Moreover, wind and PV potential were counted only in areas with water availability; additional RE potential exists in areas with medium to high water stress, which could further support increasing electricity access and decarbonization goals.

The export infrastructure dimension evaluated the availability of ammonia, LNG, and methanol terminals in African countries, identifying existing infrastructure that could support the export of hydrogen and its derivatives. A country was classified as having a high level if it had at least one operational terminal for ammonia, LNG, or methanol.

Data on ammonia and methanol terminals was sourced from the Alternative Fuels Insight Map developed by DNV,[41] while information on LNG terminals came from the Africa Gas Tracker, part of the Global Energy Monitor.[42]

Beyond the availability of port infrastructure and storage facilities, the existence of these terminals indicated the presence of an established ecosystem of skilled personnel and regulatory frameworks necessary for handling these substances safely. Since developing new terminals requires significant capital investment and long lead times, often spanning several years, existing infrastructure offered a strong indication of a country's short-term potential to export hydrogen and its derivatives.

Countries	National hydrogen commitment	H2O & RE potential	Export infrastructure	Domestic anchor demand	Country risk	Clustering result
Liberia	Low	Low	Low	High	High	-
Libya	Low	High	High	High	High	-
Madagascar	Low	Medium	High	High	High	-
Malawi	Low	Medium	Low	Low	High	-
Mali	Low	High	Low	Low	High	-
Mauritania	High	High	Low	High	High	Front runners
Mauritius	Low	Low	Low	Low	Low	-
Morocco	High	High	High	High	Low	Front runners
Mozambique	Medium	Medium	High	High	High	Momentum builders
Namibia	High	Medium	Low	High	Medium	Front runners
Niger	Low	High	Low	Low	High	-
Nigeria	Low	Medium	High	High	Medium	Strong foundation
Rwanda	Low	Medium	Low	Low	Medium	-
Sao Tome and Principe	Low	Low	Low	Low	Medium	-
Senegal	Low	Medium	High	High	Low	Strong foundation
Seychelles	Low	Low	Low	Low	Medium	-
Sierra Leone	Low	Low	Low	High	High	-
Somalia	Low	High	Low	Low	High	-
South Africa	High	High	High	High	Low	Front runners
South Sudan	Low	Medium	Low	Low	High	-
Sudan	Low	High	Low	High	High	-
Tanzania	Low	Medium	Low	High	Medium	Strong foundation
Togo	Low	Low	Low	Low	Medium	-
Tunisia	High	High	High	High	High	Front runners
Uganda	Medium	Medium	Low	High	High	Momentum builders
Zambia	Low	Medium	Low	High	High	-
Zimbabwe	Medium	Medium	Low	High	High	Momentum builders

The domestic anchor demand dimension assessed whether a country had industries capable of integrating renewable hydrogen and its derivatives into their processes, enabling local use rather than full reliance on exports. This dimension also reflected the presence of technical and industrial expertise that could serve as a foundation for developing the skills needed to support a hydrogen economy.

The dimension focused on three key sectors: nitrogen-based fertilizer production, crude steel manufacturing, and mineral extraction (excluding fossil fuels). A country was classified as having high domestic anchor demand if it had an existing fertilizer or crude steel production facility of any size, or if it engaged in extensive mineral extraction operations.

Data sources included quantitative national-level data from AfricaFertilizer (an initiative of the International Fertilizer Development Center[43]) and the FAO[44] for existing nitrogen-based fertilizer production capacity, the OECD for operational crude steelmaking capacity,[45] and the World Mining Report 2023 for mining data.[46] Fertilizer and crude steel production are among the largest consumers of fossil-based hydrogen today. The mining sector, a major industry in Africa, presents significant opportunities for decarbonization through renewable hydrogen. Hydrogen and its derivatives can serve as fuel for heavy-duty mining vehicles and as a clean basis for ammonium nitrate production, a common mining explosive. By leveraging these three sectors, African countries can enhance local value creation, reduce industrial emissions, and accelerate hydrogen adoption.

The country risk dimension was based on the OECD's publicly available and regularly updated classifications, which rank countries on a scale from 0 (best) to 7 (worst).[47] This classification followed a two-step methodology: a quantitative assessment using the Country Risk Assessment Model, followed by a qualitative evaluation by experts.

Based on OECD data, the ”high” county risk level applied to African countries rated 7, which included the majority—32 countries. The ”medium” risk level was assigned to 12 countries rated 6, while only eight countries fell into the ”low” risk level, with ratings between 3 and 5. The OECD classification reflects the likelihood of a country being unable to repay its external debt and serves as an indicative metric of political, financial, and economic stability. As such, it offers insight into which countries are in a stronger position to attract foreign investment in hydrogen projects.

Agglomerative hierarchical clustering was applied to classify African countries based on the five key dimensions. This method began by treating each country as an independent cluster, progressively merging them in a step-by-step process. Instead of assigning fixed weights to the dimensions, the clustering was guided by iterative, manual decisions, allowing for tailored and well-reasoned cluster formations. While this approach ensured a nuanced and customized analysis, it also introduced a degree of subjectivity—researchers with different perspectives or priorities might arrive at alternative categorizations. This inherent flexibility underscores the adaptability of the methodology.

The schematic dendrogram in Figure 26 illustrates the clustering process, which unfolded in seven phases and progressively grouped countries based on their readiness to develop a hydrogen economy.

The process began with Phase 0, where countries that shared identical evaluations across all five dimensions were grouped together. In Phase 1,
countries with low rankings in the H2O & RE potential dimension were merged—irrespective of their scores in the other four dimensions—since RE potential is a fundamental prerequisite for developing a hydrogen economy.

Phase 2 brought together countries that had medium or high H2O & RE potential but lacked domestic anchor demand, recognizing that domestic demand is a critical stepping stone for scaling hydrogen markets.

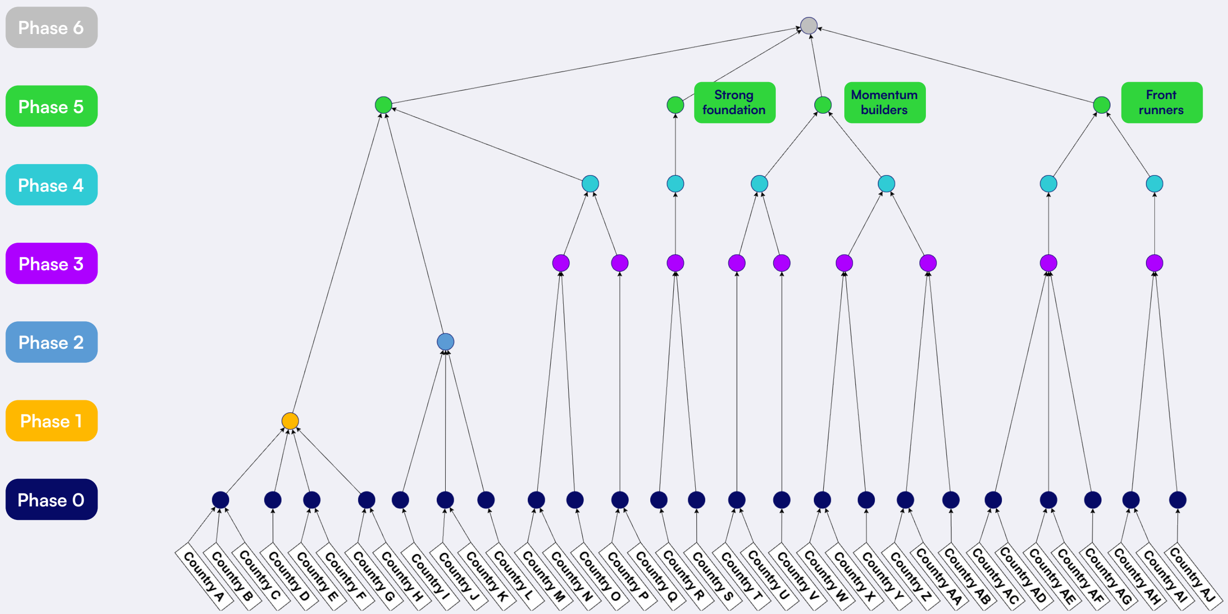
Among the remaining countries—those with sufficient H2O & RE potential and established domestic anchor demand—further clustering occurred in two consecutive steps. In Phase 3, countries with medium or low country risk were merged, while the grouping based on other dimensions remained fixed.

In Phase 4, export infrastructure was no longer used as a distinguishing factor, leading to the merging of several clusters that were previously separated based on this dimension. This was because only a few countries currently have relevant export infrastructure, and these countries vary widely across the other four dimensions. Moreover, export terminals can be built within a few years, whereas factors like H2O & RE potential, along with domestic anchor demand, are more immediate enablers of a national hydrogen economy.

In Phase 5, the eight remaining groups were consolidated into four final categories: front runners, momentum builders, strong foundation, and a less well-positioned group. Front runners and momentum builders included countries with a range of country risk levels, while strong foundation remained unchanged.

For further details on the methodology, the underlying quantitative national-level data, and the criteria used to assign levels for each dimension, please contact the author at hanna.graul@h2-global.org.

Figure 26: Schematic representation of country clustering results in the form of a dendrogram.



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