

North Africa's Energy Transition: Pioneering Regional Transformation





Introduction: A Region in Transformation

In the evolving landscape of global energy transitions, North Africa emerges as a compelling theatre of transformation, where ambitious visions meet accommodating landscapes in the quest for sustainable energy futures. Egypt, Morocco and Tunisia stand as pioneers in this regional metamorphosis, each crafting distinctive yet complementary approaches to the energy transition that reflect both their unique circumstances and shared aspirations for sustainable development.

The region's strategic position, bridging Europe, Africa and the Middle East, combined with its extraordinary renewable energy potential, creates an unprecedented opportunity for transformation. According to Global Solar Atlas, Egypt has a specific photovoltaic power output that can reach up to 5.8kWh/kWp per day in areas such as Upper Egypt, Sinai and Ain Al Sokhna, while Morocco can reach up to 5.5 kWh/kWp in the interior desert regions, and Tunisia up to 5.2 kWh/kWp in the southern desert.

These statistics put Egypt in 4th place worldwide in solar output potential, and Morocco in 13th, with Tunisia still being very attractive in specific geographic locations. These desert landscapes are uninhabited and largely free from environmental constraints, presenting ideal conditions for solar-based projects. Additionally, the region has also been generously graced by steady winds. The mean power density of wind at an elevation of 100m reaches 1,000+ W/m² in the Suez Canal Economic Zone (SCZONE) of Egypt, and up to 1,000+ W/m² and 750 W/m² in southern parts of Morocco and Tunisia respectively.

Egypt's comprehensive energy efficiency and hydrogen strategies, Morocco's pioneering renewable energy initiatives, and Tunisia's ambitious infrastructure transformation plans collectively paint a picture of a region poised to leverage its natural advantages while addressing complex developmental challenges.

Deliberate Visions and Implementation Frameworks

The strategic approaches adopted by North African nations reflect both shared regional ambitions and distinct national priorities in their pursuit of the energy transition. Egypt's sophisticated strategy demonstrates a methodical approach, targeting 40% renewable energy in its power mix by 2040. This more measured target, recently adjusted from previous more ambitious goals, reflects a realistic assessment of implementation challenges and market conditions, as evidenced by Petroleum Minister Karim Badawi's recent emphasis on natural gas as an ideal transition fuel. This strategic vision is being substantiated by concrete project developments, particularly in the green hydrogen sector. The recent addition of seven new green hydrogen MOUs in the SCZONE, representing potential investments of \$40 billion over the next decade (\$12 billion for pilot facilities and \$29 billion for large-scale production), underscores the scale of Egypt's ambitions. The country has established a comprehensive nine step project development process, from initial proposal through to financial close, demonstrating a methodical approach to project implementation that ensures thorough evaluation and sustainable development.

Morocco's vision stands out for both its comprehensive sector specific approach and its innovative project development framework. The country's "Moroccan Offer" initiative, launched in 2024, has already attracted nearly 40 green hydrogen proposals within six months, demonstrating strong investor confidence in its strategic vision. The programme's allocation of up to one million hectares (10,000 square kilometres) for renewable hydrogen projects, with an initial 3,000 square kilometres available, reflects a strategic approach to land utilisation. The government's emphasis on local industrial impact, supply chain localisation, and domestic offtake in its project assessment criteria demonstrates a

balanced approach to foreign investment and national development. This strategic framework has already yielded significant results, as evidenced by the TotalEnergies led consortium's Chbika project, which aims to develop 1 GW of renewable energy capacity for green hydrogen production.

Tunisia's strategy demonstrates similar ambition through its commitment to achieve 35% renewable energy by 2030. The country is actively pursuing international partnerships, as demonstrated by the recent memorandum of understanding between TE H2 (a TotalEnergies and EREN Group joint venture) and VERBUND for the "H2 Notos" project, which aims to export green hydrogen to Central Europe through pipelines. This represents a strategic alignment of national resources with international market opportunities, while maintaining a focus on domestic infrastructure development.

These strategic frameworks are being reinforced by careful attention to implementation mechanisms. Morocco's structured approach to project development, including six month preliminary contracts followed by 18 month advanced study agreements, provides developers with clear pathways while protecting national interests. Similarly, Egypt's nine step project process ensures thorough evaluation of proposals while maintaining momentum in project development. These mechanisms demonstrate how strategic visions are being translated into actionable frameworks that balance ambitious goals with practical implementation steps.

Infrastructure Development and Regional Integration

The infrastructure landscape across North Africa reveals a sophisticated interplay between existing assets and ambitious development plans. Egypt's strategic approach leverages its established natural gas infrastructure as a foundation for hydrogen development, while simultaneously expanding renewable energy capacity. This is exemplified by its comprehensive plan to transform the SCZONE into a green hydrogen hub, targeting 8% of the global hydrogen market by 2040. Moreover, the Suez Canal can leverage its strategic location to become a fuelling station for green maritime vessels. In August of 2023, the first ever green bunkering operation in Egypt, the Middle East and Africa took place in Port Said, at the northern end of the Suez Canal. The station fuelled the Maersk container ship with 454 Tonnes (500 Tons) of green methanol. However, since then several MOUs with various international players have been signed to study the feasibility of green methanol, but there hasn't been groundbreaking developments to transform the canal into the "hub" of green bunkering. Recently, green ammonia has attracted some interest, though there's yet to be a formal commitment.

Morocco's infrastructure development takes a different path, focusing on establishing new renewable energy installations and transmission networks. The country's success in developing major solar projects, such as the Noor Ouarzazate complex, demonstrates its capacity to implement large-scale renewable infrastructure. This is complemented by its strategic positioning of green hydrogen facilities near ideal renewable resource locations and export terminals.

Tunisia's approach represents a bold reimagining of national infrastructure, planning to transform its natural gas-dominated system into a renewable-based network. The recent signing of agreements with nine European companies for six green hydrogen projects signals a pragmatic approach to infrastructure development that balances ambitious goals with practical implementation steps.

Investment and Economic Transformation

The economic implications of energy transition in North Africa are significantly shaped by European investment and strategic interests. Egypt's hydrogen strategy, projected to contribute \$10-18 billion to GDP by 2040 and create over 100,000 jobs, has attracted substantial European involvement. Major projects like ENEC's Italian Hydrogen Demo Valley, part of a broader €433 million investment across 54 projects targeting 7,000 Tonnes/year of green hydrogen production, demonstrate the scale of European financial commitment.

Recent developments highlight growing European financial support for North African green hydrogen initiatives. The Power-to-X Development Fund, established by the German Ministry for Economic Cooperation and Development (BMZ), has awarded its first grant of €30 million to the Egypt Green Hydrogen consortium, which emerged as the sole winner of the inaugural H2Global auction.

This support, part of a larger €270 million fund managed by German asset manager KGAL, aims to incentivise green hydrogen and derivatives production in developing economies by covering partial project capital expenditure, demonstrating Europe's commitment to fostering sustainable energy development in the region.

Morocco's investment landscape has become particularly attractive to European investors, with successful mobilisation of capital for renewable energy projects, especially in solar and wind power. The country's strategic position and established regulatory framework have made it a preferred partner for European energy transition initiatives. Tunisia's emerging green hydrogen economy highlights both the opportunities and risks of European investment dependency, with recent agreements with nine European companies for six green hydrogen projects signalling strong international interest.



Regional Cooperation and Market Integration

The existing natural gas pipeline network in North Africa primarily connects Algeria, Morocco, Tunisia and Libya through various interconnected systems. The development of these regional networks has been crucial for both internal energy distribution and export capabilities. While these countries have successfully established pipeline connections among themselves, the extension to Egypt has historically been deemed technically infeasible due to geographical challenges and infrastructure limitations. However, recent technological advancements in pipeline engineering and construction methodologies warrant a re-evaluation of this assumption. Europe's extensive natural gas grid, which spans across diverse terrains and longer distances, demonstrates that such comprehensive pipeline networks are technically achievable with proper engineering solutions and investment.

The regulatory landscape presents significant challenges to regional integration, particularly in relation to European market access. The EU's Renewable Energy Directives (RED II and RED III) impose stringent requirements, that pose substantial hurdles for developing nations, not least the additionality, temporality and geographic clauses that must be met for a fuel to qualify as renewable and the clauses relating to allowable sources of CO₂ and GHG reductions for RFNBOs. These regulations, while designed to ensure sustainability and emissions reduction, often fail to account for the unique circumstances and constraints faced by developing economies. The implementation of these directives in North African countries requires significant technical expertise, infrastructure development, and regulatory alignment that may be beyond their current capabilities, potentially slowing the pace of energy transition and limiting export opportunities.

A notable example of regulatory misalignment is Egypt's experience with its Voluntary Carbon Market.

Despite the country's proactive approach in establishing this market to enable companies to offset their emissions, the EU's rejection of Egyptian carbon credits highlights the challenges of integrating developing markets into established carbon trading systems. This decision effectively limits the ability of Egyptian green energy projects to benefit from carbon offsetting mechanisms when exporting to Europe, potentially impacting project viability and investment attractiveness.

The broader Europe-Africa interconnections include significant infrastructure such as the Medgaz Pipeline (Algeria-Spain) and the Green Stream Pipeline (Libya-Italy), which have established crucial cross-Mediterranean energy bridges. These connections demonstrate the region's capability to develop and maintain complex pipeline infrastructure across the Mediterranean Sea. However, the full potential of these interconnections may be constrained by regulatory barriers rather than technical limitations.

The feasibility of expanding regional integration faces multiple challenges beyond physical infrastructure. While technical capabilities exist, as evidenced by Europe's extensive natural gas grid, the regulatory requirements and certification processes imposed by European markets create additional layers of complexity. This is particularly challenging for developing nations that must balance the need for rapid energy transition with limited resources and competing development priorities. Nevertheless, successful regional pipeline projects like the West African Gas Pipeline (WAGP) suggest that incremental expansion of interconnected gas infrastructure across Africa is possible with sufficient political will, technical expertise and financial resources. The key to unlocking this potential lies in developing more flexible and inclusive regulatory frameworks that recognise the specific challenges faced by developing nations while maintaining essential sustainability standards.

Realistic Approach to the Energy Transition

At COP27 in Egypt, the country pledged to increase its renewable energy production to 42% of its energy mix by 2035. Earlier in 2024 after realising a significant traction in foreign investment and foreign interest in general, the country decided to accelerate its renewable energy targets to 42% by 2030 instead of 2035. Not only that, they were also looking to raise their target for renewable energy to 58% by 2040. However, recently, in an opening session of the Mediterranean Offshore Conference that happened on 20 October 2024, the Petroleum Minister Karim Badawi said the country will shift its focus to natural gas, which is deemed as the ideal transition fuel.

He also urged to “increase discoveries and attract more investments through the bids being offered for exploration, aiming to achieve new discoveries in the region, which holds more wealth, particularly natural gas.” On the same note, he stated the country's new renewable energy goals, which conform to a relatively safe target of 40% by 2040.

This is a consequence of being overly optimistic about the energy transition and dismissive of the harsh reality and challenges that are looming in the background waiting to show its true colours once actions are being taken. Other North African countries will face the same challenge Egypt has faced, and will probably have to cut back on some of their ambitious targets once push comes to shove.



Water-Energy Nexus and Resource Management

The ambitious green hydrogen plans across North Africa face a critical challenge that must be carefully considered: water scarcity. The water requirements for green hydrogen production through electrolysis are substantial - typically requiring 9-13 kilograms of water per kilogram of hydrogen produced. This number goes up remarkably if a cooling tower or evaporative air cooling is needed due to the exothermic nature of the process. In regions already experiencing water poverty, this presents a significant challenge that could impact project viability and sustainability.

Egypt's approach to green hydrogen development explicitly acknowledges water constraints, incorporating desalination into project planning while carefully considering location and scale of facilities. The country's experience with water management in the Nile Delta provides valuable insights for balancing competing resource demands. However, the fiscal burden of desalination plants will curtail the scope of the government's ambitious endeavours.

The severity of the water scarcity challenge cannot be understated. Egypt is already considered water poor, with per capita water availability below the international water poverty threshold.

The United Nations predicts that Egypt could face severe water scarcity by 2025. With a population of over 105 million heavily dependent on the Nile River for drinking water and agriculture, and faced with additional pressures from the Grand Ethiopian Renaissance Dam, adding water-intensive hydrogen production creates complex resource allocation challenges.

Morocco and Tunisia face similarly dire water situations. Morocco is classified among the world's most water-stressed countries, with renewable water resources per capita significantly below the water scarcity threshold. Tunisia's renewable water resources are also critically low, with increasing drought frequency threatening both urban water supply and agricultural productivity. In this context, the water requirements for green hydrogen production pose serious questions about resource prioritisation and sustainable development.

Ethics and Resource Exploitation

The pursuit of energy transition in North Africa raises serious ethical concerns regarding resource exploitation and economic equity. The region faces a critical dilemma where European interests in securing clean energy supplies may overshadow local development needs. This is particularly evident in green hydrogen and ammonia projects, where production is primarily oriented toward European markets despite pressing domestic energy needs.

However, significant steps are being taken to ensure sustainable and equitable development. The establishment of the GH2 International Green Hydrogen Centre of Excellence (GH2 Cairo Centre) at Nile University represents a concrete commitment to building local capacity and expertise. This training centre aims to equip professionals and government officials from developing countries with essential knowledge and skills, particularly in international policy and finance, enabling informed decision making about renewable hydrogen development in their respective nations. Such initiatives demonstrate efforts to move beyond mere resource extraction to fostering genuine technological and knowledge transfer.

As previously mentioned, water scarcity presents a particularly troubling ethical dimension. The allocation of scarce water resources to produce green hydrogen primarily for export to Europe raises significant ethical concerns about resource prioritisation and sustainable development.

The risk of neo-colonialism in resource exploitation cannot be ignored. While European investment brings necessary capital and technology, there's growing apprehension about whether the renewable energy boom will translate into substantial economic progress for host countries. These concerns extend to broader developmental challenges. The region's status as a collection of developing nations demands solutions that balance ambitious environmental goals with pressing socioeconomic needs. While all three countries have emphasised domestic value creation and local capacity building in their energy transition strategies, the practical implementation of these goals requires continued vigilance and commitment from both North African nations and their European partners.



Implementation Challenges and Shortcomings

The path to energy transition in North Africa faces significant implementation challenges. Technical constraints, from grid integration of renewable energy to water availability for green hydrogen production, demand innovative solutions. The high capital expenditure (CAPEX) requirements pose a particularly daunting barrier, especially in renewable energy infrastructure development. Wind farms and solar installations, despite decreasing costs globally, still require substantial upfront investments. On the topic of green hydrogen, with the help of emerging markets and the relative maturity of the technology, the cost of electrolyzers has gone down over the years. Now, the procurement costs range from \$500 - \$750 /kW, alkaline electrolyzers being on the lower end of the spectrum and proton exchange membrane (PEM) on the higher end, but even then, it is still expensive in the big picture. Not to mention that the procurement cost of solid oxide electrolyser cell (SOEC) electrolyzers is still significantly high and can average around \$1,200 /kW. Moreover, inflation has muddled the waters even more, with the increasing cost of material and labour. These CAPEX requirements, coupled with the need for extensive transmission infrastructure and energy storage systems, create a complex financial landscape that challenges the pace of renewable energy deployment.

Financial limitations, particularly in the context of competing development priorities, require careful balancing of resources and creative financing mechanisms. The substantial costs of renewable energy projects, combined with the need for grid modernisation and storage solutions, necessitate innovative funding approaches. While renewable energy costs have decreased significantly over the past decade, the initial capital requirements for utility scale projects remain a significant barrier, especially for countries with limited fiscal space. The long term nature of these investments, often

requiring 15-25 years for full return on investment, further complicates the financing landscape.

Institutional capacity represents another crucial challenge. While all three countries have established sophisticated policy frameworks, the practical implementation of these policies often encounters obstacles in terms of technical expertise, regulatory enforcement and coordination across government agencies. Tunisia's experience with its ambitious renewable energy targets illustrates how implementation can lag behind policy ambitions, while Morocco's success in renewable energy deployment demonstrates how these challenges can be overcome through sustained institutional commitment and international partnership.

The varying pace of progress across different sectors and regions within each country highlights the complexity of managing comprehensive energy transition. Egypt's experience with energy efficiency implementation in its petroleum sector shows how established industries can both enable and constrain transition efforts. These sectoral differences, combined with the high upfront costs of renewable technologies, create a complex landscape that requires careful navigation and strategic planning to achieve successful energy transition outcomes.

Future Implications and Regional Leadership

North Africa's emerging position in the global energy transition landscape suggests significant potential for regional leadership in sustainable development. The complementary strategies of Egypt, Morocco and Tunisia, while maintaining distinct national characteristics, collectively demonstrate how regions can approach the energy transition in ways that address both global climate imperatives and local development needs.

The region's experience offers valuable lessons for other developing regions facing similar challenges. The emphasis on leveraging natural advantages – from solar resources to strategic location – while addressing development constraints provides a template for sustainable transition in resource-constrained environments. The success in attracting international investment while maintaining focus on domestic benefits demonstrates how energy transition can serve both global and local interests.



The Future is Optimistic

The Mediterranean basin, particularly North Africa, is crystallising as the next frontier for green energy development. Recent developments on the ground provide tangible evidence for this optimistic outlook. The volume and scale of new projects announced in 2024 alone signal unprecedented momentum. Egypt's SCZONE continues to attract fresh investment interest, with international developers competing to establish a first mover advantage in the region's emerging green hydrogen economy.

Beyond individual national achievements, the region's collective progress in attracting both technical expertise and capital investment demonstrates its growing strategic importance. Major European energy companies are establishing substantial presences across all three countries, bringing not just capital but crucial technology transfer and capacity building. The European Bank for Reconstruction and Development's growing portfolio in regional green energy projects, alongside increasing private sector interest, suggests sustained long term investment flows.

What makes this particularly promising is the region's ability to leverage its unique combination of advantages - abundant renewable resources, strategic location and existing infrastructure - while simultaneously developing innovative solutions to address its challenges. The emergence of integrated project approaches that consider both energy production and water management demonstrates the region's capacity for thoughtful, sustainable development.

As global competition for green energy leadership intensifies, North Africa's demonstrated ability to move from ambitious plans to concrete implementation positions it as a crucial hub in the world's energy transition landscape. The region is not just participating in the global energy transition; it is increasingly helping to shape it.

Conclusion

North Africa's approach to energy transition, as exemplified by the strategies of Egypt, Morocco and Tunisia, demonstrates the potential for developing regions to pioneer innovative approaches to sustainable development. The region's success in attracting international partnerships while maintaining focus on domestic priorities offers valuable lessons for global energy transition efforts.

The challenges facing these nations – from water scarcity to development needs – have not deterred their pursuit of ambitious energy transition goals. Rather, these constraints have fostered innovative approaches that integrate resource efficiency, economic development and environmental sustainability.

As the global energy landscape continues to evolve, North Africa's experience suggests that thoughtful energy transition can serve as a catalyst for broader sustainable development, provided it remains grounded in local realities while reaching for global opportunities.

The region's collective movement toward renewable energy and green hydrogen development, while maintaining distinct national approaches, positions North Africa as an emerging leader in global energy markets. This leadership role, built on a foundation of careful planning and strategic partnership, suggests a future where energy transition serves as a pathway to both environmental sustainability and economic development.



io consulting's Perspective on Power to X in North Africa

Who are we?

io is a strategic joint venture company held with 50:50 ownership between Baker Hughes and McDermott, operating independently with the remit to get involved from the early stages of major energy development projects and to help developers on the journey from feasibility through Front-End Engineering Design (FEED) to FID and beyond. io is best described as a project architect, possessing the full range of technical, commercial and strategic skills to shape projects from inception and to create, protect and deliver the value proposition to asset owners and shareholders. Our commitment to our clients is evident in the multiple owner's engineer roles supporting them deliver on their promises. io has a significant track record in the energy industry gained from Oil & Gas and now applied to sustainable energy and chemicals projects including Power to X encompassing Sustainable Aviation Fuel and other e-fuels, Carbon Capture and Storage, and Energy Storage. We have successfully completed 450 assignments to date, of which one third are energy transition developments.

Pioneering Presence in North Africa

We pride ourselves at io, on our profound understanding of the North African landscape, policy and regulatory environment, which is critical for successfully navigating and executing energy development projects in this region. Our extensive experience in delivering hydrocarbon project developments spans across countries like Algeria and Egypt with many of our workforce being familiar with developments in Tunisia too, where we have consistently delivered PreFEED and FEED projects and supported our clients through to Final Investment Decision (FID).

In Algeria and Egypt, we have successfully completed significant preFEED and FEED projects in the Oil & Gas sector, demonstrating our ability to manage and execute large-scale developments. Our workforce's strong knowledge of doing projects in Egypt and Tunisia further underscores our capability to deliver results in diverse and challenging environments.

One of the key strengths of io is our deep-rooted presence in the MENA region, with offices in Doha, Qatar and Abu Dhabi, UAE. This strategic positioning has allowed us to develop a nuanced understanding of the cultural and client archetypes that are prevalent across both the Middle East and North Africa. The similarities in cultures and business practices between these regions have enabled us to leverage our long-standing heritage and expertise to deliver exceptional results for our clients. Our comprehensive understanding of the policy, regulatory and business landscapes in North Africa, positions us uniquely to support new energy project developments. Worldwide, we have performed over 100 Advisory and Due Diligence assignments, where our clients have leveraged our expertise to and knowledge to navigate the intricacies of these markets, ensuring that our clients' projects are not only compliant but also optimised for success.

In summary, io's unparalleled expertise in the North African energy sector, combined with our strategic presence in the MENA region, makes us the ideal partner for any energy and chemicals development project. Our proven track record, deep understanding of local landscapes and ability to navigate complex regulatory environments, ensure that we deliver exceptional value to our clients, driving their projects from concept to completion with confidence and precision.

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