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KONRAD ADENAUER STIFTUNG

North Africa's Power Shift

Renewable Energy Development and Energy Security

Intissar Fakir, *Editor*

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Cover photo: A Moroccan worker walks in front of a solar array that is part of the Noor 1 solar power project in Ouarzazate. Photo by FADEL SENNA/AFP via Getty Images.

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Photo above: Windmills at the onshore Zaafarana windfarm along the Gulf of Suez on Egypt's Red Sea coast. Photo by KHALED DESOUKI/AFP via Getty Images.

Foreword

In the context of the global energy transition and its complex interconnections to energy security, North Africa stands at a pivotal crossroads. The region's abundant natural resources and strategic geographical positioning offer unique opportunities to transition toward renewable energy systems that can drive economic growth, enhance energy security, and mitigate environmental risks. However, in many cases, challenges related to governance, financing, and strategic planning have hindered or delayed the development of the renewable energy potential in North African countries.

Beyond the national level, the energy transition in North Africa is also set to affect intra-regional relations, offering potential new avenues for cooperation, which in turn can leverage synergies to enhance economic development and stability across the region. Yet such forms of collaboration around energy will first have to overcome existing political obstacles.

With this study, we aim to highlight current developments, challenges, and opportunities regarding the development of renewable energy in North Africa. To this end, the research and analysis delves into the dynamic and diverse energy landscapes of five North African countries — Algeria, Egypt, Libya, Morocco, and Tunisia — highlighting the distinct pathways each nation is pursuing to tap into its renewable energy potential. In addition to the individual country chapters, the report also explores three overarching themes crucial to the region's energy future: the water-energy nexus, which is vital in a water-scarce region; the evolving role of climate finance in enabling the green transition; and the potentials and challenges surrounding regional cooperation in the context of the energy transition. These thematic insights offer a broader perspective on how collaboration across national borders and sectors can address shared challenges and unlock synergies in the pursuit of the energy transition.

This project would not have been possible without our partner, the Middle East Institute. I want to offer special thanks to Intissar Fakir, the editor of this study, whose vision and passion have carried the project from the beginning. I also extend my heartfelt thanks to the authors, peer reviewers, and all those involved in bringing this report to fruition. Their dedication, expertise, and insights are reflected in the depth and quality of this work, which we hope will serve as a key resource for policymakers, economic decisionmakers, and researchers in order to contribute to a deeper understanding of the opportunities and challenges regarding renewable energy development in North Africa.

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Konrad-Adenauer-Stiftung (KAS-REMENA)

Introduction: North Africa's Renewable Energy Development Between Potential and Reality

Intissar Fakir

Photo above: A worker cleans solar panels at the Benban Solar Energy Park in Aswan, Egypt. Photo by Ahmed Gomaa/Xinhua via Getty Images.

North Africa's renewable energy resources have long been integrated into the region's power systems, particularly through hydroelectric power installations dating back to the mid-20th century. Egypt's Aswan Dam stands as the most prominent example, while Morocco's hydroelectric program began in the 1960s with cascading dams that still contribute to its power mix. Small-scale solar applications, especially for domestic use, have been common in countries like Tunisia and Morocco since the 1980s.

However, the imperative of transitioning away from fossil fuels has focused attention on North Africa's most abundant renewable energy resources: solar and wind. Solar has been a particular area of priority, as the region possesses some of the world's highest irradiation levels, with annual averages exceeding 2,500 kilowatt-hours per square meter in areas such as Egypt's western desert and southern Algeria. This potential extends across vast uninhabited areas, offering possibilities for utility-scale installations. The region's proximity to European markets, with their acute need to diversify energy supplies and their commitment to decarbonization, further enhances its attractiveness for renewable energy development.

It was not until the late 2000s that North African countries began shaping their energy transition paths in response not only to domestic needs but also to Europe's push for clean energy partnerships. Yet in North Africa, renewable energy development intersects with established hydrocarbon systems, as the region encompasses major energy exporters like Libya and Algeria and importers like Morocco and Tunisia, each pursuing renewable energy development while maintaining fossil fuel infrastructure and markets. This dual focus shapes how countries

approach their energy transition — balancing domestic energy security needs with export-oriented opportunities and managing the socio-economic implications of shifting energy systems.

This balancing act has produced distinct national approaches, as each country navigates its economic constraints, governance capabilities, energy needs, and political considerations. The result has been divergent paths that nonetheless share common challenges: fossil fuel subsidies that create fiscal burdens and potential social instability, rising domestic energy consumption that affects both fiscal planning and export capacity, and varying abilities to translate policy ambitions into implementable projects. The region also faces mounting climate pressures — particularly extreme heat and water scarcity — that demand both adaptation measures and new approaches to energy system planning. These challenges are compounded by the substantial technical and financial demands of building new renewable energy infrastructure, from generation facilities to grid modernization.

Success in renewable energy development correlates to several factors. First is the degree of entrenchment of fossil fuels in the nation's economy, both as a source of revenue and through existing infrastructure and markets. Second is each country's ability to establish clear institutional responsibilities, maintain regulatory stability, and create conditions conducive to investment. Third is the capacity to manage the technical and financial demands of building new renewable energy infrastructure.

Each country scores differently in these categories, reflecting not only their current progress but also suggesting where they might advance and what obstacles they must overcome. Morocco emerged as North Africa's renewable energy pioneer, launching ambitious solar programs in 2009 as part of a broader economic diversification strategy. The country has systematically developed institutional capacity and regulatory frameworks, attracting international investment and technical partnership. However, financing constraints and grid infrastructure limitations have slowed implementation of its ambitious plans, particularly for newer projects. Morocco's experience demonstrates both the potential for comprehensive renewable energy developments and the persistent challenges of financing and building up effective infrastructure networks.

Egypt has leveraged its size and industrial capacity to attract major investment in utility-scale projects. However, the country faces a complex transition as it balances renewable energy development with its substantial natural gas infrastructure and rising domestic energy demands. While renewable energy offers a potential solution to insufficient gas resources, Egypt's current economic crisis and governance challenges threaten to undermine future efforts. The country's experience highlights how macroeconomic conditions and institutional stability directly affect renewable energy progress.

Algeria, despite possessing vast solar potential, exemplifies how hydrocarbon dependency can constrain renewable energy development. The country's cautious approach reflects both institutional attachment to its fossil fuel legacy and the complexity of transitioning away from a hydrocarbon-dependent economy. Recent European interest in diversifying energy supplies, particularly following reduced Russian gas imports, has encouraged Algeria to remain oriented toward traditional energy exports.

Tunisia's renewable energy development illustrates the challenges facing smaller economies in the region. Despite establishing regulatory frameworks and renewable energy targets, implementation has been hampered by economic crisis, limited domestic resources, and institutional instability. The country faces particular tension between addressing domestic energy needs and pursuing export-oriented projects backed by European partners. This dynamic highlights a broader regional challenge: balancing domestic energy security with export opportunities while managing limited financial and technical resources.

Libya's limited progress in renewable energy development demonstrates how political instability fundamentally undermines energy transition efforts. Despite substantial renewables potential and financial resources from oil exports, the country lacks the basic institutional capacity and a coherent regulatory framework for sustainable renewable energy development.

These varied national experiences reveal key patterns in North Africa's renewable energy development. The

region's proximity to European markets has driven external interests and investment, particularly as Europe pursues supply diversification and decarbonization. However, this creates complex dynamics between export opportunities and domestic energy security, especially given rising local consumption and persistent subsidy burdens. The emerging focus on green hydrogen production exemplifies this tension — while offering economic opportunities, it raises critical questions about resource allocation, particularly water usage as water security emerges as a paramount concern. The water-energy nexus shapes technology choices and project viability from green hydrogen production to solar panel maintenance. This creates additional complexity in energy planning, requiring integrated approaches that consider both energy and water security.

Institutional capacity and governance frameworks determine the pace and effectiveness of renewable energy development. Countries that have established clear mandates, regulatory stability, and streamlined decision-making processes have advanced more consistently in implementing projects and drawing investments. Technical and financial barriers persist region-wide but manifest distinctly across countries. Grid infrastructure limitations and storage requirements present universal challenges, with the intermittent nature of renewable energy requiring investment to modernize infrastructure. The predominance of loans over grants in climate finance adds to regional debt concerns, creating misalignment between energy ambitions and available financing mechanisms. Despite clear technical and economic benefits, regional cooperation remains limited. Political tensions and institutional weaknesses have prevented the development of integrated power markets and resource-sharing frameworks.

Looking ahead, the success of North Africa's renewable energy development requires addressing several interconnected challenges. Additional progress will depend on: strengthening institutional frameworks; developing financing mechanisms that align with local capacity and needs; balancing domestic energy needs with export opportunities; and managing water scarcity concerns. Progress in these areas, together with advancements in storage capacity and grid management, will speed up the transition, potentially unlocking regional cooperation.

A review of North Africa's record of implementing renewable energy policies and practices offers important insights into how a green transition unfolds amid economic complexities and development challenges. The comparative analysis of the difficulties faced by these five countries illustrates how different starting points shape transition pathways. For policymakers, the intent of the study is to provide an understanding of how institutional capacity, resource constraints, and market structures affect whether existing energy systems enable or constrain renewable energy developments. For investors, the detailed experiences of North African countries highlight the importance of understanding not only technical potential but governance capacity and domestic market conditions. And for development partners, outcomes in the region, as outlined in the ensuing chapters, show the need to calibrate institutional capacities and market realities.

Major Goals, Modest Gains: Morocco's Renewable Energy Journey

Rachid Aourraz

Photo above: An aerial view of the solar mirrors at the Noor 1 Concentrated Solar Power (CSP) plant, some 20 kilometers (12.5 miles) outside the central Moroccan town of Ouarzazate. Photo by FADEL SENNA/AFP via Getty Images.

Morocco's energy transition story began in November 2009,[1] when King Mohammed IV inaugurated a large solar energy project in the city of Ouarzazate (southeastern Morocco), whose year-round sunny climate offers significant potential for solar power generation. Morocco sought to transition into renewables for three main reasons. First is the country's complete dependence on imported fossil fuels. Second is the potential of international support and opportunities accompanying such a transition from grants and investments in renewable energies. And finally is the country's location — its abundance of sun, wind, and access to the Mediterranean and the Atlantic Ocean providing 3,500 kilometers of coastline, of which the Atlantic coast represents more than 2,000 km, the longest for an African country.

Lacking oil and gas reserves, the country imported all its requirements from foreign markets, especially the Gulf. Morocco was thus dependent on external energy markets for 96 percent of its needs for years (97.5% in 2008).[2]

1. Zakia Abdennebi, "Morocco unveils $9 bln solar power scheme," *Reuters*, November 3, 2009, https://web.archive.org/web/20091107191146/http://af.reuters.com/article/investingNews/idAFJOE5A202D20091103.

2. Tayeb Amegroud, "Morocco's Power Sector Transition: Achievements and Potential," Policy Center for the New South, February 9, 2015, https://www.policycenter.ma/publications/morocco%E2%80%99s-power-sector-transition-achievements-and-potential; Ministère de la Transition Energétique et du Développement Durable, "Secteur de l'Energie: Chiffres clés," Government of Morocco, 2022, https://www.mem.gov.ma/Lists/Lst_rapports/Attachments/39/Chiffres%20cl%C3%A9s%20annuels%20de%20l'%C3%A9nergie.pdf.

This increased the country's economic vulnerably due to fossil fuel price fluctuations (crude oil prices reached a peak of $165/barrel in April 2008, as energy imports absorbed 48% of Morocco's total export revenues equivalent to 7.4% of gross domestic product (GDP) in 2009) and resulted in high shipping and distribution costs, which have risen beyond the level most Moroccan consumers can afford.[3]

Further, the transition provided an opportunity to benefit from support from Western governments and donor institutions for climate mitigation and adaptation projects. Morocco was able to take advantage of such opportunities to finance renewable energy development projects and policies to engage in the energy transition earlier than similar economies. Having been the first developing country to host the UN Climate Change Conference (Conference of the Parties, COP) twice — COP7 in 2001 and COP22 in 2016 — Morocco was able to capitalize on the momentum around climate projects and support for environmental programs it would soon begin building.

Aiming to achieve a balanced renewable energy mix of 14% each of hydropower, wind, and solar energy capacity by 2020, Morocco's $9 billion Ouarzazate Noor project included the construction of five other renewable energy facilities in Ouarzazate, Laayoune, Boujdour, Tarfya, and Ain Beni Mathar. At the outset, the Noor project was to be open to public and private capital and produce 42% of Morocco's electricity needs by 2020, equivalent to 2,000 megawatts (MW) of electric capacity.[4] The 2009 launch of the project became the first step in a comprehensive strategy that included a new legislative framework and established institutions to implement the country's energy transition goals.

But despite making progress since 2009, Morocco's transition strategy has faced delays and fallen short of achieving its targets while the country's energy needs have grown, resulting in an increase in its dependence on fossil fuels. The kingdom was able to decrease its fossil fuel use from 97.5% of total energy sources in 2009 to 90.5% in 2022, which is a modest reduction considering the goals set when the country began its energy transition project.[5]

More than a decade after forming its renewable energy strategy, the government launched a new set of goals. On Nov. 22, 2022, the palace announced plans to raise the contribution of renewable sources to the country's energy mix to 52% by 2030.[6] The statement also called for accelerating the pace of completion of projects under development, singling out the Noor Midelt section with its three solar energy projects. The revision of the country's energy transition strategy and goals highlighted the challenges encountered over the past decade, including implementation delays, discrepancies between installed capacity and usage, cumbersome regulatory processes, and availability of investment, but also made clear the lack of choices for a country with limited fossil fuel potential and a strong commitment to climate goals.

The Impetus for Morocco's Energy Transition

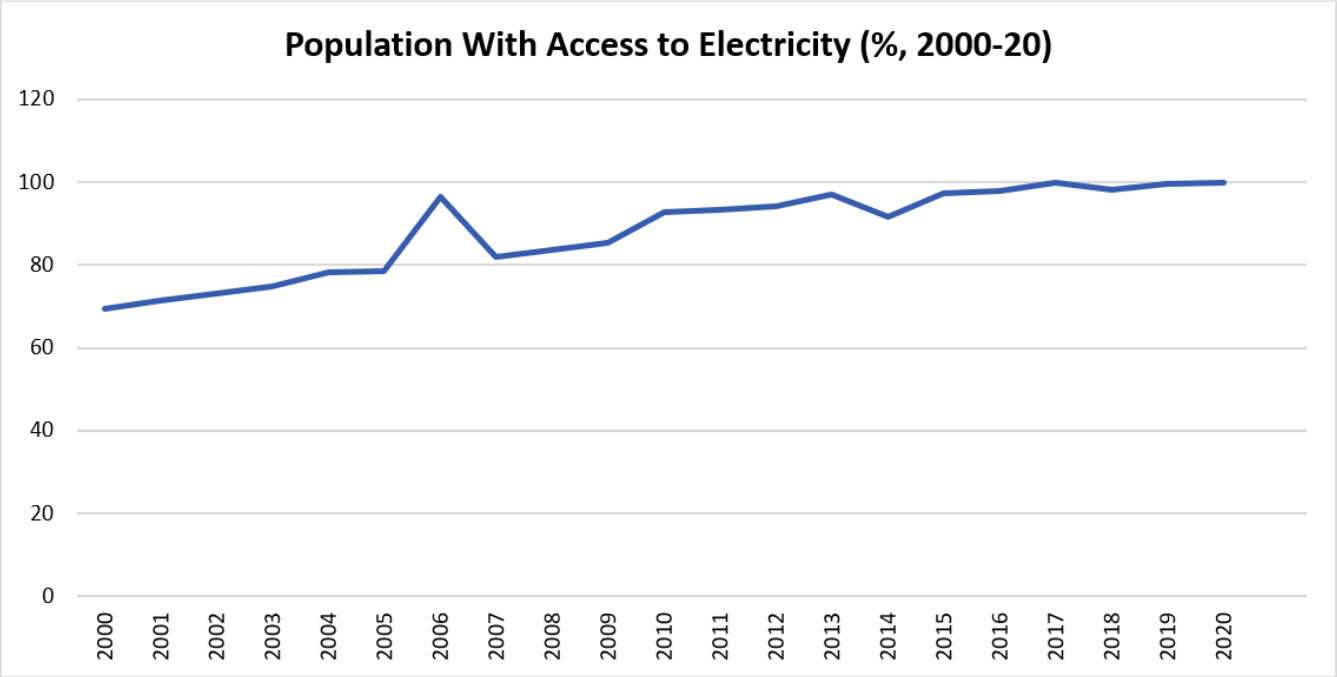
In the decade following the 2011 protests that destabilized many political systems in the region, Morocco focused on human development as a way to stave off instability. By 2017, the king had initiated a review of the country's development policies that he deemed to have reached their limits. He then launched a major national consultative process, which yielded a new development model in 2021. The 2030 Sustainable Development Goals looked to prioritize human development and improve living conditions. The goals were designed not only to provide political legitimacy domestically, but also to enhance the country's international image. Among them was an effort to provide improved and sustainable access to electricity

3. "Crude oil prices - 70 year historical chart," MacroTrends, 2024, https://www.macrotrends.net/1369/crude-oil-price-history-chart.

4. Ambassade du Royaume du Maroc en France, "Projet d'énergie solaire," Moroccan Ministry of Foreign Affairs, 2024, https://fr.diplomatie.ma/projet-d%C3%A9nergie-solaire.

5. "Crude oil prices - 70 year historical chart," MacroTrends, 2024, https://www.macrotrends.net/1369/crude-oil-price-history-chart.

6. Moroccan Royal Palace, "Royal Palace Statement," Maghreb Arab Press Agency, November 22, 2022, https://www.mapnews.ma/ar/activites-royales/خطاب-جلالة-الملك-محمد-السادس-نصره-الله-51.



Source: IEA, IRENA, UNSD, WB, WHO

for remote and underserved Moroccan households. This particular goal builds on the country's electrification drive launched in the 1990s to facilitate rural populations' access to electricity. The process continued well into the next decade, bringing electrification rates from 69% in 2000 to 99.78 % in 2020.[7] Given the wide access, electricity demand has continued to grow as the country continues to improve access and build its industrial economic base.

The enhanced accessibility of electricity has led to a significant increase in electricity consumption over the last three decades. Official data shows that consumption rose from 9,385 terawatt hours (TWh) in 1990 to 35,124 TWh in 2021.[8]

While electricity demand grew, investment in renewable energy sources remained insufficient to meet stated targets. Consequently, Morocco's reliance on coal for electricity production has tripled since 2009, the year Morocco launched its renewable energy strategy. Coal usage increased from 10,863 gigawatt hours (GWh) in 2009 to 28,282 GWh in 2021.[9] This increase occurred in a context not only of high electricity demand but also of volatility in global energy markets.

The Regulatory Framework

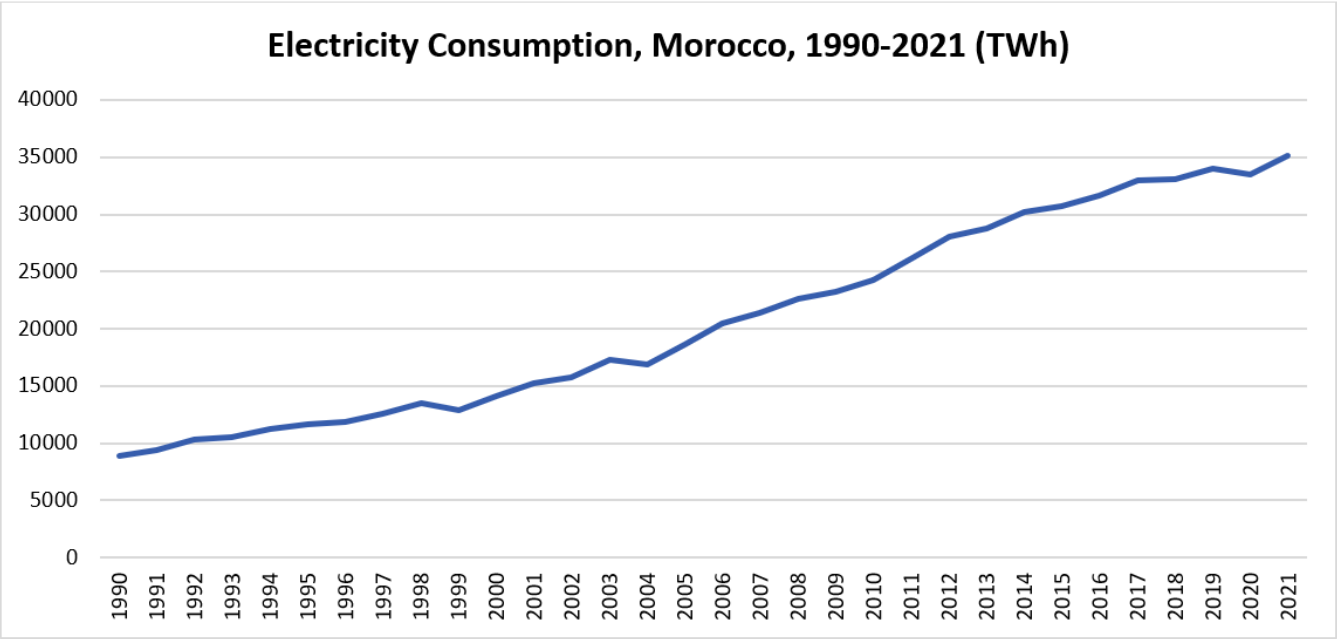
The development of Morocco's renewable energy industry took place within a regulatory framework that started with the announcement of the 2009 strategy. Since then, the government has enacted various laws to strengthen the legal framework of the renewable and electricity sectors. The first and most important was Law No. 57-09, which established the Moroccan Agency for Solar Energy (MASEN) and which clearly defined the scope of operations and authority of the agency.[10] Law No. 37-16, of Sept. 22, 2016, further expanded

7. National Electricity Office (ONEE), "Review of 2020 Activities," Kingdom of Morocco, 2020, p. 5.

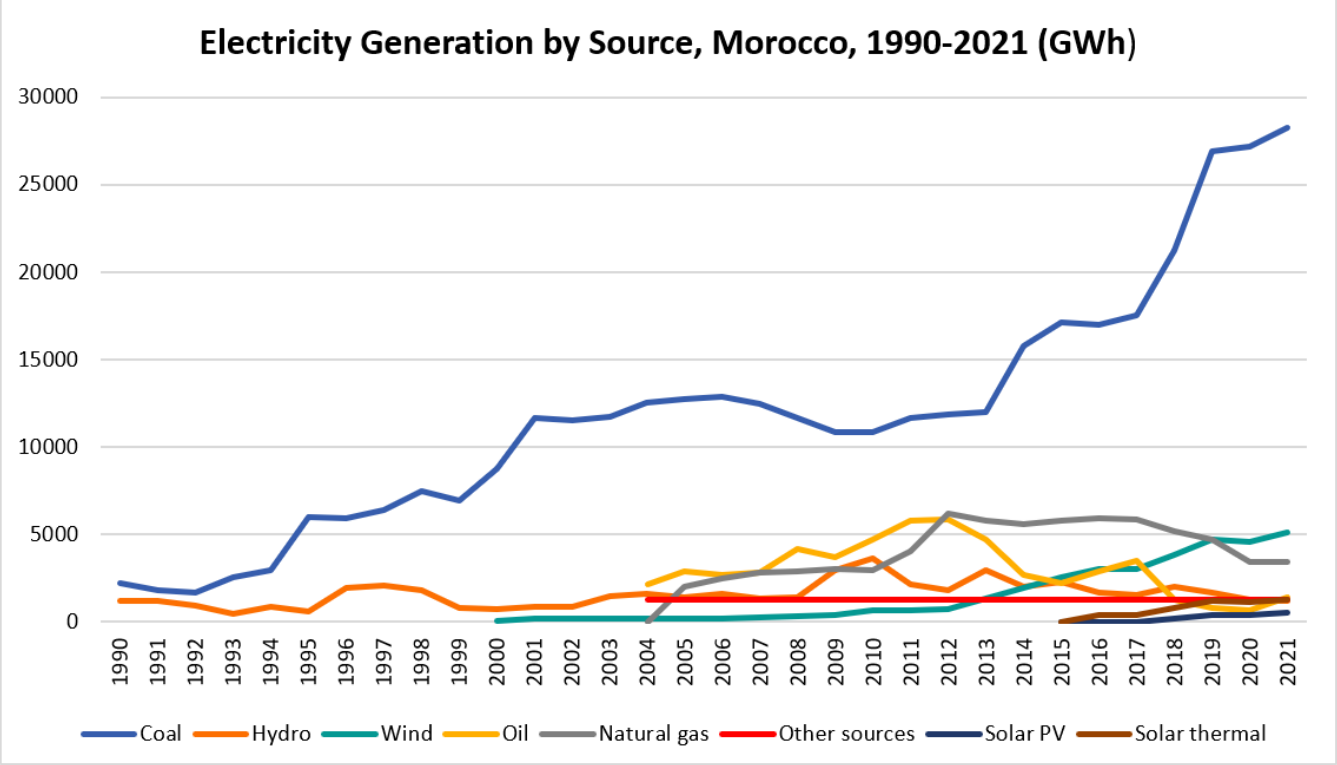
8. Data Services, "World Energy Statistics and Balances," International Energy Agency, July 2024, https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances.

9. IEA, "Morocco - Countries & Regions," International Energy Agency, Accessed June 15, 2024, https://www.iea.org/countries/morocco/electricity (accessed June 15, 2024).

10. General Secretariat of the Government, "Official Bulletin N 5822," Kingdom of Morocco, March 18, 2010, http://www.sgg.gov.ma/BO/bo_fr/2010/bo_5822_fr.pdf.



Source: IEA Data Services, July 2024



Source: IEA[11]

11. Energy Statistics Data Browser, "Electricity generation by source, Morocco, 1990-2022," International Energy Agency, December 21, 2023, https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser?country=MOROCCO&fuel=Energy%20supply&indicator=ElecGenByFuel.

MASEN's authority and changed its name to the Moroccan Agency for Sustainable Energy, allowing it to launch projects in the field of wind energy as well.[12]

The agency is headed by a chairman, chief executive officer (CEO), and a board of ten directors, each representing central ministries (the Ministry of Finance, the Ministry of Energy, and the Ministry of Interior). MASEN develops projects and their financing, generates electricity from renewable sources, and produces scientific research on sustainable energy technologies. Among its current goals is to reach 3,000 MW of clean electricity production by 2020 and 6,000 MW by 2030, which will constitute 52% of the electricity produced annually by the end of this decade. Another law, No. 1-16-133, was introduced in August 2026, promulgating Law No. 38-16 that allows for the transfer of renewable energy installations and personnel from the National Office of Electricity (ONE) to MASEN.[13]

While this legislation had the objective of regulating MASEN's energy production, other laws were issued to regulate private production of electricity. In 2010, Law No. 1-10-16[14] promulgating Law No. 13-09 allowed private operators to produce medium-voltage, high-voltage, and very-high-voltage electricity from renewable origins on behalf of a consumer or a group of consumers connected to the national electricity network. In 2011, Law No. 2-10-578[15] was issued to implement the previous law detailing the terms of authorization of installations to produce electricity from renewable sources. In 2015, Decree No. 2-15-772 was issued to allow access to the national medium-voltage electricity network.[16] This decree introduced the notion of a "predefined trajectory"[17] composed of "envelopes"[18] specifying the volume of integration of green electricity into the medium-voltage[19] grid network for each distribution zone; set by joint decree between the energy minister and the minister of the interior. An additional law specific to hydropower was also introduced,[20] law No. 1-16-3, with specifications on the modalities of access and authorizations to the network for hydraulic source installations as well as the role of the agencies of hydraulic basins, of which there currently are nine throughout the country.[21] These laws make up a thorough legislative framework that regulates renewable energy projects by private individuals to ensure their safety and suitability for the country's electrical system.

A recent step in the process was the creation of a second government agency, the National Electricity Regulatory Authority (ANRE), to regulate the free market for electricity generated from renewables and ensure that self-producers have access to the national grid. Operating under laws

12. General Secretariat of the Government, "Official Bulletin no. 6506, Law 38-16," Kingdom of Morocco, October 6, 2016, https://www.mem.gov.ma/Lists/Lst_Textes_Reglementaires/Attachments/52/Loi%2037-16%20relative%20à%20MASEN%20VFr.pdf.

13. Ibid.

14. General Secretariat of the Government, "Official Bulletin no. 5822, Dahir nº 1-10-08," Kingdom of Morocco, March 18, 2010, http://www.sgg.gov.ma/BO/bo_fr/2010/bo_5822_fr.pdf.

15. General Secretariat of the Government, "Official Bulletin no. 5936, Decree No. 2-10-578," Kingdom of Morocco, April 21, 2011, https://anre.ma/wp-content/uploads/2020/09/Decret_n_2-10-578.pdf.

16. General Secretariat of the Government, "Official Bulletin no. 4321, Décret n° 2-15-772," Kingdom of Morocco, October 28, 2015, https://www.mem.gov.ma/Lists/Lst_Textes_Reglementaires/Attachments/3/2015%20Decret%20de%20la%20MT%20Pages%20de%20BO_6414_Fr.pdf.

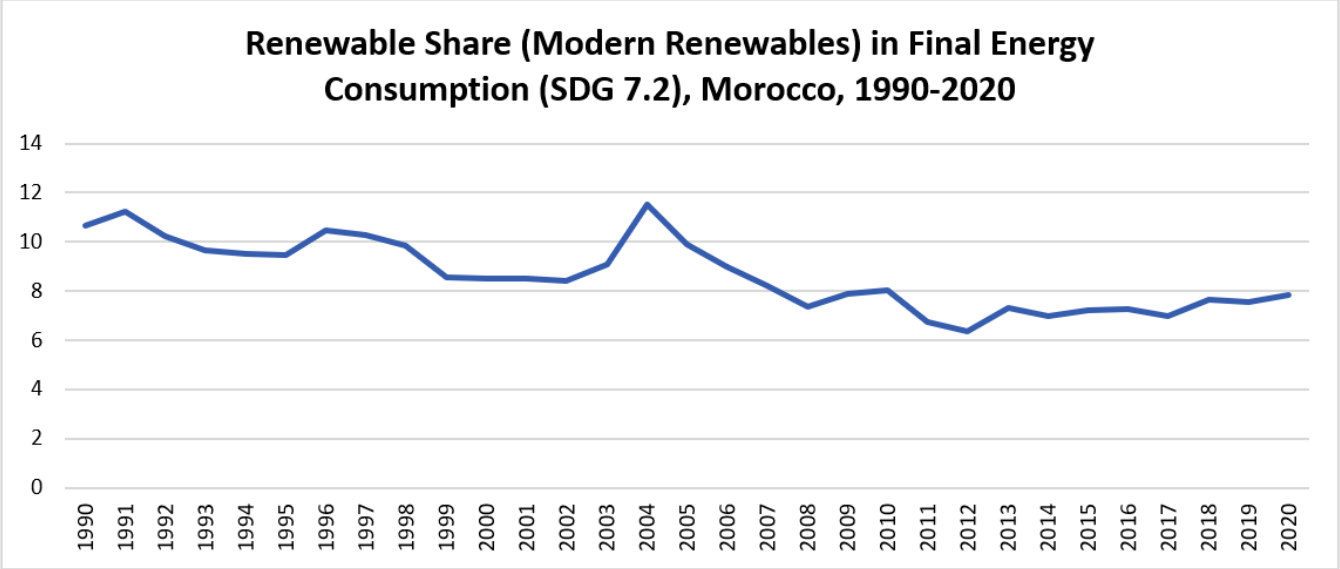
17. Ibid. Predefined trajectory is a ten-year period including the totals proposed by the distribution network managers.

18. Ibid. Envelope: the volume of integration of electricity produced from renewable energy sources into the national medium voltage network of the distribution zone of each network operator, within the limit of the available technical capacity of the said network. This volume is expressed in energy supplied (GWh) annually.

19. Ibid. Medium voltage: the voltage level between 5.5 kV and 22 kV.

20. M. Hachemi, "Agences de Bassins Hydrauliques & Gouvernance de l'eau," OECD, 2009, (accessed May 15, 2024), https://www.oecd.org/mena/governance/43316384.pdf.

21. General Secretariat of the Government, "Official Bulletin no. 1437, Law-n°58-15," Kingdom of Morocco, February 4, 2016, https://anre.ma/wp-content/uploads/2020/09/Loi-n°58-15.pdf.



Source: IEA[22]

No. 19-40 and 15-48, this agency's role is to guarantee the efficient functioning of the electricity market, promote fair competition among the electricity providers,[23] and facilitate connecting to the power grid and obtaining project licenses. This process is challenging because of the restrictions on finding large industrial customers (high voltage) to access electricity and the grid from remote areas, where renewable energy needs to be transmitted to urban customers.

Diversifying Renewable Energy Sources

In terms of renewable energy mixes, Morocco's installed power-generating capacity used to mainly be derived from hydropower due to the country's network of dams built largely to capitalize on the significant amount of rainfall that falls in the north. Presently, Morocco boasts 153 large dams and 141 small dams,[24] which have a total storage capacity of over 19.9 billion cubic meters of water.

According to 2023 data[25] from the Ministry of Energy, the production capacity for energy from dams is 1,770 MW; wind exceeded hydropower production that year, with 2,071 MW; and solar came it at 831 MW. Together, these three renewable sources provided a combined production capacity of 4,672 MW. There are approximately 28 projects to produce additional energy from wind, and these projects in turn extend from the north of the country to the south, especially on the Atlantic front of the cities of Tan-Tan, Laayoune, and Boujdour. The Boujdour and Tarfaya stations are the largest in terms of production capacity, totaling 301 MW each. The government relies on them to produce electricity sufficient for local consumption in residential and economic activities.

The production of electricity from wind kicked off in 2000, whereas solar production, both concentrated solar power (CSP) and photovoltaic (PV), did not begin in earnest until 2015. Solar energy projects have been undertaken throughout the country, with a notable concentration in the northeast, where population density and economic activities such as agro-industry, textile-leather, electronics-electrical,

22. "Electricity generation by source," IAE, 2023.

23. General Secretariat of the Government, "Official Bulletin no. 6480, Law-n°48-15," Kingdom of Morocco, July 7, 2016, https://anre.ma/wp-content/uploads/2020/09/loi-48.15-1.pdf.

24. Safae Hadri, "Stress hydrique: deux nouveaux grands barrages livrés en 2023, trois de plus en 2024," Le 360 Français, October 23, 2023, https://fr.le360.ma/economie/stress-hydrique-deux-nouveaux-grands-barrages-livres-en-2023-trois-de-plus-en-2024_S7VTOMFIVND7FFALDLDZQQUWXQ/#.

25. National Electricity Office (ONEE), Official Website - Branche Electricité, Kingdom of Morocco, Accessed August 18, 2024, http://www.one.org.ma/FR/pages/interne.asp?esp=2&id1=4&id2=53&t2=1.

mechanical-metallic, chemical-parachemical, automotive, aeronautics, and even building construction all demand high energy consumption.[26] As of 2021, CSP had produced about 1,285 GWh, and PV had produced 534 GWh.

Data from the Ministry of Energy confirms that the production capacity of renewable energy is estimated to account for 38% of the country's total energy production capacity. Hydro energy led with 16.70%, wind energy provided 13.48%, and solar energy 7.82% (see Table 2). Despite the significant and growing contribution of renewable sources to the country's energy production capacity, renewable power production as a proportion of overall power generation has not increased significantly, due to growing demand and challenging usage issues.

Technical Challenges

The Noor Ouarzazate project was the first and largest multi-technology solar complex on an international scale, with an installed capacity of 580 MW, divided into 4 units. In 2018, the Laayoune project was deployed with an installed capacity of 85 MW.[27] By 2021, the installed power in renewable energies had reached 3,701 MW, or 34% of the total power, and by 2022, six years after the launch of the project, had reached 4,031 MW, or 38% of the country's total energy production.

As installed capacity has grown, the percentage of total power generated derived from renewable sources has increased. Table 2 illustrates the share of each type of renewable energy source in 2022. Despite this positive trend, hydroelectric energy still leads, while solar energy is at the bottom.

Although Morocco has increased its renewable power-generation capacity, the country has not succeeded in reducing its reliance on fossil fuels. Even though renewable installed capacity reached 38% of total power generation in 2022, most energy consumption in the country (82%) was still derived from non-renewable sources. Two factors hamper the extent to which Morocco can meet its stated targets. The first is the increase in domestic energy consumption which has led to a decline in the contribution of renewable energies to overall consumption compared to five years before the launch of the renewable energy plans in 2009 and 10 years before solar production began in 2015. Back in 2004, renewable energy production reached 11.51%, a percentage that has decreased despite the increase in renewable development, settling at 7.86% in 2020, though bouncing back up to 21.30% in 2023.[28]

The other factor is that Morocco struggles to make full use of current production rates for renewable energy due to storage limitations and the inadequate long-distance energy transmission network. A 2024 World Bank report confirmed that "the energy transition and universal access to electricity cannot be achieved without well-performing power utilities."[29] Addressing the grid and storage challenges requires significant investments that cannot be covered solely by public funding in a country with limited financial resources. It also requires innovative efforts to develop the capacity for optimized long-distance, high-voltage power transmission from the south and storing the produced energy for future use. Morocco is still looking for solutions to both issues.

One of the challenges the country has faced is the issue of technology cost versus benefit. Morocco's leading renewable energy agency, MASEN, spent heavily on CSP at a moment when it was somewhat comparable to PV costs, especially as CSP offers evening peak power

26. Portail de l'Agence de Développement du Nord, "Industrie," Kingdom of Morocco, Accessed June 24, 2024, http://www.apdn.ma/index.php?option=com_content&view=article&id=193&Itemid=182&lang=fr.

27. CESE, "Accélérer la transition énergétique pour installer le Maroc dans la croissance verte," Conseil Economique, Social et Environnemental (CESE), 2020, p. 29, https://www.cese.ma/media/2020/11/Av-transitionEnergetique-f-1.pdf.

28. Amin Bennouna, "Offre et demande d'électricité et relation à la croissance économique en 2023," *EcoAct*, March 11, 2024, https://www.researchgate.net/publication/378875815_Offre_et_demande_d'electricite_et_relation_a_la_croissance_economique_en_2023.

29. World Bank, "The Critical Link: Empowering Utilities for the Energy Transition," World Bank, June 18, 2024, https://www.worldbank.org/en/topic/energy/publication/the-critical-link-empowering-utilities-for-the-energy-transition.

Table 1: Installed Capacity of Renewable Energies in Morocco (2022)	
Energy Type	**Share of installed capacity in MW**
Renewable energy	**4,154**
Hydroelectricity	**1,770**
Wind	**1554**
Solar	**830**

Source: Ministry of Energy Transition and Sustainable Development

Table 2: Share of Renewable Energy (2022)	
Energy type	**Share in total installed power**
Renewable energy	38%
Wind energy	13.48%
Hydroelectric energy	16.70%
Solar energy	7.82%

Source: Ministry of Energy Transition and Sustainable Development

storage benefits. MASEN made a bet that, in hindsight, proved wrong. A 2020 report from the Economic, Social and Environmental Council (CESE) indicated that costly technological choices are one of the shortcomings of the Moroccan strategy in the field of renewable energies. The report confirmed that, "considering the prices of PV and wind power, CSP technology is now, despite the advantage of storage, relatively expensive and is no longer justified for the future, especially since the levels of local industrial integration are so low that they cannot justify the additional cost."[30]

The report specifically explained that "the choice of CSP technology adopted for the Ouarzazate solar power plants was justified by its capacity to provide electricity during the peak period after sunset, thanks to storage whose duration increased by 3 to 7 hours between the first tranche and the following ones."[31] It is worth noting that the installation of this technology increased significantly from 414 GWh in 2017 to 1,285 GWh in 2021. In contrast, the capacity of PV technology increased from 1 KWh to 534 KWh during the same period.

The energy transition's profitability and MASEN's financial balance have been affected by the challenge of selecting the appropriate technology to adopt. According to the CESE report, MASEN's deficit from the Noor I, II, and III power plants due to technological choices was estimated to be 800 million dirhams (roughly $80 million) per year as of 2020.[32]

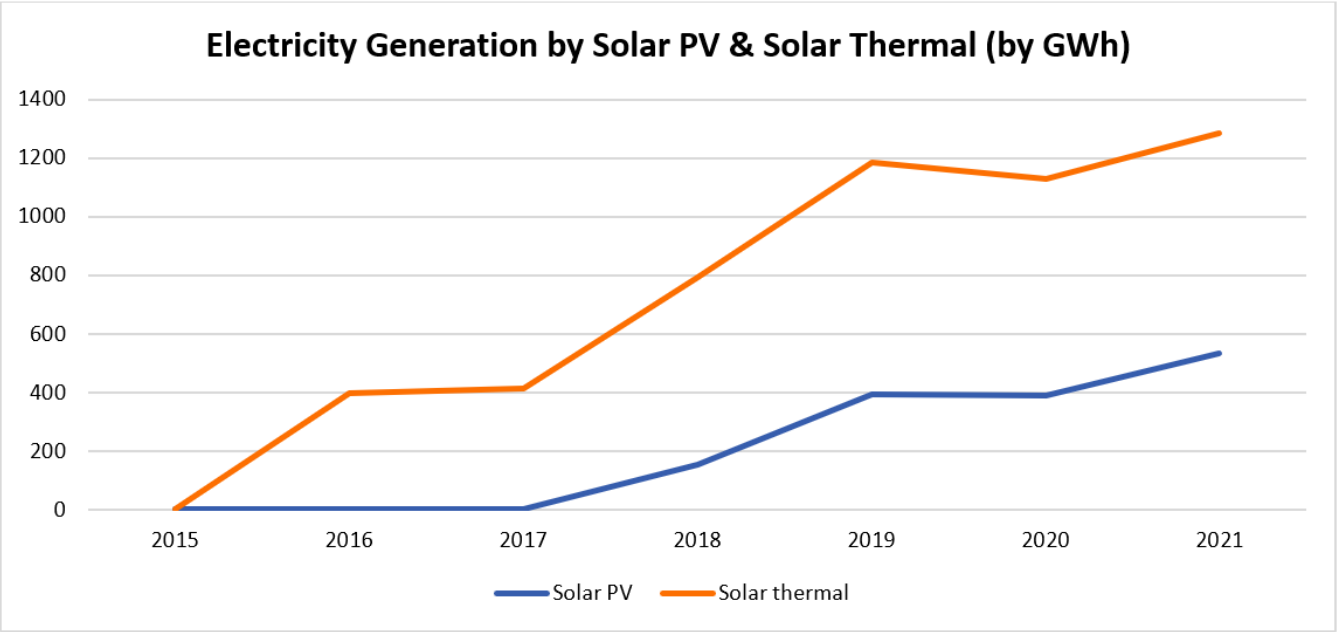
To remedy some of these issues, the CESE recommended "devoting future electrical capacities almost exclusively to renewable sources and storage (STEP, batteries and technologies under development)" to adopt a strategy that considers the energy transformation as a whole beyond electricity and beyond traditional uses.[33] Four years after the report was issued, the government remains more focused on discussing installed capacity rather than addressing the problems of implementation. Furthermore, due to the expensive nature of storage projects, selecting the right technology will remain a challenge in the coming years. At the very heart of these two challenges is the issue of resources and financing. Morocco has been able to make the most progress in using public financing,

30. "Accélérer la transition énergétique," CESE, 2020, p 30.

31. Ibid.

32. Ibid, p. 32.

33. Ibid, p. 10.



but it is at a point where it needs to bring in significant private resources to continue to push renewable energy development and the energy transition overall.

So the government is looking to prove the adage that it is often easier for the private sector to achieve what may be difficult for the public sector. The World Bank's 2022 report on climate and development recommended giving the private sector a central role in carbon reduction policies, due to its ability to mobilize financial resources.[34] The report anticipated that the private sector would be responsible for a large portion of the investments in mitigating climate change and potentially a smaller portion for adaptation efforts.[35] The report also concluded that "maximizing private climate investment would help release pressure on public finances and would also have broader positive impacts on the economy."[36] Energy transition policies additionally face the challenge of burdening public finances. Some observers believe that investing in renewable energies may not be wise, especially when other essential sectors such as education, health, and infrastructure are struggling due to limited public funds. The legislation put forward to push the development of non-traditional energy strategies seeks to allow other actors, particularly the private sector, to participate in investment, production, transmission, storage, marketing, and consumption of energy; but potential participants face an uphill battle.

Green Finance Challenge

The government's effort to attract private-sector investment will require supporting the growth of Moroccan companies that specialize in renewable energy technologies. The government believes that relying solely on public investment will not be enough to secure a successful transition. Therefore, it seeks to encourage private investment in the sector to achieve its goals. According to the World Bank's 2022 report, over 85% of the investments required for decarbonizing the Moroccan economy should come from the private sector.[37] The report estimated that the total investment required to put Morocco on a resilient and low-carbon path by the 2050s was about $78 billion.[38] This estimate represents half of Morocco's

34. World Bank Group, "Morocco Country Climate and Development Report," World Bank, November 3, 2022, https://www.worldbank.org/en/country/morocco/publication/morocco-country-climate-and-development-report.

35. Ibid, p. 17.

36. Ibid, p. 19.

37. Ibid, p 51.

38. Ibid.

annual GDP ($141.82 billion in 2021)[39] and three times the government's annual tax resources ($20 billion in 2022).[40] Financing, therefore, represents the most profound challenge to realizing this ambitious strategy.

The government knows the limitations of public investment and increasingly even public-private partnerships in all sectors, and has, therefore, made efforts to integrate local private investment and foreign direct investment into renewable energies, including formulating relevant regulations. Law 13-09, pertaining to renewable energies, outlines specific objectives, including the promotion of private-public partnership marketing and the export of renewable energy, making energy production installations from renewable sources subject to an authorization or declaration regime; additionally, it ensures the right of private operators to link to national medium-voltage, high-voltage, and very-high-voltage electricity networks within the framework of an agreement by which they consume the electricity thus produced exclusively for their use.

businesses, and communities to produce their own electrical energy for self-consumption, regardless of the network type, voltage level, or installation capacity.[41] This law also grants producers the right to access energy storage services and to sell any surplus energy to electricity network managers. Additionally, it expands the scope of access to the national electricity network for transporting electricity from the production site to the consumption site.[42]

Green Hydrogen: The Path to Private Investment?

Morocco is joining the global trend of developing hydrogen as a renewable energy solution, both to generate new investment in the sector and speed up its lagging transition. On March 11, 2024, the government published its national "Morocco offer," providing incentives and government support to attract private investment

Table 3: New Authorizations Issued (2024)

Authorizations issued under Law 13-09 for private production	Totals
Hydroelectric sources	20
Wind sources	18
Solar sources	9

Source: Ministry of Energy Transition and Sustainable Development

This year alone, the government has authorized several small/medium-sized renewable energy production licenses. Furthermore, the government issued nine self-production authorizations: one from a wind source, one from a hydroelectric source, and seven from solar sources.

The government adopted a new law for the self-production of electricity in 2024. Law 82-21 allows individuals,

to the green hydrogen sector.[43] The plan lays out a comprehensive strategy that includes six main areas, including identifying potential applications for the offer,

39. World Bank Open Data, "GDP (current US$ – Morocco," World Bank Open Data, Accessed March 30, 2024. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=MA.

40. Momar Diao, "Le détail des recettes fiscales en 2022 (rapport de la DGI)," Médias24, August 24, 2023, https://medias24.com/2023/08/24/le-detail-des-recettes-fiscales-en-2022-rapport-de-dgi/.

41. Ministere de la Transition Energetique et du Developpement Durable, "Adoption du projet de loi n° 82.21 relatif à l'autoproduction d'énergie électrique par la Chambre des représentants," December 20, 2022, https://www.mem.gov.ma/Pages/actualite.aspx?act=358.

42. Ibid.

43. Lamia El Ouali, "Hydrogène vert: l'offre Maroc se précise, le foncier pour commencer," Le 360 Français, March 11, 2024, https://fr.le360.ma/economie/hydrogene-vert-loffre-maroc-se-precise-le-foncier-pour-commencer_VJVHQ76NYVGP7KIE7YEHLRQW2A/.

securing appropriate real estate, developing necessary infrastructure, creating incentive procedures and measures, establishing a process for selecting investors and finalizing contracts, and overseeing the governance of the green hydrogen sector. The offer targets various projects, from generating renewable energy to converting green hydrogen into ammonia, methanol, and synthetic fuels. Investors can participate in one or more of these areas, allowing for an integrated chain rather than specialization in one specific field. This is a departure from the past, where private investment was solely directed toward energy production.

According to the government, more than 100 Moroccan and foreign investors are keen to invest in the production of green hydrogen, taking advantage of the country's natural potential. However, caution is in order as renewable investment trends face difficulties globally, such as "unequal geographical adoption of renewables, rising cost of capital that deters investment, underinvestment in supporting infrastructure like grids and storage, which undermines the positive impact of renewables growth, and non-financial barriers that impede the adoption of renewables at a faster pace."[44]

To overcome some of these challenges, the government has specifically made available 1 million hectares of land across different regions in the country for green hydrogen projects and has promised to aid investors in setting up the necessary infrastructure, such as gas pipelines, ports, and seawater desalination plants. MASEN will oversee the coordination process as an intermediary between investors and the government stakeholders involved. Other incentives offered to all investors are outlined in the country's investment charter, such as bonuses of up to 30% of the investment amount in certain regions (Tanger-Tétouan-al Hoceima, L'Oriental, Fès-Meknès, Béni Mellal-Khénifra, Draa-Tafilalet, Souss-Massa, Guelmim-Oued Noun, Laâyoune-Sakia el Hamra, Dakhla-Oued Ed-Dahab)[45] or a few key sectors like industry, culture, renewable energy, logistics, tourism and leisure, digital, and reconversion of waste refuse and outsourcing,[46] or the improvement of the business climate through simplifying procedures and cutting red tape, facilitating access to land, and providing access to green energy.[47] Efforts to simplify administrative procedures seek to ensure that the cost of investing in this sector is not greater than it should be, given the low or unguaranteed returns. The government is also looking to limit competition from traditional energy production sectors, which can be frustrating for investors. The package also includes tax and customs incentives, such as exemption from import duties and value-added tax (VAT) for goods purchased locally or imported for green energy use.

Looking Ahead

Morocco has made substantial strides in its effort to transition to renewable energy. On the African continent, Morocco was ranked fifth in terms of electricity production, according to 2023 statistics, with a total of 3,727 MW. Angola was in fourth place with a production of 4,078 MW, preceded by Ethiopia with 5,589 MW, and Egypt with 6,322 MW. South Africa was in the lead, producing 10,445 MW. In the Arab world, only Egypt ranked higher than Morocco in terms of electricity production.[48] Morocco's leadership has developed its legal arsenal and opened the way for investment in renewable energies through its vigorous search for foreign investors. However, the transition to an economy completely dependent on renewables is still a long way off, and the country is not where it had planned to be on the energy transition path. The kingdom still relies heavily on coal, with the fossil fuel generating 68.0% of electricity

44. Ramnath N. Iyer, "Renewable energy is having a good year, but challenges loom ahead," Institute for Energy Economics and Financial Analysis, December 11, 2023, https://ieefa.org/resources/renewable-energy-having-good-year-challenges-loom-ahead.

45. Moroccan Investment and Export Development Agency (AMDIE), "The Investment Charter: A Transparent and Clear Framework to Encourage Investment, Kingdom of Morocco," December 12, 2022, p 13, https://casainvest.ma/sites/default/files/Charte_Investissement_vFR.pdf.

46. AMDIE, "The Investment Charter," 2022, p 14.

47. Ibid.

48. Medias24, "Energies renouvelables: le Maroc 2e dans le monde arab," Medias24, March 30, 2023, https://medias24.com/2023/03/30/energies-renouvelables-le-maroc-2e-dans-le-monde-arabe/.

produced in 2022. In the same year, 79.4% of the country's annual electricity production came from non-renewable sources, including 1.6% from gas.[49]

In the wake of the Russian full-scale war on Ukraine and Algeria's halt of gas exports to Spain through the Maghreb pipeline passing through Morocco, both of which contributed to a severe global crisis in energy markets, the Moroccan authorities pumped additional investment into the continued use of coal to produce energy. This did not prevent the country's ratification, in 2022, of Articles 1, 3, and 4 of the agreement adopted by the 26th Conference of the Parties (COP26) in Glasgow, which called for accelerating the gradual phase-out of coal and eliminating dependence on it by the year 2050. In order to achieve that, however, Morocco needs to generate significant investment into renewable infrastructure to speed up the implementation of investment reforms outlined in its investment charter and prioritize building a strong infrastructural network — a backbone of renewable energy development and industrial growth.

49. IEA, "Morocco - Countries & Regions," Accessed June 15, 2024.

A Reluctant Giant Stirs: Algeria and the Energy Transition

Andrew G. Farrand

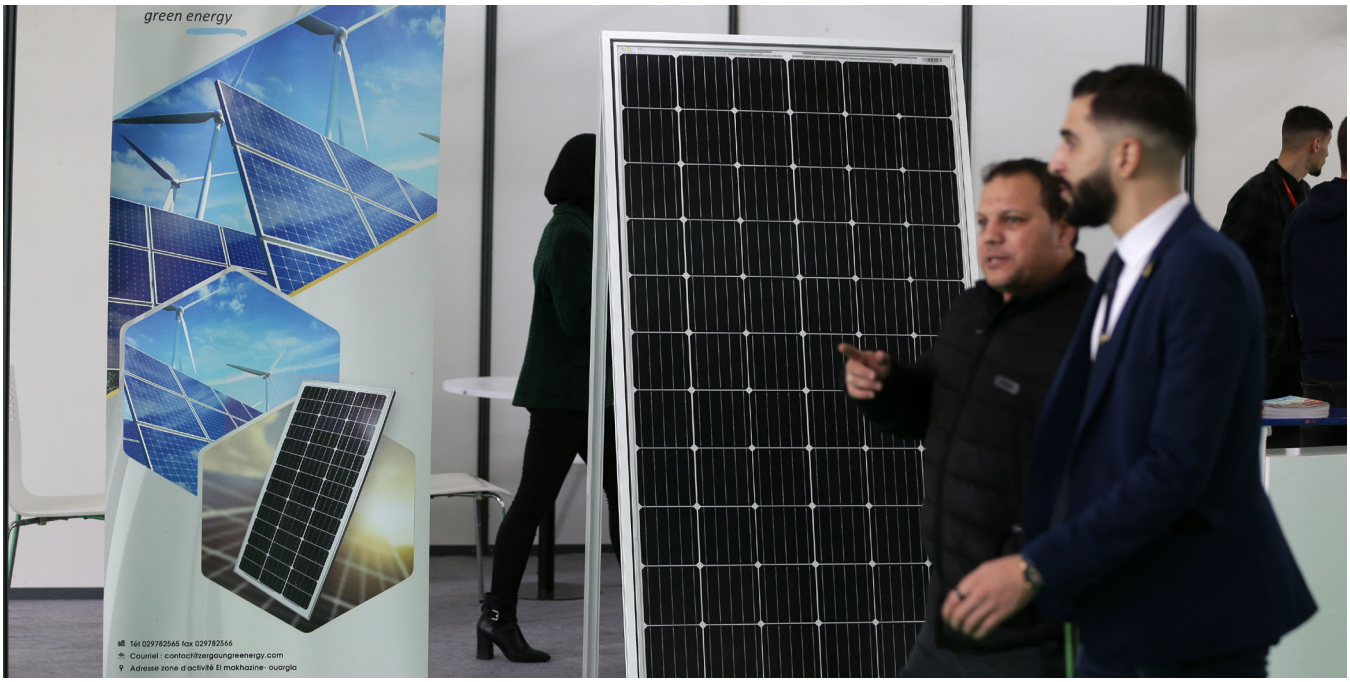


Photo above: People visit the International Fair of Electricity and Renewable Energies SEER 2024 in Algiers, Algeria, Feb. 12, 2024. Photo by Xinhua via Getty Images.

On March 25, 2024, a crowd of subordinates, local officials, and journalists clustered around Mohamed Arkab, Algeria's minister of energy and mines, as he smeared adhesive on a small marble slab. Flanking them was a wider ring of Algerian and Chinese construction workers, who craned their necks to watch as Arkab and a few of the officials slotted the ceremonial cornerstone into place. The act drew only a brief smattering of applause, belying its potentially monumental importance for the country.

The ceremony took place outside Tendla, a remote town in eastern El-M'ghaier province, on the steppe that separates Algeria's fertile northern coast from the Sahara Desert. Over the 14 months that follow, workers there will install nearly 350,000 solar panels on a plot measuring 4 square kilometers. The 200-megawatt (MW) project at Tendla is the first of 20 of varying sizes slated to begin construction this year. As they come online over the following two years, the projects' collective 3-gigawatt (GW) capacity will expand Algeria's renewable power generation capabilities sevenfold.

Breaking ground on the country's first gigawatt-scale renewable energy facilities is a particularly historic event in light of Algeria's longstanding attachment to hydrocarbons. The discovery of oil and natural gas in Algeria, which came shortly before its independence from French colonial rule in 1962, transformed the country from an agricultural producer into a major global energy supplier.

Hydrocarbon revenues have been the foundation of Algeria's economy ever since, breeding a dependence that has long discouraged Algeria from diversifying its economy or joining in the energy transition. For years, leaders have promised progress while delivering little, even as Algeria's less resource-rich neighbors surged ahead. Viewed in this context, the groundbreaking at Tendla is less a triumph than a long-overdue first step.

More could soon follow. Officials have announced plans to issue tenders for a further 3 GW of solar parks later this year, bringing Algeria on pace to reach its goal of 15 GW of renewable power by 2035.

This rapid, if belated, shift from talk to action has been enabled by a new strain of thinking among Algeria's leaders, who have recently warmed to the idea that renewables may not be a threat to the cherished hydrocarbons industry but instead a tool to preserve its revenues in the face of structural challenges.

While this apparent alignment of interests is finally spurring progress on renewables development, it may prove to have limitations. Algeria's leaders have not yet articulated a grand vision for the energy transition or how it could transform the country for the better — for a second energy revolution that goes beyond merely preserving Algeria's resource wealth to multiplying it. Despite recent progress, in the absence of such a unifying national project, much about the future of Algeria's nascent renewables sector remains uncertain.

An Energy Producer's Energy Dilemma

Oil and gas have served as the backbone of the modern Algerian state and its economy since its founding. National oil company Sonatrach was established in 1963 and immediately began producing oil from fields in the eastern Hassi Messaoud basin. Algeria also helped kick-start the global natural gas market, pioneering the world's first liquified natural gas (LNG) shipment in 1964, to the United Kingdom. Production from the Hassi R'mel gas field soon began generating a second revenue stream alongside oil. These energy exports helped to finance the young nation's ambitious development projects and comprehensive social safety net.

But Algeria also discovered the downside of dependence on oil and gas. When global prices crashed in the late 1980s, the state struggled to cover rising domestic expenses and international debts. An abrupt political opening, intended to head off social unrest, instead led the country into civil war. While this experience might have served as a cautionary tale, encouraging diversification of the economy and energy system, leaders instead emerged from the violence of the 1990s no less committed to hydrocarbons. President Abdelaziz Bouteflika, elected in 1999, leveraged once-again soaring oil and gas prices to finance a wave of new construction and consumer goods imports for Algeria's growing population. The influx of cars, home appliances, electronics, and other goods boosted living standards — and also energy usage. Another oil price crash followed in 2014 but also failed to force a fundamental rethink.

Hydrocarbons remain central today, accounting for roughly 50% of government revenue and 85% of total exports in recent years.[1] Even these figures underrepresent oil and gas's importance. In the so-called non-hydrocarbon sector, Algeria's top export products — fertilizers, iron and steel, cement, and detergents — all rely heavily on fossil fuel inputs.[2] With the world's 10th-largest gas reserves and 15th-largest oil reserves, Algeria has ample supplies to continue producing for years.[3]

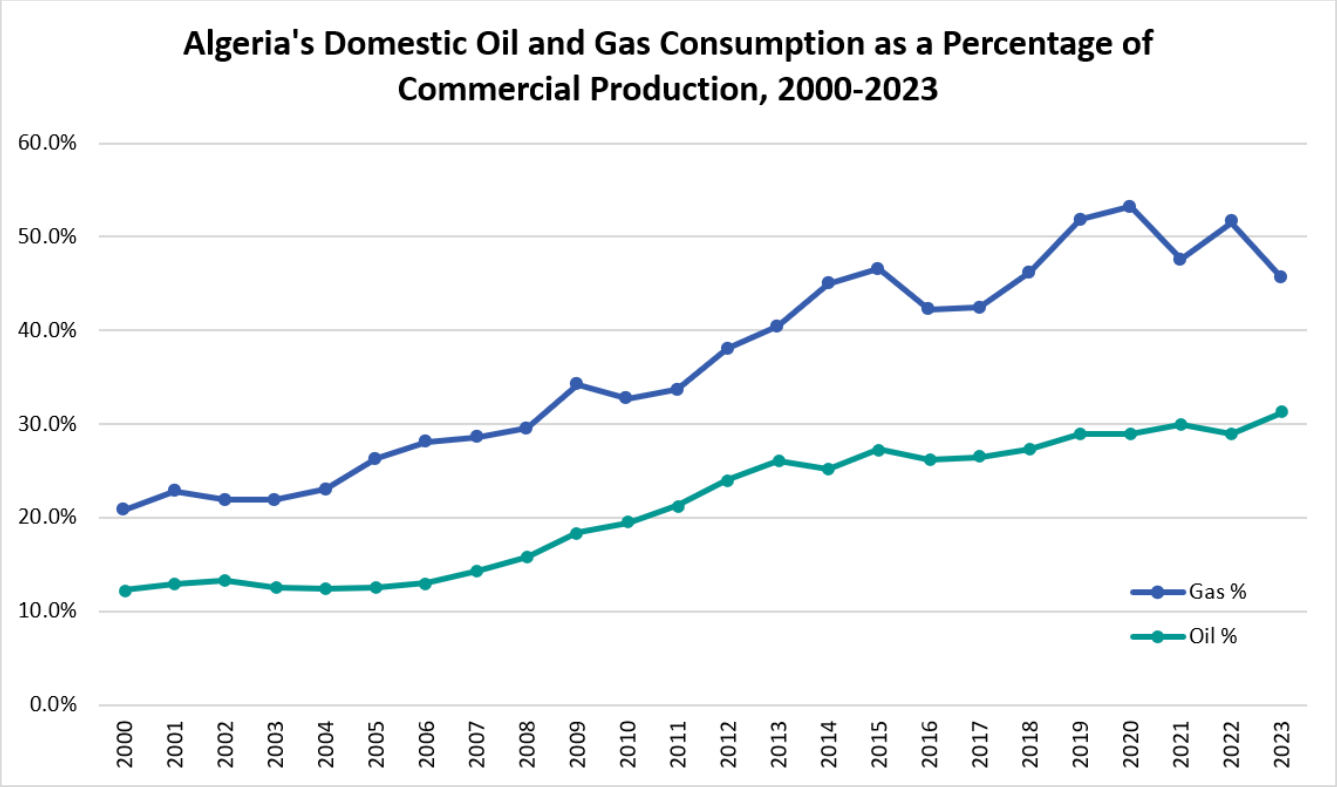
Its leaders plan to do just that. Abdelmadjid Tebboune, the former housing minister and prime minister who succeeded Bouteflika as president in December 2019, is well aware of how crucial hydrocarbon revenues are to the Algerian state. His administration — which is staffed by fellow political insiders who share this outlook — is committed to keeping them flowing. But while leaders may view oil and gas as necessary for meeting Algeria's needs, it is becoming harder to argue that those resources are sufficient for the task.

Since 2000, Sonatrach has tried with little success to increase oil and gas output, owing to technical challenges,

1. IMF, "Algeria: 2022 Article IV Consultation, Press Release and Staff Report," February 2, 2023, https://www.imf.org/en/Publications/CR/Issues/2023/02/02/Algeria-2022-Article-IV-Consultation-Press-Release-and-Staff-Report-529078.

2. "Exportations hors hydrocarbures: Bond sans précédent grâce à la diversification de l'économie," *Algérie Presse Service*, June 19, 2023, https://www.aps.dz/economie/157210-bond-sans-precedent-des-exportations-algeriennes-hors-hydrocarbures-grace-a-la-politique-de-diversification-de-l-economie-nationale.

3. OPEC, "Annual Statistical Bulletin 2023," 2023, tables 3.1 and 9.1, https://asb.opec.org/data/ASB_Data.php.



Source: Statistical Review of World Energy, June 2024 edition

mismanagement and corruption scandals, and difficulties attracting foreign investment. The net result is that oil and gas production increased on average by just 0.2% annually between 2000 and 2022.[4]

In the same period, domestic consumption of oil and gas grew by an average of 4.0% per year, driven by population growth and rising living standards, which are themselves buoyed by generous energy subsidies that leave Algeria with some of the world's lowest fuel and electricity prices.[5]

As a result, Algerians are consuming an increasing share of their energy resources at home, reducing the supplies available for export, a trend that is expected to continue. Given the country's dependence on hydrocarbon export revenues, this phenomenon presents an existential dilemma for Algeria's leaders.

In search of a solution, Tebboune has pressed Sonatrach to dramatically expand output, but the company's latest projections suggest that its conventional operations will not deliver such a leap.[6] Sonatrach is negotiating with international firms about exploiting Algeria's large shale gas resources, but previous attempts to do so were shelved amid public outcry, raising doubts about the feasibility of this option.[7] Officials have also attempted

4. Author's calculation based on *Statistical Review of World Energy* (2023 edition), Energy Institute, June 26, 2023, https://www.energyinst.org/statistical-review/resources-and-data-downloads.

5. Ibid., "Gaz naturel: les deux tiers de la consommation nationale tirés par les ménages, les tertiaires et l'agriculture," *Algérie Presse Service*, February 27, 2024, https://www.aps.dz/economie/167349-gaz-naturel-les-deux-tiers-de-la-consommation-nationale-tires-par-les-menages-les-tertiaires-et-l-agriculture.

6. "Elle devra atteindre 146,7 milliards de m3 en 2028: La production du gaz naturel en hausse," *Le Jeune Indépendant*, January 10, 2024, https://www.jeune-independant.net/elle-devra-atteindre-1467-milliards-de-m3-en-2028-la-production-du-gaz-naturel-en-hausse/.

7. Matthew Dalton, "Exxon, Chevron Near Deals to Drill in Gas-Rich Algeria," *Wall Street Journal*, June 2, 2023, https://www.

to reduce domestic demand through energy efficiency initiatives, but these appear to have slowed rising consumption only minimally.

Renewables present an alternative solution to the energy dilemma — and one that has grown more attractive in recent years as the cost of green technologies has fallen.

Huge Potential, Slow Progress

Algeria's geography lends it tremendous potential for renewable power generation. The world's 10th-largest country by surface area, Algeria has abundant land for renewables installations. The desert regions that dominate the country offer 3,500 hours of sunlight per year with an average annual solar irradiation of 2,650 kilowatt-hours (kWh) per square meter.[8] Domestic energy experts have estimated the resulting energy potential nationwide at 40 billion barrels of oil equivalent, or over 200 times Sonatrach's total 2023 energy production.[9] Wind power has received far less study, but recent research has identified numerous promising regions and estimated the country's total generating capacity at 4,000 GW.[10] (Algeria's geothermal resources, by contrast, are less promising, sufficing only for direct heating, not power generation.[11]) Harnessing just a small fraction of this theoretical solar and wind potential could enable Algeria to cover its domestic energy needs while generating additional power for export. The country's proximity to Europe offers it a willing customer for green electricity.

Nevertheless, Algeria has taken only tentative steps to harness this considerable potential, despite jumping out to an early lead.

From Leader to Laggard

In 1982, Algeria established a New Energies Commissariat to research the country's potential in nuclear, solar, geothermal, wind, and biomass electricity production.[12] The body was created on the recommendation of an inter-ministerial committee tasked with finding ways to offset domestic hydrocarbon consumption — illustrating just how enduring a challenge the energy dilemma is for Algerian policymakers. The Commissariat lasted only until 1986, when it was folded into another research body. A smaller solar research facility predated it and still exists, now as the Center for Renewable Energy Development (CDER), which serves as an important hub of technical expertise.

These research initiatives made Algeria a pioneer in the region, but it soon lost ground. The 1990s civil war disrupted research networks and prevented the country from taking steps toward piloting and deploying renewable energy technologies for a decade.[13] While overtaken by more immediate concerns, renewables were not forgotten:

wsj.com/articles/exxon-chevron-near-deals-to-drill-in-gas-rich-algeria-8aeed887.

8. Abdou Messai et al., "Feasibility Study of Parabolic Trough Solar Power Plant under Algerian Climate," *Energy Procedia* 42 (2013): 73-82, http://dx.doi.org/10.1016/j.egypro.2013.11.007.

9. Tewfik Hasni, "Quels sont les véritables enjeux derrière la transition énergétique," LinkedIn, January 10, 2024, https://www.linkedin.com/pulse/quels-sont-les-v%C3%A9ritables-enjeux-derri%C3%A8re-la-transition-tewfik-hasni-wj2qe/; "Hydrocarbures: 194 MTEP produits, 97 MTEP exportés en 2023," *Algérie Presse Service*, January 9, 2024, https://www.aps.dz/economie/165000-hydrocarbures-194-mtep-produits-97-mtep-exportes-en-2023.

10. Zhor Hadjam, "Assistance technique à la transition énergétique en Algérie: La Banque mondiale cible l'éolien et l'autoproduction électrique," *El Watan*, January 27, 2024, https://elwatan-dz.com/assistance-technique-a-la-transition-energetique-en-algerie-la-banque-mondiale-cible-leolien-et-lautoproduction-electrique.

11. Nacer Lebbihiat et al., "Geothermal energy use in Algeria: A review on the current status compared to the worldwide, utilization opportunities and countermeasures," *Journal of Cleaner Production* 302, June 15, 2021, https://doi.org/10.1016/j.jclepro.2021.126950.

12. "Décret no. 82-46 du 23 janvier 1982 portant création du commissariat aux énergies nouvelles," *Journal Officiel* 21, no. 5, February 2, 1982, pp. 128-130, https://www.joradp.dz/FTP/JO-FRANCAIS/1982/F1982005.pdf.

13. Ali Mebroukine, "La migration hautement qualifiée algérienne: Tentative d'étiologie d'un sinister," CARIM Note d'analyse et de synthèse 2010/54, 2010, https://core.ac.uk/download/pdf/45677815.pdf.

In 1998, the government's Scientific Research and Technological Development Plan outlined a goal to reach 1% renewables in Algeria's energy mix by 2050.[14]

The country's first foray into commercial-scale renewables came with the launch, in 2002, of New Energy Algeria (NEAL), a joint venture by Sonatrach, state electric and gas utility Sonelgaz, and a private agribusiness investor. In 2011, NEAL inaugurated a €250 million, 150 MW hybrid gas/concentrated solar power (CSP) array in Hassi R'Mel (of which the renewable component represented just 25 MW). It was the only facility NEAL managed to commission in a decade of operation, before the company was quietly folded into Sonelgaz in 2012 and its ambitious plans to install over 7 GW of additional CSP facilities across Algeria through 2030 were abandoned.[15]

At the time, NEAL was among many who viewed CSP technology as the future. In 2009, a German-led investment consortium formed the DESERTEC initiative around a vision to build vast CSP arrays throughout the Sahara and transfer the power to Europe by undersea cables. Predictably, Algerian leaders balked at the plan's strong neo-colonial echoes, high up-front costs, and limited benefits to the local market, and so they refused to participate.[16]

NEAL's demise left responsibility for renewables development in the hands of the Ministry of Energy and Mines, which pursued a series of piecemeal projects through Sonelgaz, Sonatrach, the Electricity and Gas Regulation Commission (CREG), and its own teams. Sonelgaz notched early successes with a 343 MW photovoltaic (PV) tender, awarded to Chinese contractors, and Algeria's first (and still only) wind farm, a €23 million, 10 MW German-made unit in Adrar province.[17] Sonatrach began pilot programs to green its upstream production sites. But other actors' institutional confusion and inexperience with renewables led to missteps. A 2014 feed-in tariff for small-scale solar and wind projects attracted no takers owing to bureaucratic obstacles, and a 4 GW tender prepared by the ministry in 2017 was shelved without explanation.[18] In 2018, CREG launched a tender for 150 MW of solar power but, after extensive delays, awarded a local consortium just one of three available lots, abandoning the others.[19] The facility was seemingly never built.

These difficulties risked embarrassing officials, who were expected to fulfill Algeria's Renewable Energy and Energy Efficiency Development Plan. Released in 2011 and updated in 2015, the plan set a goal of 22 GW of installed renewable capacity by 2030, with an interim target of 4.5 GW by 2020.[20] In late 2019, authorities established a Renewable Energies and Energy Efficiency Commissariat (CEREFE) under the prime minister's office to track progress toward these goals and advise policymakers on energy transition questions.

Lost Years

As President Tebboune settled into office in the first days of 2020, it was obvious that Algeria was not on track to achieve its renewables goals. In fact, Algeria entered the year at just 440 MW of effective renewables capacity,

14. "Loi no. 98-11 du 22 août 1998 portant Loi d'Orientation et de Programme à Projection Quinquennale sur la Recherche Scientifique et le Développement Technologique 1998-2002," *Journal Officiel* 27, no. 62, August 24, 1998, https://www.joradp.dz/FTP/JO-FRANCAIS/1998/F1998062.pdf.

15. Tewfik Hasni, Redouane Malek, and Nazim Zouioueche, "L'Algérie 100% énergies renouvelables," Friedrich Ebert Stiftung, January 2021, https://library.fes.de/pdf-files/bueros/algerien/17412.pdf.

16. Andrew Farrand, "Against the flow: Europe's role in kickstarting Algeria's green transition," *ECFR*, October 6, 2022, https://ecfr.eu/publication/against-the-flow-europes-role-in-kickstarting-algerias-green-transition/#:~:text=A%20history%20of%20successful%20delays.

17. Noureddine Yassaa and Messaoud Khelif, "Transition Energétique en Algérie: Edition 2020," *CEREFE*, 2020, 47, https://www.cerefe.gov.dz/wp-content/uploads/2020/12/Rapport_CEREFE_2020_FINAL-30-11-2020.pdf.

18. Idem., 48, 51.

19. Idem., 51.

20. "Algeria: Renewable Energy and Energy Efficiency Development Plan 2015-2030," IEA, 2015, https://www.iea.org/policies/6103-renewable-energy-and-energy-efficiency-development-plan-2015-2030.

slightly less than a tenth of its goal.[21] To give himself a fresh start, the new president simply reset the targets. According to a plan adopted in February 2020, Algeria would now aim to reach 15 GW of on-grid renewables capacity by 2035 — 7 GW less and five years later than the original goal — with an interim target of 4 GW by 2024.[22]

While the plan was less ambitious, Tebboune was committed to it. In his campaign manifesto, he had promised voters "a national program for the development of renewable energy" that would use solar and wind power to "respond to domestic needs" and then "diversify exports outside of hydrocarbons."[23]

To achieve this vision, his administration prepared to launch Tafouk 1, a 4 GW solar PV project with an estimated cost of $3.2 billion to $3.6 billion. But the COVID-19 pandemic soon made such an undertaking impossible, and yet another promising project was shelved. Frustrated by this false start, Tebboune reshuffled the energy sector's institutional architecture, hoping to catalyze a productive new dynamic. In June 2020, the energy ministry's on-grid renewables portfolio and the environment ministry's off-grid portfolio were fused into a new Ministry of Energy Transition and Renewable Energies (MTEER). To lead it, Tebboune chose Chems Eddine Chitour, a veteran energy researcher known for his progressive views on the energy transition.

While an enthusiastic booster for renewables, Chitour was unable to translate his conviction into action, in large part due to ill-conceived institutional arrangements. Although ostensibly the government's leading renewables body, MTEER was brand new and thus struggled to pull its weight against established juggernauts like the energy ministry. Its top priority was to launch a new solar tender. But it was asked to do so by overseeing the Algerian Renewable Energy Company (SHAEMS), a newly established renewables procurement firm co-owned not by MTEER but by Sonatrach and Sonelgaz. Predictably, these convoluted lines of responsibility produced substantial delays. A year after appointing Chitour to lead MTEER, Tebboune succumbed to political pressure and sacked him. His chosen replacement was Benattou Ziane, an unqualified senior official from a party in Tebboune's ruling coalition, whose nomination raised new questions about the government's commitment.

In December 2021, two full years after Tebboune took office, SHAEMS announced "Solar 1000," its inaugural tender for five solar PV lots totaling 1 GW in capacity. The release of Algeria's latest gigawatt-scale renewables procurement notice attracted considerable interest from international power producers (IPPs) on multiple continents. In the months that followed, however, SHAEMS and MTEER's inexperience and awkward institutional relationship led to problems. The partners failed to provide bidders with promised technical specifications on schedule or to clarify key questions about the projects' financing structure.

SHAEMS had already delayed the submission deadline multiple times by September 2022, when President Tebboune, seemingly frustrated by the lack of progress, disbanded MTEER in a ministerial reshuffle and restored responsibility for on-grid renewables development to the Energy Ministry. Solar 1000's status was unclear, and Algeria closed out 2022 with just 460 MW of installed renewables capacity, a figure virtually unchanged in the first three years since Tebboune had taken office.[24]

Progress at Last

Following MTEER's dissolution, the president empowered Energy Minister Arkab to make up for lost time. Arkab turned to Sonelgaz, which he had led before joining the cabinet, and which had proven itself to be the body most

21. This figure omits 120 MW of hydroelectric facilities, inherited from the colonial era, which authorities had largely decommissioned over the preceding decade owing to insufficient water levels.

22. "Renewable energy: Algeria looks to produce 15,000 MW of electricity by 2035," *Algérie Presse Service*, February 9, 2020, https://www.aps.dz/en/economy/33073-renewable-energy-algeria-looks-to-produce-15-000-mw-of-electricity-by-2035.

23. Abdelmadjid Tebboune, "The 54 Comittments," *El Mouradia*, 2019, https://www.el-mouradia.dz/ar/president/commitments.

24. CEREFE, "Communiqué: Bilan des réalisations dans le domaine des énergies renouvelables en Algérie (2020-2022)," Facebook, September 7, 2023, https://www.facebook.com/photo/?fbid=627868536137083&set=pcb.627869389470331.

capable of delivering on renewables projects. In January 2023, Sonelgaz officials announced plans for a major new solar tender.

Sonelgaz's track record on solar projects, while successful, was to that point limited to small- and medium-scale projects. The installations had been built under simple engineering-procurement-construction (EPC) contracts like those Sonelgaz used for any other infrastructure project. Rumors circulated that it would use the same model for the new solar tender. Officials at SHAEMS and several Algerian renewables specialists objected loudly, advocating instead for the use of industry-standard 25-year power purchase agreements (PPAs).[25] Using EPC contracts for a gigawatt-scale project would leave Sonelgaz to operate and maintain a vast series of solar parks, a task they argued it was unqualified for. The resulting inefficiencies, they asserted, would make the cost of the electricity both higher and less predictable, reducing the projects' utility. Finally, they argued that the EPC model would provide no knowledge transfer for Algerian workers through long-term collaboration with foreign IPPs.[26] It was for these reasons that SHAEMS had opted for PPAs in designing the Solar 1000 tender.

Undeterred, Sonelgaz forged ahead, launching an international tender in February for 2 GW of solar PV installations across 15 sites through turnkey EPC contracts. To boost the domestic solar panel industry and other Algerian suppliers, the procurement included a 35% local content requirement.[27] A total of 28 bidders competed for the lots,[28] which varied between 80 MW and 220 MW. At the ceremony held in July to mark the close of bidding, authorities announced that Solar 1000 would also close later that year, surprising many who had assumed the project had been abandoned. SHAEMS was fully merged into Sonelgaz that month, and Solar 1000 candidates were invited to submit final bids — albeit now under EPC, rather than PPA, format.

Sonelgaz announced the final results of the tenders in November and December 2023 and convened the winning bidders for contract signature in March 2024. After one 80 MW lot was selected for rebid, 19 lots totaling 2.92 GW were awarded for a total cost of over $1.9 billion and an average price tag of about $680,000 per MW of capacity. Chinese firms or consortia won 10 of the 19 lots and a similar proportion of the funds. The remaining lots were won by Algerian firms bidding alone or, in most cases, in consortia with Italian or Turkish partners. Estimated lifetime power costs for the sites range between 4.5 and 5.5 US cents per kWh.[29]

From start to finish, the 2 GW tender process took Sonelgaz just over a year to conclude. Construction timelines for the various sites range between 7 and 22 months. Since the contract signing, Energy Minister Arkab and Sonelgaz CEO Mourad Adjal have embarked on a series of visits to inaugurate the projects, beginning with the El-M'ghaier ceremony described above.

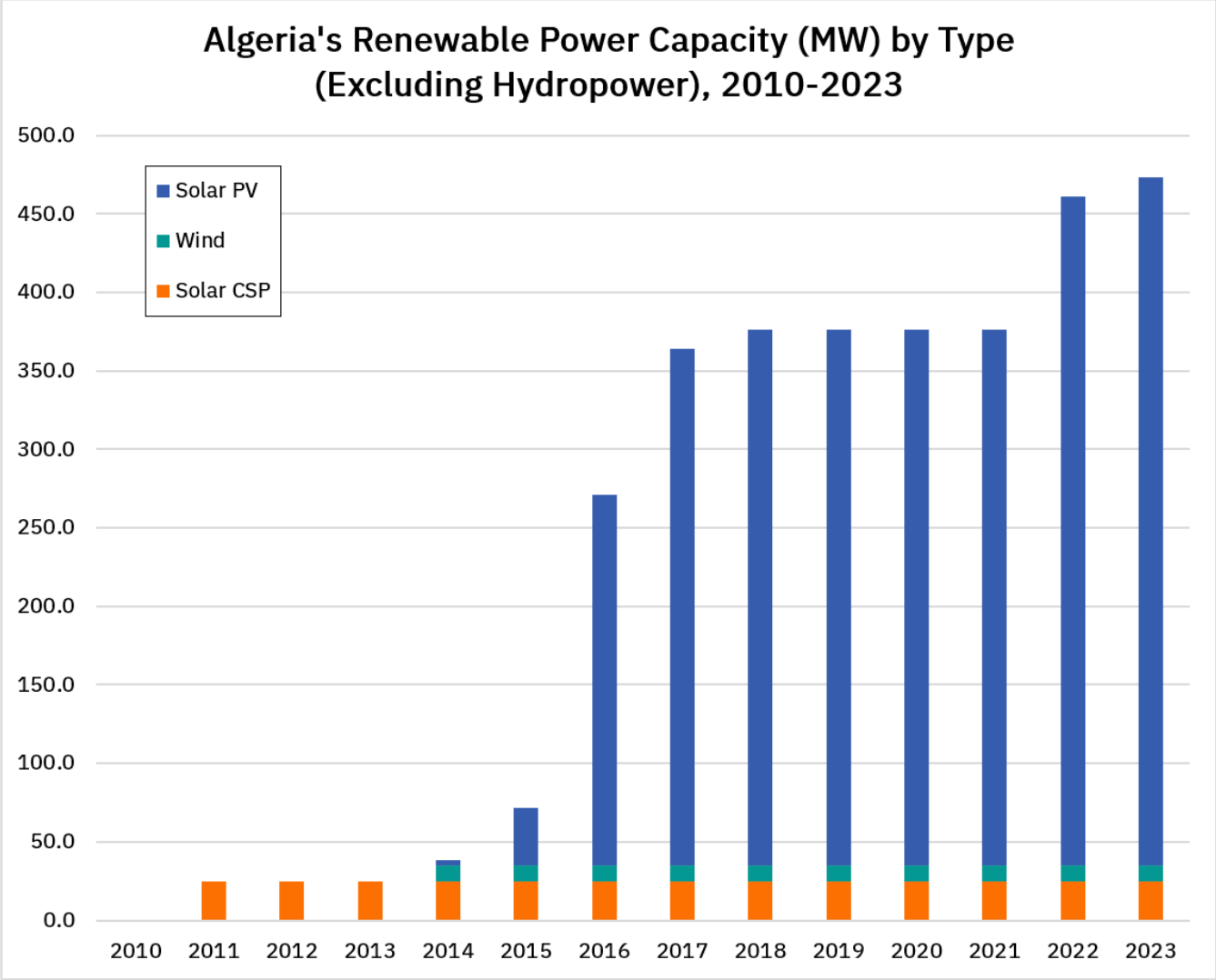
25. Under a PPA, the customer (typically a power utility) pays an independent power producer (IPP) a pre-agreed fixed price for electricity. The advantages for both sides have made this the global industry standard. The IPP shoulders the burden and costs of construction, operation, and maintenance, assuming risk in exchange for profits. And the utility receives a long-term guaranteed power price without having to worry about surprise costs.

26. "Quelle stratégie solaire pour l'Algérie – IPP Modèle SHAEMS ou EPC Modèle Sonelgaz ?" *Algérie Eco*, February 28, 2023, https://www.algerie-eco.com/2023/02/28/quelle-strategie-solaire-pour-lalgerie-ipp-modele-shaems-ou-epc-modele-sonelgaz/; Mohamed Ouanezar, "Sonelgaz rivalise-t-elle avec Shaems?" *L'Expression*, March 2, 2023, https://www.lexpressiondz.com/economie/sonelgaz-rivalise-t-elle-avec-shaems-366640.

27. "Sonelgaz: ouverture des plis du projet de 2.000 MW d'électricité solaire photovoltaïque," *Algérie Presse Service*, July 24, 2023, https://www.aps.dz/economie/158759-sonelgaz-ouverture-des-plis-du-projet-de-2-000-mw-d-electricite-solaire-photovoltaique.

28. "Sonelgaz/EnR: ouverture des plis relatifs aux offres financières de l'appel d'offres du projet de 2.000 MW," *Algérie Presse Service*, September 25, 2023, https://www.aps.dz/economie/160495-sonelgaz-enr-ouverture-des-plis-relatifs-aux-offres-financieres-de-l-appel-d-offres-du-projet-de-2-000-mw.

29. Boukhalfa Yaïci, "Du projet 2000 MWc au Projet Solar 1000: Analyse complémentaire," Algeria Green Energy Cluster, January 22, 2024.



The solar buildout is just one of several energy transition initiatives launched under a new 10-year, $22 billion energy transition budget intended to help Algeria reach its 15 GW renewables target and reduce domestic fossil fuel consumption by 15%.[30] Other initiatives focus on energy storage. Early last year, Arkab announced pilot initiatives to manufacture lithium-ion batteries and install them alongside solar panels in remote Saharan communities not served by the national grid.[31] Authorities hope that the storage can soon enable these outlying communities to rely fully on solar power, replacing expensive and polluting diesel generators.

In March 2023, Arkab also unveiled Algeria's first National Hydrogen Roadmap, which focuses on developing blue and green hydrogen production capacity through a multi-decade ramp-up. Production would go toward hard-to-abate sectors like steel and cement production, industries like fertilizers and refining that already use gray hydrogen,

30. "Énergie renouvelable: Plus de 20 milliards d'euros pour assurer la transition d'ici 2035," *Maghreb Emergent*, December 20, 2023, https://maghrebemergent.net/transition-energetique-lalgerie-elabore-une-feuille-de-route-de-plus-de-20-milliards-deuros/.

31. "Énergie solaire: l'Algérie produira bientôt des batteries au lithium," *Maghreb Emergent*, February 18, 2023, https://maghrebemergent.net/energie-solaire-lalgerie-produira-bientot-des-batteries-au-lithium/; "L'Algérie entend avancer résolument vers la concrétisation d'une transition énergétique progressive," *Algérie Presse Service*, March 4, 2023, https://www.aps.dz/economie/152606-energie-l-algerie-entend-avancer-resolument-vers-la-concretisation-d-une-transition-energetique-progressive.

and toward export, with a view to delivering 1 million tons of hydrogen annually to Europe by 2040. The plan was developed by an inter-ministerial working group convened by Arkab the previous year and was driven largely by German demand. Arkab has signed preliminary agreements with German public agencies and private firms alike to facilitate future partnership on hydrogen development as well as eventual offtake, though the country has not yet begun green hydrogen production. As a first step toward implementation, Sonatrach has reportedly begun a series of pilot projects to explore techniques for producing, storing, and transporting hydrogen.

Alongside these renewables initiatives, Arkab continues to float possible schemes to export green power to Europe, potentially via undersea cable, a dedicated hydrogen pipeline, or gas blending in existing pipelines.

In a November 2024 cabinet reshuffle, Tebboune elevated Arkab to the rank of Minister of State and unified the on-grid and off-grid renewables portfolios under his authority, consolidating his command of the entire energy sector and its future direction.

Obstacles to Transition

Throughout this recent history, a number of factors have hindered Algeria's progress on renewables development.

The first is structural. Energy transition is a difficult proposition in Algeria because the nature of the political system inhibits major policy changes of any kind. For decades, Algeria has been ruled by a system of rival groups vying for control of key state institutions and their budgets. The alliances span Algeria's military, political, and business elites, leaving the country's top echelon locked in a constant battle for power and resources. This "competitive authoritarian" model makes it very difficult for any single actor or group to affect policy change, even when it might be in the country's collective best interest. Major policy shifts tend only to occur under duress — driven by last-minute efforts to avert disaster rather than forward-thinking national strategy.[32]

In this adversarial context, enterprising individuals who propose new ideas or approaches often find themselves attacked from all sides. Such a situation naturally discourages deviation from existing policies, lending tremendous momentum to those already on the books. This helps explain why, though it has long been possible to imagine many ways Algeria could benefit from a concerted embrace of renewable energy, few have dared propose a sweeping vision for an energy transition. Instead, advocates have tended to advance more tepid, incremental proposals. While strategically sound in light of the context, such modest plans leave open questions about the strength of Algeria's commitment to renewables, limiting its ability to attract foreign partnership and investment.

The second and most obvious obstacle is Algeria's longstanding and deeply rooted reliance on oil and gas. Since NEAL met its demise in 2012, its former CEO has blamed the decision on "the oil lobby."[33] The term risks implying a situation of state capture by a small-yet-powerful interest group. The reality in Algeria is that the modern state and society have effectively been constructed around the oil and gas industry. Talk of energy transition is thus viewed as threatening — especially when presented as a "pivot," which implies replacing hydrocarbons with renewables, not developing both in parallel. Sonatrach and its many subsidiaries directly employ 66,000 workers and indirectly support hundreds of thousands more.[34] Even Algerians with no direct ties to the sector benefit from the billions spent annually on subsidized goods and services, all made possible by hydrocarbon revenues. These resources are widely viewed as the engine of Algeria's past and future economic development. Since the debt crisis of the 1990s, leaders have also pitched the receipts as a

32. Andrew Farrand, "Sixty 'Glorious' Years After Independence, Can Algeria Withstand the Challenges Ahead?" DAWN MENA, August 17, 2022, https://dawnmena.org/sixty-glorious-years-after-independence-can-algeria-withstand-the-challenges-ahead/.

33. Tewfik Hasni, Redouane Malek, and Nazim Zouioueche, "L'Algérie 100% énergies renouvelables," Friedrich Ebert Stiftung, January 2021, https://library.fes.de/pdf-files/bueros/algerien/17412.pdf.

34. "Rapport Annuel 2022," Sonatrach, August 2023, 69, https://sonatrach.com/wp-content/uploads/2023/08/RAPPORT-ANNUEL-2022-FR.pdf.

bulwark protecting Algeria's sovereignty by ensuring it will never have to accumulate foreign debt again. As a result, continuity of hydrocarbon exports is a policy with near-universal support in Algeria.[35]

As scholars Imane Boukhatem and Pao-Yu Oei assert, this robust equilibrium epitomizes the concept of "carbon lock-in," whereby economic dependence on oil and gas leads to a retrenchment that is hard to reverse, even in the face of arguments about the dangers of climate change and the economic benefits of renewables.[36]

Algeria's "lock-in" is exacerbated by the fact that the same officials are empowered to make decisions on both hydrocarbons and renewables. This can put the sectors in a direct, zero-sum competition for attention and resources. In contrast, regional renewable power leaders Egypt and Morocco each have independent ministries dedicated to renewable power, distinct from those responsible for hydrocarbons. Algeria has abandoned this approach after its ill-fated experiment with MTEER (even though that ministry's failings were due largely to leaders' poor choices around its setup). While they have enabled important steps on renewables development of late, those leaders nonetheless remain primarily committed to supporting oil and gas. In recent months they have pushed back on International Energy Agency (IEA) projections of a rapid energy transition, advocating instead for expanded investment in natural gas as a "bridge fuel" whose usage will facilitate, not hinder, the transition.[37]

This argument is one of many deployed in Algeria to argue against greater prioritization of renewables. For years, cost was also cited as a concern. While renewables' up-front investment costs remain substantial, they have plummeted in recent years, making economic arguments harder to defend, particularly in the face of sustained strong prices in global oil and gas markets. This excuse also overlooks the fact that the Algerian state need not fund all renewables projects itself. There are growing calls for Sonelgaz to loosen restrictions on renewables project financing to allow foreign banks to participate. The state could also authorize private investors to build renewables facilities and link them to the public grid, or institute net metering and ease electricity subsidies in order to incentivize households and businesses to purchase their own renewables units. The energy ministry is reportedly considering instituting some such incentives in a forthcoming revised electricity law.

Another perennial argument is that renewables' intermittency limits their reliability. The energy ministry's new battery projects, if scaled up, may soon help resolve this objection. But here too, authorities could do more. Algeria's existing pilot projects focus exclusively on lithium-ion batteries, whereas other countries are experimenting with promising alternatives — including low-cost, low-tech ones. For the past decade, Algeria has also directed its renewables investment exclusively toward solar PV projects, neglecting wind. A ramp-up in wind power investment could quickly help rebalance the country's renewables capacity, reducing the intermittency problem. This will be especially important for green hydrogen electrolysis, which will struggle to be cost-competitive if it can only operate during daylight hours.

Objections to renewables projects on grounds of opposing "green colonialism" may also pose an obstacle, especially as Algeria launches construction of an unprecedented number of solar parks. The country's violent colonial history, memories of which are kept fresh by the political

35. No polling data exists on Algerians' views around the oil and gas industry. Anecdotal evidence suggests that misgivings about the industry are more common in southern communities near oil and gas production sites. Some residents there feel that they pay the environmental costs of extraction while seeing few of the benefits, accusing northern cities of hoarding the wealth instead. Even there, however, only a minority appear to hold such viewpoints.

36. Imane Boukhatem and Pao-Yu Oei, "Fossil gas lock-in risks: analysis of Algeria's electricity sector and implications for a renewable energy transition," *Sustainability Nexus Forum*, March 6, 2024, https://doi.org/10.1007/s00550-024-00532-2.

37. Nadjia Bouaricha, "Mohamed Arkab à la clôture du 7e sommet du GECF : «Le gaz est la solution pour la transition énergétique et non pas le problème»," *El Watan*, March 4, 2024, https://elwatan-dz.com/mohamed-arkab-a-la-cloture-du-7e-sommet-du-gecf-le-gaz-est-la-solution-pour-la-transition-energetique-et-non-pas-le-probleme.

and education systems, makes Algeria fertile ground for such arguments should it one day develop a robust green power export sector. So too does an existing undercurrent of distrust of extractive industries in southern Algeria, often motivated by concerns over critical water supplies.

While less often expressed than other objections, concern around renewables' ability to provide Algeria with an export revenue stream is among the most important obstacles to green transition in the country. This problem is not unique to Algeria by any means: renewable power still lacks the robust, efficient storage and transport systems built up for hydrocarbons over the past century. Both the physical and economic viability of storing hydrogen and transporting it over long distances remain unclear. Algeria is also unlikely to take chances in search of solutions. Experiments to introduce hydrogen into the natural gas pipelines linking Algeria to Spain and Italy would risk damaging a consistent, proven income stream in pursuit of an uncertain one, and are thus likely to be rejected by Arkab and Sonatrach leaders. A dedicated pipeline like the Galsi route proposed to Italy would not have those drawbacks, but its up-front costs are a hurdle. Algerian leaders will seek to push such investments onto the European offtakers, particularly so long as European green hydrogen markets remain untested and hydrocarbons demand remains robust. Recent discussions with Italy over a potential undersea cable are more promising, but it is doubtful that electricity exports will ever be lucrative enough to match oil and gas. In the medium term, Algerian officials are therefore likely to continue focusing on renewables development to meet local needs, while continuing to evaluate the long-term potential for green energy exports.

Catalysts of Transition

Alongside the challenges and obstacles outlined above, another set of factors is actually helping to facilitate Algeria's recent progress on renewables.

The first is demand displacement. It has always been true that any barrel of oil or cubic meter of gas that Sonatrach sells in Algeria is one less unit available for export, resulting in reduced foreign exchange earnings. It is also true that Sonatrach earns far less from selling it locally, owing to implicit energy subsidies imposed through price setting by the Ministry of Energy and Mines. This gives both the country's and the firm's leaders an incentive to maximize oil and gas exports. This incentive has long been balanced against another: to maintain social peace by providing Algerians with as much subsidized energy as they would like. (Energy efficiency policies could help reduce this demand, but given the political imperative, leaders have pursued them only halfheartedly.) In recent years, dramatic falls in the price of renewable energy technologies, particularly PV panels, have raised the possibility that Algeria might, for a reasonable up-front investment, satisfy part of its domestic energy demand with renewables, freeing up more oil and especially gas for export. In Algeria, where hydrocarbons remain central to leaders' calculations, renewables' potential to offset domestic demand and boost exports has emerged as the strongest argument for renewables adoption. This is particularly true in light of Sonatrach's struggles to expand production via other means and of the spare capacity it has in gas pipelines and liquefaction facilities, which enable it to quickly commercialize spare volumes without additional infrastructure investment.

Estimates of just how much gas Algeria stands to free up through renewables projects vary considerably, though all make the case effectively. In February 2024, Sonatrach's director of new resources told the state press service that every gigawatt of solar PV capacity installed would save 0.4 billion cubic meters (bcm) of gas per year thereafter.[38] Based on similar calculations, as well as its projections of future electricity demand growth, Sonelgaz has estimated that reaching Algeria's goal of 15 GW of renewables capacity by 2035 will collectively save 40 bcm of gas by that year alone.[39] According to a recent estimate from former Energy Transition Minister Chitour, new solar PV

38. "L'Algérie déterminée à rester le plus grand fournisseur de GN en Méditerranée et Afrique," *Algérie Presse Service*, February 12, 2024, https://www.aps.dz/economie/166611-gaz-l-algerie-determinee-a-rester-le-plus-grand-fournisseur-de-gn-en-mediterranee-et-en-afrique.

39. "ENR & Hydrogène: comment approfondir la coopération Algéro-Allemande," *Energy Magazine*, October 24, 2023, https://www.energymagazinedz.com/?p=3425.

facilities built today should be able to recoup their up-front investments through gas savings within approximately three years, generating substantial profits throughout the rest of their estimated 25-year lifespan.[40] Alternatively, the gas saved through renewables deployment need not be commercialized immediately. A variant of the demand displacement argument advocates leaving the gas in the ground to preserve it for future generations.

Renewables' potential to spur job creation and economic development is a second factor helping to reduce opposition. A handful of small solar PV panel manufacture and assembly factories have operated in the country for decades, though they have done so at well below capacity in recent years while awaiting major solar tenders. By now, most of those offer outdated technologies at non-competitive prices. Two newer facilities in Ouargla and Mila, however, propose modern panels fit for use in Sonelgaz's latest 3 GW project. The two factories have a collective capacity of 300 MW, which they plan to double in the coming years.[41]

The local solar sector is organized under Green Energy Cluster Algeria (GEC-A), a small but effective industry group that successfully lobbied Sonelgaz to impose a 35% local content requirement in last year's solar tenders, helping to support the local industry and establish a new standard for future procurements. GEC-A also successfully lobbied public officials to remove import tariffs on raw materials for panel manufacturing. Even with this support, Algerian producers will struggle to compete with low-cost Chinese manufacturers but may remain viable if political leaders continue to support them through industrial policy.

Officials at the GEC-A recently estimated that achieving President Tebboune's goal of 15 GW of installed capacity will generate 50,000-60,000 jobs, though many of these will be temporary construction jobs.[42] Many green energy jobs will also require new training, for which there is a small but growing list of options. In 2019, Algeria opened a renewable energy college at the University of Batna, and more recently it began offering curricula on green hydrogen and related topics at Sonatrach's Algerian Petroleum Institute in Boumerdes. The Ministry of Higher Education is rolling out similar offerings at other universities nationwide. Vocational training options are expected to follow. For now, opportunities for job retraining remain limited.

A third factor is Algerian leaders' desire to uphold the country's international reputation, including its strong commitment to multilateral engagement. Under the 2015 Paris Agreement, Algeria pledged to reduce its greenhouse gas emissions by 7% before 2030.[43] While the goal does not appear ambitious on its face, Algeria's growing population and per capita energy consumption during this period heighten the challenge considerably. Renewables are one of the best tools at the Tebboune administration's disposal to meet the target. Failing to do so would damage the country's international reputation and raise uncomfortable questions back home about leaders' competence. Officials have effectively admitted this, as when then-Environment Minister Samia Moualfi affirmed last year that Algeria's use of solar energy "manifests Algeria's respect for its international engagements concerning the energy transition."[44]

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40. Chems Eddine Chitour, "3 000 MW de solaire: immense bond en avant et rupture salvatrice avec le tout fossile," *Le Soir d'Algérie*, March 18, 2024, https://www.lesoirdalgerie.com/contribution/3-000-mw-de-solaire-immense-bond-en-avant-et-rupture-salvatrice-avec-le-tout-fossile-114252.

41. Nabil Mansouri, "Le turc Renecore Energy veut réaliser la plus grande usine photovoltaïque d'Afrique en Algérie," *L'Algérie Aujourd'hui*, September 14, 2023, https://lalgerieaujourdhui.dz/le-turc-renecore-energy-veut-realiser-la-plus-grande-usine-photovoltaique-dafrique-en-algerie/.

42. "M. Boukhalfa Yaïci, Directeur général du Cluster Énergies renouvelables et Efficacité énergétique" (interview), Radio Alger Chaîne 3, January 11, 2024, https://www.youtube.com/watch?v=tjARzN7Z9o0.

43. "Intended Nationally Determined Contribution," People's Democratic Republic of Algeria, September 3, 2015, https://unfccc.int/sites/default/files/NDC/2022-06/Algeria%20-%20INDC%20%28English%20unofficial%20translation%29%20September%2003%2C2015.pdf.

44. "La production de l'énergie solaire traduit le respect de l'Algérie de ses engagements internationaux," *Algérie Presse Service*, February 25, 2023, https://www.aps.dz/

Algeria's desire to outshine its neighbors is another facet of this concern for its reputation. Although neither Morocco nor Egypt can match Algeria's natural resource wealth, those two countries nonetheless boast over 5 and 10 times Algeria's total installed renewables capacity, respectively.[45] They are also attracting substantial private investment and international partnerships as well as beginning to leverage their renewables capacities for hydrogen production and export projects. On the reputational level, the embarrassment of falling behind its poorer neighbors is another motivating factor for Algerian leaders. It also has important long-term implications for Algeria's trade position. Some Algerian experts fear that if the country is too slow to build commercial linkages — including trade deals and physical infrastructure — with green power buyers in Europe, it could miss out on the next wave of global energy trade.[46]

Another set of factors concerns Europe directly. The European Union is Algeria's largest trading partner and the primary offtaker for its hydrocarbon exports. Algerian leaders therefore pay close attention to changes in European energy policies and their implications. Those policies shifted considerably with the start of the full-scale Russo-Ukrainian war in 2022. Europe's energy crunch — resulting from a rapid reduction in Russian supplies — delivered a windfall of gas revenues for Algeria but also prompted Europe to rapidly accelerate its energy transition plans. For leaders in Algiers, the launch of the REPowerEU plan brought the threat of declining European oil and gas imports from the realm of the theoretical and long term to the tangible and medium term. But it also raised a new opportunity: the package includes a target of 10 million tons of green hydrogen imports by 2030, alongside plans to develop an international renewable hydrogen market.[47] Just a few months after its release, Energy Minister Arkab convened the working group to develop Algeria's National Hydrogen Roadmap.

Direct support from European partners has also helped to accelerate Algeria's progress on energy transition. Under a strategic partnership agreement signed in 2015, the EU has funded two consecutive €15 million programs to assist Algeria's energy ministry in renewables, energy efficiency, emissions reduction, and related activities. Germany, which first signed a bilateral partnership accord with Algeria the same year, has been particularly instrumental in speeding Algeria's progress on green hydrogen development. A 2021 study by German development agency GIZ helped convince Algerian policymakers of the business case for green hydrogen production.[48] Through study missions and bilateral summits, the partnership has helped build links between Algerian officials and European businesses. This led, in December 2022, to Sonatrach signing a preliminary accord on green hydrogen collaboration with German gas consortium VNG AG.[49] In February 2024, German Economy and Climate Minister Robert Habeck visited Algiers to establish a new bilateral hydrogen task force and advance Algeria's collaboration with the SoutH2 Corridor initiative, which could one day transport green

economie/152284-la-production-de-l-energie-solaire-traduit-le-respect-de-l-algerie-de-ses-engagements-internationaux.

45. "Installed renewable electricity capacity (MW) by Region/country/area," IRENASTAT Online Data Query Tool, IRENA, consulted March 2, 2024, https://www.irena.org/Data/Downloads/IRENASTAT.

46. Andrew Farrand, "Against the flow: Europe's role in kickstarting Algeria's green transition," ECFR, October 6, 2022, https://ecfr.eu/publication/against-the-flow-europes-role-in-kickstarting-algerias-green-transition/#:~:text=Hesitation%20and%20regional%20competition.

47. "REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition," European Commission, May 18, 2022, https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131.

48. Stefan Drenkard & Atom Mirakyan, "Étude exploratoire sur le potentiel du Power-to-X

(hydrogène vert) pour l'Algérie," GIZ, November 2021, https://www.energypartnership-algeria.org/fileadmin/user_upload/algeria/21_12_07_Hydrog%C3%A8ne_vert_en_Alg%C3%A9rie_-_Rapport_PE.pdf.

49. "German-Algerian hydrogen partnership: VNG to collaborate with Algerian energy company Sonatrach on green hydrogen," VNG AG, December 20, 2022, https://www.vng.de/en/newsroom/2022-12-20-german-algerian-hydrogen-partnership-vng-collaborate-algerian-energy-company.

hydrogen from North Africa to Germany.[50] Sonatrach is reportedly in discussions with German development bank KfW about co-financing a mid-sized electrolyzer to begin green hydrogen production.[51] Public statements of interest from European firms, including Germany's BASF and Spain's Enagás, in purchasing large quantities of future Algerian green hydrogen supplies have also helped reaffirm Algeria's interest in this area.[52]

Alongside these carrots, Europe also offers a stick in the form of its Carbon Border Adjustment Mechanism (CBAM), which from 2026 will impose penalties on any imports to the EU not produced with low-carbon inputs. Key Algerian exports such as oil and gas, cement, fertilizers, and steel look set to be impacted. While Algerian policymakers have mostly avoided addressing the new so-called "carbon tariff" directly, they appear to be taking its potential costs seriously. In October 2023, just days after the EU officially initiated CBAM's three-year countdown to full implementation, Sonatrach announced plans to green 80% of its upstream production sites this decade.[53] The same month, it unveiled a $1 billion tree planting campaign billed as "natural carbon storage," which should allow it to claim carbon offset credits.[54] Local executives at Holcim, a Swiss cement producer with major operations in Algeria, announced plans this year to launch decarbonization efforts, citing CBAM as the reason.[55] All this suggests that the measure is having its intended effect on trade partners like Algeria — which is why governments in the UK, US, and Canada are in various stages of preparing similar measures, potentially giving Algeria further incentive for renewables development.

What's Next?

Despite an early interest in experimenting with renewable technologies, Algeria has fallen behind its neighbors thanks to years of false starts. Today, it stands at an important inflection point. Significant obstacles and catalysts push leaders in opposing directions, but concerns about the country's growing domestic energy consumption and its impact on future export potential lately appear to be eroding opposition to renewables. The recent launch of Algeria's first gigawatt-scale solar PV projects appears to be a historic turning point.

The new solar parks are due to be completed between late 2024 and early 2026. Much rides on Sonelgaz's ability to keep those projects on schedule and on budget, successfully integrate them into Algeria's electric grid and power management systems, and demonstrate their value added in the years thereafter. Success in that undertaking will improve the prospects for future renewables investments, beginning with another 3 GW solar tender round promised for later this year.

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50. "Germany and Algeria set up hydrogen taskforce," Federal Ministry for Economic Affairs and Climate Action, February 8, 2024, https://www.bmwk.de/Redaktion/EN/Pressemitteilungen/2024/02/20240208-germany-and-algeria-set-up-hydrogen-taskforce.html.

51. Andrew Farrand, "Algeria: New Partner Drive Cautious Embrace of Hydrogen," in Silvia Weko et al., "The Politics of Green Hydrogen Cooperation: Emerging Dynamics in Morocco, Algeria and Mauritania," RIFS, December 2023, https://doi.org/10.48481/rifs.2023.031.

52. Imad-Eddine Sharif, "Attaqa publishes the names of companies wishing to purchase hydrogen from Algeria," *Attaqa*, June 19, 2023, https://attaqa.net/2023/06/19/الطاقة-تنشر-أسماء-الشركات-الراغبة-بش/; Petra Sorge, "Algeria Is in Talks to Send Green Hydrogen to Germany via Pipeline," *Bloomberg*, October 23, 2023, https://www.bloomberg.com/news/articles/2023-10-23/algeria-in-talks-to-send-green-hydrogen-to-germany-via-pipeline.

53. "Solarisation de 80% des sites de production de Sonatrach à l'horizon 2030," *Algérie Presse Service*, October 3, 2023, https://www.aps.dz/economie/160780-solarisation-de-80-des-sites-de-production-de-sonatrach-a-l-horizon-2030.

54. "Algeria's state oil and gas firm Sonatrach plans $1 billion project for natural carbon storage," *Reuters*, October 23, 2023, https://www.reuters.com/business/energy/algerias-state-oil-gas-firm-sonatrach-plans-1-billion-project-natural-carbon-2023-10-23/.

55. Samira Imadalou, "Ciment: Holcim va augmenter ses capacités de production," *El Watan*, March 9, 2024, https://elwatan-dz.com/ciment-holcim-va-augmenter-ses-capacites-de-production.

But many open questions remain: Will Algerian leaders loosen restrictions on renewables procurements to better attract international expertise and finance? Will they overcome the country's statist tradition and authorize private-sector investment in renewables, or review domestic energy pricing and metering to incentivize consumers to produce their own green power? When and how might they begin building complementary wind power installations? Will they make the sizable investments and establish the international partnerships needed to develop green hydrogen exports?

Foreign partners eager for answers to these questions — and for Algeria to fully embrace the energy transition — would do well to maintain reasonable expectations. For now, oil and gas remain foundational to both Algeria's energy security and economic security, making the country's leaders wary of alternatives. Assisting those leaders to build up renewables alongside the existing energy industry is the approach most likely to foster a successful transition.

Misaligned Priorities: Rethinking Tunisia's Renewable Energy Approach

Fadil Aliriza

Photo above: Workers demonstrate the installation of solar photovoltaic panels in central Tunisia's Kairouan Province, May 8, 2024. Photo by Adel Ezzine/Xinhua via Getty Images.

Tunisia possesses some hydrocarbon resources; but unlike its immediate neighbors Libya and Algeria, it does not have enough to generate sufficient energy to meet its current domestic consumption needs. Despite this, however, Tunisia has successfully provided for the energy needs of its population since independence through the state-owned Tunisian Electricity and Gas Company (STEG). At its launch in 1962, STEG assumed responsibility for all the production, transmission, and distribution of electricity in Tunisia, nationalizing these tasks which had previously been under the charge of multiple private companies.[1] Over the following decades, the percentage of Tunisians receiving electricity went from 21%[2] to virtually 100%, reaching 100% in urban areas by 1990.[3] But this has come at a cost: a grid dependent on natural gas imports from Algeria as well as purchases of Tunisian gas resources whose ownership was conceded by the state to foreign companies on dubious grounds.[4]

This dependence on increasingly expensive imported hydrocarbon resources in the face of continuing public financial challenges is one factor that would seem to make

1. "History," *STEG*, September 1, 2014, https://tinyurl.com/yxp37yts, accessed May 10, 2024.

2. Chafik Ben Rouine and Flavie Roche, "Renewable Energy in Tunisia: An Unjust Transition," in *Dismantling Green Colonialism*, eds. Hamza Hamouchene & Katie Sandwell, (Pluto Press, 2023), 201.

3. "Tunisie: Rapport D'Achevement Du Projet D'Electrification Urbaine Electricite III," December 1991, African Development Bank, 6.

4. See Fadil Aliriza, "Keeping Tunisia in the Dark," *Foreign Policy*, December 5, 2014, https://tinyurl.com/432zp7sv, accessed May 10, 2024.

the domestic development of renewable energy (RE) production an attractive policy avenue. Other potential incentives include a decrease in national primary energy production and a sharp increase in demand over the last decade,[5] increasing strain on the national electricity grid in recent years due to deadly and historic heat waves linked to climate change, and Tunisia's abundant sunshine. It is these factors, and not Tunisia's negligible contributions to greenhouse gas emissions[6] that are driving the country to set growing targets for RE in its energy profile mix. Indeed, Tunisia's minister of industry identified the country's "energy transition strategy" as driven by four pillars: "energy security; increasing energy independence; reducing costs; and diversifying energy resources."[7]

In its 2015 solar plan, Tunisia had set as its target to achieve 30% of its domestic electricity supply from RE by 2030. As of July 2022, Tunisia had updated that with an even more ambitious target: 35% by 2030.[8] Yet Tunisian official figures as of March 2023 indicate that only 2.3% of electricity is coming from RE,[9] only a slight increase from 1.9% in December 2022.[10] Moreover, this number is even starker than it appears. In Tunisia's larger energy mix, which includes not only electricity production but also other energy uses like heating and transportation, RE makes up only 1% of this mix.[11] And while STEG depends on imported Algerian gas to produce electricity for the national grid, those gas imports still do not produce enough electricity to cover domestic consumption needs; thus, Tunisia sometimes purchases Algerian electricity directly, which, by March 2023, included purchases that covered 12% of Tunisia's local market needs.[12]

While in recent years there have been efforts to reverse STEG's 1962 nationalization and revert back to privately owned electricity production, STEG continues to produce 99% of Tunisia's domestic electricity production as of March 2023 (up from 96% in March 2022).[13] And despite well-publicized news of potential private or private-public projects for solar power generation, only 0.3% of Tunisia's electricity in the first half of 2023 came from solar energy, with the overwhelming majority of RE's share — 2.0% of the total 2.3% — coming from wind energy.[14] This is vastly less than would be expected given Tunisia's bountiful solar resources, raising the question of what is stopping production in this field?

Energy for Export, but Energy "Austerity" at Home

Despite the relatively ambitious goal of going from 2.3% of electricity from RE to 35% in just the next seven years, it

5. "Projets D'Énergie Renouvelable en Tunisie Guide Détaillé, GIZ, Tunisian Ministry of Industry and Small Businesses, ANME, May 2019, 9.

6. Tunisia makes up about 0.16 percent of the world's population yet accounts for only 0.08 percent of the world's greenhouse gas emissions according to the UNDP citing Climate Watch (CAIT 2019), https://tinyurl.com/nhanefrd.

7. Mohamed Boussaid, "The Republic of Tunisia Renewables Readiness Assessment," International Renewable Energy Agency (IRENA), 2021, 4.

8. "RPT-Tunisia aims to generate 35% of electricity from renewables by 2030 -minister," *Reuters*, June 7, 2022, https://tinyurl.com/dnphds6y, accessed May 10, 2024.

9. Conjoncture energétique, March 2023 ONEM, Tunisian Ministry of Industry, Mines and Energy, 34.

10. Conjoncture energétique, December 2022 ONEM, Tunisian Ministry of Industry, Mines and Energy, 35.

11. Conjoncture energétique, March 2023 ONEM, Tunisian Ministry of Industry, Mines and Energy, 6.

12. Ibid., 33. Up to 50% of Tunisia's natural gas usage comes from imported Algerian gas, and 97% of STEG's electricity is generated from natural gas.

13. Conjoncture energétique, December 2022 ONEM, Tunisian Ministry of Industry, Mines and Energy, 35.

14. Conjoncture energétique, March 2023 ONEM, Tunisian Ministry of Industry, Mines and Energy, 34. For a full accounting of existing and planned solar and wind energy projects in Tunisia see Isabel Schafer, "The Renewable Energy Sector and Youth Employment in Algeria, Libya, Morocco and Tunisia," African Development Bank, 2016 https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/The_Renewable_Energy_Sector_and_Youth_Employment_in_Algeria__Libya__Morocco_and_Tunisia.pdf, 75-78.

is unclear that there is sufficient action on the part of the Tunisian state, the private sector, development agencies, international agencies and Tunisia's international partners to achieve this. Several international agencies, among them prominently Germany's main development agency, *Gesellschaft für Internationale Zusammenarbeit* (GIZ), are working closely with Tunisia's state institutions on developing strategy and implementing policy relating to RE at multiple levels within the Tunisian government.[15] This includes supporting the 2015 Solar Plan[16] but also apparently leading the way on Tunisia's green hydrogen strategy developed in 2022, with a senior official in Tunisia explicitly noting that "the idea to develop a green hydrogen sector in Tunisia was suggested by Germany. That is where this technology started to develop."[17] In both of these, it appears that an export-oriented strategy may be in tension or even at odds with a policy that would meet Tunisia's domestic energy needs.

Those domestic needs are significant and must grow for Tunisia to be able to develop and improve standards of living. The average energy use per capita globally is just over 21,000 kilowatt-hours (kWh), yet Tunisians use less than half of that: about 9,500 kWh. In contrast, Germans use nearly 41,000 kwH, slightly more than the European Union average of just over 36,000 kWh.[18] As a developing country trying to catch up to Europe and other developed nations, Tunisia would need to increase its overall energy consumption, as "there is ultimately no route to development without greater energy consumption."[19]

Yet even as Tunisia prioritizes export of RE and suffers from far less per capita energy consumption than the global average, Tunisia's strategy also calls for actually *reducing* its own overall energy consumption, with a target of 30% reduction by 2030.[20] While the Ministry of Industry's 2023 energy strategy document — produced with UNDP — says some of this reduction will come from unspecified mechanisms of improving energy efficiency, it also specifically calls for "energy austerity" (*sobriété énergétique*). The ministry's strategy document calls for an average reduction in energy demand of 2.8% per year between 2021 and 2035,[21] while suggesting that "primary energy intensity" should fall at an even faster rate of 3.6% per year.[22] The website of the government's main governmental energy agency, the National Agency for Energy Management (ANME), also reiterates the planning document's call for a 30% reduction in energy consumption by 2030.[23]

This is in contrast to Tunisia's updated Nationally Determined Contribution (NDC),[24] a 2021 document outlining Tunisia's intended NDC in line with the UNFCCC's 2016 Paris Agreement. In this text, produced in conjunction with the UNDP, two German ministries, the European Union, and the Spanish development agency AECID, Tunisia does not set any target for energy consumption reduction but rather only a reduction in "carbon intensity," which is the "ratio of net emissions to GDP." In other words, reducing carbon intensity would be tied to economic growth and, therefore, be carried out

15. IRENA, 14.

16. See "Supporting the implementation of the Tunisian Solar Plan (ASPT)," GIZ, 2017.

17. Aida Delpuech, "Who Benefits From Tunisia's Green Hydrogen Strategy?" Heinrich Böll Stiftung, Arab Reform Initiative, December 2022, https://tn.boell.org/en/2023/03/17/who-benefits-tunisias-green-hydrogen-strategy, 4.

18. See "Primary energy consumption per capita", Our World in Data, https://ourworldindata.org/grapher/per-capita-energy-use, accessed May 10, 2024.

19. Kelsey Jack, "How much do we know about the development impacts of energy infrastructure," World Bank Blogs, March 29, 2022, https://tinyurl.com/mr8fxa99, accessed May 10, 2024.

20. "Stratégie Énergétique de la Tunisie à l'horizon 2035: Synthèse," Tunisian Ministry of Industry, Mines and Energy and UNDP, April 2023, 8.

21. Ibid., 12.

22. Ibid., 13.

23. "Agence Nationale Pour La Maitrise de l'Énergie", ANME, https://www.anme.tn/, accessed November 14, 2023.

24. Updated Nationally Determined Contribution (NDC) Tunisia, October 2021, Republic of Tunisia, UNDP, German Federal Ministry for the Environment, Conservation and Nuclear Safety, Spanish Agency for International Development Cooperation (AECID), German Federal Ministry for Economic Cooperation and Development, European Union, 18.

in line with the international environmental law principle of Common but Differentiated Responsibility (CBDR). The CBDR principle maintains that developing countries' lower responsibility proportionate to their current and historical emissions allows for their continued economic development. In contrast, the absolute reduction outlined by the Ministry of Industry's 2023 energy strategy document — as well as on the website of the government's main energy agency, the National Agency for Energy Management (ANME)[25] — would appear to violate the CBDR.

Green Hydrogen for Export

Tunisia's green hydrogen strategy seems to be explicitly prioritizing production for export, with a ministry planning document noting that "Tunisia must position itself in particular as a strategic provider of green H2 [hydrogen] to Europe, which requires 20 million tons in 2030, of which 10 million tons [comes] from imports."[26] This follows a 2020 memorandum of understanding signed between Germany and Tunisia establishing the Tunisian German Coalition for Green Hydrogen.[27] This may be an economic sector where Germany has a competitive advantage, given that Germany is number two in the world in terms of green hydrogen production facilities. That means that it has the companies with the experience and technology to compete at an advantage for Tunisian bids in this sector. Moreover, it is likely that much of Tunisia's potential exports in this sector would go to Germany given that the latter's 2020 national green hydrogen strategy sets ambitious targets for green hydrogen requiring about 80% of national needs to be covered by imports.[28] Germany also has well-established industries in the sectors most suitable for consuming green hydrogen, while a Tunisian pilot project producing green hydrogen in Bizerte is already planning to export the energy to Hamburg, Germany.[29]

That said, this export-focused strategy with regard to the green hydrogen sector comes with several problems. The authors of the 2023 report "Just Transition: A Climate, Energy and Development Vision for Africa" note that "the export-oriented nature of the green hydrogen industry continues the existing extractive economic model and leaves Africa subject to endemic energy shortage," clarifying that this means "energy that could be used locally to address real and immediate energy access and growing needs will be directed to produce hydrogen for use in Europe."[30] The authors also note that producing green hydrogen is extremely water intensive, requiring 18 to 24 kilograms of water to produce 1 kg of green hydrogen.[31] Tunisia is one of the least plentiful countries in the world in terms of water resources, which are already being overexploited by intensive, export-oriented agriculture to Europe that is depleting water tables,[32] promoting desertification, and depriving communities in rural areas of water.[33] The "Just Transition" report also warns that green hydrogen projects use a lot of land, meaning that they may displace local communities, and they often depend on water desalination methods, which pollute local marine environments.[34]

Solar Power for Export

Tunisia's Solar Plan is guided by Law 12-2015, apparently designed in a way that is "conducive to private-sector

25. "Agence Nationale Pour La Maitrise de l'Énergie", ANME, https://www.anme.tn/, accessed November 14, 2023.

26. "Stratégie Énergétique de la Tunisie à l'horizon 2035: Synthèse," Tunisian Ministry of Industry, Mines and Energy and UNDP, April 2023, 19.

27. Delpuech, "Green Hydrogen," 4, 5.

28. Delpuech, "Green Hydrogen," 7.

29. Delpuech, "Green Hydrogen," 7.

30. Youba Sokona et al., "Just Transition: A Climate, Energy and Development Vision for Africa," Just Transition, https://justtransitionafrica.org/, 60, accessed May 10, 2024.

31. Ibid.

32. See Chahd Lina Belhadj and Fadil Aliriza, "The Cost of Intensive Spanish Olive Farming in Tunisia," Meshkal, May 11, 2023, https://tinyurl.com/4t2c6mak, accessed May 10, 2024.

33. See Fadil Aliriza, "'All This for a Drink of Water': New Documentary Studies Water Injustices," *Meshkal*, March 9, 2021, https://tinyurl.com/tc42nytr, accessed May 10, 2024.

34. Just Transition, 60.

investment in the production of electricity" and which lays out three new regulatory regimes: "(i) self-generation/consumption; (ii) independent power production for local consumption (concession and authorization); and (iii) independent power production for export."[35] Yet of these three regimes, it appears the last one emphasizing exports is being prioritized. Under a regime favoring privatization in the sector, investing in energy projects for export is likely far more attractive to private investors than targeting domestic consumption because: energy consumption and demand in Europe is much higher than in Tunisia; European importers of energy have the financial capacity to pay higher prices; and Europe has much higher commitments and responsibility to shifting to cleaner energy to reduce its outsized current and historical per capita GHG emissions. As scholars Chafik Ben Rouine and Flavie Roche argue, the liberalization of Tunisia's legislative framework with regard to RE production "would undermine the state's capacity to regulate — sometimes against investors' interests — and, therefore, would facilitate the introduction of European investors, who benefit from the EU's extensive subsidy programs, into the Tunisian market. This would eventually open the way for exports, thus ensuring energy security for Europe, rather than for Tunisia."[36]

This explains to some degree the attractiveness of mega-projects like the TuNur Concentrated Solar Power (CSP) plant, near Rjim Maatoug (although the legislative language conducive to such projects is reportedly already a result of TuNur's earlier lobbying over the objections of STEG).[37] Launched in 2017 with the aim of exporting solar energy to Europe via undersea cables, the project is not yet operational as of this writing. Among the hurdles to getting TuNur online are not only the numerous critiques of it and similar projects as "neocolonial"[38] but also political opposition that has successfully demonstrated its capacity to stop private projects. For example, the labor union General Federation of Electricity and Gas (FGEG)[39] blocked a smaller solar power plant in Tataouine — built as part of a public-private partnership framework — from connecting to the grid. Ben Rouine and Roche characterize that blockage as an outgrowth of FGEG's earlier opposition to the privatization of the sector outlined in the 12-2015 law.[40]

Challenges for New Solar Projects

Yet even if larger CSP projects like TuNur's mega project in Rjim Maatoug do go online, they will still face further challenges. For one, each CSP is extremely water intensive, as the solar water reflectors require washing and cooling using water. Here, the example of the Noor CSP project in Ouarzazate, Morocco, offers a useful comparison, particularly as the TuNur project is reportedly modeled on it.[41] Although the environmental impact study predicted the Noor solar power plant would consume 6 million cubic meters of water annually from a nearby dam, it appears there is no transparent reporting on the plant's actual water consumption, which, one scholar noted, seemed "considerably higher."[42]

The Noor project also appears to be losing money. Noor I, Noor II, and Noor III each produces one kilowatt per hour

35. IRENA, 12.

36. Ben Rouine & Roche, 206, 207.

37. Megan Darby, "Giant Tunisian desert solar project aims to power EU," *Climate Home News*, August 4, 2017, https://www.climatechangenews.com/2017/08/04/giant-solar-project-tests-sahara-eu-power-export-dream/; see also Chafik Ben Rouine & Flavie Roche, "'Renewable' Energy in Tunisia: an unjust transition," *TNI Longreads*, March 31, 2022, https://longreads.tni.org/renewable-energy-in-tunisia .

38. See Hamza Hamouchene, "TuNur in Tunisia: Another Case of energy Colonialism," CADTM, November 10, 2017, https://www.cadtm.org/TuNur-in-Tunisia-Another-case-of; Ben Rouine & Roche 2023, 214; Delpuech

39. The FGEG is affiliated with the Tunisian General Labour Union (French: *Union Générale Tunisienne du Travail*, UGTT).

40. Ben Rouine & Roche in *Green Colonialism*, 208.

41. Aida Delpuech and Ariana Poletti, "TuNur: What lurks in the shadow of the Tunisian sun export to Europe?" Inkyfada, November 11, 2022 https://inkyfada.com/en/2022/11/11/investigation-tunur-exportation-solar-energy-tunisia-europe/.

42. Karen Rignall quoted by Aida Delpuech and Ariana Poletti, "TuNur: What lurks in the shadow of the Tunisian sun export to Europe?", *Inkyfada*, November 11, 2022, https://shorturl.at/glyHM.

at a price higher than the energy is sold for, leaving the state exposed to its creditors in the project.[43] Moreover when it comes to employment, CSP is one of the least efficient in terms of job creation. One paper found that in Tunisia, "energy efficiency in buildings generates the most employment, followed by solar water heaters and PV [photovoltaic] installations. Wind energy and CSP follow."[44] The total estimated jobs expected to be created as part of all current and planned renewable energy projects in Tunisia by 2030 is between 7,000 and 20,000,[45] which would likely account for between 1% and 5% of the jobs that have historically been created annually.[46] Yet most of the jobs in the large solar and wind projects are temporary and come in the initial construction phase, with maintenance requiring relatively few employees.[47] Ben Rouine and Roche also conclude that "large-scale PV and wind energy projects may not be best suited to providing numerous long-term employment opportunities."

Alternative Frameworks

Tunisia does not have the technology, raw materials, or finances to build domestic RE production on its own, so it must rely on others for some of its needs in this domain. The current private, foreign investment model is helping to create and reinforce an export-led strategy serving European energy consumption at the expense of costly, water-intensive, ecologically risky, and relatively low-employment-creating projects. Yet the need for Tunisia to develop RE infrastructure remains — not so much out of climate responsibility but energy and development needs. As the authors of "Just Transition" note, "much of Africa's energy system is yet to be built," and one based on fossil fuels is at risk of "long-term viability" with "technological, economic, financial, and social risks and uncertainties."[48] In the case of Tunisia, some have concluded that in the long term, producing RE to meet domestic consumption will be more cost-efficient than using fossil fuels.[49]

So what alternative to the current framework does Tunisia have in terms of developing its RE infrastructure? There are at least two underexploited alternatives that are not mutually exclusive. The first is to actually use the United Nations' Green Climate Fund (GCF), which has adequate funding and a mission designed for developing countries like Tunisia to overcome multiple climate issues, including mitigation measures such as RE production as well as capacity-building and technology development and transfer.[50] The second alternative is for Tunisia to refocus its priorities on smaller, localized RE infrastructure at the community and household scale, which has a better record in terms of job-creation and environmental impact, and which is less dependent on costly foreign inputs.[51]

Green Climate Fund in Tunisia

Currently the GCF appears to be vastly underutilized in Tunisia, just as it is in numerous other developing countries due to political opposition from developed countries as well as overly burdensome red tape and a low appetite for risk that is incommensurate with the fund's aims.[52] The

43. Jawad Moustakbal, "The Moroccan Energy Sector: A Permanent Dependence," in *Dismantling Green Colonialism*, eds. Hamza Hamouchene & Katie Sandwell, (Pluto Press, 2023), 227.

44. "Employment from renewable energy and energy efficiency in Tunisia – new insights, new results," Energy Procedia 93, 2016, Ulrike Lehr, Anke Mönnig, Rafik Missaoui, Sami Marrouki, Ghazi Ben Salem, 227.

45. See Isabel Schafer, "The Renewable Energy Sector and Youth Employment in Algeria, Libya, Morocco and Tunisia," African Development Bank, 2016, https://shorturl.at/vNVY0, 33.

46. Author's calculations assuming 75,000 jobs created annually, using 2000-2008 numbers cited in "Job Creation essential to Tunisia's stability", *MEED*, January 10, 2013, https://www.meed.com/job-creation-essential-to-tunisias-stability/.

47. Ben Rouine & Roche in *Green Colonialism*, 213.

48. Just Transition, 54.

49. Schafer, 78.

50. "GCF in Brief: Support for Technology," Green Climate Fund, December 4, 2018, https://www.greenclimate.fund/document/gcf-brief-support-technology.

51. Ben Rouine & Roche in Green Colonialism, 215.

52. See Emma Rumney & Simon Jessop, "Insight: That sinking feeling: Poor nations struggle with U.N. climate fund," *Reuters*, November 11, 2021, https://finance.yahoo.com/news/insight-sinking-feeling-poor-nations-114313602.html; see also Isabella

GCF to date lists nine projects relating to Tunisia, all of which are multi-country projects, and Tunisia's inclusion in some of them is merely potential rather than confirmed. Of these nine, only one is advertised as relating to assistance for RE generation, a $1.1 billion project managed by the World Bank (WB), launched in March 2021, approved in March 2023, and set to be completed by 2035. However, even in this project, identified as Funding Proposal 204 (FP204), the funds will not go directly toward RE generation in Tunisia through direct investment in this industry. Instead, the funding will go to a project led by the World Bank whose three "pillars" include "(i) reform of energy subsidy accompanied by mitigation measures and communications; (ii) diagnosis of the financial, technical and commercial performance of the utility (STEG) together with a Performance Improvement Plan (PIP) to improve the technical and commercial performance and a financial recovery plan to improve the financial performance; and (iii) support for the establishment of the Electricity Regulatory Authority."[53]

The first pillar — reforming energy subsidies specifically by reducing them — has long been one of the "most important conditions" that both the WB and the International Monetary Fund (IMF) have set for their loans to Tunisia since at least 2013.[54] In their past statements linked to loan programs to Tunisia, both of these international financial institutions justified reducing energy subsidies largely due to what they see as necessary fiscal austerity as well as inefficiencies and inequality with the subsidy system — justifications that have largely been debunked.[55] However, more recent WB language has begun to include justifications for reducing Tunisia's energy subsidies on the grounds that they "undermine the green transition."[56] This prioritization of energy subsidy reductions is an analytical approach that targets consumption patterns yet is justified in market terms to support RE — i.e., based on the assumption that the barrier to RE production in Tunisia is uncompetitive prices rather than inelastic demand tied to growth, a lack of raw materials and technology, and a lack of financing. By prioritizing reductions in non-RE consumption, the WB also seems to be neglecting the pressing need of developing countries to increase their overall energy consumption for development in line with the principle of CBDR.

Rather than working with the WB to cut Tunisia's energy subsidies, GCF funding in the form of grants could go directly to Tunisia for RE projects as public goods, publicly owned with appropriate technology transfer to produce the conditions for self-sufficiency and the eventual energy independence envisioned by Tunisia's strategy. Numerous other critiques of the GCF, including from the fund's own independent evaluation unit, have also identified this issue of GCF funding being virtually inaccessible directly by developing countries.[57] The fund has also been found avoiding risk in long-term, less lucrative infrastructure

Kaminski, "UN's Green Climate Fund too scared of risk, finds official review," *Climate Home News*, April 19, 2023, https://www.climatechangenews.com/2023/04/19/uns-green-climate-fund-too-scared-of-risk-finds-official-review/.

53. "FP204: Sustainable Renewables Risk Mitigation Initiative (SRMI) Facility (Phase 2 Resilience Focus) [SRMI Resilience]", GCF Documentation, April 11, 2023, 19, https://www.greenclimate.fund/project/fp204.

54. Nada Trigui & Ameni BenSik Ali, "Reforming the Fuel Subsidy System," Observatoire Tunisien de L'Economie, Explanatory paper no1, October 10, 2023, 2 https://www.economie-tunisie.org/en/Reforming_the_Fuel_Subsidy_System.

55. See Chafik Ben Rouine & Jihen Chandoul, "How international financial institutions affect social protection in Tunisia," in *Uncovered: The Role of the IMF in Shrinking the Social Protection*, ed. Salma Hussein, Friedrich Ebert Stiftung, September 2022, https://library.fes.de/pdf-files/bueros/tunesien/19559.pdf; see also Ghaya Ben Mbarek, Chahd Lina Belhadj & Fadil Aliriza, "Ripping Tunisia's Social Safety Net to Shreds," *Meshkal*, October 3, 2022, https://meshkal.org/ripping-tunisias-social-safety-net-to-shreds/.

56. "Tunisia Economic Monitor: Reforming energy subsidies for a more sustainable Tunisia," World Bank Group, Spring 2023, 17, https://documents1.worldbank.org/curated/en/099019303282329860/pdf/IDU08730f37a0a51a04e8108a1c07409008aedb8.pdf.

57. See e.g., Georgia Hammersly, Melanie Pill, & Roland Rajah, "Revitalizing the Green Climate Fund," Lowy Institute, September 6, 2023, https://www.lowyinstitute.org/publications/revitalising-green-climate-fund; see also "Second Performance Review of the Green Climate Fund," Final Report Volume I, February 2023.

projects, where it has a clear role to play in the void left by more risk-averse, for-profit investors.[58] In Tunisia, that lack of risk appetite among private investors is clear, given that even the mild regulatory requirements the state imposes on investors, such as requiring investors to commit 30% equity for PV installations, have apparently drawn "concerns" from private-sector companies not willing to risk so much.[59]

Small-Scale Alternatives

While solar and other renewable energy sources do not make up a significant part of Tunisia's energy mix, Ben Rouine and Roche identify that most of the existing RE sector in Tunisia is made up of decentralized photovoltaic cell installation, largely at the residential level. "This sector has thus far grown mostly thanks to residential PV installation programs — 90 percent of Tunisian renewable energy sector companies work in the PV sub-sector," note the researchers.[60] This sector may also be an organic outgrowth of an earlier, well-developed economic sector in Tunisia: the importation, assembly, and installation of solar water heaters (not PV), which, although not contributing to RE, has played a role in reducing demand on the electricity grid.

This existing sector and its strengths could be the basis for expanding Tunisia's RE production in a way that produces more jobs, is less environmentally damaging, does not burden the state's fiscal resources in the way that more large-scale solar production is likely to, is more conducive to community-level participation and ownership, and is less reliant on expensive capital imports. This may require more local financing via local banks as well as regulatory changes to facilitate lengthy permitting for such projects[61] and also greater involvement from local government and businesses.[62]

Future Outlook

For Tunisia to meet its growing development needs, investment in increased energy production and availability is necessary. The official, stated strategy of reducing energy consumption by 2030 through "energy austerity" would hinder economic development, particularly as Tunisia is still far below the global average for per capita energy consumption — even less than half of average global consumption by some estimates,[63] and about one fourth of German per capita consumption.[64] Goal 10 of the United Nations' Sustainable Development Goals is to reduce inequality within and among countries, a goal which could be met by prioritizing the development of lesser-developed countries like Tunisia and facilitating that by building the energy capacity necessary to meet such development.

Addressing global inequality in this domain includes not merely increasing domestic energy consumption to help Tunisia's population achieve a higher standard of living but crucially meeting the energy needs of expanding industrial development necessary to becoming competitive with more established industrial sectors in already industrialized countries. As the authors of "Just Transition" note, "energy access is about much more than meeting current demand. It means providing access to energy at levels that truly meet energy needs for decent lives with 24/7 access that meets basic needs and provides resilient livelihoods — for all. It means making energy available to power local firms and social service providers that enable thriving local economies and small industries."[65]

58. See Isabella Kaminski, "UN's Green Climate Fund too scared of risk, finds official review," *Climate Home News*, April 19, 2023, https://shorturl.at/txJM6.

59. IRENA, 14.

60. Chafik Ben Rouine and Flavie Roche, "Renewable Energy in Tunisia: An Unjust Transition" in *Dismantling Green Colonialism*, eds. Hamza Hamouchene & Katie Sandwell, (Pluto Press, 2023), 210.

61. IRENA, 14 and 54.

62. Ben Rouine & Roche, 215.

63. See "Electricity in Tunisia 2022", https://shorturl.at/iMTU8; see also "Primary energy consumption per capita", Our World in Data, https://ourworldindata.org/grapher/per-capita-energy-use, accessed May 10, 2024.

64. See "Electricity in Germany 2022", https://shorturl.at/bck23.

65. Just Transition, A Climate, Energy and Development Vision for Africa, 2023, 38.

And while overall energy consumption will need to go up for development, one way of eventually reducing fossil fuel consumption in Tunisia without insisting on "energy austerity" would be to invest significantly in public transportation while leaving industrial, agricultural and personal energy consumption outside of any cutting targets. Rather than going up, as would be expected in a developing country, industry's share of total energy consumption in Tunisia has actually gone down progressively since 2014, from 30% then to 25% in 2021, while transportation's share has steadily increased, from 28% to 33% in the same period.[66] Greater investment in public transportation systems, especially inter- and intra-city trains and other mass transit mechanism, could significantly reduce fossil fuel consumption. Reducing personal car dependence through significant changes to urban design could also alleviate this.[67]

Achieving an increased domestic energy supply and access through the development of RE would help Tunisia meet its stated goal of attaining energy independence and moving away from its current dependence on imported fossil fuels. While the current strategy clearly lays out an increase of RE's share of electricity production from the current level of about 2.3% to 35% by 2030, this goal "should not be compromised, as seems currently the case with the Ministry of Energy favoring primarily an export market orientation," Aida Delpuech argues in a recent study for Heinrich Böll Stiftung.[68]

Smaller, more localized renewable projects at the local and residential level, which already make up the majority of businesses in the RE sector, appear better at creating more jobs and are more cost-effective because they are less dependent on costly imports. This is important from a broader economic development perspective given that Tunisia, like much of the Global South, has suffered from chronic unemployment of about 15%. Addressing unemployment is also linked to reducing global inequality: Theorists have argued that the "latent surplus" labor represented by a pool of unemployed laborers is the Global South is "tied to a whole system of polarization of wages (as well as wealth and poverty) on a world scale."[69]

International actors have a role to play in helping Tunisia achieve greater RE productive capacities. This could include technology transfer on a bilateral basis, but they could also make use of existing instruments like the GCF and the existing commitments all countries have made to this fund. The GCF should also work directly with Tunisian institutions, which, like institutions in numerous other developing countries, lack the human and financial resources[70] both to navigate funding compliance requirements as well as the project management procedures, structures, and organizational capacity to work with the fund effectively. This type of engagement, apart from addressing the shortcomings that the Global Climate Fund's internal review of its own performance found, would also restore credibility to the GCF in terms of its capacity to effectively address climate change in a just way.[71]

66. "Bilan Enérgetique 2021," L'Observatoire National de l'Energie et des Mines, Tunisian Republic, Ministry of Industry, https://tinyurl.com/5epkn3be , 38.

67. See Fadil Aliriza, "Reimagining the City: Biking and Public Space in Tunisia," *Meshkal*, August 29, 2021, https://meshkal.org/reimagining-the-city-biking-and-public-space-in-tunisia/.

68. Delpuech, *Green Hydrogen*, 6.

69. John Bellamy Foster, Robert W. McChesney and R. Jamil Jonna, "The Global Reserve Army of Labor and the New Imperialism," *Monthly Review*, November 1, 2011, https://monthlyreview.org/2011/11/01/the-global-reserve-army-of-labor-and-the-new-imperialism/.

70. On short-staffing and lack of human resources see IRENA, 56.

71. See John O. Kakonge, "Does the Green Climate Fund care about its credibility?" *Nation*, May 8, 2023, https://nation.africa/kenya/blogs-opinion/blogs/does-green-climate-fund-care-about-its-credibility--4226744.

Breaking a Vicious Cycle: The Impact of Egypt's Renewable Energy on Energy Security

Colby Connelly

Photo above: A row of air conditioning units on a building in Cairo, Egypt. Photo by Islam Safwat/Bloomberg via Getty Images.

Egypt is frequently viewed as one of the more successful cases of renewable energy deployment in the Middle East and North Africa (MENA) region, especially compared to many of its peers in North Africa. To be sure, Egypt's rollout of utility-scale solar and wind capacity has been impressive. Yet at the time of writing, the country is being wracked by an energy crisis that has seen little mitigation from its renewable power capacity. Natural gas-fired power plants make up the majority of the domestic generation fleet, and rising demand for electricity as well as increases in other gas demand segments has led to shortages. In fact, the current crisis is remarkably similar to the same predicament in which Egypt found itself about a decade ago, even though, in the time since, its generation of renewable power has grown markedly.

This chapter will argue that, while Egypt's renewable power has the potential to be a major contributor to the state's energy security, it has not developed at a pace that currently supports this outcome. This fact is evident from the current domestic energy shortfalls, despite a growing percentage of Egyptian power coming from wind and solar sources. Egypt's complicated relationship with natural gas and the mismanagement of domestic gas markets are a critical reason for those continued energy shortfalls and point to ways in which significant renewable power growth may prevent this issue from re-emerging in the future. This will require devoting significant attention to Egypt's attempts to manage its natural gas supply and demand balance. This cannot truly be separated from the wider energy issues the country is still grappling with, especially as Egypt's ongoing economic crisis appears to be worsening.

This may be foreboding of another missed opportunity for the country to grow its renewable power capacity, which

likely holds significant potential to act as a solution to cyclical energy shortages that often necessitate expensive fuel imports and contribute to wider economic burdens on both the population and the state. What much of this will likely indicate is that, for the foreseeable future, there will be strong linkages between the volume of natural gas in Egypt's energy mix and its ability to grow the role of renewable power on a national scale. The following study will also point to potential economic and political headwinds that may blur the prospects for further expansion of the renewable energy sector. Finally, it will argue that developing a green hydrogen sector holds the potential to provide a new, domestic energy source that may in turn ease Egypt's gas dependency in other demand segments outside of the power sector.

Overview of Energy Mix and Consumption Patterns

As of 2022, statistics from the London-based Energy Institute's *Statistical Review of World Energy Data* confirm that natural gas remains the largest component of Egypt's power generation mix by far, representing 79.3% of the total 200.8 terawatt-hours (TWh) generated that year.[1] Renewable energy sources, which include solar, wind, and hydroelectric (hydro)[2] power, were collectively Egypt's second-largest source of power the same year, though at 12% of total generation, these remain well below natural gas.

At a glance, Egypt would appear to be a stand-out case among its North African peers with respect to its renewable power capacity. It holds 45% of North African wind power capacity and accounts for 80% of solar capacity in the region.[3] Yet a closer look challenges that view. Morocco holds 46% of regional wind power capacity and most of the rest of the region's solar capacity. Aside from these two, other countries in North Africa have either not made significant progress with respect to solar power, or their geography lacks significant wind power potential to merit major investments in this type of energy source.

Most of the recent, significant gains Egypt has posted in renewable power generation have come from wind and solar capacity growth, with hydro likely to have largely maxed out its potential in the country. Wind made substantial contributions to this total before solar, but data from the inter-governmental International Renewable Energy Agency (IRENA) indicates that the two did not exceed 25% of total generation from renewables until 2019, later rising to 40.9% of renewable generation in 2021 (the most recent year for which IRENA data is available).[4] This highlights the fact that until recently, most of Egypt's growing renewable power generation was underpinned by its existing use of hydro.

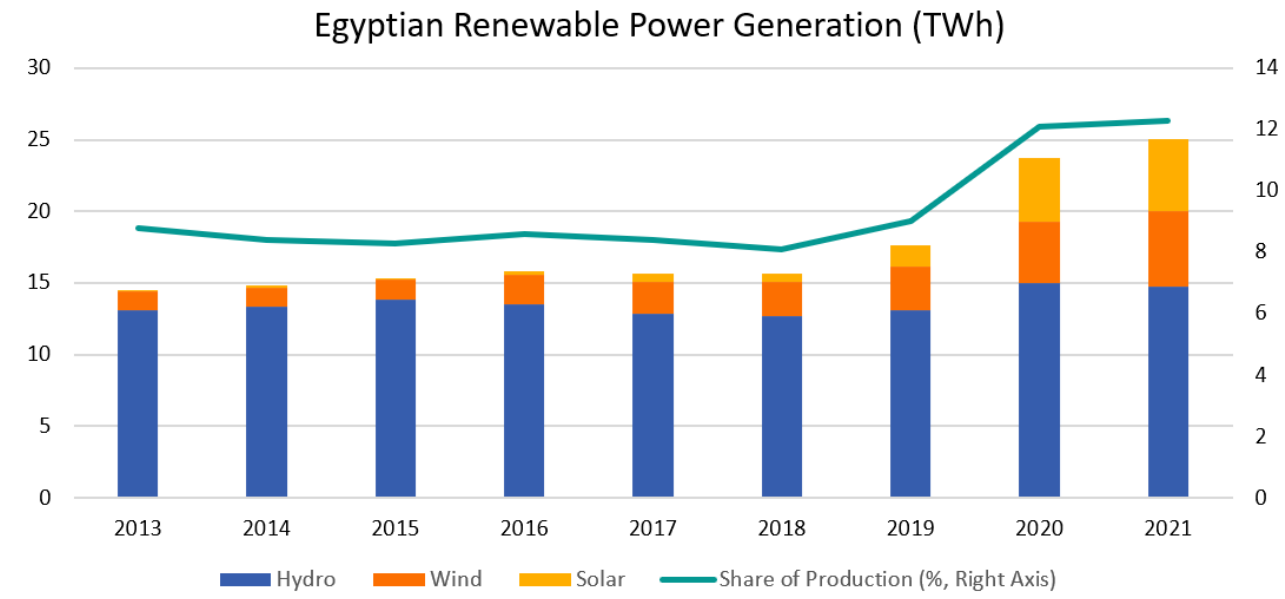
Further, Energy Institute data points to limited growth in the recent past: While generation from gas fell by almost 4.0% from 2021 to 2022, this was offset by a 3.6% increase in oil-fired generation, with renewables making marginal gains at 0.2%. This overwhelming reliance on natural gas as a primary component of the power mix in Egypt plays a major role in the country's current energy crisis, especially since the power sector is not the only significant source of gas demand. Egyptian Petroleum Minister Tarek El-Molla in 2022 referred to natural gas as

1. Energy Institute, "Home," Statistical Review of World Energy, accessed September 27, 2023, https://www.energyinst.org/statistical-review/home.

2. While there have been assertions made that hydro power generation is not a source of renewable energy, most authorities on the national and international level, including the International Energy Agency (IEA), United Nations, and the United States' Energy Information Administration (EIA), do indeed see hydro as a form of renewable energy. This study will categorize hydro as a form of renewable energy in keeping with the classifications made by the aforementioned institutions. See: IEA, "Renewables - Energy System," accessed November 5, 2023, https://www.iea.org/energy-system/renewables; UN, "What Is Renewable Energy?" accessed November 5, 2023, https://www.un.org/en/climatechange/what-is-renewable-energy; EIA, "Hydropower Explained," accessed November 5, 2023, https://www.eia.gov/energyexplained/hydropower/.

3. IRENA, "Planning and Prospects for Renewable Power: North Africa," January 2023, https://www.irena.org/Publications/2023/Jan/Planning-and-prospects-for-renewable-power-North-Africa.

4. IRENA, "Planning and Prospects for Renewable Power: North Africa," 2023.



Source: Energy Institute

Egypt's "fuel of choice."[5] The high percentage of gas in Egypt's generation mix certainly indicates this, but other policy moves, such as a push to expand offshore gas exploration amid the current crisis, point to a continued tendency by Cairo to see this resource as a way out of energy crises and less as a major cause.

Egypt's rate of electricity demand growth also places major constraints on the ability of renewables to meet a more significant percentage of power demand. This is one area where Cairo has moved more decisively to end the practice of subsidized energy consumption, with relatively recent reforms coming as a component of previous International Monetary Fund (IMF) bailout agreements. These have been slow to take effect, with one estimate suggesting that Egypt still spent $2.6 billion on electricity subsidies in 2020.[6] While some signs do point to a slowdown in household power consumption, inflationary pressures in 2022, which deeply impacted food and fuel prices, had an outsized impact on the Egyptian economy, thus making it difficult to tell if subsidy reforms are primarily responsible for curbing consumption or if economic factors are playing a larger role.

At the start of Egypt's 2021-2022 fiscal year, state utilities continued incremental power price increases that most heavily impacted households with low rates of consumption — probably representing the majority of consumers in the country. Average users were likely to see close to a 17% increase in prices on a per-kilowatt hour (kWh) basis.[7] Larger Egyptian household consumers saw less of an incentive to curb consumption. "Heavy" users were more likely to see a price increase of about 2.8% per kWh, while "extra-heavy" users saw an even lower increase of 1.2% per kWh, effectively shifting the burden of demand management to low-income Egyptians, which came with political and economic implications. Power generation in Egypt has maintained a steady growth rate of about 2% per year, based on Energy Institute data, and total consumption reached a record level of 167 TWh in 2022.[8] More recently, in July 2023, peak electricity

5. Emily Meredith, "Egypt's Choice," Energy Intelligence, January 25, 2022, https://www.energyintel.com/0000017e-8e26-d3b7-abfe-debe79f60000.

6. Adel Hamaizia and Tom Moerenhout, "Five Takeaways from a Decade of Energy Subsidy Reforms in MENA" *Chatham House*, February 16, 2022, https://www.chathamhouse.org/2022/02/five-takeaways-decade-energy-subsidy-reforms-mena.

7. Peter Stevenson, "Egypt Raises Power Prices, Waiting on Fuel Prices," *Middle East Economic Survey* 64, no. 27, July 9, 2021, http://archives.mees.com/issues/1911/articles/59837.

8. Peter Stevenson, "Egypt Power Consumption Hits Record

demand reached a record of 34.65 GW, a 3% year-on-year increase from 2022. This also coincided with the return of scheduled blackouts in a situation bearing considerable resemblance to the energy crisis of the early 2010s.

However, power demand is not the only factor playing a role in Egypt's gas supply crunch. Without doubt, supply constraints are a primary factor; natural gas consumption fell 2.3% in 2022 after rising to record levels in 2021. In the same year, gas production also fell by 4.9%, making a supply shortfall the most likely reason for a lower level of demand and logically extending its decline into 2023 when liquefied natural gas (LNG) exports were halted. Other structural factors also play a role; gas is sold to power generators at a very low rate of $3.00 per million British thermal units (MMBtu), while prices for other forms of industrial consumption are considerably higher.[9] Residential consumers, however, have also represented a fast-growing segment of gas demand due to the expansion of Egypt's gas grid. Rates per cubic meter depend on overall levels of consumption, but households that consume 60+ cubic meters in a month pay just $0.12 per unit.

Supply-Side Echoes of a Previous Crisis, Fears of a Cyclical Trend

Gas pricing described in the previous section has put Egypt's own gas resources under immense pressure. Egypt does not enjoy the sizeable reserves that other North African peers like Libya or Algeria are able to boast, meaning that most of its production comes from maturing fields where production is declining, which also raises production costs. Yet as the country with the largest population in the MENA region, energy demand continues to grow, and thus Egypt has become a net importer of fossil fuels. This holds critical implications for the country as it remains in a period of gas shortages, since the search for alternative energy supplies leads the government to import fuel oil to run its power plants, costing Cairo hundreds of millions of dollars and causing considerable erosion to its foreign exchange reserves.[10]

Egypt's upstream gas sector, most of which is concentrated in its offshore Mediterranean fields, had been a lifeline for the country's energy security since the discovery of the giant Zohr field by Italian oil and gas major Eni in 2015.[11] The find was well-timed; Egypt had been experiencing energy shortages since the early 2010s. Part of the reason for its energy shortfall has been attributed to bullish expectations for gas supply in addition to forecasts that underestimated the rate of electricity demand growth, even though the forecast used anticipated annual demand increases of as much as 10%.[12] Looking back, it almost appears that enthusiasm for exploration prospects in Egypt have fed into a similar dynamic, in which gas production growth led policymakers and state planners to believe that the country would possess sufficient gas supplies to make use of its sizeable gas-fired generation fleet. According to figures from IRENA, Egypt had the highest level of committed and planned power investments in North Africa from 2015 to 2020, although only 15% of this number applied to renewable energy projects, with the rest supporting further investment in hydrocarbon-based power generation that has yet again run short of fuel.

Notably, even in 2013, Egypt still relied on gas-fired power to meet some 70% of its electricity needs, and falling output at key fields was among the primary factors behind its energy crisis a decade ago.[13] However, the development of new domestic resources did not end the last crisis and

167TWh For 2022," *Middle East Economic Survey* 66, no. 12, March 24, 2023, http://archives.mees.com/issues/1998/articles/61951.

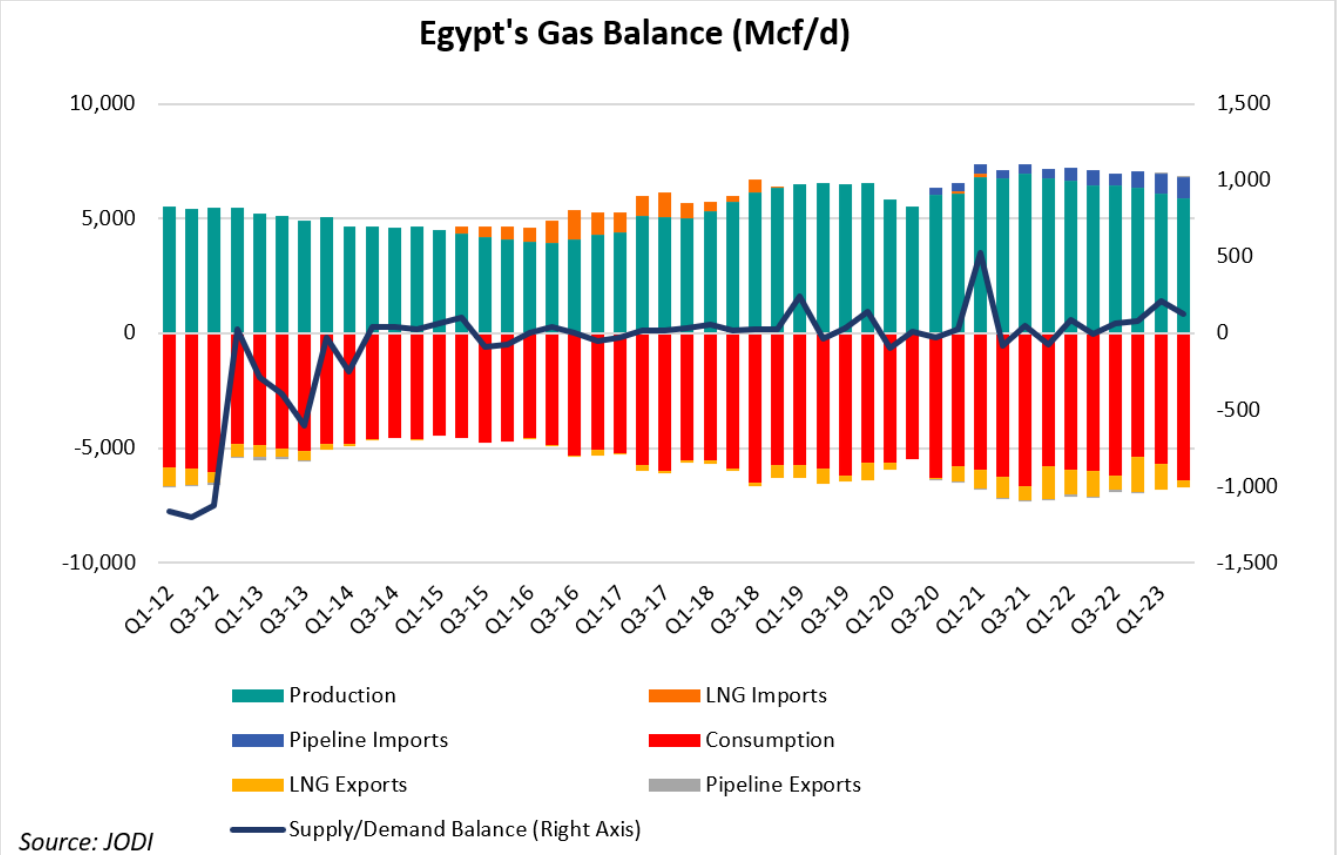
9. "Natural Gas Pricing," Gas Regulatory Authority, accessed November 5, 2023, https://www.gasreg.org.eg/natural-gas-pricing/.

10. Stevenson, "Egypt Power Consumption Hits Record 167TWh For 2022."

11. Offshore Technology, "Zohr Gas Field," February 26, 2021, https://www.offshore-technology.com/projects/zohr-gas-field/.

12. Akram Ismail, "The Power Generation Crisis in Egypt," *Middle East Institute*, September 3, 2014, https://www.mei.edu/publications/power-generation-crisis-egypt.

13. "Egypt: Gas Shortage Fuels Record Diesel Demand," *Middle East Economic Survey* 57, no. 37 (September 12, 2014), http://archives.mees.com/issues/1547/articles/51904.



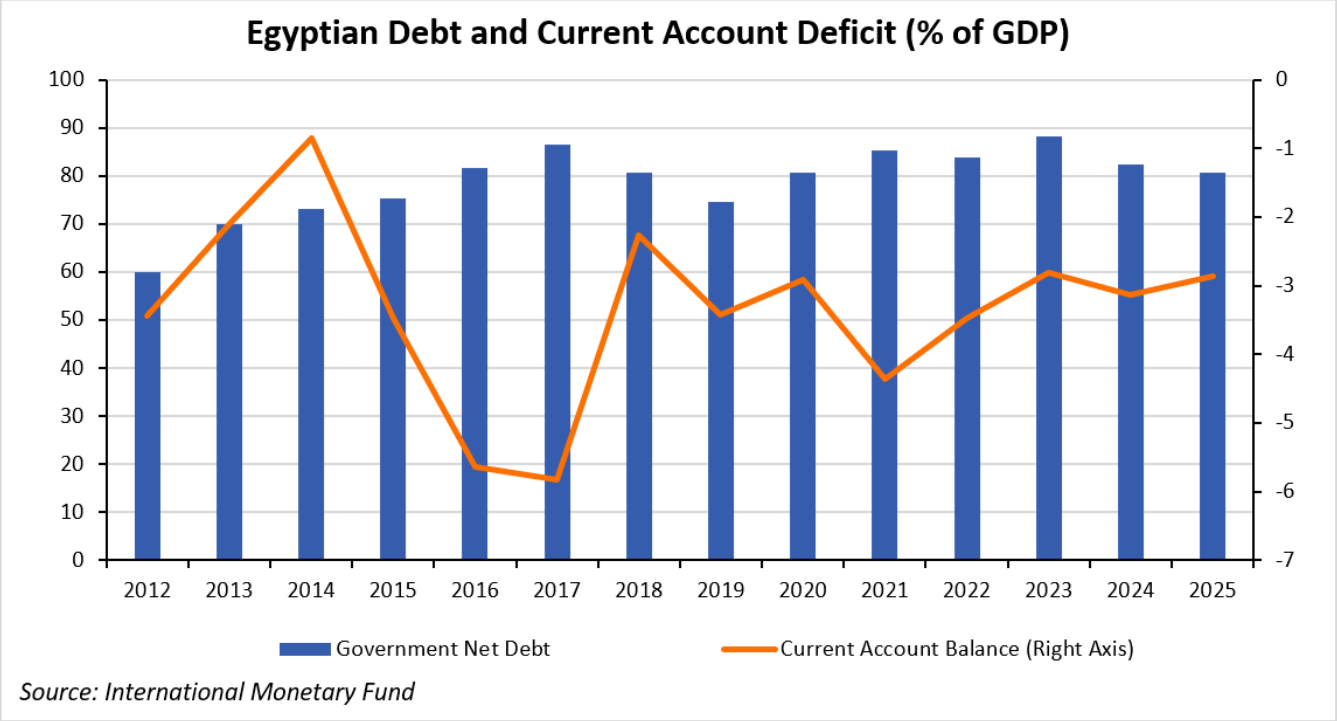
Source: JODI

provide greater security of supply, even as Zohr became the crown jewel of the Egyptian gas industry. Rather, the procurement of floating storage and regasification units (FSRUs) turned Egypt into a substantial importer of LNG, albeit for a brief period.[14] LNG imports rose to a 10.7 billion cubic meter (bcm) peak in 2016 before tapering off in 2018, when production rose again. It is currently uncertain whether Egypt will again attempt to procure one or more FSRUs to boost its access to gas supplies, especially as its ability to afford this option is highly questionable in its current predicament.

Imports of pipeline gas from Israel have helped mitigate the deficit of available gas supplies but have not completely eliminated the need for fuel imports. Challenges with Egypt's state finances and current account balance only face options ranging from bad to worse so long as the country needs to continue importing energy supplies that are still insufficient to address its shortfalls. Further, recent political developments in the region demonstrate that Israeli supply is increasingly susceptible to regional security risks. Before the outbreak of the ongoing war between Israel and Hamas in the Gaza Strip, Egypt was importing an average of 870,000 cubic feet (nearly 25,000 cubic meters) of gas per day from Israel via the East Mediterranean Gas (EMG) pipeline. This equates to about 14% of its average consumption in the first six months of 2023. However, security risks led Israel's energy ministry to order the Chevron-operated Tamar gas platform to halt operations, which has since resulted in a dramatic decrease in exports to Egypt. As Israeli and Egyptian officials have offered conflicting accounts of the actual volume of gas being piped to Egypt, which must now transit Jordan instead of flowing directly across the border, it is difficult to tell how much gas Egypt is now receiving since the start of the conflict.[15] What is clear is

14. Brendan Meighan, "Egypt's Natural Gas Crisis," Sada - Carnegie Endowment for International Peace, January 21, 2016, https://carnegieendowment.org/sada/62534.

15. Tom Pepper, "Israeli Sources Contradict Egypt on Gas Supplies," Energy Intelligence, October 30, 2023, https://www.energyintel.com/0000018b-816e-dc0c-a3cf-8dfe48d10000.



Source: International Monetary Fund

that as a result of the conflict, imports from Israel have been severely reduced and has resulted in the extension of blackouts and a near-halt to LNG exports due to a lack of available gas supply.[16]

Egypt's previous attempts to rely heavily on the development of its domestic gas resources have only provided it with periods of brief surplus before the notoriously high decline rates of its offshore gas fields have resulted in recurring shortfalls. Worryingly, there are some indications that Cairo has not abandoned this tendency after holding multiple upstream bid rounds in 2023 that were undoubtedly motivated by the urgent need to boost domestic gas production. While a recent offshore discovery by Shell has followed a string of disappointing exploration results, modest and incremental gas production growth has demonstrably failed to provide Egypt with a significant degree of energy security in the past.[17]

It is simply not feasible for Egypt to bet on continued exploration success, which is a highly uncertain prospect, as a means of keeping up with gas and power demand that is certain to continue growing at a strong trajectory to the end of the current decade and beyond. This is not to discount the fact that gas will remain a critical part of Egypt's energy mix in the long-term, both in the power sector, for residential use, and in critical segments of its industrial sector. Yet increases in power demand, continued expansion of the national gas grid to decrease household reliance on cylinders of liquefied petroleum gas (LPG), as well as the ability to grow the industrial sector are certain to face supply constraints and throw Egypt back into the same crisis it faced in the early 2010s and looks to be facing again in 2023.[18] Components of Egypt's National Climate Change Strategy (NCCS) even call for growing new segments of gas demand by converting road vehicles away from liquid fuel-based systems and toward

16. Peter Stevenson, "Egypt Power Cuts Worsen As Gas Output & Israeli Import Slump Continues," *Middle East Economic Survey* 66, no. 44, November 3, 2023, https://www.mees.com/2023/11/3/power-water/egypt-power-cuts-worsen-as-gas-output-israeli-import-slump-continues/225dea30-7a58-11ee-b245-279b87240827.

17. Peter Stevenson, "Shell Discovery Offers Hope As Egypt Gas Output Slide Continues," *Middle East Economic Survey* 66, no. 41, October 13, 2023, http://archives.mees.com/issues/2029/articles/62604.

18. World Bank, "Egypt: Installing Household Gas Connections for A Better Quality of Life," December 20, 2021, https://www.worldbank.org/en/news/feature/2021/12/20/egypt-installing-household-gas-connections-for-a-better-quality-of-life.

the adoption of natural gas.[19] This does not point towards a prioritization of demand management to any significant degree. While gas demand from the power sector is only one segment of Egypt's overall gas demand, in the current era it will likely be the path of least resistance to both offset gas use, which will preserve domestic supply and stem the need for costly imports, as well as to better provide secure and reliable supply of electricity for Egypt's growing population.

Construction of the planned 4.8 GW Dabaa nuclear power plant would provide welcome relief for the gas-starved power sector.[20] Nuclear startups in nearby Abu Dhabi have been the driving factor in helping the emirate reduce its gas demand, and although Egyptian energy markets are larger and in many ways more complex than those of the United Arab Emirates, capacity on this scale would provide a technically feasible means of low-carbon power growth.[21] While the project has been subject to multiple delays, it may move ahead, but is unlikely to start before the end of the decade. Further, as with many other energy developments in Egypt, its economic situation clouds the outlook for completing major, capital-intensive projects of this type on time. This is to say nothing of the nuclear fuel imports that would be required to keep the plant operating. As a result, there is unlikely to be any clearer alternative for Egypt to boost its energy security from domestic resources and lower its fuel costs than by devoting greater resources and other efforts to expanding its renewable energy sector. Diversifying the Egyptian energy mix in a way that reduces the role of natural gas in the domestic energy sector would provide relief from overreliance on any one energy source, and reducing gas demand ostensibly provides a view to a gas surplus in Egypt, which could in the future be called upon to address intermittency challenges persistent in the renewable energy sector. There will not be a perfect solution for Egypt's current energy woes, but falling into a remarkably similar energy crisis twice in the space of a decade must signal that a new approach to developing more secure sources of supply is necessary.

Progress and Obstacles in Renewable Energy Development

In the years between Egypt's energy crises, gas and power demand have only continued to grow. Renewable power generation has not posted serious growth until recent years, as demonstrated by data from a previous section. This has come alongside a trajectory of gas demand growth and a decline in domestic production that threatens to plunge Egypt's gas balance back into a deficit after years of surplus helped by domestic growth and Israeli imports.

Yet, there is justification for cautious optimism in the renewable power space. Egypt has a strong track record of signing new agreements for the development of renewable power capacity. However, these often take the form of non-binding memoranda of understanding (MOUs) that will not necessarily translate into a final investment decision (FID) on new projects. As of late 2022, when Egypt hosted the COP27 summit at Sharm el-Sheikh, it had signed MOUs for a total of 14 GW of new capacity to be developed by 2028. In the shorter-term, capacity looks likely to reach 5 GW by 2025, which would represent just under 2 GW in added capacity over the next two years.[22] Additionally, other projects such as UAE firm Masdar's plans for a 10 GW wind farm are so grand in their ambition and scope that there will be valid questions about their timely or full completion.

Reports point to an agreement that has secured land for what would be one of the largest wind power projects in the world; although there are existing plans for larger wind farms elsewhere, the largest currently operating project is the Dogger Bank Wind Farm in the North Sea, which will

19. "Egypt National Climate Change Strategy (NCCS) 2050," Climate Change Laws of the World, 2022, https://climate-laws.org/document/egypt-national-climate-change-strategy-nccs-2050_d3b1.

20. Stevenson, "Egypt Power Consumption Hits Record 167TWh For 2022."

21. Jamie Ingram, "UAE Sets Out To Become Green Industry Hub," *Middle East Economic Survey* 66, no. 20, May 19, 2023, http://archives.mees.com/issues/2006/articles/62124.

22. Peter Stevenson, "Masdar Secures Land For 10gw Egypt Wind Farm," *Middle East Economic Survey* 66, no. 23, June 9, 2023, http://archives.mees.com/issues/2009/articles/62200.

have a capacity of 3.6 GW upon completion.[23] Financing a project of this size, even for an entity like Masdar, may pose considerable challenges in a world that looks likely to see an extended period of higher borrowing costs for the foreseeable future. In July 2023, the New and Renewable Energy Authority (NREA) signed an agreement with Scatec for a 5 GW wind farm in the West Sohag region, advancing an earlier MOU. Scatec is an established renewables developer in Egypt, which may lend some credibility to the idea that such a large-scale project is actually feasible.[24] Additional progress on these agreements will be necessary to both drive investor confidence and to signal that Egypt and its partners have potentially advanced their ability to deliver on projects of this scale.

Cairo has also won critical allies when it comes to project finance, which is a noteworthy accomplishment given many of the chronic economic woes that are often enough linked to its energy issues in more than one respect. A key player in this process has been the European Bank for Development and Reconstruction (EBRD), which has consistently underwritten renewable power projects in Egypt in a manner that has helped it attract financing from a diverse range of sources, such as other multilateral banks and private sector lenders.[25] Given the state of Egypt's economy at the time of writing and the inherent credit risks this presents, this type of financing will doubtlessly be critical for it to post further growth in its renewables sector, regardless of whether it reaches its stated targets. In fact, it may be Cairo's ability to continue attracting developers with access to such financing that has seen it sign a succession of agreements for some of the world's most ambitious renewable energy projects long after COP27 and well into an era during which it has often appeared to be in a state of precipitous economic decline. ACWA Power, a Saudi-based developer that has lengthy experience in Egypt's power sector, managed to secure financing for a 200 MW solar project from the EBRD in September 2023, along with several other lenders including the UN Green Climate Fund and the OPEC Fund.[26]

As will be explored in a subsequent section, the EBRD has maintained consistent involvement in supporting project financing and the development of regulatory frameworks for Egypt's renewable power sector. It has expanded this support to Cairo's ambitions around developing a green hydrogen sector. While the green hydrogen industry is less developed than the renewable energy industry in much of the world, it will still be critical for Egypt to retain partnerships such as this one to support the early stages of its nascent hydrogen sector.

Looking ahead, project finance may represent a growing challenge as Cairo fights to stem a rising tide of unfavorable economic developments that have little prospect of relief in sight. Moody's downgraded Egypt's credit rating in early October 2023, due in part to concerns that Cairo may not meet its external debt obligations.[27] High import prices for essential commodities, such as the fuel oil imports mentioned earlier in addition to agricultural commodities like wheat that have been impacted by the Russia-Ukraine war, have placed the country's foreign exchange reserves under serious strain, further contributing to a vicious cycle in which debt repayments worsen Cairo's fiscal position.[28] While these reserves remain below pre-COVID-19 levels, an extremely limited

23. Anmar Frangoul, "The World's Largest Offshore Wind Farm Produces Its First Power," *CNBC*, October 9, 2023, https://www.cnbc.com/2023/10/09/the-worlds-largest-offshore-wind-farm-produces-its-first-power.html.

24. Peter Stevenson, "Egypt Looks South For 5gw Wind," *Middle East Economic Survey* 66, no. 27 (July 7, 2023), http://archives.mees.com/issues/2013/articles/62291.

25. Nibal Zgheib, "How the EBRD Became Egypt's Leading Partner for Renewable Energy," EBRD, November 4, 2022, https://www.ebrd.com/news/2022/how-the-ebrd-became-egypts-leading-partner-for-renewable-energy-.html.

26. James Cockayne, "Egypt 200mw Solar: Financing Complete," *Middle East Economic Survey* 66, no. 35 (September 1, 2023), http://archives.mees.com/issues/2022/articles/62476.

27. "Moody's Downgrades Egypt Deeper into Junk Territory," *Reuters*, October 5, 2023, https://www.reuters.com/world/africa/moodys-downgrades-egypt-deeper-into-junk-territory-2023-10-05/.

28. Adam Lucente, "Egypt's Economy Teeters Following Moody's Downgrade," *Al-Monitor*, October 6, 2023, https://www.al-monitor.com/originals/2023/10/egypts-economy-teeters-following-moodys-downgrade.

recovery materialized in the third quarter of 2023.[29] Its massive debt load has pushed it to seek more relief from the IMF, which frequently conditions its support on difficult policy options like currency devaluations that in turn add inflationary pressures to the lives of ordinary Egyptians.[30]

Political risks will also remain relevant in the near-term, especially as the Egyptian economy continues to founder and regional conflicts place pressure on its leadership. The ability to execute projects in a stable, functioning policy and economic environment is a key consideration for foreign investors and developers, and as a result these factors are difficult to ignore when considering the outlook for renewable energy growth in any country, or indeed for the prospect of growth in any sector. With Egypt's economic outlook still bleak, power generation capacity remains in question due to an inability to secure financing from international lenders.[31]

Few Other Options

Egypt's economic struggle arguably presents more of a case for greater investment in renewable energy. Cairo's efforts to boost upstream investment and encourage more natural gas exploration offer no guarantees of success. Absent a major development of this sort, Egypt has few options to increase its access to reliable gas supplies. New pipeline capacity enabling greater connectivity with Israel will be more politically difficult for Cairo than at any time in recent history due to the evolving nature of the Israel-Hamas war in the Gaza Strip. Cairo could return to its status as a seasonal LNG importer, likely via a floating storage and regasification unit (FSRU). Neither of these options provides relief for its beleaguered economy, as further currency devaluations appear likely, and exposure to international LNG markets would require yet another source of dollar-denominated energy imports. But the considerable potential of Egypt's wind and solar resources offer an alternative to long-term costs associated with natural gas imports.

Additionally, Egypt's inability to generate enough power for its citizens is not due to a lack of power generation capacity; in fact, Egypt holds a comfortable surplus of generation capacity.[32] Its real problem is insufficient fuel for its power plants, most of which run on natural gas. While some can be run on fuel oil or if necessary, diesel, the pitfalls of oil-based power generation have been described in a previous section. As a result, Egypt's complicated relationship with its natural gas demand appears to present itself as the source of its energy security issues.

As a result, near-term investment in renewable power development is one of the most likely means of avoiding the need to continue importing expensive sources of fuel that Cairo can ill afford. The oft-repeated phrase of "capex heavy, opex light" as applied to renewable energy essentially means that, although the initial capital expenditures (capex) required to build solar and wind generation sources are generally high, the operational expenditures (opex) required to maintain this capacity once it has been built is comparatively low.[33] Since renewable power generation does not have any fuel costs, the expense of maintaining solar panels and wind turbines (again, associated opex) are, for the most part, the only long-term costs associated with the life-cycle of these projects. Egypt's location in the MENA region places it at an advantage in developing further renewables capacity, since a levelized cost of energy (LCOE) assessment from Energy Intelligence estimates large solar photovoltaic (PV) as the lowest-cost form of power generation in the region at $33.2/MWh, with onshore wind the second-lowest at $61.9/MWh. However, as Egypt boasts a considerable number of highly ambitious wind power projects, its local costs are likely to be below the regional average.

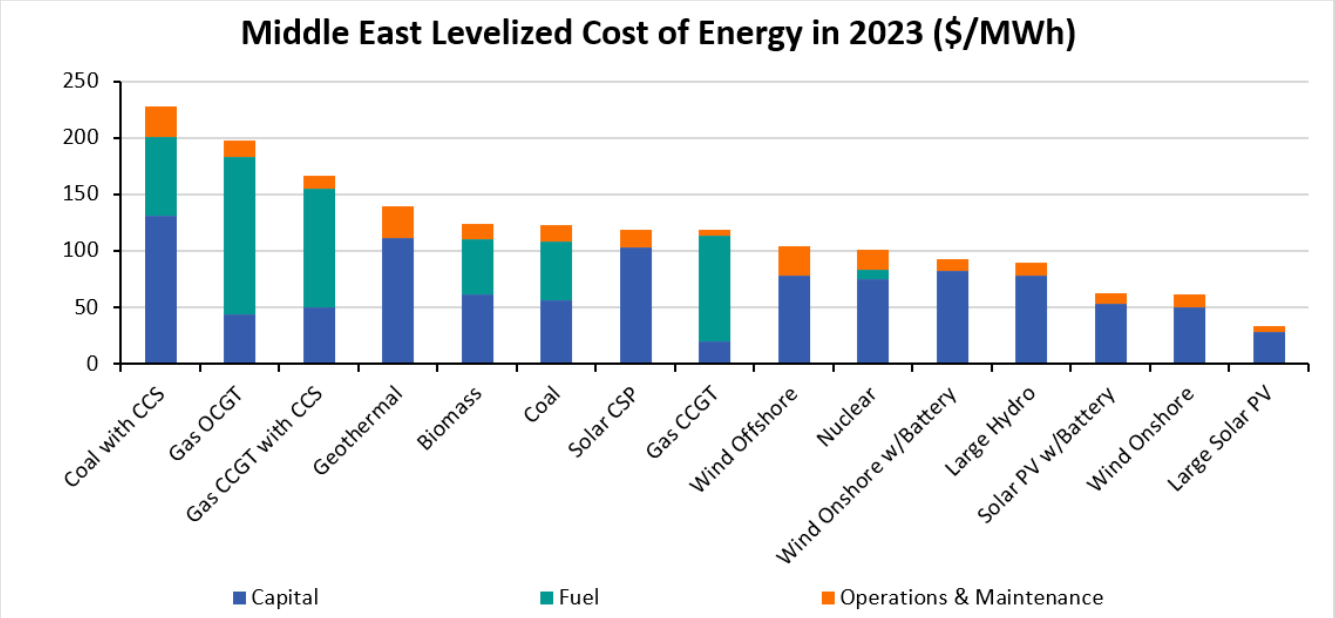
29. Peter Stevenson, "Egypt Foreign Reserves* Edge Up $49mn For August ($bn-End Month)," *Middle East Economic Survey* 66, no. 36, September 8, 2023, http://archives.mees.com/issues/2023/articles/62502.

30. Tom Pepper, "Brics No Match for Egypt's Economic, Gas Woes," Energy Intelligence, August 31, 2023, https://www.energyintel.com/0000018a-486b-d109-af8a-d8ebc53d0000.

31. Ismail, "The Power Generation Crisis in Egypt."

32. Stevenson, "Egypt Power Consumption Hits Record 167TWh For 2022."

33. Philippe Roos, "Energy Intelligence Forum Leadership Dialogue: Paddy Padmanathan, Acwa Power," Energy Intelligence, October 18, 2020, https://www.energyintel.com/0000017b-a7db-de4c-a17b-e7dbca550000.



Source: Energy Intelligence

Finally, displacement of gas from the power sector with renewable energy could support Egypt's ambitions of becoming a regional gas export hub, which would further provide the country with economic benefits.[34] If substantial reductions in the need for gas-fired power generation could be achieved, this would enable Egypt to export more of its gas as LNG, supporting economic growth and providing a greater influx of foreign currency due to the fact that the gas trade is still mostly dollar-denominated. IOCs present in the region have demonstrated a continued willingness to link gas discoveries in Cyprus and Israel to Egypt's extensive offshore gas infrastructure with a view to using export terminals at Idku and Damietta.[35] This interest persists despite perennial fears that gas shortages will lead Cairo to divert gas away from liquefaction facilities and towards its domestic markets at a time of shortage. Yet if renewable power generation were to expand at a faster pace, this would provide potential safeguards against this outcome taking place in the future and would provide the added benefit of increasing Egypt's viability as a major gas export hub.

Areas for Further Consideration

Electricity Infrastructure

Even if Egypt achieves its renewable energy capacity targets, it still requires substantial investment in its transmission infrastructure. This will present a new challenge of its own, and one that generally attracts less attention than major announcements around the development of major new renewable energy projects. As it stands, existing capacity faces significant challenges from issues with intermittency, due in part to the fact that most major solar projects are located significantly far away from the major population centers where power is required.[36]

Rectifying these issues may be less challenging than developing large solar and wind projects, but it is one that will need continued emphasis in order for projects that do come to fruition to live up to their full potential in providing Egypt with more secure, reliable supplies of

34. Tom Pepper, "Egypt Pins Hopes on Exploration Amid Gas Crunch," Energy Intelligence, October 5, 2023, https://www.energyintel.com/0000018a-fc2a-dba2-adef-fe6a58b20000.

35. Tom Pepper and Rafiq Latta, "Cyprus Pursues Elusive Gas Solution," Energy Intelligence, September 5, 2023, https://www.energyintel.com/0000018a-4c79-d6e8-a9be-5cfd65200000.

36. Stevenson, "Egypt Power Consumption Hits Record 167TWh For 2022."

electricity. Here too, the EBRD continues to display its vital role in unlocking financing for Egyptian renewable energy projects; in October 2023, $174 million in EBRD backing was announced for a wider $2 billion effort to upgrade Egypt's power grid to better integrate upcoming renewable power projects.[37]

Energy Strategy and Capacity Targets

One major issue with Egyptian renewable energy targets is that they do not appear to be based on a specific capacity goal. Its Integrated Energy Strategy (ISES), which sets renewable power goals for the year 2035, envisions 42% of power being generated from renewables. The majority of this is expected to come from solar PV at 22%, followed by wind at 14%, concentrated solar power (CSP) at 3%, and hydropower at 2% and likely to be made up of existing capacity. However, this does not point to distinct capacity targets, only the portion of Egypt's generation mix it expects to come from each source. In fairness, the lack of more quantifiable capacity or generation goals does not make Egypt particularly distinct from the rest of the countries in the region or their renewable power targets. Additionally, it is possible that there may be a lack of faith in official projections given that Egypt has essentially run into the same type of energy crisis in the space of a decade. Moreover, the uneven rate of implementation for energy polices, such as subsidy reductions, would be an added challenge in attempting to project demand growth. Yet even several scenarios for the possible trajectory of peak power demand in Egypt would enable those considering investment in the renewable energy sector to determine how great a role Egypt's current level of capacity is expected to play relative to future demand.

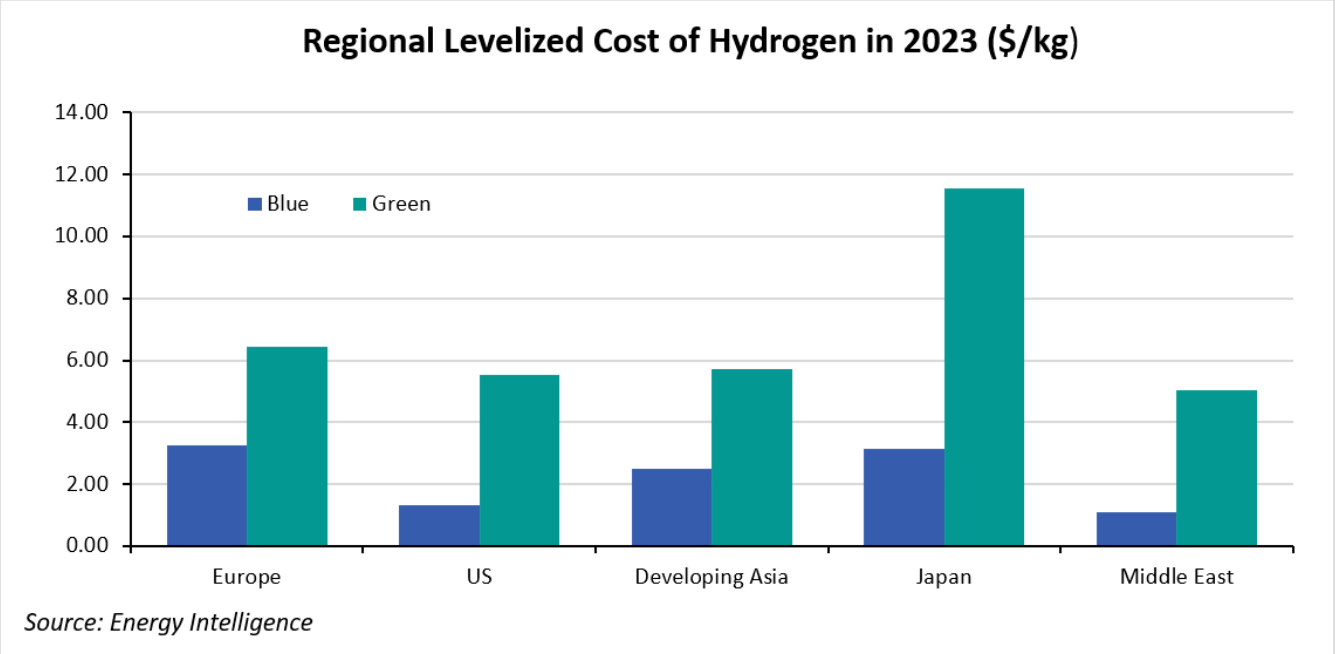
Green Hydrogen and Ammonia Ambitions

As an aspiring green hydrogen producer, a more well-articulated hydrogen strategy would likely help Egypt attract greater investment into the nascent sector, which has thus far been slow to develop. COP27 was the originally intended venue for the strategy's debut, but at the time of writing nearly a year has passed, and yet no strategy has been revealed. Some reports indicate that a finalized strategy is forthcoming, with intra-ministry infighting over management of the sector supposedly resolved by senior authorities.[38] Critically, it does appear that the EBRD has been involved in consultative sessions on the strategy's development, which may provide a greater degree of investor confidence in Egypt's path forward. Other measures, such as the establishment of a National Green Hydrogen Council, signal more coherent state support for the sector as well.

The development of global "clean" hydrogen markets remains distinctly uncertain, due in part to many of the difficulties associated with transporting hydrogen, in addition to the fact that "blue" hydrogen produced using natural gas and a steam methane reforming (SMR) process is currently more cost-competitive than producing green hydrogen. Given Egyptian supply issues with natural gas and the cost of developing the necessary carbon capture and storage (CCS) capacity, the idea of Egypt emerging as a major center of blue hydrogen production can be almost definitively ruled out. Further, much of the current skepticism around the development of clean hydrogen markets comes from the costs associated with transporting hydrogen. As hydrogen is a volatile substance in its gaseous form, conversion into ammonia is currently viewed as the most viable means of transporting clean hydrogen over long distances. This section will address the advantages Egypt is expected to be able to leverage in producing green hydrogen, but it will face little distinction from other aspiring exporters when it comes to projects that for the moment appear highly focused on ammonia exports. Yet Egypt currently relies on natural gas to support its ammonia production capacity of 6 million tons per year, demonstrating just one avenue in which

37. "NWFE Electricity Grid Reinforcement," EBRD, accessed November 5, 2023, https://www.ebrd.com/work-with-us/projects/psd/54716.html.

38. Africa Intelligence, "Egypt Finalises Strategy to Launch Hydrogen Production," October 9, 2023, https://www.africaintelligence.com/north-africa/2023/10/09/egypt-finalises-strategy-to-launch-hydrogen-production,110062869-art; Africa Intelligence, "Electricity and Oil Ministries Clash over Green Hydrogen Plans," March 28, 2023, https://www.africaintelligence.com/north-africa/2023/03/28/electricity-and-oil-ministries-clash-over-green-hydrogen-plans,109928715-art.



further use of renewable energy could reduce natural gas dependency outside of the power sector and contribute to future-proofing of strategic industries by shifting production to low-carbon processes.[39]

Additionally, hydrogen has many potential applications in a range of industrial segments that are major drivers of Egypt's natural gas demand, raising the prospect of domestically produced green hydrogen being consumed as an alternative to natural gas in processes such as oil refining, steelmaking, and as other industrial feedstocks. Enthusiasm around new applications of green hydrogen has also included discussion of "blending" hydrogen in natural gas distribution networks, although this comes with many technical challenges of its own.[40] However, the existing Egyptian natural gas network is vast, perhaps opening future avenues for meaningful domestic use beyond industrial applications.

The MENA region is expected to enjoy competitive advantages in green hydrogen production due to low renewable energy costs, mostly for solar PV. Egypt could leverage both its wind and solar potential in this regard, which is not an advantage possessed by every country in the region. Outside of power generation, it is the one demand segment that definitively calls for renewable power usage and may serve something of a dual purpose in boosting renewable energy use in Egypt. Many of Egypt's current plans for green hydrogen projects center around the Ain Sokhna area, where a test facility built by Scatec and Fertiglobe, the latter of which is a joint venture of Egypt's OCI and the Abu Dhabi National Oil Company (ADNOC), is already in operation.[41] Other plans for industrial development in this area may support industrial use of green hydrogen in "hard to abate" sectors, which could hold the potential to support decarbonization of export-oriented industries.

If Egypt is able to secure the required investment for green hydrogen production, use of the fuel in its domestic energy sector may hold the potential to begin offsetting natural gas consumption in key industries. This would theoretically enable Egypt to use renewables to tackle

39. Kevin Rouwenhorst, "Renewable Ammonia Opportunities in Egypt," Ammonia Energy Association, December 18, 2022, https://www.ammoniaenergy.org/articles/renewable-ammonia-opportunities-in-egypt/.

40. Natasha Nguyen, "Hydrogen Blending as a Pathway Toward U.S. Decarbonization," National Renewable Energy Laboratory, January 24, 2023, https://www.nrel.gov/news/program/2023/hydrogen-blending-as-a-pathway-toward-u.s.-decarbonization.html.

41. James Cockayne, "Egypt Green Hydrogen: Slow Progress," *Middle East Economic Survey* 66, no. 32, August 11, 2023, http://archives.mees.com/issues/2019/articles/62408.

its gas demand issues from both sides of the problem, which are overconsumption of gas in both the power and industrial sector. However, a realistic approach to this sector's development is essential. In addition to the aforementioned questions around the commoditization of hydrogen and challenges with shipping methods and costs, there is still further uncertainty around international standards for what constitutes green hydrogen. Potential investors will also be wary of economic and political factors in Egypt when determining how to proceed with FIDs on major projects. In order for hydrogen to truly displace significant volumes of natural gas demand, considerable investments will likely need to be made in new technological processes other than green hydrogen production capacity alone, further raising the stakes for Cairo's ability to continue attracting investors into this space.

Conclusions

Improvements in Egyptian energy security will not comprehensively rectify the structural factors that caused the country's current economic crisis to come about. Yet an improvement in this area would free up state resources and other capacities that are currently being used to provide what is already a shortfall in supply. In a time of crisis, a lack of reliable and affordable energy has the potential to exacerbate already poor circumstances. This chapter is not attempting to argue that Egypt should cease its efforts to continue developing domestic gas resources. On the contrary, gas has a demonstrated role to play in supporting economic development. Rather, the chapter's central argument is that far greater efforts must be placed on developing alternative sources of low-cost domestic supply, and in the current era renewable resources in the form of wind and solar capacity present the most viable option. The initial investment required to develop this capacity is likely to present the most significant challenges for Egypt, but the dynamics explored above indicate that Cairo is not without allies and partners that, despite its deteriorating economy, continue to provide it with critical support. Placing greater emphasis on building out these channels of support has perhaps never been more critical, as current patterns of policy behavior may indicate that energy crises induced by gas shortages may become a cyclical feature of Egypt's energy sector rather than an aberration.

The Dry Transition: Water Security and North Africa's Renewable Energy Future

Mohammed Mahmoud

Photo above: A man and children walk toward a tank distributing distilled sea water in the Moroccan village of Sidi Bouchta, on Aug. 23, 2024. Photo by AFP via Getty Images.

Introduction

In the context of global energy transition that seeks to address the climate crisis through mitigation efforts to reduce carbon and other greenhouse gas emissions, renewables and alternative forms of low-emission fuels have been touted as the mechanisms toward a greener, cleaner, and more sustainable future. But often ignored are the hidden resource costs behind implementing and expanding the use of these energy substitutes for higher-emission fuels. For example, climate mitigation and adaptation strategies that involve hydropower, desalination, and green hydrogen might not adequately consider the critical role of water in those processes. Similarly, climate resilience solutions that look toward improving the efficiency of food production often pursue technological improvements with only a secondary consideration of the availability of a robust water supply, even though water is the most essential input in those applications and is needed to sustain a productive agricultural sector, which is the backbone of global food security.

The water-energy nexus serves as a pivotal framework outlining the intricate relationship between water and energy resources and underscores their interdependence within North Africa. From the energy-intensive processes of desalination as a means of addressing water scarcity to the synergy between hydropower and climate adaptation, the nexus emerges as a linchpin for the region's transition to a more secure energy future. This intersection of water and energy interdependency is quite critical for a region like North Africa, especially considering the extreme effects climate change has (and will continue to have) on the region under a rapidly warming future. However, as challenges mount due to climate-induced water scarcity, flooding risks, and geopolitical tensions surrounding major

water infrastructure projects, leveraging the water-energy nexus demands strategic investments, collaborative policies, and a comprehensive approach to ensure a resilient and successful energy transition for the region.

The Water-Energy Nexus

The water-energy-food nexus is an important framework for identifying the co-benefits and interdependence of these three critical resources toward effective and sustainable management within their respective sectors. A better understanding of these linkages can help to interpret how external drivers like climate change, population growth, and socioeconomics might affect the way these sectors interoperate and could enable the development of holistic policies and strategies to address the long-term resource insecurity challenges posed by these factors.

For example, the **energy-food** part of the nexus highlights energy as a critical component in agricultural systems, playing a key role from early stages such as the planting and harvesting of crops to end stages such as the processing and distribution of food. As such, the food production sector consumes a significant amount of energy in the processing, transportation, and storage of food. Conversely, materials and products from the food sector can be utilized in the manufacturing of biofuels, offering an alternative form of renewable energy. Recognizing these types of interdependencies is an essential step toward more sustainable and secure food production systems that balance the energy needs of the food sector with the demand for stable and reliable sources of food.

Much of the emphasis on this multi-resource nexus has traditionally been on the interconnection between **food and water**. This is because, quite simply put, food security is a direct byproduct of water security. Without adequate and reliable water supplies, agricultural systems would collapse. To put that into context, on average, 70% of global water supplies are consumed by the agricultural sector.[1] This figure is actually more pronounced in North Africa, where in 2020, average agricultural water withdrawal as a percent of total water withdrawals was closer to 80% (with that statistic ranging from 64% in Algeria to 96% in Sudan).[2]

Shifting to the **water-energy** section of the nexus, it is also clear that at a fundamental level, the water and energy sectors are highly dependent on each other to function and meet their respective objectives. For example, the availability of reliable energy resources is critical to enable water management systems to operate infrastructure assets like dams and treatment plants, and to move water from source points to areas of utilization through pipelines or canal networks (such as in urban water systems). Similarly, water is an often overlooked but important component of energy generation. Power plants and other industrial facilities need water for cooling requirements (e.g., in cooling towers to regulate temperature). Thermoelectric plants in particular (such as nuclear and natural gas power plants) utilize water to improve the efficiency of electricity generation. These power plants boil water to create steam that spins the plant turbines to generate electricity. This steam must then be cooled down to revert back into water before it is reused again to generate electricity — cold water cools steam efficiently, thus making electricity generation more efficient.

Furthermore, the water-energy nexus is an area that deserves greater attention because climate change will stress the relationship between these resources, and because several critical climate mitigation and adaptation strategies will rely heavily on the interconnectivity of these sectors. Enhanced warming propelled by climate change is a primary cause behind sustained drought and prolonged water scarcity, as warming simultaneously reduces available freshwater supplies and inflates demand. This cascading climate impact is especially heightened in arid and semi-arid regions that already face existing challenges regarding access to adequate and reliable water supplies, which is emblematic of hydrological conditions in North Africa. Warming also results in inflated energy demands, especially as it relates to cooling needs in urban and built environments, to protect human populations from the

1. "Topics: Water in Agriculture," World Bank, accessed May 9, 2024, https://www.worldbank.org/en/topic.

2. "AQUASTAT Dissemination System," Food and Agriculture Organization of the United Nations (FAO), accessed May 9, 2024, https://data.apps.fao.org/aquastat/?lang=en.

public health risks of heat exposure and illness due to dangerously elevated temperatures.

When it comes to addressing climate change, the water-energy nexus also offers several climate resilience solutions that take advantage of the complementary nature of these two resources. In terms of climate adaptation intended to alleviate the effects of drought and water stress, desalination offers the coastal nations of North Africa an additional source of water that can help meet the shortfall in freshwater supplies and increased water demand due to warming. North African countries currently incorporate desalinated water as part of their respective water portfolios, with future plans of ramping up desalination capacity. Egypt, for example, has over 80 desalination plants of varying capacities operating along the coastlines of both the Red Sea and the Mediterranean.[3] Similarly, Tunisia's desalination plants generate 6% of its potable water and additional plants are planned so that desalination can meet 30% of the country's water demand by 2030.[4] Algeria, at one point, operated Africa's largest desalination facility — the Magtaa desalination plant in Wilayat Oran with a capacity of 500,000 cubic meters per day (CMD).[5] The distinction of having Africa's largest desalination plant now belongs to Morocco with its facility in Chtouka,[6] soon to be eclipsed with a 548,000 CMD-capacity plant in Casablanca.[7] Desalination already provides 25% of Morocco's agricultural water use, and that percentage will likely increase with the construction of additional plants.[8]

The greatest resource cost associated with desalination plants, outside of the financial investment needed to build new facilities or expand existing capacity, is the amount of energy needed to operate them. Desalination is an energy-intensive enterprise, because of the energy required to apply the high pressure needed to separate salt and other dissolved matter from seawater. This accounts for 25-40% of the cost of the water produced from desalination.[9] However, research efforts in this field have continued to explore opportunities for energy efficiency that could reduce the energy consumption of desalination via alternative membrane technologies (e.g., reverse osmosis) or increase the volume of water produced using similar energy consumption rates.

Other water security solutions to meet the potential regional imbalance between water supply and demand include conservation and reuse applications. In the case of conservation, there is great potential in North Africa for improving the efficiency of water use in both agricultural and urban sectors (certainly more so for agricultural use due its higher water footprint).[10] Water efficiency improvement in both sectors would involve

3. Yasser Elsaie et al., "Water desalination in Egypt; literature review and assessment," *Ain Shams Engineering Journal*, vol. 14, no. 7, July 2023, https://doi.org/10.1016/j.asej.2022.101998.

4. Redaction Africanews, "Drought-hit North Africa turns to purified sea and wastewater," Africa News, July 27, 2023, https://www.africanews.com/2023/07/27/drought-hit-north-africa-turns-to-purified-sea-and-wastewater/.

5. Tedagua, "Tedagua will operate and maintain the largest desalination plant in Africa," *Smart Water Magazine*, November 29, 2021, https://smartwatermagazine.com/news/tedagua/tedagua-will-operate-and-maintain-largest-desalination-plant-africa.

6. Oumaima Latrech, "Africa's Largest Desalination Plant in Chtouka Aitbaha To Open in March," Morocco World News, February 4, 2022, https://www.moroccoworldnews.com/2022/02/346887/africas-largest-desalination-plant-in-chtouka-aitbaha-to-open-in-march.

7. Raul Redondo, "Acciona wins the contract to build the largest desalination plant in Africa in Casablanca," Atalayar, November 21, 2023, https://www.atalayar.com/en/articulo/economy-and-business/acciona-wins-the-contract-to-build-the-largest-desalination-plant-in-africa-in-casablanca/20231211110623193855.html.

8. Redaction Africanews, "Drought-hit North Africa," July 27, 2023.

9. Office of Energy Efficiency and Renewable Energy, "Chapter 7: Desalination," US Department of Energy, April 2019, https://www.energy.gov/sites/default/files/2019/09/f66/73355-7.pdf.

10. Achref Chibani, "Confronting Water Scarcity in North Africa," Arab Center Washington DC, August 31, 2022, https://arabcenterdc.org/resource/confronting-water-scarcity-in-north-africa/.

reducing loss during transmission and employing conservative approaches in how water is utilized in both sectors. For agricultural use this can include the widespread application of drip irrigation and the growing of less water-intensive crops, and for urban use this can include incentivizing the installation of water-saving appliances and mindful consumption habits in homes and communities. Furthermore, scaling up reuse and recycling efforts can help to moderately reduce the demand from urban areas by utilizing treated water effluent for non-potable demand.

With respect to climate mitigation solutions that look to reduce carbon emissions by using energy sources that generate low or zero emissions, the water-energy nexus provides a couple of energy alternatives. Hydropower is a clean and renewable source of energy that relies on renewable surface water supplies, dams, and reservoirs to generate electricity. Hydroelectric dams can also have the added benefit of providing flood control and expanded water storage for surface river systems. In North Africa, the leading nations in terms of installed hydropower capacity are Egypt, Sudan, and Morocco, which in 2022 had installed hydropower capacities of 2,876 megawatts (MW), 1,923 MW, and 1,770 MW respectively.[11] In terms of percentage of total electricity produced, hydropower accounts for 60% of Sudan's electricity, highlighting the critical importance of that renewable energy source for Sudan in comparison to Egypt and Morocco (where it currently accounts for 7% and 1% respectively of total electricity produced).[12]

This is not surprising, considering that a major portion of these three nations' respective water supplies is derived from surface river systems with high-elevation headwaters that are sustained by mountain precipitation and snowpack. In the case of Egypt and Sudan, the Nile River provides the water needed to operate their respective hydroelectric dams along the river's waterways (with Sudan having significant untapped and unrealized potential for expanded hydropower). For Morocco, its surface water rivers and tributaries are sourced from the Atlas Mountains, supporting hydropower generation that accounts for 22% of the country's total power generation.[13]

While the potential for hydropower expansion in large river basins that already utilize hydropower generation (like the Nile River Basin) is promising, studies indicate that little to no additional hydropower capacity will likely be added in Africa beyond 2030.[14] This is primarily due, from a cost-competitive standpoint, to the declining costs of incorporating renewable energy sources (particularly solar).[15] In comparison to the installation of photovoltaic panels for solar farms, the construction of new hydropower generation infrastructure requires significant financial investments and a longer timeframe for project completion. Additionally, prolonged droughts brought about by increased warming due to climate change threaten to reduce annual surface water flow into hydroelectric dams, thus curbing the most critical component necessary to reliably generate hydropower. Despite an outlook that may see the use of hydropower diminish in favor of cheaper forms of renewable energy, existing hydropower generation assets should be utilized in North Africa while they are still considered economically and environmentally viable.

Energy generation sources derived from solar power also have a water consumption component. In the case

11. IHA, "Regional Profile: Africa," International Hydropower Association (IHA), 2023, https://www.hydropower.org/region-profiles/africa.

12. Our World in Data, "Share of electricity generated by hydropower, 2023," Ember and Energy Institute, June 20, 2024, https://ourworldindata.org/grapher/share-electricity-hydro?country=~SDN.

13. OBG, "Hydropower plays a growing role in the development of renewables in Morocco," Oxford Business Group (OBG), accessed May 9, 2024, https://oxfordbusinessgroup.com/reports/morocco/2016-report/economy/pumped-up-hydropower-plays-an-increasingly-significant-role-in-the-renewables-segment.

14. Angelo Carlino et al., "Declining cost of renewables and climate change curb the need for African hydropower expansion," *Science*, vol. 381, no. 6685, August 2023, DOI: 10.1126/science.adf5848.

15. Nichola Groom, "China solar panel costs drop 42% from year ago – report," *Reuters*, December 14, 2023, https://www.reuters.com/world/china/china-solar-panel-costs-drop-42-year-ago-report-2023-12-14/.

of solar farms that utilize solar panels (photovoltaics), a modest amount of water (approximately 20 gallons per MW hour) is deployed primarily for maintenance purposes associated with keeping the solar panels clean in order to efficiently absorb sunlight (and thus produce electricity).[16] Water is similarly used in concentrated solar panel (CSP) power plants to clean the mirrors necessary to reflect and concentrate the incoming sunlight into a receiver (to convert it into heat). Keeping panels and mirrors clean for both photovoltaics and CSPs is especially important for a region like North Africa (and the Middle East), where frequent dust storms can deposit sand and dust on the surfaces of panels and mirrors to the point where energy generation efficiency is impacted.[17] CSP power plants, however, consume more water as part of their energy generation process. The concentrated sunlight in CSP power plants is used to heat water, thus converting it into steam in order to spin plant turbines and generate electricity (the steam can then be cooled down to repeat the electricity generation process). In this regard, CSP power plants are also thermoelectric plants, and in contrast to photovoltaic solar farms, consume considerably more water (up to 925 gallons per MW hour),[18] likely making this a less attractive solar-based generation option for the water-stressed nations of North Africa.

Water is also a contributing factor in the production of hydrogen. In the production of grey and blue hydrogen, water is used in the form of high-temperature steam to produce hydrogen from methane (e.g., from natural gas) via a process called steam-methane reforming.[19] This process also produces carbon dioxide, but the difference between the production of grey and blue hydrogen is the way this byproduct is handled. Grey hydrogen does not intercept the release of carbon dioxide in the atmosphere (making it a high-carbon emission source), while blue hydrogen production processes and stores the carbon dioxide to make it a cleaner and lower-carbon emission alternative.[20]

Alternatively, green hydrogen is a much cleaner and potentially zero-carbon emission form of hydrogen that is wholly dependent on water to generate. Green hydrogen is produced when water molecules are split into hydrogen and oxygen through a process referred to as electrolysis. Electrolysis requires energy as part of the process, and thus can be a zero-carbon emission method of creating green hydrogen if that energy comes from renewable sources such as solar or wind farms. The concept of green hydrogen has gained traction in recent years in the context of climate mitigation efforts to reduce greenhouse gas emissions into the atmosphere. The growing interest in green hydrogen has also influenced the development of future energy transition plans in North Africa. In 2022, Egypt, Morocco, and Mauritania joined three other African countries to form the Africa Green Hydrogen Alliance,[21] and subsequently have signaled ambitious goals for incorporating green hydrogen into their energy transition plans. With planned investments of at least $60 billion for more than 450 projects involving green hydrogen (and ammonia), Morocco is looking to start production and exports of green hydrogen as early as 2024. Meanwhile, Egypt is planning to produce green hydrogen at the lowest global cost and to capture 8% of the world's hydrogen

16. SEIA, "Water Use Management," Solar Energy Industries Association (SEIA), accessed May 9, 2024, https://seia.org/water-use-management/.

17. Hamid Pouran, "The Middle East's worsening dust storms are making it harder to deploy solar energy," Middle East Institute, July 21, 2022, https://mei.edu/publications/middle-easts-worsening-dust-storms-are-making-it-harder-deploy-solar-energy.

18. Directorate-General for Research and Innovation, "Water consumption solution for efficient concentrated solar power," European Commission, June 28, 2019, https://projects.research-and-innovation.ec.europa.eu/en/projects/success-stories/all/water-consumption-solution-efficient-concentrated-solar-power/.

19. Office of Energy Efficiency and Renewable Energy, "Hydrogen Production: Natural Gas Reforming," US Department of Energy, accessed May 9, 2024, https://www.energy.gov/eere/fuelcells/hydrogen-production-natural-gas-reforming.

20. J.M.K.C. Donev et al., "Types of hydrogen fuel," Energy Education, accessed May 9, 2024, https://energyeducation.ca/encyclopedia/Types_of_hydrogen_fuel.

21. Climate Champions, "African Green Hydrogen Alliance launches with eyes on becoming a clean energy leader," UN Climate Champions Race to Zero, May 18, 2022, https://climatechampions.unfccc.int/african-green-hydrogen-alliance-launches-with-eyes-on-becoming-a-clean-energy-leader/.

market by 2050. Even Tunisia has committed to producing an astounding annual green hydrogen yield of 8.3 million tons by 2050.[22]

When considering that the production of one kilogram of hydrogen requires one liter of water, the impact of green hydrogen production on regional water resources from these proposed projects can be substantial. The unit-water footprint for green hydrogen can be much higher when taking into account additional water needed for cooling, prevention of mineral buildup, and water rejected as part of the process (inflating the unit rate up to 35 liters of water per kilogram of hydrogen). If the source of water used for green hydrogen generation requires treatment, this unit rate increases further depending on the type of water supply and the treatment it requires (e.g., approximately 37 liters of water per kilogram of hydrogen for freshwater sources and 48 liters of water per kilogram of hydrogen for seawater).[23]

While green hydrogen plans in North Africa are still in their early stages, European countries have already begun to take steps toward establishing future imports of North Africa's green hydrogen production through various framework agreements and financial subsidies.[24] Yet, from a regional energy transition and climate resilience perspective, it is unclear whether North Africa fully benefits from this arrangement (besides economic and financial gain), since local resources (e.g., water) are used to produce a decarbonized energy resource that is then deployed outside of the region.

Water and Energy Challenges in North Africa

Even though North Africa, like the rest of the Middle East, is hotter and more arid than other parts of the world, the current rate of warming due to climate change will exacerbate these physical conditions and compound water scarcity issues. North Africa's surface water systems that receive water from higher elevation sources, especially the Nile River and the tributaries of the Atlas Mountains, will likely experience a reduction of water flow. This is a consequence of global warming diminishing the rate of precipitation over the headwaters of these watersheds, sublimating mountain snowpacks (turning snow into water vapor prior to snowmelt) and significantly increasing evaporation along the course of the various waterways and from surface water reservoirs. A reduction in surface water supply for these countries will translate to a greater dependency on other sources of water, such as from desalination and water reuse (thus ramping up energy demand). Shifting extensively to the only other form of freshwater available in the region, groundwater, comes with risks as it is a finite, non-renewable, and depleting water resource. Groundwater aquifers in North Africa, such as the North Western Sahara Aquifer System shared by Algeria, Libya, and Tunisia, already face a multitude of impacts (rising salinity from seawater intrusion, pollution from industrial waste contamination, and overexploitation) that deteriorate the water quality of these subsurface systems.[25]

An overreliance on groundwater is at the core of the current challenges facing Libya and its Great Man-Made River Project (GMMRP), a large-scale water infrastructure system that pumps groundwater from aquifers in the south and transports it through a series of underground pipelines to highly populated cities in the northern and coastal part of the country. With an absence of renewable surface water supplies and an over pumping of coastal aquifers, Libya's

22. Liesl Venter, "North Africa's Hydrogen Pathway Potential: Green Fuel To Catalyze Region's Project Demand," Breakbulk, November 22, 2023, https://breakbulk.com/articles/north-africas-hydrogen-pathway-potential/.

23. Polly Martin, "Green hydrogen should be prioritised over blue due to the latter's higher water use: Irena," Hydrogen Insight, December 11, 2023, https://www.hydrogeninsight.com/policy/green-hydrogen-should-be-prioritised-over-blue-due-to-the-latters-higher-water-use-irena/2-1-1569100.

24. Polly Martin, "Analysis: Europe courts green hydrogen supply from North Africa, but when can the region deliver?", Hydrogen Insight, February 14, 2024, https://www.hydrogeninsight.com/production/analysis-europe-courts-green-hydrogen-supply-from-north-africa-but-when-can-the-region-deliver-/2-1-1598009.

25. Younes Hamed et al., "Climate impact on surface and groundwater in North Africa: a global synthesis of findings and recommendations," *Euro-Mediterranean Journal for Environmental Integration*, vol. 3, no. 25, July 11, 2018, https://link.springer.com/article/10.1007/s41207-018-0067-8.

northern cities rely heavily on the water provided through the GMMRP. Originally, the justification for pursuing the project (as opposed to implementing desalination for these coastal communities) was that it would be more cost-effective and efficient. However, the grand scale of the project has made it very costly in terms of construction, maintenance, and the energy needed to pump and distribute the extracted groundwater. Additionally, upkeep and expansion of the project is jeopardized by unreliable financial support and security risks from vandalism and crime.[26] Ultimately, groundwater remains a finite resource (even if it is sourced from Libya's deeper southern aquifers), and thus in hindsight, and in the modern context, desalination may have been a more prudent strategy to provide water to Libya's northern cities.

Another concern that comes from climate change is the threat of flooding from short-duration and intense, extreme weather brought on by warmer sea surface temperatures that can produce tropical storms or even cyclones and hurricanes. Historically, hurricanes and cyclones are more prevalent over the Atlantic, Pacific, and Indian oceans. Cyclones can form over the Mediterranean Sea, although less frequently and with a lower likelihood of making landfall.[27] However, with warmer water now a byproduct of climate warming, these Mediterranean cyclones (also referred to as medicanes) can develop and make landfall with great intensity in the countries of North Africa, resulting in major flooding events.

In addition to the potential catastrophic outcomes of flood events on human life and the built environment, uncontrolled flooding due to rainfall deluge is a serious threat to water infrastructure such as hydroelectric dams. When the flow of water upstream of a dam because of flooding is greater than the capacity of the dam to store or to safely release it, catastrophic dam failure is extremely likely. As such, efficient water operations and the regular inspection and maintenance of dams can help to minimize the potential of failure for these critical infrastructure assets. The unfortunate confluence of extreme weather, severe flooding, and inadequate dam maintenance is what lead to the natural disaster that struck Libya's coastal city of Derna in September 2023. Though the city was initially inundated by torrential rain from Storm Daniel making landfall after forming in the Mediterranean Sea, the more dangerous flooding did not transpire until the upstream Derna and Mansour dams failed. The failure of these dams as a consequence of neglected upkeep and an extraordinarily large downpour unleashed a massive pulse of water that wiped out and washed to sea large segments of Derna, resulting in a tragic death toll exceeding 10,000 lives.[28]

In the Nile River Basin, a new hydroelectric dam is the root cause of ongoing tensions between riparian countries in the Blue Nile section of the river. The Grand Ethiopian Renaissance Dam (GERD), now essentially complete (in terms of construction), operational (can generate electricity), and filled (with respect to water storage),[29] has been a source of water management dispute between Egypt, Sudan, and Ethiopia since construction began in 2011. Ethiopia's unilateral decision to build the dam and the continued deadlock between the three nations on agreement regarding operations[30] means, in effect, that Ethiopia will continue to unilaterally decide how to operate the dam (with respect to water releases for hydropower generation

26. Malek Altaeb, "What's next for Libya's Great Man-Made River Project?", Middle East Institute, August 10, 2022, https://www.mei.edu/publications/whats-next-libyas-great-man-made-river-project.

27. Davide Faranda and Erika Coppola, "The "Medicanes" (Mediterranean Hurricanes) and Climate Change," Xaida, accessed May 9, 2024, https://xaida.eu/medicanes-and-climate-change/.

28. "Storm Daniel leads to extreme rain and floods in Mediterranean, heavy loss of life in Libya," World Meteorological Organization, September 12, 2023, https://wmo.int/media/news/storm-daniel-leads-extreme-rain-and-floods-mediterranean-heavy-loss-of-life-libya.

29. AFP, "Filling of Grand Renaissance Dam on the Nile complete, Ethiopia says," *Al Jazeera*, September 10, 2023, https://www.aljazeera.com/news/2023/9/10/filling-of-grand-renaissance-dam-on-the-nile-complete-ethiopia-says.

30. AP News, "Ethiopia and Egypt say no agreement in latest talks over a contentious dam on the Nile," AP News, December 20, 2023, https://apnews.com/article/ethiopia-egypt-dam-nile-dispute-21571634b25f5aa9a8f857fb16cabaf3.

purposes) with little regard for the concerns of its downstream neighbors.

With a storage capacity of 74 million cubic meters, the GERD is now Africa's largest hydropower dam.[31] The water source of the dam's hydropower generation is the Blue Nile, also one of the main tributaries of the Nile, contributing 83% of the river's annual volume.[32] Uncertainty on how Ethiopia's dam operations (to generate hydroelectricity) will affect river flow downstream is worrisome for Egypt and Sudan, which combined account for nearly 90% of annual water withdrawals from the Nile. Both nations draw on the waters of the Nile to support agricultural irrigation for food production, and in the case of Egypt, the resource needs of its rapidly growing population have caused its water demand to outpace the available supply.[33]

In the case of Sudan, even with the vast hydropower potential the Nile provides, the country's electricity grid remains unreliable and intermittent to the point where lengthy blackouts are a common occurrence. The absence of reliable electricity only applies to a portion of Sudan's residents (primarily in urban and highly populated areas), as a staggering 60% of Sudan's population lacked access to electricity as of 2022.[34] Part of the issue is on the energy demand side, since electricity demands far exceed Sudan's available capacity. In fact, Sudan's annual electricity demand growth rate is at an exceptionally high 11%.[35] To close the gap on this imbalance between energy demand and availability, large-scale improvements and upgrades to Sudan's electricity infrastructure, energy generation capacity, and allocation of alternative energy sources will be necessary. This will not come without large financial cost, as just the basic maintenance and restructuring of Sudan's existing energy sector is estimated to cost $3 billion.[36]

Supporting North Africa's Energy Transition Through Enhanced Water Security

Leveraging the synergetic relationship of the water-energy nexus is a strategic pathway for North Africa to advance its energy transition goals. But, as previously discussed, to truly take advantage of the full breadth of opportunities this nexus can offer in terms of cleaner, greener, and renewable energy will necessitate investments, improvements, reforms, and expansions in the water and energy sectors for the countries of North Africa. And though these hurdles may seem daunting from a feasibility perspective, there are international policy incentives to motivate countries to adopt national energy portfolios that are less reliant on fossil fuels.

At the end of 2023, following several days of negotiations, the United Nations Climate Change Conference (28th Conference of Parties, COP28) in Dubai, UAE, concluded with an agreement that called for parties to the 2015 Paris Agreement to transition away from fossil fuels.[37] As part of their commitment

31. IHA, "Sediment management: Ethiopia - Grand Ethiopian Renaissance Dam (GERD)," International Hydropower Association (IHA), accessed May 2024, https://www.hydropower.org/sediment-management-case-studies/ethiopia-grand-ethiopian-renaissance-dam-gerd.

32. Philip J. Akol, Robert P. Z. Galla, Sabuni Wanyonyi et al., "The Nile Basin Water Resources Atlas," Nile Basin Initiative, February 6, 2016, https://nilebasin.org/node/12311.

33. Catherine Nikiel and Elfatih Eltahir, "Past and future trends of Egypt's water consumption and its sources," *Nature Communications*, vol. 12, no. 4508, July 2021, https://doi.org/10.1038/s41467-021-24747-9.

34. Razaz H. Basheir, "The electricity crisis in Sudan: Between quick-fixes and opportunities for a sustainable energy transition," Transnational Institute, October 14, 2022, https://www.tni.org/en/article/the-electricity-crisis-in-sudan#note-17977-1.

35. Kenta Usui et al., "From subsidy to sustainability: Diagnostic review of Sudan's electricity sector," World Bank, June 30, 2019, https://documents1.worldbank.org/curated/en/486961588608080192/pdf/From-Subsidy-to-Sustainability-Diagnostic-Review-of-Sudan-Electricity-Sector.pdf.

36. Monged Abdalla and Tamer Qarmout, "An analysis of Sudan's energy sector and its renewable energy potential in a comparative African perspective," *International Journal of Environmental Studies*, vol. 80, no. 4, February 2023, pp. 1169-1187, https://doi.org/10.1080/00207233.2023.2177417.

37. Mohammed Mahmoud, "Reflecting on COP28: What

to the Paris Agreement, countries have submitted nationally determined contribution (NDC) proposals to the UN Framework Convention on Climate Change. These NDCs are documentations describing the climate mitigation plans and goals of each party toward reducing greenhouse gas emissions, primarily through energy transition efforts that shift to lower-emission sources of energy.[38] With respect to North Africa, Algeria, Morocco, Tunisia, Sudan, and Egypt have submitted NDCs (Libya signed the Paris Agreement but has not formally ratified it and therefore has not submitted a corresponding NDC).[39]

An energy transition future for North Africa that is based on the water-energy nexus will involve the mainstreaming and proliferation of energy consumption from the zero-emission energy generation of hydropower and production of green hydrogen, and the reduction of energy consumption by the water sector (such as from desalination) by satisfying more of that sector's energy demand from renewables. The ability to harness hydropower effectively and efficiently is directly associated with the volume and flow of water that a hydroelectric dam is able to store and then release to generate electricity. However, this also caps the hydropower potential of any hydroelectric dam to the hydrological conditions of the river(s) that are routed through it. And as evidenced by the amplifying effects of climate change, surface water systems will experience reduced river flows due to diminished precipitation and elevated evaporation rates. In North Africa, this puts Egypt, Sudan, and Morocco at a disadvantage from the impacts of climate change in their ability to generate hydropower from their dams that utilize the Nile's waters and runoff from the Atlas Mountains.

A climate adaptation strategy that can help lessen the decline of snowmelt contributions to these surface water systems is cloud seeding, a weather modification application that enhances the ability of clouds to produce rain or snow by introducing material that acts as cloud condensation or ice nuclei to enable water droplets to coalesce and form more quickly.[40] This enhanced level of precipitation can then contribute to the high-elevation headwaters of surface river systems through snowpack accumulation and subsequent snowmelt. Cloud seeding in this manner can be suitable for application in the Atlas Mountains of Morocco and the headwaters of the Nile River.

In fact, the Maghreb region of North Africa already has a history with cloud seeding experiments and pilot projects. In 1952, France conducted cloud seeding experiments in Algeria.[41] Morocco's Al Ghait cloud seeding program launched in 1982, as part of a collaboration between the government of Morocco and the United States Agency for International Development (USAID). During the pilot phase of the program (1984-1989), the Central High Atlas Mountains were seeded to increase snowpack, resulting in an estimated 14 to 17% increase in winter precipitation.[42] In 2023, Tunisia began conducting cloud seeding experiments to combat the effects of drought on its farmlands.[43]

The efficacy and cost of cloud seeding operations can be variable, depending on a number of factors.[44] Differences

happened and what comes next?," Middle East Institute, January 18, 2024, https://mei.edu/blog/reflecting-cop28-what-happened-and-what-comes-next.

38. UNCC, "Nationally Determined Contributions (NDCs)," United Nations Climate Change, accessed May 9, 2024, https://unfccc.int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs.

39. UNCC, "NDC Registry," United Nations Climate Change, accessed May 9, 2024, https://unfccc.int/NDCREG.

40. DRI, "Cloud Seeding Program," Desert Research Institute (DRI), accessed May 9, 2024, https://www.dri.edu/cloud-seeding-program/what-is-cloud-seeding/.

41. Mandala Projects, "Database of Cloud Seeding Countries," Mandala Projects, accessed May 9, 2024, https://mandalaprojects.com/wordpress/index.php/rain-making-event-database-rmed/.

42. Times Aerospace, "Raining champions of the Arab world," Times Aerospace, August 6, 2010, https://www.timesaerospace.aero/features/defence/raining-champions-of-the-arab-world.

43. CGTN Africa, "Tunisia experiment technique to combat drought, (video)" YouTube, March 8, 2023, https://www.youtube.com/watch?v=OzNICn2Nn0o.

44. NAWMC, "Cloud Seeding: The Environment and the Climate," North American Weather Modification Council (NAWMC), accessed May 9, 2024, http://www.nawmc.org/publications/Environment%20r11%20press_final.pdf.

exist between cold- and warm-season cloud seeding operations and the respective materials they use to either enhance snow or rain precipitation. Both seasonal applications are contingent on ideal seeding conditions for optimal efficacy (e.g., the presence of supercooled liquid water for cold-season seeding). Similarly, the deployment of seeding materials through ground-based generators or aircraft can be a differentiator for cost of operations (with airborne deployment typically the costlier alternative).

For North African countries that do not have major surface water systems to rely on for larger-scale hydropower generation (such as Libya), an alternative, albeit smaller scale of hydropower generation may still be possible. Pumped-storage hydropower generation is based on a closed-loop system that does not need free-flowing renewable surface water supplies to produce electricity. This system works by having two connected reservoirs at different elevations, where water is released from the higher to the lower reservoir to generate hydropower, and water from the lower reservoir can be pumped back up to the higher reservoir (thus using electricity) to repeat the process as needed.[45] Pumped-storage hydropower systems are usually used as both an energy generation and storage scheme and can be paired with other forms of renewable energy to increase the reliability of an energy grid. For example, power generated by solar farms can be used to pump water from the lower to the higher elevation reservoir during the day, and at night or whenever solar generation is not possible, the pumped-storage hydropower system can release water from the higher to the lower reservoir to generate hydropower. The water needed to operate this type of system, in the absence of a renewable freshwater supply, can come from groundwater or seawater. Regular hydroelectric dams can also be retrofitted to simulate the pumped-storage component of these types of systems.

An alternative way of incorporating hydropower into North Africa's energy portfolio is by simply purchasing electricity derived from hydropower generation that is sourced elsewhere (without having to bear the capital and operating costs of building and operating a hydroelectric dam). One example would be an energy purchase and transfer between Sudan and Ethiopia, leveraging the large hydropower generation capacity of the GERD. Though this solution would help shore up Sudan's constrained electricity generation sector, costly upgrades to the country's electric grid and transmission connectivity with Ethiopia would be required.[46]

While the production of green hydrogen through the process of electrolysis generates zero-carbon emissions, this process may not truly be emission-free if the energy used to power the process is derived from energy sources that produce emissions (e.g., fossil fuels). So, for a green hydrogen production plant to be fully zero-emission, the energy powering the plant must come from renewable sources, such as solar and wind farms. Fortunately, the solar generation potential for North Africa is quite high, given that the Sahara Desert is considered the largest solar-irradiated region in the world, experiencing over 3,000 hours of annual sunshine.[47] That potential is already greatly realized, not just for energy use within North Africa but as a form of energy export, as Morocco has done by producing and selling solar energy to Europe.[48] Renewable energy sources can also help to mitigate some of the costs associated with operating desalination treatment plants, a nonconventional water supply that is becoming an essential source, considering the extremely arid conditions of North Africa.

45. Office of Energy Efficiency and Renewable Energy, "How Pumped Storage Hydropower Works," US Department of Energy, accessed May 9, 2024, https://www.energy.gov/eere/water/how-pumped-storage-hydropower-works.

46. Mohammed Mahmoud, "Chapter Three: The Nile River: Modern Solutions for Evolving Challenges," in *Enhancing Water Security in the Middle East*, Al Sharq Strategic Research, May 2023, https://research.sharqforum.org/mena-water-security-task-force/.

47. Samwill, "The Influence of Average Annual Sunshine and Total Solar Radiation Intensity in Africa for Solar Street Light," Luxman, July 2, 2019, https://luxmanlight.com/the-influence-of-average-annual-sunshine-and-total-solar-radiation-intensity-in-africa-for-solar-street-light/.

48. Fred Pearce, "In Scramble for Clean Energy, Europe Is Turning to North Africa," Yale Environment 360, February 16, 2023, https://e360.yale.edu/features/africa-europe-solar-wind-power.

Another point of consideration regarding energy consumption for the production of green hydrogen is the source of water to be used. If desalinated water is used for the electrolysis process instead of freshwater, the expense of treating seawater raises indirect costs. However, there are promising research advancements that could allow for the use of seawater for electrolysis without the negative effects of saltwater corrosion on the electrolyzers used to produce green hydrogen.[49]

Another alternative source of water for green hydrogen production that avoids the depletion of scarce freshwater supplies in the region and the added resource cost (financial and energy) of desalinated water is treated effluent (wastewater). While there are exploratory testing phase questions on the acceptable levels of wastewater treatment required to make effluent suitable for the electrolysis process behind green hydrogen generation, scaling up this option and coupling it with green hydrogen production appears to be a beneficial application of water reuse within the context of the energy-water nexus.[50] In fact, a feasibility case study for this approach in Oman has demonstrated the technical and economic feasibility of producing green hydrogen from treated wastewater effluent (with projected production of over 500,000 kilograms of hydrogen per day).[51]

The widespread utilization and mainstreaming of green hydrogen as a zero-emission fuel source cannot be achieved without significant overhauls of infrastructure and transmission systems. For example, the transportation sector, which accounts for 15% of global greenhouse gas emissions, will need to be revamped to enable vehicles, airplanes, and ships to utilize hydrogen fuel cells and have access to abundant hydrogen fueling stations.[52] This systemic shift in the way the world consumes fuel will also need to be cost-effective to convince consumers to support and invest in modes of transportation using hydrogen fuel.

Conclusion

The water-energy nexus effectively highlights the indispensable nature of reliable energy resources for managing water infrastructure, alongside the often-overlooked role of water in energy generation. In the face of climate change, the nexus emerges as a focal point for climate mitigation and adaptation strategies, with applications such as hydropower, green hydrogen production, and renewable energy exploration contributing to the reduction of carbon emissions from the energy sector. In North Africa, the challenges posed by a hot and arid climate, exacerbated by climate change, necessitate integrated strategies for water and energy management. The region's reliance on nonrenewable and alternative water sources like groundwater and desalination, coupled with risks associated with flooding events and dam failures, underscores the urgency of addressing these interconnected challenges.

However, amidst these challenges, there are promising solutions and opportunities for North Africa's energy transition. The synergetic relationship within the water-energy nexus becomes a strategic pathway to capitalize on the benefits of hydropower generation (from renewable surface water or pumped-storage), cloud seeding, and green hydrogen production for sustainable energy and enhanced water security. The importance of aligning these efforts with global commitments, as exemplified by the COP28 agreement on transitioning away from fossil fuels and implementing NDCs under the Paris Agreement, further emphasizes the need for collaborative and concerted action. Leveraging the water-energy nexus

49. Robert F. Service, "Splitting seawater could provide an endless source of green hydrogen," *Science*, March 15, 2023, https://www.science.org/content/article/splitting-seawater-provide-endless-source-green-hydrogen.

50. FutureBridge, "Green Hydrogen from Wastewater: A Viable Option?", FutureBridge, June 8, 2022, https://www.futurebridge.com/industry/perspectives-energy/green-hydrogen-from-wastewater-a-viable-option/.

51. Hind Barghash et al., "Cost benefit analysis for green hydrogen production from treated effluent: The case study of Oman," *Frontiers in Bioengineering and Biotechnology*, vol. 10, no. 1046556, November 2022, https://doi.org/10.3389/fbioe.2022.1046556.

52. Mohammed Mahmoud, "The Future of Climate Change Mitigation in the Middle East and North Africa," Middle East Institute, November 30, 2023, https://mei.edu/publications/future-climate-change-mitigation-middle-east-and-north-africa.

is crucial for North Africa to navigate its energy transition successfully. The vast potential for realizing cleaner, greener, and renewable energy sources requires strategic investments, infrastructure improvements, and policy reforms. As the region moves toward a sustainable and resilient future, the holistic integration of policies and cross-sectoral collaborative efforts (as demonstrated through the framework of the water-energy nexus) will play a pivotal role in ensuring a successful and secure energy transition.

Broken Promises and Unfulfilled Potential: The Implications of Limited Climate Financing

Mirette F. Mabrouk

Photo above: People walk past a COP28 sign at the Expo City during the United Nations climate summit in Dubai on Dec. 5, 2023. Photo by AFP via Getty Images.

In November 2023, the president of the 2023 United Nations Climate Change Conference (28th Conference of Parties, COP28), Sultan al-Jaber, started his speech with what, for many, was a welcome new drive to unlock climate finance. Initially, his call appeared to have been heeded. According to the United Arab Emirates, more than $85 billion was pledged during the summit, with more than $700 million pledged to the Loss and Damage Fund, a groundbreaking initiative launched during COP27 in Egypt, promising economic assistance from developed countries to those most harmed by the negative effects of climate change.[1] Considering that most developed countries have been polluting since the Industrial Revolution, while most developing countries have had to live with the results of pollution they did not cause or contribute to in a meaningful way, the Loss and Damage Fund seemed like a natural development.

However, the fact that it was a precedent-setting, highly controversial agreement that took 27 COPs to see the light testifies to the difficulties of getting countries to discuss responsibility, let alone restitution. Indeed, up until 2022, the United States had repeatedly blocked demands from developing countries to even mention loss and damage in the Intergovernmental Panel on Climate Change, pushing

1. UNEP, "What you need to know about the COP27 Loss and Damage Fund," United Nations Environment Programme (UNEP), November 29, 2022, https://www.unep.org/news-and-stories/story/what-you-need-know-about-cop27-loss-and-damage-fund.

for those words to be replaced with "impacts."[2] That the criteria for both eligibility and spending are nebulous yet highly specific to individual countries has only contributed to the confusion. Further diluting the potential impact was the fact that, according to advocacy groups, "the language on financing got watered down a little," and there were attempts by some developed countries to limit access to the fund to "only the most vulnerable countries" — a vague term that could not only restrict funding but also potentially lead to desperate competition between poor countries for available financing.[3]

Furthermore, there is a growing sense of competition between seeking financing for mitigation vs. adaptation. As far as the fund is concerned, if finance is made available, decisions must be made about how and where it is allocated. Forward planning, in the form of renewable energy projects, for example, takes a back seat to urgent mitigation.[4] Some countries are seeking funds to rebuild infrastructure damaged or destroyed by natural events, while others are seeking ways to shore up their resistance to climate change, for example by protecting water resources. This tension is not entirely accidental. One of the fund's board members, Avinash Persaud, noted that it was intended to help deal with crises, rather than be expanded to help prevent them. "This fund is not replacing relief agencies. This is not a resilience-building fund," said Persaud, who participated in the drafting of COP27's policy recommendations. "This is doing the stuff in the middle — what happens the day after the relief agencies pack up and leave your people fed and watered but under blue tarpaulins."[5]

In terms of sources of funding, the countries that have contributed the most to the negative effects of climate change have not been the ones to step up. Of the amount pledged to the Loss and Damage Fund at COP28, the vast majority came from four countries — Italy, France, Germany, and the UAE — all of which pledged over $100 million, according to the Natural Resources Defense Council.[6] None of those countries are individually on the list of top 10 polluters by emissions (although the European Union is in 4th place). Of that list, only the US, the world's second-largest polluter, pledged any funds, offering a paltry $17.5 million, which is still subject to uncertain congressional approval.

China, India, and Indonesia — in first, third, and ninth place on the list of the world's current top carbon emitters, respectively — failed to pledge any funds and refused to endorse the COP28 agreement, which calls for a tripling of renewable energy sources by 2030.[7] To put their actions into context, it might be useful to revert to the text of the Loss and Damage Fund. That document did not link contributions to historical emissions, merely encouraging sufficient donations to enable the fund to "operate on a significant scale." However, that general phrasing leaves the door open to contributions from any funder, particularly those without historical emissions guilt. While China and India are currently at the top of the offenders list, they are not considered historical emitters and are reluctant to modify their development plans and stifle economic growth in order to limit emissions. It is vital, advocates say, that history not dictate the future.

Financing for climate initiatives has been consistently difficult to eke out. According to the Copenhagen Accord

2. Chloe Farand and Patrick Galey, "US seeks to remove 'losses and damages' from scientific report on climate impacts," Climate Home News, February 23, 2022, https://www.climatechangenews.com/2022/02/24/us-seeks-to-remove-losses-and-damages-from-scientific-report-on-climate-impacts/.

3. James Dinneen, "COP28: Countries agree on how to fund climate 'loss and damage'," New Scientist, November 23, 2023, https://www.newscientist.com/article/2404233-cop28-countries-agree-on-how-to-fund-climate-loss-and-damage/.

4. Laurie Goering, "Expectations mount as loss and damage fund staggers to its feet," Climate Home News, March 25, 2024, https://www.climatechangenews.com/2024/03/25/expectations-mount-as-loss-and-damage-fund-staggers-to-its-feet/.

5. Ibid.

6. Joe Thwaites, "Climate Funds Pledge Tracker, National Resource Defense Council, November 27, 2024, https://www.nrdc.org/bio/joe-thwaites/cop-28-climate-fund-pledge-tracker.

7. Bilal Hussain, "India, China Break Ranks at COP28 on Target for Renewables," Voice of America, December 13, 2023, https://www.voanews.com/a/india-china-break-ranks-at-cop28-on-target-for-renewables-/7396989.html.

formulated at COP15 in 2009, developed countries promised to gradually increase contributions to $100 billion annually by 2020 and to continue funding at that level through 2025. That goal consistently has not been met. For 2020, the Overseas Development Institute found that of the Annex II countries (developed countries with special financial responsibilities), only seven had provided their fair share toward the $100 billion target: Sweden, France, the Netherlands, Japan, Norway, Denmark, and Germany.[8] The US, the world's second-largest polluter, had lived up to a mere sliver of its financial responsibilities — just 5%. In fact, the 95% that is still owed by the US was "overwhelmingly responsible for the 2020 finance gap."[9]

For vulnerable countries to have a real chance at mitigating the shocks of climate change, let alone adapting to them, that financing gap will have to be closed, or at least narrowed. A 2021 UN report noted that by 2030, expenditures of $300 billion a year would be required to counter the effects of climate change, rising to $500 billion a year by 2050.[10] However, that did not take into account the extent of developing countries' need for both funds and expertise. As the effects of climate change have become ever more disturbingly apparent, the estimated costs have risen significantly, as two reports released just before COP28 show. The UN has calculated that the finance gap for adaptation efforts is at least 50% greater than previously thought; developing countries will have to spend 10-18 times more on financing for adaptation than originally expected.[11]

In July 2022, the COP27 Presidencies and the UN Climate Change High-Level Champions launched an Independent High-Level Expert Group on Climate Finance, to "assess how the climate finance system must change if it is to support the investment and actions necessary to deliver the goals of the Paris Agreement, within the broader goals of sustainable development."[12] It produced two reports, the second of which, released a few days before COP28, concluded that a staggering $2.4 trillion of annual investment would be needed by 2030 in emerging markets and developing countries (EMDCs) — excluding China. The report distilled desirable forms of investment into four categories: energy transition; adaptation and resilience; loss and damage; and the conservation and restoration of nature.

In order to understand the nature and scope of the estimated financing required, it is necessary to outline the full gamut of climate change issues confronting a large number of countries, including the North Africa region. As the scale of the current finance gap becomes apparent, and as nations with a responsibility to contribute remain reluctant to pay, the increasing urgency of the threat requires a closer look at climate finance — who needs it, who should provide it, and how it should be prioritized.

The Climate Finance Quandary

Climate finance loosely refers to a selection of financial instruments and resources that are used to help mitigate or adapt to the negative effects of climate change, including grants by international funds, loans from public

8. Sara Colenbrander, Laetitia Pettinotti, and Yue Cao, "A fair share of climate finance: An appraisal of past performance, future pledges and prospective contributors," Overseas Development Institute/Flood Resilience Alliance, June 2022, https://odi.org/en/publications/a-fair-share-of-climate-finance-an-appraisal-of-past-performance-future-pledges-and-prospective-contributors/.

9. Liselotte Jensen with Johanna Roniger, "International climate finance: Status quo, challenges and policy perspectives," European Parliamentary Research Service, November 2023, https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/754616/EPRS_BRI(2023)754616_EN.pdf.

10. UNEP, "Adaptation Gap Report 2021," United Nations Environment Programme (UNEP), November 1, 2021, https://www.unep.org/resources/adaptation-gap-report-2021.

11. UNEP, "Adaptation Gap Report 2023," United Nations Environment Programme (UNEP), November 2, 2023, https://www.unep.org/resources/adaptation-gap-report-2023.

12. Amara Bhattacharya, Vera Songwe, Eleonore Soubeyran, and Nicolas Stern, "A Climate finance framework: Decisive action to deliver on the Paris Agreement - Summary," Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science, November 2023, https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2023/11/A-Climate-Finance-Framework-IHLEG-Report-2-SUMMARY.pdf.

or private financial institutions, revenue from carbon trading or taxes, and sovereign green bonds issued by governments. The funds can be public, private, bilateral, or multilateral.

The most prominent climate funds are the Clean Technology Fund (CTF), run by the World Bank, the Green Climate Fund (GCF), and the Global Environment Facility (GEF). The Inter-American Development Bank and African Development Bank are also significant contributors to climate initiatives.[13] Grants or loans from these institutions may be invested by the recipient country in projects that reduce, absorb, or prevent greenhouse gas (GHG) emissions. These include renewable energy power plants, public transport that utilizes renewable energy, mitigation and adaptation tools, agricultural conservation or resilience schemes, and projects that aid in weathering natural disasters.

Governments can also allocate funds to the climate goals set out in their Nationally Determined Contributions (NDC), sell green sovereign bonds, or access financing through carbon trading or taxes. One tradable carbon credit equals one ton of carbon dioxide emissions, or an equivalent amount of any other GHG, which may be purchased by any entity and "retired" to enhance their GHG emissions reduction efforts.[14] Carbon taxes, on the other hand, are levied to discourage the use of carbon-heavy goods or services, like gasoline or power generated by non-renewable energy. The proceeds from these taxes can then be used to invest in renewable energy, forest conservation, and other forms of climate-friendly action.

Carbon trading, however, is not to be confused with carbon offsets. While carbon credits are officially bought and sold through a cap-and-trade system, carbon offsetting is an entirely voluntary market where any entity can aim to reduce, or at least give the appearance of reducing, its carbon footprint. No regulations govern this market, in which any entity that produces GHG can pay another entity to produce something at a reduced emissions rate. Airlines, for example, may pay to "protect" or "preserve" a tract of woodland. The drawbacks to this, however, are obvious: Polluters may use this as a license to continue polluting with no consequences. Critics view it as simply a means of greenwashing.[15]

Location, Location, Location

The nature of financing instruments and implications of their use are only some of the challenges facing climate finance. Among those is the question of access to available financing and its disbursement. Most financing between 2016 and 2020 went to middle-income countries in Asia, while least developed countries (LDCs) trailed behind with below-average per capita funding, according to the Organization for Economic Cooperation and Development (OECD).[16]

Take, for example, climate financing flows to Africa. African countries need $277 billion annually to implement their NDCs by 2030; yet as of 2023, they were receiving only $30 billion annually — less than 11% of requirements.[17] The continent is home to 20% of the earth's population but had contributed just 3% of the world's total greenhouse

13. Jessica Obeid and Alice Gower, Mind the Gap: Highlighting MENA's Climate Finance Challenge," SRMG Think Research & Advisory, December 2023, https://www.srmgthink.com/highlighting-menas-climate-finance-challenge/.

14. Climate Promise, "What are NDCs and how do they drive climate action?" United Nations Development Programme (UNDP), May 31, 2023, https://climatepromise.undp.org/news-and-stories/NDCs-nationally-determined-contributions-climate-change-what-you-need-to-know; Carbon Offset Guide, "What is a Carbon Credit?" Management Institute and Stockholm Environment Institute, Accessed September 2024, https://offsetguide.org/understanding-carbon-offsets/what-is-a-carbon-offset/.

15. Patrick Greenfield, "Carbon offsets used by major airlines based on flawed system, warn experts," *The Guardian*, May 4, 2021, https://www.theguardian.com/environment/2021/may/04/carbon-offsets-used-by-major-airlines-based-on-flawed-system-warn-experts.

16. OECD, "Climate Finance and the USD 100 Billion Goal," *Climate Finance Provided and Mobilised by Developed Countries in 2016-2020: Insights from Disaggregated Analysis*, September 22, 2022, https://doi.org/10.1787/286dae5d-en.

17. Mahmoud Mohieldin, "The case for climate financing," Brookings Institution, August 25, 2023, https://www.brookings.edu/articles/the-case-for-climate-financing/.

gas emissions through 2020. Africa is also a continent of immense promise — McKinsey estimates an astonishing $3 trillion of investment opportunities as of 2023 — but the cost of realizing that business potential can be punishingly high.[18] For example, the weighted average cost of capital (WACC) for a solar power farm in emerging economies in 2021 was as high as 10-16% annually, whereas the cost of a similar project in the EU was only 4%. In Germany, the WACC amounted to 1.3%, compared to 21% for Lebanon.[19] Writing for the UN Framework Convention on Climate Change (UNFCCC), Amar Inamdar notes, "For venture-backed private businesses the numbers are worse.[20] It is not unusual to see 16-18 percent coupons on dollar denominated debt in emerging markets. In local currencies, expect mid-twenty percent returns and higher. Given these costs of capital, you wonder how many businesses in Europe or the US would be profitable."

Private financing will have to scale up. The International Energy Agency (IEA) estimated that government funding accounted for about half of clean energy spending in emerging economies in 2022, as opposed to around 20% in developed economies.[21] It estimates that private financing will need to increase, from the current $135 billion annually to just over $1 trillion by the early 2030s. The problem, of course, is one of risk and reward. Private sector finance involves private businesses, which are primarily concerned with the bottom line. The question, then, is how to incentivize businesses to look beyond immediate profit to long-term, sustainable gain.

In Africa, the outlook is particularly challenging. The IEA notes that energy investment has been falling in Africa in recent years, due to a combination of factors.[22] Higher perceived and actual risks drive up the cost of capital, potentially making projects commercially unviable, or more expensive for end users. Much of the continent is saddled with crippling debt, which means only limited public capital available. The shortage also extends to state-owned utilities, despite the fact that they are often supported by public funds. While this theoretically presents huge opportunities for private capital, many private investors are leery of entering African markets due to high perceived and actual risks. In fledgling markets, the regulatory environment is often weak or nonexistent, potentially resulting in contract instability and delays. High debt means higher payment risks from state-owned utilities. And in states troubled by conflict, the political and reputational risks can be too high. This is particularly challenging in light of the fact that the IEA estimates energy investment needs to more than double from today's $90 billion by 2030, at which point nearly two-thirds of spending would go to clean energy.

Although better developed than many parts of the African continent, the Middle East and North Africa region remains in a similar bind. One of the areas of the world most vulnerable to the impacts of climate change, its rapidly growing population is expected to swell to 700 million by 2050, outpacing the population of Europe. While most countries of the region have committed to implementing mitigation and adaptation measures, funds are still lacking for the region as a whole. That underfunding exacerbates vulnerability to climate shocks for poorer countries without the resources to dedicate to emergency spending, social networks, disaster risk reduction, climate preparedness, and so on.

A 2023 report on climate financing for 19 MENA countries

18. Meghan Daharwal, Hauke Engel, Sarah Frandsen, Kartik Jayaram, Adam Kendall, and Bob Mwaniki, "Solving the climate finance equation for developing countries," McKinsey Sustainability, December 6, 2023, https://www.mckinsey.com/capabilities/sustainability/our-insights/solving-the-climate-finance-equation-for-developing-countries.

19. Michael Taylor, Philipp Beiter, and Florian Egli, "The cost of financing for renewable power," International Renewable Energy Agency, 2023, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2023/May/IRENA_The_cost_of_financing_renewable_power_2023.pdf.

20. Amar Inamdar, "Unlocking climate finance for Africa: A call for action," UN Climate Change High-Level Champions, December 4, 2023, https://climatechampions.unfccc.int.

21. IEA, "Scaling Up Private Finance for Clean Energy in Emerging and Developing Economies," International Energy Agency, 2023, https://www.iea.org/reports/scaling-up-private-finance-for-clean-energy-in-emerging-and-developing-economies.

22. IEA, "Financing Clean Energy in Africa," International Energy Agency, 2023, https://www.iea.org/reports/financing-clean-energy-in-africa.

concluded the region received a mere $24.4 billion from the three major funds, amounting to 6.6% of global totals.[23] Climate financing would need to "be increased by a factor of 20, at least, to reach the overall financial requirement of the nine countries (Egypt, Tunisia, Morocco, Jordan, UAE, Iraq, Djibouti, Palestine, and Sudan) that have quantified climate costs in their Nationally Determined Contributions. This requirement, as stipulated in the NDCs, is $495 billion." These amounts are outdated, so the current estimated costs are likely higher.

While the figures for some MENA countries (notably Egypt, Morocco, and Jordan) initially look promising, it is important to take a look at what the funding represents when compared to the rest of the world. Over the last decade or so, the GCF, for example, financed 119 projects, to the tune of $12.7 billion.[24] Only 24 of those projects, a mere $967 million, went to MENA countries. By contrast, the CTF handed over a proportionally larger sum ($857 million of $5.3 billion) although that represented only 13 out of 161 projects. In both cases, the bulk of the financing was in the form of loans – 68% in the case of the GCF.

Financing often has a particular focus; energy-related projects attract the bulk of all MENA climate funds. Not surprisingly, countries that have prioritized energy renewal like Morocco and Egypt have been particularly successful at attracting funds. Morocco, in particular, is ahead of the game.[25] It has enacted the required regulations to support the development of its renewables sector and set up an oversight institution, the Moroccan Agency for Sustainable Energy (MASEN), to oversee it. Approximately 37% of the country's total installed generation capacity is from renewable sources, with a goal of 52% by 2030.[26]

The bulk of Egypt's funds have been devoted to clean energy and technology, with the UAE alone investing an estimated $25 billion in the sector, primarily in Egypt and South Africa, as of late 2023.[27]

Not surprisingly the report found that distribution of this limited climate financing was uneven, with approximately 78% of funding going to North African countries — Egypt and Morocco alone accounted for 60% of the total figure. The North African countries also have advantages that allow them easier access. Apart from an ability to navigate the cumbersome application process and a proven track record of applying for and implementing internationally funded projects, they are in certain cases eligible for Africa-focused funds and those with broader geographic remits.[28] The picture is further complicated by the fact that most climate financing is in the form of non-concessional loans, which increases already high and growing national debt levels.

A report by the OECD found that as of 2020, an LDC's level of vulnerability did not necessarily correlate with the amount of financing available to it, in many cases because of the sheer complexity of the application process.[29] Many LDCs simply lack the institutional capacity — even the GCF's simplified approval process for projects under $50 million involved a process described as "lengthy and burdensome" in a 2021 assessment by the World Resources Institute.[30] The report also noted that the fund's

23. Obeid and Gower, "Mind the Gap," SRMG Think, 2023.

24. Ibid.

25. Ibid.

26. Moroccan Agency for Sustainable Energy (MASEN), Home page, Accessed September 2024, https://www.masen.ma/en.

27. Sandile Hlophe, "EY Africa Attractiveness Report 2023: South Africa, Egypt at forefront of FDI projects," EY, November 15, 2023, https://www.ey.com/en_za/services/consulting/ey-africa-attractiveness-report-2023--south-africa--egypt-at-for.

28. Obeid and Gower, "Mind the Gap," SRMG Think, 2023.

29. OECD, "Country vulnerability level and adaptation finance provided and mobilised," *Climate Finance Provided and Mobilised by Developed Countries in 2016-2020: Insights from Disaggregated Analysis*, September 22, 2022, https://www.oecd-ilibrary.org/sites/286dae5d-en/1/3/1/index.html?itemId=/content/publication/286dae5d-en&_csp_=46b868d4f630525e4ccc5f67e501847f&itemIGO=oecd&itemContentType=book#boxsection-d1e1106.

30. Molly Caldwell and Gaia Larsen, "Improving Access to the Green Climate Fund: How the Fund Can Better Support Developing Country Institutions," World Resources Institute (WRI), March 10, 2021, https://doi.org/10.46830/wriwp.19.00132.

Enhancing Direct Access pilot got off to a slow start, with only two projects approved in its first five years. This is especially galling when one considers that the approval process could take a staggering four to five years in some cases. Of the funding disbursed globally, a sizeable 67% went to mitigation, with adaptation projects securing only 24% (9% went to cross-cutting projects).

The "What" Is as Important as the "Whom"

The estimates of amounts required for climate finance can differ significantly. According to a 2022 report by the Intergovernmental Panel on Climate Change (IPCC), funding for mitigation needs to be increased four to seven times.[31] The figures for adaptation are even higher and illustrate the vast variations in climate financing estimates; the IPCC reports between $14 billion and $411 billion annually, while the 2023 Adaptation Gap Report estimates range between $215 billion and $387 billion.[32] The 2021 UNFCCC Report, however, states that developing countries require a gargantuan $5.8 trillion to cover their climate action plans or NDCs by 2030.[33] Even that figure, however, is a low estimate, since it contains only those plans that have financial estimates, comprising a mere 42%. What is certain is that these figures will continue to grow every year.

Additionally, those figures differ from country to country due to domestic circumstances and levels of commitment. A 2023 comparison between four North African countries — Algeria, Libya, Morocco, and Tunisia — showcases these differences.[34] Tunisia initially developed an excellent policy framework for adaptation, however, following domestic political upheavals, a lack of clarity has undermined confidence in the country's plan, as demonstrated by decreasing EU funding commitments despite Tunisia having been quite specific about its financing needs.

Algeria has made progress on climate policy but its high dependence on fossil fuels, economic stagnation, labor market disparities, and corruption have hindered foreign funding. Morocco has a clear plan to address climate concerns, has slashed fossil fuel subsidies, and is adept at navigating the field of international climate funding. Libya, lacking a national climate plan and not part of the UNFCCC process, stands in contrast to its neighbors. Thirteen years into a civil conflict, environmental concerns are marginalized in political debate, access to environmental information is restricted and, as the catastrophic Derna flood of September 2023 showed, there is little disaster preparedness.[35]

Another complication is that although Article 4 of the UNFCCC charter specifically states that developed countries "shall provide new and additional financial resources" to prevent LDCs losing out on other funding, thereby increasing their vulnerability to climate shocks, this simply is not happening.[36] One report on "decoding the conditionality of finance" suggested that in the decade between 2011 and 2020, a staggering half of climate financing was carved out of existing funds previously earmarked for development, with only 7% added funding.[37]

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31. IPCC, "Climate Change 2022: Mitigation of Climate Change," Intergovernmental Panel on Climate Change, 2022, Chapter 15, https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf#page=1590.

32. UNEP, "Adaptation Gap Report 2023," 2023.

33. UNFCCC, "Executive summary by the Standing Committee on Finance of the first report on the determination of the needs of developing country Parties related to implementing the Convention and the Paris Agreement," United Nations Framework Convention on Climate Change (UNFCCC), 2021, pg. 5, https://unfccc.int/sites/default/files/resource/54307_2%20-%20UNFCCC%20First%20NDR%20summary%20-%20V6.pdf#page=5.

34. Kawsar Laanani, "The struggle for effective climate governance in North Africa," ECDPM, December 4, 2023, https://ecdpm.org/work/struggle-effective-climate-governance-north-africa.

35. Chris Clayton et al., "Libya floods: Why damage to Derna was so catastrophic," BBC, September 14, 2023, https://www.bbc.com/news/world-africa-66799518.

36. UN, "Article 4: Commitments," United Nations Framework Convention on Climate Change, 1992, https://unfccc.int/resource/ccsites/zimbab/conven/text/art04.htm.

37. CARE, "Seeing Double: Decoding the 'Additionality' of Climate Finance," CARE International, 2023, pg. 4, https://www.care-international.org/sites/default/files/2023-09/Seeing-

Some developed countries appear to have taken a creative accounting approach to shirk their promises. Chief among these is the United Kingdom, which has been accused of "moving the goalposts" by reclassifying what constitutes climate finance.[38] A February 2024 report by the Independent Commission for Aid Impact (ICAI) said that the UK government had essentially adjusted its accounting methodology to achieve the $14.4 billion goal, so that $2.17 billion that had already been earmarked for aid was counted toward climate finance goals.[39] The report noted that "these changes meant that the government counted an extra $2.17bn towards the target, while countries expecting support from the ICF [international climate finance] pledge did not receive any additional money to tackle climate change." This was especially jarring because, according to the report, the reclassifications were significant, representing 15% of the UK's entire climate pledge. The ICAI's chief commissioner and lead reviewer, Dr. Tamsyn Barton, noted that not only was the UK offering less money, that money would be delivered late and might "also not be as suited to the needs of the most vulnerable countries at risk from climate change, notably the least developed, conflict-affected, and small island developing states."

ICAI explained that the £1.724 billion ($2.24 billion) had been found by reclassifying as green finance over £750 million ($979 million) in "core contributions to multilateral development banks and by classifying as green a fixed proportion of 30% of humanitarian programs operating in the 10% of countries most vulnerable to the climate crisis," amounting to £470 million ($613 million). That essentially meant that there would be no additional financing for those hardest hit. Additionally, part of the financing had been changed from grants into loans via multilateral development banks, which was detrimental to the poorest countries — i.e., aid-dependent, least-developed, conflict-afflicted, and small island developing states. Specifically, humanitarian aid to Afghanistan, Yemen, Somalia, the DRC [Democratic Republic of the Congo], Uganda and Sudan was being counted towards climate finance.[40] In some cases, lip service was paid to climate financing; funded aid projects in Somalia mention the importance of "climate resilience."[41] However, in the case of Yemen, the summary for one of the projects stated that it would provide "few opportunities" to address climate change, while the other four projects did not mention the issue at all.

The ICAI report noted that "there is also insufficient transparency about the new accounting, making it difficult to hold the government to account for its climate finance commitments." Consequently, said ICAI, the reputation of the UK (initially hailed as a climate leader) had been damaged. The report, however, does not seem to have affected the British government's assessment of its own policies: as late as mid-April 2024, the UK government was accused of double counting a staggering £500 million ($652 million) in aid as climate finance.[42] According to documents released under a freedom of information request by the website Carbon Brief, the UK government was counting aid for war-torn countries like Afghanistan, Somalia, and Yemen as climate finance in an attempt to meet its commitments.[43]

Double-2023_15.09.23_larger.pdf#page=4.

38. Patrick Wintour, "UK accused of 'moving goalposts' on climate finance commitments," *The Guardian*, February 28, 2024, https://www.theguardian.com/global-development/2024/feb/28/uk-accused-of-moving-goalposts-on-climate-finance-commitments.

39. ICAI, UK aid's international climate finance commitments," Independent Commission for Aid Impact (ICAI), February 29, 2024, https://icai.independent.gov.uk/review/uk-aids-international-climate-finance-commitments/review/.

40. Helena Horton, "UK accused of double counting £500m of aid to meet climate pledge," *The Guardian,* April 16, 2024, https://www.theguardian.com/global-development/2024/apr/16/uk-accused-of-double-counting-500m-overseas-aid-to-meet-climate-pledge.

41. Josh Gabbatiss, "Revealed: UK 'double counting' £500m of aid for war-torn countries as climate finance," Carbon Brief, April 16, 2024, https://www.carbonbrief.org/revealed-uk-double-counting-500m-of-aid-for-war-torn-countries-as-climate-finance/.

42. Horton, "UK accused of double counting," *The Guardian,* 2024.

43. Gabbatiss, "Revealed: UK 'double counting'," Carbon Brief, 2024.

For many of the eligible recipient countries, when aid becomes available, it is rarely in a form most conducive to helping with the most urgent needs. A significant portion of this financing is granted as non-concessional loans awarded at standard market interest rates — astonishing when one considers the economic situation of the borrowers. According to the April 2024 statistics from the International Monetary Fund (IMF), half of all low-income countries are either in debt distress or well on their way.[44] Far from being a lifeline, climate financing in the form of loans adds to the recipient's domestic debt burden, compounding their financial challenges and economic resilience. In Africa, where climate change hits hardest and the needs of financial assistance are urgent, countries spend over half (53%) of their gross domestic product (GDP) servicing their debt, according to a 2023 Development Finance International report.[45] More specifically, a report by the European Parliamentary Research Service detailed how, in a 2021 study on 59 LDCs and small island developing states (SIDS), those countries collectively spent $33 billion on servicing their debt, as compared to the $20 billion they received in climate financing — over 50% more outgoing capital than incoming.[46][47]

The fact that these countries often suffer from poor credit ratings compounds the problem. Low ratings result in higher interest rates, which can lead to debt overhang — meaning the extent of existing debt can prevent them from acquiring new loans, regardless of how attractive, valuable, necessary, or profitable a potential project is. These conditions result in a vicious circle: Not only is there a direct negative impact on the ability of such countries to actively fight climate change ramifications in terms of adaptation or mitigation, but their inability to borrow money also exacerbates their vulnerability to climate change effects, which in turn has a further effect on their creditworthiness. This is a direct result of climate finance being made available largely in the form of non-concessional loans.[48]

The already crippling crisis of debt is further complicated by the crisis of liquidity. In fact, the 2023 Independent High-Level Expert Group on Climate Finance Report posits that the bigger problem may be one not of over-indebtedness or lack of solvency but of liquidity and roll-over problems.[49] Developing countries frequently struggle with liquidity because, in addition to debt and lower growth rates, they often have less developed financial markets, less stable currencies, and limited access to credit. Liquidity is vital for states in precisely the same way it would be vital for individuals: emergencies happen, and one needs to react to them. For countries dealing with the effects of climate change, these emergencies can strike with terrifying speed and severity. The August 2022 floods in Pakistan, which destroyed water and sewage systems and forced over 5.4 million people to rely on contaminated water, are a case in point. Pakistan contributes approximately 0.3% to global emissions, but its people are 15 times more likely to die from climate-related incidents.[50] In addition to the human toll of the floods, the country was saddled with the financial burden of a staggering $30 billion in damage. The already indebted country did not have the liquidity to respond to the disaster. UN Secretary-General Antonio Guterres called

44. IMF, "List of LIC DSAs for PRGT-Eligible Countries as of October 31, 2024," International Monetary Fund (IMF), April 2024, https://www.imf.org/external/pubs/ft/dsa/dsalist.pdf.

45. Matthew Martin, "The Worst Ever Global Debt Crisis," Development Finance International (DFI), 2023, pg. 3, https://www.development-finance.org/files/Debt_Service_Watch_Briefing_Final_Word_EN_0910.pdf#page=3.

46. Jensen and Roniger, "International climate finance," European Parliamentary Research Service, 2023.

47. IIED, "Drowning in debt: Help for climate-vulnerable countries dwarfed by repayments," International Institute for Environment and Development (IIED), June 20, 2023, pg. 2, https://www.iied.org/sites/default/files/uploads/2023/06/IIED_drowning_in_debt.pdf#page=2.

48. Serhan Cevik and Joao Tovar Jalles, "Feeling the Heat: Climate Shocks and Credit Ratings," International Monetary Fund (IMF), January 26, 2021, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3772492.

49. Bhattacharya et al., "A Climate finance framework," Grantham Research Institute on Climate Change and the Environment, 2023.

50. Abid Hussein, "UN chief says Pakistan floods 'litmus test for climate justice' as aid lags," *Al-Jazeera*, September 28, 2023, https://www.aljazeera.com/news/2023/9/28/un-chief-says-pakistan-floods-litmus-test-for-climate-justice-as-aid-lags.

the international community's response to the floods a "litmus test for climate justice." Pakistan, he said, was a "double victim — of climate chaos and of our outdated and unjust global financial system that prevents middle-income countries from accessing much-needed resources to invest in adaptation and resilience."[51]

The 2022 Bridgetown Initiative

A potential solution has been offered up by developing countries in the form of a policy proposal introduced by Prime Minister Mia Mottley of Barbados at COP27. Dubbed the Bridgetown Initiative, it essentially rethinks the role of the world's multilateral finance institutions in the face of climate change by taking a trilateral approach calling for immediate emergency funding from the IMF for countries in desperate need, private sector engagement to drive climate financing efforts, and expansion of multilateral lending by up to $1 trillion.[52]

The initiative presented some truly groundbreaking approaches. According to a summary of the plan, the IMF was given a major role to play, with recommendations that it should: "fast-track the transfer of $100 billion in [unused] special drawing rights [SDRs] to programmes that support climate resilience and subsidize lending to low-income countries"; "immediately suspend surcharges — additional interest payments imposed on heavily indebted borrowing countries — for two to three years"; and "restore 'enhanced access limits' established during the COVID pandemic for two emergency financial support instruments, the rapid credit facility (RCF) and rapid financing instruments." On debt sustainability, G20 creditor countries were called upon to "redesign their Common Framework for restructuring the debt of poor countries in default." Most importantly, and innovatively, the initiative asked both public and private creditors to include disaster clauses in lending deals to allow countries "to divert debt payments to disaster relief [and to] refinance high-interest and short-term debt with credit guarantees and longer maturities."[53]

However, even the best constructed initiatives can start to crumble around the edges in the face of inertia. As of 2024, the Initiative was on its third iteration, with some of its most interesting proposals, among them the capital increase and debt relief clauses, having been shaved off. It is currently among a raft of policy changes that are still on the table for consideration, without having had a chance to come to fruition.[54]

Next Steps

While the obstacles to fair and effective climate financing might seem insurmountable, the situation is not hopeless. First, success requires a concerted effort to ensure that all developing countries have access to fair and equitable climate financing that does not become a burden on their already slim resources.

As far back as 2021, the World Resources Institute noted that not only had more than two-thirds of all developing countries not managed to receive any funding but that there was actually a "lack of clarity over what activities qualified for funding."[55] It recommended not only that the processes be simplified but that more technical advice be given to guide countries through the application process. Two years later, the UN recommended tailored processes and support for capacity building. There are existing tools for mobilizing and making the best use of climate funds, among them the Integrated National Financing

51. Ibid.

52. Bridgetown Initiative, "Urgent and Decisive Action Required for an Unprecedented Combination of Crises: The 2022 Bridgetown Initiative for the Reform of the Global Financial Architecture," *EU Observer,* September 23, 2022, https://pmo.gov.bb/wp-content/uploads/2022/10/The-2022-Bridgetown-Initiative.pdf.

53. Simon Jessup and Leigh Thomas, "Explainer: What is the 'Bridgetown Initiative' asking for at Paris financial summit?" *Reuters,* June 20, 2023, https://www.reuters.com/business/finance/what-is-bridgetown-initiative-asking-paris-financial-summit-2023-06-20/.

54. Bodo Ellmers, "Bridgetown Initiative 3.0 released: What's the news?" Global Policy Forum, June 5, 2024, https://www.globalpolicy.org/en/news/2024-06-05/bridgetown-initiative-30-released-whats-news.

55. Caldwell and Larsen, "Improving Access to the Green Climate Fund," WRI, 2021.

Framework, and they should be more extensively utilized.[56] There have been calls for official development assistance (ODA) to be redefined to help ensure that SIDS get access to non-concessional financing, with the UN recommending the establishment of a dedicated funding pool for them.[57]

Since countries that have developed national strategies to combat climate change are more likely to attract climate financing, help should be provided to those that have not, whether due to a lack of institutional capacity or external factors. In the MENA region, for example, the 2023 SRMG Report notes that while nine countries have quantified their climate costs in NDCs and have made some progress in the financing maze, others, like Syria and Yemen, "find it difficult to meet the eligibility criteria for international financing from climate funds due to the low prioritization of climate action, little to no institutional capacity, slow engagement with the UNFCCC and its related processes, difficulties in collecting climate-related data, and deteriorating or unsafe security environments."[58]

Second, both public and private finance needs to be increased. This is not particularly straightforward — developed countries often redirect funds that might have been earmarked for climate finance to more urgent priorities like emergent conflict. Creditor countries and private lenders should take immediate action to implement the recommendations of the Bridgetown Initiative. In June 2023, in the wake of the Summit for a New Global Financing Pact, the World Bank did actually announce a "comprehensive toolkit" to help indebted countries, including a clause that would pause debt repayment in the event of an extreme climate emergency.[59]

To help bring in the private sector, the initiative suggests that the IMF and multilateral development banks provide currency risk guarantees to help cushion any blow and encourage private capital to support transitions to lower-carbon economies. The private sector is fundamental to any significant growth in climate investment, and it has the capital at its fingertips; currently, the sector manages over $210 trillion in assets that can be leveraged. At the end of the day, however, investment in climate finance is just that — an investment — and for the private sector, it needs to make solid financial sense. That, in turn, will often depend on the domestic investment climate. Can governments or public institutions de-risk private investment by taking on first-mover and longer-term risk? Is the infrastructure sound and ready to accommodate new investment projects? In many developing economies, the needed regulation is not yet in place, or not yet sufficient.

It is also important to focus on what might be most attractive to investors. While that is not the case with loss and damage projects, mitigation and, better yet, adaptation, would offer the more attractive options for investors. The increasing urgency for climate finance has given rise to some surprisingly creative measures that may act as a blueprint for future use. Among them are debt-for-nature swaps, which would typically permit a nation to have a portion of its debt forgiven in exchange for commitments to invest in climate adaptation and mitigation projects. According to the European Parliamentary Research Service (EPRS), "the largest such swap was completed in May 2023 in Ecuador, when $1.6 billion of existing debt was converted into a $656 million loan" in exchange for a commitment to provide "around $323 million to the conservation of the Galapagos Islands."[60]

There is also the possibility of using existing mechanisms. The European Commissioner for Climate Action had suggested channeling revenues generated from established emissions trading schemes, such as the EU emissions trading system (ETS), to international climate

56. Integrated National Financing Framework, United Nations/ European Union, https://inff.org/.

57. Evert-jan Quak, "How losing access to concessional finance affects Small Island Developing States (SIDS), Knowledge, Evidence and Learning for Development (K4D), July 16, 2019, pg. 10, https://assets.publishing.service.gov.uk/media/5d41b473ed915d09de9d1af4/626_SIDS_graduation_impacts_losing_concessional_finance.pdf#page=10.

58. Obeid and Gower, "Mind the Gap," SRMG Think, 2023.

59. World Bank, "World Bank Group Announces Comprehensive Toolkit to Support Countries After Natural Disasters," World Bank Group, June 22, 2023, https://www.worldbank.org/en/news/factsheet/2023/06/22/comprehensive-toolkit-to-support-countries-after-natural-disasters.

60. Jensen and Roniger, "International climate finance," European Parliamentary Research Service, 2023.

finance, although it is not clear how this can be achieved as ETS regulations stipulated how funds can be used. Revenues from global carbon taxes and emissions trading schemes amounted to almost $95 billion in 2022.[61] While some of that revenue was earmarked for climate purposes, very little of it was dedicated to developing countries, which could use the financing.

The ramifications of climate change will only continue to grow, taking a larger toll on the world and disproportionately injuring lesser developed countries, which is likely to exacerbate regional conflict and illegal migration. There are tools in place to help countries manage the fallout, however, and the sooner they are employed, the greater the chances of success.

61. World Bank, "State and Trends of Carbon Pricing 2023," World Bank, May 2023, https://openknowledge.worldbank.org/entities/publication/58f2a409-9bb7-4ee6-899d-be47835c838f.

Powering Past Politics: Energy Cooperation in a Fragmented North Africa

Intissar Fakir

Photo above: High-voltage transmission towers run along a highway in El-Shorouk, Egypt. Photo by KHALED DESOUKI/AFP via Getty Images.

The Case for Regional Cooperation in a Disaggregated Region

While two overarching urgent pressures are shaping North Africa's energy transition — the impact of climate change on the one hand and energy security considerations on the other — several factors play into the policies driving action toward this goal. Even before the increasing intensity and frequency of heatwaves that characterized recent years, North African countries already faced concerns about dissipating water sources, increasing temperatures, and wildfires, especially as these affect agriculture and communities heavily dependent on subsistence farming. Energy security likewise has been a driving concern for the region as domestic energy consumption rises even though North Africa boasts two large energy producers, Algeria and Libya, both of which export to European markets. The Maghreb countries' energy use is increasing as domestic demand grows for industrial and household consumption. For energy importers Morocco and Tunisia, price fluctuations have long strained their budgets. All states in the region continue to subsidize domestic energy consumption in one fashion or another as demand grows and energy prices remain unstable in the face of global shocks.

North African countries have grasped the importance of diversifying their energy mix and improving energy consumption practices to limit the budgetary and economic impact of external shocks, alleviate the burden of domestic energy consumption, and meet decarbonization pledges. Morocco and Egypt have pursued early development of renewable output into their energy mix, Tunisia has pursued energy efficiency

policies, and Algeria and Libya are looking to balance developing renewables for domestic production without diminishing their reputation as key hydrocarbon energy exporters — which remains their priority. All this points to a stronger moment ahead for renewable development and for the energy transition in general. While the case for proceeding is clear, the challenges facing implementation are significant. Each of these countries has chosen a path toward energy transition, but each faces unique challenges in reaching this goal, as the preceding chapters explain.

North African countries have scaled up their renewables to 40% of installed capacity over the past 10 years, according to the International Energy Agency (IEA).[1] Some of them are expanding renewables beyond electricity into transport and industrial use. But the process is halting — and outside of electricity generation, the region's economies remain heavily reliant on fossil fuels for industry, cooking, and transport. IEA places renewables at 4.6% of North Africa's energy mix compared to the global average of 25%.[2] Much more progress remains to be achieved, and the road ahead requires greater momentum on policy design and implementation, investment, and sustained engagement.

The impulse is for each government to focus domestically on its singular path and eschew cooperation — the Maghreb region, after all, is notorious for its lack of cooperation in a context of high political tension and suspicion. Precedent is such that most cooperative endeavors are weak from the outset and face endless political, and at times practical, obstacles, and eventually end up withering on the vine. While each country has a unique experience to share and perspective to understand in its energy transition process, the region as a whole has not leveraged this cumulative experience. Some of this lack of cooperation is driven by the domestic challenges faced in each country and, overall, can be expected given the realities of a disaggregated region. Over the course of decades, the absence of regional coordination on economic, political, and at times security issues has led to missed opportunities for shared prosperity and growth. Some of this is by design, as several of these governments are suspicious of each other, having experienced periods of diplomatic tension and even conflict. Nevertheless, certain plans and visions for regional cooperation have lingered, waiting for the right political moment domestically or a regional or even global push that could prove strong enough to overpower existing divides.

Meanwhile, the aftermath of the 2022 Russian invasion of Ukraine, as the latest geopolitical disruption to energy cooperation, helped solidify thinking around renewables as a possible means to achieve energy security. The pursuit of energy security does not, however, preclude cooperation. There remains an equally strong case for cooperation on renewables not only between countries in the Global North (which might lack the natural resources) and South but also among the Global South countries themselves. Such intra-regional cooperation provides an opportunity to strengthen domestic pathways to energy transition and decarbonization as well as to lessen the financial burden of growing energy demands by providing easier and potentially less costly shared access. It provides opportunities to shorten the distance each country must pursue individually, and it allows for countries to maintain their specialization and competitive advantage. In principle, the idea of cooperation in this sphere holds tremendous potential.

Progress and potential for the renewable industry remain firmly rooted in electricity production, and North African countries are hewing closely to this trend. Globally, electricity makes up 20% of energy consumption and is expected to rise to 50% by 2050, as consumption grows and access to electricity increases.[3] Industrial consumption reached 37% of global energy usage, highlighting speedy industrial expansion.[4] Transportation, according to 2016 EIA data, accounted for 25% of global

1. International Energy Agency (IEA). *Clean Energy Transitions in North Africa*. October 2020. https://iea.blob.core.windows.net/assets/b9c395df-97f1-4982-8839 79f0fdc8c1c3/Clean_Energy_Transitions_in_North_Africa.pdf.

2. International Energy Agency (IEA). *Clean Energy Transitions in North Africa*. October 2020. https://iea.blob.core.windows.net/assets/b9c395df-97f1-4982-8839-79f0fdc8c1c3/Clean_Energy_Transitions_in_North_Africa.pdf.

3. International Energy Agency (IEA). "Electricity." https://www.iea.org/energy-system/electricity.

4. International Energy Agency (IEA). "Industry." https://www.iea.org/energy-system/industry.

energy usage.[5] In this context, there is room for Maghreb countries to leverage their cumulative expertise. Varied degrees of knowledge and accumulated experience could allow for rich knowledge sharing. Importantly, there is the potential to promote cross-border power trading by expanding existing infrastructural connections.

Taking stock of existing foundations and determining what remains to be achieved is important to fully understand the real prospects of cooperation. To do that, the key is to bring together geopolitical *and* sector-specific considerations to identify small openings for cooperation in a region where cooperation has been fraught, if not entirely unsuccessful.

A Fragmented Region

Geopolitically and economically, the North African region has struggled to pursue cooperation at the regional level. Bilateral cooperation is more common, but in trade and economy it is limited in volume. Politically, conflict and tension between Morocco and Algeria have divided the region — as did suspicion of Muammar Gaddafi's Libya during his unpredictable rule. Egypt has often looked to the Levant and the Gulf more than to its Maghreb neighbors. The 1963 border war between Morocco and Algeria and subsequent territorial dispute over the former Spanish colony of the Western Sahara have hindered region-wide initiatives, as have the ways in which these political systems have evolved along divergent political orthodoxies and even economic trajectories over the decades.

Over the past year, however, the Algerian presidency has reengaged with the idea of regional cooperation, albeit in a truncated form. In April 2024, the presidents of Algeria and Tunisia and the head of Libya's presidential council held their first consultation to discuss regional development and issues including security and energy. Absent from the gathering, which is planned to recur once every three months, were Mauritania and Morocco. Such consultative meetings are an indication of a new regional trend — Tunisia's close alignment with Algeria. Tunisian President Kais Saied has grown close to his Algerian counterpart, with whom he shares a regional outlook and world view. Until Saied's election as head of state, the Tunisian foreign policy establishment had largely stayed neutral on the Western Sahara conflict and vis-à-vis the repeated bilateral spats between Morocco and Algeria. But Saied has been supportive of Algerian positions, thereby creating tensions with Morocco as well. Mauritania, keen to stay neutral, has avoided commenting on the Algeria-led consultations.

Underlying Obstacles

The Maghreb is consistently spoken of as a region of lost potential because of the lack of economic integration. The fraught relationship between Morocco and Algeria over the Western Sahara issue and the controversial foreign policy of Libya's former ruler Gaddafi are historically understood to be the major culprits in the lack of regional integration. Regional economic cooperation failed to gain traction through institutions such as the Arab Maghreb Union, which never managed to overcome political distrust and divisions. Since Algeria severed diplomatic ties with Morocco in 2021, the already limited cooperation that existed diminished and the prospects for regional cooperation dimmed further.

Even aside from these bilateral tensions, the political systems of Maghreb countries have, since their independence, followed distinct political trajectories that have yielded divergent economic approaches. Morocco and Tunisia have pursued more diversification and liberalization than Algeria. Morocco's liberalization reforms began in the 1990s, following a difficult decade of poor macro-economic performance and limited growth. The country has sought to open certain aspects of its economy and institute reform in order to build industrial sectors attractive to foreign investors, such as the automotive and, increasingly, renewables industries. In the aftermath of President Ben Ali's fall, the extent of Tunisia's economic fragility came into focus. The economy had opened unevenly, allowing certain sectors to be dominated by a small elite, while the rest continued to rely on a centralized state structure. In the years since the 2011 revolution, the economy became more fragile as growth slowed within a politically uncertain outlook, and as structural reforms lagged due to their potential impact on an already struggling citizenry.

5. Energy Information Agency (EIA). "Transportation Sector Energy Consumption." https://www.eia.gov/outlooks/ieo/pdf/transportation.pdf.

Algeria has, since its independence, followed a statist protectionist economic development model. Focused on preserving its sovereignty and able to benefit from substantial hydrocarbon resources, the country has not pursued liberalization and integration into the global economy to the same extent. Libya's economy and overall governance struggled to jumpstart after the 2011 revolution and remains beholden to political division despite the country's energy resources. Competing political camps are pursuing policies that lack a broader vision and are focusing primarily on maintaining their patronage and support networks.

Given this divergence in approach, there has been little effort to build broader regional integration. The last attempts that achieved any kind of momentum date back to the foundation of the Arab Maghreb Union in 1989. So economic cooperation has been largely restricted to bilateral efforts and remains modest due to tariff and non-tariff barriers, limited trade complementarity, and the lack of efficient infrastructural connections like highways, railways, and port infrastructure.[6]

Given these challenges, Maghreb countries have focused on developing advanced bilateral cooperation with partners further afield. Most have well-developed trade partnerships with European countries, European Union institutions, regional actors such as Turkey and some Gulf states, and, of course, global economic and trade powerhouses like China and the United States. Turkey over the past 20 years has built substantial trade relationships with several Maghreb countries, including a free trade agreement with Morocco and Tunisia. Since 2005 and 2006, respectively, the trade relationship between these countries and Turkey expanded and brought an influx of Turkish goods and services to the region. Algeria, despite lacking a formalized agreement, is also an important North African trading partner for Turkey. Beyond these non-European partners, Maghrebi trade relations within the rest of the African continent are still limited. Morocco and Tunisia have more developed trading partnerships, especially with Sahelian and West African markets. On the continental level, the effort to develop a comprehensive African free trade area continues and would expand opportunities for trade. Further, if such a union were successful, it would ultimately encompass regional economic integration mechanisms and eliminate the need for sub-continental arrangements such as a Maghreb trading bloc.

Limited Intra-Maghreb Trade

Long-lasting political tensions have played a role in limiting the impetus to address these barriers. With lingering bilateral tensions and competition — together with a lack of a strong economic case for cooperation that could overshadow political grievances — frameworks for cooperation have failed to advance. Economically, the region is often understood through its lack of cooperation, its disintegration, and the wasted potential for collective growth brought about by foregoing cooperation. The IMF put the figure of existing trade among Maghreb countries at 2% of their total international trade flows in 2019.[7]

Zooming in on regional energy trade, the picture is likewise limited. The bulk of energy trade is outwardly focused, especially toward Europe. For instance, Algeria's energy export is routed through a gas pipeline to Spain and through spot market liquified natural gas (LNG) shipments to France, Spain, Italy, and the United Kingdom (accounting for 53% of LNG sales to Europe in 2021).[8]

Prior to the outbreak of civil conflict, Libya was a leading African energy exporter. Its exports also focused mostly on European markets, which absorbed 85% of its

6. Intissar Fakir and Hanen Zeghlem. "The Limitations of Economic Integration in the Maghreb: The Costs of 'Non-Maghreb'." *ISPI,* November 2023

7. Alexei Kireyev et al. *Economic Integration in the Maghreb: Untapped Source of Growth*. IMF February 2019, Accessed July 29, 2024. https://www.imf.org/en/Publications/Departmental-Papers-Policy-Papers/Issues/2019/02/08/Economic-Integration-in-the-Maghreb-An-Untapped-Source-of-Growth-46273

8. Energy Information Administration (EIA). "Algeria is a Major Crude Oil and Natural Gas Producer." https://www.eia.gov/todayinenergy/detail.php?id=56580#:~:text=Algeria%20is%20a%20major%20crude,exports%20are%20sent%20to%20Europe.

From Border Wars to Broken Ties: The Algeria-Morocco Story

The 1963 border war between Morocco and Algeria left the two countries perpetually suspicious of one another. They have remained on opposite sides of the Western Sahara territorial dispute, with Algeria supporting the Polisario and even engaging in skirmishes in the 1970s. The ongoing diplomatic tension reached a breaking point in the summer of 2021, as Algiers grew frustrated with Rabat's success in gaining support for its position on the Western Sahara and broke relations, ending not just cooperation but all communications. The dispute, which goes back to Spanish decolonization, pits Morocco against the Polisario, an armed group representing segments of the Sahrawi population, regarding who can rightfully claim sovereignty over the territory. Morocco and the Polisario were embroiled in armed conflict between 1975 and 1999, when the two sides agreed to a cease-fire, negotiated by the United Nations. The Polisario group has received support from Libya's Ghaddafi early on, and later from the Algerian military and successive governments. In November 2020, the Polisario revoked the cease-fire agreement following a dispute about creeping control of the buffer zone — which the UN's MNRSO patrols. Following the dispute, Morocco took control of a road known as the Guarguarate road, and the Polisario declared a resumption of active hostilities. In December 2020, US President Donald Trump struck a deal, recognizing Rabat's sovereignty over the territory for Morocco's normalization with Israel. Following this recognition, tension between Algeria and Morocco increased, with the country's representatives antagonizing each other at the UN as the two governments enlisted media and social media to whip up a frenzy of distrust and hatred between their populations. Algeria was also displeased about Morocco's normalization with Israel and what it portended in terms of the regional security balance, with Morocco set to benefit from its bilateral relationship in defense cooperation. Algeria finally broke ties with Morocco in August 2021, ceasing all marginal cases of cooperation between the two states, including on the Maghreb Europe Gas pipelines, suspending mutual flights, and severing communication between the two governments.

produced oil.[9] In recent years, amid diminishing energy export numbers, Libya's intra-North Africa energy exports have focused on Tunisia. In 2021, Libya exported $20.2 million in refined oil, accounting for 28.1% of total exports, to Tunisia, and roughly 0.23% of Libya's exports.[10] Libyan exports to Morocco are even smaller, standing at 0.11% ($32.7 million). Of that total, petroleum gas made up 8.56%.[11]

Algeria's exports to Tunisia stood at 2.19%, with petroleum gas accounting for 78.7% of total exports in 2021 (electricity accounting for 6.8% and refined petroleum 1.27%). In 2021, Algeria's exports to Morocco reached a mere 1.7%, totaling $600 million, with petroleum gas making up 83% of that amount.[12] Algeria's gas exports to Morocco ended as of Oct. 31, 2021, when the two parties opted against renewing the Maghreb Europe Gas Pipeline contract that delivered Algerian gas to Spain through Morocco, allowing the latter to draw a small percentage of the gas and transit fees. Once the contract expired, Morocco had to rely on LNG imports. As the country lacks its own regasification facilities, Spain's terminals receive LNG destined for Morocco that is then reverse flowed to Moroccan terminals through the pipeline.[13]

9. Energy Information Administrations (EIA). "Libya, the Largest Holder of Proved Reserves in Africa." https://www.eia.gov/todayinenergy/detail.php?id=590#:~:text=Libya%2C%20the%20largest%20holder%20of,natural%20gas%20exports%20from%20Libya.

10. Energy Information Administrations (EIA). "Libya, the Largest Holder of Proved Reserves in Africa." https://www.eia.gov/todayinenergy/detail.php?id=590#:~:text=Libya%2C%20the%20largest%20holder%20of,natural%20gas%20exports%20from%20Libya.

11. Observatory of Economic Complexity (OEC). "Libya Export Profile." https://oec.world/en/profile/country/lby.

12. Observatory of Economic Complexity (OEC). "Algeria Export Profile." https://oec.world/en/profile/country/lby.

13. Jonas Rosenthal, "In Reverse: Natural Gas and Politics in the Maghreb and Europe," Foreign Policy Research Institute, June 27, 2023, https://www.fpri.org/article/2023/06/in-reverse-natural-

Egypt's regional trade with Maghreb countries is also minimal. Egyptian exports to Morocco make up 1.88% of its total exports, with similarly small amounts going to Libya (1.72%), Algeria (1.14%), and Tunisia (0.56%). The bulk of Egypt's exports are refined petroleum and petroleum gas (to Morocco and Tunisia,) with other markets receiving primarily agricultural products. Fuel is among the commodities with the potential to allow for increased trade flows regionally; yet there has been little movement in that direction.[14] This limited regional trade picture reflects the extent to which North African countries have internalized the deep political hurdles and the resulting lack of regional opportunities and focused on building stronger trade ties with the EU and the US as well as, increasingly, with China, Turkey, and India.[15]

Renewables in Electricity Production as a Driver for Regional Exchanges

Cooperation on renewable energy holds tremendous potential for North Africa in general and the Maghreb in particular. The obstacles are clearly significant but so is the potential mutual benefit of depoliticized sector-specific cooperation in the development and use of renewable energy. This type of cooperation is by no means intended to change the geopolitical dynamics in the region but would allow for practical benefits to be reaped by all sides and could conceivably open the door to coordination on other issues. As the transition to renewable energy is largely driven by government initiatives, with small but growing involvement by the private sector, the onus will fall primarily on state actors to drive this cooperation, although there is a role for non-state actors to play.

Sector-specific technical regional engagement is possible, and, in fact, a particularly promising example of existing cooperation in this field is electricity exchanges. With the potential for renewable energy to shift electricity consumption trends, there is more reason to push cooperation on electricity exchanges driven by the production of renewables and the increase of renewables in electricity production shares in each country. Without much competition for renewable energy use beyond electricity production, most discussions of the topic in North African countries focus on increasing shares of renewable energy in their electricity mix. While progress along this front is uneven in the region, and the share of produced capacity remains relatively small compared to regions with less potential, the trend is in favor of renewable energy development. Indeed, IEA forecasting models show a potential three-to-five-fold increase in North Africa's renewables production capacity. These increases are likely to favor wind and photovoltaic (PV) solar, as the latter's cost continues to decrease, displacing the appeal of concentrating solar-thermal power (CSP).[16]

With this growth in production, the IEA forecasts a corresponding increasing in pressure on grid systems. Morocco has already been affected by strains on its national grid, which has prevented the country from fully utilizing its renewable energy production and potential. Other regional states will face similar challenges as their share of renewables rises in coming years. Regional interconnection and coordination offer the potential to feed increasing consumption at the regional level and address variability issues. This would provide an opportunity to increase electricity trade among North African countries and potentially facilitate regional renewable energy exports to Europe. Electricity trade is one of the areas where the Maghreb has established a history of cooperation, although limited to certain areas and ad hoc, and it is a precedent upon which to build.

gas-and-politics-in-the-maghreb-and-europe/.

14. Alexei Kireyev et al. *Economic Integration in the Maghreb: Untapped Source of Growth*. IMF February 2019, Accessed July 29, 2024. https://www.imf.org/en/Publications/Departmental-Papers-Policy-Papers/Issues/2019/02/08/Economic-Integration-in-the-Maghreb-An-Untapped-Source-of-Growth-46273

15. Intissar Fakir and Haneen Zeglam. "The Limitations of Economic Integration in the Maghreb: The Costs of 'Non-Maghreb'." *ISPI*, November 2023. Accessed July 25, 2024. https://www.ispionline.it/en/publication/the-cost-of-non-maghreb-153636.

16. International Energy Agency (IEA). *Clean Energy Transition in North Africa*. October 2020. Accessed July 25, 2024. https://iea.blob.core.windows.net/assets/b9c395df-97f1-4982-8839-79f0fdc8c1c3/Clean_Energy_Transitions_in_North_Africa.pdf.

Renewable Energy Capacity, Current Shares, and Targets in North Africa				
Country	**Total electricity production 2022**	**Current RE capacity 2023**	**Current share of power mix**	**National target**
Morocco	40.5 TWh	4.6 GW	20% of electricity generation	52% of installed capacity by 2030
Algeria	76.4 TWh	0.8 GW	3% of electricity generation	15 GW by 2035 or 1.8% (unspecified if capacity or generation)
Tunisia	21.3 TWh	0.4 GW	3% of electricity generation	35% of electricity generation by 2030
Libya	15.6 TWh	<0.1 GW	<1% of electricity generation	22% of electricity generation by 2030
Egypt	203.1 TWh	6.9 GW	12% of electricity generation	42% of electricity mix by 2035

Sources: IEA Africa Energy Outlook 2023, IRENA Renewable Capacity Statistics 2023, national energy ministries

Decoupling Electricity Exchanges From Geopolitics

Although North African governments have understood the case for an integrated regional electricity market and the benefits of such cooperation for decades, progress in that direct has been hostage to political tensions.[17] Various local and international institutions have championed stronger interconnections for their trade and export potential.[18] Having a strong interconnection system would provide a basis on which these countries could make the most of their forecast increases in renewable development. And by trading excess energy, governments could potentially reduce waste and make electricity cheaper and more widely available. Maghrebi governments have already achieved some success in establishing a common electricity market, even before other regional cooperation bodies.

In the decades since independence, North African countries have invested in electrification drives and grid connections, including between countries — most of them achieving near-universal electrification by the early 2000s.[19] The Infrastructure Consortium for Africa indicated in a 2010 report a total installed capacity for the Maghreb Electricity Committee of 27,347 megawatts (MW).[20] Over a decade later, the International Renewable Energy Agency (IRENA) put the "physical capacity" of the interconnection for North African inter-regional trade at 4,500 MW — although, due to technical issues, it is

17. Abdelnour Keramane. "Maghreb: L'Interconnexion des Réseaux Électriques á Intégration Énergétique. 2015. Accessed July 25, 2024. https://www.encyclopedie-energie.org/maghreb-interconnexion-reseaux-electriques-integration-energetique/.

18. International Energy Agency (IEA). *Clean Energy Transition in North Africa*. October 2020. Accessed July 25, 2024. https://iea.blob.core.windows.net/assets/b9c395df-97f1-4982-8839-79f0fdc8c1c3/Clean_Energy_Transitions_in_North_Africa.pdf.

19. International Energy Agency (IEA). *Clean Energy Transition in North Africa*. October 2020. Accessed July 25, 2024. https://iea.blob.core.windows.net/assets/b9c395df-97f1-4982-8839-79f0fdc8c1c3/Clean_Energy_Transitions_in_North_Africa.pdf.

20. Infrastructure Consortium for Africa. *Annual Report 2010.* Accessed July 25, 2024.

limited to 1,310 MW.[21] In terms of grid interconnections, by 2020 several were operational or had been operational at one time. The connections between Morocco, Algeria, and Tunisia range in capacity. Historically, there have been two connections (four lines)[22] between Morocco and Algeria, two links (five lines) between Tunisia and Algeria, one connection (two lines) between Libya and Tunisia, and one line linking Egypt and Libya.[23] The Tunisia-Libya interconnections operated in the early 2000s but faced flow and overloading issues that required further maintenance and have thus operated below capacity.

Part of the context within which these interconnections were established was the creation in 1974 of a regional electricity cooperation oversight body known by its French acronym, COMELEC (Comité Maghrébin de l'Electricité or Maghreb Electricity Committee), by the national utility companies of Morocco, Algeria, and Tunisia. Within two years, Libya and Mauritania (although the latter draws additional energy from the West African Power Pool) joined COMELEC.

The driving force behind COMELEC was the understanding that a first step toward industrial integration required a shared network of power production and distribution. The body adopted the key objectives of strengthening and expanding interconnections to facilitate electricity exchange, especially distribution to border communities, and exploring the feasibility of future joint ventures, including on renewable energy, which at the time focused on nuclear power. COMELEC did allow for a significant exchange of information and practices, policy discussions among partner countries, or cooperation on electricity interconnection projects, several of which were completed well into the mid-2010s and all of which provide an important infrastructural basis upon which cooperation can be built. These connections continued as the effort to build a common electricity market stalled. An energy policy protocol signed in Rome in 2003 by ministers of energy from Morocco, Algeria, and Tunisia sought to establish the framework for a common electricity market.[24] The initiative had the support of the EU, and COMELEC was envisioned to play a role in the implementation but was not the empowered supra-national body that could cut through the geopolitical tensions, policy divergences, and infrastructural disparities. In the absence of a common Maghreb electricity market, bilateral agreements have been the main vehicle of cooperation, in addition to one-off or ad hoc agreements.

Interconnections have in the past supplied cross-border communities and filled supply gaps during emergencies. Recently, Tunisia has increased its reliance on Algerian electricity imports, highlighting the prevailing bilateral cooperation. Tunisia's electricity trade with Algeria grew as Tunis has grown increasingly reliant on Algiers not just in terms of energy imports but also to address national budget shortfalls. The neighbors share three interconnections with a total capacity of 900 MW, which have allowed Tunisia to import 5.5% of its total power supply in 2021[25] and 13% in 2022.[26] As Algeria's

21. International Renewable Energy Agency (IRENA). *Planning and Prospects for North Africa Renewable Power*. January 2023. Accessed July 25, 2024. https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Jan/IRENA_Planning_Prospects_NAfrica_2023.pdf?rev=3c742bf754a540d8929a5856aaa4575f.

22. The two grid connections run on 4 lines — 225 and 400 KV (linking Oujda to Ghazouat and Oujda to Tlemcen. The second connection runs on two lines of 400 KV, linking station Bourdin to Sidi Ali Bousidi. https://anre.ma/wp-content/uploads/2023/12/AR-RA_ANRE-2022-PLANCHE-DV.pdf

23. World Bank. *Middle East and North Africa: Integration of Electricity Networks in the Arab World*. December 2013. Accessed July 25, 2024. https://documents1.worldbank.org/curated/en/415281468059650302/pdf/ACS71240ESW0WH0I0and0II000Final0PDF.pdf.

24. The European Commission. *The European Commission promotes integration of the electricity markets of the Maghreb.* June 20, 2020. Accessed November 15, 2024. https://ec.europa.eu/commission/presscorner/detail/en/ip_10_763.

25. Aydin Calik. "Tunisia Draws Record Power From Algeria in 2021." *MEES.* February 18, 2022. Accessed July 25, 2024. https://www.mees.com/2022/2/18/power-water/tunisia-draws-record-power-from-algeria-in-2021/234b3270-90ba-11ec-8282-b9124e4705f4.

26. Meriem Ben Yahya. "L'Algérie Prête á Augmenter Ses Exportations d'Électricité Vers la Tunisie." *Il Boursa,* March

renewable energy production is minimal, exported electricity is largely gas generated. But this picture is likely to shift as both Tunisia and Algeria work to increase their renewable energy capacity.

Aside from this jump in bilateral exchange, trade between the other countries remained limited due to a range of challenges — primarily insufficient resources but also technical issues, obstructive policy frameworks, and political tensions. Nonetheless, there is a history of regional exchanges, especially in times of emergency or on a temporary basis. In 2018, Morocco and Algeria signed an agreement to provide Tunisia with electricity, and a similar agreement to supply Libya was under discussion.[27] Tunisia (and Egypt) likewise supplied Libya with electricity during a blackout in 2015,[28] and Tunisia has received support from Libya during its own periods of shortage.[29] Algeria, Tunisia, and Libya have various plans to increase grid connections and electricity trade between them,[30] with Morocco left out as it relies on European electricity imports, and no doubt also due in some part to the diplomatic tensions between Morocco and Algeria.

A cross-cutting dynamic in these countries' electricity markets is the fact that demand has grown substantially and is expected to continue to climb. Even gas producers like Libya and Egypt have struggled with securing their own supply. Producers face the challenge of prioritizing between domestic usage versus export. In addition, technical issues have limited the utility of interconnections or caused them to be used below capacity.[31] North African countries have grappled with issues such as the lack of consistent and clear regulations on electricity transfers, limited reserve capacity, and the absence of institutional ability, resources, and even political will to address the issues. To some extent, however, political tension between Morocco and Algeria was as much of an obstacle to cooperation in this area until recently. The two countries had engaged in various exchanges through the existing three connections with a total capacity of 1,200 MW.

As an example of decoupled sector-specific cooperation, COMELEC has had some success in facilitating policy discussions and initiating cooperation on infrastructural connections; it remains one of the few enduring examples of regional engagement. Although the organization has struggled to create common projects in its almost 50 years of existence, it continues to attempt to pave the way. Most recently, in 2020, then-CEO of the Tunisian Electricity and Gas Company (STEG), Moncef Harrabi, launched a study on transport tariffs from country to country while presiding over COMELEC. This was part of feasibility studies and other attempts to create an environment conducive to the launch of a common electricity market by 2025.[32] To achieve a fully integrated market, COMELEC must clear additional hurdles, including addressing the disparities in grid infrastructure, developing and adopting common grid codes, harmonizing operational standards, and establishing regulatory frameworks. An integrated renewables market requires some degree of alignment on policies, including pricing procedures and mechanisms.

3, 2023. Accessed July 25, 2024. https://www.ilboursa.com/marches/l-algerie-prete-a-augmenter-ses-exportations-d-electricite-vers-la-tunisie_39727.

27. Safaa Kasraoui. "Agreement Between Morocco and Algeria to Supply Tunisia with Electricity." *Morocco World News,* July 16, 2018. Accessed July 25, 2024. https://www.moroccoworldnews.com/2018/07/250646/algeria-morocco-electricity-tunisia.

28. Reuters. "Libya to Get electricity from Egypt, Tunisia to Ease Blackouts-Tripoli Govt." August 5, 2015. Accessed July 25, 2024. https://www.reuters.com/article/libya-power/libya-to-get-electricity-from-egypt-tunisia-to-ease-blackouts-tripoli-govt-idINL5N10G1OJ20150805/

29. LibyaMohammed. "Tunisian Electricity Company Thanks Its Libyan Counterpart for Its Assistance." September 25, 2023. Accessed July 25, 2024. https://libyaobserver.ly/news/tunisian-electricity-company-thanks-its-libyan-counterpart-its-assistance.

30. Maghreb Times. "Maghreb Electricity: Algeria, Tunisia and Libya Interconnect," November 27, 2023. Accessed November 15, 2024. https://themaghrebtimes.com/maghreb-electricity-algeria-tunisia-and-libya-interconnect/

31. Arab Fund for Economic and Social Development. "Arab Regional Projects, Maghreb Interconnections." Accessed July 25, 2024. https://www.arabfund.org/default.aspx?pageId=454.

32. L'Opinion. "Une Nouvelle Opportunité pour le Maroc." February 20, 2020. Accessed July 25, 2024. https://www.lopinion.ma/Une-nouvelle-opportunite-pour-le-Maroc_a384.html.

A phased approach to deeper integration would allow COMELEC to build on what has been established by continuing and capitalizing on limited exchange arrangements where countries have established bilateral or multilateral import-export agreements, as is the case between Algeria and Tunisia. As these countries continue to build their renewables industries, develop their grid systems and adopt smart grids, and improve their regulatory landscapes to attract private investors, they will each arrive at a better position from which to capitalize on their separate strengths, resources, and experiences. While deeper integration requires a harmonized and coordinated approach, Maghreb countries can establish more effective cooperation through limited coordination on specific mechanisms for cross-border trade by focusing on a specific aspect, such as renewables, or a particular geographical area (as has been done in the past with providing for border communities), or even on a bilateral level, or by focusing on a particular period, such as peak hours. This is where COMELEC can play a bigger role, provided there is the political will.

The Potential of Cooperation on Renewables and the Pitfalls of Previous Experiences

Discussions of cooperation on renewable energy often focus on cooperation between the EU and Maghreb countries or the EU and North African countries and less so on intra-Maghreb cooperation. The EU has long supported initiatives among Maghreb countries, but this approach has been influenced by several factors. First is the lack of a willingness to cooperate (on regional initiatives, not at the bilateral level). More important is the European demand for solar energy — not as abundant compared to North Africa. External investment flows from European markets are concerned first and foremost with helping facilitate export back to Europe, particularly since access to North African solar energy could help European countries meet their own clean energy targets. Likewise, technical cooperation has largely been between interested European actors and their Maghreb counterparts and not as much among North African actors.

For years, Europe has designed and implemented a series of country-focused mechanisms for energy cooperation with North Africa on energy transition, with renewable energy taking an increasingly important aspect of the design, if not always the implementation. European investment in support of sustainable energy and renewable energy development is an important part of the European Neighborhood Policy (ENP). Cooperation at the regional level between Europe and Maghreb countries has run into a host of challenges, however, with the German-led initiative Desertec being a leading example.

Born out of regional ambitions to build stronger cooperation between the EU and the Middle East and North African region as well as to capitalize on the export potential of solar energy from the Maghreb to European markets, the Desertec project kicked off with an ambitious goal in 2009. Seeking to link MENA's abundant solar energy potential with European markets, the idea was to build renewable energy plants that would utilize a series of grid connections, known as Medgrid. The project was to reach a production capacity of 20 gigawatts (GW), with 5 GW dedicated to EU exports. With an investment target of about 400 billion euros, the project generated significant interest and curiosity at the outset. A consortium of enterprises and power utilities joined Desertec and Medgrid.

Almost immediately, challenges emerged regarding disharmonious regulations among the participating countries; but soon enough, almost every aspect of the project became a hurdle. Desertec initially envisioned a reliance on CSP, but the PV option became more cost competitive. A key market reality at the time threatened to derail the project: the abundance of non-renewable energy sources and their lower costs challenged the economic rationale of various renewable energy options. And within the project consortium, disagreement about which part of Europe would benefit from electricity imports became an increasing issue. Meanwhile, European concerns about developing new energy dependency added to the project's downward momentum. Investor anxiety about the geopolitical and economic context in some of the Maghreb partner countries was also a factor. Another major barrier was the difficulty of securing reliable and profitable interconnections. Finally, despite early enthusiasm, the

project was eventually tainted by concerns about social and environmental justice.[33]

The discourse in Europe about North African renewable energy being the solution to its energy security issues has created a backlash against a perceived neo-colonial nature of cooperation that prioritizes exports. Whether looking at the thinking behind Desertec, the planned connections to link Tunisia to Italy, or upcoming green hydrogen projects, public onion across the Maghreb has repeatedly pushed back against the idea that the region should become an exporter of clean energy to Europe. Civil society responses to some of these projects underline local fears about exploitation of land and labor that benefits Europe while they face shortages and high prices at home. These responses reflect the lack of trust in local governance structures and the inherent fears of exploitation that locals face. This fear is in part driven by local governments' responses to European or western needs. While the fundamental basis of this fear is understandable, there has increasingly been a tendency to lump all cooperation under the "potentially exploitative" umbrella. It is incumbent upon local governments to ensure the parameters of proposed projects actually develop local capacity by exporting excess production and to address such fears and provide reassurances about the potential benefits of any arrangements.

While the regional multi-faceted infrastructural behemoth Desertec ultimately failed, it did highlight the importance of building more interconnections between North African and southern Mediterranean countries; and the momentum for interconnectivity has persisted. Beyond existing pipeline infrastructure, new interconnectivity initiatives are seeking to pave the way for clean energy trade with Europe. Over the past 15 years, grid and cable connection projects have multiplied. Morocco has had such submarine power cable connections cross the Strait of Gibraltar since 1997, which were expanded in 2006 to a capacity of 1,400 MW. Initially, these transmission lines were used largely for import; but in recent years, Morocco's renewable energy production has increased, allowing it to reserve flows to Spain.[34] Morocco has been planning an additional connection to increase the capacity of these cables to 2,100 MW. To date, this remains the only completed interconnection between Europe and the Maghreb. But others are on the horizon.

Algeria and Tunisia have been exploring their own interconnectivity to Europe for well over a decade. Tunisia is planning a link to Italy through the ELMED interconnection to Sicily, with an initial capacity of 600 MW and the potential to expand.[35] Since 2009, Algeria has been in the early planning stages of a submarine cable connection to Italy with a capacity of a 1,000 MW and to Spain with a capacity of 2,000 MW.[36] In turn, the Euro-Africa Interconnector project was launched in 2012 with plans to connect Egypt, Cyprus, and Greece via high-voltage direct current (HVDC) submarine cables, which will boast a capacity of about 2,000 MW and span 1,396 kilometers. With support from the EU, the project will rely on private investment. The Egyptian-European project is in the advanced planning stages but has faced delays and challenges, including pertaining to the technical aspects of building and maintaining cable connections over vast distances and geopolitical tensions in the eastern Mediterranean.[37]

The broader regional focus on interconnectivity to Europe is similarly driving Morocco's plans for the Xlinks UK-Morocco Power project, a cable connection that will export renewable energy to the United Kingdom. The Xlinks project will provide a novel approach to energy export through submarine cables, drawing energy from

33. Thomas M. Schmitt. "(Why) Did Desertec Fail? An Interim Analysis of a Large-Scale Renewable Energy Project from a Social Studies of Technology Perspective." 2018. Accessed July 25, 2024.

34. World Bank. *Middle East and North Africa: Integration of Electricity Networks in the Arab World*. December 2013. Accessed July 25, 2024. https://documents1.worldbank.org/curated/en/415281468059650302/pdf/ACS71240ESW0WH0I0and0II000Final0PDF.pdf.

35. ELMED Project, accessed September 19, 2024, https://elmedproject.com/#:~:text=The%20ELMED%20project%20will%20allow,and%20renewable%20future%20for%20energy.

36. Zhor Hadjam. "Deux projects d'ineterconnection vers l'Espagne et l'Italie a l'etude." December 31, 2009. Algeria Watch, accessed August 2024 https://algeria-watch.org/?p=10158.

37. EuroAfrica internconnector. Assessed August 2024. https://www.euroafrica-interconnector.com/.

a dedicated solar and wind farm, with the potential to add more sources down the line. If completed it will be the world's longest undersea high-voltage cable and carry substantially more capacity than currently exists on the market. It is planned to include a lithium-ion battery storage facility and will transmit electricity via a high-voltage alternating current (HVAC) network.[38] The £16 billion project secured an initial £49 million in developmental funds.

With feasibility studies completed and licensing underway, the project closed its first funding round in Q1 2024. In the previous two years, the company announced con|energy joined the group of investors in 2022, with an unspecified amount.[39] In 2023, Xlinks revealed a £20 million investment from the Abu Dhabi National Energy Company (TAQA) and £5 million from Britain's Octopus Energy. [40] In an April 2023 press release, the group stated it had secured £20 million from TotalEnergies.[41] In April 2024, the Africa Finance Corporation, announced a $14.1 investment in the project.[42] Shortly after GE Vernova, an investor in renewable energy declared an additional $10.2 to survey cable connections.[43] Cable manufacturing is expected to be managed by Xlinks' subsidiary XLCC,[44] which is building the largest cable laying vessel and is in talks to undertake the project.[45]

Infrastructural projects like Xlinks focus on North Africa to Europe interconnections (Morocco to the UK and Spain, Tunisia to Italy, and Egypt to Greece via Cyprus), while intra-North African links lack a similar focus. The imbalance reflects the pull of European markets and the persistent challenges of regional cooperation. The European orientation of infrastructural investment also highlights a broader challenge: the gap between rhetoric and reality in climate finance. While investments in these projects signal growing private-sector confidence in North African renewable energy projects, they represent a fraction of what is needed for the region's energy transition. The gap between ambitions announcements and actual financing remains stark. This discrepancy between soaring rhetoric and available financial resources is most clear regarding EU cooperation and European pledges of support to partner countries. Financial instruments are often promised but slow to come or never see the light of day. Such routine shortfalls in climate financing are well documented — a 2024 Organization for Economic Cooperation and Development (OECD) report estimates the global gap to reach $16.7 billion.[46]

38. Xlinks. "Press Release." Accessed March 2024. https://xlinks.co/.

39. Con|energy. "Press Release." November 14,2022. Accessed November 14, 2024. https://www.conenergy.com/en/allpressreleases/xlinks-marokko-gewinnt-mit-conenergy-neuen-investor.

40. TotalEnergies. "Press Release." November 29, 2023. Accessed July 25, 2024. https://totalenergies.com/media/news/press-releases/totalenergies-acquires-minority-stake-xlinks-morocco-uk-power-project.

41. Xlinks. "First of a Kind Renewable Energy Project Secures Backing from TAQA and Octopus." Accessed July 25, 2024. https://xlinks.co/taqa-octopus-energy-partnership/.

42. Africa Finance Corporation. "News and Insights." Accessed November 15, 2024. https://www.africafc.org/news-and-insights/news/africa-finance-corporation-invests-14-1m-in-developing-xlinks-morocco-uk-power-project

43. Power Engineering International. "GE Vernova invests in Xlinks Morocco-UK power project." April 30, 2024. Accessed November 15, 2024. https://www.powerengineeringint.com/finance-investment/ge-vernova-invests-in-xlinks-morocco-uk-power-project/.

44. Mark Kleinman. "Clean Energy Start-Up Xlink Eyes Investor Backing for Revolutionary £16bn Project." *Sky News*, April 29, 2022. Accessed July 25, 2024. https://news.sky.com/story/clean-energy-start-up-xlinks-eyes-investor-backing-for-revolutionary-16bn-project-12601045.

45. Lena Dias Martins. "Connecting to net-zero: building the Morocco-UK interconnector." *Current,* March 14, 2024. Accessed November 15, 2024. https://www.current-news.co.uk/connecting-to-net-zero-building-the-morocco-uk-interconnector/.

46. Carty and Kowalzig. "Climate Finance: Short-Changed." *Oxfam*, 2022. Accessed July 25, 2024. https://reliefweb.int/report/world/climate-finance-short-changed-real-value-100-billion-commitment-2019-2020-enar.

Additional Steps

The development and expansion of energy interconnections and infrastructure are important to pursue not only with European countries but among Maghreb neighbors. While there is already a foundation to build upon, further investment is needed to update and modernize these preexisting connections. The grid discrepancy in Maghreb countries requires not only efforts to streamline codes but also to promote the adoption of new technologies to boost domestic efficiency and allow for the greater integration of renewables. Morocco is leading the region in this regard by gradually adopting "smart" features and capabilities into its national grid systems to match production and demand and make the most of renewable energy production. Notably, Morocco launched a pilot project in Casablanca in 2008 employing a dispatch system with such smart features.[47] In 2022, Siemens announced its commission to implementing grid-control technology and smart meters in Egypt's Nile Delta.[48] The European Bank of Reconstruction and Development in 2023 was considering a loan to upgrade Egypt's electricity transmission system of $174 million that would include decommissioning an old gas-power plant.[49] With EU support, Tunisia has been upgrading its grid and integrating smart capabilities in phases.[50]

Although lagging, the state company Sonelgaz is seeking to upgrade Algeria's grid system to integrate renewables.

Promoting joint or cross-border projects will require further steps — steps that are well understood and the benefits of which are clear but held up due to the divergent landscapes in each country and the lack of political desire to promote cooperation. Yet as governments realize the need to bring in more private-sector engagement, they will have to boost investor confidence and create opportunities for lucrative large-scale, cross-regional projects. These will require, if not a fully harmonized regulatory landscape, at least some efforts to reduce administrative barriers by, for instance, aligning technical, licensing, and feasibility study requirements. Additional steps also necessitate aligning land allocation requirements, environmental assessments, and the role of the state in the industry. And most importantly, a regional body like COMELEC should be designated to oversee and facilitate these projects.

Beyond the involvement of the state, civil society organizations can play a role in supporting regional cooperation by helping facilitate knowledge-sharing experiences and technology transfer. Research institutions and non-governmental organizations (NGOs) can facilitate partnerships for the transfer of technology. Some of this already occurs through international organizations like IRENA, but local and national groups can play a bigger role in this arena. NGOs can convene gatherings of experts and policymakers to share lessons learned, advocate for common goals, and work toward more harmonized policies. The range of civil society groups currently operating in the energy transition space and for climate action at the community, national, and regional levels has grown and can help drive a more cooperative vision for the future of renewables in North Africa.

47. Meryem Meliani et al. *Smart grid implementation in Morocco: case study.* March 2021. Accessed July25, 2024. https://www.researchgate.net/publication/350490789_Smart_grid_implementation_in_Morocco_Case_study

48. Siemens. "Press Release." December 8, 2022. Accessed November 15, 2024. https://press.siemens.com/global/en/pressrelease/siemens-wins-new-order-grid-control-and-smart-metering-infrastructure-egypt

49. Business Today Egypt. "EBRD reveals potential new 164M loan for Egypt's electricity grid update. October 15, 2023. Accessed November 2024. https://www.businesstodayegypt.com/Article/1/3227/EBRD-reveals-potential-new-%E2%82%AC165M-loan-for-Egypt-electricity-grid

50. Sia Partners. "Corporate News." November 16, 2023. Accessed November 15, 2024. https://www.sia-partners.com/en/about-us/corporate-news/sia-partners-support-tunisias-smart-grid-transformation-next-four-years

Conclusion: A Roadmap for North Africa's Renewable Energy

Intissar Fakir

Photo above: Floating solar panels in a water reservoir in Le Kram, on the eastern edge of Tunisia's capital, Tunis. Photo by FETHI BELAID/AFP via Getty Images.

The report's layering of thematic focus and country-based case studies provides an opportunity to identify crucial shared areas of improvement such as regulatory streamlining, infrastructure development, market reforms, and technology acquisition — but each of these requires tailored policies that acknowledge the different contexts and needs of each country.

Embedded throughout each chapter are a series of actionable perspectives and items that can further the successes of each North African state. This roadmap of policy recommendations is distilled into cross-cutting recommendations, for the attention of local and international actors. It must address a range of needs often at the same time — through a gradual and sustained implementation process, with regular review and adjustment to ensure success.

For Local Administrations

1. Legal and Regulatory Frameworks

Cross-Cutting

While varying in maturity, each country has put in place regulatory frameworks and bodies. The challenges lie primarily in implementation, taking different forms in each country. Regional frameworks could benefit from the following improvements in implementation:

- Clarifying and streamlining bureaucratic processes and simplifying procedures;
- Removing redundancies and improving coordination between the different existing regulatory bodies, which would help remove overlap and clarify guidelines for existing legal frameworks; as well as

- Empowering institutional bodies to carry out their mandates.

On the regulatory and legislative sides, most countries could improve on the following:

- Removing hurdles for private-sector participation, often a political consideration that points back to the extent to which governments are willing to allow private-sector penetration in this specific sector;
- While keeping in mind country-specific differences, instituting clearer and more transparent licensing procedures as well as and technical standards for issues such as grid connection rules, and equipment standards across the region; and
- Granting greater autonomy to and supporting the independence of energy regulators —another inherently political issue but one that could go a long way in instilling confidence in private investors, domestic and foreign.

Country-Specific

At the country level, regulatory frameworks would benefit from the following improvements:

- **Morocco** would benefit from simplifying its extensive legislative framework and bureaucratic process which often stand as hurdles to implementation and project success.
- Eliminating jurisdiction overlap of regulatory institutions would remove yet other obstacles investors have to navigate especially foreign companies.
- **Algeria** can overcome some of its institutional inertia but empowering specific entities to execute projects within existing frameworks as was the recent with case with Sonelgas' solar project progress.
- **Tunisia**, however, needs to regulatory uncertainty resulting from ongoing political changes and their impact on institutional bureaucracy.
- Likewise, institutional capacity needs to be improved either through recruitment or training of personnel capable of executing policies effectively.
- **Egypt** also needs to political will and attention to put policies into action, and more practically to ensure the consistency of existing policies.

2. Market Access and Development

Cross-Cutting

Across North Africa, renewable energy development requires a balanced approach that leverages both private and public capabilities, market access remains a challenge for private sector, one that requires regulatory reforms as it faces challenges navigating complex bureaucratic and regulatory challenges, governments can improve market access for private sectors:

- Establishing more competitive procurement processes for a range of company sizes.
- Improving transparency of bidding and procurement processes.
- Improving access to credit and financing to support local industry development.
- Developing local manufacturing capacity and creating supply chain opportunities.

Country-Specific

- **Morocco** could help improve market access by increasing grid capacity an issue that requires investment in smart grid infrastructure and development.
- **Tunisia** could inject more transparency in STEG procedures and reduce financial barriers to entry.
- **Algeria** too could benefit from simplifying and making bidding procedures more transparent.
- **Egypt** could particularly do more to provide data for energy consumption and demand to help clarify consumption patterns and make for more efficient renewable energy development and deployment for potential investors.

3. Technology and Innovation

Cross-Cutting

Technology and innovation are clear cross-cutting areas of need. Each country would benefit from:

- Investing more in its electricity grid infrastructure and improving the grid's management;
- Allocating more funding for R&D so as to improve the capacity of academic and technical institutions to build out a domestic renewable sector workforce and boost tailored domestic innovation.
- Researching water-efficient cooling technologies for solar plants and drought-resistant renewable energy solutions; and
- Integrating together more water desalination and renewable energy projects.

Country-Specific

- **Morocco** could particularly benefit from more initiatives to develop technical expertise and middle management through education and training.
- **Algeria** could benefit from making technology more accessible and appealing for domestic consumption.
- **Tunisia** could put more effort into developing smaller decentralized projects that serve clear community centers.

4. Social and Environmental Protections

The social and environmental impact of renewable energy development is still unclear as the region forges ahead, but areas of priority are already clear for the region's governments and private companies:

- In most cases, governments lack clear environmental impact assessment frameworks or fall short of following them — developing and implementing clearer assessment frameworks is an important tool still missing for protection of both investor and regulator.
- Most governments have yet to show seriousness in establishing conservation measures that would support biodiversity protection and ensure proper monitoring systems and procedures.
- Developing a regional water management framework is crucial for a region whose water challenge is cross-cutting and has deep implications for the future of renewable energy development.
- The renewable industry needs to focus on showing improved social impact through better energy access for neighboring communities as well as through job opportunities and local business development.
- Community engagement through stakeholder consolation processes and community grievance resolution mechanisms is still missing region wide and would help improve perceptions, especially around the question of export to Europe, which faces a popularity crisis.

For International Actors

1. Funding and Financing

The underlying financial need is significant. Financial institutions can play an important role in putting forward financially innovative mechanism through:

- Putting forward financial products that don't exacerbate sovereign debt issues, particularly given that several countries in the region face a debt trap;
- Creating blended financing instruments specifically designed for North African renewable projects;
- Developing risk-sharing mechanisms to encourage private investment; and
- Establishing dedicated funding windows for small- and medium-scale projects.

2. Technical Support and Capacity-Building

Most North African countries can draw on sophisticated technical expertise throughout their domestic industries.

While the degree of this sophistication varies, there are still areas where the constellation of local actors from governments, the private sector, and civil society groups could benefit from international support. This includes:

- Providing technical and financial support for comprehensive grid modernization studies;
- Providing feasibility studies for cross-border projects that support regional resource and knowledge sharing; as well as
- Providing extended education and exchange programs focused on vocational training at the regional and international levels.

3. Regional Integration

Given the politically divided and economically disaggregated nature of the region, international actors can help pave the way for regional cooperation by:

- Supporting existing regional structures like COMELEC in their pursuit of a shared power market;
- Investing in regional infrastructural connections and modernizing existing ones;
- Supporting existing initiatives and incentivizing resource sharing in times of shortages;
- Promoting regional exchanges for mid-level officials and providing regional training programs for technical staff; as well as
- Supporting regional civil society in advocating on behalf of the private sector and consumers.

At its core, the challenge facing renewable energy development is fundamentally about governance. While international actors — foreign governments, financial institutions, or international companies — have both the capacity and obligation to provide technical and financial support for energy transition, they cannot solve these underlying governance challenges. Improving governance structures and practices must be driven by the countries themselves. Governments and domestic actors' ability to muster the political will to implement necessary reforms and push these initiatives forward will be an important determinant of success.

Addendum: A Renewable Energy Agenda for Libya

Mary Fitzgerald

Photo above: Motorists drive through a sandstorm in Libya's eastern city of Benghazi on April 22, 2024. Photo by ABDULLAH DOMA/AFP via Getty Images.

Libya finally started waking up to its significant potential to become a key producer and exporter of green energy in the post-hydrocarbon era. In 2023, the Libyan government announced ambitious decarbonization plans and a national strategy for renewable energies and energy efficiency leading up to 2035. The Libyan National Oil Corporation (NOC) signed a memorandum of understanding (MoU) with Italy's Eni SpA., the biggest player in Libya's oil and natural gas sector, with the aim of identifying opportunities to reduce greenhouse gas emissions and developing sustainable energy in the country.[1] Libya also signed an MoU with Malta for the export of green electricity to help the Mediterranean island achieve its carbon neutrality goal.[2] This fresh momentum opens new opportunities for investing in renewable energy and green hydrogen, even if the country remains a challenging environment for international investors due to continuing wrangling over political legitimacy and a dysfunctional legal system.

With most of its land mass comprising desert, Libya has considerable potential to shift toward renewable energy. According to the Renewable Energies Authority of Libya (REAoL) annual brightness is estimated to amount to approximately 3,200 hours and average solar radiation is estimated at 6 kilowatt-hours (kWh) per square meter

1. Eni Press Release, "Eni launches a major gas development project in Libya," Eni, January 28, 2023, https://www.eni.com/en-IT/media/press-release/2023/01/eni-launches-a-major-gas-development-project-in-libya.html.

2. Esi Africa, "Libya to export renewable energy to Malta," *Transformers Magazine*, June 28, 2023, https://transformers-magazine.com/tm-news/libya-to-export-renewable-energy-to-malta/.

per day.[3] In recent years, there has been a growing — if at times, tentative — realization of Libya's challenges in both adapting to climate change and reducing its emissions.

Advocates of the renewables agenda in Libya argue that adopting alternative energies would not only help address Libya's electricity needs sustainably but also reduce carbon emissions in line with international norms and open a new economic sector anchored in lucrative green energy exports to Europe. While Libyan officials generally tend to publicly express support for such policies, some of them privately question how those ambitions can be realized when there is little funding allocated in the government's budget to support new renewable energy projects, whether through the NOC or the Renewable Energy Authority of Libya (REAoL). Officials point out that considerable foreign direct investment will be required to build the sector and note that, for now, investors with limited experience of Libya remain cautious given the country's continuing political power struggles, even if a cease-fire has held since late 2020.[4]

Key Actors

A number of Libyan state entities are focused on the country's renewable energies potential, and heightened external interest — from potential investors to international development agencies — has fed institutional rivalries over who should take the lead in developing the sector. Traditionally, the key player in the Libyan electricity sector has been the General Electric Company (GECOL), a state-owned company established in 1984. Additionally, the Gaddafi regime established REAoL in 2007 with the mandate to develop the renewable energy sector and integrate renewables in the national power generation. A decade ago, REAoL launched the Strategic Plan for Renewable Energy 2013-2025, which aimed to integrate the locally available renewable energy resources with the national energy system, but progress has been limited.[5]

The NOC, particularly under the chairmanship of former Central Bank governor Farhat Bengdara, appointed in 2022, has sought to position itself as the key driver of Libya's renewables agenda. This is despite the fact that the organization's plans in this sector up to now have largely derived from proposals made by international partners, including major international oil companies (IOCs). Nevertheless, the NOC considers itself better placed, both financially and administratively, to take the lead than GECOL and REAoL, both of which struggle with underfunding.[6]

At present, however, the NOC is hamstrung by the fact that it lacks a clear legal mandate to oversee the development of the renewables sector. This may change if a draft law aimed at reforming the NOC and giving it more independence is approved by the Libyan House of Representatives (HoR). The bill, which was presented to the HoR in October 2023, proposes that the NOC be renamed the National Oil, Gas and Renewables Corporation, thus apparently absorbing REAoL.[7] While elements of the proposed law dovetail with Bengdara's vision for NOC reform, it was widely seen as a politicized move designed to circumvent the GNU's plans to expand its control of the sector.[8]

Current Targets

The REAoL-drafted Strategic Plan for Renewable Energy 2013-2025 sought a 7% contribution from renewables in the country's energy mix by 2020, increasing to 10% by 2025.[9] This was to be derived from wind, concentrated

3. Ali O.M. Maka, Salem Salem, Mubbashar Mehmood, "Solar photovoltaic (PV) applications in Libya: Challenges, potential opportunities and future perspectives," *Cleaner Engineering and Technology,* Vol. 5, December 2021, https://www.sciencedirect.com/science/article/pii/S2666790821002275.

4. Author interviews with Libyan officials and environmental campaigners.

5. IEA, "Energy System of Libya," International Energy Agency (IAE), 2022, https://www.iea.org/countries/libya.

6. Author interviews with NOC officials and other contacts from Libya's energy sector.

7. Menas Associates, "NOC Navigates Libya's Political Turbulence to Boost Production," Libya Politics & Security Report, November 27, 2023, https://menas.co.uk/blog/noc-navigates-libyas-political-turbulence-to-boost-production.

8. Author interviews with figures from Libya's energy sector.

9. IEA, "Energy System of Libya," 2022.

solar power, photovoltaics, and solar water heating, with GECOL opening up the power generation market to national and foreign investors. Progress since has been limited, and Libya is unlikely to meet its 2025 targets.

In December 2023, the Tripoli based GNU's Prime Minister Abdul Hamid Dbeibeh launched what was billed as Libya's National Strategy for Renewable Energies and Energy Efficiency 2023-2035.[10] This was expected to overlap with the final stages of the REAoL-drafted plan and not challenge it as such. The strategy plan was developed by the Ministry of Planning with support from the United States Agency for International Development (USAID). It includes a target to source up to 20% of the country's electricity from renewables by 2035. At present, energy subsidies account for a significant part of the government's annual budget.[11]

Prior to the 2023 commitment to transition to renewable energy sources, REAoL's renewable undertakings included a solar street light project in Ubari in 2020 and a wind power project in Msallata, which was reported nearly complete in 2016.[12] Projects in various stages of completion as of 2024 include a number of grid-scale solar parts in Sadada, Beni Walid, Tajoura, Kufra, and Gadames.[13]

10. Sami Zapita, "Libya launches National Strategy for Renewable Energies and Energy Efficiency 2023-2035," *Libya Herald*, December 12, 2023, https://libyaherald.com/2023/12/libya-launches-national-strategy-for-renewable-energies-and-energy-efficiency-2023-2035/.

11. Ministry of Planning, "National Strategy for Renewable Energy & Energy Efficient – Libya (NSREE) 2023-2035," Government of National Unity, March 2023, https://reaol.ly/wp-content/uploads/2024/04/NSREEE_23_35_REAOL_EN.pdf.

12. UNDP Libya, "Street lighting opens up new horizons in Ubari," United Nations Programme (UNDP), December 3, 2020, https://www.undp.org/libya/stories/street-lighting-opens-new-horizons-ubari; Abdullah Ben Ibrahim, "Msallata city to use power wind for electricity," *Libya Observer*, January 16, 2016, https://libyaobserver.ly/tech/msallata-city-use-power-wind-electricity#google_vignette.

13. Global Data, "Power plant profile: Ghadames Solar PV Park, Libya," Power Technology, October 21, 2024, https://www.power-technology.com/data-insights/power-plant-profile-ghadames-solar-pv-park-libya/.

Regulatory Framework

Libya still lacks a comprehensive legal framework governing the renewable energy sector. More generally, the country's restrictive and complex regulatory environment has hindered foreign investment across several sectors. Given rising interest in renewables, both institutionally in Libya and from potential external investors, there is pressure to introduce a specific legislative framework for the sector.[14] The United Nations Development Program (UNDP) has recommended the enactment of an electricity law that provides a clear regulatory framework and incentives for renewable energy investments.[15]

In the meantime, according to a summary by Chambers and Partners, Libya's laws that apply to renewable energy projects include the following:[16]

- Law 17/1984, which established GECOL, and Ministerial Decree Nr 426/2007, which established REAoL;
- The Administrative Contracts Regulation 563/2007, which governs tender proceedings and contracting with the public sector;
- Decree 207/2012 on Regulating the Activity of Foreign Enterprises in Libya;
- The Libyan Civil Code (1953) and Commercial Code (2010), which govern general contractual and company matters; as well as
- Investment Law 9/2010 and ancillary regulations, which establish a special regime for "investment

14. Author interview with Libyan and foreign officials

15. UNDP Libya, "Renewables in Libya: Right for the planet and good for business," United Nations Development Programme (UNDP), June 23, 2023, https://www.undp.org/libya/blog/renewables-libya-right-planet-and-good-business.

16. Kilian Balz and Hussam Mujally, "Libya on the Road to Decarbonisation: Investing in Renewable Energy and Green Hydrogen," Chambers and Partners, September 15, 2023, https://chambers.com/legal-trends/investing-in-renewable-energy-in-libya.

projects" that are commonly used by investors in the renewables sector.

Apart from the need for a specific regulatory framework, developing Libya's renewables sector will require massive investment. There is little appetite in Tripoli for allocating significant state funds. The hope instead is that foreign investors — whether existing partners in the oil and gas sector or new players dedicated solely to renewables — could contribute most of the financing required.

Apart from REAoL, GECOL, and the NOC, state institutions such as the Audit Bureau and the Libyan Investment Authority (LIA) have begun to recognize the importance of creating an environment conducive to investment in alternative energies. And the Libyan authorities are also considering other fiscal incentives, including "allocating public land for renewable energy projects at no cost for investors and providing access to zero-interest credit."[17]

In the relative calm following the 2020 cease-fire that ended six years of civil conflict, there has been an increasing realization within official Libyan circles of the high potential of renewables. Green energy may prove a lucrative addition to the country's energy sector in the form of exports along with helping solve its long-standing domestic power crisis. There is much work to be done before Libya's potential in this area is fully harnessed, however. Hefty investment is required, as is a tailored legislative framework. Institutional rivalries need to be set aside to ensure better coordination. Merging bodies like the NOC, REAoL, and GECOL could help streamline the process and produce swifter outcomes. Above all, more political will is required to move toward a renewables-driven future, in which Libya is less dependent on oil exports and achieves greater energy security while also meeting its sustainability goals.

17. ELTC, "Harnessing the Power of the Sun: Libya's Ambitious Leap into Renewable Energy," Euro-Libyan Trade Center (ELTC), May 12, 2023, https://euroly.org/libyas-ambitious-leap-into-renewable-energy/.

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Mohammed has conducted water management research and work covering the Middle East and North Africa region, most extensively on the Nile River Basin. His other water management work in the MENA area explored formalizing the administration of Saudi Arabia's groundwater resources by using other established groundwater management frameworks as application templates, such as Arizona's 1980 Groundwater Management Code. Mohammed's educational background includes a BS and MS in Civil Engineering from Michigan Technological University, and a PhD in Hydrology and Water Resources from the University of Arizona.

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