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Policy Research Report

Powering the Future of MENA: Energy Transition Country Profiles

Review of Data and Literature

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Table of Contents

Table of Contents

List of Figures, Tables and Boxes

Figures

List of Figures, Tables and Boxes

Tables

Summary

Background

The Middle East and North Africa (MENA) region stands at a critical crossroads in its energy transition. As home to between 48.3% and 58% of the world's oil reserves and over 43% of global gas reserves, MENA countries have long depended on fossil fuel exports for economic stability. However, with increasing global commitments to decarbonization, declining oil and gas demand, and mounting climate change vulnerabilities, the region must rapidly adapt. Despite policy commitments to renewable energy (RE), the region's RE share remains critically low, contributing only 0.4% to the total primary energy mix, with non-hydro renewables making up just 6% of total energy generation. Many MENA economies have not fully leveraged their fossil fuel wealth to develop diversified, resilient economies. Instead, they remain rentier states, highly dependent on external markets for revenue. Energy demand across MENA is rising at an annual rate of 1.9%, creating an urgent need to expand renewable energy infrastructure to meet future consumption needs sustainably.

A key driver of the energy transition in MENA is the role of micro, small, and medium-sized enterprises (MSMEs), which make up 90% of businesses in several countries and play a significant role in economic activity, employment, and innovation. MSMEs can be instrumental in advancing RE adoption, particularly in decentralized energy systems such as solar microgrids, energy efficiency technologies, and distributed power generation. Their contributions extend beyond economic benefits, as they help reduce dependence on fossil fuels, lower carbon emissions, and create sustainable employment opportunities. However, despite their potential, MSMEs in MENA face substantial barriers, including limited access to climate finance, regulatory inefficiencies, and inadequate infrastructure. Without targeted policies and financial mechanisms to support them, their role in the transition will remain constrained.

Methods

The research employs a comprehensive mixed-methods approach to examine MENA's energy transition. A thorough literature review analyzes existing policies, regulatory frameworks, and economic conditions across the region. Country-specific case studies provide in-depth assessments of energy trends, policy implementation, financing mechanisms, and MSME involvement in RE adoption in six selected countries: Egypt, Jordan, Lebanon, Morocco, Sudan, and Tunisia. To understand the key players shaping the energy landscape, the study conducts stakeholder mapping, identifying the roles of governments, financial institutions, international organizations, and private sector actors. Quantitative data analysis is also employed to evaluate energy consumption patterns, RE investments, employment trends, and MSME contributions using national and international datasets. Finally, a comparative policy assessment highlights differences in RE policies, financing strategies, and economic incentives across the six countries, identifying best practices and areas for improvement.

Summary

Findings and Recommendations

The study finds that the MENA region faces significant challenges in its energy transition, including an over-reliance on fossil fuels, inadequate grid infrastructure, high regulatory and financial barriers, and growing electricity demand, particularly for space cooling and desalination. However, it also identifies opportunities for transformation, such as the region's abundant solar and wind resources, declining costs of RE technologies, and increasing international support for green investments. While some countries, such as the UAE, Egypt, and Morocco, have demonstrated leadership in RE development, others lag behind due to political instability, weak governance, or financial constraints.

Examining the six selected countries, the report highlights Egypt's ambitious RE targets under its Integrated Sustainable Energy Strategy 2035, which aims to achieve 42% RE in electricity generation. Egypt has undertaken major projects, such as the Benban Solar Park and new wind energy installations, but challenges persist, including policy inconsistencies, financial barriers, and continued reliance on natural gas. Jordan has emerged as a regional leader in solar and wind energy, despite having limited natural resources, due to strong government policies that encourage private-sector participation through net metering and wheeling mechanisms. However, high financing costs remain a major challenge for MSMEs seeking to expand RE adoption. Lebanon's energy sector is severely constrained by political instability and economic crises, limiting RE expansion. Although some MSMEs have adopted small-scale solar solutions to cope with unreliable grid electricity, widespread adoption is hindered by financial instability and lack of infrastructure. Morocco stands out as one of the most successful RE adopters in MENA, benefiting from a strong policy framework and government support for solar and wind projects. MSMEs in Morocco actively participate in RE supply chains, particularly in solar manufacturing, but challenges remain in financing and grid integration. Sudan, despite its vast renewable energy potential, struggles with political instability, weak governance, and lack of investment, preventing significant RE progress. MSMEs in Sudan face severe barriers in accessing financing and reliable energy sources, though small-scale solar microgrids hold promise for rural electrification. Tunisia has made progress in RE development through regulatory reforms and financial incentives. MSMEs in Tunisia are particularly active in distributed solar solutions, but economic volatility and regulatory delays pose obstacles to large-scale RE expansion.

The study underscores the critical role of MSMEs in advancing MENA's energy transition. These enterprises contribute to decentralized energy solutions, energy efficiency improvements, and innovation in green technologies. However, access to finance remains a major constraint. MSMEs face difficulties in securing climate finance due to a lack of tailored financial products, stringent collateral requirements, and regulatory hurdles. Governments must create targeted incentives, such as tax breaks, concessional loans, and subsidies, to encourage MSME participation in RE markets.

Summary

One of the most pressing issues in MENA's energy transition is financing. While investment in RE has grown significantly—from $1.2 billion in 2008 to $11 billion in 2016—financing gaps persist, particularly for small-scale and off-grid projects. Public-private partnerships, sovereign green bonds, and international climate funds could help bridge this gap. The report also highlights the role of digitalization in accelerating the energy transition. Digital technologies such as smart meters, blockchain-enabled energy trading, and AI-driven grid management can enhance RE adoption, improve efficiency, and create new market opportunities. MSMEs can leverage digital platforms to access financing, monitor energy consumption, and participate in decentralized energy markets. However, policymakers must ensure that digitalization efforts are inclusive and accessible to smaller enterprises.

To advance the energy transition, the report provides key policy recommendations. Governments should establish clear and stable regulatory frameworks for RE investments, phase out fossil fuel subsidies, and reallocate funds toward RE development. They must also introduce financial instruments tailored to MSMEs, including low-interest loans, green bonds, and grants. Policymakers should invest in energy infrastructure, particularly in grid modernization, energy storage, and smart grids. MSMEs should actively invest in energy efficiency measures, form partnerships with financial institutions, and advocate for policy reforms that support small-scale energy producers. International stakeholders can contribute by providing technical assistance, capacity-building programs, and facilitating cross-border energy trade to enhance regional energy security.

The study concludes that while the MENA region still lags behind global standards in RE adoption, there is significant potential for transformation. Countries that have implemented strong policy frameworks and investment strategies, such as Morocco and the UAE, demonstrate that a successful transition is possible. However, broader institutional reforms, financial mechanisms, and capacity-building initiatives are needed to accelerate RE deployment across the region. MSMEs, as key drivers of economic activity and employment, must be at the center of this transition. By addressing policy, financial, and infrastructural barriers, MENA can harness its renewable energy potential, create sustainable economic opportunities, and secure a resilient, low-carbon future.

Conclusion

The MENA region's energy transition is imperative for economic diversification, climate resilience, and sustainable development. While some countries have made significant progress in RE adoption, others lag due to political, financial, and regulatory constraints. MSMEs can play a transformative role in accelerating this transition, provided they receive adequate policy support and financial access. Targeted policy interventions, investment in digital energy solutions, and enhanced regional cooperation will be crucial in shaping a sustainable and prosperous energy future for MENA.

1. Introduction

Renewable energy policies are the cornerstone for unlocking the multiple benefits associated with RE adoption in the MENA region.[1]

Energy plays a vital role in driving economic activity and enhancing the well-being of individuals worldwide.[2] The advent of renewable green energies presents a sustainable and cost-effective alternative to the current fossil energy system, offering the potential for sustainable development, substantial cost savings, clean environment and job creation. This is particularly significant for countries in the Middle East and North Africa (MENA) region, many of which grapple with high unemployment rates, undiversified economies, and polluted environments.

Furthermore, as rent-seeking economies heavily reliant on the sale of fossil energy resources, a few MENA countries have not fully leveraged their affordable and accessible fossil energy reserves to develop productive economies.[3] Recent years have witnessed a substantial increase in energy demand in the region, driven by population growth, socio-economic development, and urbanization, fueled by growth-oriented policies and high oil and gas revenues. Despite the commitment to renewable energy deployment, these sources currently contribute only 0.4% to the region's total primary energy mix.[4] Moreover, the advantages of the expansion of renewable energy (RE) and improvements in energy efficiency (EE) include: environmental preservation, mitigation of climate change, and positive economic outcomes such as cost savings, value generation, and domestic job creation.

Renewable energy (RE) policies are crucial for achieving key energy-policy objectives and unlocking the multiple benefits associated with RE adoption in the MENA region.[5] Aligning short-term actions with medium- and long-term strategies is vital for fulfilling the Paris Agreement on climate change and the Sustainable Development Goals (SDGs).[6] The literature has shown that strategic financing, redirecting investments from fossil fuels to investing in transition-related infrastructure and productive industries while targeting social and inclusive transformative actions are needed to be at the cornerstone of national strategies.[7] By embracing renewable green energy, the MENA region can pave the way for a sustainable and prosperous future.[8]

The MENA region has ample potential with regards to expanding its RE sector.

With an anticipated annual increase in energy demand of 1.9%, the MENA region has the capacity to expand renewable energy generation and contribute up to 45% of the world's potential renewable energy generation. Currently, the installed renewable energy capacity in the MENA region is approximately 28 GW, primarily dominated by hydropower while non-hydro renewables account for only 6% of total energy generation, with four countries contributing to 80% of this share.[9] Renewable energy accounts for only 7% of the region's power generation capacity with solar photovoltaic (PV) and wind energy representing currently the cost-effective and competitive energy resources in the region.[10]

MSMEs (Micro, Small and Medium Enterprises) can play a significant role in the renewable energy transition in multiple ways.

Incorporating renewable energy technologies into their operations presents an opportunity for organizations to lower their energy costs and enhance their environmental performance.[11] This transition to renewable energy is critically dependent on MSMEs leading this process as these agents of change have the opportunity to contribute most to job creation in the renewable energy sector. This thriving industry has proven to be a significant source of employment opportunities. By actively engaging in the development and implementation of renewable energy technologies, not only can MSMEs contribute to the growth of the sector but they can also generate new jobs in areas such as manufacturing, installation, maintenance, and research and innovation.[12] By investing in renewable energy projects within their communities, MSMEs have the opportunity to foster local economic

[1] "Renewable Energy in the MENA Region: Key Challenges and Lessons Learned." 2021.

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Ibid.

[6] Ibid.

[7] Ibid.

[8] Ibid.

[9] Ibid.

[10] Ibid.

[11] The United Nations Industrial Development Organization (UNIDO): https://www.unido.org/

[12] The International Finance Corporation (IFC): https://www.ifc.org/

development and inclusive growth. Such investments can have multiple positive impacts beside job creation as they stimulate overall economic activity, more balanced, inclusive and equitable regional development, cleaner environments and reduced dependence on imported energy sources.[13]

In the MENA region, MSMEs play a crucial role as they comprise a significant share of the economy.

These enterprises are essential contributors to employment, representing up to 90% of businesses, accounting for approximately 60% of job creation and are on the verge of becoming leading exporters of energy and products.[14] MSMEs are already active participants and contributors to the renewable energy transition of the MENA region. A notable example can be observed in Morocco, where MSMEs are embracing solar energy to meet their energy needs. By adopting solar power for their operations, these enterprises are not only reducing their energy costs but also making a positive environmental impact by reducing their carbon footprint and creating a significant export engine.[15]

In Jordan, MSMEs are actively harnessing the power of wind to generate electricity for their operations. By embracing wind power, these enterprises are taking significant steps towards reducing their dependence on fossil fuels and aligning with the country's renewable energy objectives.[16] In Egypt, MSMEs are actively adopting biogas technology to generate electricity and heat, enabling them to access a reliable and cost-effective energy source. By embracing sustainable energy solutions, these enterprises are not only ensuring their own energy security but also that of the country at large as well as promoting environmental sustainability. [17]

Despite the MENA region currently having a lower proportion of renewable energy compared to global standards, there is an encouraging outlook for the future.

The region still faces a myriad of challenges hindering its transition to renewable and green energy manifested in: regulatory reforms, policy amendments, grid flexibility for integrating solar power, decoupling electricity and water generation, and internalizing externalities associated with non-renewable energy sources. Overcoming these challenges requires institutional reforms, time, accessible finance and the implementation of well-structured business models.[18] Despite those challenges, the future outlook appears promising where investments in renewable energy development across the Arab region surged from USD 1.2 billion in 2008 to USD 11 billion in 2016.[19] It seems that robust investment and planning efforts inspire optimism for renewable energy's trajectory.[20]

This report aims to explore the intricacies of the energy sector in MENA, considering at depth the lay of the land of the region and then delving into the country profiles of Egypt, Jordan, Lebanon, Morocco, Sudan, and Tunisia.

For each of the aforementioned countries we will conduct a thorough review of the status of the energy transition with the aim of mapping the different stakeholders, the energy mix and trends. We will also examine the different strategies, NAPs (National Adaptation Plans), NDCs (Nationally Determined Contributions), and policies undertaken by each country in order to gain an understanding of where each country stands with regards to the transition and what type of incentives and policies or lack thereof exists within each country. Finally, we will review the contributions, role and activities of the various MSMEs in each country in order to be able to highlight the factors that can affect the role of the sector within the transition to renewable energy and what implications this transition will have for the MSMEs. We will start off by a regional overview and following that we will delve into country specificities as mentioned above.

2. Regional overview

The MENA region, being heavily dependent on oil and gas exports, faces both challenges and opportunities in its energy transition. Diversification efforts are needed to mitigate the potential setbacks arising from the declining world demand for oil and gas. Given the region's vulnerability to climate change impacts and its substantial requirements for space cooling and desalinated seawater, the adoption of renewable energy sources and the implementation of energy efficiency measures can create many job opportunities besides

[13] The Clean Energy Ministerial (CEM): https://cleanenergyministerial.org/

[14] The International Renewable Energy Agency (IRENA): https://www.irena.org/

[15] The International Finance Corporation (IFC): https://www.ifc.org/

[16] The Global Environment Facility (GEF): https://www.thegef.org/

[17] The Clean Energy Ministerial (CEM): https://cleanenergyministerial.org/

[18] "Renewable Energy in the MENA Region: Key Challenges and Lessons Learned." 2021.

[19] Ibid.

[20] Ibid.

dealing directly with the environmental challenges of water scarcity and pollution. Through proactively addressing energy transitions, MENA countries might be able to secure sustainable futures, effectively balancing economic stability with climate change mitigation and adaptation. Moreover, MSMEs can play a significant role in combating climate change by enhancing energy efficiency, reducing carbon emissions and adopting sustainable practices. In addition, incentivizing MSMEs to embrace green technology and environment-friendly strategies is a crucial step towards achieving Sustainable Development Goal 7 "Affordable and Clean Energy".

To understand the region's energy transition strategies, it is vital to consider the unique circumstances and starting points of the countries understudy in the MENA region, including demographic issues, governance, and financial capabilities. The choices and strategies adopted by these countries have the ability to shape their economic stability and international relevance within the global energy landscape. This section provides a regional level examination of the MENA region's challenges and vulnerabilities to climate change, as well as the opportunities and strategies for addressing them.

2.1. Exploring the geographic, demographic, and environmental dynamics in the MENA region

The MENA region holds a significant position in the global energy landscape, being home to between 48.3% and 58% of the world's oil reserves and over 43% of its gas reserves as of 2021[21] The region includes major oil and gas producing and exporting countries and has benefited from substantial export revenues, known as oil rents, which have contributed to major socio economic advancements. The primary role of the state has been to allocate and distribute the wealth generated from hydrocarbon exports, reducing the need for citizen taxation but also leading to limited political representation. Despite variations in resource abundance, the entire MENA region has developed a rentier mentality due to the historical distribution of oil revenues. This deep interplay between oil, economics, and politics makes the MENA region unique.[22]

2.1.1. Different starting points, different opportunities and challenges

The impact of the global energy transition on MENA oil and gas producing and exporting countries is expected to vary significantly due to their diverse characteristics and circumstances. Several factors will shape the national strategies and responses of these countries to adapt to the energy transition. Demographics play a crucial role in defining the environment for diversification strategies and transforming the rentier state model. Countries with larger and predominantly young populations may face greater challenges compared to those with smaller populations, making it relatively easier for them to adjust. Population growth influences per capita income and employment patterns. If demographic growth outpaces economic growth, it can lead to domestic unrest and socioeconomic instability, posing a threat to the hydrocarbon industry and potentially delaying energy transformation.[23]

Domestic stability and financial capabilities are two other key factors. Stable and effective governance is essential for implementing socioeconomic transformations. Countries facing governance issues and instability, such as Libya and Iraq, may prioritize maximizing short-term oil and gas revenues rather than focusing on long-term energy sector and economic diversification strategies. On the other hand, countries in the Gulf region with more stable governance structures are better positioned to drive the transformation of their energy sectors.

Additionally, Gulf countries with significant financial reserves and institutions like Sovereign Wealth Funds (SWFs) have greater capacity to finance the transformation and mitigate potential negative impacts, such as price volatility, in order to maintain domestic stability. In contrast, countries in North Africa may face greater challenges due to limited financial capabilities. The interplay between domestic stability and financial capacity is crucial, as stability attracts the necessary investments for energy transformations, especially when countries lack sufficient domestic resources to counterbalance adverse economic conditions and ensure social stability. Furthermore, wealthier producers may increase their financial support for global decarbonization initiatives to enhance their international prominence. An example of this is the UAE, which, together with the US, established the Partnership for Accelerating Clean Energy (PACE) during COP27 in Egypt. This initiative aims to mobilize $100 billion in financing, investment, and support, and deploy 100 gigawatts (GW) of clean energy worldwide by 2035 to drive the energy transition and maximize

[21] https://www.statista.com/statistics/237065/share-of-oil-reserves-of-the-leading-ten-countries/ puts these reserves at 48.3% of global reserves while OPEC puts this share at 58% https://www.opec.org/opec_web/en/2211.htm#:~:text=OPEC%20Member%20Countries%20in%20MENA,metres%20of%20proven%20gas%20reserves.

[22] IEA , The case for energy transitions in major oil- and gas-producing countries,2020

[23] Ibid.

climate benefits.[24] The potential for regional cooperation in the region is immense, necessary and lucrative. Transitioning to renewable energy does not mean to be confined to initiatives in the domestic economy. The investment opportunities in the region are massive given the imbalances in their natural endowments and their financial and investment needs.

2.1.2. Navigating the transition: the path to change

Given the global energy transition and the shift towards low-carbon futures, hydrocarbon producing countries in the MENA region, including their energy sectors, are expected to undergo significant transformations and face increasing pressures and losses. As key players in the global energy market, the choices and strategies adopted by particularly the oil producing and exporting MENA countries will shape their economic stability and international relevance, making them crucial to the success of the energy transition.[25]

The pace and progress of this transition vary across regions. As the energy transition focuses on reducing fossil fuel usage and expanding clean energy usage and technologies, it challenges the existing hydrocarbon production model. In the MENA region, hydrocarbon-producing countries have prioritized maximizing prices over production volumes, which means they haven't fully utilized their competitive advantage of low production costs. This approach has allowed them to preserve their reserves for the future, which is crucial as these reserves serve as the primary source of government revenue. Consequently, these countries possess reserves-to-production ratios that extend well beyond projected peak oil demand in any deep decarbonization scenario. This strategy poses a risk of facing the potential of fossil fuels assets becoming stranded assets, as lower oil and gas demands limit the future monetization opportunities for their extensive reserves. This situation has significant implications for the economies and sociopolitical structures of MENA countries heavily dependent on hydrocarbon revenues.[26]

2.1.3. Economic incentives drive ambitious climate goals

Over the past eight years, global commitment to addressing climate change has significantly increased since the Paris Agreement in 2015. This has led to a rapid expansion of decarbonization strategies and targets worldwide. Currently, 88% of global emissions are covered by countries' net-zero ambitions. Notably, two hydrocarbon-producing countries in the MENA region, Egypt and the UAE, hosted the COP27 and COP28 climate conferences in 2022 and 2023, respectively.[27] While international pressure plays a role in driving these countries' climate ambitions, they also recognize the domestic reasons for embracing the energy transition. The shift towards clean energy is motivated by economic and political factors. Given the close relationship between fossil fuels, economics, and politics in the region, hydrocarbon-producing countries aim to ensure continued export revenues even in a decarbonizing world. This energy transition is closely intertwined with ambitious economic diversification strategies, often referred to as "Visions".[28]

The primary concern for these countries is to secure enough export revenues to sustain their rentier-state model while undergoing this transformative process. The energy sector, therefore, faces increasing pressure to demonstrate its ability not only to generate rents that facilitate the creation of new industries and sectors but also to expand the value chain and foster the development of new industries within the energy sector itself at the same time as they develop sectors and activities totally divorced from fossil fuels.[29] It's important to note that achieving net-zero emissions does not imply that these countries will completely cease oil exports. While renewables may replace hydrocarbon resources in the domestic energy mix, they have not yet generated the same high returns as the hydrocarbon industry, which continues to contribute significantly to government budgets.[30] Nonetheless, the export potential of renewable energy products is quite promising and plans are being made to exploit it at a pace consistent with decreasing their dependence on fossil fuels exports.

[24] Ibid.

[25] Ibid.

[26] Ibid.

[27] Ibid.

[28] Ibid.

[29] Ibid.

[30] Ibid.

2.2. Unveiling the landscape: an in-depth analysis of the MENA region and its context

2.2.1. Empowering women for enhanced talent and sustainability in the clean energy sector

The rapidly expanding clean energy industry is creating a wealth of employment opportunities across various stages of its value chain, demanding a diverse range of skills and talents. The active involvement of more women in the clean energy sector can broaden the pool of expertise and abilities within the industry. Women are likely to find the clean energy sector particularly appealing compared to the broader energy sector, as they often demonstrate a heightened interest in matters of local and global sustainability.[31] Extensive research conducted on over 1,500 companies revealed a significant correlation between the presence of women on corporate boards and a greater inclination to invest in renewable energy and address environmental risks when making financial decisions. Moreover, studies conducted at the national level indicate that the proportion of women in the clean energy workforce surpasses their representation in the broader energy sector, though it remains lower than their share in the overall economy. By promoting increased participation of women in the clean energy sector, we can unlock numerous advantages, including a more diverse and inclusive workforce, an enriched range of perspectives and ideas, and ultimately, a stronger and more sustainable clean energy industry.[32]

Discriminatory social norms can limit women's access to economic opportunities, encompassing their participation in work outside the home, acceptable job types, domestic responsibilities, marriage, and girls' education. These norms are particularly prevalent in fragile and conflict-affected countries, where approximately one-third of men deem it unacceptable for women to work outside the home, rising to one-half in the MENA region. Decentralized and renewable energy systems have the potential to empower women economically by enabling them to utilize energy for income-generating activities.[33] The energy transition also presents an opportunity to increase female labor participation, as women currently account for 32% of full-time employees in the renewable energy sector globally, compared to an average of 22% in the global oil and gas industry.[34]

2.2.2. All countries in the MENA region have submitted their first Nationally Determined Contributions (NDCs), with 10 countries recently submitting updated NDCs[35]

Additionally, Morocco, Tunisia, Oman, and the UAE have submitted their second NDCs, indicating an increased commitment to climate action. Several countries in the region have made carbon neutrality commitments, with the UAE aiming to achieve carbon neutrality by 2050, Saudi Arabia by 2060, and Bahrain also targeting 2060. These commitments reflect recognition of the urgent need to transition to low-carbon economies.[36] A number of cities in the MENA region have also joined the Race to Zero initiative, demonstrating their commitment to achieving net-zero emissions.37 Cities such as Amman in Jordan, Dubai in the UAE, and Chefchafouen, Rabat, and Benslimane in Morocco are among those participating in this global effort. Mashhad in Iran and the Arta Region in Djibouti have also made commitments to the Race to Zero initiative, demonstrating the regional scope of the movement.[38]

Egypt, Sudan, and Jordan have shown significant commitment to addressing climate change through their Nationally Determined Contributions (NDCs). Egypt's NDC outlines ambitious targets for mitigating greenhouse gas emissions and adapting to the impacts of climate change. The country aims to achieve a 40% reduction in greenhouse gas emissions by 2030, with a focus on renewable energy development, energy efficiency, and sustainable transportation. Sudan's NDC focuses on increasing climate resilience and reducing emissions by promoting sustainable agriculture, land use management, and renewable energy deployment. Jordan's NDC emphasizes renewable energy expansion, energy efficiency improvements, and sustainable water management. These countries recognize the urgency of climate action and are actively working towards aligning their NDCs with the global efforts outlined in the Paris Agreement. By setting clear targets and implementing

[31] "Women in Clean Energy." International Renewable Energy Agency (IRENA), 2017.

[32] Ibid.

[33] "Energy Access: State Fragility and Fossil Fuels." 2020. Working Paper, International Growth Centre (IGC).

[34] "Renewable Energy in the MENA Region: Key Challenges and Lessons Learned." 2021.

[35] Ibid.

[36] Ibid.

[37] Ibid.

[38] Ibid.

measures to reduce emissions and enhance resilience, Egypt, Sudan, and Jordan are positioning themselves as leaders in the region's transition to a low-carbon and climate-resilient future. The effective implementation of their NDCs will contribute to global climate goals and promote sustainable development in these countries.

While MENA countries have made commitments to climate action, with many announcing ambitious goals, the overall progress in implementing these commitments has been slow. The estimated climate finance needs for the region stand at $186 billion, as outlined in their Nationally Determined Contributions (NDCs).[39]

2.3. Shining a light on the energy landscape: an in-depth analysis of the MENA region

2.3.1. Navigating energy transitions: challenges and opportunities for producer economies in the MENA region

In light of the recent energy crisis triggered by Russia's invasion of Ukraine, MENA producing countries have advocated for a balanced approach to the energy transition in international climate negotiations, emphasizing the importance of combining renewable energy with decarbonized fossil fuels, aligning with their own strategic objectives.[40] As countries heavily reliant on oil and gas exports face the implications of energy transition, uncertainties arise. The potential decline in oil demand, as outlined in the International Energy Agency's Sustainable Development Scenario, poses a threat to the revenues of these "Producer Economy" countries. The COVID-19 pandemic has already demonstrated the risks of over-reliance on oil, with reduced demand and lower prices. Diversification efforts become crucial to avoid future setbacks. Despite fiscal and economic constraints, it is vital for these countries to resist the temptation of delaying their energy transition plans. Failing to adapt to changing energy landscapes could jeopardize their future prospects, as the transformation holds significant implications for broader economic changes.[41]

Moreover, the MENA region is particularly vulnerable to the impacts of climate change. Rising temperatures, coupled with existing water shortages, pose significant challenges. Climate models predict that the region will face intensified water stress, exacerbating an already critical situation. The economic consequences of climate-related water stress alone could reach 6% to 14% of the Gross Domestic Product by 2050, according to the World Bank.[42] Some estimates predict a loss of 0.4 to 1.3% of GDP in MENA countries due to climate change effects, rising to 14% in the absence of appropriate mitigation and adaptation measures. Many of these economic impacts are linked to projected climate change impacts on the highly interlinked factors of water security, agricultural productivity, and migration, displacement and urbanization.

Furthermore, the hotter climate will significantly impact the energy requirements for sustaining normal life in these producer economies. With space cooling already representing a substantial share of peak residential electricity demand, the demand is expected to triple by 2050. Additionally, as precipitation decreases and demographics grow, the production of desalinated seawater for water usage is projected to increase dramatically by 2040.[43] In light of these challenges, producer economies in the MENA region are encouraged to proactively address energy transitions, balancing the need for economic stability with the urgent necessity to mitigate the rise in greenhouse gas emissions.[44]

Meeting the increasing energy demand in the MENA region holds significant importance. There are strong reasons to consider renewable energy sources, particularly solar photovoltaic (PV), to play a more significant role in the energy mix of producer economies. According to the International Energy Agency (IEA), solar PV is already competitive with oil-fired generation in terms of the levelized cost of electricity, especially when oil prices exceed $40 per barrel. Furthermore, the recent cost reductions in solar PV are allowing it to compete with natural gas-fired generation and increasingly so by 2030. This, combined with the region's abundant solar resources (even the least advantaged areas of Iraq receive higher solar irradiance than Germany's best regions), provides a clear rationale to increase efforts and ambitions in this area.[45]

[39] Ibid.

[40] IEA, The case for energy transitions in major oil- and gas-producing countries,2020

[41] Ibid.

[42] Ibid.

[43] Ibid.

[44] Ibid.

[45] Ibid.

The MENA region's rapid population growth and the potential rise in unemployment are viewed as significant risks with potential destabilizing effects. The IEA's assessment suggests that building retrofits can generate up to 30 jobs per million dollars of capital invested, making it an appealing option for countries with larger populations like Algeria and Iraq, which may lack the financial capacity for extensive industrial transformations.[46]

The energy transition is not solely about achieving carbon-free energy but also about thriving throughout the journey. Several producer economies have recognized the need to diversify their energy production while simultaneously diversifying their economies, placing energy transitions at the core of their development strategies.[47] Electrification presents another pathway for large-scale decarbonization in the industrial sector. Countries capable of providing low-cost and carbon-free generation could prosper, as the Middle East and North Africa, being major oil-producing economies, boast abundant solar resources and, in some cases, wind resources, offering long-term advantages.[48]

2.4. The landscape of Micro, Small, and Medium-sized Enterprises (MSMEs) in the MENA region: opportunities and challenges

According to the World Bank, Micro, Small, and Medium Enterprises (MSMEs) are categorized based on employee numbers: micro enterprises have 1-9 employees, small enterprises have 10-49 employees, and medium enterprises have 50-249 employees. It's important to note that the specific definition of MSMEs can vary across countries, taking into account factors such as turnover and assets in addition to employee count. MSMEs hold a significant position within the broader business landscape. Start-ups and young firms, often falling under the small or micro category, serve as the primary creators of new jobs in many nations and act as catalysts for innovation and sustainability in the private sector. Emerging markets are home to an estimated 365-445 million MSMEs, with around 25-30 million classified as formal SMEs, 55-70 million as formal micro enterprises, and 285-345 million as informal enterprises.

MSMEs play a significant role in driving GDP growth and generating employment opportunities . In OECD countries, these enterprises are the prevailing form of business and make substantial contributions to economic expansion, accounting for an average of 50 % to 60 % of value added. In emerging economies, MSMEs contribute up to 33 % of GDP. Additionally, considering the contribution of informal businesses, MSMEs contribute to more than half of the GDP in the majority of these countries, regardless of income levels. Their collective impact underscores their importance as engines of economic development. Furthermore, MSMEs play a vital role in providing employment and entrepreneurship opportunities, particularly for marginalized groups such as young people, women, migrants, ethnic minorities, and individuals with disabilities. These enterprises offer a pathway to economic empowerment and are instrumental in uplifting the income levels of the bottom 40 % of the global population. By creating jobs and fostering entrepreneurial endeavors, MSMEs contribute to inclusive growth and socioeconomic development, enabling broader participation and reducing inequality.

2.5. Unlocking the potential of micro enterprises in energy transition: affordability, adoption, and constraints in renewable energy technologies

2.5.1. Challenges in environmental, social, and governance practices in MENA economies

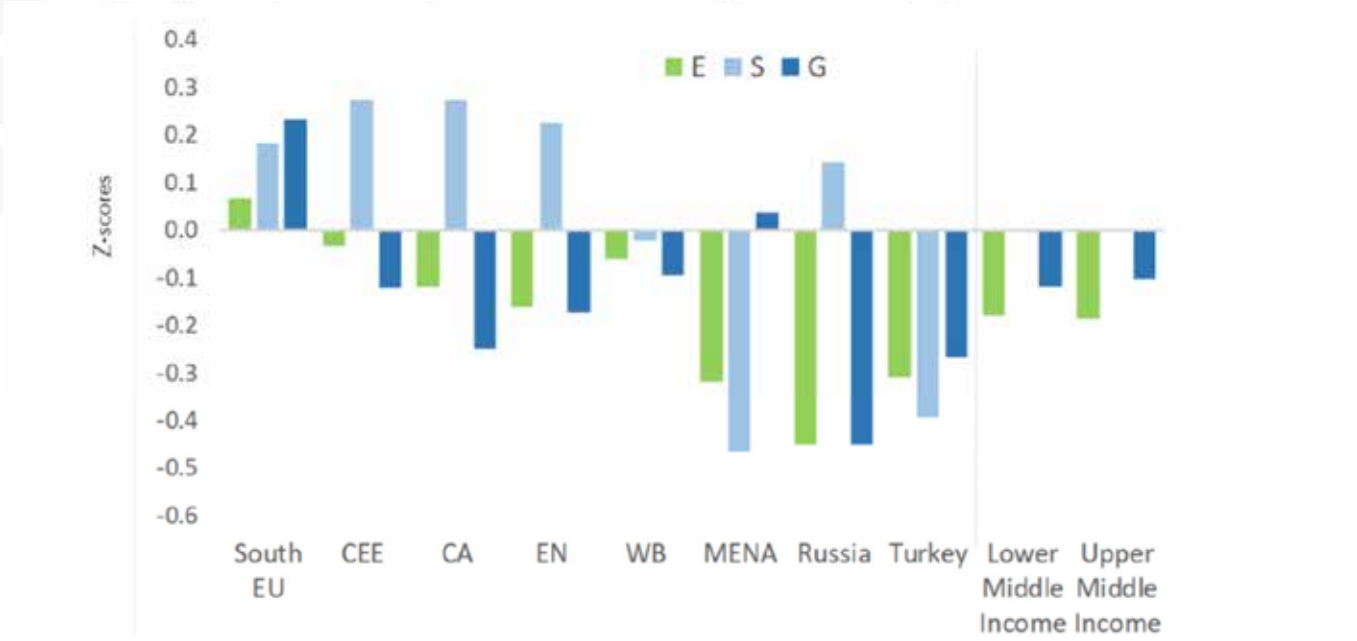
Among the economies covered by the Environmental, Social, and Governance (ESG) practices assessment, MENA economies emerge as the weakest performers. Notably, Egypt, the West Bank and Gaza stand out as the poorest performers within the MENA region, closely followed by Lebanon. Disturbingly, these economies also rank among the worst across the 40 economies evaluated by the ESG assessment. The underperformance of MENA economies primarily stems from their social component, with the region displaying the weakest performance in this area. Particularly concerning is the gender subcomponent, as female representation in the workforce and management positions significantly lags behind other regions. Additionally, the environmental component of MENA economies is also a significant concern, placing them as the second poorest performers, surpassed only by Russia. In contrast, Jordan, Tunisia, and Morocco demonstrate ESG scores more aligned with their level of economic development, as indicated by their per

[46] Ibid.

[47] Ibid.

[48] Ibid.

Figure 1. Average quality of corporate ESG responsibility pillars



Note: Z-scores are calculated based on thre entire Enterprise Survey sample. Corporate ESG weighted: 40% for E, 25% for S, 35% for G.
Source: Ferrazzi, Marco, and Jan Tueske. 2022

capita income.[49] Nevertheless, the analysis reveals that small and medium-sized enterprises (SMEs) in MENA economies generally exhibit lower levels of corporate ESG responsibility compared to larger firms, particularly in emerging economies like those in the MENA region. This is significant considering that SMEs, according to a 2019 report by the International Monetary Fund (IMF), account for 70-80% of total employment in most MENA countries. This is significantly higher than the global average of 50-60%. SMEs in MENA face significant challenges related to working conditions, productivity, and informality rendering them the weakest performers across all economies and categories. Addressing these shortcomings is crucial for promoting sustainable practices and fostering inclusive growth in the region.[50]

2.5.2. Gender dynamics: exploring the influence and impact

The inclusion of women in the energy sector has gained increasing attention and has become a significant concern for policymakers in the corporate sector, international organizations, and academic researchers. The academic discourse on the intersection of gender, climate change, and energy has typically been divided into two distinct bodies of literature. The first body of literature focuses on developing countries, aiming to understand the disparities in energy access and the effects of climate change on the lives of rural women. These discussions often highlight the challenges faced by women due to limited access to energy resources and the resulting negative impacts on their health and safety. This literature has; however, often overlooked broader aspects such as the equal participation of women in decision-making processes within the energy sector and the development of climate change policies.[51]

Female workforce participation in MENA countries is relatively low, with only 25% of female workers in the region compared to other areas, excluding Turkey. The representation of women in management positions is also lacking, with only 5% of firms in MENA having female managers, in contrast to rates exceeding 20% in Russia, Central and Eastern Europe, and Central Asia. Among the countries surveyed, Morocco and Tunisia exhibit higher levels of female workforce participation, surpassing 30% of the total workforce. Tunisia also demonstrates better performance in terms of female representation in management, with 10% of firms having female managers. Conversely, the West Bank and Gaza, as well as Jordan, display the lowest presence of women in management, with only 1% and 3% of firms, respectively. Lebanon, Morocco, and Egypt show modest rates of around 5% to 6% in terms of female representation in management.[52]

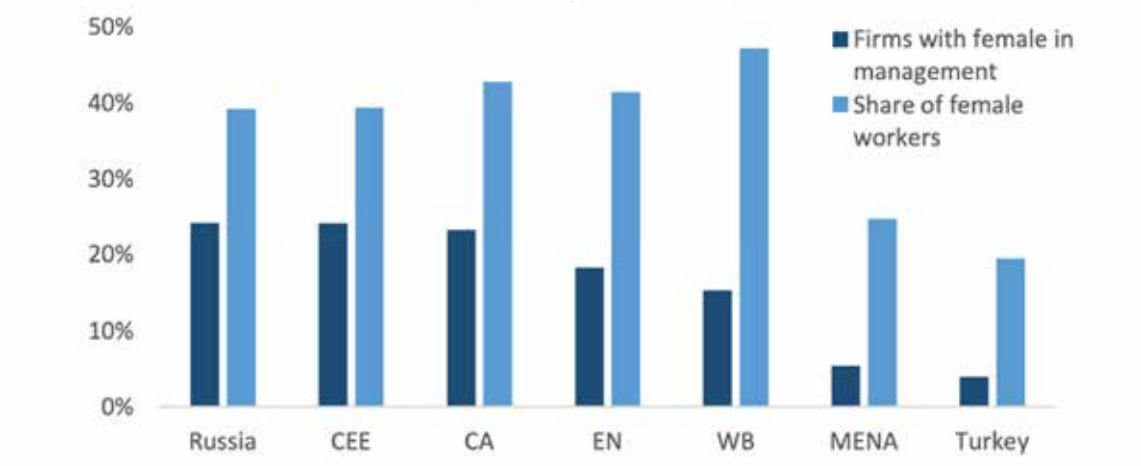
[49] Ferrazzi, Marco, and Jan Tueske. 2022

[50] Ibid.

[51] "The Role of Women in the Clean Energy Transition." World Bank, 2022

[52] Ferrazzi, Marco, and Jan Tueske. 2022

Figure 2. Female participation (percentage on total)



Source: Ferrazzi, Marco, and Jan Tueske. 2022

2.6. The dual dynamics of energy transition and MSMEs: exploring the impact and interplay between micro enterprises and renewable energy adoption

MSMEs possess the potential to enhance their energy efficiency and contribute to sustainable practices. Although individual small businesses have relatively low environmental footprints, their cumulative impact can surpass that of larger enterprises. The informal nature of MSMEs, coupled with a lack of regulations and supervision, can result in higher pollution levels compared to big businesses. Studies indicate that MSMEs in developing economies may account for 60-70 % of pollution.[53] To advance Sustainable Development Goal 7, it is crucial to incentivize MSMEs to adopt green technology and environmentally-friendly strategies The adoption of energy-efficient practices remains limited due to factors such as technology unavailability, lack of local service providers, inadequate technical capacities, and limited access to credit.[54]

Larger enterprises can play a significant role in encouraging sustainable practices among MSMEs by showcasing the value of sustainability premiums and promoting sustainability standards within their supply chains.[55] They can also benefit from investing in MSMEs to access new markets. Climate finance poses challenges for MSMEs due to a lack of awareness, limited availability of financial products for green activities, and the absence of an enabling environment. Efforts like the Green Climate Fund's dedicated MSME program and initiatives by organizations such as the Renewable Energy and Energy Efficiency Partnership and the Response Ability Energy Access Fund aim to support MSMEs in implementing energy-efficient approaches and generating clean energy market growth.[56]

In addition, MSMEs can implement various business practices to contribute to Goal 7.[57] These include pursuing energy-efficient certifications, prioritizing energy efficiency across all operations, investing in skills development for clean technology adoption, and exploring new business models and solutions aligned with the SDGs. The shift towards renewable energy sources presents significant business opportunities, with an estimated business value of over US $4.3 trillion by 2030. The International Renewable Energy Agency projects that the share of renewables in global power generation could reach 45 % by 2030. This trend opens avenues for MSMEs, particularly in distribution, installation, operations, and maintenance of renewable energy technologies. Supporting existing MSMEs and start-ups in seizing these opportunities will contribute to achieving Goal 7's targets.[58]

[53] United Nations Department of Economic and Social Affairs (UNDESA). 2018.

[54] Ibid.

[55] Ibid.

[56] Ibid.

[57] Ibid.

[58] Ibid.

2.6.1. MSMEs have the potential to enhance the climate resilience of vulnerable populations and households

Given that MSMEs are significant providers of employment and entrepreneurship opportunities in developing countries, they can strengthen household capacities by offering stable and diversified incomes, thereby helping communities withstand the impacts of climate-induced shocks and stressors.[59] Furthermore, MSMEs, being heavy energy users, also have the capacity to contribute to mitigation efforts. As outlined in SDG 7, many MSMEs operate in energy-intensive sectors, presenting opportunities for them to play a role in greenhouse gas (GHG) emissions reduction. Studies have revealed that sectors such as agriculture, hunting, forestry, fishing, manufacturing, electricity, gas, and water supply are responsible for substantial volumes of GHG emissions, with a significant number of MSMEs engaged in these sectors. By adopting energy-efficient approaches for lighting, buildings, and refrigeration, promoting the use of renewable energy sources, and implementing water conservation measures, MSMEs can actively contribute to reducing energy consumption, emissions, and water usage. This highlights the scale of MSMEs and their potential impact in GHG mitigation, making them key players in addressing climate change.[60]

The vulnerability of MSMEs to climate change is further heightened by their operation outside the formal sector. These businesses often lack access to public social safety nets, formal financial channels, and post-disaster insurance, making it challenging for them to recover from the impacts of extreme weather events. Strengthening the capacities of MSMEs is crucial in enhancing the adaptive capacity of key economic sectors such as agriculture, manufacturing, food processing, and tourism. Individual MSMEs have the potential to contribute to the goal by adopting specific actions within their business practices, such as conducting energy audits and implementing energy-efficient measures like transitioning to LED lighting. They can also assess climate risks and incorporate resilience-building measures into their assets and supply chains. Additionally, MSMEs can promote sustainable forest management through responsible sourcing practices.[61]

[59] Ibid.

[60] Ibid.

[61] Ibid.

2.7. Digitization and its role in driving energy transition: an comprehensive overview

Digitization, which encompasses the use of digital technologies and digitized data, has a profound impact on how work is conducted and how companies and customers interact. It plays a crucial role in the structural transformation of developing countries.[62] Through various pathways, digitization has the potential to expedite the renewable energy transition. Digitization is significantly contributing to the advancement of the renewable energy transition, playing a pivotal role in enhancing efficiency, decentralizing energy systems, fostering the emergence of innovative business models, and promoting transparency. As digitization continues to progress, it is anticipated to assume an increasingly prominent role in driving the transition towards renewable energy in the future.

Energy efficiency. Efficiency gains are a significant benefit of digitization. By enabling the monitoring and control of energy flows, digitization enhances the efficiency of energy systems. Real-time monitoring, powered by sensors and data analytics, allows for immediate identification of issues in renewable energy systems and adjustments to optimize their performance. This proactive approach to monitoring helps reduce energy losses and enhances the overall efficiency of energy systems.[63]

Decentralizing energy. Digitization enables the decentralization of energy systems by simplifying the integration of distributed energy resources like solar panels and wind turbines into the grid. This facilitates a reduction in dependence on centralized power plants and enhances the resilience of energy systems. For instance, peer-to-peer energy trading platforms empower consumers to engage in energy exchange, while distributed energy resources create novel avenues for businesses to generate and sell their own energy. By leveraging digitization, energy systems can become more inclusive, efficient, and adaptive to meet the evolving needs of consumers and businesses.[64]

Create new business models. Digitization is fostering the emergence of novel business models that are propelling

[62] "Morocco - Financial Inclusion, Entrepreneurship, and MSME Support Programme for Economic Recovery (FIFE) - Project Appraisal Report."

[63] International Renewable Energy Agency (IRENA). "Digitization for Renewable Energy: Opportunities and Challenges.", 2020

[64] Middle East Institute. "Digitization and the Future of Renewable Energy in the Middle East." Middle East Institute, 2021

the transition to renewable energy. Companies are actively exploring innovative approaches that leverage data and analytics to assist consumers in effectively managing their energy consumption. These new business models empower individuals and organizations to make informed decisions, optimize energy usage, and contribute to a more sustainable energy landscape.[65]

Enhance transparency. Digitization is enhancing transparency within energy markets, facilitating consumers in monitoring their energy usage and making well-informed choices about their consumption. This enhanced transparency has the potential to stimulate the demand for clean energy and lead to reduced energy costs. For instance, companies are employing innovative data and analytics techniques to empower consumers with a better understanding of their energy usage, enabling them to make informed decisions regarding their energy consumption.[66]

Promote awareness: Digitization is actively employed to raise awareness of renewable energy among both consumers and businesses. This involves the implementation of online campaigns, social media initiatives, and various digital platforms to disseminate information and engage stakeholders in the promotion of renewable energy.[67] [68]

Facilitate investment: Digitization is employed to simplify the process of investment in renewable energy projects. This involves enabling investors to access comprehensive information about these projects and facilitating connections with project developers. Through digital means, investors are provided with the necessary resources and streamlined platforms to gather information, evaluate opportunities, and engage with project developers, thereby fostering increased investment in the renewable energy sector.[69] [70]

Support policy development. Digitization is utilized to assist in policy development for renewable energy, aiming to provide policymakers with enhanced access to data, information, and effective communication channels with stakeholders. By leveraging digital technologies, policymakers gain valuable insights and resources to inform their decision-making processes. This includes access to comprehensive data and information on renewable energy, as well as improved means of engaging and collaborating with relevant stakeholders, enabling more informed and effective policy development in the renewable energy sector. [71] [72]

For the MENA region, realizing the benefits of digitization necessitates the establishment of institutional and regulatory frameworks that facilitate access to and utilization of digital technologies and market platforms, particularly for MSMEs.[73] To capture a larger share of value-added along the supply chain, countries in MENA need to adeptly navigate digitization.[74] Bridging the digital divide within each region also requires the provision and competition of data infrastructures that extend beyond national borders.[75]

3. Country-specific analysis: unveiling the dynamics of energy transition and MSMEs

3.1. Egypt

Egypt faces vulnerability to climate change, resulting in significant challenges across various sectors including water, agriculture, health, fisheries, coastal zones, tourism, and energy.[76] Adverse effects such as elevated heat, soil salinization, groundwater contamination, sand storms, freshwater scarcity, and rising sea levels have led to consequences like beach erosion, coral reef degradation, reduced crop yields and quality, livestock losses, and increased food insecurity. These implications of climate change can have severe multifaceted effects. According to a study by the World Bank, heat stress can reduce labor productivity in Egypt by up to 50% at temperatures

[65] www.worldbank.org/en/topic/energy/publication/the-role-of-Digitization-in-the-clean-energy-transition.**

[66] Ibid.

[67] International Renewable Energy Agency (IRENA). "Digitization for Renewable Energy: Opportunities and Challenges." IRENA, 2020

[68] Middle East Institute. "Digitization and the Future of Renewable Energy in the Middle East.", 2021

[69] International Renewable EnergyAgency (IRENA). "Digitization for Renewable Energy: Opportunities and Challenges.", 2020

[70] World Bank. "The Role of Digitization in the Clean Energy Transition.", 2021

[71] World Bank. "The Role of Digitization in the Clean Energy Transition.", 2021

[72] International Renewable EnergyAgency (IRENA). "Digitization for Renewable Energy: Opportunities and Challenges.", 2020

[73] ERF. "Structural Transformation in MENA and SSA: The Role of Digitization." 2022.

[74] Ibid.

[75] Ibid.

[76] "Sustainable Arab Finance Report." 2021.

above 33-34° C.77Another study by the Egyptian Center for Economic Studies found that heat stress costs the Egyptian economy $1.5 billion per year in lost productivity.[78] The International Labour Organization found that extreme weather events such as heat waves, floods, and sandstorms can reduce labor productivity in Egypt by up to 30%.[79] Another study by the Egyptian Ministry of Planning found that extreme weather events cost the Egyptian economy $2 billion per year in lost productivity.[80] Hence, in response to these challenges, Egypt has implemented a series of policy actions and regulatory reforms to address climate change and mitigate its detrimental impact on the economy.[81]

MSMSEs play a significant role in Egypt's private and energy sector hence contributing to combating the vulnerabilities resulting from climate change. Micro enterprises, which employ less than ten employees, make up the majority of firms, constituting around 91% of all firms (CAPMAS 2018). According to the World Bank, four out of each five jobs created in emerging economies are generated by MSMEs. In Egypt, it's been estimated that there are 2.5 million created by MSMEs alone, comprising around 75% of the labor force.[82] To address these obstacles and foster their growth, the Egyptian government has taken proactive measures. These include increased financing allocation to SMEs by the Central Bank of Egypt. Furthermore, initiatives such as the "Forsa" program, launched by the Ministry of Social Solidarity, target vulnerable groups and recipients of cash transfer programs, empowering them to establish their own MSMEs. The establishment of the Micro, Small, and Medium Enterprise Development Agency in 2018 further supports the promotion and development of MSMEs in Egypt. By nurturing these enterprises and providing the necessary support, Egypt aims to leverage their potential for economic growth and sustainable development.

3.1.1 Exploring the interplay of demographics and identities: dynamics and implications

Located in the north-eastern part of Africa, the Arab Republic of Egypt is bordered by the Mediterranean Sea to the north and the Red Sea to the east, and is therefore at the crossroads between Europe, the Middle East, Asia and Africa. With an area of over 1 million square kilometers (km2), Egypt is the world's 30th-largest country, the 15th most populous in the world, and the most populous country in North Africa and the Arab region. The majority of Egypt's landscape is desert with a few scattered oases and half of its residents are concentrated in urban areas.

The country's demographic composition skews towards a youthful population, with a median age of 24 years. Urban areas accommodate the majority of residents, presenting Egypt with various challenges such as rapid urbanization, environmental degradation, and food insecurity. As an energy consumer, Egypt relies heavily on imports, particularly oil and natural gas. Despite possessing abundant solar and wind resources, the progress of renewable energy development in Egypt has been sluggish. This can be attributed to multiple factors, including limited investments, regulatory obstacles, and societal resistance.[83]

Egypt faces challenges in both the level and composition of its economic growth. The growth has been driven by employment opportunities in sectors with low value-added or declining productivity. The largest employers are the agriculture sector and the public sector, including social services. Despite a growth rate of 2.5% per year, labor productivity remains low in Egypt. The country heavily relies on primary commodity exports, particularly oil products, which account for over 25% of total exports. Non-tariff barriers and export restrictions hinder Egypt's integration into global value chains. The ability to move towards higher value-added manufacturing activities is limited due to the costs and limited availability of high-quality inputs and critical technology for production. State-Owned Enterprises (SOEs) play a significant role, and regulatory gaps and the need for better contract enforcement discourage private sector participation and hamper firm-level productivity.[84]

[77] World Bank, "Turn Down the Heat: Confronting the New Climate Normal"

[78] Egyptian Center for Economic Studies, "The Impact of Heat Stress on Labor Productivity in Egypt"

[79] International Labour Organization, "The Impact of Extreme Weather Events on Labor Productivity in Egypt"

[80] Egyptian Ministry of Planning, "The Impact of Extreme Weather Events on the Egyptian Economy"

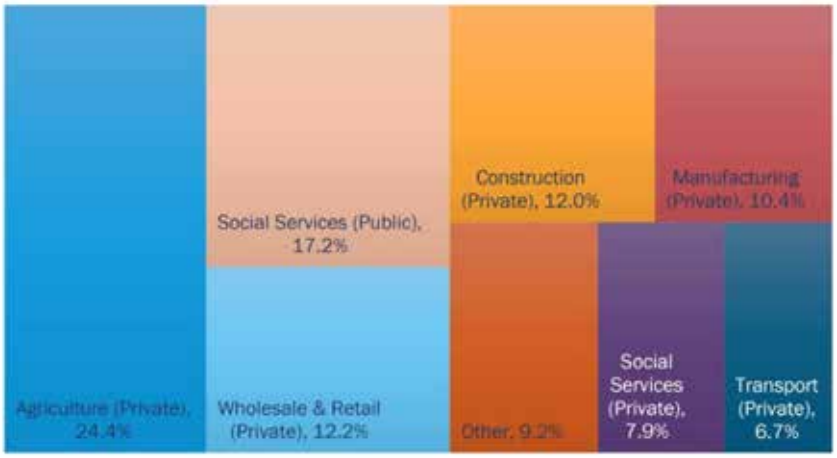
[81] "Sustainable Arab Finance Report." 2021.

[82] International Labour Organization. (2017). Investing in Egypt's Future: Supporting Micro, Small & Medium Enterprises [Fact Sheet]. Embassy of the Arab Republic of Egypt. http://www.egyptembassy.net/media/Egypt_MSME_FactSheet_101717.pdf

[83] International Energy Agency: https://www.iea.org/countries/egypt

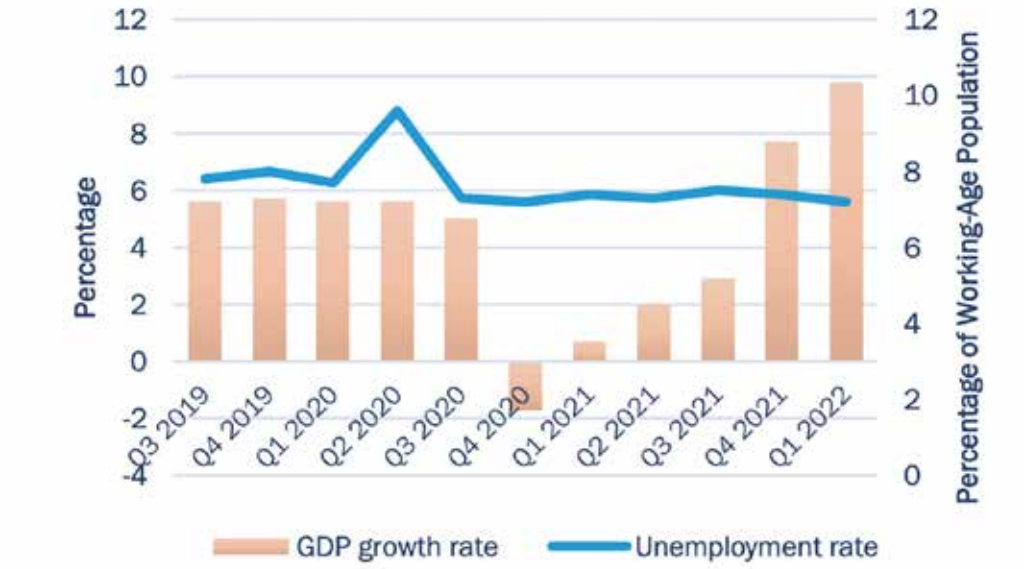
[84] World Bank, Egypt Economic Update: Restoring Growth, Reducing Poverty, and Protecting the Vulnerable (April 2023)

Figure 3. Largest employers remain relatively low value-added (FY-16-FY18)



Source: World Bank (2020) Egypt Economic Monitor: From crisis to economic transformation; Unlocking Egypt's productivity and job creation potential

Figure 4. Real growth and employment rates in Egypt (FY2016Q1-FY2021Q4)



Source: CAPMAS and Ministry of Planning and Economic Development

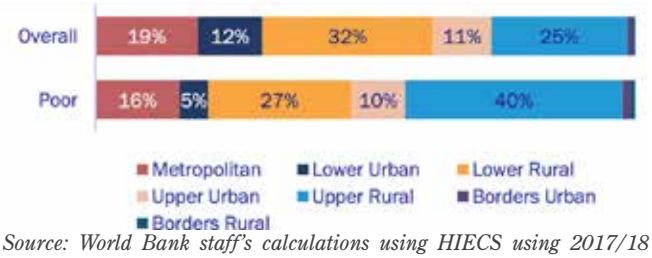
High population growth and rising fertility rates suggest that creating jobs for youth and women will remain a challenge. The employment rate has experienced a decline, particularly impacting youth and women due to structural barriers in labor demand. Even before the pandemic, there was a decrease in labor force participation, dropping from its peak of 49% in 2010 to 42% in 2019, with a slight recovery to 44% by the end of 2021. While supply-side issues such as skill mismatches and inadequate education quality exist, the primary factors driving youth unemployment are on the demand side. These include an overall decrease in employment opportunities, slow growth in formal employment within the private sector, a significant rise in informal employment in non-agricultural activities (from 26% in 2007 to 42% in 2018), and a limited expansion of high-skilled occupations. Egypt's population is predominantly young, with 76% under the age of 40, yet in 2019, only 24% of youth (ages 15-24) were actively participating in the labor market. Given the high population growth and fertility rates, creating sufficient employment opportunities for future generations poses an ongoing challenge. Women face additional barriers, with a formal labor force participation rate of only 16% compared to 74% for men. The pandemic further exacerbated this disparity, highlighting the vulnerability of women to external shocks. Moreover, disadvantaged women in Egypt tend to have lower human capital accumulation, placing them at a disadvantage in the labor market.[85]

[85] World Bank, Egypt Economic Update: Restoring Growth, Reducing Poverty, and Protecting the Vulnerable (April 2023)

Climate change is expected to increase mean temperatures and heat extremes in an already dry, arid environment as well as introduce significant uncertainty regarding the availability of Nile River water to Egypt. The Nile River serves as the primary source of freshwater in Egypt, accounting for approximately 97% of the country's water resources. As climate change progresses, alterations in temperature, evapotranspiration, and precipitation patterns within the Nile Basin will have a profound impact on Egypt's water availability. Given the unique hydrology and vast expanse of the Nile Basin, even minor fluctuations in precipitation can significantly influence water availability in Egypt. Projections indicate that in the coming century, the region's rainfall variability will increase, leading to more frequent periods of drought and high-flow years, as well as heightened frequency and intensity of flash flooding along Egypt's coastal areas. Furthermore, shifts in global and regional weather patterns are modifying the timing and intensity of rainfall in Egypt's coastal regions, posing an elevated risk of flash-flood events and placing an additional 1.1 million people at risk annually.86 While water scarcity in Egypt can be attributed to multiple domestic factors, its disputes with Ethiopia over the construction of the Grand Ethiopian Renaissance Dam (GERD) further aggravates the problem. Egypt's reliance on the activities of its Ethiopian neighbors represents a significant source of tension in the region where the dispute is not only centered on the dam's filling and operation. Rather it extends beyond that where Ethiopia has extended claims to a Nile inflow of 55.5 BCM/yr which has been promised to Egypt in bilateral agreements with Sudan a century ago. [87]

The densely populated cities and urban areas situated in the Nile Delta will experience substantial consequences resulting from the compounding factors of sea level rise, heightened frequency of flood events, and difficulties in water availability. The updated NDC of Egypt emphasizes the vulnerability of densely populated cities and fertile agricultural lands located in the Nile Delta. These geographical concentrations amplify the potential impacts of sea level rise on Egypt's population and economic productivity. Egypt ranks fifth globally in terms of the potential economic consequences of sea level rise on urban areas. Evaluations of coastal flooding scenarios indicate that Alexandria, in particular, will face challenges such as saltwater intrusion, inundation,

Figure 5. Distribution of the overall population and the population, by region



Source: World Bank staff's calculations using HIECS using 2017/18 following the official poverty methodology

and erosion as sea levels continue to rise. These effects will exacerbate the impact of climate change on water resources available for agriculture and the availability and quality of drinking water.[88]

The adverse effects of climate change disproportionately impact the impoverished and most vulnerable communities who possess limited resources to mitigate and adapt to climate-related risks. Projections indicate that the population living below the national poverty line, defined as less than US$4 per day, is expected to increase by 0.8% by 2030 as a result of specific climate change impacts. These effects will not be uniformly distributed across all regions. Upper Egypt, home to a significant share of the impoverished population heavily dependent on agriculture for livelihoods, is anticipated to face more profound consequences.[89] Climate change will have a profound impact on biodiversity and crucial ecosystems, thereby exerting a multiplier effect on the broader economy as they support the livelihoods and employment opportunities of local communities. The preservation of natural resources directly correlates with the economic growth of the country, as approximately 10% of Egypt's revenues originate from these resources. The cost of environmental degradation in 2018 alone was estimated to surpass 3% of the GDP. According to the Notre Dame-Global Adaptation (ND-Gain) Index, Egypt is categorized as "highly vulnerable" to the effects of climate change. Projections for Egypt indicate that the combined consequences of climate change on water resources, tourism revenue, coastal resources, agriculture, and human health, including air pollution and water stress, could represent between 2% and 6% of the country's GDP by 2060.[90]

[86] Ibid.

[87] https://www.atlanticcouncil.org/blogs/menasource/egypt-has-a-water-problem-and-no-its-not-only-the-gerd/

[88] World Bank, Egypt Economic Update: Restoring Growth, Reducing Poverty, and Protecting the Vulnerable (April 2023)

[89] Ibid.

[90] Ibid.

3.1.2 Energy outlook: trends, challenges, and future prospects

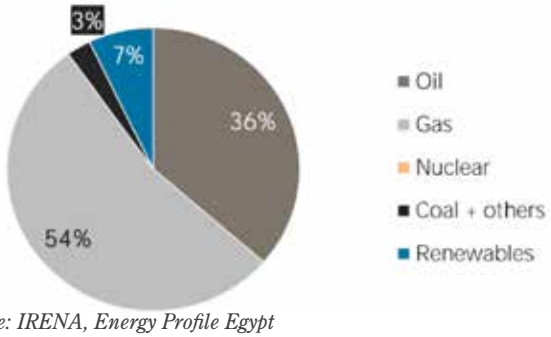
3.1.2.1 Analyzing energy trends: understanding energy demand, efficiency, sectoral distribution of consumers, and energy supply

The energy sector value chain presents considerable prospects for reducing carbon emissions. In a recent evaluation of sustainable energy policies and regulations, Egypt achieved a score of 79, surpassing the MENA regional average of 66.73.[91]

Energy supply and demand. The substantial increase in Egypt's population has naturally led to a surge in energy demand, resulting in significant strains on domestic energy resources. To ensure the country's ability to meet this demand, the government formulated an energy diversification strategy known as the Integrated Sustainable Energy Strategy (ISES), set to be achieved by 2035. The primary objective of this strategy is to ensure a reliable energy supply that can effectively meet the needs of the population.[92]

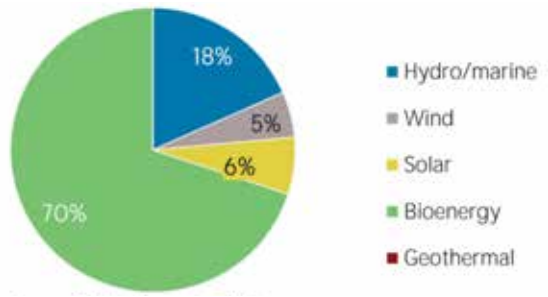
The energy sector value chain in Egypt continues to heavily rely on the production and use of Natural Gas (NG) and crude oil, which are the primary sources of energy supply and greenhouse gas (GHG) emissions. Despite the ambitious goals outlined in Egypt's Integrated Sustainable Energy Strategy ISES 2035 to integrate renewable energy and implement energy efficiency measures, NG and oil still accounted for approximately 90% % of the total primary energy supply in 2019, according to the statistics obtained from IRENA. [93] Although Egypt possesses a significant surplus of available power generation capacity, reaching 21 GW in 2022, the majority of this capacity is derived from thermal plants, representing 90% of the installed capacity.[94] The current surplus of power generation capacity, predominantly based on gas, along with the existing lifespan of gas-based power plants, restricts the immediate and near-term requirement for the integration of renewable energy (RE) into the generation mix.[95]

Figure 6. Total energy supply, Egypt, 2019



Source: IRENA, Energy Profile Egypt

Figure 7. Renewable energy supply, Egypt, 2019



Source: IRENA, Energy Profile Egypt

Egypt possesses a notable competitive edge in renewable energy (RE), capitalizing on its substantial potential for harnessing wind and solar power generation.[96] To expedite the integration of renewable energy (RE) in alignment with the National Climate Change Strategy (NCCS) and updated Nationally Determined Contributions (NDCs), additional infrastructure, including storage systems, will be necessary to accommodate and stabilize the power grid. Egypt has directed its efforts towards utilizing natural gas (NG) to fulfill its energy requirements while progressively increasing the penetration of RE and enhancing energy efficiency in both supply and demand aspects. As of 2019 , renewable electricity generation accounted for 7% of the total power produced, according to IRENA.[97]

Transitioning Towards Renewable Energy Sources. Since 2007, Egypt has encountered various challenges, particularly in the electricity domain, mainly due to a remarkable surge in electricity consumption. Recognizing the critical importance of renewable energy (RE), the country has made significant strides in raising awareness

[91] Ibid.

[92] Salman, Gomaa I., and Ahmed M. Hosny. "The Nexus between Egyptian Renewable Energy Resources and Economic Growth for Achieving Sustainable Development Goals." 2021.

[93] IRENA, Egypt Energy Profile

[94] Egyptian Electricity Holding Company, FY21 Report.

[95] World Bank, Egypt Economic Update: Restoring Growth, Reducing Poverty, and Protecting the Vulnerable (April 2023)

[96] Ibid.

[97] IRENA, Egypt Energy Profile

and addressing these obstacles.[98] Egypt's commitment to RE became evident in early 2008 with the adoption of a new national RE strategy, spearheaded by the Egyptian Solar Plan. Subsequently, the introduction of feed-in tariffs for wind and solar photovoltaic (PV) projects, as well as tax reductions for renewable equipment in 2014 and tax incentives for RE in 2015, further underscored the government's dedication to fostering sustainable energy practices. These initiatives align with the Egypt Vision 2030, emphasizing the positive impact of utilizing RE and improving energy efficiency on the nation's development.[99]

Solar energy production experienced significant growth between 2018 and 2019, with the total electricity generated increasing from 0.529 billion KW to 1.465 billion KW (a 177% increase).[100] The Benban Solar Park, one of the world's largest solar energy projects, was inaugurated in 2019. Developed in collaboration with the private sector, it is expected to mitigate 2 million tons of greenhouse gas emissions annually, according to the IFC World Bank Group. In the realm of wind energy, Egypt is constructing the largest wind power plant in the MENA region in Jabal El-Zeit area, located in the Red Sea Governorate. This project aims to enhance Egypt's wind energy capacity by 18%. Furthermore, in the field of nuclear power, the GoE, in partnership with the Russian company Rosatom, is actively engaged in the construction of a nuclear power plant in Al-Dabaa, located in the Matrouh Governorate. The first unit of this project is anticipated to become operational in 2026.[101]

Egypt's favorable solar radiation levels enable efficient electricity generation and utilization of solar energy for thermal heating applications. Solar energy in Egypt can be divided into two types: latent solar energy, which involves direct utilization of solar energy, and dynamic solar energy, which converts the sun's electromagnetic radiation into electrical energy. A notable solar photovoltaic (PV) project, the largest in the world, is currently under construction in Benban, Aswan. This project, with an estimated cost of $4 billion, aims to produce over 1.8 gigawatts (GW) of power. Solar PV projects in Egypt play essential roles in various applications such as water pumping, lighting, advertising, and desalination. Since 2014, following electricity shortages and a decline in PV panel costs; Egyptian authorities have prioritized efforts to promote PV applications. Two additional major solar PV plants are planned for completion by late 2019 in Hurghada and Kom Ombo, financed by Japan and France, respectively. These plants are expected to reduce CO2 emissions by 40,000 tons and generate an annual output of approximately 32 to 42 GWh.[102]

The primary source of hydropower in Egypt is the River Nile.The Aswan region in particular is an important source of hydropower where multiple power stations have been established with a total capacity of 2,800 megawatts (MW). These power stations contribute significantly to the annual electricity generation, totaling 13,545 gigawatt-hours (GWh). In the 1960s and 1970s, approximately 50% of Egypt's electricity was generated from hydropower. The rise of thermal power stations led to a substantial decline, and by 2015/2016, hydropower's share had diminished to only 7.2%. Egypt currently operates five main hydroelectric stations, with plans to add four additional power stations in Assiut by the end of 2018. Furthermore, there are intentions to construct a 2,400 MW pumped storage hydroelectric plant in Attaqa, further expanding the hydroelectric capacity.[103]

Egypt possesses abundant wind resources, particularly in the Gulf of Suez region, making it one of the best locations globally for wind energy generation. The availability of high and stable wind speeds, averaging 8 to 10 meters per second at a height of 100 meters, contributes to this advantage. The Gulf of Suez area offers vast uninhabited desert regions that are suitable for wind energy projects. Additionally, new wind-rich areas have been identified east and west of the Nile, including Beni Suef, Menya, and El Kharga Oasis. These regions exhibit average wind speeds ranging from 5 to 8 meters per second, providing suitable conditions for electricity generation and water pumping.[104]

Biomass energy production derived from agricultural sources represents a significant opportunity for energy generation. Egypt, in particular, possesses abundant resources that can be harnessed for biomass production. These resources encompass agricultural waste, urban solid waste, and animal fertilizers. Agricultural waste alone amounts to approximately 35 million tons per year, with nearly 60% of this waste being utilized for energy purposes.

[98] Salman, Gomaa I., and Ahmed M. Hosny. "The Nexus between Egyptian Renewable Energy Resources and Economic Growth for Achieving Sustainable Development Goals." 2021.

[99] Ibid.

[100] United Nations. (2021). Egypt's 2021 Voluntary National Review. [Sustainable Development Knowledge Platform]. https://sustainabledevelopment.un.org/content/documents/279512021_VNR_Report_Egypt.pdf

[101] World Bank. (2022). Vulnerability and resilience report: Egypt.

[102] Ibid.

[103] Ibid.

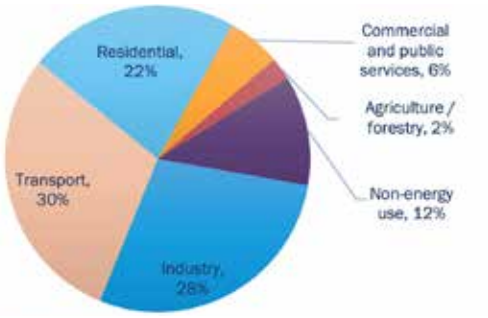
[104] Ibid.

Urban solid waste in Cairo alone reaches 10,000 tons per day. Consequently, in recent years, there have been notable advancements and innovations in biomass technologies, particularly in the production of biogas from animal waste in rural areas. These technologies have not only created numerous job opportunities in rural regions but have also contributed to a decline in the rate of migration of young individuals from rural to urban areas.[105]

The sectoral distribution of energy consumption has remained relatively stable over the years. Based on official data from 2015, the energy sector represented 43% of total energy consumption, while manufacturing industries and construction accounted for 23%, and the transport sector accounted for an additional 23%. Other sectors, including residential areas, contributed 8% to energy consumption, while fugitive emissions from oil and natural gas activities accounted for 3% of fuel combustion. Notably, the transport sector, which has experienced rapid expansion, was responsible for 30% of energy consumption and emerged as a significant contributor to air pollution. Between 2005 and 2019, emissions from the transport sector witnessed a substantial increase of 75%, rising from 31.47 MtCO2e in 2005 to 55.2 MtCO2e in 2019. This growth rate exceeded the overall growth rate of greenhouse gas (GHG) emissions, which stood at 44% during the same period.[106]

In 2017, approximately 11% of total CO2 emissions were attributed to road transportation, primarily influenced by factors such as urban expansion, high car usage in large cities, and the reliance on trucks for transporting goods. Notably, Greater Cairo experiences some of the highest emissions among global cities, posing a significant health burden on its residents. Even within the MENA region, known for its elevated levels of morbidity and mortality resulting from ambient air pollution (AAP), Egypt exhibits the highest rates of pollution-related health issues. Given that the industry sector accounts for approximately 33% of Egypt's gross domestic product (GDP), it is imperative to adopt environmentally friendly approaches in both production processes and energy supply. The key industries contributing to the highest emissions in Egypt include iron and steel, aluminum, cement, and oil refineries. Collectively, these industries release approximately 29 MtCO2e per year, accounting for around 9% of the country's total greenhouse gas (GHG) emissions in 2015. Without intervention, emissions from these sectors are projected to rise

Figure 8. Final sectoral energy consumption by sector (%), 2019



Source: IEA statistical data, 2019

alongside the population growth, emphasizing the need for proactive measures to mitigate their impact.[107]

3.1.2.2. Pathways to energy transition: strategies, goals, and implementation plans for diversifying the energy mix and achieving sustainable energy goals

In Egypt's energy sector, various key stakeholders, including government entities, private companies, and international partners, play crucial roles in shaping the country's energy landscape and addressing its sustainability challenges. These stakeholders work to ensure the reliable supply of energy, promote sustainable practices, and drive the transition towards cleaner and more efficient sources of power. With their combined efforts, they contribute to the development and implementation of policies, investment strategies, technological innovations, and community engagement initiatives that propel Egypt's energy sector towards a more sustainable and resilient future.

Institutional framework for climate change in Egypt. Egypt has established key policy mechanisms and institutional arrangements to address climate change:

- *National Climate Change Council (NCCC):* Founded in 2015 by Prime Minister Decree No.1912 (later amended by Prime Minister Decree No. 1129/2019), the NCCC serves as the national authority responsible for climate change. Its Supreme Committee comprises representatives from relevant line ministries, with the Egyptian Prime Minister as the head.[108] The Council's responsibilities encompass the development and regular updating of a comprehensive national strategy for climate change, as well as the formulation of sectoral plans and policies that align with Egypt Vision 2030.[109]

[105] Ibid.

[106] World Bank, Egypt Economic Update: Restoring Growth, Reducing Poverty, and Protecting the Vulnerable (April 2023)

[107] Ibid.

[108] Egypt's First Updated Nationally Determined Contributions (NDC),(2022).

[109] "Sustainable Arab Finance Report." 2021.

- *Ministry of Environment (MoE):* Established in 1997 by Presidential Decree No. 275/1997, the MoE executes environmental policies through the Egyptian Environmental Affairs Agency (EEAA). The Climate Change Central Department (CCCD) within the EEAA serves as the technical secretariat to the NCCC and acts as the focal point for the UNFCCC. The CCCD coordinates climate efforts with relevant ministries and governmental entities, ensuring participatory approaches in planning and implementing climate measures.[110] [111]
- *Ministry of Electricity and Renewable Energy (MOERE):* The first dedicated Ministry for the Electricity & Energy in Egypt was instituted in 1964. Then many decrees were issued by the state to regulate and specify its activities. The Ministry of Electricity and Renewable Energy (MOERE) is entrusted with the overall management of the Egyptian electricity sector through its subsidiary company the Egyptian Electricity Holding Company (EEHC), and in coordination with the Egyptian Electric Utility and Consumer Protection Regulatory Agency (EgyptERA), NREA, Hydro Power Plants Executive Authority, Nuclear Power Plant Authority and Atomic Power Plants Authority.
- *Egyptian Electric Utility and Consumer Protection Agency (EgyptErA):* In 1997, Presidential Decree No. 326 was issued regarding the establishment of The Egyptian Electric Utility Regulatory Agency and Consumer Protection.
- *New and Renewable Energy Authority (NREA):* In 1986 NREA was established to act as the national focal point for expanding efforts to develop and introduce renewable energy technologies to Egypt on a commercial scale together with implementation of related energy conservation programs. NREA is entrusted to plan and implement renewable energy programs in coordination with other concerned national and international institutions within the framework of its mandate.[112]
- *Egyptian Electricity Transmission Company (EETC):* Established in is an Electricity transmission company located at the Ministry of Electricity.
- *Egyptian Electricity Holding Company (EEHC):* Established in 1976 as the Egyptian Electricity Authority, is responsible for all power plants, transmission and distribution in the Arab Republic of Egypt. In 2001, EEHC and its subsidiaries were restructured under a new umbrella of 16 companies.
- *Ministry of Petroleum and Mineral Resources (MPMR):* The first independent Ministry of Petroleum was established in March 1973 and is entrusted with the overall management of all petroleum activities in the country, including exploration, production and distribution of oil, oil products and gas, as well as all related services. The ministry implements its mandate through three affiliated entities: the Egyptian General Petroleum Corporation (EGPC), the Egyptian Natural Gas Holding Company (EGAS), and Ganoub El Wadi Petroleum Holding Company (GANOPE).
- *The Supreme Energy Council (SEC):* It was established in 1979 and most recently reformed in 2014, controls the pricing, regulations and development of the sector.
- *Egyptian Environmental Affairs Agency (EEAA):* The Ministry of Environment and EEAA are the highest authority in Egypt responsible for promoting and protecting the environment, and coordinating adequate responses to these issues.

Egypt's proactive approach towards climate change is evident through its array of initiatives aimed at tackling environmental challenges and promoting sustainable practices. Listed below are some examples of Egypt's climate initiatives.

- *Early Warning System:* Egypt aims to establish an early warning system to provide timely information and alerts related to climate change impacts. This initiative aims to benefit approximately 30 million people, enhancing their preparedness and resilience.[113]
- *Resilience for Vulnerable and Marginalized Regions:* Egypt is implementing measures to enhance resilience in regions that are most vulnerable to climate change. This initiative targets approximately 5 million people, focusing on improving their adaptive capacity and reducing vulnerability.[114]
- *Climate Change Adaptation and Disaster Risk Reduction Strategy.* In 2011, Egypt introduced the National Strategy for Adaptation to Climate Change and Disaster Risk Reduction, aimed at enhancing the country's capacity to adapt to climate change impacts in highly vulnerable sectors like coastal zones, water resources and irrigation, agriculture, housing, roads, and tourism, among others. [115]
- *National Energy Strategy and Regulatory Framework:* In pursuit of its Strategy for Integrated Sustainable

[110] Egypt's First Updated Nationally Determined Contributions (NDC),(2022)

[111] "Sustainable Arab Finance Report." 2021.

[112] http://nrea.gov.eg/test/en/About/Intro

[113] "Egypt Updated NDC." 2022.

[114] Egypt's First Updated Nationally Determined Contributions (NDC),(2022)

[115] "Sustainable Arab Finance Report." 2021.

Energy 2035, the Egyptian government implemented a series of reforms in 2014, aiming to enhance energy efficiency, bolster energy security, and significantly increase the share of renewable energy in the overall electricity mix, targeting 37% by 2035. These reforms were designed to foster private investment in the sector through mechanisms such as feed-in tariffs, net metering, and other schemes.[116]

- *Feed-in tariffs:* To catalyze the development of renewable energy,Feed-in Tariffs (FITs) for solar photovoltaics (PV) and wind projects were introduced in September 2014. By guaranteeing a predetermined price for privately generated clean energy, FITs incentivized investment in renewable sources and paved the way for their expansion.[117]
- *Build, own, and operate system:* In line with the strategy, legislation was introduced by the end of 2014 to scale up electricity generation from renewable sources. The Build, Own, and Operate system was implemented for projects tendered by the Egyptian Electricity Transmission Company (EETC), promoting greater participation in the renewable energy sector. [118]
- *Liberalization of the energy market:* A significant milestone in the liberalization of the energy market was achieved through the enactment of Electricity Law No. 87/2015, further reinforcing the regulatory framework. This comprehensive legislation played a pivotal role in fostering a more open and competitive energy market environment.[119]
- *Phasing out energy subsidies:* The Egyptian Government initiated a comprehensive energy policy reform program in July 2014, aimed at phasing out energy subsidies and implementing comprehensive reforms in the electricity, oil, and gas sectors. This program, expected to be completed by FY2024/25, was a response to the significant share of government expenditure (22%) and the country's GDP (6%) that was previously allocated to energy subsidies in 2012/13. Over the period from 2014 to FY 2017/18, energy subsidies were reduced by nearly half, accounting for only 3.4% of Egypt's total GDP. In FY 2019/2020, energy subsidies accounted for a mere 0.3% of the country's GDP. These reforms also included substantial renewable energy and energy efficiency programs outlined in the Integrated Energy Strategy 2035.[120]
- *The Egyptian Sustainable Development Strategy (ESDS) 2030:* It was established in 2015, the vision of the primary goal of this strategy is to establish a competitive, balanced, and diversified economy by 2030, ensuring sustainable development and environmental protection. To accomplish this, the Egyptian government has taken significant measures to adopt an energy diversification strategy, focusing on the accelerated development of renewable energy sources and the implementation of energy efficiency measures.[121]
- *Promoting Energy Efficiency and Low Carbon Fuels in the Petroleum Sector.* In 2016, the petroleum sector launched the Oil and Gas Sector Modernization Project, which included a specific focus on improving energy efficiency within the sector.[122]
- *Transforming Egypt into a Regional Energy Hub:* With a surplus of energy, the Government of Egypt has initiated electrical interconnection projects to export electricity and meet the electricity demand of neighboring countries.[123] In 2020, the project to establish an electrical linkage line with Sudan was launched. Additionally, plans are underway to implement electrical interconnection projects with the Kingdom of Saudi Arabia, Cyprus, and Greece, scheduled to commence in 2021. These initiatives will solidify Egypt's position as a regional energy hub in the Middle East, further strengthened by the recent natural gas discoveries in the Mediterranean.[124]
- *Egypt's National Climate Change Strategy 2050 (NCCS 2050):* It was established in 2022, and serves as a framework for effectively addressing the impacts of climate change, achieving sustainable development and growth, preserving natural resources and ecosystems, and enhancing Egypt's global leadership in climate change.125 The strategy aligns with the objectives of the Egypt Vision 2030 national strategy.
- *Enhancing Energy Efficiency in the Electricity Sector:*

[116] Ibid.

[117] Ibid.

[118] Ibid.

[119] Ibid.

[120] Government of Egypt. (2022). Egypt's First Updated Nationally Determined

[121] Salman, Gomaa I., and Ahmed M. Hosny. "The Nexus between Egyptian Renewable Energy Resources and Economic Growth for Achieving Sustainable Development Goals." 2021.

[122] Government of Egypt. (2022). Egypt's First Updated Nationally Determined

[123] World Bank. (2022). Vulnerability and resilience report: Egypt.

[124] Ibid.

[125] "Towards a Sustainable Finance Report." RCREEE, 2022.

Egypt has implemented a comprehensive national plan to improve energy efficiency in the electricity sector, targeting both the supply and demand sides. Significant progress has been made through power station maintenance, upgrades, and replacements, resulting in a notable decrease in fuel consumption for electricity generation in FY 2019/20. This improvement in electricity generation efficiency, combined with the integration of renewable energy sources, has contributed to a substantial reduction in fuel consumption over a two-year period from 2017/2018 to 2019/2020.[126]

- *Promoting Low Carbon Transport:* Egypt has made significant strides in expanding the Greater Cairo underground metro network, including the operation of stage 4 of the third Cairo metro line. This expansion aims to facilitate a modal shift towards low carbon mass transit. The third line, which connects east and west Cairo, is projected to accommodate 2 million passenger trips per day. Additionally, high-quality service buses have been introduced to encourage car owners to utilize the integrated public transportation system, with over 200 smart buses connected to mobile applications.[127]
- *Climate Adaptation Initiatives:* Egypt has implemented various sectoral adaptation projects funded by national and international sources. These projects include the Sustainable Agriculture Investments and Livelihoods Project (SAIL), Building Resilience Food Security Systems in the Southern Egypt Region, Participatory Development Programme in Urban Areas (PDP), Adaptation to Climate Change in the Nile Delta through Integrated Coastal Zone Management, and Enhancing Climate Change Adaptation in the North Coast and Nile Delta Regions. These initiatives aim to enhance resilience and adaptation to climate change impacts in different regions and sectors of the country.[128]

To align with the global targets outlined in the Paris Agreement under the UNFCCC, Egypt submitted its Intended Nationally Determined Contribution (INDC) in November 2015. Egypt became a party to the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, demonstrating its commitment to address the challenges posed by climate change. 129 Additionally, Egypt has actively engaged with the UNFCCC by submitting her initial, second, and third national communications in 1999, 2010, and 2016, respectively.[130]

3.1.2.3. Powering the transition: a focus on financing

Egypt encounters a challenge in securing adequate financing for its development projects, attributed to constrained fiscal capacity, low savings rates, and insufficient foreign investments. The country grapples with above-average inflation rates and below-average levels of savings. A significant share of domestic savings is directed towards addressing an overall budget deficit, which surpasses that of comparable nations, primarily driven by substantial debt servicing obligations. This has resulted in a decrease in the availability of domestic funding for new investments.[131] The estimated cost for climate change adaptation and mitigation activities from 2020 to 2030 was noted as USD 73 billion. Egypt emphasized the importance of securing international financial support and technical assistance for technology transfer and capacity building required for implementing the INDCs.[132] Development partners have already provided significant support to Egypt, with $10.27 billion received in 2021 to accelerate the achievement of its Sustainable Development Goals (SDGs). Collaboration with the international community is crucial to realize a green and low-carbon future.[133]

Egypt has taken initiatives to mobilize both national and international green finance through various mechanisms. The Ministry of Finance launched the first Sovereign Green Bonds in the Middle East and North Africa region. Egypt's portfolio of eligible green projects encompasses renewable energy, clean transportation, sustainable water and wastewater management, and pollution reduction and control. The Environmental Sustainability Criteria Guideline has facilitated a significant enhancement in green investments, elevating them from 15% in Fiscal Year 2019/20 to 30% in Fiscal Year 2020/21. Projections indicate a continued upward trend, with an expectation to achieve 50% by Fiscal Year 2024/25. Financial Regulatory Authority companies listed in the Egyptian Stock Exchange and those operating in the non-banking sector to submit disclosure reports on environmental, social, and governance aspects related to sustainability and the financial impacts of climate change. Moreover, attractive

[126] Government of Egypt. (2022). Egypt's First Updated Nationally Determined

[127] Ibid.

[128] Ibid.

[129] Ibid.

[130] Ibid.

[131] World Bank, Egypt Economic Update: Restoring Growth, Reducing Poverty, and Protecting the Vulnerable (April 2023)

[132] "Sustainable Arab Finance Report." 2021.

[133] Government of Egypt. (2022). Egypt's First Updated Nationally Determined

green finance options are made available through public and private financial institutions, notably the Green Economy Financing Facility (GEFF).[134]

Financial support has been channeled into Egypt's climate mitigation and adaptation initiatives through international public climate finance from various sources. These include climate funds, development financial institutions, as well as international and regional organizations. From 2005 onwards, the Egyptian government has received an estimated USD 20 million in international support funding for climate adaptation, primarily directed towards coastal protection, agriculture, and wastewater management.[135] The funds allocated for adaptation efforts remain significantly lower compared to those allocated for mitigation activities, despite Egypt's pressing need for adaptation measures. The government's planned budget for future adaptation projects and programs from 2016 to 2035, focusing on the three most vulnerable sectors to climate change, exceeds USD 20 million.[136]

3.1.2.4. Powering sustainable jobs: employment opportunities in renewable energy

The transition towards clean energy in Egypt has gained significant traction in recent years, offering the potential for substantial job creation. Egypt possesses a notable advantage in renewable energy due to its favorable geographic conditions, particularly in wind and solar resources. Despite these advantages, renewable energy technologies still contribute a relatively small share to the country's overall electricity generation. Among the renewable sources, hydropower currently holds the largest share, representing 47% of the installed capacity in 2020, followed by solar PV at 28% and onshore wind at 23% according to the International Renewable Energy Agency (IRENA) 2020 report. Employment opportunities in the renewable energy and energy efficiency sectors remain limited in Egypt, with IRENA's 2019 estimate indicating approximately 12,000 employees across all renewable energy technologies. [137]

Egypt is recognized as a leading country in the region for the successful implementation of wind and solar energy projects, yet when it comes to job creation, it lags behind other countries outside of North Africa.The energy sector plays a pivotal role in the development of Egypt, contributing significantly to its GDP with a share of over 20%. In 2017, this sector employed more than 300,000 individuals. In 2017, a study conducted by RCREEE, commissioned by GIZ and executed by GWS in Germany, utilized Input-Output and employment factors methodologies to calculate employment in both the current and future years. This tool was updated to reflect new installations in 2017 and 2018, as well as future installations based on newly announced targets collected during a scoping mission in Egypt.[138]

Empirical evidence suggests that the transition to renewable energy (RE) and energy efficiency (EE) in Egypt has the potential to generate substantial employment opportunities. Various studies have estimated the job creation potential in these sectors, albeit with varying outcomes. A 2011 study by Plan Bleu projected that additional EE investments could result in nearly 700,000 jobs by 2030. Similarly, a 2017 study by RCREEE indicated that the number of RE jobs could exceed 70,000 by 2030. Another study conducted in 2016 by the Egyptian Center for Economic and Social Justice and Heinrich Boll Stiftung examined job creation potential under different scenarios, estimating a net creation of approximately 143,936 jobs (excluding coal) and 89,860 jobs (including coal) in thermal, hydro, wind, solar, and EE sectors by 2030 under a business-as-usual scenario. Other scenarios "toward zero-carbon", "toward zero-carbon with CSP" "toward energy independence", and "toward decentralized energy" presented the following employment estimates by 2030; 152,473, 165,679, 161,553, 1666,291, respectively.[139]

According to a recent World Bank report in 2022, the energy transition in Egypt presents both opportunities and challenges for employment. The transition has the potential to generate a substantial number of jobs, primarily within the renewable energy sector. It also carries some risks, including potential job losses in the fossil fuel industry. To ensure the equitable distribution of benefits, the Egyptian government will need to implement measures to mitigate these risks. The report highlights that the energy transition could potentially create around 1.2 million jobs in Egypt by 2030. The majority of these employment opportunities would be in the renewable energy field, such as solar and wind power. Additionally, there would be job creation in sectors like construction, manufacturing, and services.[140] The report highlights potential employment risks associated with the energy transition in Egypt. One

[134] Ibid.

[135] "Sustainable Arab Finance Report." 2021.

[136] Ibid.

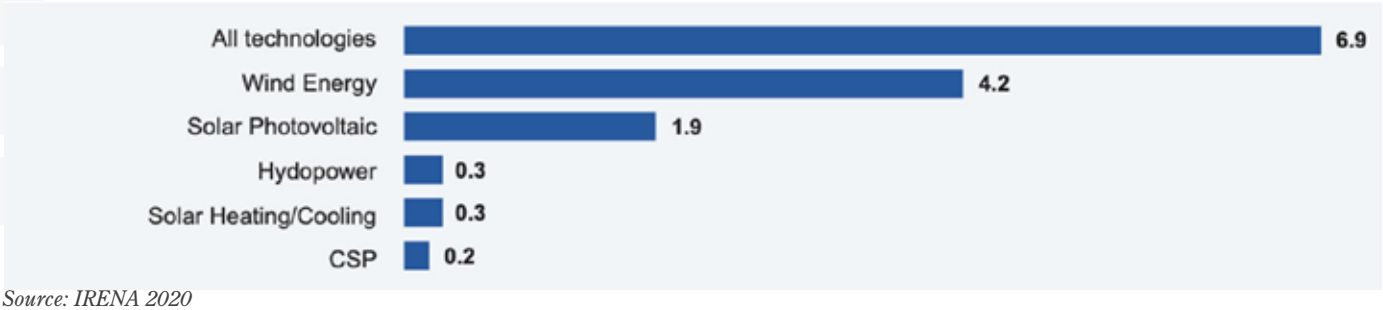
[137] World Bank MENA Energy. (2022, November). The Employment Benefits of an Energy Transition in Egypt.

[138] RCREEE. (2020). Mapping EE and RES Market Potential Areas with Higher Impact on Local Economy and Job Creation

[139] World Bank MENA Energy. (2022, November). The Employment Benefits of an Energy Transition in Egypt.

[140] Ibid.

Figure 9. Renewable energy employment by technology, Egypt (number of jobs , in thousands)



Source: IRENA 2020
Note: CSP = concentrated solar power

of the main concerns is the potential job losses in the fossil fuel sector, which currently serves as a significant source of employment in the country. [141]

Solar water heaters represent a growing source of employment generation in Egypt. During the period from 2010 to 2017, the average annual growth rate of direct jobs created by solar water heaters (SWH) technology was 24.78%. In 2010, SWH technology generated 607 direct jobs, which increased to 2812 in 2017. In 2018, there was a growth rate of 35%, resulting in 2696 direct jobs. From 2019 to 2030, SWH technology is expected to maintain an average share of 8.9% of the total number of direct jobs created by renewable energy (RE). In terms of indirect jobs, SWH technology has represented a small share of the total number of jobs created over the years. Between 2010 and 2013, its average share was 3.75%, while it increased to 6.9% between 2014 and 2017. In 2010, 72 indirect jobs were created, which rose to 345 in 2017. In 2018 and 2019, 346 and 333 indirect jobs were created, respectively.[142]

Based on a study conducted by RCREEE, Since 2015, there has been a gradual increase in job opportunities generated by the RE sector. From 2010 to 2014, the number of jobs remained relatively stable, averaging around 5,096 jobs per year. In 2015, there was a 28% increase compared to the previous year. The most significant growth was observed in 2018, with an annual growth rate of 87.8% and a total of 14,345 direct jobs created. By 2019, this number further increased to 16,383 jobs. Analyzing Figure 31, we can observe changes in the distribution of direct jobs among different renewable energy sectors over the past decade. In 2010, hydropower accounted for 78% of direct jobs, while solar water heaters represented 12.36%. In 2018, out of the 7,629 direct jobs created, hydropower contributed 39.70% and solar water heaters accounted for 35.35%.[143]

According to a report by RCREEE, the impact of renewable energy (RE) resources on employment has been studied, particularly focusing on wind power and PV (photovoltaic) technologies. The study reveals that wind power has shown steady growth in the creation of direct jobs, accounting for an average of 4.6% of total direct employment in the past decade.. In terms of indirect jobs, wind power has played a significant role as well, making up 25.66%, 14.65%, and 25.21% of total indirect jobs created in 2010, 2014, and 2018, respectively. On average, this technology has created 322 indirect jobs annually between 2010 and 2015, and this number has grown to 1225 jobs in the subsequent four years.[144]

In contrast, until 2016, the combined share of PV on grid and off-grid technologies in the total number of direct jobs created in the RE sector remained below 1%. In 2018, this share increased to 10%, with 796 direct jobs created, primarily driven by PV on-grid technology. Specifically, the share of PV on-grid technology accounted for 10% until 2017, while PV off-grid technology contributed less than 1% to indirect job creation. In 2017, the share of PV on-grid increased to 20.14%, and it is projected to reach 13.71% in 2019. Over the past three years, this technology created 132, 626, and 2737 indirect jobs, respectively.[145]

To assess the employment effects of various energy efficiency (EE) technologies in Egypt, a comprehensive tool developed by the Regional Center for Renewable Energy and Energy Efficiency in 2017 was utilized. In contrast to renewable energy (RE), assessing the employment implications of energy efficiency (EE) presents considerable difficulties and has received limited attention in the region. The field of EE across the Middle East and North Africa (MENA) remains relatively untapped and calls for further exploration and utilization in the coming years. Consequently, there exists significant potential for job creation in alignment with the ambitious targets outlined in each country's National Energy Efficiency

[141] Ibid.

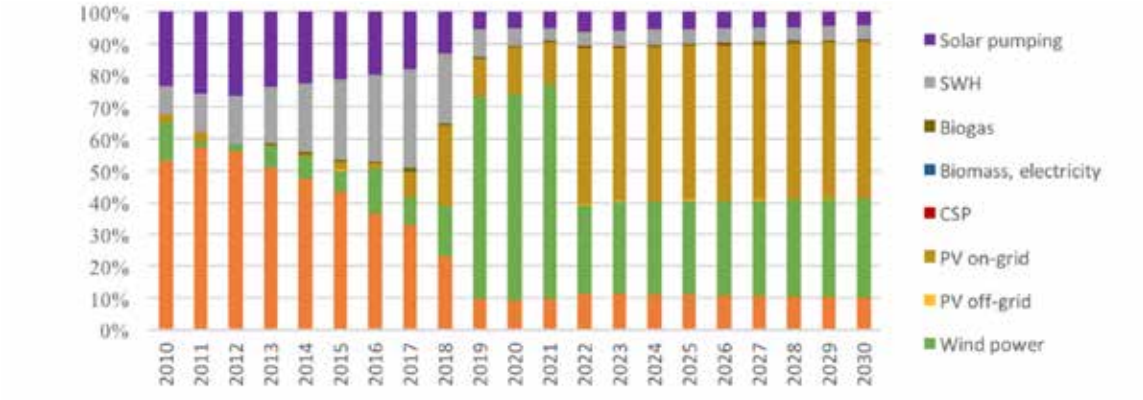
[142] RCREEE. (2020). Mapping EE and RES Market Potential Areas with Higher Impact on Local Economy and Job Creation.

[143] Ibid.

[144] Ibid.

[145] Ibid.

Figure 10. Share of each technology in total jobs created by the RE sector, in Egypt, between 2010 and 2030

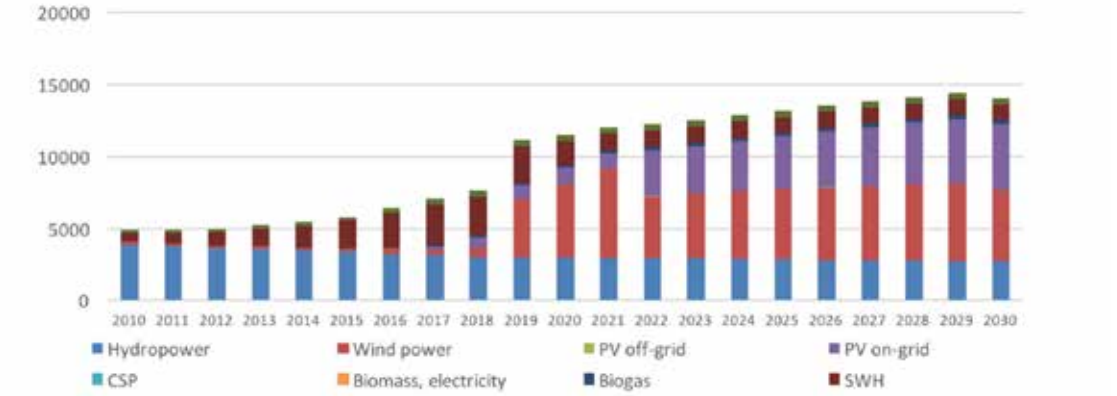


Source: (RCREEE, 2017)

Figure 11. Number of indirect jobs created per technology, in Egypt, from 2010 to 2030

Source: (RCREEE, 2017)

Figure 12. Direct jobs generated by RE sector per technology in Egypt from 2010 to 2030



Source: RCREEE (2017)

Figure 13. Total number of jobs created by EE technologies and the share of each in total, in Egypt from 2010 to 2019

Source: RCREEE (2017)

Action Plans (NEEAPS).[146] The tool takes into account multiple factors, including data on specific EE measures implemented, employment factors associated with each measure, the level of effort required across the supply chain, the productivity of the Egyptian workforce, as well as economic indicators such as GDP, exchange rates, and investment levels. By incorporating these inputs, the tool calculates the potential job creation stemming from key EE technologies utilized in Egypt, including Motor, LED production, Power Factor Correction Panel, Lighting, and Steam, which represent the most prevalent technologies in the country.

The employment statistics reveal a significant rise in job creation from 2017 onwards, as depicted in Figure 13. This upward trend commenced in 2015 and persisted throughout 2016. During the period spanning from 2010 to 2014, an average of 599 jobs were generated, with the majority stemming from LED technology. This can be attributed to extensive awareness campaigns and a decline in investments in other energy-efficient measures. Notably, the years 2014 and 2015 stood out, with lighting accounting for 29% and 56% of total job creation, respectively. In 2016, this share diminished to 8%, bringing the job creation pattern back to its normal state, where LED production constituted the predominant source. Moreover, while motor technology contributed 4% and 7% to total jobs in 2010 and 2011, respectively, its share increased in 2012 and has since maintained a presence of no less than 15%. This indicates a heightened investment in this sector.

3.1.3 Exploring the landscape of micro, small, and medium-sized enterprises (MSMEs)

3.1.3.1. Examining the profile of micro, small, and medium-sized enterprises (MSMEs) and their engagement with renewable energy: policies, adoption, and access to climate finance

The MSME sector in Egypt is characterized by the size and sectoral distribution of firms. According to the definition provided by the Central Bank of Egypt, firms are classified as micro when they employ less than ten employees, small and medium when they employ between ten and two hundred employees, and large above that threshold. In 2017, micro enterprises accounted for approximately 91% of all firms, while small and medium enterprises represented around 8% of the total, and large firms constituted less than 1%. This data highlights the dominance of micro enterprises in Egypt's private sector. As per the Small Enterprise Law (No. 141, 2004) in Egypt, Small and Medium Enterprises (SMEs) are defined as companies or establishments engaged in productive, commercial, or service-related economic activities, with a capital ranging from LE 50,000 to LE 1 million and employing up to 50 individuals. According to the Central Agency for Public Mobilization and Statistics (CAPMAS), Egypt is home to a substantial number of micro-enterprises, estimated to be between 3 to 8 million, and approximately 67,000 small businesses. These enterprises collectively operate with a capital of $4.9 billion as of 2020. Furthermore, Egypt's SME landscape also encompasses various types of exporting enterprises, including sole agents, joint ventures, subsidiaries, management contracts, turnkey operators, countertrade arrangements, as well as informal businesses utilizing online platforms and social media channels.[147]

3.1.3.2. Assessing the drivers and impediments for msmes in adopting renewable energy technologies: country-level analysis

MSMEs play a crucial role in various sectors and serve as a major source of employment. According to the economic census of 2017/2018, there are approximately 3.6 million MSME establishments, employing 9.7 million individuals (which accounts for 37% of total employment) and generating a production value of around USD 108 billion.[148] Unfortunately, micro firms in Egypt face various structural weaknesses that hinder their potential for expansion. These challenges include a lack of managerial skills and financial resources, intense competition, and low profit margins. Additionally, a significant share of micro enterprises operate informally, which limits their ability to fully benefit from government initiatives aimed at supporting their development.[149]

Since the 1990s, the SME sector in Egypt has experienced significant growth, driven by the increasing labor supply and a shortage of job opportunities in the public sector (ILO, 2019). Recognizing the importance of SMEs, the Egyptian government has actively promoted their development through the implementation of the "National Policy for SME Development" in the late 1900s and early 2000s. This commitment has been further reinforced by the introduction of various laws aimed at providing financial and technical support to SMEs, with a particular focus on fostering entrepreneurship in recent years. To ensure the stability and inclusivity of the financial sector,

[146] Ibid.

[147] Egyptian Industrial Development Center (IDSC). (2020). The Egyptian SMEs' Force Field Analysis.

[148] "VNR Report Egypt." 2022.

[149] EMNES. (2017). Micro, Small and Medium Sized Enterprises Development in Egypt, Jordan, Morocco & Tunisia.

the government has collaborated with the Central Bank of Egypt (CBE) to enhance banking supervision, regulation, and overall financial stability. This comprehensive initiative encompasses various support measures and interventions designed to strengthen the institutional framework and promote financial-sector stability and inclusion. [150]

Various entities, including the Egyptian Financial Regulatory Authority (FRA) and the Central Bank of Egypt (CBE), have played an active role in supporting MSMEs and SMEs. As part of the Entrepreneur National Strategy overseen by the MSME Development Agency, Egypt has harnessed the potential of 2.5 million MSMEs, while the government has introduced several initiatives aimed at facilitating and financing SME growth. Furthermore, measures have been taken to support SMEs in areas such as clustering, value chain integration, innovation, and the utilization of national resources. In terms of financing, the microfinance institutions have been upgraded by the MSMEDA, and the CBE has launched the SME-financing initiative, encouraging banks to increase their lending to SMEs. A new SMEs law is currently under development, with expectations that it will provide incentives for small businesses to formalize their operations and join the formal economy.[151]

Recognizing the financing challenges faced by MSMEs globally, the Government of Egypt (GoE) has implemented various initiatives to support their funding. One such measure was the directive issued by the Central Bank of Egypt (CBE) on 21 February 2021, instructing banks to increase their financing allocation to SMEs from 20% to 25% of the banks' credit facilities portfolio.[152] This change is expected to inject an additional USD 7.4 billion into the vital MSME sector by the end of December 2022. This funding was intended to benefit over 120,000 companies and establishments, leading to the creation and sustenance of approximately one million jobs.[153] The Ministry of Social Solidarity has also launched the "Forsa" (Opportunity) program, aimed at empowering recipients of the Takaful and Karama cash transfer program, as well as other vulnerable groups, by supporting the establishment of their own MSMEs. This initiative aims to integrate them into value chains that ensure sustainable income for these individuals.[154]

Furthermore, the establishment of the Micro, Small, and Medium Enterprise Development Agency in 2018 is another step taken to promote the growth of MSMEs in Egypt.[155]

3.1.4. Drawing the final threads: a resolute conclusion

Egypt is the most populous nation in North Africa and the Arab region and the third-largest emitter of greenhouse gasses (GHGs) in the Middle East and Africa. In 2019, the country's GHG emissions reached 351.96 $MtCO_2e$, and a substantial 74% of these emissions were attributed to its energy sector.[156] As of early 2022, only 12% of Egypt's electricity was derived from renewable sources, falling significantly short of the targeted 20% by 2022.[157]

Egypt, being a significant energy consumer, heavily depends on imports, especially of oil and natural gas. This poses a problem to the country where there are concerns that the country's crude oil reserves may be depleted within the next 15 years.[158] Despite the country's ample solar and wind resources, the advancement of renewable energy projects has been slow. This sluggish progress can be ascribed to several factors, such as inadequate investments, regulatory challenges, and societal opposition.[159] Egypt heavily relies on primary commodity exports, particularly oil products, constituting more than 25% of its total exports. The country faces challenges in integrating into global value chains due to non-tariff barriers and export restrictions. The limited availability and high costs of quality inputs and critical technology hinder the transition to higher value-added manufacturing activities.

Egypt is currently trailing many other countries in the adoption of renewable energy technologies, ranking thirty-first globally in solar energy utilization. Furthermore, the utilization of bioenergy, geothermal, wave, and nuclear energy accounts for a mere 0.16% of the country's total electricity generation, despite their potential to make a substantial contribution to Egypt's energy needs. The Mediterranean coast, particularly locations like

[150] Egyptian Industrial Development Center (IDSC). (2020). The Egyptian SMEs' Force Field Analysis.

[151] Ibid.

[152] "VNR Report Egypt." 2022.

[153] Ibid.

[154] Ibid.

[155] Ibid.

[156] Salah, A., Abdelfatah, M., & Ali, H. (2022). Renewable energy in Egypt: Needs and priorities. Alternative Policy Solutions.

[157] Salah, S. I., Eltaweel, M., & Abeykoon, C. (2022). Towards a sustainable energy future for Egypt: A systematic review of renewable energy sources, technologies, challenges, and recommendations. Materials Engineering, 8(8), 100497.

[158] Salah, A., Abdelfatah, M., & Ali, H. (2022). Renewable energy in Egypt: Needs and priorities. Alternative Policy Solutions.

[159] International Energy Agency: https://www.iea.org/countries/egypt

Sallum, Matruh, and Port Said, holds promise for wind energy utilization. Southern Egypt also displays high potential in solar, wind, and bioenergy, although it is not as concentrated as the Gulf of Suez region. While agricultural waste biomass offers significant energy generation potential and could contribute substantially to Egypt's growing energy demand, it has not received sufficient attention thus far. The Middle Delta region, with its abundance of residues from agricultural, manure, sewage, and municipal solid waste, stands as an ideal location for initiating biomass-related power generation initiatives.160 Solar PV plants, on the other hand, are distributed across Egypt rather than concentrated in specific regions.[161]

Egypt possesses significant potential for manufacturing solar and wind energy components. For instance, locally manufactured wind turbine towers demonstrate cost competitiveness within the country. Nevertheless, local manufacturing of other components, such as blades and related electronics, remains limited. The country also holds advantageous strengths for manufacturing concentrated solar power (CSP) components, including low labor costs, affordable energy expenses for the industrial sector, ample availability of glass and steel, and robust manufacturing capabilities.

The adoption of renewable energy in Egypt offers opportunities to diversify the energy mix and address the country's high youth unemployment and poverty rates. The ongoing deployment of renewable energy has already created approximately 6,000 direct and indirect jobs, with solar photovoltaic (PV) alone accounting for half of these positions. Manufacturing plays a significant role in job creation within the solar PV industry, while wind energy predominantly generates jobs in operations and maintenance (O&M). Additionally, the implementation of diverse biomass technologies, particularly in rural biogas production and agricultural waste management, provides employment opportunities in rural areas, mitigating the migration of young people to urban centers and contributing to poverty reduction.[162]

Further research is necessary to investigate FIT values for wind and solar energies in the Gulf of Suez area, given its substantial potential. Various studies have explored feed-in tariff (FIT) values for renewable energy plants across different Egyptian locations, noting variations in FIT values among sources and cities, facilitating the selection of appropriate energy sources based on kWh costs. Similarly, bioenergy and geothermal energy FIT values in the Gulf of Suez merit additional study.

The establishment of electrical interconnections between Egypt and neighboring countries can significantly reduce the capital required for setting up electrical power plants and contribute to resolving Egypt's energy crisis. Considering the time difference and varying ambient temperatures between countries, regional interconnections with Arab and African nations are considered a reasonable strategy.[163]

Hurdles, formidable challenges to overcome, stand in the way of Egypt's energy ambitions.

- Concerning the Egyptian workforce, several challenges have been identified, encompassing four key aspects: limited technical knowledge concerning the design and manufacturing of solar energy components, insufficient qualifications for operation and maintenance roles, the absence of specialized training centers for skill development, and low productivity levels. Additionally, the glass typically produced in Egypt contains a relatively high iron content, which does not meet the requirements for CSP (Concentrated Solar Power) glass.[164]
- The expansion of Egypt's renewable energy sector encounters several hurdles, encompassing technological, economic, and political aspects. Technological challenges arise from the lack of well-defined operation and management specifications. Egypt's solar energy technology and investments are still in the experimental phase, and they have not yet reached the stage of widespread production.[165] Furthermore, there is a shortage of skilled labor in the field of renewable energy technology, and suitable storage techniques are also lacking. In addition to these technological challenges, economic constraints pose a significant hurdle, especially in rural regions with populations below the poverty line, where affordability becomes a barrier to accessing expensive renewable energy solutions.[166]
- Infrastructure is also a major obstacle, particularly

[160] Salah, S. I., Eltaweel, M., & Abeykoon, C. (2022). Towards a sustainable energy future for Egypt: A systematic review of renewable energy sources, technologies, challenges, and recommendations. Materials Engineering, 8(8), 100497.

[161] Ibid.

[162] Salah, A., Abdelfatah, M., & Ali, H. (2022). Renewable energy in Egypt: Needs and priorities. Alternative Policy Solutions.

[163] Salah, S. I., Eltaweel, M., & Abeykoon, C. (2022). Towards a sustainable energy future for Egypt: A systematic review of renewable energy sources, technologies, challenges, and recommendations. Materials Engineering, 8(8), 100497.

[164] Ibid.

[165] Salah, A., Abdelfatah, M., & Ali, H. (2022). Renewable energy in Egypt: Needs and priorities. Alternative Policy Solutions.

[166] Ibid.

in transmitting energy from wind farms, which necessitates special substations and high voltage cables.

- Political obstacles arise from inconsistent regulations across various government departments. This includes a lack of standardization, the absence of a unified regional regulatory framework, limited grid access for third parties, and constrained electrical grid capacity. Furthermore, there is a dearth of guidelines, regulations, or decrees governing geothermal energy, and the government's investment opportunities and support for geothermal energy industrialization are lagging behind. The lack of governmental control over the investment scale in the renewable energy sector also impacts the adaptation of industrial investment direction. Addressing these issues is crucial to foster the growth of renewable energy in Egypt.
- The prevalence of fossil fuel subsidies has led to an over-reliance on conventional non-renewable energy sources, hindering the adoption of slightly higher-priced renewable energy (RE) technologies. The subsidized electricity tariff in Egypt further enhances the feasibility of conventional energy over various RE techniques. It is worth noting that subsidies for petroleum products have been reduced by almost 1.9 times between 2019-2020 and 2020-2021.
- In underserved rural communities below the poverty line without government subsidies, the adoption of costly RE solutions might be unfeasible. To tackle this issue, local governments can manage funding services through micro-finance institutions, such as financial cooperatives, operating at a local level. This approach aids in debt management and provides support for impoverished households that face challenges dealing with large banks and financial institutions.

In the realm of business and economic growth, MSMEs play a vital role as small and medium-sized enterprises with significant potential for innovation and job creation.

- Micro firms in Egypt, especially MSMEs, encounter various obstacles, including a lack of managerial skills and financial resources, fierce competition, and narrow profit margins.
- To encourage banks to finance small and medium-sized companies and enterprises, the Central Bank included the renewable energy sector in an initiative aimed at supporting such entities in February 2017.
- The government has also taken legislative measures to promote private sector involvement in renewable energy projects. This entails introducing the feed-in tariff system in September 2014 to incentivize electricity production from renewable sources.[167] That being said, the private sector, small and medium-sized businesses face difficulties due to high payback rates and consistently elevated annual interest rates, making investments in the renewable energy sector a challenging proposition. Additionally, despite efforts to maintain the annual interest rate below 10% in 2022, it is still considered high, posing challenges for small and medium companies to invest due to the elevated payback levels.

3.2 Jordan

The Jordanian economy is facing significant challenges due to climate change, population growth, and refugee migration. These factors are putting increased pressure on limited natural resources, including land and water. The evidence of these challenges is seen through rising temperatures, drought, loss of ecosystems, deforestation, increased forest fires, unpredictable rainfall patterns, and reduced availability of ground and surface water. The interconnectedness of water, climate, and food security has negatively affected agricultural production, food security, as well as inclusion and social protection efforts.[168]

Recognizing the vital role played by Entrepreneurship and Micro, Small, and Medium Enterprises (MSMEs) in its economy, Jordan has implemented laws and established institutions such as JEDCO and the Central Bank of Jordan to support these businesses. Although efforts have been made to facilitate business entry and reduce costs, there is a need to shift focus towards enhancing competitiveness and generating sustainable employment. The recent business census highlights the significant presence of MSMEs in Jordan, constituting a majority of active enterprises, contributing significantly to the GDP, and employing a substantial share of the workforce. While the adoption of renewable energy technologies poses challenges for MSMEs, there are opportunities for government subsidies, cost savings, reduced dependence on imported energy, improved air quality, and employment generation. To capitalize on these prospects, the government should provide support to MSMEs in adopting renewable energy technologies, thereby contributing to a more sustainable energy future for Jordan while reaping the benefits of renewable energy.

[167] Salah, A., Abdelfatah, M., & Ali, H. (2022). Renewable energy in Egypt: Needs and priorities. Alternative Policy Solutions.

[168] "Sustainable Arab Finance Report." 2021.

3.2.1. Exploring the interplay of demographics and identities: dynamics and implications

Situated strategically in the Middle East region, Jordan's geographic location at the crossroads of Asia, Africa, and Europe offers unique advantages. The country encompasses diverse terrain covering 89,318 square kilometers, with approximately 75% characterized by desert landscapes. Geographically, Jordan can be divided into the Jordan Valley, the Mountain Heights Plateau, and the Eastern Desert or Badia region. The Jordan Valley, stretching along the western side of Jordan to the Dead Sea, is particularly fertile and serves as the country's food basket, benefiting from a favorable agricultural climate, abundant summer irrigation, and higher temperatures compared to other regions.

As of the end of 2019, Jordan's total population reached 10,554,000, with an uneven distribution between urban and rural areas. Around 90.3% of the population resides in urban areas, while 9.7% live in rural regions. The gender distribution is relatively balanced, with 53% males and 47% females. The age structure of the population indicates a predominantly youthful population, with 44.3% falling within the 0-19 years age category, and the workforce category (20-59 years old) representing 50.3% of the total population. Over the past decade, the population growth rate has experienced fluctuations, particularly influenced by the influx of refugees from Iraq and Syria. From 1994 to 2004, the population growth rate was 2.6%, while it sharply increased to 5.3% from 2004 to 2015.

Jordan has faced significant challenges in its development, experiencing economic shocks equivalent to around 44% of GDP over the past decade. Events such as the "Arab Spring," the Syrian conflict, and the emergence of ISIS, along with trade disruption and refugee flows, have contributed to a decline in economic growth rates.[169] From an average of 6.5% in 2000-2009, the growth rate dropped to around 2.4% in 2010-2019. This is particularly concerning considering the country's demographic trends. Jordan's population has dramatically increased due to forced migration, rising from 6.7 million in 2010 to 11.1 million in 2021.[170] With approximately 62.5% of the population being under 30 years old, there are advantages and opportunities associated with this youth bulge. It also places a burden on the economy to ensure sufficient investment, growth, and employment opportunities in the future. The number of university graduates exceeds the annual job creation rate, further exacerbating the challenge. This demographic reality adds pressure to the provision of public services and infrastructure at the local and national levels.[171]

The Syrian refugee crisis has had significant humanitarian, social, and economic impacts on the affected region and beyond. In 2015, Jordan hosted 1.3 million Syrians, with 664,226 registered refugees under the United Nations High Commissioner for Refugees. The majority of the Syrian refugees reside in urban areas and receive basic services and infrastructure provided by the government. This influx has put additional strain on the country's limited natural resources. After nearly a decade of the Syrian crisis, Jordan continues to bear the cost of hosting refugees, with an estimated annual budgetary cost of around US$1.4 billion to meet their humanitarian and resilience needs..[172]

Despite the ongoing pressures of the protracted Syrian conflict, Jordan is implementing economic and structural reforms.[173] These challenges have intensified economic pressures and unemployment, particularly among youth and women. In line with the principle of leaving no one behind, Jordan ensures that Syrians in the country have access to essential services and has expanded the issuance of work permits, including flexible ones.[174] This commitment significantly impacted Jordan especially due to reduced international support for the Syrian crisis. In 2021, the funding required for the Jordan Response Plan to the Syrian crisis (JRP) amounted to $2.4 billion, of which Jordan received $774 million, representing only 30.6% of the necessary funding. This insufficient funding level has increased pressures on the budget and resulted in a decline in the quality and quantity of services provided by implementing partners.[175]

3.2.2 Energy outlook: trends, challenges, and future prospects

3.2.2.1. Analyzing energy trends: understanding energy demand, efficiency, sectoral distribution of consumers, and energy supply

Jordan is grappling with the economic strains caused by rapid population growth, necessitating the pursuit of new

[169] "VNR 2022 Jordan Report."2022.

[170] Ibid.

[171] "VNR 2022 Jordan Report."2022.

[172] Ibid.

[173] Ibid.

[174] Ibid.

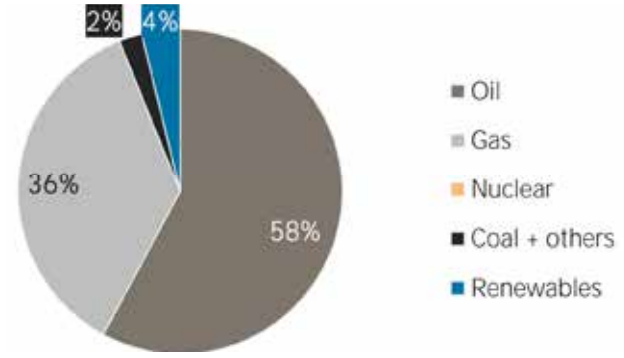
[175] Ibid.

avenues for economic development that can yield long-term benefits for both present and future generations. Amid the challenges posed by the COVID-19 pandemic, Jordan is determined to harness its domestic energy resources to address its energy needs. Currently reliant on energy imports, the country faces economic burdens and energy security risks.

To tackle these vulnerabilities, the Master Energy Strategy 2007-2020 was formulated, emphasizing the greater utilization of domestic resources, including renewable energy. Jordan has made significant progress in the renewable energy sector, with the share of renewable electricity increasing from 0.7% in 2014 to over 13% in 2019, positioning the country as a regional leader in renewables. To further advance its energy sector, the Ministry of Energy and Mineral Resources (MEMR) has developed the updated Master Strategy for the Energy Sector 2020-2030. This strategy focuses on achieving a sustainable energy supply, diversifying the national energy mix, relying more on domestic energy resources, enhancing energy security, and reducing dependency and costs associated with electricity supply. The strategy aims for renewables to contribute 31% of the total power generation.[176]

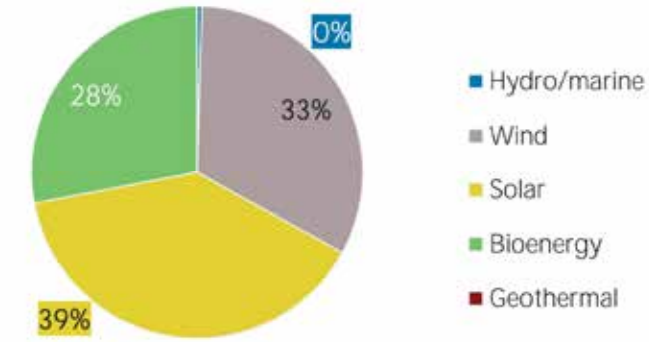
Jordan's energy demand in 2020 reached a total of 8.47 million tonnes of oil equivalent.[177] The majority of Jordan's energy demand is met by imported oil and natural gas.[178] The demand for electricity is experiencing rapid growth and is projected to reach 52 terawatt-hours (TWh) by 2030.[179] Jordan domestic energy production is limited and fulfills only approximately 40% of the nation's energy requirements.[180] The production of oil in Jordan has experienced a downward trend in recent years and is projected to stabilize by 2025.[181] Jordan has limited natural gas production and relies on imports to meet its NG energy needs.[182] Renewable energy is experiencing significant growth in Jordan and is becoming an increasingly important source of energy. The government has established an ambitious goal of

Figure 14. Total energy supply, Jordan, 2019



Source: IRENA, 2019

Figure 15. Renewable energy supply, Jordan, 2019



Source: IRENA, 2019

achieving 31% renewable energy in the country's power mix by 2030.[183]

Jordan possesses considerable potential for renewable energy, benefiting from ample solar and wind resources. The country has made noteworthy advancements in renewable energy development, positioning itself as a leading nation in solar energy within the Middle East.184 Jordan has abundant renewable energy resources, primarily solar and wind, with additional potential in bioenergy, hydropower, and geothermal sources. The widespread adoption of renewable energy solutions in Jordan will play a vital role in enhancing energy security, lowering energy costs, promoting environmental conservation, and facilitating the country's post-COVID-19 recovery.185

Jordan's favorable solar conditions make it a prime location for harnessing solar energy. According to IRENA, in 2019 solar energy represented the highest share of renewable energy sources, with a 39% share of total renewable energy sources. The country benefits from abundant solar resources, receiving an average

[176] International Renewable Energy Agency (IRENA). (2021). Renewable Readiness Assessment: Jordan.

[177] Jordan energy profile, https://ourworldindata.org/energy/country/jordan

[178] Jordan energy report, https://www.enerdata.net/estore/country-profiles/jordan.html

[179] Ibid.

[180] Ibid.

[181] Ibid.

[182] Ibid.

[183] Ibid.

[184] Green Growth Knowledge Platform, 2022

[185] IRENA. (2021). Renewables Readiness Assessment: The Hashemite Kingdom of Jordan.

daily solar radiation ranging between 5 and 7 kWh/m2. Recognizing the potential of solar power, the government of Jordan has set an ambitious target of incorporating 20% of renewable energy into the power mix by 2025. Solar energy is poised to play a pivotal role in attaining this goal, showcasing its significant contribution to the country's renewable energy transition.[186]

Jordan possesses favorable wind resources, representing the second highest share of renewable energy sources following solar energy. The country is characterized by its average wind speeds ranging from 6 to 8 m/s in certain regions. Recognizing the potential of wind energy, the government has actively granted licenses for numerous wind projects. This proactive approach reflects the country's commitment to expanding its renewable energy portfolio.[187]

While Jordan possesses certain geothermal resources, their utilization is still in its nascent stages. The government is actively engaged in evaluating the potential of geothermal energy within the country. This strategic assessment aims to ascertain the viability and capacity of geothermal resources to become a substantial source of renewable energy in the foreseeable future. With ongoing efforts and exploration, geothermal energy holds promising prospects for contributing to Jordan's renewable energy mix and bolstering its sustainable energy landscape.[188]

Although Jordan's hydropower resources are limited, there is still potential for the development of small-scale hydropower projects. Recognizing the challenges, the government is actively exploring alternative solutions, including the prospect of importing hydroelectricity from neighboring countries. By exploring these avenues, Jordan aims to leverage the benefits of hydropower and diversify its renewable energy portfolio, contributing to a more sustainable and resilient energy future.[189]

The total primary energy supply in Jordan has undergone substantial transformation, reflecting the nation's evolving energy landscape and its strategic initiatives to diversify energy sources and bolster energy security. Between 2010 and 2017, the Total Primary Energy Supply (TPES) experienced a steady growth rate of 3% annually, reaching 10 million tonnes of oil equivalent (mtoe) in 2017. In 2018, it witnessed a 3% decline due to stagnant consumption in certain sectors. The dominant sources of energy in 2018 were oil, natural gas, and electricity, with oil accounting for more than half of the total energy supply.

Table 1. Total primary energy supply by fuel , Jordan in 2009 and 2018

Energy source	% share in 2009	% share in 2018	
Natural gas	40%	35%	Average annual growth of TPES at 3%
Oil share	58%	55%	
Coal share	-	2%	
Renewable energy share	1.6%	2.9%	

Source: MEMR (2019b)

Over the past decade, the share of natural gas in TPES has exhibited significant fluctuations. It decreased from 40% in 2009 to 4% in 2014 but then rose to 35% in 2018, according to the Ministry of Energy and Mineral Resources. These fluctuations were primarily caused by disruptions in imported natural gas supply in 2011. The decline in natural gas share was compensated by increased use of oil products, such as heavy fuel oil and diesel, particularly in the power sector. The dependency on energy imports has remained high in the TPES over the past decade, reaching its peak in 2014 at 99.9% and standing at 92% in 2018.[190]

At the end of 2018, Jordan's total installed power capacity had increased to 5.2GW, compared to 3.9GW in 2014, showcasing significant growth. Among the various power generation technologies, combined cycle power plants held the largest share of installed capacity, surpassing 50%. Notably, diesel accounted for a significant share of the total installed capacity, amounting to 16% in 2018. On the other hand, the share of renewable power capacity experienced substantial growth, rising from less than 1% in 2014 to over 20% in 2018. The increase in the proportion of renewable power capacity within the total installed capacity is primarily driven by the addition of wind and solar photovoltaic capacity.[191]

The composition of the energy mix in Jordan witnessed dramatic changes over the years. As of the conclusion of 2014, the majority of the electricity mix in Jordan was comprised of diesel and heavy fuel oil, making up more than 90% of the total. Conversely, the share of natural gas had declined to slightly over 7%. With the introduction of liquefied natural gas (LNG) imports through the port of Al-Sheikh in Aqaba in mid-2014, the utilization of natural gas for electricity generation experienced a resurgence,

[186] Jordan energy report (2023)

[187] Ibid.

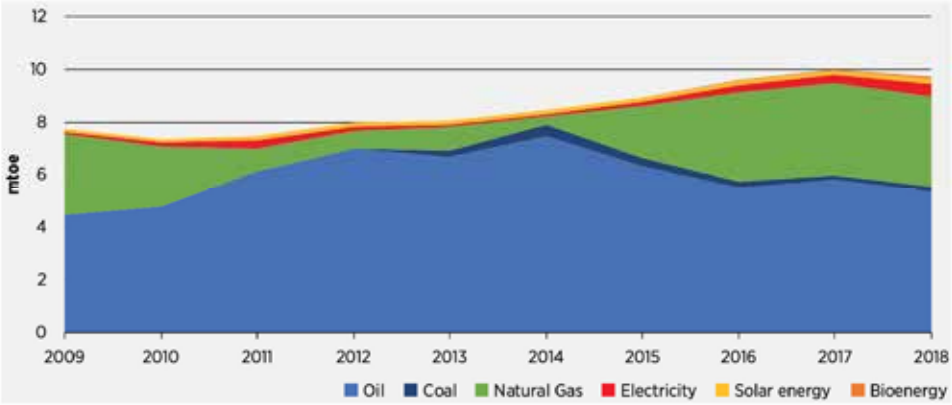
[188] Ibid.

[189] Ibid.

[190] International Renewable Energy Agency (IRENA). 2021. "Jordan Renewable Readiness Assessment." IRENA, February.

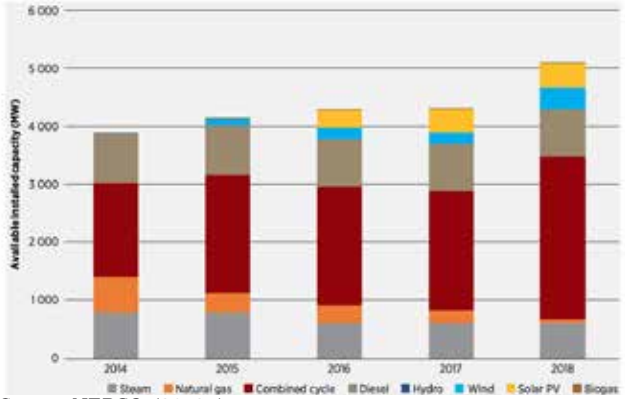
[191] Ibid.

Figure 16. Total primary energy supply by fuel, Jordan in 2009 and 2018



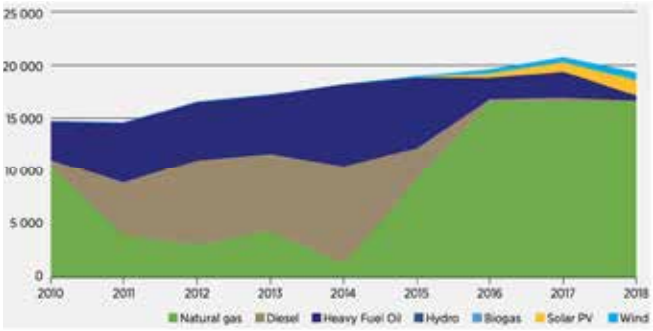
Source: MEMR (2019b)

Figure 17. Installed capacity in the power sector, by source (2014-2018)



Source: NEPCO (2019a)

Figure 18. Total electricity generated, by fuel



Source: NEPCO (2019a, 2018)

reaching over 80% by 2018.[192] Jordan recognizes the importance of grid interconnection with neighboring countries and the wider region as a vital aspect of its diversification efforts. In 2018, electricity imports reached over 188 GWh, a substantial increase from the previous year's 51 GWh but a significant decrease from 604 GWh in 2015. Given the limited growth in domestic electricity consumption and the upcoming launch of several power projects, cross-border electricity exports play a crucial role in stimulating demand. To enhance export capabilities, the National Electricity Company of Jordan entered an agreement in October 2019 with the Jerusalem local electricity company to boost its electricity export capacity. In 2019, the volume of exported electricity grew by 4.7%.[193]

Sectoral analysis reveals that the rapid population growth resulted in a decline in the per capita annual electricity consumption. Per capita average electricity consumption fell from 2.3 MWh in 2014 to 1.7 MWh in 2018, in comparison to the global average per capita electricity consumption which stands at 3.2 MWh. Notably, the per capita household electricity consumption was approximately 0.77 MWh in 2018, indicating a significant share of the population residing in energy poverty. This energy poverty extends to refugee camps, where access to reliable, affordable energy services for electricity and heating remains inadequate. Given the relatively low per capita consumption, there is considerable potential for electricity consumption to grow. Historically, electricity consumption has witnessed an average annual growth rate of around 4% since 2010. In 2018, the growth rate stagnated, resulting in a total consumption of 17.5 TWh (Figure 19).[194]

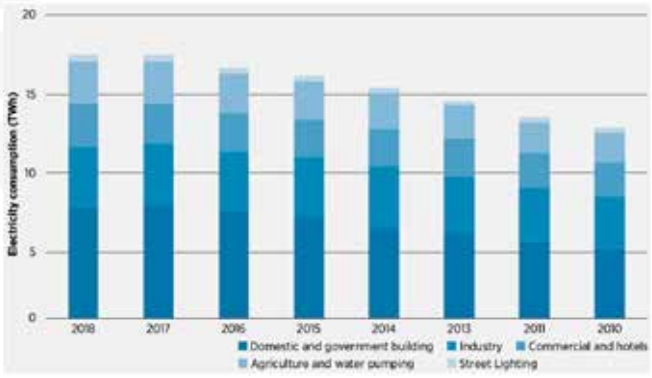
With regards to the sectoral analysis of electricity consumption, households represent the largest consumers of electricity in Jordan followed by the industrial sector. Based on MEMR data, households were responsible for approximately 46% of the overall electricity consumption in 2018, making them the largest consumer group. The industrial sector ranked second, accounting for around 25% of the total electricity usage, with notable contributions from industries such as cement, phosphate, and fertilizer. The commercial sector constituted about 14% of the total

[192] International Renewable Energy Agency (IRENA). 2021. "Jordan Renewable Readiness Assessment." IRENA, February.

[193] Ibid.

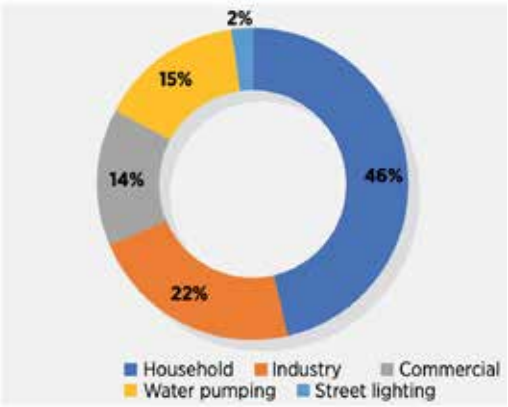
[194] Ibid.

Figure 19. Electricity consumption, by sector (2010-2018)



Source: MEMR (2019a)

Figure 20. Total electricity consumption by sector (2018)



Source: MEMR (2019a)

electricity consumption. Additionally, water pumping played a significant role, representing 15% of the overall consumption, driven by the country's water scarcity and the energy-intensive processes involved in water extraction, transportation, and treatment.[195]

3.2.2.2 Pathways to energy transition: strategies, goals, and implementation plans for diversifying the energy mix and achieving sustainable energy goals

Jordan is facing the adverse impacts of climate change, which pose significant threats to its natural and built assets. The country is particularly vulnerable to climate hazards, including rising temperatures, decreased precipitation, more frequent droughts, and increased evaporation. These factors exacerbate the challenges already faced by Jordan, such as limited natural resources and a scarce water supply.

Key stakeholders in the energy sector. The Jordanian energy sector comprises a wide array of key stakeholders, including government bodies, energy companies, regulatory agencies, international organizations, and local communities, each playing a significant role in shaping the country's energy landscape and driving sustainable development.

Ministry of Environment (MoE) / The Royal Scientific Society (RSS) / Renewable Energy Department at the Ministry of Energy and Mineral Resources (MEMR): Established in 1984, the Ministry of Energy and Mineral Resources in Jordan has been charged with overseeing the energy sector to meet national goals. With the sector's restructuring, the Ministry's duties expanded to include comprehensive planning, developing general strategies, and ensuring their execution to fulfill key sector objectives. These include ensuring diverse energy supply for development, managing energy affairs, facilitating power exchange with neighboring nations, and drawing international investment into critical areas such as electricity generation, oil derivative production, oil and gas transportation, and the exploitation of local energy resources.

The National Energy Research Center (NERC): It is part of the Royal Scientific Society (RSS), and was established in Amman for the purposes of research, development, training in the fields of new and renewable energy and raising the standards of energy use in the different sectors and to promote the utilization of renewable energy in Jordan.

Jordanian Renewable Energy and Energy Efficiency Fund (JREEEF): was established in 2012 by the EE and RE law 13 yet it became operational in 2015 after the promulgation of bylaw 49 of 2015. It is established at the Ministry of Energy and Mineral Resources (MEMR) to provide necessary funding for EE and RE measures at the end-user's level. It supports any program and financial mechanism allowing RE and EE users to access financing from banks, local and international financial institutions.

The Jordanian-German Energy Partnership: A high-level energy dialogue between Jordan and Germany had already been established in 2016. At the margins of the fifth Berlin Energy Transition Dialogue, this dialogue was upgraded to a fully-fledged Energy Partnership between the countries. To establish this partnership, both governments signed a Joint Declaration of Intent. Germany was represented by the Federal Minister for Economic Affairs and Energy; Jordan was represented by the Minister of Energy and Mineral Resources.

Renewable Energy for Energy Efficiency (REEE) European Renewable Energy and Energy Efficiency Program in Jordan About the Regional Climate and Energy Project at Friedrich-Ebert-Stiftung (FES): The Friedrich-Ebert-Stiftung (FES), founded in 1925 and the oldest political foundation in

[195] Ibid.

Germany, remains dedicated to the principles of social democracy—freedom, justice, and solidarity—through its Regional Climate and Energy Project MENA in Amman, Jordan, advocating for climate justice and the transition to renewable energy in the MENA region.

The country's policy framework for renewable energy and energy efficiency is governed by the Renewable Energy and Energy Efficiency Law No. 13 of 2012 and its subsequent amendments. Jordan has also established reporting requirements for greenhouse gas emissions through Bylaw (79) of 2019 for Climate Change.[196] Jordan has progressed in integrating sectoral policies with its Climate Change Policy (2013-2020) goals, notably following the Paris Agreement, by implementing Bylaw No. 79 of 2019 to define greenhouse gas reporting requirements and establish a structured approach for stakeholder engagement in climate change initiatives, though further clarity is needed to enhance the Ministry of Environment's legislative oversight in alignment with UNFCCC obligations.[197]

In response to climate change challenges, Jordan launched a national Reform Matrix in 2018/2019. The matrix focuses on policy and structural reforms in Jordan to enhance competitiveness, stimulate growth, and create jobs, with areas including business improvement, cost reduction, export and investment promotion, and macroeconomic stability, and has expanded to incorporate public sector efficiency and tourism—a sector critical to the economy—to boost investment, competitiveness, and inclusive practices, supported by debt management and adherence to IMF program benchmarks.[198]

Introduced in 2015, Jordan 2025 outlines a comprehensive national vision and strategy aligned with the UN 2030 Sustainable Development Goals (SDGs). This ten-year plan targets Jordan's sustainable development across economic, social, and environmental realms, supported by Executive Development Programs and strategies such as the National Climate Change Policy, Sustainable Consumption and Production Action Plan, Economic Growth Plan, and initiatives in sustainable finance, energy, water, and green growth.[199]

The NGGP serves as a roadmap for Jordan's transition towards sustainable, greener growth. Developed through stakeholder consultation, this strategy guides green growth projects in line with investment policies, focusing on enhancing Jordan's energy security by increasing renewable energy's share to 9% by 2025 and domestic energy reliance to 39% by 2020, in response to limited primary resources and rising demand.[200]

As part of its commitment to climate action, Jordan's nationally determined contribution (NDC) aims to reduce greenhouse gas emissions by 14% by 2030. Jordan has exceeded its renewable energy goal by achieving 12% of electricity generation from renewables in 2021 against a 10% target for 2020, setting a new ambition of 30% by 2030, supported by declining technology costs and competitive bids, highlighting the country's commitment to sustainable energy and reduced greenhouse gas emissions.[201]

In line with its efforts to combat climate change, Jordan has made a significant commitment to phase out coal-fired power plants by 2025. This commitment is crucial as coal is a major contributor to greenhouse gas emissions and transitioning away from it will facilitate a greener energy landscape.

Furthermore, Jordan is actively taking measures to enhance energy efficiency across sectors. Jordan aims to reduce its economy's energy intensity by 15% by 2030 through innovative technologies and sustainable practices, alongside improving building energy efficiency by 30%, highlighting its leadership in sustainable energy solutions and commitment to climate change mitigation.[202] [203]

3.2.2.3 Powering the transition: a focus on financing

In line with its dedication to sustainable development, Jordan has made notable strides in implementing sustainable finance practices within its financial sector. The Sustainable Banking Network Global Progress Report reveals that the majority of surveyed banks in Jordan have established sustainability targets, although the extent of sustainability practices varies. The country has also employed Islamic bonds, or sukuks, to finance national projects, particularly in the green energy sector. International financing institutions like AFD and EIB have contributed funds to support Jordan's green finance initiatives. The Association of Banks in Jordan

[196] Ibid.

[197] "VNR 2022 Jordan Report."2022.

[198] Ibid.

[199] Sustainable Arab Finance Report. 2021.

[200] Sustainable Arab Finance Report. 2021.

[201] IRENA. (2021). Renewables Readiness Assessment: The Hashemite Kingdom of Jordan.

[202] Green Growth Knowledge Platform, 2022

[203] World Bank, 2022

and the Central Bank of Jordan have played pivotal roles in promoting sustainable finance practices among banks and fostering financial inclusion. Jordan has set ambitious targets for reducing greenhouse gas emissions, increasing renewable energy generation, and phasing out coal-fired power plants.

The World Bank Group and the International Monetary Fund are providing assistance for the development of a roadmap aimed at ensuring the financial sustainability of the electricity sector. This comprehensive plan encompasses various measures such as streamlining the cross-subsidized tariff system, implementing charges that accurately reflect costs, restructuring debt, and resolving the outstanding debts owed by NEPCO.[204]

Jordan has made significant progress in implementing sustainable finance practices, as highlighted in the Sustainable Banking Network (SBN) Global Progress Report of 2019. The country has entered the commitment phase of developing a national framework that incorporates environmental, social, and governance (ESG) factors into the financial sector's business model.[205]

The financial sector has shown improvement in non-financial reporting and sustainability disclosure. Sustainability is still perceived by some as a philanthropic practice rather than a strategic consideration to be fully integrated into the business model.[206] Jordan's efforts in sustainable finance demonstrate a commitment to aligning the financial sector with sustainable development principles and fostering a more resilient and inclusive economy.[207]

In 2012, the Islamic Finance Sukuk Law was enacted, enabling Islamic banks to mobilize their capital through Shariah-compliant funding options. Islamic bonds, known as sukuks, have become an innovative financing instrument for national projects in Jordan, supporting economic expansion and infrastructure development. Sovereign sukuks have been utilized to finance green energy projects, such as the issuance of a five-year bond in 2016, supported by the Islamic Development Bank and the Japan International Cooperation Agency. Additionally, the National Electric Power Company issued sukuks in 2016 and a second tranche in 2017, both priced under a murabaha framework. These initiatives demonstrate the use of Islamic bonds to fund critical projects in Jordan's development.[208]

International financing institutions are playing a crucial role in supporting Jordan's green finance initiatives by providing new sources of funding. This assistance aims to accelerate sustainable growth and increase investments in energy efficiency, renewable energy, and socially responsible projects. Notable examples include:[209]

Agence Française de Développement (AFD): AFD has extended a soft credit line of USD 53 million to Cairo Amman Bank and Capital Bank of Jordan. These funds are intended to be lent to businesses and households and are part of AFD's Sustainable Use of Natural Resources and Energy Finance (SUNREF) program. European Investment Bank (EIB): In 2019, the EIB signed a loan agreement worth EUR 45 million with the Cities and Villages Development Bank. The funds will be allocated to finance energy efficiency projects targeting municipal, building, and lighting infrastructure across Jordan.

The Association of Banks in Jordan (ABJ): In 2016, the ABJ launched Jordan's first industry-wide Sustainability Report for the Banking Sector. This report assesses the sustainability practices of Jordanian banks, including socially responsible investment and banking services.[210] The Central Bank of Jordan (CBJ): has taken significant steps to promote sustainable finance practices in alignment with the Jordan 2025 Vision and Strategy and the Jordan National Economic Growth Plan. In 2017, the CBJ launched the National Financial Inclusion Strategy (NFIS) for the period 2018-2020. The NFIS is designed to address socio-economic inequalities and enhance financial inclusion, with a particular focus on underserved populations such as women, refugees, low-income groups, youth, and micro, small, and medium enterprises (MSMEs).[211]

Stock Exchange and Islamic Bonds (Sukuks) in Jordan. The Amman Stock Exchange (ASE) has been a member of the Sustainable Stock Exchange (SSE) Initiative since 2016. As part of its commitment to sustainability, the ASE has published the Guidance on Sustainability Reporting in 2018. This initiative aims to encourage listed companies in the Jordanian capital market to report on their sustainability performance and promote sustainability practices.[212]

[204] International Renewable Energy Agency (IRENA). 2021. "Jordan Renewable Readiness Assessment." IRENA, February.

[205] Sustainable Arab Finance Report. 2021.

[206] Ibid.

[207] Ibid.

[208] Ibid.

[209] Ibid.

[210] Ibid.

[211] Ibid.

[212] Ibid.

These financial partnerships provide vital support to Jordan's sustainable development goals and contribute to the country's efforts in promoting environmental sustainability and energy efficiency. [213]

3.2.2.4. Powering sustainable jobs: employment opportunities in renewable energy

The diversification of the energy mix presents promising prospects for job generation and the emergence of new industries especially in developing economies.

The solar photovoltaic sector has grown substantially. Since 2013, nearly 300 licensed companies have been established in the PV sector. These companies engaged in various activities such as design, procurement, installation, and operation and maintenance. This expansion has resulted in the creation of thousands of full-time jobs. Notably, the establishment of a 50MW solar PV plant necessitates approximately 229,055 person-days of work, with operation and maintenance workers comprising the majority of the labor force (56%). Significant labor inputs are also required for equipment manufacturing (22%) and installation and grid connection (17%).[214]

Job opportunities within the Jordanian energy sector span the entire value chain, encompassing manufacturing as well. One example is Philadelphia Solar, a company engaged in the assembly of solar PV modules and the manufacturing of mounting structures, which employs 250 individuals on a full-time basis. The diverse segments of the value chain for different renewable energy technologies, including solar PV, onshore wind, and solar water heaters, demand a range of skills and material inputs. By integrating existing industries into renewable energy supply chains, local value creation can be enhanced. In the development of Concentrated Solar Power (CSP), for instance, a minimum of 30% (in terms of value) of a project could be produced locally, including components such as steel support structures, piping systems, storage vessels, coating materials, connection boxes, and cables.[215]

3.2.3 Exploring the landscape of micro, small, and medium-sized enterprises (MSMEs)

3.2.3.1. Examining the profile of micro, small, and medium-sized enterprises (MSMEs) and their engagement with renewable energy: policies, adoption, and access to climate finance

In Jordan, various institutions with different legal statuses are involved in the regulation, supervision, and support of MSMEs, highlighting their significance for the economy. Within the ecosystem of institutions under the Ministry of Industry, Trade and Supply, the Jordan Enterprise Development Corporation plays a crucial role in supporting the growth and internationalization of MSMEs, while the Companies Control Department focuses on creating a favorable investment climate in the private sector. Additionally, the Amman Chamber of Commerce, established in 1923, promotes best practices and provides a platform for private sector trade, while the Amman Chamber of Industry, founded in 1962, represents and supports the industrial sector, indirectly contributing to MSME support through its lobbying activities.

While the Ministry of Industry, Trade and Supply oversees the regulation and supervision of the MSME sector, the absence of a comprehensive national strategy limits its capacity to serve as an effective coordinator, resulting in fragmented support efforts for MSMEs.

The section below offers an overview of key institutions that directly support MSMEs through funding, facilities, mentoring, training, and facilitation services.[216]

Main institutions involved in the implementation of MSME policies in Jordan

- *Business Development Centre:* Encouraging entrepreneurial spirit and fostering innovation, generating job prospects and personal development, facilitating the establishment of public-private collaborations, bolstering the competitiveness and export capacity of MSMEs, and facilitating access to credit for MSMEs.
- *Central Bank of Jordan:* Playing a crucial role in attracting and managing loans to facilitate the growth of the private sector.
- *Jordan Enterprise Development Corporation:* Facilitating the establishment and growth of enterprises.
- *Jordan Loans Guarantee Corporation:* Assisting

[213] Ibid.

[214] International Renewable Energy Agency (IRENA). 2021. "Jordan Renewable Readiness Assessment." IRENA, February.

[215] Ibid.

[216] EMNES Studies No 3 / December, 2017. (2017)

SMEs and exporters by offering loan guarantees to financial institutions, thereby improving their access to finance and export credit.

- *Jordanian Free Zones Corporation:* Creating a favorable business environment to attract and nurture both domestic and foreign investments.
- *King Abdullah II Fund for Development:* Prioritizing the youth demographic to foster innovation and entrepreneurial activities.
- *Queen Rania Centre for Entrepreneurship:* Non-profit organization offering assistance and resources for technology-based entrepreneurship.
- *Vocational Training Corporation:* Providing training and preparing individuals to meet the demands of the job market.[217]

Entrepreneurship and Micro, Small, and Medium Enterprises (MSMEs) hold significant importance for Jordan's economy. They are instrumental in creating employment opportunities and driving economic development.218 SMEs play a vital role in driving Jordan's economy, accounting for 98% of private sector entities. However, these SMEs face various challenges, including limited access to new markets, a shortage of skilled labor, a lack of business planning, intense competition from price-competitive imported goods, difficulties in accessing financing, and low adoption of new technologies. To support SMEs, the Jordanian government has enacted several regulations and laws, such as the Ministry of Industry and Trade law (18/1998), the Chamber of Industry law (10/2005), and the Investment law (68/2003). Additionally, public and private financing organizations, including JEDCO, NAFES, the Development and Employment Fund, and the Jordan Investment Board, have been established to provide financial assistance.

The most recent census of businesses in Jordan in 2018 determined that there were 167,519 active enterprises, of which 166,638 (99.5% of the total) were MSMEs. Micro enterprises, defined as having 1 to 4 employees, made up 89.7% of the total, followed by small enterprises (5-19 employees) at 8.0% of the total, medium enterprises (20-99 employees) at 1.7%, and large enterprises at 0.5%. [219] In 2021, SMEs accounted for 95% of the business market in Jordan, comprising approximately 95% of registered companies. They make a significant contribution to the country's GDP, with 50% or more, and are responsible for employing around 60% of the Jordanian workforce.

Table 2. Size of MSMEs in Jordan

	% of employees	% of enterprises	% of total
Micro	1-4	150,338	89.7%
Small	5-19	13,485	8.0%
Medium	20-99	2,815	1.7%
Large	100+	881	0.5%
	Total	167,519	100%

Source: MSME financial inclusion study in Jordan 2022

Compared to European definitions, Jordan's SME criteria are relatively smaller, with fewer than 100 employees and a total turnover not exceeding JOD 3 million.[220] Micro businesses make up 89% of total enterprises in Jordan, followed by small enterprises at 9%, and medium and large enterprises at 2%.

The majority of SMEs in Jordan are in the commercial establishment category (35%), followed by the service provider category (23%), with significant representation in industrial production (20%), as well as sectors like tourism, construction, transport, and finance (9%, 8%, 4%, and 1%, respectively).[221]

3.2.3.2 Assessing the drivers and impediments for MSMES in adopting renewable energy technologies: country-level analysis

There are various obstacles that MSMEs in Jordan encounter when embracing renewable energy technologies. These include:[222]

- *High initial expenses:* The upfront costs associated with implementing renewable energy technologies can pose a challenge for MSMEs, particularly those with limited financial resources.
- *Insufficient information and awareness:* Many MSMEs lack awareness of the advantages offered by renewable energy technologies and are unfamiliar with the process of adoption.
- *Limited government assistance:* The Jordanian government has yet to offer substantial support to MSMEs seeking to adopt renewable energy technologies.
- *Inadequate infrastructure:* The current state of the Jordanian electricity grid does not adequately support the widespread integration of renewable energy technologies.

Despite the presence of these difficulties, MSMEs in Jordan have several prospects to embrace renewable energy technologies. These possibilities encompass:

[217] EMNES Studies No 3 / December, 2017. (2017)

[218] Al-Atawneh, H., & Gharaibeh, M. (2021)

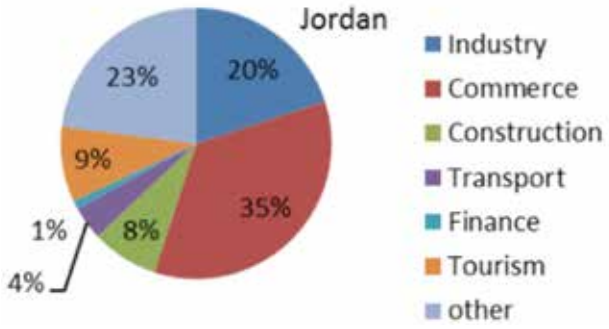
[219] GIZ. (2023). MSME Financial Inclusion Study in Jordan 2022.

[220] Shqair, M. I., & Altarazi, S. A. (2022)

[221] Ibid.

[222] EMNES Studies No 3 / December, 2017, p. 27

Figure 21. Sectoral distribution of MSMEs in Jordan



Source: Jordan Department of Statistics.

The presence of government subsidies: Recently, the Jordanian government has implemented various subsidies for renewable energy technologies, aiming to decrease the initial expenses for MSMEs.[223]

The increasing desire for renewable energy: In Jordan, there is a rising demand for renewable energy, opening up fresh prospects for MSMEs to participate in the market.[224]

The possibility of financial savings: Implementing renewable energy technologies can enable MSMEs to reduce their energy expenses.[225]

Reduced reliance on imported energy: By embracing renewable energy technologies, Jordan can decrease its dependence on imported energy sources, particularly oil, which currently dominates its energy landscape. This shift towards renewables presents an opportunity for the country to enhance its energy security and decrease its vulnerability to fluctuations in global energy markets.[226] [227]

Improved air quality: By embracing renewable energy technologies, Jordan can decrease its dependence on imported energy sources, particularly oil, which currently dominates its energy landscape. This shift towards renewables presents an opportunity for the country to enhance its energy security and decrease its vulnerability to fluctuations in global energy markets.[228] [229]

3.2.4. Drawing the final threads: a resolute conclusion

Jordan's energy transition has made remarkable strides motivated by energy security concerns following the Arab Spring, positioning Jordan as a leading advocate of clean energy in the region. The country now boasts over 300 photovoltaic companies and around 13,000 employees in the renewable energy sector. Recent advancements have faced obstacles due to conflicts between Jordan's renewable energy objectives and the costs of fossil fuel over-capacity for the state-owned electricity transmission and distribution company.[230]

The government's efforts towards addressing issues that encounter the energy sector in Jordan have led to a significant rise in renewable energy generation. According to IRENA, renewable energy comprised only 4% of the total electricity mix in 2019 (Figure 14), this share rose to 10% in 2020 and continued rising throughout 2021 and 2022 to reach 26% and 29%, respectively. With a stable political environment and supportive regulatory frameworks, Jordan has successfully attracted foreign investments in large-scale renewable projects, positioning itself as an attractive destination for further investment in the region.[231]

Potential, the untapped possibilities lying ahead, holds the key to Jordan's energy future.

Jordan is a country which benefits from 5 to 7 kWh/m2 of direct solar radiation intensity. The country also averages 310 sunny days annually. One of the advantages of solar electricity generation in regions with hot climates like Jordan is that electricity generation happens largely during peak load demands. There has been an influx of investments in solar energy in Jordan, with over 500 registered solar installation companies. The abundance of solar radiation is evident in the five regions in Jordan. [232]

Geothermal wells, distributed throughout Jordan, offer

[223] World Bank, 2022, p. 15

[224] Green Growth Knowledge Platform, 2022, p. 12

[225] EMNES Studies No 3 / December, 2017, p. 28

[226] World Bank. (2022). Jordan: Renewable Energy Market Assessment, p.7

[227] Green Growth Knowledge Platform. (2022). A National Green Growth Plan for Jordan, p.12

[228] EMNES Studies No 3 / December, 2017, p.29

[229] United Nations Framework Convention on Climate Change. (2015).p.16

[230] Ahmad A. Salah, Mohammad M. Shalby & Firas Basim Ismail (2023) The status and potential of renewable energy development in Jordan: exploring challenges and opportunities, Sustainability: Science, Practice and Policy, 19:1, DOI: 10.1080/15487733.2023.2212517

[231] Ibid.

[232] Al-Refai, Ghassan, Ahmed H. Khatib, and Mohammad Al-Smadi. "Solar energy in Jordan: Investigating challenges and opportunities of using domestic solar energy systems." Renewable Energy 176 (2022)

the potential to leverage subterranean reservoirs for heating and cooling purposes. This approach could lead to a reduction in the expenses associated with traditional energy sources.[233]

Jordan's consistently moderate temperature and clear air throughout the year, coupled with wind speeds that typically range between 7 and 11 meters per second (m/s), also make it an ideal location for wind turbines.[234]

Due to its political stability and well-developed regulatory and legal frameworks, many large-scale renewable energy projects have been successfully executed. This remarkable growth gives Jordan an advantage in attracting further renewable energy investment compared to other counties in the region.

The strategic location of Jordan in the Middle East as a connection between Asia, Africa, and Europe enables the country to play a leading role in linking electricity networks and importing and/or exporting energy to international energy markets.[235]

Hurdles, formidable challenges to overcome, stand in the way of Jordan's energy ambitions.

Official documents indicate that Jordan possesses vast reserves of oil shale, yet continues to rely on the importation of essential petroleum products from neighboring nations. This persistent dependence on fossil fuels has led to Jordan producing a considerable amount of greenhouse gas emissions on a per capita basis.[236]

Although policies have been enacted to promote the uptake of renewable energy sources, progress in their adoption at a broad domestic scale has been somewhat gradual. This may be partly attributed to a challenge common across many Middle Eastern nations which is the demographic concentration of the population. Specifically, around 75% of Jordanians reside in three major urban centers: Amman, Zarqa, and Irbid, which may impact the nationwide implementation of renewable energy initiatives.[237]

In the country, there is a notable absence of regulatory frameworks pertaining to energy storage across various stages, including large-scale generation, transmission, distribution, and at the end-user level. Furthermore, there are insufficient policies addressing the recycling and decommissioning of photovoltaic (PV) power plants. Implementing measures in these areas could conserve resources, lower manufacturing costs, minimize waste, and reduce greenhouse gas (GHG) emissions.[238]

In the domain of small-scale renewable energy investments, the government has rolled out initiatives like the net-metering system, which have faced criticism for their narrow focus and inadequate financial incentives. Additionally, the substantial initial expenses associated with installing renewable energy systems in households, coupled with a scarcity of financing options, stand as significant obstacles to the implementation of small-scale projects in Jordan.[239]

Furthermore, the introduction of new electricity tariffs in Spring 2022 has added complexity to the development of small renewable energy projects. These tariffs do not provide adequate support for system owners, impacting the economic viability of such initiatives. Consequently, this has made it increasingly difficult to encourage participation in renewable energy projects, particularly among low-income households, due to the diminished financial attractiveness.[240]

The lack of technical expertise related to maintaining the stability of the electrical grid presents a significant challenge to the expansion of renewable energy projects in Jordan. Instances of blackouts across various regions in 2021 highlighted substantial issues arising from electrical load fluctuations. The electrical grid's limited capacity restricts its ability to handle a diverse range of electricity generation sources. Furthermore, there is inadequate support for the development of electric vehicle charging stations and the advancement of small-scale renewable energy initiatives, further impeding progress in these areas.[241]

To date, international investment has constituted 75% of the funding in Jordan's renewable energy sector, with only minimal involvement from domestic financial institutions. Specifically, local investors have shown limited engagement

[233] Salah, A. A., Abu-Qdais, M., & Abu-Qdais, M. H. (2023). The status and potential of renewable energy development in Jordan: exploring challenges and opportunities. Sustainability, 19(1), 1-22.

[234] Ibid.

[235] Ibid.

[236] Al-Refai, Ghassan, Ahmed H. Khatib, and Mohammad Al-Smadi. "Solar energy in Jordan: Investigating challenges and opportunities of using domestic solar energy systems." Renewable Energy 176 (2022)

[237] Ibid.

[238] Salah, A. A., Abu-Qdais, M., & Abu-Qdais, M. H. (2023). The status and potential of renewable energy development in Jordan: exploring challenges and opportunities. Sustainability, 19(1), 1-22.

[239] Ibid.

[240] Ibid.

[241] Ibid.

in financing utility-scale renewable energy projects. Despite this, a considerable share of investments has come in the form of secured loans made in collaboration with international financiers, which have placed a substantial strain on the state budget. Moreover, the high cost associated with renewable energy technologies presents a formidable challenge, potentially hindering their broad adoption within Jordan.[242]

In the realm of business and economic growth, MSMEs play a vital role as small and medium-sized enterprises with significant potential for innovation and job creation.

The report from the EMRC indicates that Jordan hosts around 506 registered companies specializing in installation services, with 20 of these firms actively engaged in the renewable energy market. Moreover, there are nine energy audit service providers that have obtained licenses to operate within the country. This scenario has heightened competition within the renewable energy sector, yielding benefits for both consumers and businesses.[243]

The adoption of solar power in residential and medium-sized enterprises has seen substantial expansion, with the total number of photovoltaic (PV) systems connected to the grid escalating from 9,603 systems in 2018 to 24,157 systems by the end of 2020. In the year 2020 alone, around 9,018 systems were integrated into the grid, representing approximately 37% of all installations since 2015. This indicates a robust growth trajectory in the utilization of solar energy within the specified period.

In the renewable energy sector, companies have diverse financial requirements based on their position within the value chain. To address this, Jordan has set up entities that offer equity financing to both new and existing firms. The Jordan Enterprise Development Corporation (JEDCO), for example, is one such entity that supports startup companies by providing up to 80% equity financing for renewable energy projects and Small and Medium Enterprises (SMEs). The attractiveness of this equity financing is heightened by JEDCO's modest requirement of a 10% return on profits, significantly lowering the cost of equity. Despite these advantages, the uptake of this fund has been limited. Additionally, the World Bank initiated the Innovative Startups Fund Project in Jordan, with an investment of USD 50 million and an additional USD 49 million in co-financing from the Central Bank of Jordan (CBJ). This project aims to facilitate early-stage financing for startups in various sectors, including the green energy sector.[244]

The Jordan Chamber of Industry offers a non-refundable capital subsidy through its Factories Support Program, targeting small industrial enterprises interested in installing solar PV systems or solar water heaters. This program aims to introduce the industry to renewable energy technologies through the implementation of small-scale projects. The establishment of dedicated enterprise funds is pivotal in stimulating the local industry, driving innovation within the renewable energy sector, and advancing complementary technologies such as energy storage, smart grid infrastructure, demand side management, and digitalization.[245]

3.3. Lebanon

Lebanon, a country with a population of approximately 6.8 million, faces a multitude of economic and political challenges and particularly in its energy sector. The country's unique geographic and demographic characteristics contribute to disparities in energy resources and infrastructure development. With a concentrated coastal population and sparsely populated interior, Lebanon struggles to provide equal access to energy across its regions. Moreover, the country's dire political and economic circumstances, compounded by a severe economic crisis since 2019 and the strain caused by the Syrian refugee crisis, further complicate the energy landscape. The electricity system in Lebanon, which heavily relies on power plants fueled by heavy fuel oil and diesel generators, has resulted in substantial air pollution, leading to detrimental effects on the environment and public health. Greenpeace estimates suggest that this pollution may be responsible for causing thousands of premature deaths annually in Lebanon.[246]

These challenges have resulted in disparities in electricity access, with the poorest quintile enduring extended periods without power. Corruption, mismanagement, and the influence of political elites have plagued Lebanon's electricity sector, hampering progress and hindering the country's energy transformation efforts. Despite heavy reliance on energy imports, predominantly oil

[242] Ibid.

[243] Ibid.

[244] International Renewable Energy Agency (IRENA). (2021, February). Renewable Readiness Assessment: Jordan. Retrieved from https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Feb/IRENA_RRA_Jordan_2021.pdf

[245] Ibid.

[246] Human Rights Watch, 2023

and natural gas, Lebanon has set ambitious goals for renewable energy adoption to reduce its dependence on conventional sources. The unreliability of the state-operated company, Électricité du Liban (EDL), has led to the widespread use of costly and polluting diesel generators. Overcoming these multifaceted challenges necessitates persistent and ongoing efforts to address Lebanon's energy sector effectively.

Lebanon's energy sector is currently undergoing a transition towards renewable energy sources while grappling with the need to ensure reliable and sustainable electricity access. The nation's heavy reliance on thermal sources for energy generation has resulted in significant pollution and greenhouse gas emissions. To mitigate these environmental impacts, efforts have been made to reform the electricity sector, introduce private sector participation, and establish an independent regulatory body. Previous attempts at regulation and enforcement have encountered limited success. Lebanon has initiated initiatives to diversify its energy sources, including the development of wind farms and solar power plants. The Ministry of Industry has also implemented strategies to promote sustainable consumption and production practices in the industrial sector. The energy sector is regulated by the state-controlled (EDL), while the full implementation of the Electricity Regulatory Authority (ERA) is still pending. Financial challenges, inadequate cost-recovery mechanisms, and reliance on expensive fuel imports further exacerbate the sector's financial viability issues.

3.3.1. Exploring the interplay of demographics and identities: dynamics and implications

The interior of Lebanon is mountainous and sparsely populated, with important water resources but limited development. The rugged terrain poses challenges for infrastructure development, including power transmission, road networks, and water supply systems, affecting energy provision to the interior. Lebanon's energy landscape is also impacted by its political and economic circumstances. The demographic and geographic factors, coupled with the political and economic situation, collectively shape Lebanon's energy requirements and resources, necessitating the government's ongoing efforts to address these complex challenges.[247]

The Syrian Refugee Crisis is taking a significant toll on Lebanon's resources where according to the Government of Lebanon; approximately 1.5 million Syrians have fled their ongoing conflict and are currently residing in the country.[248] This figure encompasses over one million registered displaced individuals under the United Nations High Commissioner for Refugees (UNHCR), as well as 31,000 Palestinians who have been displaced from Syria. Additionally, there are 35,000 Lebanese individuals who have returned from Syria, along with an existing population of approximately 200,000 Palestinian refugees already present in Lebanon.[249] By mid-2017, the number of displaced individuals in Lebanon amounted to nearly 25% of its citizen population, signifying a significant strain on the country's resources. The overwhelming majority, around 90%, of these displaced individuals reside in 251 localities that are particularly vulnerable and lack the necessary resources and capacity to adequately address the heightened demands on public and social services.[250]

The conflict in Syria influenced Lebanon's economic growth and developmental trajectory. The presence of displaced individuals has exacerbated the gaps between the supply and demand for crucial infrastructure, particularly in terms of electricity. Consequently, the existing public infrastructure has suffered from deterioration, partly due to the strain caused by the influx of displaced individuals.[251] The Syrian crisis aggravated the financial situation which Lebanon was already grappling with, where financing the incremental deficits arising from the Syria crisis has further increased Lebanon's public debt between the end of 2011 and 2016. The UN Development Programme (UNDP) estimates that government expenditure on providing electricity for the displaced alone rose by USD 1 billion from 2012 to 2016.[252]

Disparities in electricity access in Lebanon are deeply rooted in long-standing income and wealth inequalities, which are among the highest in the MENA region. Household income is closely correlated with the duration of electricity outages, with the poorest quintile experiencing longer periods without electricity compared to the wealthiest quintile. Financially vulnerable households and those unable to afford generators or alternative energy sources face the greatest challenges, enduring up to 16 hours without electricity daily. The reliance on private generators perpetuates social inequality, transforming

[247] Energy Sector Management Assistance Program (ESMAP). (2020).

[248] "Lebanon Voluntary National Review (VNR) on Sustainable Development Goals (SDGs)." 2018.

[249] Ibid.

[250] Ibid.

[251] Ibid.

[252] Ibid.

electricity provision into a privilege reserved for the affluent. Moreover, the reliance on fuel oil-powered plants and diesel generators contributes to air pollution, impacting both the environment and public health. Limited access to state-provided electricity and the high costs of alternative sources exacerbate the challenges faced by low-income households, highlighting the disparities in electricity access across income levels in Lebanon.253 Furthermore, the removal of fuel subsidies in 2021 exacerbated the financial burden on low- and middle-income households.

In order to overcome the persistent political gridlock in governance, the three highest-ranking leaders in Lebanon assumed significant roles in policy-making. These three highest-ranking leaders in Lebanon represent the Maronite Christian (President of the Republic), Sunni Muslim (Prime Minister), and Shiite Muslim (Speaker of Parliament) communities, respectively. They often bypassed the strict constitutional requirements and instead engaged in ad hoc and informal decision-making methods. Referred to as the "troika," these leaders reached agreements that involved the distribution of state institutions and resources among different confessional parties, a practice known as "muhassasa" or apportionment. Consequently, this system fostered close relationships between politicians and business figures, with some politicians even directly owning major private sector enterprises. As a result, Lebanon's political elites prioritized their personal interests, often at the expense of the state.254 The electricity sector experienced the same divisive apportionment that plagued other public institutions, making it another channel through which politicians maintained patronage networks by granting public sector positions to their loyal supporters and benefiting from lucrative business contracts.255
The failings in Lebanon's energy sector stem from deep-rooted political economic challenges. Decision-making is diffused, with no single entity being politically accountable for the mismanagement of the sector and EDL. Although the operations of private diesel generators are conducted outside the legally authorized mechanism, consecutive governments have turned a blind eye to the sector due to their inability to address the issue of power under-supply.256 Despite the Lebanese constitutional agreement reached in the Tariff that ended the civil war affirmed the objective of abolishing the confessional system as an organizing principle of the Lebanese polity , no concrete steps have been taken to dismantle this system, and no specific timeline has been established for its eradication.[257]

Similar to many other public institutions, the electricity sector in Lebanon has been plagued by corruption, negligence, and mismanagement. Political parties in government have deliberately weakened the EDL by appointing boards of directors based on partisan affiliations rather than merit. They have also obstructed the appointment of members to the independent Electricity Regulatory Authority (ERA) as required by law, creating a decentralized decision-making structure that effectively avoids accountability. Consequently, politicians and individuals with political connections have exploited the electricity sector to advance their political interests, including through the distribution of jobs at EDL as a form of clientelism and by securing lucrative contracts that often come at the expense of the state. Furthermore, they have capitalized on the private generator market to generate personal profits.[258]

In July 2020, a judicial investigation in Lebanon revealed that the government had been involved in the procurement of adulterated and defective fuel since 2005. The investigation indicated that officials from the Ministry of Energy and individuals working at testing labs had allegedly accepted bribes to provide false reports indicating that the fuel met international standards. This contaminated fuel, which contained prohibited substances, not only caused damage to Lebanon's power plants but also posed significant risks to the environment and public health.[259]

Another instance of alleged mismanagement that garnered attention and led to a judicial inquiry involved a contract between Lebanon and a Turkish company. The contract involved the provision of approximately 370 megawatts of electricity from two floating barges stationed at the Jiyeh and Zouk ports, accounting for around 20 to 25 % of Lebanon's energy capacity. The Lebanese Central Inspection, the government agency responsible for overseeing public administration, identified breaches in certain aspects of the contract, with indications that certain terms favored the interests of Karpowership at the expense of EDL and the Lebanese State.[260]

253 "Cut off from life itself: Lebanon." 2023.

254 Human Rights Watch, 2023

255 Ibid.

256 ESMAP. (2020). Distributed Power Generation for Lebanon: Market Assessment and Policy Pathways. World Bank, Washington, DC. License/ Creative Commons Attribution CC BY 3.0 IGO.

257 Human Rights Watch, 2023

258 Ibid.

259 Ibid.

260 Ibid.

Moreover, due to EDL's inability to meet the electricity demand in Lebanon, an informal and lucrative private diesel generator industry has emerged, estimated to be worth around $3 billion. To address the generation gap, the Lebanese government has resorted to temporary measures such as renting Turkish power barges, which accounted for a significant share of the country's electricity supply. Consequently, access to electricity in Lebanon has become a privilege reserved for the affluent, those with political connections and influence thereby exacerbating deep-rooted inequality in the country and further pushing vulnerable populations into poverty amidst one of the most severe economic crises in modern history.[261]

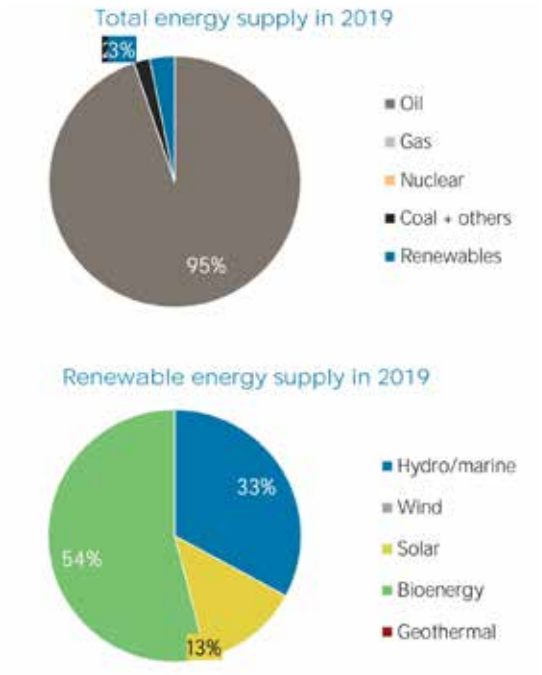
The sector has significant influence and is resistant to reform, partly due to the vested interests of diesel importers who hold political influence. The workforce associated with the generator industry is substantial, estimated at around 13,200 individuals, with jobs linked to fuel imports, generator sales and maintenance, and retail operations.[262] The significant financial stakes involved in the generator market, coupled with the vested interests of diesel importers, contribute to the resistance to reform within the electricity sector and the government's persistence in maintaining policies that reinforce Lebanon's dependence on oil. Diesel importers wield substantial influence at the national level, largely because of the overlapping interests between the shareholders of these companies and the political establishment.[263] Given this context, it is unsurprising that the Lebanese government has not prioritized investments in renewable energy sources, despite experts recognizing the country's abundant solar and wind resources, which could potentially provide multiple times the energy needed. [264]

3.3.2 Energy outlook: trends, challenges, and future prospects

3.3.2.1. Analyzing energy trends: understanding energy demand, efficiency, sectoral distribution of consumers, and energy supply.

According to IRENA's country profile report for Lebanon in 2019 the country's total energy supply is mostly dependent on oil, representing 95% of its energy supply as shown in Figure 22 above. With regards to the composition of the country's renewable energy supply in 2019, as shown in the graph above; bioenergy followed by hydro/marine sources constitute the highest shares in the country's renewable energy mix. In recent years, there has been a consistent increase in energy demand in Lebanon, and this upward trend is projected to persist in the coming years.[265] Lebanon's primary energy demand in 2020 amounted to 7.4 million tonnes of oil equivalent (Mtoe).[266] In 2020, Lebanon had a per capita energy consumption of 1.1 toe/cap, and a per capita electricity consumption of 2,300 kWh. The total energy consumption in the country decreased by 14% to 7.4 Mtoe in 2020 having declined by 6% in 2018. It was stable in 2019. Prior to this, there was a significant increase in energy consumption between 2011 and 2017, with an average annual growth rate of approximately 6%. The graph below highlights Lebanon's consumption trends by various energy sources.

Figure 22. Total energy supply and renewable energy supply in Lebanon, 2019



Source: Jordan Department of Statistics.

Lebanon heavily relies on energy imports to meet the majority of its energy needs. Domestic energy production is limited and accounts for only around 40% of the total energy demand. Lebanon primarily imports energy in the form of oil, natural gas, and electricity to bridge the gap between its energy consumption and domestic production.[267]

[261] Ibid.

[262] Ibid.

[263] Lebanon. 2018. Voluntary National Review (VNR) on Sustainable Development Goals (SDGs). New York: United Nations.

[264] Ibid.

[265] Energy Information Administration, 2023

[266] Our World in Data (2023)

[267] World Bank, 2023

Lebanese laws grant the exclusive right to generate and sell electricity to EDL and licensed independent power producers, making the commercial generator sector largely informal and resistant to regulation. Although fuel imports for generators generate income through customs and taxes, generator operators often do not declare their revenues or pay taxes, resulting in significant losses for the state. Despite this, successive governments have overlooked the sector due to their inability to address EDL's shortages.[268]

Solar energy requires high upfront costs but has low and predictable operating and maintenance costs. Similar to wind power, it has minimal emissions and pollution. Utility-scale solar projects can make a significant contribution to Lebanon's energy mix, while household solar systems can enhance household energy security. The recent growth in renewable energy in Lebanon has mainly been driven by the installation of solar photovoltaic (PV) systems. From 2010 to 2020, the cumulative installed solar PV capacity experienced a remarkable increase rising from 330 kWp in 2010 to 89.84 MWp in 2020. From the perspective of Electricité du Liban (EDL), these systems can reduce the need for costly grid upgrades and expensive peaking capacity. For consumers, substantial cost savings are possible, although the extent of these savings depends on project parameters. Additionally, distributed solar PV can enhance energy resilience, expedite the scaling up of renewable energy (RE), reduce emissions, and foster a positive cultural change.[269] Currently, on-grid solar PV systems appear to be the most cost-effective deployment option, with a levelized cost of electricity (LCOE) of 8 US cents/kWh. Dual-mode solar PV systems with storage have an electricity cost of around 37 US cents/kWh. As storage costs are projected to decrease, the economics of off-grid systems are expected to improve in the coming years.[270]

The feasibility of distributed solar PV. 271 The National Energy Efficiency and Renewable Energy Action (NEEREA) was designed to initiate the deployment of distributed renewables, particularly solar PV systems, and can serve as a transitional mechanism until costs further decrease. NEEREA mechanism, although not financially sustainable, significantly affects the financial feasibility of distributed solar PV systems by reducing the discount rate from a market-based 8% to a subsidized 2.75%. This leads to a decrease in LCOE from 8 to 5 US cents/kWh under current market and technology conditions. The economic impact of distributed renewables should be assessed based on unsubsidized cost estimates that accurately reflect their real impact on Lebanon's economy.272 In Beirut City, there is a potential capacity for distributed rooftop solar PV systems ranging from 200 to 300 MWp. The average rooftop area is estimated at 185 m2, resulting in an average capacity of 12 to 17 kWp.[273]

The financial benefits of incorporating solar PV systems are maximized when diesel prices are high, as the displaced fuel leads to greater savings. While future price changes are difficult to predict, including solar PV systems in the operations of commercial diesel generators can help mitigate price volatility risks. The economic value of these systems will also improve as technology costs decrease and knowledge advances.[274]

Amid the economic crisis, the removal of diesel subsidies and the significant decline in the national electricity generation, there has been a surge in residential solar power systems. The Lebanese Center for Energy Conservation (LCEC) reported a significant increase in inquiries about solar PV installations, from approximately one call per week in 2018 to an average of five calls per day in 2021. Moreover, the Lebanese Solar Energy Society noted that nearly 100 new companies entered the market since the crisis began in 2019, almost matching the number of companies that entered the market in the previous ten years.[275] Experts have expressed concerns about the unregulated nature of the solar PV market. Despite initiating discussions on standardization and technical supervision of solar PV systems with the order of engineers, no regulations have been issued thus far, according to the head of LCEC.

Challenges in the adoption of solar PV systems. Distributed solar PV systems present technical challenges that vary based on penetration level, capacity, and connection points with the electricity grid. The nature and magnitude of these challenges depend on the deployment model. In the short term, the main challenge related to Lebanon's power sector is the "islanding" effect, which requires on-grid renewable sources to disconnect immediately from the grid during disruptions. Lebanon's frequent power

[268] Human Rights Watch, 2023

[269] ESMAP. (2020, May). Distributed Power Generation for Lebanon: Market Assessment and Policy Pathways. World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO.

[270] ESMAP. (2020, May).

[271] Ibid.

[272] Ibid.

[273] Ibid.

[274] Ibid.

[275] Human Rights Watch, 2023

outages exacerbate the islanding effect, leading to energy waste in the absence of storage. This challenge can be addressed as grid supply improves.276Energy storage solutions can play a crucial role in supporting solar PV systems. Incorporating storage, particularly for on-grid dual-mode systems, can minimize power waste due to the islanding effect prevalent in Lebanon. Nonetheless, energy storage remains expensive, despite recent cost reductions. In the short term, a smart rationing system could be implemented by EDL, prioritizing supply hours to areas with solar generation above a certain threshold that significantly impacts operations.[277]

In the past, hydropower played a significant role, accounting for 70 to 75 % of Lebanon's electricity production in the 1970s. As of 2019, renewable energy constituted only 7.83 % of the total electricity generation, with solar power contributing just 0.73 % and hydropower 1.82%.[278] Lebanon's hydroelectric power stations suffer from aging infrastructure and outdated tariff rates ($0.1 per kilowatt-hour), resulting in financial losses and inadequate maintenance. Consequently, production losses of approximately 30-40 % have been observed. The LCEC suggests that rehabilitating these hydroelectric power stations could increase their production capabilities by 25%.[279]

While wind energy requires substantial initial investment, it has low and predictable operating costs. While setting wind power projects appropriately is a challenge, they generally pose fewer human rights risks. Incorporating wind power can play a significant role in Lebanon's energy mix. Despite the substantial percentage increase, wind energy still accounts for around 1% of Lebanon's overall energy mix.[280] Despite its significant potential, wind energy currently contributes negligibly to Lebanon's electricity generation. In 2018, the Energy Ministry signed a power purchase agreement for three utility-scale wind power projects in Akkar. These projects were put on hold due to the economic crisis. The LCEC and Lebanese Foundation for Renewable Energy estimate that wind speeds in Lebanon and the availability of public lands could support the generation of approximately 5,000 MW of electricity annually, enough to power the entire country.[281]

[276] ESMAP. (2020, May).

[277] Ibid.

[278] Human Rights Watch, 2023

[279] Ibid.

[280] Ibid.

[281] Ibid.

3.3.2.2. Pathways to energy transition: strategies, goals, and implementation plans for diversifying the energy mix and achieving sustainable energy goals

The urgent global challenge of climate change necessitates a paradigm shift towards sustainable energy systems. As the world seeks to mitigate environmental degradation and fulfill the growing energy demands, the transition to renewable and diverse energy sources emerges as a critical pathway especially in Lebanon where electricity blackouts is a salient issue. Through a focused analysis, this study seeks to identify the various policies and strategies adopted in order for a smooth and inclusive transition to take place, we also look into the key stakeholders and financial resources offering insights into the optimization of energy mix diversification and the realization of sustainable energy futures.

The following section looks at the key stakeholders operating in the energy sphere in Lebanon:

Lebanese Ministry of Energy and Water (MEW): The Ministry of Energy and Water is the government ministry responsible for energy, water, resources, mines and quarries in Lebanon.

Electricity of Lebanon/Electricité du Liban (EDL): Electricité du Liban (EDL) is a public establishment with an industrial and commercial vocation. It was founded by Decree No. 16878 dated July 10, 1964, and is responsible for the generation, transmission, and distribution of electrical energy in Lebanon. Currently, EDL controls over 90% of the Lebanese electricity sector.

The National Energy Efficiency and Renewable Energy Action (NEEREA): is a national platform launched on 25 November 2010. It is based on the Circular 236 of the Central Bank of Lebanon, which, in collaboration with the EU, lists the terms and conditions to get subsidized green loans.

The Office of Minister of State for Administrative Reform (OMSAR): It is a government entity that leads the transformation to a citizen-centric and performance-oriented public sector by promoting and employing innovative modern policies and methodologies that develop the Lebanese administration and engage citizens. It funds projects that introduce alternative energy into homes and schools in the Bekaa region.

The Lebanese Petroleum Administration (LPA): was established to advise Cabinet and Parliament. In 2017 the Cabinet issued decrees for the delineation of Lebanon's maritime borders, and the tendering and award process for hydrocarbon exploration.

The Lebanese Solar Energy Society (LSES): It was formed in April 1980 on the initiative of highly educated engineers and was composed of solar company owners, chairs of university engineering departments, along with mechanical and electrical engineers who became the heart of the Lebanese Solar Energy Society LSES.

Industrial Research Institute (IRI): Established in 1953, the Industrial Research Institute (IRI) seeks to ensure an adequate service regarding technical and scientific support to the Lebanese industrialists and the national economy, especially in the framework of the partnership's agreements with the European Community and Lebanon's integration in the World Trade Organization (WTO)

National Council for Scientific Research (CNRS): Since its establishment in 1962, the CNRS has been serving the scientific community in Lebanon covering all scientific disciplines. Its main objective is to encourage scientific research and support human resources development along the general scientific policies adopted by the government.

Lebanese Atomic Energy Commission (LAEC): The CNRS established the LAEC in 1996 with the full support of the IAEA for preparing the national legal and technical infrastructures allowing an effective implementation of a comprehensive radiation safety scheme in the country.

Association of Lebanese Industrialists (ALI): It was established in 1942 as the main national entity representing manufacturing companies operating in Lebanon. It addresses economic and social issues that industrialists face, and seeks to create and maintain an environment that is favorable to industrial investment, job creation, growth, and development.

The Lebanon Green Building Council (LGBC): The aim of the organization is to provide a Lebanese certification system for buildings that adopt environmental parameters and to transform the way buildings and communities are designed into a prosperous environment that improves the quality of life.

Government's strategic initiatives for renewable energy development and adoption:

On the Legatum Prosperity Index, Lebanon currently ranks 105 out of 149 countries. The country has experienced a decline in its ranking over the years, moving down by 19 places since 2006. This decline is attributed to various shocks that led to reduced real growth, with an average rate of 1.7% between 2011 and 2016 compared to an average exceeding eight percent from 2007 to 2010.[282]

Since 2010, the Lebanese government has launched action plans and policies aiming to enhance the renewable energy sector, aligning with Paris Agreement commitments to achieve up to 20% renewable energy and 10% energy efficiency by 2030. Despite these ambitions, the integration of renewable energy into Lebanon's electricity sector has been slow, with climate change posing threats to agriculture, power generation, and water supply. Although Lebanon ratified the Paris Agreement in 2016, legislation specific to climate change remains pending in Parliament. Yet, various existing policies on energy efficiency, renewable energy, and air pollution reflect Lebanon's dedication to combating climate change and advancing Sustainable Development Goals. The government has set forth ambitious renewable energy targets in its updated Nationally Determined Contributions of 2021, aiming for significant increases in renewable power and heat demand coverage by 2030, contingent on international support. The goal to install 1 million square meters of solar water heaters by 2020 fell short, achieving only 735,000 square meters, highlighting challenges in meeting renewable energy objectives.[283]

During the 2009 UN Climate Change Conference, Lebanon set a target of 12% renewable energy by 2020. The Ministry of Energy acknowledged in 2016 that the government's commitment lacked clarity and was more of a political vision rather than a well-defined target.[284] According to the International Renewable Energy Agency, achieving 30 % renewable energy consumption by 2030 could save Lebanon $250 million annually by reducing fossil fuel imports. Transitioning to renewable energy would also have environmental and public health benefits, in addition to generating significant savings for the country.[285]

Below is a more detailed timeline of the different initiatives that Lebanon undertook towards its attempt to increase its reliance on renewable energy.

In 2002, the Lebanese parliament enacted Law No. 462 in order to "unbundle" the monopolized activities of electricity generation, transmission, and distribution, which were solely controlled by EDL. The intention was to introduce private sector participation in the generation

[282] Lebanon. 2018. Voluntary National Review (VNR) on Sustainable Development Goals (SDGs). New York: United Nations.

[283] Enerdata (2023)

[284] Human Rights Watch, 2023

[285] Ibid.

and distribution segments, while establishing an independent and autonomous regulatory body known as the Electricity Regulatory Authority (ERA) which would operate under the policy guidance of the Ministry of Energy and Water.[286]

In 2010, the Energy Ministry incorporated a 12% target for both electricity and thermal supply into its Electricity Policy Paper and also established the National Energy Efficiency and Renewable Energy Action Plan (NEEREA). This paper emphasized the support for public, private, and individual initiatives to adopt renewable energy sources and achieve the aforementioned 12% target for both electricity and thermal supply.

In 2011, efforts were made towards enforcing a monthly tariff for diesel generators, protecting consumers from overbilling, and holding violators accountable were implemented. Previous attempts to regulate the electricity industry in Lebanon have been largely unsuccessful. The relevant ministries failed to take action, resulting in consumers continuing to pay unregulated and often inflated flat monthly tariffs set by generator owners. Similarly, subsequent decisions, including emission limits for generators and an income tax on commercial diesel generator owners, were not enforced.[287]

In 2013, the government initiated a tender for the construction of the first wind farms as part of efforts to diversify into renewable energy sources.

In 2016, the Ministry of Energy developed the second National Energy Efficiency Action Plan (NEEAP 2016-2020) to address energy efficiency issues. The NREAP provided pathways to achieve the 12% target and highlighted the vast potential for solar farms, which could generate over 87.6 gigawatts of power output, far exceeding Lebanon's 2010 power demand.288 The NREAP only aimed for 150 megawatts of solar installation and an additional 100 megawatts through distributed generation by 2020. The plan also outlined targets for wind power, hydropower, and geothermal energy. Despite these goals, Lebanon fell short of its renewable energy targets, and by 2019, renewables accounted for only 7.8 % of total electricity generation, a modest increase from 5.2 % in 2010.[289]

In 2017, the Council of Ministers approved a five-year strategy for the electricity sector, building upon a previous plan from 2010. This strategy aims to address the gap between electricity generation and demand, tackle transmission and distribution issues to enhance accessibility and reliability, focus on energy efficiency measures, and promote the utilization of renewable energy sources.[290]

In 2017, tenders were launched for the installation of solar power plants, reflecting Lebanon's growing interest in transitioning towards cleaner and more sustainable energy options.[291]

In 2018, then-Minister of Economy Raed Khoury issued a circular requiring generator owners to install metering systems for their subscribers and adhere to the tariff set by the Ministry of Energy. This time, the ministries took action by imposing fines on non-compliant generator owners, confiscating generators, and questioning some owners. Many generator owners opposed the new pricing structure, claiming it would negatively impact their profits. They resorted to measures such as suspending services, leading to widespread blackouts. Some generator owners were reported to tamper with meters or coerce subscribers into signing waivers and paying the previous flat fee. While the Ministry of Economy claimed progress with meter installation and reduced invoices, metering and pricing issues persisted, and many generator owners continued to charge inflated fixed fees. Approximately 70% of households using neighborhood generators currently receive meter-based bills. In September 2021, amidst severe EDL blackouts and surging diesel prices, the government once again attempted to mandate meter installation and charging based on Energy Ministry rates, but with limited success.[292]

In 2017, the Council of Ministers approved two Nationally Appropriate Mitigation Actions (NAMAs) targeting the transport and municipal solid waste sectors. These actions aim to promote the use of fuel-efficient and hybrid vehicles. Also, three companies were granted licenses to generate wind energy, and over forty bids were received by the government for the construction of solar plants. Various renewable energy bids were initiated, aiming for a total cumulative installation of 1,680 to 1,970 megawatts of renewable energy capacity by 2025.

[286] Ibid.

[287] Ibid.

[288] Ibid.

[289] Ibid.

[290] Lebanon. 2018. Voluntary National Review (VNR) on Sustainable Development Goals (SDGs). New York: United Nations.

[291] Ibid.

[292] Human Rights Watch, 2023

In 2018 the prime minister set a more optimistic goal of 30 % of electricity consumed from renewables by 2030. Despite the limited progress in achieving the 12 % target, the prime minister announced in 2018 a more optimistic but still insufficient goal of 30 % of electricity consumed from renewables by 2030. This was reflected in the 2019 electricity reform paper issued by the Ministry of Energy.

In April 2018, Lebanon implemented a law on air quality protection. The law establishes emission standards, roles, responsibilities, and penalties for polluters. Additionally, article 55 of the 2018 National Budget Law provides customs and registration reductions for hybrid and electric cars.[293] As part of its commitments under the Paris Agreement, Lebanon has set targets for public transport mode and fuel-efficient vehicles by 2030. Tax exemptions on electric and hybrid vehicles have been implemented, aligned with article 55 of the 2018 National Budget Law.

In 2019, Parliament tried to tax the sector, requiring generator owners to pay an annual fee based on their electricity generation capacity. Generator owners rejected the tax, arguing that it would significantly impact their profits and warned of non-compliance. This tax proposal was never implemented. The influential role of the generator industry and its financial stakes help explain the sector's resistance to reform and the government's perpetuation of policies that maintain Lebanon's dependence on oil.

Lebanon ratified the Paris Agreement in March 2019. By doing so, Lebanon committed to limit global warming below 2 degrees Celsius.[294] Lebanon updated its 2020 NDC under the Paris Agreement. The country reaffirmed its commitment to achieve 18 % of its power demand from renewable energy sources by 2030, with a conditional target of reaching 30 %.[295]

In March 2022, the Lebanese government approved a policy paper for the electricity sector. The Lebanese government did so with the aim to increase the daily supply of electricity from 2 hours to 8-10 hours in the first half of 2022, and eventually to 16-18 hours per day by 2023. The plan also includes a commitment to building renewable energy power plants through public-private partnerships (PPPs) and achieving a 15 % share of the energy mix from renewables.[296] The plan primarily relies on importing fossil fuel-fired electricity from Jordan and methane gas from Egypt, even in the medium and long term. Renewable energy sources are seen as a last resort and remain limited in Lebanon's energy mix. This approach risks locking in fossil fuel generation capacity and hindering the integration of renewables in the future.[297]

As of January 2023, the government had made limited progress in increasing electricity generation and meeting its targets. Residents were still receiving less than three hours of state electricity per day. [298]

The latest policy paper to reform the electricity sector was approved in March 2022. Since 2010, the government has approved three policy papers to reform the electricity sector, but implementation has been lacking. The latest plan, approved in March 2022, sets ambitious targets for improving electricity supply. [299]

On November 3, 2022, the board of directors of EDL issued decision number 420-26/2022, outlining the pricing structure of the new tariff. The new tariff will be implemented gradually once the electricity supply reaches a duration of eight to ten hours per day.

In 2022, the Lebanese government made the announcement that it would reorganize its electricity sector, and that the ERA is going to be a key stakeholder in it. It is not clear when the ERA will be established, or what its powers will be. As part of the reform efforts in the sector, the plan includes the appointment of members to the ERA. The latter is an independent oversight body responsible for regulating and setting tariffs, issuing licenses, promoting transparency, and fostering competition in the sector. Additionally, the plan aims to open up opportunities for private sector investment in EDL.[300]

Strategies and Initiatives related to the industrial sector:

In Lebanon, the promotion of Sustainable Consumption and Production (SCP) in the industrial sector is underpinned by the Environment Protection Law (444/2002) and its associated decrees, focusing on cleaner production, biodiversity conservation, natural resource preservation, pollution monitoring, and recycling enhancement.

[293] Lebanon. 2018. Voluntary National Review (VNR) on Sustainable Development Goals (SDGs). New York: United Nations.

[294] Human Rights Watch, 2023

[295] Ibid.

[296] Ibid.

[297] Ibid.

[298] Ibid.

[299] Ibid.

[300] Ibid.

The collaborative efforts between the Ministries of Environment and Industry culminated in the development of Lebanon's Action Plan for SCP in 2015, aiming to integrate SCP into policy frameworks, bolster consumer education on SCP, and dissociate economic growth from environmental strain. Noteworthy initiatives include "Lebanon Industry 2025" and the 2016-2020 executive strategy, emphasizing the adoption of green industry practices as pivotal for sustainability. This strategic direction is further evidenced by policies mandating green industry standards for operational permits and efforts to align existing industries with environmental laws. Additionally, the Lebanon Environmental Pollution Abatement Project, launched in 2014, provides technical assistance and financial incentives to industries for enhancing environmental compliance, marking a significant step towards operationalizing SCP and reinforcing environmental stewardship in Lebanon's industrial sector.301

In 2022, Lebanon made strides in renewable energy with the Council of Ministers approving a draft law for distributed power generation, introducing a peer-to-peer net metering system for solar energy owners to earn credits for surplus electricity. Awaiting parliamentary adoption, this initiative complements efforts to organize and enhance industrial zones and develop sustainable ones nationwide.[302]

3.3.2.3 Powering the transition: a focus on financing

In November 2011, the Council of Ministers approved the first National Energy Efficiency Action Plan for 2011-2015 (NEEAP 2011-2015) as a national financing mechanism in collaboration with the Central Bank to incentivize investments in renewable energy. This mechanism seeks to provide subsidized loans with a low interest rate of 2.5 % for renewable energy and energy efficiency projects.[303]

Following the economic crisis that began in October 2019 and the subsequent devaluation of the Lebanese pound, the government implemented a new fuel import subsidy. This involved the Central Bank providing importers with dollars at rates lower than the actual value of the currency. It was estimated that this policy cost the state approximately $3 billion annually. The subsidy ended in August 2021 due to the Central Bank's lack of funds. Despite the intention of ensuring affordable fuel supply in Lebanon, the country experienced severe diesel shortages, leading generator owners to ration their supply. The shortages were attributed to smuggling to Syria, where the subsidized fuel was sold at higher prices. In fact, in 2021, the state spent more on diesel imports for generators than on fuel for EDL, according to an analysis by L'Orient Today newspaper. [304]

Lebanon relies on costly heavy fuel oil and diesel for power generation. The financial challenges faced by EDL can be attributed, in part, to the high costs associated with electricity production and inadequate cost-recovery mechanisms. The country's aging and inefficient power plants operate below their capacity, resulting in reduced electricity output. Additionally, the country's cost-recovery rate remains extremely low due to artificially low tariffs that have remained unchanged since 1994. Moreover, inadequate maintenance practices contribute to high technical losses, and widespread electricity theft and non-payment of bills further exacerbate the financial viability of the sector.[305]

Between 2010 and 2021, the Lebanese government spent $10 billion on diesel imports for generators. This accounts for 40 % of the country's total fuel bill for electricity and produces approximately 33 % of electricity. These private fuel importers have benefited from state policies that reinforce Lebanon's reliance on fuel imports, including diesel. They have increased their market share and received subsidies from the government through various means, such as cash transfers, VAT exemptions on diesel, and maintaining the Lebanese pound's peg to the US dollar. The fuel subsidy regime allowed companies to sell fuel at lower prices, with the government covering the difference and allowing for profit margins.[306]

The government provides a universal subsidy on energy prices, aimed at supporting all income brackets, including the poorest households. Consequently, one of the significant expenditures in the government's budget is the annual transfer of funds to the national utility, EDL, to cover its deficit. This payment has amounted to nearly USD2 billion per year since 2002. The deteriorating condition of infrastructure, coupled with inadequate maintenance practices, has resulted in outdated generation technologies, an inefficient transmission network, and significant technical losses.

[301] Lebanon. 2018. Voluntary National Review (VNR) on Sustainable Development Goals (SDGs). New York: United Nations.

[302] Human Rights Watch, 2023

[303] Ibid.

[304] Ibid.

[305] Ibid.

[306] Ibid.

3.3.2.4 Powering sustainable jobs: employment opportunities in renewable energy

The renewable energy industry in Lebanon is growing, leading to a multitude of job openings in this sector. As stated in the 2018 Voluntary National Review on Sustainable Development Goals (SDGs) for Lebanon, it is projected that the renewable energy field will generate more than 10,000 employment prospects by 2030.[307] The socio-economic aspect of renewable energy holds great significance for developing nations aiming to optimize the advantages of the transition, particularly in terms of job opportunities and local value generation. Upon the initiation of renewable energy projects in Lebanon, EDL established a specialized taskforce to supervise the generation of renewable energy.[308]

As stated in the 2019 CEDRO report, the service sector of the Lebanese economy is highly developed. This indicates potential for domestic involvement in various aspects of renewable energy technologies. This includes job opportunities in design and planning, installation, transportation and logistics, as well as operation and maintenance. Additionally, the robust research and science sectors in Lebanon are well-equipped to contribute essential services for the advancement of renewable energies.[309]

According to UNDP-CEDRO, the number of university graduates with qualifications in renewable energy technologies (RET) is theoretically sufficient to meet the local demand for professional staff. With 1,500 RET graduates, there are actually more graduates available than required for the current RET workforce. Manufacturers and importers are facing challenges in finding workers with lower-level expertise, specifically skilled workers and technicians, who make up the majority of their workforce. This shortage is not unique to Lebanon but is a global issue. Due to the relatively small industrial base in Lebanon, there is a limited pool of trained workers who can be readily assigned to such roles. Since RET is still relatively new in the local market, there is a general lack of experience and knowledge, which necessitates significant investment in employee training by companies.[310]

Various measures are required to facilitate the implementation of renewable energy (RE) projects and stimulate job creation in Lebanon. According to the UNDP's "Renewable Energy Sector in Lebanon" report, there is a potential for creating approximately 25,000 job opportunities from the adoption of renewable energy systems in the coming years.[311] The choice of renewable energy sectors examined in this research has been based on considering the job creation potential of each technology, their ability to address the existing challenges of the Lebanese energy system, and their feasibility in terms of implementation. The study has focused on three specific value chains for a detailed evaluation, namely: solar photovoltaic (PV), wind energy, and bioenergy.[312]

According to the UNDP report, the majority of positions generated in renewables are concentrated in the photovoltaic (PV) sector. These positions encompass both distributed and large-scale PV installations. The primary job opportunities arise during the installation phase, which are typically temporary in nature. A series of installations can potentially transform these temporary roles into long-term careers. This is supported by the rise in employment within private sector companies. Solar PV is an established sector in Lebanon with a considerable presence of competitive private companies. There is still significant room for growth in this sector. This expectation is reinforced by the government's plans to expand the installed capacity of solar PV technology, as evidenced by the ongoing processes of signing Power Purchase Agreements (PPAs) for large-scale solar farm installations. Moreover, solar PV is seen as a means to decentralize power supply, aligning with the increasing market interest in such installations. These factors have led to prioritizing solar PV as a sector with promising prospects for future job creation. On the other hand, in already mature technologies like solar water heaters, further domestic value creation opportunities have been largely exhausted. Growth in this field is expected to arise from new production and installation projects.[313]

The employment demand in the solar energy sector in Lebanon has witnessed a significant rise due to the increased number of solar projects. Companies are expanding their teams to ensure timely completion of projects, leading to an increased demand for both engineers and technicians. To address this surge in demand, companies like ACEMCO are employing technicians on a project basis to meet the considerable workforce requirements. According to a study conducted by IRENA, the solar energy sector in

[307] Lebanon. 2018. Voluntary National Review (VNR) on Sustainable Development Goals (SDGs). New York: United Nations.

[308] IRENA (2020), Renewable Energy Outlook: Lebanon International Renewable Energy Agency, Abu Dhabi.

[309] CEDRO. (2019). Energy Value Chain Report 2019.

[310] USAID/Community Support Program (CSP) in Lebanon. (2022, April 28).

[311] Ibid.

[312] CEDRO. (2019). Energy Value Chain Report 2019.

[313] Ibid.

Lebanon has the highest number of employees compared to other renewable energy technologies.[314]

Bioenergy has not received significant emphasis in Lebanon's previous development efforts nor has it been prioritized in the government's long-term plans. Bioenergy holds substantial potential for synergies with other sectors including forestry, agriculture, water treatment, and waste management. In terms of job creation, bioenergy technologies that require fuel offer the largest share of permanent employment opportunities. The deployment of biogas, in particular, has the potential to generate a significant number of permanent jobs. Due to the lack of refined waste management strategies in Lebanon, which encompass incineration, waste-to-biogas conversion, and other utilization methods, there are no modeled employment figures related to waste collection.[315]

3.3.3 Exploring the landscape of micro, small, and medium-sized enterprises (MSMEs)

3.3.3.1 Examining the profile of micro, small, and medium-sized enterprises (MSMEs) and their engagement with renewable energy: policies, adoption, and access to climate finance

MSMEs have a crucial presence in Lebanon's economy, constituting approximately 90% of all businesses. Similarly, in the energy sector, MSMEs hold a significant position. They contribute substantially to both energy production and consumption in the country, while also serving as a prominent generator of employment opportunities.[316] The renewable energy industry in Lebanon is experiencing rapid growth, presenting MSMEs with an opportunity to participate in this expanding market. There are several challenges that hinder their engagement in the energy sector and hinder a fair energy transition. These challenges include high energy costs, limited access to financing, and a lack of technical expertise. The elevated cost of energy in Lebanon creates a competitive disadvantage for MSMEs compared to larger enterprises. Moreover, MSMEs often face difficulties in securing financial resources to invest in energy-efficient technologies. Additionally, a shortage of technical skills within MSMEs poses obstacles to the installation and maintenance of energy-efficient systems.[317]

The Lebanese government is actively assisting MSMEs operating in the energy sector by offering tax incentives and financial support. Furthermore, there is a growing market demand for energy-efficient solutions in the country. This presents MSMEs with a favorable prospect to supply energy-efficient products and services.[318]

Here are a few instances of Lebanese MSMEs involved in the energy sector:

- Solef is a company specializing in solar energy solutions, offering a range of products and services such as solar panels and solar water heaters.[319]
- Eco Green is an MSME operating in the renewable energy sector in Lebanon. They specialize in offering renewable energy products and services, including wind turbines, solar panels, and other related solutions. [320]
- Energy Efficiency Lebanon is an MSME-focused non-profit organization in Lebanon that offers specialized training and consultancy services in the field of energy efficiency. [321]

3.3.3.2 Assessing the drivers and impediments for MSMEs in adopting renewable energy technologies: country-level analysis

The adoption of renewable energy (RE) technology by micro, small, and medium enterprises (MSMEs) faces various drivers and impediments in each country. In Lebanon, the high unemployment rate, exacerbated by the Syrian crisis, has pushed many Lebanese individuals into poverty and increased the number of unemployed individuals. Informal waged employees constitute a significant share of the labor force, with more than 70 % of the labor force being either formally or informally employed. Micro and small enterprises make up the majority of companies in Lebanon, and efforts have been made to create an enabling environment for entrepreneurship and SME development through legislation and access to financing.

[314] USAID/Community Support Program (CSP) in Lebanon. (2022, April 28).

[315] CEDRO. (2019). Energy Value Chain Report 2019.

[316] USAID/Community Support Program (CSP) in Lebanon. (2022, April 28).

[317] Ibid.

[318] Ibid.

[319] Solef, n.d.

[320] Eco Green, n.d.

[321] Energy Efficiency Lebanon, n.d.

The formalization of micro and small enterprises has been limited, with the majority falling under the classification of microenterprises. The Ministry of Economy and Trade in Lebanon recognizes the importance of SMEs as an economic engine for growth and has developed a national SMEs strategy to support their development. This strategy aims to promote innovation, ensure business viability, sustainability, and competitiveness, and address financing gaps through a national job creation program. Various organizations, including the Central Bank of Lebanon, Kafalat, and the Investment Development Authority, provide support and subsidies for SMEs in productive sectors, research and development, and investment promotion.

3.3.4. Drawing the final threads: a resolute conclusion

Despite Lebanon's abundant renewable energy potential, the country's current energy mix heavily relies on fossil fuels, leading to detrimental impacts on public health, climate change, and the economy. Despite government commitments to increasing the share of renewable energy, progress in this regard has been limited. Lebanon possesses abundant renewable energy potential, particularly in solar and wind resources. While solar photovoltaic (PV) systems have experienced significant growth, wind energy remains underutilized.

While the country is actively exploring its first oil and gas reserves, it has also made commitments to reduce greenhouse gas emissions by at least 15% by 2030, with the potential to achieve up to a 30% reduction with the support of international partners. Notably, the electricity sector in Lebanon contributes to over 53% of the national greenhouse gas emissions, and a significant share of the energy supply, approximately 98%, still heavily relies on imported fossil fuels.[322]

Nevertheless, despite the government's pledges to enhance the proportion of renewable energy in Lebanon's energy portfolio, the contribution from renewable sources in 2019 stood at a mere 3 %. This contributes to Lebanon's fiscal deficit by requiring costly purchases of fossil fuels with valuable foreign currency reserves, leaving consumers vulnerable to price fluctuations.[323]

The existing energy supply framework, dominated by Electricite du Liban (EDL) as the sole provider, lacks consideration for the well-being of future generations in Lebanon.[324] The electricity sector imposes significant financial strain on Lebanon's public finances. In 2017, EDL incurred an operating loss of USD 1.4 billion, and the subsidies provided to the sector between 2008 and 2017 amounted to nearly half of Lebanon's total external debt (World Bank, 2019). EDL's tariffs are still based on the 1996 fuel cost of USD 23 per barrel of oil, covering only 37% of the average operating cost in 2018. Despite substantial subsidies, the electricity supply remains inadequate to meet the demand.[325]

Potential, the untapped possibilities lying ahead, holds the key to Lebanon's energy future.

Solar energy presents a viable and sustainable solution to address electricity rationing in Lebanon, particularly during daylight hours, providing an alternative to power cuts and diesel generators. The country's solar photovoltaic (PV) sector has gained traction, boasting more than 100 competitive companies, and it holds promise for further expansion. With abundant solar PV energy production, Lebanon has the potential to complement it with wind power, addressing its energy shortage dilemma. Yet it seems that policymakers in Lebanon seem to underestimate the significant potential of solar PV in enhancing energy security, optimizing energy billing, and reducing the dependence on fossil fuels for electricity generation.[326] Lebanon has already demonstrated its capacity for market development in renewable energy systems, with 38 % of solar water heating (SWH) systems installed being partially or entirely manufactured within the country. This success indicates promising prospects for further advancement and growth in other renewable energy systems.[327]

Transitioning to renewable energy sources in the long term is expected to result in cost-saving advantages. The main hurdle in achieving a fully renewable energy-based system is the associated costs, which are currently high. Nevertheless, solar photovoltaic (PV) and wind power offer a more economical alternative to Lebanon's current reliance on costly diesel and gas. Solar PV, in particular,

[322] Da Silva, A.J.C., do Amaral, J.C.B., Silva, A.A.C., & Oliveira, P.V.P. (2020). A review of the application of machine learning in renewable energy forecasting. Energy, 195, 117163. doi: https://doi.org/10.1016/j.energy.2020.117163

[323] Human Rights Watch, 2023

[324] da Silva, A.J.C., do Amaral, J.C.B., Silva, A.A.C., & Oliveira, P.V.P. (2020). A review of the application of machine learning in renewable energy forecasting. Energy, 195, 117163. doi: https://doi.org/10.1016/j.energy.2020.117163

[325] Ibid.

[326] Ibid.

[327] Ibid.

stands out for its notably lower generation cost per kilowatt-hour compared to diesel and nuclear power. Moreover, in most cases, solar PV and wind power prove to be more cost-effective than gas-fueled power plants.

Lebanon possesses considerable bioenergy resources, with approximately one-third of its land being arable. Incorporating these local resources and biofuels is a crucial element in Lebanon's renewable energy transition, which unfortunately, the government has yet to acknowledge adequately. [328]

According to a study conducted by IRENA and UN ESCWA in 2018, Lebanon possesses strong capabilities in local manufacturing, particularly in industries such as electronics, steel, aluminum, and plastics, which can stimulate the renewable energy (RE) sector. The country's universities also offer relevant programs focused on RE research, providing technical expertise and fostering the potential for local integration and manufacturing of RE technology.

Given the unreliability of the current electricity supply, decentralized RE systems emerge as a feasible, cost-effective, and sustainable solution. The costs of RE technologies are lower than those of diesel generators and the average expenses incurred by EDL for energy distribution and generation. While legal and political obstacles hinder large-scale RE projects, the prospects for Lebanon's RE transition and future prosperity lie in community-led, decentralized initiatives.[329]

Lebanon has recognized agriculture, infrastructure, and the environment as sectors that offer employment opportunities for displaced individuals. This underscores the significance of investing in and implementing renewable energy (RE) infrastructure as a means of providing employment solutions in the country. An assessment of the RE technology value chain in Lebanon indicates that the deployment of RE technologies could potentially generate around 20,000 jobs by 2021, with the majority of these opportunities emerging in the solar photovoltaic (PV) sector.[330]

Hurdles, formidable challenges to overcome, stand in the way of Lebanon's energy ambitions.

Traditional sectors in Lebanon face difficulties in terms of job creation and export decline. Lebanon has implemented development-oriented strategies to support traditional sectors like agriculture and industry, aiming to increase productivity while minimizing environmental degradation. These sectors were challenged especially following the Syrian conflict particularly in job creation and export decline following the Syrian conflict. Overall, while there are challenges, Lebanon has been working on creating a supportive environment for MSMEs and renewable energy adoption, with various initiatives, financing options, and public-private collaborations in place.

EDL does not directly compensate consumers for their net energy production; instead, it credits any surplus energy to the following bill. In 2011, EDL implemented a net-metering policy aimed at promoting solar energy adoption among households, and later extended it to communities in 2016. While over 50 projects are now connected to the net-metering network, the policy's effectiveness is hindered by the absence of meters at EDL, which necessitates manual calculations for net amounts.[331]

The institutional and legal frameworks in Lebanon lack clarity and essential components, leading to challenges in implementing reforms due to political fragmentation. The delayed implementation of a legal framework for privatization, liberalization, and unbundling of the sector has resulted in limited progress. As a result, EDL still retains a monopoly in generation, transmission, and distribution under existing decrees. The absence of a legal regulator to set prices and facilitate communication between the government and private power producers adds to the complexity. Currently, the responsibility for assigning PPAs lies with the CoMs, but the government's approach to resolving this issue remains unclear, causing uncertainty and hindering significant investments in utility-scale renewable energy projects. That being said, the government's recent request to join the Extractive Industries Transparency Initiative indicates a positive step toward addressing this concern.[332]

Another obstacle to Lebanon's transition to renewable energy is the strong influence of vested interests in the economy, particularly in oil imports, and the entrenched power of private generator owners. The majority of profits in this sector go to fuel importers, while generator owners also benefit significantly from the existing system and have a vested interest in maintaining the status quo.[333]

[328] Ibid.

[329] Ibid.

[330] Ibid.

[331] Ibid.

[332] Ibid.

[333] Human Rights Watch, 2023

New residential buildings are constructed with designated spaces for generators, leaving new tenants with little choice but to accept this informal arrangement. This close association between private generators and daily life showcases the adaptability of the population in seeking access to this essential service.

Lebanon hosts a significant refugee population, representing further strain to the nation's already limited energy resources.

The establishment of large-scale wind farms requires substantial technical expertise and significant investments, necessitating considerable government support. To address land constraints and foster public acceptance of the technology, smaller-scale wind farms or individual turbines could be employed, engaging citizens more actively in the process.[334]

The lack of established legal and physical infrastructure poses challenges in managing market ownership and structure effectively. The potential discovery of natural resources has sparked significant investment interest and political discussions. If domestic gas reserves are found, they could reduce the country's dependence on imports and lower emissions. Initially, the gas market is expected to rely on imports, which may later be partially replaced by locally sourced gas. This is hindered by the wanting legal and physical infrastructure.[335]

The deployment of RE is hindered by the presence of low and non-cost-reflective electricity tariffs, mainly due to the extended amortization period required. EDL faces challenges in increasing tariffs, as it depends on reliable infrastructure and grid systems, which are currently lacking due to financial constraints. As a result, EDL's financial deficit and bankability issues pose risks for potential investors in large-scale RE projects. Additionally, the absence of a dedicated department within EDL for integrating RE into the national grid and the lack of internationally recognized grid codes further complicate the situation.[336]

Large scale renewable energy RE projects still face limitations in obtaining financing. While the NEEREA provides support for new and existing energy-efficient, RE, and sustainable building initiatives, it mainly focuses on subsidizing loans for environmentally friendly projects intended for individual consumption. Unfortunately, this means that financing for large scale RE projects aimed at independent power production is restricted under the NEEREA scheme.[337] Despite government efforts through action plans and policies to promote renewable energy adoption, the unregulated nature of the solar PV market and the substantial upfront costs pose challenges to progress.

Additionally, the continued dependence on importing fossil fuel-fired electricity remains a primary strategy, which could hinder the seamless integration of renewables in the future. To effectively address the energy crisis, Lebanon needs to prioritize the implementation of renewable energy projects and reduce its reliance on fossil fuels.

In the realm of business and economic growth, MSMEs play a vital role as small and medium-sized enterprises with significant potential for innovation and job creation.

Burdensome administrative procedures pose a challenge to maximizing the benefits of loans aimed at supporting SMEs in Lebanon. Despite the availability of favorable loan schemes, there is a need to address these administrative hurdles to ensure successful risk allocation for both large-scale and small-scale projects. Moreover, local banks show limited interest in funding small-scale distributed projects due to high transaction costs, which hinders the widespread adoption of decentralized applications in the residential sector, despite the increasing size of renewable energy projects in Lebanon.[338]

The private sector's uptake of renewable energy (RE) is hindered by unattractive tariffs and a complicated administrative framework. Existing concessions for large-scale hydropower installations, predating the establishment of EDL, present two primary challenges: the need for a reassessment of the administrative framework and the inadequacy of current tariffs to incentivize efficient production. Although the tariff for the Litani River Authority was increased from USD 0.03 to 0.04 per kWh in 2017, it still remains relatively low.[339]

The economic crisis of 2019 had an impact on loans meant to support SMEs in their transition. To address this, a new credit line called LEEREFF was established through collaboration between the European Investment

[334] da Silva, A.J.C., do Amaral, J.C.B., Silva, A.A.C., & Oliveira, P.V.P. (2020). A review of the application of machine learning in renewable energy forecasting. Energy, 195, 117163. doi: https://doi.org/10.1016/j.energy.2020.117163

[335] Ibid.

[336] Ibid.

[337] Ibid.

[338] International Renewable Energy Agency (IRENA). (2020). Renewable Energy Outlook: Lebanon.

[339] Ibid.

Bank (EIB), the Agence Française de Développement (AFD), and the Lebanese government. The LEEREFF initiative aimed to provide EUR 80 million in global loans to facilitate small-scale investments in energy efficiency and renewable energy projects, particularly targeting SMEs. The disbursement of loans came to a halt after 2019 due to the prevailing economic crisis.[340]

NEEREA, the sole green financing mechanism in the Arab region offering substantial loan limits, aims to provide loans to SMEs to support their transition to renewable energy. The approval process for loan funds can be lengthy. The NEEREA program supports the private sector, including individuals, small and medium enterprises (SMEs), and corporate entities, in obtaining subsidized loans for renewable energy and energy efficiency projects. These loans come with favorable interest rates, as low as 0.3% and a repayment period of 14 years, including a two-year grace period for new projects. All private sector entities are eligible to apply for these subsidized loans, which are dispersed through commercial banks for easier accessibility to end-users. The allocation of funds for loans is contingent upon LCEC's technical approval after studying and reviewing the projects.[341]

3.4. Morocco

Morocco, despite possessing commendable energy efficiency programs and low greenhouse gas emissions per unit of GDP, grapples with energy resource scarcity and heavy reliance on imports. The country's electricity production continues to be predominantly polluting, presenting economic energy efficiency challenges within the global landscape. The recovery of the Moroccan Saharan provinces following Spanish decolonization strains regional relations, compelling Morocco to collaborate with neighboring countries and prioritize the development of renewable energy sources as its only proven resource. While large-scale renewable plants gradually address pollution concerns stemming from coal-fired power facilities, the scheduled shutdown of these coal plants is not expected until 2044 due to existing purchase power agreements. Moreover, the potential of biomass renewable energy remains largely untapped. Nonetheless, the combination of decentralized solar photovoltaic energy and drip irrigation has yielded significant benefits, such as safeguarding agricultural production and farmers' income, reducing water waste, diversifying cultivable land, and enhancing food self-sufficiency.

Morocco is currently facing a critical moment where it must address multiple interconnected challenges simultaneously. These challenges include increased vulnerability to a changing climate, as evidenced by recent droughts in 2019-20 and 2022. The country also requires urgent structural reforms to establish a more stable, fair, and sustainable development trajectory. Furthermore, Morocco faces significant fiscal constraints that limit its capacity to respond effectively to the aforementioned challenges.[342] Climate change disrupts the water cycle, leading to detrimental effects on economic growth and people's livelihoods. Water resources play a vital role in the Moroccan economy as a fundamental factor of production across various sectors. The changing availability and variability of water due to climate change are likely to hinder the country's economic prospects and pose a risk of exacerbating inequality and compromising social sustainability.[343]

3.4.1. Exploring the interplay of demographics and identities: dynamics and implications

Climate change poses a development challenge to the Moroccan economy, as it increases the vulnerability of key sectors to environmental factors such as higher temperatures, rising sea levels, and reduced rainfall. The agricultural sector, which contributes 15% to the country's GDP, suffered significant setbacks in 2016 due to regional droughts, resulting in a sharp decline in cereal production and a GDP growth rate of only 1.1%.[344] In response, Morocco introduced its National 2030 Climate Plan in 2019, which aims to enhance the resilience of vulnerable sectors like water, agriculture, and fisheries, while also mitigating greenhouse gas emissions from industries such as power generation and transportation. The successful implementation of this plan will require substantial investment, estimated at approximately USD 50 billion for mitigation programs and an additional USD 35 billion for

[340] Ersoy, S.R., Terrapon-Pfaff, J., Ayoub, M., & Akkouch, R. (2021). Sustainable Transformation of Lebanon's Energy System.

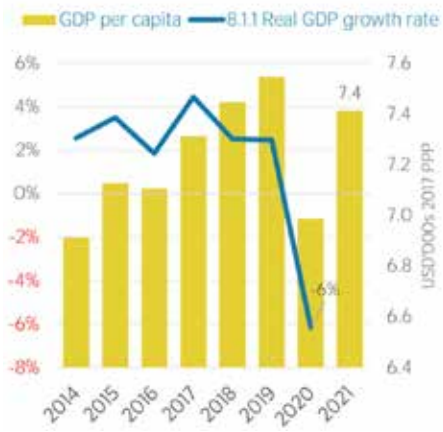
[341] Ibid.

[342] World Bank Group. (2022). Morocco Country Climate Development Report. Washington, DC: World Bank. https://www.worldbank.org/en/country/morocco/publication/morocco-country-climate-and-development-report

[343] Ibid.

[344] UNEP FI. (2021). Promoting Sustainable Finance and Climate Finance in the Arab Region. https://www.unepfi.org/wordpress/wp-content/uploads/2021/01/Sustainable-Arab-Finance-Report-Jan-2021.pdf

Figure 23. GDP per capita and Real GDP growth rate



Source: IRENA Morocco Energy Profile , 2020

adaptation projects by 2030.[345] Morocco's population was 33.01 million in 2013. [346]

Morocco is experiencing severe impacts from climate change, and was classified as a climate hotspot, where it has witnessed significant warming trends since the 1960s, surpassing the global average with average increases of 0.2°C per decade. This includes rising temperatures, reduced snowpack, erratic precipitation, increased drought conditions, intense rainfall events, rising sea levels, and ocean acidification. These climatic conditions are affecting various sectors such as agriculture, water resources, tourism, coastal zones, and ecosystems. The country's main concern is the effect on its limited and diminishing water resources. With population growth, expanded irrigation schemes, and tourism, the demand for water is expected to increase while water resources are projected to decline due to drought conditions. Water shortages are anticipated by 2020.[347]

The intricate nexus between water and energy management plays a pivotal role in Morocco's development agenda. Recognizing the interdependencies between water and energy systems has become essential for the country's progress. Water plays a vital role in every stage of energy production and electricity generation, while energy is indispensable for water extraction, transportation, treatment, and wastewater management before its return to the environment or reuse. Effectively managing the water-energy nexus is paramount for sustainable development in Morocco.[348]

While Morocco's greenhouse gas (GHG) emissions have increased in recent decades, they remain relatively small. The energy sector, as the primary contributor to emissions, has rightly focused on decarbonization efforts through the development of renewable energy sources. The progress in decarbonization has been hindered by the expanding use of coal for power generation.[349]

The consequences of climate change are devastating lives and livelihoods in Morocco, particularly for women who bear the brunt of these impacts. Women play a central role in household survival and management, as well as in the agriculture sector as workers. They face challenges such as increased distances to fetch water and firewood, loss of income and harvests, and heightened poverty due to climate-related factors. Women are actively engaged with NGOs in efforts to mitigate and adapt to climate change. One example is the women-led NGO called Dar Si Hamad, which has made significant progress in solving water scarcity through innovative initiatives like "fog farming." As a result, women have gained valuable time previously spent on water fetching, which they are now investing in economic activities such as argon oil production.[350]

Morocco is recognized as the third-best performer on the Climate Change Performance Index, following Sweden and Lithuania. The country places great emphasis on conserving its ecosystems and addressing climate risks, focusing on two key pillars: respect for human rights and gender balance. In line with this, one of Morocco's Intended Nationally Determined Contributions (INDCs) includes the establishment of a monitoring and assessment system that considers gender issues in vulnerability and adaptation to climate change.[351]

Morocco's approach highlights the recognition of the important role women play in climate action and their inclusion in decision-making processes.[352] To promote gender equality in the environment and sustainable development sectors, the Ministry of Solidarity, Women, Family, and Social Development collaborated with UN Women to develop a gender equality plan. This plan

[345] Ibid.

[346] United Nations Environment Programme. (2019). Energy profile Morocco. [PDF]. Retrieved from https://wedocs.unep.org/bitstream/handle/20.500.11822/20524/Energy_profile_Morocco.pdf?sequence=1&isAllowed=y

[347] World Bank Group. (2022). Morocco Country Climate Development Report. Washington, DC: World Bank. https://www.worldbank.org/en/country/morocco/publication/morocco-country-climate-and-development-report

[348] Ibid.

[349] Ibid.

[350] Ibid.

[351] Ibid.

[352] Ibid.

aims to ensure the active involvement of women in addressing climate change challenges and opportunities. Morocco's government expressed solidarity and support for women's positive contributions to the fight against climate change during the COP 21 Gender Day.[353]

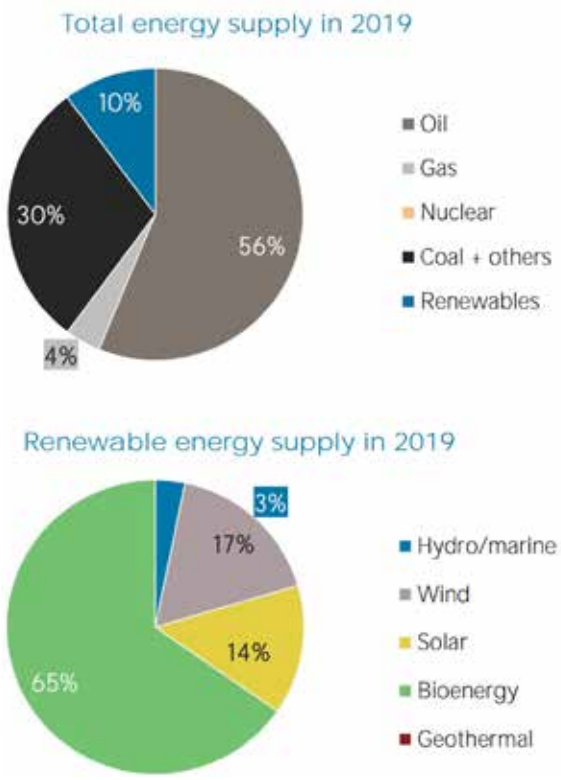
3.4.2 Energy outlook: trends, challenges, and future prospects

3.4.2.1 Analyzing energy trends: understanding energy demand, efficiency, sectoral distribution of consumers, and energy supply

Morocco has experienced a consistent increase in energy demand in recent years, driven by various factors such as population growth, economic development, and urbanization. In 2021, the country's total primary energy demand reached 22.6 million tonnes of oil equivalent (Mtoe), marking a 7.5% rise compared to the previous year. Notably, the industrial sector constituted the largest share of energy demand in Morocco, accounting for 41% in 2021. The phosphate industry, cement industry, and metalworking industry are the primary consumers of energy within the industrial sector. The residential sector ranks as the second largest energy consumer, representing 34% of the total energy demand. This sector primarily utilizes energy for cooking, heating, and lighting purposes. In the transportation sector, which occupies the third position in energy consumption, 17% of the total energy demand is attributed to road transportation, rail transportation, and air transportation. Additionally, the remaining 8% is allocated to the "other" sector, encompassing energy uses in agriculture, commercial and public services, as well as non-energy applications.[354]

Morocco's power sector remains one of the most carbon-intensive sectors globally. Despite efforts to harness Morocco's considerable RE potential, the commissioning of three new coal power plants during the 2010s expanded the total coal-fired power capacity to over 4GW, representing 39 % of the country's total power generation capacity in 2021. Consequently, the carbon intensity of the power sector has continued to rise, making Morocco's power sector one of the most carbon-intensive globally, emitting approximately 600 tons of CO2 per GWh in 2020. The significant reliance on coal for power generation, which is atypical in the MENA region, stems from Morocco's limited domestic natural gas resources and a cautious approach toward depending on gas imports from neighboring countries.[355]

Figure 24. Total energy supply and renewable energy supply in Morocco, 2019



Source: IRENA, 2019

The reliance on imported fossil fuels continues to pose a substantial vulnerability for the Moroccan economy, leaving it exposed to international price shocks, including the conflict in Ukraine.[356] This heavy reliance on fossil fuels carries significant macroeconomic implications for Morocco. Between 2010 and 2020, energy accounted for 19.4 % of total imports. Furthermore, despite the partial liberalization of hydrocarbon prices in 2012-2015, explicit subsidies for liquid petroleum gas (LPG) still consume nearly 2.4 % of government expenditure, equivalent to almost 1 % of GDP annually.

Despite Morocco's efforts to transition to renewable energy (RE), the progress has been overshadowed by the increasing reliance on coal for electricity generation, with around 30 % of power coming from coal plants in 2019, as shown in the above figure. The country has not provided a clear indication of its plans to phase out these relatively young coal plants.

[353] World Bank Group. (2022). Morocco Country Climate Development Report. Washington, DC: World Bank. https://www.worldbank.org/en/country/morocco/publication/morocco-country-climate-and-development-report

[354] Enerdata, 2022

[355] World Bank Group. (2022). Morocco Country Climate Development Report. Washington, DC: World Bank. https://www.worldbank.org/en/country/morocco/publication/morocco-country-climate-and-development-report

[356] Ibid.

Fossil fuels continue to play a prominent role in Morocco's energy supply, representing 90% of the total primary energy supply in 2019 according to IRENA. The primary fossil fuels utilized in the country include coal, oil, and natural gas. Among these fossil fuels, oil holds the greatest significance followed by coal. The country primarily relies on imports from Algeria and Saudi Arabia to meet its oil demands. Natural gas follows closely behind, accounting for 4% of the total primary energy supply in Morocco. The main sources of natural gas are imports from Algeria and Nigeria.[357]

Renewable energy sources contribute 10% to the overall primary energy supply in Morocco as of 2019. Morocco has made a dedicated commitment to augmenting the proportion of renewable energy within its energy portfolio. With a clear vision in mind, the government has established a goal to achieve 52% of its electricity generation from renewable sources by the year 2030.

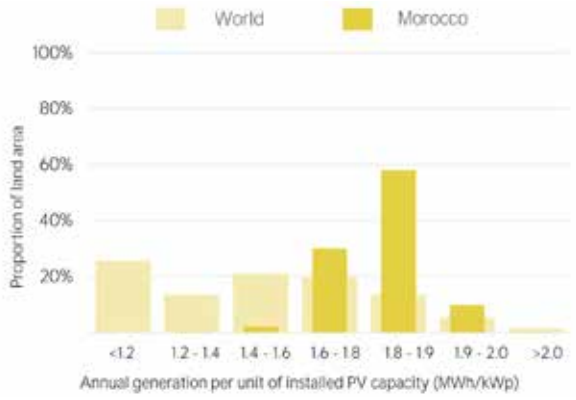
In 2019, bioenergy represented the predominant segment of renewable energy, accounting for approximately 65% of the total renewable energy (as illustrated in Figure 34). The substantial and dynamic agricultural sector in Morocco plays a critical role in supplying the majority of this renewable energy component.

Hydropower occupies the least share among other renewable energy sources in Morocco accounting for just 3% of the total renewable energy supply. The major hydropower plants in Morocco are strategically located in the High Atlas Mountains.

Solar energy represented 14% of total renewable energy supply in 2019. With Morocco's substantial solar potential, the government is actively investing in solar power projects. Leveraging its significant solar resources, the Moroccan government is actively promoting the expansion of solar energy through key projects. A notable achievement in this effort is the construction of the Noor-Ouarzazate complex, the world's most extensive concentrated solar power facility. This complex spans 3,000 hectares (11.6 square miles) and features an expansive array of curved mirrors that focus sunlight onto fluid-filled tubes. The heated fluid is then utilized to generate electricity, facilitating power production even during nighttime hours to meet peak demand.

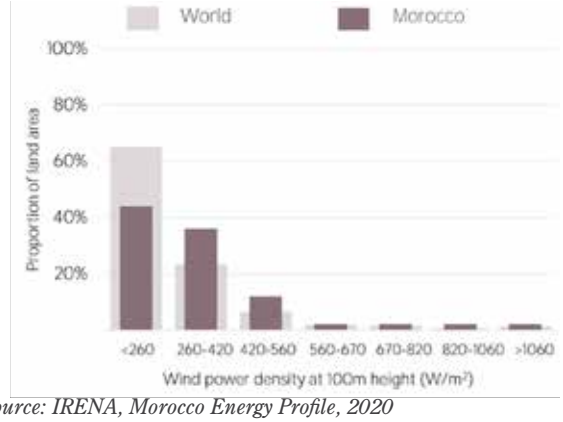
Furthermore, amidst growing US-China tensions, Morocco has positioned itself as a strategic player in the renewable energy sector with a significant investment from China's CNGR Advanced Material. The company

Figure 25. Distribution of solar potential



Source: IRENA, Morocco Energy Profile, 2020

Figure 26. Distribution of wind potential



Source: IRENA, Morocco Energy Profile, 2020

plans to establish a cathode materials plant in Morocco, aimed at serving the US and European battery markets. This $2 billion investment is set to transform Morocco into a significant battery producer, bolstering its solar power initiatives and ambitions to become a leading electric vehicle (EV) manufacturer.[358]

Wind energy constitutes contributing 17% to the total primary energy supply. Morocco possesses a moderate wind potential and the government is making efforts to develop wind power projects.[359]

Figures 25 and 26 highlight the potential for the distribution of solar energy.

Morocco, endowed with abundant wind and solar resources, is poised to capitalize on the advantages that come with embracing a decarbonization agenda. The Kingdom has been at the forefront among middle-income countries in pursuing an ambitious renewable energy (RE) program since the late 2000s, effectively doubling the contribution

[357] International Energy Agency, 2022

[358] Dempsey, Financial Times (2023) https://www.ft.com/content/9539f746-82bf-49db-ae87-237196a60c88

[359] Enerdata, 2022

of RE to its power generation capacity, which now stands at nearly 4 GW. Despite these achievements, Morocco has also witnessed a continued, and even accelerated, use of coal for power generation. It is crucial for Morocco to fully tap into its vast and competitive RE potential, while significantly reducing or eliminating the reliance on coal, in order to actively contribute to the global decarbonization effort and reap the associated economic benefits.[360]

3.3.2.2 Pathways to energy transition: strategies, goals, and implementation plans for diversifying the energy mix and achieving sustainable energy goals

A recent assessment of Morocco's institutions regarding climate change reveals that the majority of central-level ministries are involved in climate action to varying degrees. The Ministry responsible for the environment is designated as the national focal point for coordinating the country's climate change agenda. Within this ministry, the Department of Climate Change takes on the coordination role for climate issues, leading the development of national plans and strategies such as the 2030 National Climate Plan, the National Adaptation Plan, and the Nationally Determined Contribution (NDC), as well as the national communication to the United Nations Framework Convention on Climate Change (UNFCCC).

Many line ministries have incorporated climate change actions into their mandates, and some ministries, along with certain state-owned enterprises, have formulated sector-specific climate plans (such as the Ministry of Agriculture, Ministry of Energy, and Ministry of Transport). The newly elected regional and municipal councils are currently in the process of preparing their five-year plans, scheduled for adoption in the last quarter of 2022.

This broad institutional engagement in Morocco's climate change efforts brings into focus a diverse array of stakeholders, encompassing central government ministries, state-owned enterprises, and newly elected regional and municipal councils, all of whom play a pivotal role in shaping and implementing the nation's climate agenda.

Ministry of Energy, Mines, Water and Environment (MEM): a Moroccan Ministry charged with implementing national strategies in the fields of geology, minerals, hydrocarbons and energies, and building the necessary human competencies in these fields.

L'Office National de l'Électricité et de l'Eau potable (ONEE): The National Office for Electricity and Drinking Water (ONEE) is the pillar of the energy strategy and armed arm of the State in the water and sanitation sector in Morocco. Since the mid-1990s, the Office has been on all fronts: generalization of access to electricity and drinking water, wastewater treatment and development of the liquid sanitation service, modernization and expansion of networks for the production, marketing and distribution of electrical and hydraulic resources, the fight against waste and the implementation of new instruments and techniques for saving water and electricity, etc.

Moroccan Agency for Sustainable Energy (MASEN): is the group responsible for managing renewable energy in Morocco. As a central player committed to making optimal use of renewable resources, Masen transforms natural power into power for progress. The integrated model Masen has devised aims to establish self-sustaining and financially viable ecosystems

Société d'Investissements Energétiques (SIE): is a state-owned energy services company, a public entity whose mission is to sustainably reduce the energy consumption of public and private organizations, while improving their energy performance. Founded in 2010, SIE was initially the State's financial arm for the sector of renewable energies and energy efficiency. Along this line, its mission was to finance and co-develop national programs and clean energy projects.

Institut de Recherche en Energie Solaire et Energies Nouvelles (IRESEN): created to bring R&D in applied sciences to the national scale, develop innovation and encourage networking.

Centre National pour la Recherche Scientifique et Technique (CNRST): Created in 1976, it is a public institution placed under the supervision of the state. Its responsibilities include implementing scientific and technological research and development programs as well as funding research within the framework of the choices and priorities set by the supervisory government authority.

Alliance Marocaine pour le Climat et le Développement Durable (AMCDD): is the largest Moroccan platform of associations and networks of associations in Morocco working in the fields of the environment and sustainable development.

[360] World Bank Group. (2022). Morocco Country Climate Development Report. Washington, DC: World Bank. https://www.worldbank.org/en/country/morocco/publication/morocco-country-climate-and-development-report

Morocco's climate commitments, policies and capacities: an ambitious set of policies and strategies

Morocco's commitment to addressing climate change is evident through an ambitious array of policies, strategies, and capacities developed over the past 15 years, including the initiation of landmark initiatives such as the Plan Maroc Vert (PMV) and the Moroccan Solar Plan, culminating in the adoption of the 2030 National Sustainable Development Strategy and the subsequent launch of the 2030 National Climate Plan (2030-NCP).[361]

Morocco has recently introduced a comprehensive plan known as the New Development Model (NDM), which aims to bring about profound socioeconomic changes. The NDM centers around four key areas of transformation and sets ambitious goals, including the ambitious target of doubling per capita GDP by 2035. Achieving such a remarkable feat requires a sustained average annual growth rate of nearly 7 % over the next 12 years.[362] The NDM seeks to establish Morocco as a regional leader in green energy, through its focus on transforming the country's energy mix. Furthermore, the plan emphasizes the need to tackle water scarcity through policy reforms, enhancing water resource planning, allocation, and valuation to accurately reflect the true value of this increasingly limited resource.[363]

Energy efficiency is a key national policy priority, with an initial target of achieving 12% energy savings by 2020 and 15% by 2030. This target has been revised upwards to a more ambitious goal of 20% energy savings by 2030. To guide its transition towards a low-carbon energy system, Morocco adopted the National Energy Strategy in 2009.[364] As part of this strategy, Morocco initially set a target of achieving 42% renewable energy in its total installed power capacity by 2020. In 2015, the target was revised upward to 52% by 2030, with a distribution between solar, wind, and hydropower resources. It is estimated that achieving this 2030 renewable energy target will require significant investments totaling around USD 30 billion.[365]

Morocco's National Sustainable Development Strategy paving the path towards reaching its INDCs. Morocco's commitment to sustainability is enshrined in its 2011 constitution, which recognizes sustainable development and environmental protection as fundamental rights alongside healthcare and social protection. The strategy is built upon seven interconnected pillars, including transitioning to a green economy, fostering a culture of sustainable development, enhancing governance for sustainability, improving natural resource management, promoting human development and reducing social inequalities, prioritizing sensitive areas, and expediting the implementation of climate change policies.

In preparation for COP26 in Glasgow in November 2021, Morocco presented an updated Nationally Determined Contribution (NDC) with an ambitious mitigation target. The revised NDC aims to achieve a 45.5 % reduction in greenhouse gas emissions by 2030 compared to a business-as-usual scenario, representing a 3.5 % point increase from the 2016 NDC. Notably, Morocco's updated NDC includes the cement and phosphates sectors for the first time. The inclusion of the phosphates sector is significant as Morocco holds around 75 % of global phosphate reserves and is a major exporter of fertilizers.

According to the Climate Action Tracker (CAT), Morocco's climate targets and policies are deemed "almost sufficient," with its unconditional commitments meeting its fair-share contribution to the Paris Agreement.[366] Building upon the four sectors previously addressed in the 2015 NDC (agriculture, water, fisheries and aquaculture, and forestry), the revised NDC enhances interventions in these sectors and includes additional sectors such as meteorology, sensitive environments (coastline, mountains, and oases), urban and rural planning, and health.

In February 2021, Morocco launched the National Disaster Risk Management Strategy (2020-2030), building upon the extensive work on disaster risk management (DRM). The strategy was spearheaded by the Ministry of Interior over the past decade. The DRM strategy presents a comprehensive approach to managing risks associated with disasters and climate change, emphasizing proactive risk reduction and preparedness in addition to post-recovery efforts. Through these initiatives, Morocco seeks to reinforce its ability to address the challenges posed by climate change, with a specific emphasis on adaptation and resilience. By integrating various sectors and engaging in comprehensive planning and strategies, the country aims to enhance the well-being and long-term sustainability of its population and the environment.[367]

[361] World Bank Group. (2022). Morocco Country Climate Development Report. Washington, DC: World Bank. https://www.worldbank.org/en/country/morocco/publication/morocco-country-climate-and-development-report

[362] Ibid.

[363] Ibid.

[364] Ibid.

[365] Ibid.

[366] Ibid.

[367] Ibid.

The NDC's adaptation objectives are further elaborated in the National Strategic Adaptation Plan (NSAP), which was adopted in January 2022. The NSAP outlines a roadmap for 2020-2030, providing a collaborative and inclusive framework for adaptation planning. It prioritizes actions aimed at strengthening the resilience of both the population and the territory in the face of climate change.[368]

In addition to the NDC, Morocco is actively developing a long-term low emission development strategy for 2050 (2050-LEDS). This strategy aims to guide Morocco towards achieving climate neutrality by the end of this century.

Morocco's commitment to addressing climate change has been commendable, with significant progress made in various sectors. While challenges remain, the country's efforts to integrate climate considerations into its policies and strategies demonstrate a commitment to sustainable development and global climate action.

3.3.2.3 Powering the transition: a focus on financing

In November 2016, Morocco hosted the COP22 in Marrakech and took the opportunity to introduce its national Roadmap for Aligning the Financial Sector with Sustainable Development and climate change commitments. The roadmap's objective is to encourage increased investment in sustainable and climate-related projects to address Morocco's social and environmental challenges. By mobilizing the financial sector to contribute to closing the green investment gap, estimated at USD 24 billion, the roadmap aims to facilitate the transition to a green economy. Additionally, in line with its commitment to South-South cooperation, the roadmap includes a section on integrating green finance within the African continent.[369]

The roadmap is built upon a comprehensive and unified vision, outlining five main pillars that guide the financial sector's commitment to mainstream sustainability. To further enhance sustainable finance, the roadmap sets forth several key actions, including:

- Implementing risk-based governance that encompasses socio-environmental risks.
- Creating sustainable financial instruments and products.
- Advancing financial inclusion as a means to promote sustainable finance.
- Providing training and capacity building in the field of sustainable finance.
- Enhancing transparency and market discipline.[370]

Specific measures outlined in the roadmap include:

- Developing a sustainable finance charter that integrates environmental, social, and governance (ESG) factors into financial institutions' core operations, strategies, and decision-making processes.
- Establishing a shared definition for green assets, projects, and instruments.
- Assessing financial institutions' carbon footprint and evaluating climate change-related risks and opportunities.
- Publishing guidelines to promote transparency and market discipline within the financial sector.
- Conducting training and financial education programs to raise awareness about environmental concerns and the benefits of sustainable finance.

Morocco's progress in aligning its financial sector with sustainable development is classified as "advancing" according to the Sustainable Banking Network Country Report. This assessment is based on international best practices and the country's commitment to national and regional climate change targets, including Nationally Determined Contributions (NDCs). The roadmap supports the development of green financing products such as green bonds, providing guidelines, standards, and definitions for implementation within financial institutions. Additionally, the roadmap allocates MAD 6 billion for investment in green assets over a five-year period.

The Central Bank of Morocco, Bank Al-Maghrib (BAM), is dedicated to supporting the Sustainable Development Goals (SDGs) and fostering a transition towards a resilient, low-carbon economy. BAM has played a crucial role in formulating a national strategy to steer the banking sector towards sustainability and environmental responsibility, with a focus on mitigating climate change and advancing financial inclusion to combat poverty by 2030. A key initiative is the adoption of the National Financial Inclusion Strategy in 2019, designed to improve financial access for youth, women, and rural communities, and to encourage green financing. This strategy promotes the development of alternative financing options, such as mobile payments, microfinance, and inclusive insurance, and introduces incentives for green loans to micro, small, and medium

[368] Ibid.

[369] Ibid.

[370] Ibid.

enterprises (MSMEs) through a public credit guarantee institution. Additionally, it aims to mitigate climate-related losses for small farmers via the Solidarity Fund and addresses gender disparities by urging financial institutions to incorporate a gender perspective into their services.[371]

In order to facilitate the financing of Morocco's transition to a more sustainable economy, the Moroccan Capital Market Authority (AMMC) partnered with the International Finance Corporation (IFC) to publish guidelines in 2016, establishing the regulatory framework and rules for issuing green bonds.[372] These guidelines were followed by the issuance of the Corporate Social Responsibility and Environmental, Social, and Governance Reporting Guide in cooperation with the Casablanca Stock Exchange (CSE). This guide aims to foster a culture of corporate social responsibility among publicly traded companies and provide a practical resource for reporting on environmental, social, and governance (ESG) factors.

In 2018, the AMMC further expanded the financing opportunities by introducing new funding mechanisms through the publication of guidelines for green, social, and sustainability bonds. These guidelines opened avenues for diverse forms of financing. To promote socially responsible investments (SRIs) and encourage the adoption of ESG best practices.[373]

In November 2016 the Moroccan Agency for Sustainable Energy issued the country's first green bonds worth USD 125 million to finance the Noor (I) concentrated solar power plant. In October 2018, Morocco also successfully launched its first Shariah-compliant sovereign bonds (sukuks) valued at USD 104.2 million, receiving significant market demand. Since then, Morocco has continued to issue green bonds to fund various projects.[374] Aligning with its vision to establish Casablanca as a green finance hub in Africa, the Casablanca Statement for Financial Centers Sustainability was issued in 2017. This statement advocates for strategic actions to scale up green and sustainable finance, leveraging international expertise in climate change and sustainable development to increase capital flows into clean energy and sustainable agriculture.[375]

[371] Ibid.

[372] Ibid.

[373] Ibid.

[374] Ibid.

[375] Ibid.

Morocco has made significant strides in establishing the groundwork for greening its financial system, yet the development of a comprehensive climate finance strategy remains outstanding. Since 2016, Bank Al Maghrib (BAM), the Moroccan Capital Market Authority (AMMC), and the Ministry of Economy and Finance (MEF) have laid the foundations necessary to promote sustainability within the financial sector. Notable achievements include the formulation of a comprehensive roadmap to align financial institutions and capital markets with sustainable development goals, the implementation of disclosure and reporting standards, and the enactment of crucial reforms to stimulate the growth of a corporate green bond market. Despite these advancements, Morocco currently lacks a comprehensive national strategy specifically addressing green climate finance.[376]

Hence, climate action financing continues to face limitations and primarily concentrates on mitigation efforts. The majority of investments have been directed towards the energy and transport sectors, accounting for 38 % and 32 % respectively. The agriculture sector has also received a share of the investments, with 20 % allocated through initiatives like the Plan Maroc Vert (PMV) to expand drip irrigation. Despite witnessing an upward trend between 2011 and 2018, the overall amount of climate financing remains inadequate compared to the ambitious goals outlined in the Nationally Determined Contribution (NDC). It represents less than one fifth of the estimated annual financial requirements. Furthermore, funding for adaptation measures specifically lags behind, indicating a gap that needs to be addressed.[377]

The adoption of a national "green taxonomy" holds the potential to attract substantial green financing. An essential obstacle hindering the development of a sustainable financial market is the absence of a national green taxonomy that provides a classification system for economic activities considered environmentally sustainable and in line with Morocco's climate objectives. Such taxonomies have been increasingly adopted worldwide as valuable tools to assist issuers and investors in identifying green financial assets and projects.

The green bond market in Morocco is still in its early stages of development where it is characterized by low levels of activity suggesting obstacles in mobilizing capital for green bond products and financially viability of projects.[378] The AMMC produced guidelines between 2016

[376] Ibid.

[377] Ibid.

[378] Ibid.

and 2018, outlining the necessary principles and actions for issuing green bonds, including the use of proceeds and project evaluation and selection criteria. The market has seen limited activity, with only five green bonds issued in Morocco thus far. This low level of activity suggests potential obstacles in mobilizing capital for green bond products (demand side) and challenges in making projects financially viable (supply side). 379

3.4.2.4 Powering sustainable jobs: employment opportunities in renewable energy

The renewable energy sector in Morocco presents a favorable avenue for young individuals, as it provides lucrative employment opportunities with promising career prospects.[380] Within the renewable energy sector, there is a diverse range of employment opportunities available, encompassing roles in construction, engineering, installation, operation and maintenance, as well as research and development.[381] In a 2011 study conducted by the World Bank, it was projected that the renewable energy sector in Morocco, Algeria, Egypt, Tunisia, and Jordan could generate approximately 64,000 to 79,000 local jobs by 2025. Estimates from IRENA (2016) indicate the potential for around 16,000 renewable energy jobs across the North Africa region.[382] Hence, the Moroccan government is dedicated to advancing the renewable energy sector, and this dedication is expected to result in a surge of job opportunities within the sector in the foreseeable future.[383]

According to MASEN, the renewable energy sector in Morocco employed approximately 12,500 individuals in 2021.[384] As per the International Trade Administration (ITA), Morocco's investment in renewable energy projects is projected to lead to an increase in job opportunities within the sector in the forthcoming years.[385] Sylvain Côté's study revealed that the solar photovoltaic (PV) industry is the primary source of employment within Morocco's renewable energy sector, with the wind power sector and concentrated solar power (CSP) sector following closely behind.[386] Concentrated solar power (CSP) employs a workforce of 1,800 individuals in Morocco, making it the leading renewable energy sector in terms of employment. These findings align with economic studies highlighting solar PV as the most labor-intensive technology among green power options.[387]

Introduced in 2009, Morocco's National Energy Strategy (NES) stood out as a remarkably ambitious and all-encompassing renewable energy strategy within the MENA region. The NES aimed to attain 42% of the country's total installed power generating capacity from solar, wind, and hydropower sources by 2020. Among the initial objectives of the NES was the establishment of a conducive business environment that fosters growth and job creation, facilitated by the advancement of higher education programs dedicated to the renewable energy sector.[388]

In 2015, ANAPEC introduced its 2020 Vision, aiming to broaden its scope to encompass job seekers without specialized skills. ANAPEC, a public service company, plays a pivotal role in advancing renewable energy usage and fostering energy efficiency in Morocco. Additionally, it serves as an active intermediary in the labor market, facilitating the alignment of labor supply with demand for renewable energy positions. For this purpose, ANAPEC initiated three labor programs: Idmaj (offering wage subsidies to unemployed graduates), Te'hil (providing youth training), and Moukawalati (supporting entrepreneurship through training and financial aid).[389]

Relevant ministries also played a significant role by implementing strategies to enhance the training system and facilitate the integration of young individuals into the job market through internships and skills matching. Despite these efforts, challenges persist. The availability of "green" training courses did not yield the anticipated results, as many university students continued to pursue non-technical fields like social sciences. This ongoing imbalance has contributed to the persistently high unemployment rates in Morocco.[390]

Facing a shortfall in job creation targets, the Moroccan Center of Conjuncture examined the German model of

[379] Ibid.

[380] MASEN, n.d.

[381] Côté, S. (2019). Renewable energy and employment: The experience of Egypt, Jordan and Morocco. Discussion Papers ks–2019-dp69, King Abdullah Petroleum Studies and Research Center.

[382] Ibid.

[383] ITA, 2022

[384] MASEN, n.d.

[385] ITA, 2022

[386] Côté, S. (2019). Renewable energy and employment: The experience of Egypt, Jordan and Morocco. Discussion Papers ks–2019-dp69, King Abdullah Petroleum Studies and Research Center.

[387] Ibid.

[388] Ibid.

[389] Ibid.

[390] Ibid.

renewable energy projects as a potential blueprint for Morocco. This decentralized approach could facilitate the development of small-scale, community-based energy systems, allowing the country to take greater ownership of its energy production, a viewpoint also shared by the National Agency for the Development of Renewable Energy and energy Efficiency (ADEREE) in Morocco.

The development, management, and maintenance of renewable energy installations can generate sustainable employment opportunities, ensuring a just transition for the workforce as they adapt to changes in location and required skill sets. In Morocco alone, it is projected that the cumulative net job creation over the next three decades could reach 761,914.

Looking at the feasibility of renewable energy technologies, in Morocco it is deemed more economically viable to import most renewable energy technologies, like solar panels. Countries like China emerged as providers of renewable energy equipment at highly competitive prices. As a result, the emphasis shifted from direct job creation in manufacturing to the secondary effects of job opportunities. Attention turned towards roles in project management, installation and construction, and operation and maintenance as targets for job creation.[391]

3.4.3 Exploring the landscape of micro, small, and medium-sized enterprises (MSMEs)

3.4.3.1 Examining the profile of micro, small, and medium-sized enterprises (MSMEs) and their engagement with renewable energy: policies, adoption, and access to climate finance

Despite accounting for 73% of job creation in Morocco, micro, small, and medium enterprises (MSMEs) face significant structural constraints that limit their contribution to the country's GDP, which stands at only 35%. The majority of MSMEs, approximately 81%, operate in the informal sector and receive a mere 15.6% of bank credit. Additionally, 67% of MSME managers lack formal qualifications, posing further challenges. The informal MSMEs in Morocco are particularly vulnerable due to low labor productivity, intense competition, and difficulties in accessing cash resources and financing. A survey conducted among MSMEs revealed that 77.1% expressed the need for capacity-building in areas such as business strategies, market research, and credit application preparation.

The rate of entrepreneurial activity showed fluctuations, rising from 6.5% to 11.5% between 2018 and 2019 before declining to 7.1% in 2020. Moreover, data from the Moroccan Office of Industrial and Commercial Property (OMPIC) indicated a 20% decrease in the number of business start-ups in November 2020 compared to the previous year. It is worth noting that MSMEs managed by women are even more vulnerable and face greater challenges in accessing financing. Despite these hurdles, businesses owned by women in Morocco show promising potential.[392]

3.4.3.2 Assessing the drivers and impediments for MSMEs in adopting renewable energy technologies: country-level analysis

The Moroccan economy is composed of numerous small and medium-sized enterprises (SMEs) that operate independently with limited integration. This poses a challenge for them to compete with larger foreign companies that have advantages in terms of economies of scale and greater resources for research and innovation. The entrepreneurial ecosystem in Morocco is still in its early stages, resulting in very few national companies being able to participate in large-scale industrial projects. These companies lack the financial and human resources required to invest in complex projects like concentrated solar power (CSP). Consequently, national companies are often limited to being financial partners or potential subcontractors. However, there is a potential niche market for industrial actors in small-scale solar photovoltaic (PV) applications, which also presents export opportunities for SMEs.[393]

Surveys conducted by the Moroccan Federation for Financial Education (FMEF) involving over 100,000 micro, small, and medium enterprises (MSMEs) unveiled critical insights into their financial engagement. Notably, 45% of MSMEs identified the limited volume of their activities as a major hindrance to accessing formal financial services. Additionally, 41% of MSMEs perceive no need for the financing options offered by banks, suggesting a reliance on internal resources or alternative financing methods. Furthermore, a significant trust deficit towards financial institutions was expressed by approximately 13% of MSMEs.[394]

[391] Ibid.

[392] African Development Bank. (2020). Financial Inclusion, Entrepreneurship and MSME Support Programme for Economic Recovery (FIFE).

[393] Côté, S. (2019). Renewable energy and employment: The experience of Egypt, Jordan and Morocco. Discussion Papers ks–2019-dp69, King Abdullah Petroleum Studies and Research Center.

[394] African Development Bank. (2020). Financial Inclusion, Entrepreneurship and MSME Support Programme for Economic Recovery (FIFE).

According to the World Bank's Enterprise Survey, the level of engagement by Moroccan businesses on climate change varies and, overall, remains relatively low. Approximately one-third of companies in Morocco have integrated climate change considerations into their strategic decision-making or daily operations, with significant differences observed across firms. Only around 17 % of businesses have designated a manager responsible for environmental or climate change issues. This figure is lower than the number of businesses that have established strategic climate-related objectives, suggesting that many firms have yet to take concrete actions to address their stated ambitions. It is worth noting that companies that have experienced financial losses due to extreme weather events show greater awareness of climate change issues and are more likely to have implemented adaptation or mitigation measures compared to those without such losses.[395]

Although the private sector's involvement in climate action has been somewhat limited thus far, it has the potential to significantly contribute to climate adaptation efforts. Overall, private sector contributions have accounted for approximately 60 % of climate action financing between 2011 and 2018. They have been particularly instrumental in the expansion of renewable energy through large-scale public-private partnerships. In October 2021, the main union group for private operators in Morocco, the Confédération Générale des Entreprises du Maroc (CGEM), published a comprehensive document titled "White Book Towards a Sustained, Responsible and Green Economic Growth." This publication reaffirmed their strong commitment to supporting the decarbonization of the economy.

The private sector in Morocco is facing structural limitations that have impeded the growth of productivity and job opportunities, which could also hinder the country's transition to a greener economy. The Country Private-Sector Diagnosis (CPSD) report for Morocco highlights various factors that have contributed to these constraints, including regulatory barriers, unequal treatment of businesses, and weak enforcement of competition policies. Consequently, the current business environment does not facilitate the entry and expansion of young firms in the market. This represents a missed opportunity for Morocco, as evidence from other economies demonstrates the vital role of such firms in driving productivity growth and job creation.[396]

3.4.4. Drawing the final threads: a resolute conclusion

In Morocco, there has been an annual average increase of 7% in electricity consumption demand since 2002. This growth poses challenges for the electrical power production industry, as it must meet rising demand while adhering to environmental protection requirements. In response, the Moroccan government has introduced a comprehensive plan to enhance the share of renewable energy in the energy mix and significantly improve energy efficiency. Specific targets have been set, aiming to achieve 42% of renewable energy electricity generation capacity by 2020 and 52% by 2030.[397] In 2020, nearly 20% of Morocco's electricity production was provided by renewable energy resources (RES), while the installed capacity of RES was around 36%.[398] At present, Morocco boasts a diverse and well-established renewable electricity system that comprises a combination of solar, wind, and hydroelectric power plants. As a result, the Kingdom of Morocco has gained recognition as a leading country in the global energy transition, particularly within Africa. [399]

Potential, the untapped possibilities lying ahead, holds the key to Morocco's energy future.

Leveraging its strategic geographical position and favorable environment, Morocco has positioned itself as a leading player in the field of renewable energy, particularly solar power. Launched in 2009, the Moroccan Solar Plan is an ambitious initiative with several solar power plants scheduled for installation. Among these, Noor 1 stands out as it utilizes advanced Concentrating Solar Power (CSP) technology with Parabolic Trough Collector (PTC).

Additionally, Morocco boasts significant wind energy potential, estimated at approximately 6000 MW, thanks to its favorable geographic locations. The windiest regions

[395] World Bank Group. (2022). Morocco Country Climate Development Report. Washington, DC: World Bank. https://www.worldbank.org/en/country/morocco/publication/morocco-country-climate-and-development-report

[396] Ibid.

[397] M. Boulakhbar, B. Lebrouhi, T. Kousksou, S. Smouh, A. Jamil, M. Maaroufi, M. Zazi, Towards a large-scale integration of renewable energies in Morocco,Journal of Energy Storage,

[398] https://www.policycenter.ma/index.php/publications/moroccos-decarbonization-pathway-part-iii-costs-and-benefits-energy-transition

[399] M. Boulakhbar, B. Lebrouhi, T. Kousksou, S. Smouh, A. Jamil, M. Maaroufi, M. Zazi, Towards a large-scale integration of renewable energies in Morocco,Journal of Energy Storage.

are primarily situated in the northern areas, along the Strait of Gibraltar in the Tangier-Tetouan region, the Essaouira region, the South Atlantic area from Tarfaya to Lagouira, and the Taza corridor between the Atlas and Rif mountain ranges. Notably, the operational Tarfaya wind farm is one of the country's most prominent wind energy projects and stands as the largest wind energy undertaking on the African continent.[400]

Currently, Morocco possesses significant biomass potential attributed to its vast forest and agricultural areas, as well as a diverse livestock sector. Despite these abundant resources, Morocco is currently utilizing less than 1% of its full biomass capacity due to high initial costs and limited knowledge of energy production techniques and processes. Nonetheless, the country's substantial biomass potential remains largely untapped by national policies, although some small companies have started to engage in this sector.[401]

Morocco aims to enhance power system resilience against water stress by replacing coal power plants with natural gas combined-cycle power plants. Currently, coal power plants constitute around two-thirds of the country's electricity generation, and they are projected to face increasing aridity in the future. This poses a challenge as coal plants rely on water for cooling. To address this, Morocco plans to install 2,400 MW of natural gas power plant capacity by 2030 and completely phase out coal-fired plants by 2050. This shift is beneficial as natural gas power plants emit fewer greenhouse gases and require less cooling water per MWh compared to coal-fired plants, thereby improving climate resilience and supporting climate change mitigation efforts.[402]

Regional electricity interconnections between Morocco and Europe are highly advanced, and there are ongoing studies for new cross-border interconnections. Notably, Morocco and Portugal are collaborating to construct a new 220 km long interconnection line with a capacity of 1,000 MW. Additionally, Morocco intends to strengthen its interconnection with Spain through a third line, offering a capacity of 700 MW. Establishing cross-border electric transmission lines requires substantial capital investment.[403]

Hurdles, and formidable challenges to overcome, stand in the way of Morocco's energy ambitions.

Morocco encounters various challenges in its energy transition, particularly in aligning energy supply with the increasing energy demand. With primary energy demand growing at approximately 5% annually, driven by a steady increase in electricity demand of around 7% per year, efforts are being made to develop new electricity production capacities and achieve an installed capacity of 25,000 MW by 2030. Additionally, ensuring energy security remains a major concern for the Moroccan energy model.404 The limited availability of domestic resources is driving increased dependence on external sources, rendering the country susceptible to fluctuations in energy prices and potential supply disruptions.[405]

Achieving an efficient production capacity of hydropower is largely contingent on water reservoirs being at their maximum, which is not always attainable. Morocco currently possesses a hydropower generation capacity of 1,770 MW, with 464 MW operating under Pumped Energy Transfer Systems (PETS) mode. Achieving this production capacity is largely contingent on water reservoirs being at their maximum, which is not always the case due to Morocco's semi-arid climate. Another important consideration in hydraulics is irrigation, as the usage of turbines for electricity generation is somewhat dependent on meeting irrigation needs. Globally, the production of hydroelectric power tends to fall short of the level indicated by the existing installed capacity.[406]

The power system in Morocco is characterized by an extensive and complex network that was established five decades ago, comprising a mix of old and modern technological components. The majority of the system is outdated and has experienced aging over time, mainly due to stress factors such as extreme temperatures, vibrations, water infiltration, and damage from civil engineering activities.[407]

[400] Ibid.

[401] Ibid.

[402] https://www.iea.org/reports/climate-resilience-for-energy-transition-in-morocco

[403] https://www.policycenter.ma/index.php/publications/moroccos-decarbonization-pathway-part-iii-costs-and-benefits-energy-transition

[404] M. Boulakhbar, B. Lebrouhi, T. Kousksou, S. Smouh, A. Jamil, M. Maaroufi, M. Zazi, Towards a large-scale integration of renewable energies in Morocco,Journal of Energy Storage.

[405] Ainou, F.Z., Ali, M. & Sadiq, M. Green energy security assessment in Morocco: green finance as a step toward sustainable energy transition. Environ Sci Pollut Res 30, 61411–61429 (2023).

[406] M. Boulakhbar, B. Lebrouhi, T. Kousksou, S. Smouh, A. Jamil, M. Maaroufi, M. Zazi, Towards a large-scale integration of renewable energies in Morocco,Journal of Energy Storage.

[407]https://www.policycenter.ma/index.php/publications/moroccos-decarbonization-pathway-part-iii-costs-and-benefits-energy-transition

The increased adoption of renewable energy in Morocco's grid, though beneficial for socio-economic development, has introduced new infrastructure challenges that the country is currently addressing. Integrating large amounts of intermittent renewable capacities with varying load types poses challenges in terms of grid stability, power balancing, and supply reliability. As the country experiences rapid economic growth and urbanization, concerns have arisen regarding the grid's capacity to handle the growing renewable energy load.[408]

Although electricity access has improved overall, the southern region of the country, with its substantial wind potential, remains the least integrated into the national grid. Moreover, the aging and outdated nature of significant shares of the grid results in delays for renewable energy projects to obtain grid access authorizations, which are typically granted during the permitting stages.[409]

Electricity prices in Morocco do not adequately reflect the actual costs, as they are set below the average production and transportation costs. This poses a significant barrier to establishing an open and competitive energy market. The practice of subsidizing or cross-subsidizing electricity has emerged as a major concern. Currently, the electricity tariff structure is centrally determined, aiming to maintain affordable energy costs for various consumers (social tariffs) while ensuring financial returns to distributors irrespective of their size, location, or client type. Despite relatively lower subsidies compared to other countries in the region, they still exert significant pressure on the national budget.[410]

The lack of a grid code poses a threat to the successful execution of renewable energy projects and erodes confidence among private investors. A grid code serves as a foundation for establishing clear and transparent guidelines for managing transmission and distribution grids. It should encompass essential details to mitigate investment risks, including unambiguous rules for grid access, transparent information on fees and tariffs, and public disclosure of energy purchasing prices. In Morocco, third-party access to the grid remains restricted.[411]

Increasing temperatures may impose additional strain on Morocco's power generation and distribution infrastructure. As heatwaves are expected to become more frequent and severe, certain components of the energy system, such as solar PV, wind power, and grids, could experience escalating impacts. Solar PV and wind power generation might be affected during heat waves since their designs are typically optimized for conditions around 25°C. Additionally, rising temperatures can diminish transmission capacity and increase power losses as power lines heat up, expand, or sag. Considering the anticipated growth of solar PV and wind power in Morocco and the expansion of power grids, their resilience to changing climate conditions is likely to gain greater significance.[412]

Another significant challenge for Morocco is to identify the stages along the renewable energy value chain that have the potential to create the most employment opportunities. Initially, there were expectations that both industrial-style manufacturing and research and development activities could thrive, given the availability of skilled and unskilled labor in Morocco. Additionally, the development of renewable energy was expected to generate spillover effects in related sectors such as construction, transportation, research, and service industries.[413]

In the realm of business and economic growth, MSMEs play a vital role as small and medium-sized enterprises with significant potential for innovation and job creation.

A significant emphasis on large-scale projects characterizes Morocco's approach to renewable energy generation. While the country has been a pioneer in African renewable energy, the primary focus remains on massive solar power initiatives. Challenges associated with distributed solar systems further support the preference for mega energy projects managed by major public enterprises (ONEE and MASEN) rather than smaller, localized decentralized projects.[414]

The "Tatwir Vert" program, a component of the Industrial Recovery Plan initiated under the auspices of Morocco SME and the Ministerial Department of Industry, aims to provide grants to bolster enterprise investments. Beyond reducing industrial pollution, the "Tatwir green growth" initiative seeks to facilitate the emergence of new green

[408] https://www.policycenter.ma/index.php/publications/moroccos-decarbonization-pathway-part-iii-costs-and-benefits-energy-transition

[409] https://www.policycenter.ma/publications/moroccos-decarbonization-pathway-part-i-introduction-joint-study

[410] Ibid.

[411] Ibid.

[412] https://www.policycenter.ma/index.php/publications/moroccos-decarbonization-pathway-part-iii-costs-and-benefits-energy-transition

[413] Côté, S. (2019). Renewable energy and employment: The experience of Egypt, Jordan and Morocco. Discussion Papers ks–2019-dp69, King Abdullah Petroleum Studies and Research Center.

[414] https://www.policycenter.ma/publications/moroccos-decarbonization-pathway-part-i-introduction-joint-study

industrial sectors. It serves as a mechanism to assist industrial players in enhancing their process development operations and creating low-carbon products. This program aligns with the broader objective of fostering the development of the green economy, encouraging industries to adopt sustainable production models and promote energy efficiency.[415]

3.5 Sudan

Sudan's government is currently grappling with a significant economic stagnation and a challenging unemployment landscape. Moreover, the forces of globalization and rapid technological advancements are exerting pressures and placing demands on the pace of social and economic progress. Within this context, entrepreneurship is widely recognized as a crucial catalyst for driving economic development. It plays a pivotal role in job creation, efficient resource utilization, and enhanced production through innovation, value creation, and the accumulation of wealth.[416]

Sudan recognizes the urgency of addressing climate change, which has become a crucial policy priority globally. As temperatures rise and electrification rates increase, the demand for air conditioning, refrigeration, and lighting is expected to escalate. Sudan, as a party to the Paris Agreement, is committed to achieving climate targets, including achieving net greenhouse gas neutrality by the mid-21st century. To accomplish this, Sudan is progressively raising its ambition and establishing specific sector goals within its Nationally Determined Contributions (NDCs), employing a ratcheting up mechanism.

A study conducted by United for Efficiency (U4E), an initiative of the United Nations Environment Program, revealed that Sudan could achieve significant annual electricity savings of two terawatt hours (TWh) by 2030 through minimum ambition energy efficiency policies in lighting, cooling, industrial motors, and distribution transformers. According to a World Bank report, Sudan's population is projected to grow at a rate of 2.4 % per year, reaching 56 million by 2031 from 40 million in 2019. While 2.2 million households currently have access to electricity, approximately 4.5 million households still lack access. This underscores the importance of implementing highly efficient technologies to curb the overall growth in energy demand while ensuring widespread access to energy for as many households as possible.[417]

3.5.1 Exploring the interplay of demographics and identities: dynamics and implications

The energy sector in Sudan has faced significant challenges due to the political and socio-economic upheavals triggered by the Arab Spring. Sudan's alleged involvement in sponsoring terrorism led to international isolation and a blockade, making it difficult for the transitional government to attract foreign investors and revive the poorly managed economy left by previous administrations. As a result, Sudan is grappling with frequent and increasingly prolonged power cuts, disrupting businesses and depriving households of a reliable energy supply. These power cuts, lasting up to six hours, are compounded by hyperinflation, fuel shortages, and the government's inability to maintain existing power stations or import necessary spare parts. Furthermore, the imposition of high electrical tariffs on the industrial sector may discourage potential investors and hinder economic growth.[418]

As a consequence of this situation, Sudan currently has a Regulatory Indicators for Sustainable Energy (RISE) score of only 30, well below the global average of 48. RISE provides an assessment of a country's regulations and policies in the energy sector, focusing on energy efficiency, energy access, and renewable energy. Sudan ranks 120th out of 138 countries evaluated in RISE, reflecting the inadequacy of policies and regulations within the energy sector. This should prompt the government to develop new policies and approaches to address the structural challenges, including a greater emphasis on renewable energy sources.[419]

Despite growth in power generation since independence, access to electricity remains limited in Sudan. In 2020, only around 55% of the population had access to electricity, with urban areas enjoying a higher access rate of 82% compared to rural areas at 41%. Those without grid connectivity rely on biomass or diesel-fired generators for their energy

[415] https://www.academia.edu/105516240/A_New_Approach_to_Energy_Transition_in_Morocco_for_Low_Carbon_and_Sustainable_Industry_Case_of_Textile_Sector_

[416] A/Rahman W., Ahmed, A., Ragab, M., & Alsaeed, M. (2022). Global Entrepreneurship Monitor: Sudan National Report 2021/2022.

[417] United for Efficiency. (2021). National Energy Efficiency Strategy for Sudan.

[418] Abdalla, H., & Qarmout, A. (2023). An analysis of Sudan's energy sector and its renewable energy potential in a comparative African perspective.

[419] Ibid.

needs. The transmission and distribution network in Sudan primarily serves major demand centers like Khartoum, mainly concentrated in the more populous eastern region. Rural areas in western Sudan face significant limitations in electricity transmission and distribution infrastructure.[420]

The discovery of oil, particularly in South Sudan in 1998 shifted the energy dynamics. During the early 1980s, Sudan made significant advancements in utilizing solar and wind energy technologies to improve access to electricity in rural areas. Certain regions in Sudan, such as the Red Sea State, have favorable wind conditions, with north trade winds blowing at speeds of up to 6 m/s, making them ideal for wind energy production. The discovery of oil, particularly in South Sudan in 1998, shifted the focus away from solar energy and led to a heavy reliance on oil resources. The subsequent independence of South Sudan in 2011 resulted in Sudan losing 75% of its oil reserves and 25% of its hydropower capacity. This loss, coupled with increasing energy demands driven by population growth, posed a threat to Sudan's energy security and contributed to the current energy crisis.[421]

3.5.2 Energy outlook: trends, challenges, and future prospects

3.5.2.1 Analyzing energy trends: understanding energy demand, efficiency, sectoral distribution of consumers, and energy supply.

Sudan relies heavily on energy imports and faces challenges due to insufficient investments in the energy sector, which puts a strain on the energy market. Additionally, there is a significant electricity deficit in Sudan, particularly in rural areas where a large share of the population lacks access to the national grid. Recent data indicates that less than 50% of rural communities in the country have electricity. To address this issue, Sudan is actively working to expand its renewable energy market and meet its growing energy needs.[422]

As of 2020, the total installed capacity of Sudan's electric power sector was 4.4 gigawatts (GW). Fossil fuel sources accounted for approximately half of the capacity, hydroelectricity contributed around 44%, and the remaining share came from renewable energy sources like solar and biomass. Hydropower accounted for 56% of the total electricity generation in Sudan, which amounted to 14 billion kilowatt hours (kWh) in 2020.[423]

Based on IRENA's 2019 country profile data, the energy supply in Sudan in 2019 mainly relied on oil and renewables. The main sources of renewable energy that the country relied on are bioenergy and hydro/marine representing 84% and 16% of the country's total renewable energy mix, respectively.

The domestic consumption of petroleum products in Sudan experienced rapid growth due to industrialization, increased car ownership, and improved access to electricity during the 2000s. The ongoing instability has hindered consumption. The decline in domestic oil production since the 2000s has resulted in a greater reliance on imported petroleum products to fulfill the domestic demand, which was previously met by domestically refined crude oil. Collectively, Sudan and South Sudan had a peak total liquid fuels consumption of 152,000 barrels per day (b/d) in 2016, and this level has remained relatively stable since then. Motor gasoline and distillate fuel oil, such as diesel, constitute the majority of the liquid fuels utilized in both countries.[424]

In terms of primary energy consumption, Sudan recorded a total of 0.345 quadrillion British thermal units (quads) in 2019. Approximately 80% of Sudan's primary energy consumption is derived from petroleum and other liquid fuels, with the remaining share coming from renewable sources like biomass. The Figure below displays renewable energy consumption in Sudan in 2019. The renewables Total Final Energy Consumption (TEFC) is mainly composed of bioenergy, where bioenergy alone represents 83% of renewable energy consumption while electricity consumption stood at 17% in 2019. It is worth noting that as of 2019 only 55% of the population had access to electricity while renewable energy as a % of TFEC represented 62%. Examining the sectoral consumption, we can see that almost half of the RE consumption (48%) is undertaken by households where the remaining half is divided between industry and other sectors.

As of January 2022, Sudan and South Sudan collectively possessed proven oil reserves of 5 billion barrels, according to the Oil & Gas Journal (OGJ). The primary production of crude oil in both countries occurs in the Muglad Basin and Melut Basin, with Sudan and South Sudan offering three distinct crude oil blends: Dar, Nile, and Fula. In an effort to

[420] Ibid.

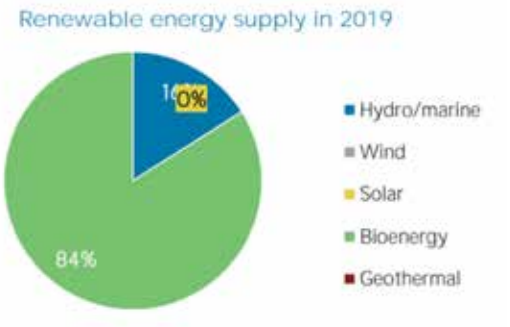
[421] Ibid.

[422] U.S. Agency for International Development. (2021). Sudan Energy Sector Assessment.

[423] Abdalla, H., & Qarmout, A. (2023). An analysis of Sudan's energy sector and its renewable energy potential in a comparative African perspective.

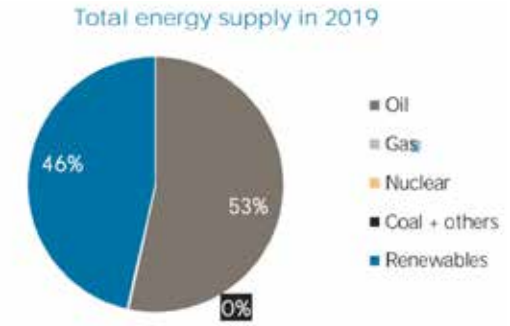
[424] Ibid.

Figure 27. Renewable energy supply in Sudan, 2019



Source: IRENA, 2019

Figure 28. Total energy supply in Sudan, 2019



Source: IRENA, 2019

revitalize upstream development, Sudan has made eight oil blocks available in its latest licensing round.[425]

Refining and refined oil products. Sudan possesses three oil refineries, but only two are currently operational, along with three topping plants, which are smaller and less complex refineries. The active refineries are the Khartoum (al-Jaili) refinery, situated around 45 miles north of Khartoum, and the El-Obeid topping plant. The al-Jaili refinery is the largest in the country. The Port Sudan refinery, the other full-conversion refinery, has suspended its operations. Among the three topping plants, only El-Obeid is currently functioning, while the Shajirah and Abu Gabra topping plants are inactive.[426]

Petroleum and other liquids trade. Sudan predominantly exports to the Nile and Dar blends of crude oil to Asian markets. The oil is shipped from Port Sudan to Asia through the Bab el-Mandeb Strait, which serves as a crucial transit point. The Bab el-Mandeb Strait is strategically important, as any disruptions or closures at this chokepoint could result in significant delays and increased shipping costs due to the absence of alternative routes. In 2021 according to ClipperData, Sudan and South Sudan exported approximately 132,000 barrels per day (b/d) of crude oil. The primary export destinations for their crude oil were Asia and the Middle East. Among Middle Eastern countries, the United Arab Emirates stood out as the sole export destination and the largest recipient, receiving about 45% of the total exports from both countries.[427]

Natural gas. In Sudan, most of the natural gas is either flared or reinjected into associated oil fields rather than being utilized for consumption. As a result, the potential of natural gas as an energy resource remains largely untapped.[428]

With its vast geographical area, abundant sunshine, and regions characterized by high wind speeds, Sudan possesses significant potential for sustainable geothermal, solar, and wind renewable energy production. Recognizing this opportunity, the Ministry of Energy and Petroleum has expressed the government's interest in harnessing additional renewable energy resources to augment the existing hydropower capacity. New plans have been devised to address the expansion of renewable energy projects and overcome previous challenges.

Combining fossil fuels with renewable energy resources is indeed a common approach for many countries to achieve energy security, address climate change concerns, and reduce dependence on oil. Clean energy technologies offer numerous advantages, including job creation, economic growth, and reduced vulnerability to fluctuating oil prices. It is crucial for the Sudanese government to adopt environment-friendly regulations and policies that incentivize both local business leaders and foreign investors to embrace renewable energy and support the transition.

Advancements in technology have made solar and wind energy increasingly feasible and affordable. While Sudan has mainly been relying on bioenergy as its main source of renewable energy, yet it has significant potential for the development of its renewable energy resources, particularly solar and wind. Sudan possesses substantial untapped wind and solar energy resources. The country's coastal areas along the Red Sea and the Northern State exhibit significant wind power potential, as highlighted by a recent World Bank study. Additionally, Sudan has ample solar power potential. Renewable energy usage, particularly solar and wind power, currently tends to be

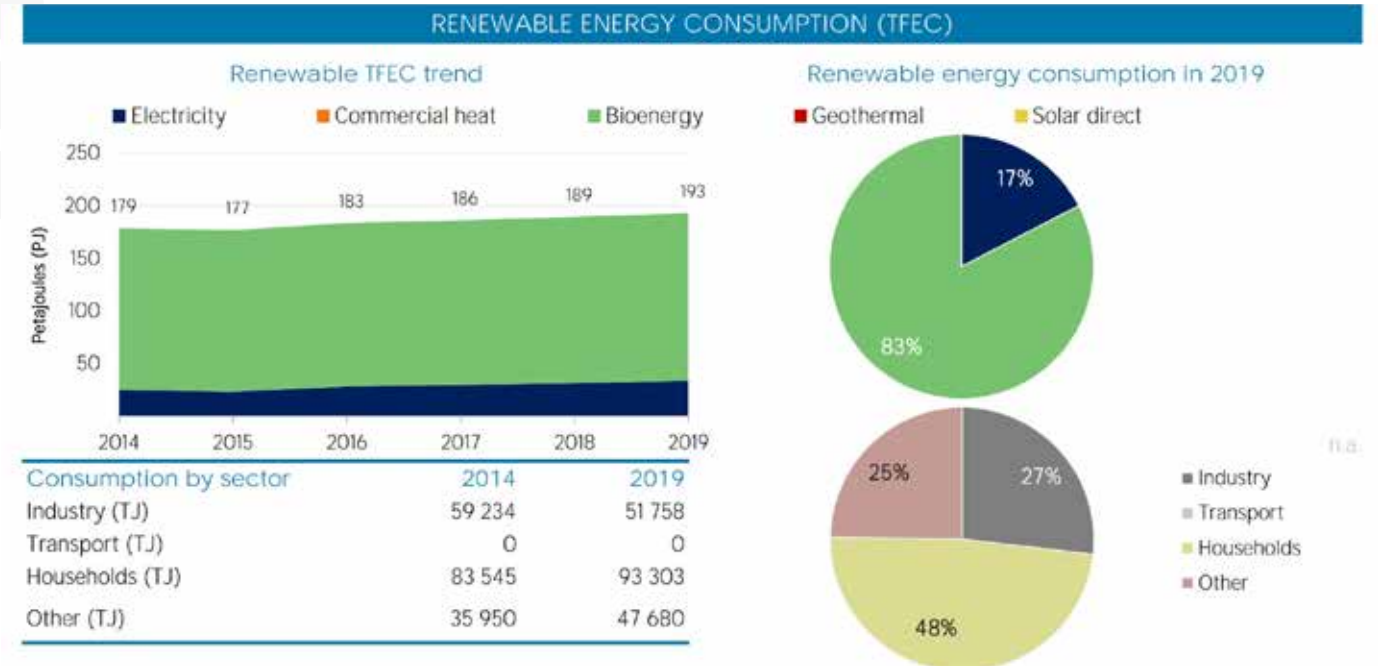
[425] South Sudan - International - U.S. Energy Information Administration [EIA]. https://www.eia.gov/international/overview/country/SSD

[426] Ibid.

[427] Ibid.

[428] Ibid.

Figure 29. Renewable energy consumption in Sudan, 2019



Source: IRENA, 2019

limited in scale and primarily employed for off-grid solutions.[429] While solar energy may have higher initial capital expenditures compared to wind energy, the cost of solar technologies has been decreasing rapidly, especially with the introduction of new crystalline silicon fixed-tilt panels. Photovoltaic technologies, such as parabolic troughs and solar power towers, have already proven successful in electricity generation in many countries.[430]

Wind Energy. In 2010, a preliminary agreement was signed with Omene Company, based in Dubai, to construct a wind power facility along the Red Sea coast with a capacity of approximately 500 MW. Unfortunately, this agreement has not been realized, and the utilization of wind power remains limited to applications such as irrigation and water pumps.431 In June 2021, the Sudanese government, in collaboration with the United Nations Development Program (UNDP), received the first wind turbine. The project, facilitated by the Global Environment Facility (GEF), aims to provide expertise and support to the Sudanese government in utilizing wind energy. The installation of the wind turbine in the Northern state not only demonstrates the country's potential in wind energy generation but also offers training opportunities for Sudanese engineers, enabling them to develop skills for future wind projects. The turbine is expected to provide electricity to around 14,000 people and serves as a step towards attracting more investment in renewable energy in Sudan.[432]

Solar energy. While solar energy requires substantial upfront investment costs, it boasts low operating expenditures due to minimal maintenance requirements and the absence of fuel requirements for operation. The cost of wind energy installation depends on factors such as the elevation of the wind plant and the turbine technology. Investing in geothermal energy carries inherent risks that necessitate detailed planning and information. Solar energy holds the greatest potential for Sudan compared to other renewable energy sources. The country's annual radiation range exceeds the global average, ranging from 436 to 639 W/m2 per year. Sudan also benefits from a significant period of solar radiation, averaging between 8.5 and 11 hours per day. Moreover, Sudan has ample available land that can be utilized for renewable energy development. By capitalizing on these opportunities and implementing supportive policies, Sudan can accelerate the adoption of renewable energy, leverage its natural resources, and unlock the economic, environmental, and social benefits

[429] U.S. Energy Information Administration. (2022). Country Analysis Executive Summary: Sudan and South Sudan.

[430] Abdalla, H., & Qarmout, A. (2023). An analysis of Sudan's energy sector and its renewable energy potential in a comparative African perspective.

[431] Ibid.

[432] Ibid.

associated with clean energy transition.[433] To expand its solar energy capacity, the Sudanese government has entered into a Memorandum of Understanding (MoU) with the United Arab Emirates (UAE) to establish a solar power plant. The MoU allows a private company from the UAE to install a 500 MW solar power plant and operate it for a period of 20 years. This agreement highlights the commitment of Sudan to increase its solar energy share and attract foreign investment in the sector.

Geothermal Energy. Sudan also possesses significant potential for geothermal energy production, which involves harnessing heat from underground to generate electricity by driving turbines with steam. Promising indications of geothermal heat have been identified in various regions, including the Tagbo and Beidob hills, Jebel Marra volcano in the Darfur region, and Bayud volcano in the Red Sea State. These geothermal resources have an estimated capacity to generate around 400 MW of electricity.[434] Recognizing the need for a diversified power portfolio, the Sudanese government has focused on thermal power investments in recent years. Plans are underway to construct additional thermal power generation units at Garri (El-Jaili) and Port Sudan. These new units have the potential to contribute nearly 1 gigawatt (GW) of generation capacity, although the progress made in their construction remains uncertain.[435]

Hydropower. Sudan harnesses hydroelectricity from several large-scale hydropower plants located in different regions. These include the Roseires and Sennar plants in the south, the Merowe plant in the north, and the Rumela and Burdana plants in the east, situated along the Upper Atbara and Seteit rivers. The completion of the Rumela and Burdana dams, in 2018, added 320 megawatts (MW) of power generation capacity to the grid.436Although hydroelectricity accounts for approximately half of Sudan's electricity generation, there are various challenges impeding its full utilization. These challenges include issues related to international boundaries, environmental degradation, and limited financial resources for investment. According to a World Bank estimate in 2019, 47% of the Sudanese population still lacked access to electricity. The demand for electricity has been consistently growing since 2013, averaging an annual increase of 11%. In rural areas, around 47% of households remain without electricity access.[437]

While there is potential for the exploitation of renewable energy resources other than hydropower, fossil fuels continue to be widely used. In 2020, the total electricity generation capacity in Sudan was approximately 4,400 MW, with over 96% of this capacity derived from fossil fuels and hydropower, and the remaining dependent on renewable energy sources such as solar and biomass. Sudan has gradually increased its solar energy production, with capacity growing from 14 MW in 2019 to 18 MW in 2020. Overall, Sudan faces the challenge of diversifying its energy sources, overcoming infrastructure limitations, and addressing financial constraints to improve access to electricity and reduce reliance on fossil fuels.[438]

3.5.2.2 Pathways to energy transition: strategies, goals, and implementation plans for diversifying the energy mix and achieving sustainable energy goals

The Sudanese energy sector involves a diverse range of key stakeholders, including government entities, private companies, international organizations, and local communities, all playing vital roles in the development, regulation, and operation of the country's energy infrastructure and services.

The Ministry of Petroleum (MOP): is responsible for the administration and management of the petroleum sector.

Sudapet: the national oil company holds minority stakes in the international consortia involved in oil operations.

National Petroleum and Gas Corporation (NPGC): serves as the main policymaking and supervisory body, reporting directly to the president and national legislative assembly. The NPGC participates in all aspects of the hydrocarbon sector and approves petroleum agreements on behalf of the government.

The Ministry of Water Resources, Irrigation, and Electricity (MoWRIE): oversees the electric power sector in Sudan as the primary government body. Under MoWRIE, the Sudan Electricity Holding Company (SEHC) plays a crucial role

[433] Ibid.

[434] Ibid.

[435] U.S. Energy Information Administration. (2022). Country Analysis Executive Summary: Sudan and South Sudan.

[436] Ibid.

[437] Abdalla, H., & Qarmout, A. (2023). An analysis of Sudan's energy sector and its renewable energy potential in a comparative African perspective.

[438] Ibid.

in managing four subsidiaries responsible for different segments of the electric power sector: the Sudanese Hydropower Generation Company, the Sudanese Thermal Power Generation Company, the Sudanese Electricity Transmission Company, and the Sudanese Electricity Distribution Company. Ensuring regulatory compliance and standards in the electric power sector is the responsibility of the Electricity Regulatory Authority. The SEHC and its subsidiaries receive budget allocations from MoWRIE, which also supervises key functions like finance, investment, and personnel management.[439]

Enhancing Community Resilience and Gender-responsive Adaptation in Sudan's National Adaptation Plan (NAP). The National Adaptation Plan (NAP) in Sudan aims to strengthen the resilience of the most vulnerable communities, with a particular focus on promoting the participation of women and young people in development processes and environmental conservation, especially in the Kordofan region. Recognizing the local level impacts of climate change on pregnant women and mothers in Khartoum, the NAP acknowledges their vulnerability. To inform data collection for vulnerability hotspot maps, the NAP identifies seven key factors, including gender, age, and income, highlighting the importance of analyzing these intersectional concerns.[440]

The NAP of Sudan includes gender-responsive adaptation measures, outlining policy objectives and actions related to capacity-building and women's empowerment in the Eastern and Central states. The NAP proposes specific adaptation measures tailored to address gender-related challenges. These include establishing a rural women's development program in North Darfur, raising women's awareness of hygiene, environmental health, and harmful social practices in South Kordofan, supporting agriculture home gardens for women, and facilitating the organization of women's cooperatives to provide relevant services in the Blue Nile state. These measures demonstrate a commitment to gender equality and the empowerment of women in the context of climate change adaptation.[441]

Sudan has actively engaged in the development and updating of its Nationally Determined Contributions (NDCs). With the submission of its first NDC in August 2017, Sudan continued updating its NDCs in May 2021, and a subsequent update in September 2022. The NDC, although concise, seeks to transform itself from a mere communication document into a comprehensive action plan. The focus of mitigation efforts is on promoting low emissions, resilient, and sustainable development within the energy, forestry, and land use sectors.[442]

A key objective is the transition to renewable energy sources and the utilization of blended fuels to reduce biomass energy consumption. Within the transport sector, there is an emphasis on encouraging the shift of goods transportation from trucks to rail. The forestry sector plays a significant role in both adaptation and mitigation strategies, encompassing activities such as restoration, carbon removal, blue carbon mangrove restoration, and protection. In the water sector, mitigation measures include the implementation of waste management systems, composting, recycling, and other relevant approaches. In terms of adaptation, Sudan's predominant focus lies in ensuring food security and addressing vulnerabilities in water, agriculture, coastal zones, and health.[443] Sudan has demonstrated its commitment to various national and international regulations and agreements pertaining to specific sectors, as outlined below and categorized into three policy areas.[444]

Climate policies: Sudan signed the Paris Agreement on April 22, 2016, and subsequently ratified it in August 2017. The Paris Agreement became operational on November 4, 2016, after reaching the required number of ratifications. In October 2015, Sudan's Ministry of Environment submitted its initial Nationally Determined Contribution (NDC) in line with the agreement. Furthermore, Sudan participated in the amendment of the Montreal Protocol in 2016, known as the Kigali Amendment, which came into effect on January 1, 2019, following sufficient ratifications.[445]

Energy policies: Sudan currently lacks comprehensive national policies addressing energy efficiency, particularly in the energy and refrigeration, air conditioning, and cooling (RAC) sectors. There is a draft Electricity Sector Strategy for the period 2020-2035 that highlights the need for policies concerning quality control and energy efficiency regulations for imported electrical equipment.[446]

[439] Ibid.

[440] ESCWA. (2023). Mainstreaming gender in climate action in the Arab region. Policy brief.

[441] Ibid.

[442] Tutundjian, S., & Maroun, D. (2023). Climate Action in the Arab Region: White Paper on The Nationally Determined Contributions of Middle East and North Africa Countries. Thriving Solutions L.L.C.

[443] Ibid.

[444] United for Efficiency. (n.d.). National Energy Efficiency Strategy for Sudan.

[445] Ibid.

[446] Ibid.

3.5.2.3 Powering the transition: a focus on financing

Sudan's energy system operates effectively from a technical perspective, but it faces several significant challenges, particularly in terms of low access and financial sustainability. The country boasts one of the largest power systems in Sub-Saharan Africa, with a capacity of 3,500 MW generated primarily from hydro and thermal sources. The potential for renewable energy remains largely untapped. The major obstacle lies in the sector's financial sustainability, with the average retail tariff of US¢ 0.7 per kWh being the lowest in the region, significantly below the actual cost of supply. This shortfall is covered through direct subsidies from the Ministry of Finance and implicit exchange rate subsidies financed by the Central Bank. These subsidies, which account for approximately 13.5 % of the government's expenditure, have adverse effects on macroeconomic stability and the allocation of resources to other critical sectors. Additionally, Sudan faces a low electricity access rate of only 32 %, necessitating a six-fold increase in the current connection rate to achieve universal access. Furthermore, the absence of a robust policy and planning framework, guided by the least-cost option, undermines the country's progress towards meeting Sustainable Development Goal 7, which aims for universal access to electricity.[447]

The Sudanese government is increasing its efforts to prioritize renewable energy and tap into Sudan's vast solar and wind resources, yet financial constraints remain an obstacle. By promoting the development of solar and wind projects, Sudan aims to enhance its energy diversification, reduce dependence on fossil fuels, and contribute to a more sustainable and resilient energy sector.[448] Some financial obstacles and environmental concerns continue to hinder the progress of initiatives aimed at increasing hydroelectric production capacity, including the Kajbar, Roseires, and Setit Dams. Despite the immense solar energy potential in Sudan, solar power currently contributes less than 0.1% to the country's energy supply. This stands in contrast to the average daily sunshine duration of 8.5 to 11 hours.[449] In light of the ongoing energy crisis, the Sudanese government has recognized the importance of renewable energy (RE) in alleviating the long-term challenges faced by the country. The new energy strategy aims to achieve significant renewable energy targets, including the generation of 4,500 MW of solar energy and 3,000 MW of wind energy by the year 2035.[450]

Additionally, Sudan's energy sector currently relies on government subsidies. In 2019, these subsidies amounted to $667 million, accounting for 13.5% of total government expenditures. To achieve financial sustainability, it is recommended to gradually adjust tariffs. External factors such as fluctuating exchange rates and inflation impact domestic electricity prices. The devaluation of the Sudanese pound and ongoing inflation make it challenging for Sudan to cover operational costs for electricity production, particularly as the energy sector heavily depends on imported fossil fuels for thermal generation. The World Bank has proposed an incremental annual increase of 2.6 cents per kWh in the electrical tariff over five years to recover approximately 50% of operational expenditures.[451]

In 2019, the transitional government announced a phased increase in fuel prices as part of its plan to eliminate government subsidies. In 2020, a three-year reform program for electricity prices was initiated, which faced public protests. The rate adjustments implemented in the first year allowed the government to save 69% of actual generation costs. By the program's conclusion in 2023, the subsidy reduction may reach 95%. In January 2022, as part of the reform program, the authorities imposed a 500% increase in electricity prices for household consumption, leading to widespread protests. This price reform also affected the industrial sector, with the cost of electricity for the agricultural sector skyrocketing from 1.6 to 9 pounds per kilowatt-hour. The abrupt price hike resulted in numerous local businesses shutting down, and economists warned that relying on heavy tax increases to create a tax-dependent economy could further fuel inflation and push the nation into a recession.[452]

Despite the ongoing efforts, the Sudanese government currently lacks the financial means to implement immediate solutions that would ensure a consistent and uninterrupted electricity supply. Sudan's domestic market requires 3,020 MW of electricity production, while the current capacity stands at 2,220 MW, creating a significant shortfall. To compensate for this deficit, Sudan imports electricity from neighboring countries such as Ethiopia (200 MW) and Egypt (78 MW). The agreement with Egypt entails

[447] African Development Bank. (2022). Enhancing socioeconomic transformation and resilience in Sudan. Country Diagnostic Note.

[448] Abdalla, H., & Qarmout, A. (2023). An analysis of Sudan's energy sector and its renewable energy potential in a comparative African perspective.

[449] Ibid.

[450] Abdalla, H., & Qarmout, A. (2023). An analysis of Sudan's energy sector and its renewable energy potential in a comparative African perspective.

[451] Ibid.

[452] Ibid.

the exchange of electricity for goods like food crops and animal protein. In the case of Ethiopia, Sudan purchases electricity at a rate of 4.5 cents per kilowatt-hour. In August 2021, the Minister of Energy and Petroleum emphasized the urgent need for maintenance and restructuring in Sudan's energy sector, estimated to cost $3 billion, highlighting the dire financial requirements of the sector.[453]

3.3.2.4 Powering sustainable jobs: employment opportunities in renewable energy

The majority of Sudan's electricity production is derived from hydropower sources, while a significant share of the oil-based power capacity in the Eastern African region is situated within the country. Sudan is also considering expanding its initiatives in solar power projects in the near future.[454] Anticipated employment opportunities in Sudan's renewable energy sector are poised to experience substantial growth in the foreseeable future. The government has established an ambitious objective of generating 20% of the country's electricity from renewable sources by 2030. As a result, there will be a notable demand for proficient professionals in various roles within the renewable energy sector.[455]

A study conducted in 2016 by Awad et al. examines the linkages between economic growth, energy production and employment in Sudan between 1980 and 2013. [456] The results show that a long run relationship exists between these three variables. In the short-run, a unidirectional relationship was detected from employment to both energy production and economic growth. Also, the study proves the existence of a strong long-run bi-directional causality relationship between each pair of the variables. Overall, the results suggest that, even in the short run, should there be a decrease in electricity (or economic growth), this will be accompanied with a decline in economic growth (or energy production). The study also suggests that over time, this effect will extend resulting in a reduction in the number of employment. The results support the current effort by the Sudan's government in the expansion of energy production given its positive impact on and interconnectedness with the country's economic development. [457]

3.5.3 Exploring the landscape of micro, small, and medium-sized enterprises (MSMEs)

3.5.3.1 Examining the profile of micro, small, and medium-sized enterprises (MSMEs) and their engagement with renewable energy: policies, adoption, and access to climate finance

Historically, large family-owned conglomerates and public sector companies have dominated Sudan's private sector, with only a select few benefiting from limited competition due to US sanctions. These conglomerates, primarily focused on agriculture, have seen wealth and growth by expanding their business into livestock, meat production, and processing. To meet the rising demand for crops and overcome challenges related to limited agricultural land, conglomerates have increasingly relied on the contract farming model. On the other hand, micro-, small, and medium-sized enterprises (MSMEs) in Sudan exhibit greater diversity but are more susceptible to vulnerabilities, particularly in the face of disasters. MSMEs encounter obstacles such as biased governmental policies that favor conglomerates, resulting in limited access to financial resources and heightened exposure to shocks and business disruptions. Emerging opportunities in the technology and solar energy sectors present MSMEs with avenues for growth, benefiting from relatively low competition compared to major conglomerates.[458]

The private sector in Sudan encounters various obstacles related to the political, regulatory, and institutional aspects of the business environment. The Sudanese Revolution had enduring effects on businesses, particularly MSMEs, with many struggling to recover from the disruptions it caused. Although most of the US sanctions on Sudan have been lifted, companies continue to grapple with their long-term consequences. Additionally, challenges such as inadequate infrastructure, notably limited access to energy, and recent business closures stemming from the COVID-19 pandemic further compound the difficulties faced by the private sector.[459]

The Adult Population Survey (APS) conducted in Sudan in 2021, following the inaugural survey in 2018, reaffirmed the positive perception of societal values associated with entrepreneurship. Notably, a significant majority

[453] Abdalla, H., & Qarmout, A. (2023). An analysis of Sudan's energy sector and its renewable energy potential in a comparative African perspective.

[454] https://www.iea.org/countries/sudan

[455] United Nations Development Programme. (2022, February 14). Sudan: Renewable energy jobs booming, but skills gap a challenge.

[456] Awad, A., & Yossof, I. (2016). Electricity Production, Economic Growth and Employment Nexus in Sudan: A Cointegration Approach. International Journal of Energy Economics and Policy. https://dergipark.org.tr/tr/download/article-file/361582

[457] Ibid.

[458] U.S. Agency for International Development. (2021). Sudan Energy Sector Assessment.

[459] Ibid.

of respondents (64%) expressed favorable views, considering entrepreneurship as an appealing career choice that carries a high level of status and respect. Moreover, a substantial share of participants (79.8%) recognized the primary objective of entrepreneurship as addressing social problems.[460]

One indicator reflecting the adult population's perception, specifically regarding the ease of starting a new business, experienced a decline. The % of respondents perceiving the ease of starting a business decreased from 53.6% in the GEM 2018 survey to 42.8% in the recent APS survey of 2021. This decline can be attributed to the prevailing political and economic complexities and uncertainties over the past three years, compounded by the disruptive effects of the COVID-19 pandemic, which have contributed to an overall unstable business environment.[461]

In a comprehensive analysis conducted in 2021, the concept of fear of failure as a potential deterrent to engaging in entrepreneurial endeavors was examined. The findings revealed that 41.5% of the participants acknowledged that fear of failure plays a substantial role in hindering their involvement in entrepreneurial activities. Notably, these individuals expressed confidence in possessing the requisite skills, knowledge, and experience to undertake entrepreneurial ventures and initiate new businesses. Despite this self-perception of entrepreneurial aptitude, the apprehension of potential failure emerged as a significant factor influencing their decision-making process.[462]

The GEM 2021 survey included a series of inquiries aimed at assessing the social responsibility of entrepreneurs. Notably, a significant majority of Total Early-stage Entrepreneurial Activity (TEA) participants (82.1%) and Established Business Ownership (EBO) participants (85.1%) scored highly in terms of social responsibility, indicating that entrepreneurs demonstrate a consideration for the societal impact their businesses will have on their communities. Furthermore, respondents exhibited favorable ratings in terms of environmentally conscious decision-making, with TEA participants scoring 81% and EBO participants scoring 90.1%. This signifies a positive attitude towards conducting business in an environmentally responsible manner. It is essential to exercise caution when interpreting these findings, as they may reflect subjective perceptions rather than actual behavioral patterns.[463]

Despite the positive perceptions and attitudes observed regarding entrepreneurship in Sudan, there is a significant disparity between these perceptions and the actual establishment of businesses. The Total Early-stage Entrepreneurial Activity (TEA) category exhibits the highest % (33.6%) in terms of entrepreneurial activity, surpassing the Established Business Ownership (EBO) category at 8.15% and the Established Employment (EEA) category at 20.1%. This discrepancy reflects the deficiencies in the business environment in Sudan, where the proportion of established businesses is less than 10% compared to the total of Nascent and New businesses, which stands at 33.6%. Additionally, there is a considerable rate of business discontinuation, exceeding 17.3%. These findings highlight the challenges and obstacles faced by entrepreneurs in Sudan, indicating a need for further examination of the factors influencing entrepreneurial activity in the country.

3.5.3.2 Assessing the drivers and impediments for MSMEs in adopting renewable energy technologies: country-level analysis

Realizing the full potential of Sudan's private sector is crucial for achieving strong and equitable economic growth. Recently, new laws on investment and public-private partnerships (PPPs) have been implemented with the aim of enhancing the investment climate, promoting dialogue between the public and private sectors, strengthening the legal and institutional framework for PPPs, and supporting the growth of MSMEs. While these developments are initially positive, it is important to ensure that PPPs and investment incentive schemes are carefully structured to mitigate potential fiscal risks.[464]

To obtain a comprehensive understanding of the Sudanese private sector in relation to potential alignment with the humanitarian sector, feedback from interviewees regarding the private sector's involvement in development initiatives and humanitarian assistance in Sudan includes, but is not restricted to, the following points: Limited access to energy hinders progress and development in remote regions, as well as the absence of adequate financial resources which poses a challenge across all sectors, particularly for MSMEs.[465]

[460] A/Rahman W., Ahmed, A., Ragab, M., & Alsaeed, M. (2022). Global Entrepreneurship Monitor: Sudan National Report 2021/2022.

[461] Ibid.

[462] Ibid.

[463] Ibid.

[464] International Monetary Fund. (2021). Sudan: National Energy Efficiency Strategy.

[465] U.S. Agency for International Development. (2021). Sudan Energy Sector Assessment.

The Sudanese private sector faces a number of political, regulatory, and institutional challenges. The private sector in Sudan encounters various political, regulatory, and institutional obstacles that have impeded the development of a favorable business environment and hindered robust economic growth. The Sudanese Revolution and the subsequent transition from the Bashir regime resulted in prolonged and recurring disruptions, particularly impacting MSMEs, many of which have struggled to recover. The rapid restructuring of the government has led to uncertainties regarding the division of responsibilities and roles among ministries and departments, causing concerns among business leaders who fear that further changes within the cabinet may have adverse effects on their businesses.[466]

Moreover, revisions in trade laws and regulations, particularly import-export laws, have resulted in significant financial losses for businesses, as imported goods have been left abandoned at ports due to the changes. Despite the lifting of most United States sanctions on Sudan and its removal from the "State Sponsors of Terrorism" list, the repercussions of these sanctions continue to impact Sudan's economy. During the period of sanctions, Sudan faced restrictions in accessing international loans and attracting foreign investments, which has had enduring effects on the country's economic situation.[467]

Sudan's designation as a State Sponsor of Terrorism (SST) imposed restrictions that excluded international banks and businesses from engaging with Khartoum, thereby limiting Sudan's access to international financial resources. With the lifting of US sanctions and the removal of the SST designation, Sudan is expected to experience long-term economic benefits. This change will allow Sudan to actively participate in the global economy, expand its market and investments, and engage in trade deals and foreign investments. Furthermore, the peace agreement has created investment opportunities in previously inaccessible areas of Sudan, such as the Blue Nile State, South Kordofan, and Darfur, opening up avenues for investment in sectors like agriculture, mining, and cross-border trade.[468]

Sudan's economic difficulties pose significant challenges for companies, particularly MSMEs and startups. These challenges stem from high inflation rates and limited access to finance, which hinders the growth of MSMEs. Compounding the issue is the scarcity of venture capital funds, with only two small funds available in Sudan (Dawish Bros and ANAFI Capital Partners), while the financial instruments offered by banks are more suitable for larger businesses. Fluctuating exchange rates add to the burden faced by MSMEs, with multiple USD prices in circulation. In 2020, there was a significant drop in the Sudanese Pound to USD exchange rate, resulting in pricing struggles for businesses and rendering imported goods unaffordable for consumers. This creates market imbalances, favoring companies that import essential commodities with better access to foreign exchange compared to other entities like MSMEs. The persistent shortage of USD in Sudanese banks has forced MSMEs and individuals to rely on unofficial or illegal networks and black-market dealers to access competitive exchange rates.[469]

Inadequate infrastructure, particularly the limited access to energy, poses a significant hurdle for Sudan's private sector. A significant share of the population, over half, remains excluded from the national energy grid, while even those with access experience frequent disruptions in power supply. Businesses, particularly those located outside major urban centers, heavily rely on diesel generators to meet their energy needs, often facing challenges such as regular shortages of diesel fuel. Moreover, Sudan's logistics and supply chains are hindered by various infrastructure deficiencies, including limited railway coverage, unpaved roads, frequent road blockages caused by flooding, and insufficient capacity at ports and airports.[470]

Lastly, the COVID-19 pandemic and subsequent lockdown measures have had a profound impact on companies in Sudan, particularly MSMEs and startups that lacked the necessary resources and contingency plans to sustain their operations. Many businesses that were unable to adapt to remote work or implement mobile solutions experienced significant revenue loss.[471]

Access to finance poses a challenge across sectors, but it is particularly difficult for small-scale farmers and MSMEs to secure microfinance. Interviewees highlighted the limited availability of financial products tailored to the needs of these entities, as most Sudanese banks primarily focus on serving larger companies. Despite a legal requirement for banks to allocate 12 % of their resources to microfinance, enforcement is lacking. The prevailing economic

[466] U.S. Agency for International Development. (2021). Sudan Energy Sector Assessment.

[467] Ibid.

[468] Ibid.

[469] Ibid.

[470] Ibid.

[471] Ibid.

conditions, characterized by hyperinflation and currency devaluation, have heightened risk aversion among banks, discouraging lending to these groups. Additionally, high transaction costs associated with engaging directly with individual smallholders further deter banks from extending loans to this population.[472]

Moreover, the finance sector in Sudan is governed by Islamic banking principles and regulations, which adhere to Sharia law and prohibit the charging or payment of interest. While these principles have their merits, they present challenges for microfinance due to strict requirements related to installment plans, maximum loan amounts, and permissible sectors for lending. As a consequence, financial technology companies, classified as service providers, are often ineligible to access credit under the framework of Islamic banking principles.[473]

Despite ongoing efforts to transition towards more inclusive banking practices and extend credit opportunities to small-scale producers, the progress achieved thus far has been limited. The insufficient availability of finance and capital acts as a barrier for farming communities residing in remote and rural areas of Sudan, hindering their ability to invest in technology and machinery that could enhance productivity and contribute to the development of sustainable livelihoods.[474]

The absence of financing mechanisms poses a significant challenge not only to farming communities but also to agribusinesses that depend on small-scale farmer production. Successful examples involving blended finance facilities or risk-sharing funds have demonstrated that incentivizing banks to provide access to small-scale producers can lead to increased production, improved yields, and enhanced value chain performance. The lack of capital and financing options acts as a major obstacle for farming communities to build resilience against economic downturns and other shocks. Interviews revealed that financial institutions and agribusinesses are interested in expanding access to insurance products, both to mitigate their own investment risks and to provide coverage against various risks. The emerging concept of mobile money is gaining attention in Sudan; however, limited infrastructure hampers its reach to the most vulnerable populations who would benefit the most from digital financial services. Additionally, fintech companies which have the potential to improve mobile money payment systems face constraints in accessing finance due to the principles of Islamic banking.[475] Nonetheless, there are emerging opportunities for MSMEs in the technology and solar energy sectors, where major conglomerates have limited presence. Sudan's innovation hubs, including 249 Startup Hub and Impact Hub Khartoum, actively support MSMEs and entrepreneurs, and their reach is expanding to regions such as Darfur, Gadarif, and Kassala states, aiming to provide opportunities beyond urban areas. Representatives from the energy sector have also emphasized the potential for advancements in this field. Despite these opportunities, MSMEs face a challenge as they are subjected to the same tax rate as larger businesses under Sudan's tax system.[476]

To address the issue of energy access, several energy companies in Sudan have prioritized the development of off-grid energy solutions as their primary focus. For example, MD Energy, an emerging MSME, specializes in providing solar energy solutions tailored for Sudan's agricultural and residential sectors. Both energy and non-energy companies have identified obstacles in promoting and expanding the adoption of solar energy in Sudan. One key challenge is the lack of data and awareness regarding the benefits of renewable energy, making it less appealing to potential users. Representatives from MD Energy highlighted that rural communities in Sudan often distrust the reliability and quality of available renewable energy options in the market. Moreover, the conventional energy supplied by the national grid is considerably cheaper than solar energy, providing little incentive for individuals to invest in solar as an alternative. [477]

3.5.4. Drawing the final threads: a resolute conclusion

Energy consumption in Sudan is on the rise, with traditional biomass being the primary source for energy needs, particularly in rural areas lacking electricity access. Despite this, electricity usage has been increasing at a significant rate of about 13% annually, yet only 47% of the rural population is currently connected to the electric grid.

In recent years, Sudan has witnessed a notable surge in the adoption of renewable energy installations, encompassing diverse sources such as hydro energy, biofuels, and solar energy for electricity generation. This pronounced shift towards renewable energy solutions aligns with the country's reliance on power imports and aims to address the burgeoning energy demand while fostering the utilization of clean and sustainable energy sources.

[472] Ibid.

[473] Ibid.

[474] Ibid.

[475] Ibid.

[476] Ibid.

[477] Ibid.

The decreasing costs associated with renewable energy technologies, notably in the domains of solar and wind power, have contributed significantly to their mounting competitiveness when compared to conventional fossil fuel-based power generation methods.

Potential, the untapped possibilities lying ahead, holds the key to Sudan's energy future.

Sudan possesses a considerable abundance of energy resources, encompassing renewables such as solar, hydro, wind, geothermal, and biomass. Currently, the utilization of renewable resources, with the exception of hydro and biomass, remains largely untapped. Notably, Sudan boasts a substantial solar energy potential, thanks to its strategic location as one of the 148 Sunbelt countries near the equator. This positioning contributes to exceptionally high metrics for solar energy generation, making it feasible for electricity production through photovoltaic (PV) or concentrating solar power (CSP) systems.[478] Additionally, Sudan is considering expanding its initiatives in solar power in the near future.[479]

The Sudanese power industry is poised to witness a notable dominance of hydropower as a key generating source. The nation's abundant water resources, particularly from the Nile River and its tributaries, present a favorable environment for the development of hydropower projects. The inherent potential to leverage its rivers for dam construction and power generation establishes hydropower as a viable and reliable electricity source.

Projected employment prospects in Sudan's renewable energy sector are expected to witness significant expansion in the coming years. With the government's ambitious target of producing 20% of the nation's electricity from renewable sources by 2030, the demand for skilled individuals in diverse roles within the renewable energy industry is set to increase notably.480

The Sudan Power Market is projected to grow from 4,344 MW in 2023 to 4,451.48 MW by 2028, with a CAGR of 0.49% during the forecast period. Despite the negative impact of COVID-19, the market has rebounded to pre-pandemic levels. In an effort to enhance electricity accessibility across the nation, the Sudanese government has proactively undertaken measures to promote the power sector. As a result, there has been a substantial increase in the demand for grid-connected electricity in recent times, which is expected to be a significant driver for market growth throughout the forecast period.

The growth of the Sudan power market faces challenges primarily stemming from the inadequacy of power transmission infrastructure and the persistently unreliable electricity supply. These factors have deterred private sector developers from making investments, thereby hindering the overall expansion of the Sudanese power market.

Several noteworthy renewable energy initiatives are in progress including efforts to diversify power generation beyond large-scale hydropower and thermal power. Solar and wind resource mapping exercises have been undertaken, and planning is underway for the installation of three wind projects totaling 300 MW and four solar PV projects totaling 20 MW. Feasibility studies and technical specifications have been completed for most of these projects.

Hurdles, formidable challenges to overcome, stand in the way of Egypt's energy ambitions.

The growth of the Sudan power market faces challenges primarily stemming from the inadequacy of power transmission infrastructure and the persistently unreliable electricity supply. These factors have deterred private sector developers from making investments, thereby hindering the overall expansion of the Sudanese power market. The government's efforts to increase electricity access are driving the demand for grid-connected electricity, but challenges in power transmission infrastructure and reliability hinder private sector investments. Sudan's plan to construct four nuclear power plants by 2030 presents promising opportunities for the power market's future.
The division of responsibilities has resulted in disjointed policymaking and hindered the widespread adoption of renewable energy in the market. The responsibility for renewable energy policymaking in Sudan lies with three interrelated entities; The General Directorate of Renewable Energy and Alternative Energy is tasked with resource assessment and planning, while the management of hydro resources falls under the purview of the aforementioned SHGC. Additionally, the SEDC oversees electricity distribution, including small home systems for rural electrification and rooftop solar installations. Capacity building, knowledge exchange, and interagency staff coordination have also been affected due to a weak

[478] UNDP, 2020. Empowering Sudan: Renewable Energy Addressing Poverty & Development

[479] https://www.iea.org/countries/sudan

[480] United Nations Development Programme. (2022, February 14). Sudan: Renewable energy jobs booming, but skills gap a challenge.

institutional planning framework.

Additionally, there is a lack of comprehensive policies and regulations to systematically promote energy efficiency in residential, commercial, and industrial sectors, compounded by inadequate institutional capacity.[481]

Moreover, Sudan faces economic and financial barriers in its efforts to advance renewable energy and energy efficiency. Rising government debt, high trade deficits, and depleting foreign reserves, along with persistently high inflation rates of 63% in 2018 and 50% in 2019, present significant challenges.

Unattractive low electricity tariffs deter private investments in power generation. For potential investors, the unattractive low electricity tariffs, especially the US$ 0.028/kWh rate for domestic customers, deter private investment in power generation, while the substantial government subsidies further strain public finances.

Additionally, the dispersed rural settlements across Sudan's vast land area make electric grid extension costly, and the limited paying capacity of rural customers offers minimal prospects for recouping investments, even for off-grid systems.[482]

Securing financing for different renewable energy initiatives remains a challenge. Furthermore, although a Renewable Energy Act and a Renewable Energy Master Plan are currently being developed, their completion is pending to create a favorable policy environment for renewable energy investments.[483]

The current transitional government grapples with a delicate political system and a considerable loss of oil revenues. South Sudan's separation in 2011 gave rise to a significant loss in oil revenues and hence the urgent need for both short-term stabilization and long-term structural reforms in the economy.

Potential investments in renewable energy continue to face obstacles as they are hindered by delays in finalizing a new electricity law and the absence of an approved IPP Act to encourage private sector involvement in power generation.[484]

3.6 Tunisia

Tunisia is recognized as one of the most climate change-vulnerable countries in the region due to escalating temperatures, rising sea levels, diminished rainfall, and extreme weather events like floods and droughts. These factors have heightened Tunisia's exposure to climate risks, leading to negative socio-economic and environmental consequences such as water scarcity, increased evapotranspiration, decreased agricultural land, output, and productivity, land salinization, and coastal erosion.[485]

In its recently adopted 2014 Constitution, Tunisia expressed its commitment to global climate change efforts by pledging to "provide the necessary resources to ensure a healthy and balanced environment and contribute to climate integrity" (Tunisia 2019). As a demonstration of its strong dedication, Tunisia ratified the Paris Agreement in 2017 and has also ratified the UNFCCC in 1993, the United Nations Convention to Combat Desertification in 1995, and the Convention on Biological Diversity in 2003.[486]

3.6.1 Exploring the interplay of demographics and identities: dynamics and implications

Tunisia, situated in the northernmost part of Africa, has its capital, Tunis, located in the northeastern region. The country spans a total surface area of 163,610 square kilometers (km2), with approximately 19% of the land being arable and the Sahara Desert covering over 30% of the territory. In 2017, the population of Tunisia reached 11.54 million, with an annual growth rate of 1.1%. Around 69% of the population resides in urban areas. Tunisia benefits from unique climatic characteristics, making it an emerging economic center and attractive tourist destination. The climate varies significantly across the country, with a Mediterranean climate in the north and along the coast, semiarid conditions in the interior and arid conditions in the south. The landscape presents diverse features, including mountainous regions in the northwest, steppes in the central area, extensive plains in the north, the Sahel region in the east, and desert terrain

[481] UNDP, 2020. Empowering Sudan: Renewable Energy Addressing Poverty & Development

[482] Ibid.

[483] Ibid.

[484] Ibid.

[485] Arab Sustainable Finance Forum. (2021).

[486] Ibid.

in the south.[487] Tunisia achieved an average annual Gross Domestic Product (GDP) growth rate of 4.3% from 2000 to 2010, positioning it as the most competitive economy in Africa. Despite political instability, the country demonstrated a rapid recovery in GDP growth following a recession in 2011, reaching 4.0% in 2012. Sustaining this level has been challenging, resulting in a growth rate of 2.6% in 2018.488 Presently, Tunisia faces various economic challenges, including the devaluation of the Tunisian dinar, which has contributed to significant increases in the public debt and the foreign trade deficit. As of September 2018, Tunisia's public debt amounted to 71.4% relative to GDP, while the foreign trade deficit expanded by 16.8% in 2017.[489]

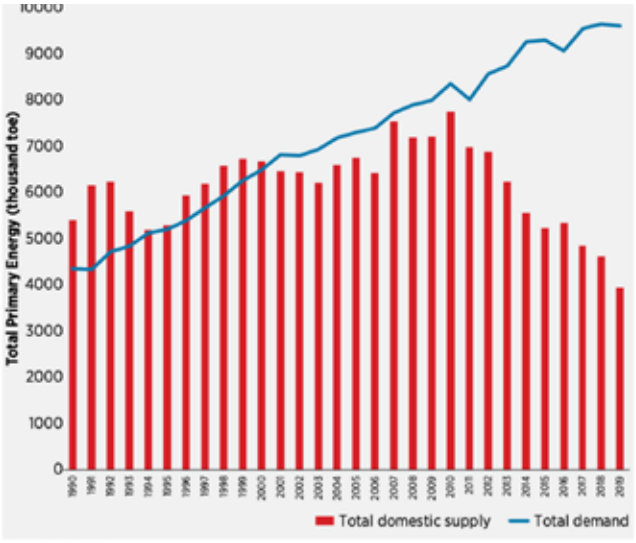
3.6.2 Energy outlook: trends, challenges, and future prospects

3.6.2.1 Analyzing energy trends: understanding energy demand, efficiency, sectoral distribution of consumers, and energy supply

The energy sector plays a significant role in Tunisia's economy across various sectors. Over the past two decades, the country has experienced a growing deficit in its energy balance, primarily due to reliance on fossil fuels such as oil and natural gas to meet the increasing energy demand. Declining domestic hydrocarbon resources have resulted in a heightened dependence on fossil fuel imports, reaching record levels in 2019, where the primary energy balance deficit stood at 5,672 thousand tonnes of oil equivalent (ktoe), as depicted in the Figure below. This indicates that 49% of the total energy consumed in Tunisia is imported. In response, Tunisia has initiated efforts to tap into its abundant renewable energy sources as a means to diversify its energy mix. Additionally, the country has implemented energy efficiency programs aimed at addressing the energy balance deficit.[490]

Generation Outlook, Energy supply and demand in Tunisia. Tunisia has achieved a high level of

Figure 30. Evolution of domestic primary energy supply and demand, Tunisia, 1990-2019



Source: MSME, 2019a

electrification, with 99.8% of the country having access to electricity. The energy generation mix is heavily reliant on natural gas, accounting for 97.5% of the electricity produced. This heavy dependence on natural gas raises concerns about Tunisia's energy security, as domestic production has experienced stagnation and decline in recent years. Domestic natural gas production has remained stagnant or even declined in recent years, necessitating increased imports from Algeria, which accounted for 61% of total national gas consumption in 2019. The volatile gas prices on the international market have further exacerbated supply costs and subsidies. With a current installed capacity of 5.4 GW, the average load factor stands at 44%. Between 1990 and 2019, primary energy production decreased from 5,400 ktoe to 3,703 ktoe. Notably, the production of oil and natural gas dropped significantly since 2010, with oil witnessing a 54% decrease and natural gas experiencing a 47% decrease, as depicted in Figure 3. In 2018, natural gas constituted 48.7% of the total primary energy supply (TPES), amounting to 5,569 ktoe, while oil (including primary and secondary oil) represented 40.8% of TPES, totaling 4,665 ktoe, as shown in the figure below (MISME, 2018b). The remaining energy supply largely relied on biomass and waste sources.

Tunisia's future appears promising as it possesses significant potential for renewable energy. The Tunisian National Agency for Energy Conservation (ANME) estimates the exploitable potential of photovoltaic energy to be several hundred gigawatts, with an average annual production of approximately 1,650 kWh/kWp given the average global horizontal radiation of around 1,850 kWh/m2. Additionally, ANME's Wind Atlas reveals favorable wind conditions, particularly in regions like Nabeul Bizerte and the central areas of Kasserine, Tataouine,

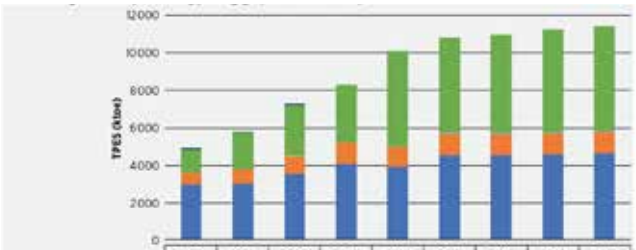
487 IRENA. (2021). Renewables Readiness Assessment: Tunisia. Abu Dhabi, United Arab Emirates: IRENA.

488 IRENA. (2021). Renewables Readiness Assessment: Tunisia. Abu Dhabi, United Arab Emirates: IRENA.

489 IRENA. (2021). Renewables Readiness Assessment: Tunisia. Abu Dhabi, United Arab Emirates: IRENA.

490 IRENA. (2021). Renewables Readiness Assessment: Tunisia. Abu Dhabi, United Arab Emirates: IRENA.

Figure 31. Total primary energy supply (TPES) by source, Tunisia, 1990-2018



	1990	1995	2000	2005	2010	2015	2016	2017	2018
Coal	82	71	79	0	0	0	0	0	0
Natural Gas	1234	1924	2732	3098	5083	5055	5209	5436	5569
Nuclear	0	0	0	0	0	0	0	0	0
Hydro	4	3	6	12	4	6	4	2	1
Geothermal, solar, wind	0	0	2	4	39	89	100	103	103
Biofuels and waste	638	750	934	1121	1058	1076	1081	1082	1090
Primary and secondary oil	2989	3053	3554	4087	5033	4573	4552	4612	4665

Sources: INS (2018a), MISME (2019a).

Médenine, and Gabès, with an estimated wind potential of 8,000 MW. To achieve its energy mix objective by 2030, Tunisia needs to install 3,815 MW of renewable energy capacity.[491]

Tunisia's energy mix comprises a combination of fossil fuels, renewable sources, and a growing emphasis on energy efficiency measures to meet the country's energy needs and promote sustainable development.

Fossil fuels. The utilization of fossil fuels in Tunisia has significant environmental implications, contributing to air and water pollution, as well as climate change. The Tunisian government acknowledges the need to decrease reliance on fossil fuels, yet this endeavor poses challenges. Presently, natural gas constitutes the primary energy source in Tunisia, representing approximately 97% of the nation's overall energy supply, while the remaining 3% is composed of other fossil fuels like oil and coal.[492] While Tunisia possesses limited oil reserves, it plays a notable role in oil product production. The country experienced its highest level of oil production during the early 1980s; however, output has been steadily decreasing since then.[493] Tunisia possesses minimal coal reserves and does not engage in domestic coal production. Instead, the country relies on coal imports to fulfill its limited demand for this energy source.[494] Tunisia encounters various challenges in reducing its dependence on fossil fuels. One of the main obstacles is the high cost associated with renewable energy technologies, which currently remain more expensive than traditional fossil fuels.Additionally, the lack of adequate infrastructure poses a significant challenge as the country's electricity grid requires substantial upgrades to accommodate the integration of renewable energy on a large scale. Furthermore, public acceptance of renewable energy projects is not unanimous, with some individuals expressing concerns about potential environmental impacts. Overcoming this opposition and fostering public support for renewable energy initiatives are essential tasks that need to be addressed in Tunisia's energy transition efforts.[495]

Renewable energy. Renewable energy sources play a minor yet expanding role in Tunisia's energy composition. Wind power, solar power, and hydroelectric power are the primary renewable energy sources in the country.496 Tunisia possesses considerable potential for renewable energy, boasting ample resources of solar, wind, biomass, and hydropower. The government is fully dedicated to the growth of the renewable energy sector, positioning the country favorably to emerge as a frontrunner in renewable energy within the Mediterranean region.

Solar energy. With an annual average of 3,000 hours of sunshine, Tunisia offers an ideal environment for harnessing solar energy. The nation has already established a solar power capacity exceeding 1 GW, and the government aims to augment this further by an additional 2 GW by the year 2030.[497]

Wind energy. Tunisia possesses favorable wind resources, characterized by average wind speeds ranging from 6 to 8 m/s. The nation has already implemented more than 2 GW of wind power capacity and is projected to introduce an additional 1 GW by 2030. In terms of biomass, Tunisia boasts substantial resources, including agricultural waste, forestry residues, and municipal solid waste. The country has already established over 100 MW of biomass power capacity and intends to augment this by a further 50 MW by 2030.[498]

Hydropower. Tunisia's hydropower resources are relatively limited, currently standing at approximately 100 MW of installed capacity. Nonetheless, the government

[491] IRENA. (2021). Renewables Readiness Assessment: Tunisia. Abu Dhabi, United Arab Emirates: IRENA.

[492] Tunisia's Energy Sector: A Just Transition Analysis: https://www.arab-reform.net/publication/tunisias-energy-sector-a-just-transition-analysis/, Arab Reform Initiative, 2020

[493] Hamdi, A., Rebai, A., & Ayadi, M. (2019). Multi-criteria analysis of electricity generation mix scenarios in Tunisia. Energy Policy, 128, 111198. https://doi.org/10.1016/j.enpol.2019.111198

[494] Ibid

[495] Ibid.

[496] Ibid.

[497] "Renewable Energy in Tunisia." REN21, 2022, www.ren21.net/country/tunisia.

[498] "Tunisia's Renewable Energy Targets." World Economic Forum, 2022, www.weforum.org/agenda/2022/01/tunisia-renewable-energy-targets/.

is exploring the potential for new hydropower projects, recognizing their reliability as a source of renewable energy.[499]

Imports. Tunisia relies heavily on energy imports, primarily in the form of natural gas. In 2020, approximately 75% of Tunisia's total energy requirements were met through imports.[500]

The Tunisian government has achieved notable success in promoting renewable energy. In recent years, there has been a significant rise in the number of renewable energy initiatives throughout the country. Presently, Tunisia has a combined installed capacity of approximately 472 megawatts (MW) from renewable sources, comprising 244 MW of wind power, 166 MW of solar power, and 62 MW of hydroelectric power. The energy landscape of Tunisia is expected to undergo further transformation in the coming years. Although the government's target of attaining a 35% share of renewable energy in the overall energy mix by 2030 is ambitious, it is feasible with sustained investment in renewable energy projects.

3.6.2.2 Pathways to energy transition: strategies, goals, and implementation plans for diversifying the energy mix and achieving sustainable energy goals

Key Stakeholders in the Energy Sector. Multiple institutions play a role in the governance of renewable energy deployment in Tunisia. These institutions provide support through various mechanisms, including the formulation of strategies, establishment of regulatory frameworks, and provision of grants and subsidies (more information on these institutions and their specific responsibilities).

The previously known Ministry of Energy, Mines and Renewable Energy is now known as the Ministry of Industry, Energy and Mines (MIEM). From March 2020 to October 2020, renewable energies were taken up by the Ministry of Energy,Mines and the Energy Transition. The Tunisian Government is acting as the licensing and regulatory authority through the ME. Its main mission is to define the strategic orientations of the energy sector, to set the energy tariffs, the prices for the transfer of surplus electricity from self-generators and the price of transmission through the network.From September 2018 to March 2020, renewable energies were taken up by Ministry of Industry and Small and Medium Enterprises.

The Technical Commission for the private production of electricity from renewable energies was created under Article 29 of Law 2015-12. Its mission is to issue an opinion on applications for authorization to carry out or grant concessions for electricity generation from renewable projects, as well as the extension and withdrawal of such authorization, and to examine any question submitted to it by the Minister responsible for energy relating to the implementation of renewable energy electricity generation projects.

Interdepartmental Commission for Independent Electricity Production (CIPIE): Based in the ME (Ministry of Energy), they oversee calls for tender, contract negotiations and proposals of advantages to be granted to concessionaires of independent electricity production projects. It has dealt with major projects such as Radès 2 Elmed Bizerte/ Kalaat Landalous and Barca British Gas. The members of CIPIE have the task of providing their expertise to their supervisory Ministry (the ME).

The National Centre for Continuous Vocational Training and Professional Promotion (Centre National de Formation Continue et de Promotion Professionnelle) manages the allocation of 1.5% of tax revenues for vocational training of professionals in the renewable energy field.

The National Centre for Instructor Training and Training Development (Centre National de Formation de Formateurs et d'Ingénierie de Formation) and the Mechanical and Electrical Industries Technical Centre (Centre Technique des Industries Mécaniques et Électriques) develop training programs and resources to disseminate the necessary knowledge and skills.

National Institute of Standardisation and Industrial Property (Institut National de la Normalization et de la Propriété Industrielle) is responsible for developing standards, certifying compliance, and ensuring that Tunisia's national certification system aligns with ISO standards.

The National Agency for Energy Management (ANME) was founded in 1985. It is an administratively independent governmental organization under the supervision of the Ministry of Industry, Energy and Mines. It is a non-administrative public establishment under the supervision of the Ministry in charge of energy. ANME designs and runs energy efficiency and renewable energy development programs. Its mission is to implement the State's policy in the field of energy management through the study and promotion of energy efficiency, renewable energy and energy substitution.This authority deals with problems relating to projects carried out including refusal to grant the agreement or agreement in principle or authorisation,

[499] "Hydropower in Tunisia." International Hydropower Association, 2022, www.hydropower.org/country/tunisia.

[500] Tunisia Energy Profile: https://www.iea.org/countries/tunisia, International Energy Agency, 2022

withdrawal of the agreement, agreement in principle or authorisation and disputes between the project company and STEG during the execution of the contract or its interpretation.

Tunisian Company of Electricity and Gas (STEG) is the historical electricity company in Tunisia. Initially a vertically integrated monopoly, it is now a dominant player in generation, is the sole purchaser of all electrical energy produced in Tunisia and has a monopoly on the transmission, distribution and marketing of electricity in Tunisia. Its installed power generation capacity in 2017 is 4,838 MW, which is more than 91% of the total installed capacity nationwide.

Tunisia National Adaptation Plan. Since the late 1980s, Tunisia has demonstrated a strong commitment to environmental protection. This includes the establishment of the National Environment Protection Agency in 1988, the development of the National Environmental Action Program in 1990, and the creation of the Ministry of Environment and Territorial Improvement in 1990. In 1994, the Tunisian Observatory for Environment and Sustainable Development was established to further enhance environmental efforts.[501]

Previously, Tunisia adopted a sectoral approach to climate adaptation, focusing on vulnerable sectors such as water, agriculture, health, coastline, and tourism. Close collaboration with development partners like the UNDP and GIZ facilitated the development of adaptation strategies. In recent years, Tunisia has made significant progress in developing its National Adaptation Plan (NAP) and establishing a National Roadmap for implementing both its Intended Nationally Determined Contributions (INDCs) and NAP. This progress emphasizes the importance of cross-sectoral coordination in shaping the adaptation planning framework.[502]

Tunisia has been proactive in adopting a sustainable energy framework since the mid-1980s, making it stand out among developing countries. The acceleration of the energy transition process in the mid-2000s was driven by global oil price increases and the country's growing energy deficit. To address these challenges, Tunisia implemented ambitious renewable energy and energy efficiency programs, aiming to meet national energy needs in a cost-effective manner while reducing vulnerability to oil price fluctuations.[503]

The main objectives of Tunisia's Sustainable Energy Policy include diversifying energy sources by reducing energy intensity and dependence on fossil fuels through the development of renewable alternatives. This not only enhances the country's economic competitiveness by reducing energy costs but also contributes to global climate change mitigation efforts by reducing greenhouse gas emissions.[504]

Tunisia adopted a three-year program (2005–2007) followed by a four-year program (2008–2011) to promote sustainable energy development by increasing investments in renewable energy and energy efficiency. To tackle the rising oil prices and their impact on the energy fiscal cost (estimated at 12% of GDP in 2007), Tunisia adopted a three-year program (2005–2007) followed by a four-year program (2008–2011). These programs aimed to promote sustainable energy development by increasing investments in renewable energy and energy efficiency. The energy-saving action plan for 2017–2030 outlines a total investment cost of over USD 11 billion and focuses on scaling up energy efficiency and renewable energy in sectors such as industry, residential buildings, transportation, public lighting, agriculture, and fishery.[505]

In 2009, Tunisia established its initial regulatory framework to enable the utilization of renewable energy for electricity generation. This was accomplished through the enactment of Law No. 2009-7 on February 9, 2009. The law permits households, businesses, and groups of companies across various economic sectors to harness renewable resources for their electricity needs. It also allows companies connected to medium voltage (MV) and high voltage (HV) grids to sell their excess power production to STEG (Société Tunisienne de l'Électricité et du Gaz). Decree No. 2009-2773, issued on September 28, 2009, sets forth the requirements and procedures for such projects.[506] Recognizing the importance of regulatory reforms to attract private investment in renewable energy development, the Tunisian government initiated discussions in 2012 to establish a new legislative framework that would be more appealing to diverse private developers.[507]

Government strategies and targets, Tunisia has formulated its Tunisian Solar Plan (PST) in 2010 in response to the worsening energy deficit and rising fossil fuel prices,

[501] Arab Sustainable Finance Forum. (2021).

[502] Ibid.

[503] Ibid.

[504] Ibid.

[505] Ibid.

[506] IRENA (2021). Renewables Readiness Assessment: Tunisia. Abu Dhabi, United Arab Emirates: IRENA.

[507] Ibid.

subsequently updated in 2015. The Tunisian Solar Plan (TSP) was formulated in 2009 with the primary objective of achieving a renewable energy penetration target of 30% in the national electricity generation mix by 2030. Additionally, the plan aimed to implement energy efficiency measures to reduce electricity demand by an average of 1.4% annually between 2013 and 2020. Implementation of the TSP was expected to result in significant greenhouse gas (GHG) emission reductions, estimated at 53 MtCO2 during this period. The key objectives of the TSP include the deployment of renewable energy, particularly wind and solar, in electricity generation, enhancing energy demand management and conservation, and fostering the growth of the solar energy equipment industry in Tunisia.[508]

From 2010 to 2016, a total of forty projects were implemented under the TSP, covering various areas such as solar power, wind power, energy efficiency, and research. The United Nations Development Programme (UNDP), in collaboration with the Global Environment Facility (GEF), supported the National Agency for Energy Conservation in developing a Nationally Appropriate Mitigation Action to assist the TSP's implementation.[509]

In 2012, Tunisia initiated the National Strategy on Climate Change, with a particular focus on mitigating climate change impacts in the economy, primarily in the energy sector. Tunisia has been at the forefront of developing nationally appropriate mitigation actions that target various sectors such as energy, cement, building, wastewater treatment, agriculture, and forestry, aiming to facilitate the transition towards a low-carbon economy.[510]

The strategy sets forth the following mitigation objectives:

- Achieving a reduction of approximately 60% in the carbon intensity of the entire economy by 2030 compared to 2009 levels. This will be accomplished through the implementation of energy efficiency policies and measures, resulting in a continuous annual decrease of 2-3% in carbon intensity.
- Increasing the share of renewable energy in electricity generation to 30% by 2030.
- Stabilizing greenhouse gas (GHG) emissions by 2050.

The Renewable Energy Law of 2013. The 2013 Renewable Energy Law in Tunisia serves as a regulatory framework for the advancement of renewable energy initiatives. One key provision of this law is the implementation of a feed-in tariff system, whereby producers of renewable energy are assured a predetermined price for the electricity they generate. This mechanism offers financial stability to renewable energy producers, incentivizing investment in the sector.

- Tax incentives: The legislation offers various tax incentives for renewable energy ventures, such as exemptions from import duties and taxes on equipment and materials.
- Land allocation: The law grants preferential access to land for renewable energy developers, facilitating the allocation of suitable areas for project implementation.
- Establishment of ANRT: The legislation establishes the National Agency for the Regulation of Electricity and Gas (ANRT) to oversee and enforce the provisions of the law. ANRT's responsibilities include granting licenses to renewable energy projects, overseeing sector performance, and offering technical and financial support to developers.

In 2014, Tunisia established an energy transition strategy relying on 2 main pillars; enhancing energy efficiency and expanding renewable energy sources; this strategy was then updated in 2019.[511] To address energy security challenges and reduce vulnerability to volatile international energy prices, Tunisia has embarked on an energy transition process aligned with its broader sustainable economic and social development strategy. In 2013, a national energy debate was initiated to define strategic objectives through extensive consultations with key stakeholders, including institutions, public and private organizations, civil society, experts, financial organizations, and academia. The outcome of this debate concluded that Tunisia must fully commit to an energy transition that strengthens energy security, preserves economic competitiveness, and safeguards the environment. The energy transition is based on an energy management strategy comprising two key components: enhancing energy efficiency and expanding renewable energy sources. The main objectives, established in 2014 and updated in 2019, are as follows:[512]

- Energy Efficiency: Implement policies and measures to promote the efficient use of energy, aiming to achieve a 30% reduction in overall primary energy consumption by 2030 compared to the baseline scenario.
- Renewable Energy: Increase the contribution of renewable energy in the electricity production mix, aiming to reach a 30% share by 2030.

[508] Arab Sustainable Finance Forum. (2021).

[509] Ibid.

[510] Ibid.

[511] IRENA. (2021). Renewables Readiness Assessment: Tunisia. Abu Dhabi, United Arab Emirates: IRENA.

[512] Ibid.

These objectives reflect Tunisia's commitment to fostering energy efficiency and renewable energy adoption to achieve a more sustainable and resilient energy system.[513]

In September 2015, Tunisia submitted its Intended Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCCC). Tunisia's INDCs outline its plans to reduce greenhouse gas (GHG) emissions in various sectors, including industry, energy, agriculture, forestry, land use, waste, and wastewater treatment. The goal is to achieve a 41% reduction in carbon intensity by 2030 compared to 2010 levels.[514] Tunisia's climate change mitigation efforts primarily target the energy sector, which is the largest emitter of GHGs. The aim is to achieve a 46% reduction in the sector's carbon intensity by 2030. Additionally, Tunisia's national adaptation efforts focus on reducing vulnerability to global warming and its impacts on crucial sectors such as water, agriculture, coastline, ecosystems, health, and tourism.[515]

According to Tunisia's INDCs, the country aims to achieve a 13% reduction in carbon intensity by 2030 compared to 2010 levels through unconditional contributions using domestic resources. An additional 28% reduction in carbon intensity is possible through conditional contributions, relying on international support in terms of financial resources, capacity building, and technology transfer. The estimated cost to achieve Tunisia's climate change mitigation and adaptation targets by 2030 is approximately USD 20 billion, accounting for both conditional and unconditional contributions.[516]

In 2015, Tunisia introduced new legislation, Law No. 12 of May 11, 2015, specifically focused on electricity generation from renewable energy sources. This law was implemented to promote renewable energy development, incentivize private-sector investments, and liberalize regulations pertaining to the production and potential export of clean energy. The law establishes three regulatory regimes to facilitate different types of projects:[517]

- Production projects for self-consumption.
- Independent Power Producers (IPPs) to fulfill local consumption requirements.
- IPPs aimed at export purposes.

Tunisia has embraced a new development model outlined in its National Development Plan (2016–2020) that focuses on transitioning to a greener economy. The plan aims to achieve several key objectives, including promoting sustainable development and the green economy, fostering human development and social inclusion, reducing poverty, and ensuring balanced regional development.[518] To achieve these goals, the plan targets an average annual economic growth rate of 4%, which is significantly higher than the average of less than 2% recorded during the 2011–2015 period. Additionally, the plan aims to reduce poverty rates from 4.6% to 2% and create 400,000 new job opportunities.[519]

The National Development Plan (2016–2020) aligns with Tunisia's Sustainable Development Strategy (2014–2020), which emphasizes the integration of sustainability considerations into national policies. This includes promoting sustainable production and consumption, optimizing natural resource management, fostering balanced regional development, and enhancing capacity building for climate change adaptation.[520]

In 2018, the Tunisian government established the National Climate Change Unit, operating under the Ministry of Local Affairs and Environment. The primary function of this unit is to coordinate, monitor, and implement climate change activities across all sectors. Key responsibilities of the unit include developing the National Adaptation Plan and overseeing two advisory committees dedicated to mitigation and adaptation. Additionally, the unit is tasked with integrating climate change considerations into the national development planning framework, enhancing stakeholders' capacity, and monitoring the implementation of the Intended Nationally Determined Contributions (INDCs).[521]

3.6.2.3 Powering the transition: a focus on financing

Financial flows into Tunisia's climate mitigation and adaptation. The Tunisian government, in its Intended Nationally Determined Contributions (INDCs), has outlined the financial resources necessary to achieve its

[513] Ibid.

[514] Arab Sustainable Finance Forum. (2021).

[515] Ibid.

[516] Ibid.

[517] IRENA. (2021). Renewables Readiness Assessment: Tunisia. Abu Dhabi, United Arab Emirates: IRENA.

[518] Arab Sustainable Finance Forum. (2021).

[519] Ibid.

[520] Ibid.

[521] Ibid.

climate change mitigation and adaptation objectives. The total funding requirement for this endeavor is estimated at USD 20 billion from 2015 to 2030. Of this amount, approximately USD 17.5 billion is allocated to climate change mitigation, while the remaining USD 1.9 billion is dedicated to adaptation efforts. According to the INDCs, the energy sector will receive more than 80% of the funding for climate change mitigation, as it is the largest contributor to Tunisia's greenhouse gas emissions. In terms of adaptation, the majority of the funding needs are associated with institutional support, capacity building, and research and development initiatives.[522]

Establishing the Energy Transition Fund. In 2014, Tunisia established the Energy Transition Fund to support its national energy transition agenda. The agenda focuses on enhancing energy sector management with a particular emphasis on energy efficiency and renewable energy. The goals of the agenda include a 30% reduction in primary energy demand and a 30% increase in the share of renewable energy in electricity production by 2030. The Energy Transition Fund replaced the National Energy Management Fund, offering a broader range of interventions and initiatives. Tunisia acknowledges in its Intended Nationally Determined Contributions (INDCs) that the Transition Fund requires international funding support to enhance its financial resources, which are partially generated through energy consumption taxes.[523]

Climate funding initiatives in Tunisia aim to support the country's efforts in mitigating and adapting to climate change by providing financial resources and assistance for the implementation of sustainable projects, renewable energy infrastructure, and initiatives to enhance resilience and reduce greenhouse gas emissions. Below listed are examples of the most notable climate funding initiatives in Tunisia.

The Adaptation Fund (AF).Tunisia has benefitted from various climate funds aimed at addressing climate change impacts and fostering sustainable development. The Adaptation Fund (AF) has allocated approximately USD 10 million to support Tunisia's integrated natural resource management and livelihood project. Implemented in the rural Kairouan region, this initiative aims to enhance sustainable land management practices, reduce poverty, and enhance the resilience of rural communities to climate change, safeguarding their livelihoods.[524]

The Green Climate Fund (GCF). The GFC has also played a role in supporting climate change mitigation and adaptation efforts in Tunisia through several projects. One such project focuses on sustainable energy financing facilities and is implemented in collaboration with the European Bank for Reconstruction and Development (EBRD). Additionally, the GCF has provided funding support for its Green Cities Facility project, which aims to facilitate the transition of cities, including Tunisia, towards low-carbon and climate-resilient urban development. This initiative, implemented in coordination with the EBRD, aims to promote sustainable and climate-friendly practices in urban settings.[525]

The High Impact Program for the Corporate Sector. Another significant project supported by the GCF in collaboration with the EBRD is the High Impact Program for the Corporate Sector. This project seeks to drive a structural transformation within energy-intensive industries, non-fossil energy mining companies, agribusinesses, and related value chains by facilitating decarbonization processes. These climate funding initiatives demonstrate the commitment to promoting sustainable development and resilience in Tunisia, fostering a transition towards a more climate-friendly and sustainable future.[526]

3.6.2.4 Powering sustainable jobs: employment opportunities in renewable energy

As per a 2016 study conducted by Schäfer, the energy sector is a significant generator of jobs in Tunisia, representing approximately 5% of total employment. It is also a notable recipient of foreign direct investment, with more than $1 billion invested in renewable energy projects in recent years. According to the International Labour Organization (ILO) data from 2020, employment in the energy sector accounted for around 10% of total employment in Tunisia. The state-owned electricity company, STEG, is the dominant employer in the sector, with a workforce of approximately 20,000 individuals. Other prominent employers in the sector include oil and gas companies like ETAP and ENI, as well as renewable energy companies such as Engie and Sonelgaz.[527] The aforementioned study indicates that the renewable energy sector in Tunisia has the capacity to generate approximately 100,000 employment opportunities by 2030. The study identifies solar photovoltaics, wind power, and biomass as the most favorable areas for job creation within

[522] Ibid.

[523] Ibid.

[524] Ibid.

[525] Ibid.

[526] Ibid.

[527] International Labour Organization (ILO). "Tunisia: Employment in Renewable Energy." ILO, 2020, www.ilo.org/tunisia/lang–en/index.htm.

the renewable energy sector.[528] As per the World Bank, the energy sector in Tunisia had a workforce of 100,000 individuals in 2019. It is projected that by 2030, the sector will generate an additional 100,000 job opportunities, with a significant share of these positions arising in the renewable energy sector.[529] According to IRENA, the renewable energy industry in Tunisia has the potential to generate approximately 200,000 employment opportunities by the year 2030. The sectors with the most promising prospects for job creation include solar photovoltaics, wind power, and biomass.[530] The Ministry of Energy in Tunisia has established a target of achieving 30% of the nation's electricity generation from renewable sources by 2030. This objective is anticipated to result in substantial job openings within the renewable energy sector.[531] The Tunisian government's endeavors to advance the renewable energy sector are being backed by the African Development Bank, aiming to stimulate job creation and foster economic growth.[532]

The Tunisian government is collaborating with the UNDP to enhance the development of the country's renewable energy sector. The UNDP is offering technical support and expertise to assist Tunisia in cultivating a proficient workforce specialized in renewable energy.533 According to the Global Wind Energy Council (GWEC), the wind energy sector in Tunisia has the potential to generate approximately 100,000 job opportunities by 2030. The installation and maintenance of wind turbines are identified as the key areas for employment growth in this sector.534 According to Solar Power Europe (SPE), the solar photovoltaic (PV) industry in Tunisia has the potential to generate around 100,000 employment opportunities by 2030, primarily in the installation and upkeep of solar PV panels.[535] The International Labour Organization (ILO) has recognized the energy sector as a significant industry for generating employment in Tunisia. Collaborating with the Tunisian government, the ILO is involved in formulating policies that will foster job growth within the energy sector.[536] In partnership with the Tunisian government and private sector, the Tunisian Association of Renewable Energy (APERE), a non-profit organization dedicated to advancing renewable energy in Tunisia, is actively engaged in facilitating job creation within the renewable energy sector.[537]

3.6.3 Exploring the landscape of micro, small, and medium-sized enterprises (MSMEs)

3.6.3.1 Examining the profile of micro, small, and medium-sized enterprises (msmes) and their engagement with renewable energy: policies, adoption, and access to climate finance

SMEs in Tunisia hold great potential for driving economic growth and job creation, especially in technology-related sectors. According to the World BankMSMEs in Tunisia account for 98% of all firms and they account for 70% of employment. The Bank also estimates that MSMEs constitute 40% of GDP.[538] In order to unlock this potential, significant and systematic investments are needed in areas such as business financing, digital infrastructure, and workforce development. Currently, SMEs face obstacles such as high costs of doing business, government control over key markets, and skill gaps in the workforce. Addressing these constraints is crucial to encourage economic expansion and job growth in Tunisia, particularly within the technology sector, and to tap into untapped regional markets.

Recognizing the significant role of cluster policies in supporting the growth of micro, small, and medium-sized enterprises (MSMEs), Tunisia has established various initiatives such as technological parks, competitiveness areas, and business incubators. These endeavors aim to foster collaboration among large companies, start-ups, and higher education institutions, providing essential training

[528] Schäfer, Isabel. "The Renewable Energy Sector and Youth Employment in Algeria, Libya, Morocco and Tunisia (2016)." ResearchGate, 1 Jan. 2016,

[529] "Tunisia: Employment in the Energy Sector." The World Bank, 2020, www.worldbank.org/en/country/tunisia/publication/tunisia-employment-energy-sector.

[530] "Tunisia: Renewable Energy." International Renewable Energy Agency (IRENA), 2020, www.irena.org/countries/tunisia.

[531] "Tunisia: Energy." Ministry of Energy, Mines and Hydraulic Resources, 2020, www.energie.gov.tn/en/.

[532] "Tunisia: Energy Sector." African Development Bank, 2020, www.afdb.org/en/countries/tunisia/sector/energy.

[533] "Tunisia: Renewable Energy." United Nations Development Programme (UNDP), 2020, www.undp.org/tunisia/content/renewable-energy-tunisia

[534] "Tunisia: Wind Energy." Global Wind Energy Council (GWEC), 2020, www.gwec.net/country/tunisia.

[535] "Tunisia: Solar PV." Solar Power Europe (SPE), 2020, www.solarpowereurope.org/country/tunisia.

[536] "Tunisia: Employment in Renewable Energy." International Labour Organization (ILO), 2020, www.ilo.org/tunisia/lang–en/index.htm.

[537] "APERE: Association Tunisienne des Energies Renouvelables." APERE, 2020, www.apere.tn/.

[538] "Tunisia: MSMEs." The World Bank, 2020, www.worldbank.org/en/country/tunisia/publication/tunisia-msmes.

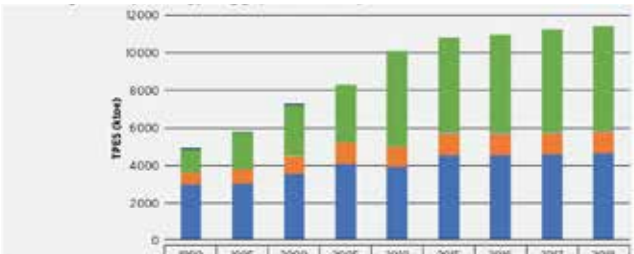
and support to small and innovative enterprises. Since the 2011 revolution, international donors such as the Qatar Friendship Fund and the German Cooperation Agency have demonstrated increased interest in supporting high-value-added MSMEs in Tunisia, reinforcing existing partnerships and contributing to the development of the sector.[539]

The structure of the MSME sector in Tunisia. Tunisia's MSMEs sector is characterized by the prevalence of micro firms, both domestic and foreign. Micro firms make up the majority, accounting for 90% of foreign firms and 98% of national firms based on 2014 data. Small firms are dominant in the private sector, as highlighted in the World Bank Development Policy Review (2005), but their productivity is comparatively lower than that of larger firms. [540]

In Tunisia, micro firms are the most prevalent type of MSMEs, including both domestic and foreign firms. According to 2014 data, micro firms represent 90% of foreign firms and 98% of national firms. The World Bank Development Policy Review (2005) confirms that small firms dominate the private sector in Tunisia, but their productivity is relatively low compared to larger firms. Interestingly, even the most productive firms in Tunisia face challenges in achieving growth and effectively utilizing resources. There appears to be a lack of resource reallocation towards more productive firms, indicating that productivity and innovation are not adequately rewarded in the country.[541]

The decision to remain small, limit recruitment, and restrict capital investments is a deliberate choice aimed at minimizing risks of predation. Surprisingly, this lack of ambition persists even after the revolution. According to the Tunisian Institute for Competitiveness and Quantitative Studies' annual report for 2015, only 45% of interviewed firms reported making investments in 2014, compared to 47% in 2013 and 55% in 2012. Furthermore, only 37% of firms that invested in 2014 initiated the modernization of their production equipment. This behavior is likely influenced by actual or perceived

Figure 32. Mean TFP by firm size



	1990	1995	2000	2005	2010	2015	2016	2017	2018
Coal	82	71	79	0	0	0	0	0	0
Natural Gas	1234	1924	2732	3098	5083	5055	5209	5436	5569
Nuclear	0	0	0	0	0	0	0	0	0
Hydro	4	3	6	12	4	6	4	2	1
Geothermal, solar, wind	0	0	2	4	39	89	100	103	103
Biofuels and waste	638	750	934	1121	1058	1076	1081	1082	1090
Primary and secondary oil	2989	3053	3554	4087	3933	4573	4552	4612	4665

Source: EMNES Report

political instability, insecurity, institutional barriers, and distorted incentives. Across most sectors, the average annual productivity growth rates remain below 1%.[542]

The distribution of Tunisian firms by activity shows that medium and large firms are primarily engaged in the industry sector, accounting for 58% of the total. On the other hand, the majority of micro and small firms operate in the tertiary sector, with micro firms representing 89% and small firms representing 56% of the sector.

Supporting Actors and Policies for the Tunisian MSME Sector. At the national level, the Ministry of Training and Employment and the Ministry of Trade and Tourism play key roles in formulating policies to support MSMEs. Meanwhile, the Regional Development Offices, under the supervision of the Ministry of Economic Development, focus on promoting economic growth in disadvantaged areas within their respective regions.

In terms of private sector involvement, the Chambers of Commerce plays a significant role in influencing policy development through lobbying activities. They contribute to the promotion, market expansion, and internationalization of private businesses. The Industry, Trade and Handicrafts Federation serve as the primary representative body for the private sector in negotiations and social dialogue.

Several government entities are responsible for providing guidance, assistance, and training to small business promoters. The Ministry of Training and Employment, along with its subordinated offices like ANETI and

[539] Mouelhi, R. (2017). Tunisia. In R. Ayadi & E. Sessa (Eds.).

[540] Morsy, H., Kamar, B., & Selim, R. (2018). Tunisia Diagnostic paper: Assessing Progress and Challenges in Unlocking the Private Sector's Potential and Developing a Sustainable Market Economy. European Bank for Reconstruction and Development. https://www.ebrd.com/documents/strategy-and-policy-coordination/tunisia.pdf

[541] Morsy, H., Kamar, B., & Selim, R. (2018).

[542] Ibid.

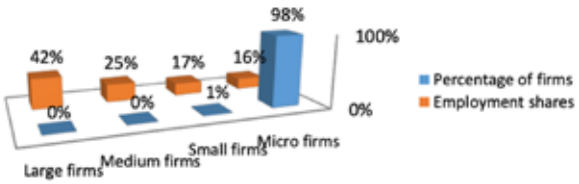
Espace Entreprendre, have the mandate to support small business development. Additionally, the Ministry of Trade and Tourism oversees the National Handicrafts Office and the National Office of Tourism, which coordinate the development of their respective sectors, where MSMEs are prevalent.[543]

3.6.3.2 Assessing the drivers and impediments for MSMEs in adopting renewable energy technologies: country-level analysis

Promoting entrepreneurship and enhancing competition in Tunisia. In late 2016, the chamber of deputies in Tunisia introduced a new investment code with the objective of fostering entrepreneurship, streamlining firm entry and exit processes, and stimulating competition across diverse sectors. This code, which became effective in April 2017, is anticipated to generate higher levels of competition and incentivize low-productivity firms to either upgrade their operations or exit the market, ultimately leading to overall improvements in productivity. To ensure the effectiveness of public subsidy programs and align them with the country's development objectives, the Tunisia Development Policy Review (2015) emphasized the importance of rigorous assessments and monitoring.[544]

The Role of the MSME Sector in Economic Contribution: Primary Challenges to Job Creation in the Tunisian MSME Sector. Micro firms make up around 98% of all firms in the private sector, indicating their dominance. Despite their large presence, micro firms only contribute to 16% of total employment. On the other hand, large firms employing over 200 workers represent only 0.1% of all firms but account for 42% of total employment. In summary, medium and large firms with more than 50 workers collectively contribute to over 50% of total employment. The Global Competitiveness Survey of 2014-2015 ranks Tunisia poorly in terms of labor market efficiency, placing it 129th out of 144 countries. This is primarily attributed to inflexible wage determination, restrictive hiring and firing practices, and a lack of cooperation between employers and employees. These stringent labor regulations contribute to the prevalence of informal employment and a higher proportion of low-skilled jobs. As a result, some businesses opt for informality or limit their workforce size to avoid compliance with these regulations. In comparison to its North African counterparts like Morocco and Egypt, Tunisia has a significantly lower number of large firms.[545]

Figure 33. Employment shares of Tunisian firms in 2014 by size



Source: EMNES report authors' own computation using RNE database.

In Tunisia, a significant proportion of firms (54%) perceive political instability as a major hindrance to their growth. Since the revolution in 2011, many managers and entrepreneurs have adopted a cautious approach, leading to 41% of firms refraining from making investments in 2014, citing political troubles as the primary reason for their restrained management.

Unfair market practices, including unfair competition, fiscal evasion, informal networks, and low prices, have also been prevalent. Surveys conducted by the Tunisian Institute of Competitiveness and Quantitative Studies in 2013 and 2014 revealed an increase in such practices following the revolution. In 2014, 37% of the interviewed firms considered unfair competition a significant obstacle to their business, compared to 43% in 2009.[546]

According to the World Bank's Ease of Doing Business annual report in 2016, Tunisia ranked 74th out of 189 countries. The country also ranked poorly (91st) in the "trading across borders" criterion, which measures the time and cost associated with imports and exports. In terms of "protecting minority investors," Tunisia was ranked 105th among 189 countries. Furthermore, the country experienced a decline in its ranking for the "starting a business" criterion, dropping to 103rd place, a decline of 56 places between 2010 and 2015. In comparison, Morocco ranked 54th in this criterion.

Access to Credit as a Significant Constraint in Firm Management. Access to finance is a significant hurdle for the establishment and growth of businesses in Tunisia, particularly for micro enterprises that make up the majority of the private sector. The Tunisian Institute for Competitiveness and Quantitative Studies conducted a survey revealing a paradox: while 55% of interviewed firms reported having obtained a loan, which is relatively high compared to neighboring countries (Egypt 6%, Turkey 40%, Morocco 50%), 27% of managers still perceive access to bank financing as a major constraint.[547]

[543] Morsy, H., Kamar, B., & Selim, R. (2018).

[544] Mouelhi, R. (2017). Tunisia. In R. Ayadi & E. Sessa (Eds.).

[545] Ibid.

[546] Morsy, H., Kamar, B., & Selim, R. (2018).

[547] Ibid.

According to the report from the International Monetary Fund (IMF), Tunisia's public institutions are deemed ineffective in ensuring transparency and accountability. The country's performance in areas such as corruption, property protection, and judicial independence falls below that of comparable peers. The presence of regulatory barriers and anti-competitive practices, including excessive approval requirements and restrictions on investment in specific sectors, hinders the development of the private sector.[548] The 2016 country report by the International Monetary Fund confirms that domestic firms in Tunisia face limited access to finance due to credit rationing by domestic banks. This limitation is partly attributed to the absence of an appropriate and effective legal framework, which increases the perceived risk for banks. For instance, the bankruptcy law, combined with a weak judicial system, hinders banks from efficiently recovering collateral from delinquent loans.

Additionally, the annual survey conducted by the Tunisian Institute of Competitiveness and Quantitative Studies on 1200 firms in Tunisia highlights several constraints impeding growth prospects. These include the unavailability of suitable candidates for employment, the lack of operational diplomas and the requirement for long traineeships, and high absenteeism rates, particularly among export-oriented micro, small, and medium-sized enterprises (MSMEs).[549]

Tunisia's private sector faces challenges, including the dominance of the public sector and inefficient state-owned enterprises (SOEs), leading to limited growth and job creation for small firms. Five key obstacles hinder private sector development and firm performance.

In the renewable energy sector, which is gaining importance globally and in the region, the state-owned Tunisian Company of Electricity and Gas (STEG) holds significant control over project development, impeding private sector involvement in green energy production. Lack of transparency regarding technical and operational matters directly affecting private renewable energy projects and subsidized pricing practices undermine the commercial viability and sustainability of renewable projects.[550]

To meet Tunisia's Nationally Determined Contributions (NDC targets) set by the government in 2016, substantial private sector investment and the removal of regulatory barriers are required in the renewable energy sector.551

3.6.4. Drawing the Final Threads: A Resolute Conclusion

Tunisia is recognized as one of the most climate change-vulnerable countries in the region due to escalating temperatures, rising sea levels, diminished rainfall, and extreme weather events like floods and droughts. Tunisia faced a sluggish economic recovery in 2022, primarily attributed to regulatory obstacles hindering growth and the escalation of global energy and food costs.[552] Prompt action is needed to implement reforms that enhance the business climate and foster competition in Tunisia. The country's climate change mitigation efforts primarily target the energy sector, which is the largest emitter of GHGs. The aim is to achieve a 46% reduction in the sector's carbon intensity by 2030. Additionally, Tunisia's national adaptation efforts focus on reducing vulnerability to global warming and its impacts on crucial sectors such as water, agriculture, coastline, ecosystems, health, and tourism.[553]

Tunisia is actively pursuing renewable energy capacities to reduce its heavy reliance on gas, which currently accounts for 86% of its installed capacity and 95% of power generation as of 2020. In contrast, renewables constituted only 13% of installed capacity and 5% of power generation in the same year. The country heavily depends on gas imports to meet its primary energy demands, with nearly 97% of its electricity generation sourced from gas in 2016. Nevertheless, the energy policy in Tunisia is now shifting the focus towards renewable energy, leading to significant growth in wind power generation since 2014.[554]

Potential, the untapped possibilities lying ahead, holds the key to Tunisia's energy future.

[548] Mouelhi, R. (2017). Tunisia. In R. Ayadi & E. Sessa (Eds.), Micro, Small and Medium Sized Enterprises Development in Egypt, Jordan, Morocco & Tunisia: Structure, Obstacles and Policies (EMNES Studies, Vol. 3). EMNES.

[549] Morsy, H., Kamar, B., & Selim, R. (2018).

[550] Morsy, H., Kamar, B., & Selim, R. (2018). Tunisia Diagnostic paper: Assessing Progress and Challenges in Unlocking the Private Sector's Potential and Developing a Sustainable Market Economy. European Bank for Reconstruction and Development. https://www.ebrd.com/documents/strategy-and-policy-coordination/tunisia.pdf

[551] Ibid.

[552] Tunisia Economic Monitor, Spring 2023: Reforming Energy Subsidies for a More Sustainable Tunisia

[553] Arab Sustainable Finance Forum. (2021).

[554] https://www.iea.org/countries/tunisia

Blessed with good wind and solar resources, Tunisia is well positioned for investment in utility-scale renewable energy projects. Wind and solar PV provide the opportunity to improve Tunisia's energy security, to meet growing energy demand, and to create a future power-export industry for Tunisia and can also support Tunisia's contributions to climate change under the UNFCCC. A report conducted in 2018 by the UNDP uses the methodology to systematically identify public de-risking measures to target investment risks in Tunisia's energy environment. The modeling demonstrates that investing in public de-risking measures creates significant economic savings in achieving the investment objectives in Tunisia's Solar Plan and it also clearly shows that investing in public de-risking measures should in every case be more cost-effective for Tunisia. The end result can be more reliable, affordable and clean power for Tunisian citizens.[555]

For example, certain electrical and mechanical components of wind turbines can be produced locally that could account for more than 70% of wind turbine costs. Tunisia has well-qualified staff for research and development activities, such that intellectual property rights are well protected, and the quality of its research institutes is acknowledged. Despite these assets, upgrading programmes are necessary for local companies to move from low-value to relatively high value activities.[556]

Deployment of renewable energy presents considerable socioeconomic benefits and opportunities for local value creation along the various segments of the value chain. IRENA's assessment of Tunisia's renewable energy manufacturing potential found that there is unfulfilled potential to leverage local value creation along the entire value chain of large-scale solar and wind projects.[557]

Hurdles, formidable challenges to overcome, stand in the way of Tunisia's energy ambitions.

Tunisia does not have a solid long-term timeframe to account for capacity additions. Achieving higher shares of renewable energy in the electricity mix - as well as successful integration of VREs such as wind and solar energy - into the national electricity grid requires an integrated long-term energy planning process. The integrated planning for the period 2017–2022 was set mainly by MIEM (Ministry of Industry, Energy and Mines) with reference to the objectives of the TSP. The preparatory phase of this programme did not consider the various aspects relating to the implementation of energy planning, such as access to land.558A comprehensive least cost assessment for the development of generation assets, however, is yet to be developed, in addition to a corresponding assessment of the cost of reinforcing the electricity grid.[559]

The implementation of grid infrastructure projects by STEG, is subject to lengthy public procurement procedures, delaying the evacuation of electricity from the completed renewable energy projects. STEG is currently developing studies for the development and reinforcement of the national electricity grid infrastructure to align renewable generation development with grid infrastructure reinforcement to enable smooth integration of renewable electricity, yet the process is lengthy due to the complex procedures.

Under the Self-consumption scheme, developers are subject to complex administrative procedures. Furthermore, based on past experiences - and given the inadequacy of information and lack of clarity on the regulatory environment and tendering process - stronger involvement of key stakeholders in the revision process of the regulatory framework would enable addressing some of the key concerns of private investors. The lengthy administrative procedures particularly discourage small-scale renewable energy project developers from advancing their projects.[560]

In addition, the current regulatory framework stipulates a complex metering and billing system for establishments connected to the MV grid, which are registered under the uniform tariff regime. This mode of energy metering excludes those consumers that do not match the required renewable energy production profile, including solar PV projects by local administrations for public lighting purposes. [561]

[555] United Nations Development Programme (UNDP). (2018). DREI Tunisia 2018_Key Points (English) (Aug 2018)

[556] International Renewable Energy Agency (IRENA). (2021). Renewable Readiness Assessment: The Republic of Tunisia. Abu Dhabi: IRENA.

[557] International Renewable Energy Agency (IRENA). (2021). Renewable Readiness Assessment: The Republic of Tunisia. Abu Dhabi: IRENA.

[558] International Renewable Energy Agency (IRENA). (2021). Renewable Readiness Assessment: The Republic of Tunisia. Abu Dhabi: IRENA.

[559] Ibid.

[560] Ibid.

[561] Ibid.

Due to their highly intricate transaction structures, these projects require customized and complex legal and financial solutions, which have been inherited by renewables. The energy sector today has a legacy where power generation projects were predominantly large in scale and technically complex. This has resulted in high transaction costs and prolonged project development timelines, hindering further capacity growth, particularly in small- to medium-scale renewable energy projects.[562]

The tariffs for the sale of surplus electricity produced are currently set at low levels and have not been revised since 2014, despite multiple increases in electricity prices. This has constrained growth in electricity production, pushing self-consumers to reduce their installed renewable capacity to levels in line with their own consumption needs, rather than selling excess production to STEG.[563]

The absence of any guarantee scheme regarding the off-taker risks limits the attractiveness of PPAs. With respect to the Authorisation scheme, one of the main concerns for private developers is the absence of standardized contractual documents for bid submissions, thus resulting in discrepancies and lack of transparency, eventually reducing the bankability of PPAs.[564]

Additionally, private developers have often raised concerns pertaining to land acquisition. With the interest shown by these developers in regions with high potential for renewable energy and within proximity of the grid, the price of such land has increased considerably. These landholdings are generally agricultural, and several administrative procedures must be followed to obtain the authorisation to use them for renewable energy facilities. This situation has prompted developers to search for state land; however, renewable energy Law No. 2015-12 does not set clear criteria for the allocation of state land to private investors. To overcome this problem, MIEM (Ministry of Industry, Energy and Mines) is considering an alternative law that allows temporary occupation of state land by the private sector for a period not exceeding three years.[565]

The substantial number of actors involved poses a challenge in the absence of a clear and transparent definition of the responsibilities of each institution, sometimes resulting in conflicting roles. Current procedures for the execution of renewable energy projects involve several ministries and public institutions, thus causing challenges in the absence of a clear, structured, and transparent system.

The absence of an independent regulatory authority for the electricity sector. This regulatory function is currently performed by MIEM. Law No. 2015-12 provides for the creation of a specialized authority responsible for the examination of possible disputes and appeals against decisions of the public administration. At present, however, the specialized authority functions as an advisory body to provide recommendations to MIEM, raising concerns over guaranteeing investors' rights and ensuring transparency during the development, execution and operation of renewable energy projects.[566]

The FTE is the main financing tool for renewable energy and energy efficiency, however its practicality has not yet been tested and its contributions remain limited. The actions financed by this fund and the forms of its support have been broadened through in 2017. The practicality of these new schemes is not yet tested, and the participation of the FTE is still limited to grant contribution to renewable projects. The payment of such grant support by the ANME - in charge of managing the FTE - is currently processed with significant delay, causing serious financial problems for companies that are active in the fields of solar water heating and solar PV.

The law establishing the FTE envisages the possible imposition of taxes on consumed energy products to resource the FTE, but no provision has been made so far to this effect. In addition, the incentives granted by the FTE cover a small proportion of the investment.

In the realm of business and economic growth, MSMEs play a vital role as small and medium-sized enterprises with significant potential for innovation and job creation.

The implementation of the current regulatory framework for renewables presents several obstacles and challenges for private sector participation. Strengthening the confidence of private investors to invest in renewables would require the enhancement of relevant primary and secondary legislation (particularly, Law No. 2015-12, Decree No. 2016-1123 and ministerial orders of 9 February 2017).

The development of renewable energy solutions, especially for farmers and small- and medium-size enterprises (SME), requires a stronger involvement of local banks in the

[562] Ibid.

[563] Ibid.

[564] Ibid.

[565] Ibid.

[566] Ibid.

financing of renewable energy projects. The technical dimension of local banks may need to be reinforced to develop capacity for renewable energy projects. Appropriate partnership/ co-financing mechanisms should be explored with international financing institutions and bilateral funding partners, including climate funding instruments and programmes, to meet the country's NDC commitments. In turn, allowing local banks to serve as a financial intermediary to receive resources from international banks may address risk concerns surrounding lending procedures. In this case, setting up credit lines through intermediary financial institutions tends to attract investments to the sector.[567]

Access to bank loans represents a major constraint for renewable energy developers, especially for small projects. Renewable energy promoters generally seek to close the financing of their projects through bank credits. Accessibility to bank loans continue to represent a major hurdle for renewable energy developers, particularly small projects, since local banks are not accustomed to assuming renewable energy project-specific risks and generally require additional guarantees as a precondition for loan approval.[568]

Industrial upgrade programmes can serve as strong assets in the effort to strengthen the capabilities of local firms. These programmes would aim to enhance the technological capabilities of SMEs by enabling them to capture value from renewable energy investments and to facilitate closer linkages with business partners. Therefore, with the support of public authorities and other local stakeholders, developing industrial and service-sector policies can help promote the solar and wind value chains.[569]

Corruption also represents a major hurdle in Tunisia. Findings of Ayadi and De Groen (2014), convey that corruption and informality are the primary constraints faced by micro, small, and medium enterprises (MSMEs) in the country. These issues result in increased costs, uncertainty, and unfair competition for formal businesses.570 Competition in Tunisia faces significant barriers and restrictions, especially in sectors monopolized by the state, such as public utilities (water, electricity, gas, railways, etc.), as well as in areas where the state has a strong presence, including telecommunications, air transport, cereals, sugar, and tobacco. Furthermore, the government maintains control over the prices of essential goods like sugar, bread, and rice. The absence of competition has had adverse effects on firm productivity and has resulted in high prices for both businesses and consumers, notably in the telecommunications sector.[571]

4. Conclusion

4.1 Assessing the status of renewable energy transition across countries: an overview

Energy plays a vital role in sustaining livelihoods, enabling the satisfaction of essential needs such as food production, lighting, power generation, and mobility. Access to modern energy is crucial for overcoming poverty, promoting economic growth, and supporting human development. While developed nations have greatly benefited from fossil fuels and electricity in their industrialization, many developing countries still rely on traditional energy sources like wood fuel, hindering progress in providing modern and affordable energy. Currently, only 38% of rural populations in least developed countries have access to electricity, highlighting the need for improved energy access. Access to sustainable and affordable energy is essential for economic sectors, education, healthcare, and public services. Various dimensions of energy access including reliability, affordability, and safety impact human health and socioeconomic inequality especially in rural areas. Limited access to modern energy perpetuates poverty in developing countries, as households struggle to secure energy supplies, hindering income-earning capabilities and purchasing power. Poor households spend a significant share of their income on inefficient energy sources, exacerbating the energy access challenge.[572]

The growth of renewable energy (RE) projects can have positive impacts on job creation, reducing unemployment rates, and encouraging businesses to enter the RE sector.573 Increased usage of RE will stimulate domestic competition and enhance competition among countries, particularly in the export of high-tech energy inputs. Furthermore, transitioning to RE can lead to a reduction in subsidies, as more investments are directed towards RE projects instead of diesel generators, particularly in sectors

[567] Ibid.

[568] Ibid.

[569] Ibid.

[570] Mouelhi, R. (2017). Tunisia. In R. Ayadi & E. Sessa (Eds.).

[571] Ibid.

[572] UNDP, 2020. Empowering Sudan: Renewable Energy Addressing Poverty & Development

[573] Salman, Gomaa I., and Ahmed M. Hosny. "The Nexus between Egyptian Renewable Energy Resources and Economic Growth for Achieving Sustainable Development Goals." 2021.

like agriculture where solar power can replace diesel in pumping water thus avoiding the need for subsidies.[574] The significant expansion of RE may have adverse effects on other sectors of the economy. The allocation of payments to PV projects for electricity generation can reduce the budget available for other macroeconomic investments. This can result in decreased demand for investment goods, especially in the construction sector. The increase in RE exports can lead to a phenomenon known as "Dutch disease," where the dominance of one sector's exports may lead to a decline in other sectors' competitiveness as this can lead to currency appreciation, impacting the competitiveness of other exported products.[575]

MENA region

Climate change poses unparalleled challenges throughout the Middle East and North Africa (MENA) region, characterized by escalating temperatures, shifts in precipitation patterns, and increasing sea levels. These phenomena are not only currently occurring but are also expected to intensify in the forthcoming years, leading to extensive socio-economic repercussions for individuals, economic frameworks, and the environment. The aggravation of climate risks will be further compounded by additional stressors including demographic expansion, urbanization, and enduring instability in certain nations, thereby presenting substantial obstacles to the socio-economic advancement of the region.[576]

Pursuing climate mitigation and adaptation is crucial for enhancing resilience within the Middle East and North Africa (MENA) region. These efforts towards effective transition can unlock economic prospects for MENA economies. Decarbonization and the shift towards sustainable energy sources are anticipated to bolster economic growth and diversification, opening up new avenues for expanding employment opportunities, developing new exports and bolstering entrepreneurship. The crucial move to decarbonize the energy sector and embrace renewable energy sources offers a chance to reduce current dependencies and foster novel economic opportunities across the region. Such transformation necessitates action at every governmental level and by all stakeholders, including the private sector, civil society, and individuals. Within this framework it is possible to effectively manage the risks while capitalizing on the opportunities that arise from responding to climate change. But this demands collective effort and is anchored in forward-looking strategies.[577]

Projected to witness an annual energy demand increase of 1.9%, the Middle East and North Africa (MENA) region holds significant potential to boost its renewable energy production, potentially contributing up to 45% of global renewable energy capacity. Currently, the region's renewable energy infrastructure boasts an installed capacity of around 28 gigawatts (GW), with hydropower being the predominant source. At present, non-hydro renewable sources generate approximately 6% of the total energy, with four nations accounting for 80% of this output. Nevertheless, renewable sources comprise merely 7% of the region's overall power generation capacity. Solar photovoltaic (PV) and wind energy are identified as the most economically viable and competitive alternatives for the region's energy landscape.[578]

The examination of green hydrogen's status and potential deployment in the MENA region was conducted comprehensively. Countries such as Morocco, Saudi Arabia, Oman, and the UAE have articulated strategic plans and objectives aimed at advancing green hydrogen production. Primary challenges associated with its deployment include water scarcity, economic viability, and the inadequacy of storage and transportation infrastructure. To facilitate the future deployment of green hydrogen, a three-tiered strategy is proposed. Short-term objectives involve substantial economic reforms, such as increasing electricity prices derived from fossil fuels. Medium-term goals entail initiating large-scale investments in renewable energy sources and ensuring access to sufficient fresh water for electrolysis. Long-term ambitions encompass the establishment of extensive renewable energy-powered desalination facilities, substantial investments in green hydrogen production and transportation infrastructure, modifications to existing infrastructure to accommodate hydrogen combustion, increased production and importation of fuel cell electric vehicles, and significant investments in dedicated pipelines.[579]

In response to climate change, economies in the Middle East and North Africa (MENA) region are increasingly

[574] Salman, Gomaa I., and Ahmed M. Hosny. "The Nexus between Egyptian Renewable Energy Resources and Economic Growth for Achieving Sustainable Development Goals." 2021.

[575] Ibid.

[576] Organization for Economic Co-operation and Development (OECD). (2023). Greening the MENA-OECD Competitiveness Programme.

[577] Ibid.

[578] "Renewable Energy in the MENA Region: Key Challenges and Lessons Learned." 2021.

[579] Alkhalidi, A., Battikhi, H., Almanasreh, M., & Khawaja, M. K. (2024). A review of renewable energy status and regulations in the MENA region to explore green hydrogen production – Highlighting the water stress effect.

incorporating climate objectives into their strategic frameworks. Numerous countries within the region have pledged to achieve net-zero emissions, initiating measures to shift towards sustainable and renewable energy sources. Governments, including those of oil-producing nations, have established ambitious renewable energy goals. Additionally, several MENA countries have initiated comprehensive programs to accelerate decarbonization efforts and foster economic diversification. These initiatives aim to stimulate entrepreneurship in non-oil sectors and nascent low-carbon technologies, alongside the development of tourism and trade hubs. Despite these proactive climate commitments, the MENA region confronts substantial policy obstacles. Thus, climate mitigation and adaptation efforts necessitate dedicated and strategic engagement from both governmental and non-governmental entities to facilitate a more sustainable transition.

Egypt

In 2019, the nation's greenhouse gas (GHG) emissions totaled 351.96 million metric tons of CO2 equivalent ($MtCO_2e$), with the energy sector being responsible for a significant 74% of these emissions.580 By early 2022, Egypt's electricity generation from renewable sources constituted merely 12%, markedly below the target of 20% set for the year.581 As a major energy consumer, Egypt relies extensively on the importation of crucial resources, particularly oil and natural gas.[582] Egypt lags behind numerous countries in embracing renewable energy technologies, occupying the thirty-first position worldwide in terms of solar energy utilization. Despite the nation's abundant solar and wind resources, progress in renewable energy projects has proceeded at a sluggish pace.[583] Additionally, the contribution of bioenergy, geothermal, wave, and nuclear energy to Egypt's total electricity generation is minimal, representing only 0.16%, despite the significant potential these sources have to fulfill the country's energy requirements.[584] Contrastingly, Solar Photovoltaic (PV) plants in Egypt are dispersed throughout the country, instead of being clustered in specific areas.[585]

The growth of Egypt's renewable energy sector faces a variety of challenges, including technological, economic, and political barriers.[586] There is a notable scarcity of skilled labor in renewable energy technology and appropriate storage solutions. Moreover, affordability issues pose a significant obstacle to the adoption of costly renewable energy technologies in rural regions.[587] Infrastructure challenges, particularly in transmitting energy from wind farms, which require specialized stations and high-voltage cables, significantly hinder progress. Additionally, insufficient governmental oversight concerning investment volumes in the renewable energy sector adversely affects its expansion in Egypt. The widespread subsidization of fossil fuels contributes to a pervasive dependence on traditional non-renewable energy sources.

Jordan

Jordan's energy transition has achieved significant progress, driven by concerns over energy security in the aftermath of the Arab Spring.[588] As reported by the International Renewable Energy Agency (IRENA), renewable energy constituted a mere 4% of the total electricity mix in 2019. This percentage increased to 10% in 2020 and continued to rise in the subsequent years, reaching 26% in 2021 and 29% in 2022.589 Jordan enjoys an intensity of direct solar radiation ranging from 5 to 7 kilowatt-hours per square meter (kWh/m2) and experiences an average of 310 sunny days per year.590 Jordan's landscape is dotted with geothermal wells, presenting opportunities to tap

580 Salah, A., Abdelfatah, M., & Ali, H. (2022). Renewable energy in Egypt: Needs and priorities. Alternative Policy Solutions.

581 Salah, S. I., Eltaweel, M., & Abeykoon, C. (2022). Towards a sustainable energy future for Egypt: A systematic review of renewable energy sources, technologies, challenges, and recommendations. Materials Engineering, 8(8), 100497.

582 Salah, A., Abdelfatah, M., & Ali, H. (2022). Renewable energy in Egypt: Needs and priorities. Alternative Policy Solutions.

583 International Energy Agency: https://www.iea.org/countries/egypt

584 Salah, S. I., Eltaweel, M., & Abeykoon, C. (2022). Towards a sustainable energy future for Egypt: A systematic review of renewable energy sources, technologies, challenges, and recommendations. Materials Engineering, 8(8), 100497.

585 Ibid.

586 Salah, A., Abdelfatah, M., & Ali, H. (2022). Renewable energy in Egypt: Needs and priorities. Alternative Policy Solutions.

587 Ibid.

588 Ahmad A. Salah, Mohammad M. Shalby & Firas Basim Ismail (2023) The status and potential of renewable energy development in Jordan: exploring challenges and opportunities, Sustainability: Science, Practice and Policy, 19:1, DOI: 10.1080/15487733.2023.2212517

589 Ibid.

590 Al-Refai, Ghassan, Ahmed H. Khatib, and Mohammad Al-Smadi. "Solar energy in Jordan: Investigating challenges and opportunities of using domestic solar energy systems." Renewable Energy 176 (2022)

into underground reservoirs for heating and cooling applications. With wind speeds generally oscillating between 7 and 11 meters per second (m/s), the country is exceptionally well-suited for wind turbine installations. Furthermore, Jordan's strategic geographical position as a nexus between Asia, Africa, and Europe positions it to play a pivotal role in connecting electricity grids and facilitating the import and export of energy to global markets.[591]

Jordan is endowed with substantial reserves of oil shale but still depends on importing crucial petroleum products from neighboring countries, leading to significant greenhouse gas emissions. While policies to encourage the adoption of renewable energy sources have been progressively implemented, the concentration of the population in three major urban centers influences the pace and focus of these energy initiatives.[592] The development of Jordan's renewable energy sector has been hampered by a significant lack of regulatory frameworks concerning energy storage at different phases. Additionally, there is a shortage of policies for the recycling and decommissioning of photovoltaic (PV) power plants. The electrical grid's limited capacity poses a challenge to integrating a varied mix of electricity generation sources. Furthermore, the elevated costs associated with renewable energy technologies represent a considerable obstacle, possibly impeding widespread adoption.[593]

Lebanon

Lebanon boasts significant potential for renewable energy, yet its existing energy matrix is predominantly fossil fuel-based, adversely affecting public health, climate change, and economic stability. Despite government pledges to enhance the proportion of renewable energy within the mix, advancements have been modest. The nation is especially rich in solar and wind resources, though these remain largely untapped. Additionally, Lebanon has substantial bioenergy resources, with around one-third of its territory being suitable for agriculture.[594] Lebanon has pledged to cut its greenhouse gas emissions by at least 15% by 2030, aiming for a reduction of up to 30% with assistance from international allies. Despite governmental vows to increase the share of renewable energy within Lebanon's energy composition, the actual contribution from renewable sources in 2019 was only 3%.[595]

Lebanon's current energy supply system, with Electricite du Liban (EDL) serving as the singular provider, does not adequately account for the future well-being of its population. The country's traditional sectors are struggling with job creation and a downturn in exports. Moreover, the institutional and legal structures in Lebanon are marred by ambiguities and deficiencies, complicating the enactment of reforms amidst political divisiveness.[596] A significant barrier is the prevailing sway of entrenched interests within the economy, especially concerning oil imports, and the substantial influence wielded by private generator owners.[597] In Lebanon, new residential buildings are being designed with specific areas allocated for generators, effectively compelling new tenants to acquiesce to this unofficial setup. Additionally, the presence of a substantial refugee population places extra pressure on the country's already constrained energy resources. The development of large-scale wind farms demands extensive technical knowledge and considerable financial outlays, requiring substantial backing from the government.[598] The absence of a well-defined legal and physical infrastructure presents obstacles in efficiently managing market ownership and its structure. Securing financing for large-scale renewable energy (RE) projects continues to be a challenge. Furthermore, the persistent reliance on importing fossil fuel-generated electricity as a primary approach may impede the smooth integration of renewable energy sources in the future.[599]

[591] Salah, A. A., Abu-Qdais, M., & Abu-Qdais, M. H. (2023). The status and potential of renewable energy development in Jordan: exploring challenges and opportunities. Sustainability, 19(1), 1-22.

[592] Al-Refai, Ghassan, Ahmed H. Khatib, and Mohammad Al-Smadi. "Solar energy in Jordan: Investigating challenges and opportunities of using domestic solar energy systems." Renewable Energy 176 (2022)

[593] Salah, A. A., Abu-Qdais, M., & Abu-Qdais, M. H. (2023). The status and potential of renewable energy development in Jordan: exploring challenges and opportunities. Sustainability, 19(1), 1-22.

[594] da Silva, A.J.C., do Amaral, J.C.B., Silva, A.A.C., & Oliveira, P.V.P. (2020). A review of the application of machine learning in renewable energy forecasting. Energy, 195, 117163. doi: https://doi.org/10.1016/j.energy.2020.117163

[595] Human Rights Watch, 2023

[596] da Silva, A.J.C., do Amaral, J.C.B., Silva, A.A.C., & Oliveira, P.V.P. (2020). A review of the application of machine learning in renewable energy forecasting. Energy, 195, 117163. doi: https://doi.org/10.1016/j.energy.2020.117163

[597] Human Rights Watch, 2023

[598] da Silva, A.J.C., do Amaral, J.C.B., Silva, A.A.C., & Oliveira, P.V.P. (2020). A review of the application of machine learning in renewable energy forecasting. Energy, 195, 117163. doi: https://doi.org/10.1016/j.energy.2020.117163

[599] Ibid.

Morocco

Since 2002, Morocco has experienced an annual average surge of 7% in electricity consumption, posing significant challenges for the electrical power production industry to meet escalating demands in alignment with environmental protection mandates. In reaction to this, the Moroccan government has rolled out an ambitious strategy aimed at attaining 52% of its electricity generation capacity from renewable energy sources by 2030.[600] As of 2020, renewable energy resources contributed nearly 20% to Morocco's electricity production. Currently, the Kingdom of Morocco is acknowledged as a frontrunner in the global transition towards sustainable energy, especially within Africa. The country has emerged as a key figure in renewable energy, with a notable focus on solar power, and possesses considerable wind energy potential, estimated to be around 6000 MW.[601] At present, Morocco has a substantial biomass potential, yet it exploits less than 1% of its full biomass capacity.[602] Morocco is working to improve the resilience of its power system against water stress by transitioning from coal power plants to natural gas combined-cycle power plants.[603] Morocco and Europe have highly advanced regional electricity interconnections, with ongoing studies exploring the potential for new cross-border connections.[604]

Morocco faces several hurdles in its energy transition, notably the limited availability of domestic energy resources, which leaves the country vulnerable to fluctuations in energy prices and potential supply disruptions.[605] The efficient production capacity of hydropower in Morocco heavily depends on water reservoirs being at full capacity, a condition that is not consistently achievable.[606] The bulk of the country's power system is antiquated, having undergone significant aging over the years.[607] The growing integration of renewable energy (RE) into Morocco's electrical grid has brought about new infrastructure challenges. Rising temperatures could further stress the nation's power generation and distribution systems. Notably, the southern region of Morocco, despite its significant wind energy potential, remains the least connected to the national grid. Furthermore, electricity pricing in Morocco does not accurately represent the true costs, being set below the average costs of production and transportation.[608]

Sudan

In Sudan, energy consumption is escalating, with traditional biomass serving as the main energy source, especially in rural areas without access to electricity. Nevertheless, electricity consumption has been surging at an impressive annual rate of approximately 13%, though only 47% of the rural population presently has access to the electric grid. Sudan is endowed with a vast wealth of energy resources, including renewable sources like solar, hydro, wind, geothermal, and biomass. The exploitation of these renewable resources, apart from hydro and biomass, remains largely underexplored.[609] The power industry in Sudan is set to see a significant predominance of hydropower as a principal source of generation, leveraging the country's rich water resources. The expansion of Sudan's power market is hindered by challenges, chiefly the deficiency of power transmission infrastructure and the consistently unreliable supply of electricity. Moreover, the absence of thorough policies and regulations to systematically encourage energy efficiency across residential, commercial, and industrial sectors, along with insufficient institutional capacity, further complicates the growth prospects of the sector.[610] Furthermore, Sudan encounters economic and financial obstacles in promoting renewable energy and enhancing energy efficiency. This situation is exacerbated by the unappealingly low electricity tariffs for domestic consumers, which discourage private investment in power generation. Meanwhile, significant

[600] M. Boulakhbar, B. Lebrouhi, T. Kousksou, S. Smouh, A. Jamil, M. Maaroufi, M. Zazi, Towards a large-scale integration of renewable energies in Morocco,Journal of Energy Storage.

[601] Ibid.

[602] Ibid.

[603] https://www.iea.org/reports/climate-resilience-for-energy-transition-in-morocco

[604]https://www.policycenter.ma/index.php/publications/moroccos-decarbonization-pathway-part-iii-costs-and-benefits-energy-transition

[605] Ainou, F.Z., Ali, M. & Sadiq, M. Green energy security assessment in Morocco: green finance as a step toward sustainable energy transition. Environ Sci Pollut Res 30, 61411–61429 (2023).

[606] M. Boulakhbar, B. Lebrouhi, T. Kousksou, S. Smouh, A. Jamil, M. Maaroufi, M. Zazi, Towards a large-scale integration of renewable energies in Morocco,Journal of Energy Storage.

[607]https://www.policycenter.ma/index.php/publications/moroccos-decarbonization-pathway-part-iii-costs-and-benefits-energy-transition

[608]https://www.policycenter.ma/publications/moroccos-decarbonization-pathway-part-i-introduction-joint-study

[609] https://www.iea.org/countries/sudan

[610] UNDP, 2020. Empowering Sudan: Renewable Energy Addressing Poverty & Development

government subsidies exert additional pressure on public finances. The scattered nature of rural settlements across Sudan's extensive territory also renders the extension of the electric grid financially burdensome. Securing funding for various renewable energy projects continues to be a significant challenge.[611]

Tunisia

Tunisia is identified as one of the countries in the region most susceptible to climate change impacts. The nation's climate change mitigation strategies are chiefly focused on the energy sector, the primary source of greenhouse gas (GHG) emissions. The objective is to attain a 46% decrease in the carbon intensity of this sector by the year 2030.[612] Tunisia is vigorously working to expand its renewable energy capacities to diminish its substantial dependence on gas, which, as of 2020, represented 86% of its installed capacity and 95% of its power generation. By comparison, renewable energy sources accounted for merely 13% of installed capacity and 5% of power generation within the same timeframe. Tunisia's energy policy is now increasingly oriented towards renewable energy, resulting in notable advancements in wind power generation since 2014.[613]

Wind and solar photovoltaic (PV) energy offer significant opportunities to enhance Tunisia's energy security, satisfy increasing energy demands, and establish a future industry for power exports. Additionally, these renewable energy sources can bolster Tunisia's efforts to contribute to climate change mitigation under the United Nations Framework Convention on Climate Change (UNFCCC).[614]

The execution of grid infrastructure projects by the Tunisian Electricity and Gas Company (STEG) is hampered by protracted public procurement processes. Furthermore, the existing regulatory framework mandates a complicated metering and billing system for establishments linked to the Medium Voltage (MV) grid.615 Owing to their complex transaction structures, these projects necessitate tailor-made legal and financial solutions that are both sophisticated and specific. The contemporary energy sector carries a legacy characterized by power generation projects that were traditionally large-scale and technically intricate.[616] Private developers frequently express concerns regarding land acquisition, especially in areas with high renewable energy potential where land prices have surged significantly. Moreover, numerous administrative steps are required to secure authorization for using these lands for renewable energy facilities. The lack of an independent regulatory authority for the electricity sector, combined with the involvement of numerous actors, presents challenges due to the absence of a clear and transparent delineation of each institution's responsibilities. This situation can lead to overlapping and conflicting roles among the various entities involved.[617]

[611] UNDP, 2020. Empowering Sudan: Renewable Energy Addressing Poverty & Development

[612] Arab Sustainable Finance Forum. (2021).

[613] https://www.iea.org/countries/tunisia

[614] United Nations Development Programme (UNDP). (2018). DREI Tunisia 2018_Key Points (English) (Aug 2018)

[615] International Renewable Energy Agency (IRENA). (2021). Renewable Readiness Assessment: The Republic of Tunisia. Abu Dhabi: IRENA.

[616] Ibid.

[617] Ibid.

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Esraa Medhat is a public policy researcher focused on social equity, gender policy, and sustainable development. She is pursuing a Ph.D. in Public Affairs at the University of Minnesota, where she also earned a Master's in Development Practice with a specialization in Gender and Public Policy. Esraa has worked with organizations like the Economic Research Forum, GIZ, and Chemonics Consultants, contributing to gender equality in renewable energy and green policy analysis. Fluent in English and Arabic, she is skilled in STATA and R, bringing both technical expertise and a commitment to impactful development projects across diverse regions.

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