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Policy Research Report

A Regional Report on:

Transition to Renewable Energy in the Middle East and North Africa Region:

The Imperatives, Benefits, Drivers, Barriers and the Role of MSMEs

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ECONOMIC RESEARCH FORUM
منتدى البحوث الاقتصادية

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Foreword

This report is one contribution to a large and rich compendium of seminal research studies conducted by a team of distinguished researchers assembled by the Economic Research Forum (ERF) and supported by a grant from the Canadian International Development Research Centre (IDRC) to undertake this important and unique project on "The Role of MSMEs in Fostering Inclusive and Equitable Sustainable Economic Growth in the Context of the Clean Energy Transition in MENA."

In more than one sense the MENA region is a microcosm of the world. The region is home to major global fossil fuels' producers and exporters as well as being home to a few fossil fuels' importers. There is a relative imbalance in the adaptive capacity and resilience between rich and poor countries of MENA. Rich countries are in a much better position to dampen the economic effects of climate change through policy and adaptation strategies. They have some of the major Sovereign Wealth Funds (SWF) with huge investible funds such as Saudi Arabia, the United Arab Emirates (UAE), Qatar and Kuwait. The region also includes some of the poorest countries of the world such as Yemen and Somalia.

The scientific community in general and climate scientists in particular are convinced that carbon emissions from the use of fossil fuels are the main factors driving these climate change developments. It is now a well-established scientific fact that extraction and use of fossil fuels at the same rates and volumes as the world used in the recent past are inconsistent with sustainable life and threatens the very existence of life on our planet. The case against Business As Usual (BAU) where the use of fossil fuels and their contributions to climate change is typically argued on moral and environmental grounds is not sufficient or complete. There are valid economic reasons; however, that suggest that investing in fossil fuels exposes the investors to higher risks and lower returns than investing in renewable energy. Better yet, the development of renewable energy and phasing out of fossil fuels extraction, production and transportation hold the promise to generate more and better jobs, higher incomes, cleaner environment, more secure energy sources, more productive and diversified economies and better social outcomes.

The study proposes a policy road map to guide the region's energy transition, with a particular focus on ensuring the active participation of the informal sector, the public sector, the private sector and particularly the MSMEs in this critical and unique transition. This road map outlines some key milestones, policy interventions, stakeholder responsibilities, and concrete measures that sought to provide a clear path for achieving regional and national renewable energy targets. By including the informal economy in this framework, and by emphasizing the targeting of the empowerment of women and the youth of the region, this road map could be relied upon to promote an inclusive and just transition that benefits all segments of society.

In a nutshell the road map prioritizes the reduction of regulatory and financial barriers faced by MSMEs, providing targeted support to informal businesses, developing public-private partnerships and cooperative clusters of firms to facilitate the adoption of renewable energy technologies across sectors. It also focused on raising public awareness, improving energy literacy, energy efficiency, training of labor, and building a supportive ecosystem for businesses and community stakeholders to transition to clean energy solutions.

Acknowledgments

This study could not have been completed without the substantive contributions of the ERF research team and their partners at The Middle East Institute and the Lebanese Policy Centre. I have literally summarized their work with a few adjustments and additions. I would like here to express my gratitude to all of those who contributed to the success and feasibility of this ERF study. My sincere thanks go first to the Economic Research Forum (ERF) management, especially Drs. Ibrahim Elbadawi, Sherine Ghoneim, Yasmine Fahim, Neamatallah Elsayed, Yasmeen Oraby and Sara Ragab for their invaluable contributions, guidance and support they have given me throughout the project and the opportunity to finalize this study and to comment on the many contributions made under this unique project.

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Last but not least, I have benefited immensely from the thorough, comprehensive and detailed reviews of this study, the excellent comments and the very helpful suggestions made by Dr. Ragui Assaad, Dr. Bipasha Baruah and Mr. Khalid Ghozlani. I owe them a great debt of gratitude and appreciation.

The views and specific recommendations expressed in this study and any errors or omissions are solely mine.

Summary

World temperatures may rise between 1.1 degree Celsius and 6.4 during this century relative to the period 1980-1999, depending on the emissions' scenario realized. Equally sea levels will rise by 18-59 centimeters by 2100, with thermal expansions of oceans being the single most significant contributor to this rise. Since the turn of the century, the MENA region and the Central Asia region have suffered about 10% of all global climate disasters. Already the MENA region has suffered at least a total of $40 billion in climate damage, about 4% of affected people, and 9% of global fatalities.

The scientific community in general and climate scientists in particular are convinced that carbon emissions from the use of fossil fuels are the main factors driving these climate change developments. This means that there is no viable pathway to limiting global warming without a fundamental and effective transitioning away from the use of fossil fuels to renewable and green energy such as solar, wind, hydro, thermal, green hydrogen and nuclear. This global transition; however, carries the risk of rendering fossil fuel assets of the MENA region into stranded assets which will have a drastic negative impact on the countries of the region that rely on the revenues from the export of oil and gas to run their economies as well as on other countries in the region that benefit indirectly from trade, investment, remittances and aid from the region's oil and gas exporters.

The region's stakes in limiting emissions and managing efficiently its energy use are quite high and urgent. But more importantly is the fact that the natural endowments of the region, with some of the highest solar radiation rates, large open deserts, and a few locations with strong and continuous wind flows, puts it in a very favorable position to make credible, profitable and meaningful transition to renewable and green energy. The benefits of the transition to RE are many and are not restricted to re-basing the regional economy on sustainable, clean, and diversified structures; the transition also holds the promise of creating abundant, meaningful and inclusive jobs. The transition to renewable energy has emerged as a winning regional development strategy capable of addressing these objectives simultaneously and effectively. The real challenge is now about surmounting barriers, accessing finance, building the requisite infrastructure, developing the needed skills, energizing the private sector through the engagement of MSMEs, the informal economy, and aligning public policy and the governance systems to speed and deepen the transition.

The MENA region stands at the threshold of a transformative opportunity to become a global leader in green hydrogen production, exports and investment. Leveraging its abundant renewable resources, strategic location straddling three continents, major global Sovereign Wealth Funds, and international partnerships, the region can drive its own and global transition to a sustainable and low-carbon energy future while simultaneously addressing water scarcity and building a more diversified and inclusive economy. Two countries in the MENA region stand out as trail blazers in the transition to Renewable and Green energy; both Morocco and the United Arab Emirates (UAE) have made or are planning to make considerable investments in developing their green and renewable energy industries and have been seriously considering the development of several downstream and upstream complementary industries such as green hydrogen, green ammonia, green fuels, green metals and significant electric vehicles' production and exports.

1. Introduction

The Earth's climate is warming and this trend has accelerated during the last three decades. The ten warmest years on record have all occurred since 1998, with 2023 being ranked as the warmest year on record. It is now clear that 2024 will perhaps stand out as another temperature record breaking year.

Warmer and moisture-laden air is more turbulent and tends to produce more violent weather patterns. These phenomena have contributed to the increasing frequency and severity of extreme weather events, such as floods, thunderstorms, droughts and heat waves in various regions of the world. There has been a steady increase in devastating disasters across the globe in recent years. The United Nations (UN) Disaster Risk Reduction Program found that over the last few decades, 76 percent of all disasters were associated with climate and/or weather conditions such as heat waves, freezing or winter storms, wildfires, droughts, tropical storms, hail, tornados, flash floods, river floods and landslides. These events accounted for 45 percent of all deaths and 79 percent of the economic losses caused by natural hazards.[1]

The physical impacts of climate change translate into significant public and private costs, in the aggregate and across numerous sectors and many social groups. The exposure and vulnerability of people, physical and natural assets to climate change are dynamic, varying across temporal, spatial scales, gender, age structure and several socioeconomic classes and are significantly influenced by economic, social, geographic, demographic, cultural, institutional, governance, and environmental factors. Quantifying the economic impacts of climate change is becoming a pre-requisite to an informed policy debate regarding the urgency and choice of actions to mitigate the most severe impacts and to increase resiliency of communities and social groups, particularly the most vulnerable primarily women, girls and the youth to its aftermath.

There is practically very little research done on this subject for the MENA region, the study of the transition to green energy undertaken by ERF "The Role of MSMEs in Fostering Inclusive and Equitable Sustainable Economic Growth in the Context of the Clean Energy Transition in MENA." and supported by the Canadian IDRC is at the heart of the research agenda on climate change issues and challenges, sustainable and inclusive development in the region.

MSMEs account for a very high share of private sector employment in the Middle East and North Africa (MENA), particularly in countries with large informal sectors. According to official statistics, MSMEs typically account for 10 to 40 percent of all employment in the MENA region and in a few countries this share is even higher at 60 percent.[2]

In general, economic losses are critically dependent on the frequency and severity of climatic and extreme weather events and also on a host of socioeconomic factors that define exposure, vulnerability, adaptability and resiliency. Risk relates to the probability of the occurrence of an event and the magnitude of the consequences of its occurrence. It can be quantified in formal ways using probability density functions of the variables and forecasts, but it is also dependent on a host of socioeconomic factors that are often ignored.

World temperatures may rise between 1.1 degree Celsius and 6.4 during this century relative to the period 1980-1999 depending on the emissions' scenario realized. Equally sea levels will rise by 18-59 centimeters by 2100, with thermal expansions of oceans being the single most significant contributor to this rise.[3]

There is greater than 90% confidence level that there will be more frequent warm spells, heat waves, high evaporation, intense precipitation and severe weather events. There is greater than 66% confidence level that there will be an increase in droughts, tropical cyclones, extreme high tides and storm surges.

The scientific community in general and climate scientists in particular are convinced that carbon emissions from the use of fossil fuels are the main factors driving these climate change developments. It is now a well-established scientific fact that extraction and use of fossil fuels at the same rates and volumes as the world used in the recent past are inconsistent with sustainable life and threatens the very existence of life on our planet. The case against Business As Usual (BAU) use of fossil fuels and their contributions to climate change is typically argued on moral and environmental grounds. There are sufficient and valid economic reasons; however, that suggest that investing in fossil fuels exposes the investors to higher risks and lower returns than investing in renewable energy.

[1] https://www.undrr.org/our-work/our-impact.

[2] Qamar Saleem. 2017. Overcoming Constraints to SME Development in MENA Countries and Enhancing Access to Finance. International Finance Corporation. World Bank Group.

[3] Climate Change: Global Sea Level. https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level

Better yet, the development of renewable energy and phasing out of fossil fuels extraction, production and transportation holds the promise to generate more and better jobs, higher incomes and better social outcomes.

A 2015 study in *Nature* argued that an estimated one-third of oil reserves, half of gas reserves and more than 80 percent of known coal reserves must remain unburned in order to meet global temperature targets under the Paris Agreement.[4] The development of alternative or green energy has increasingly been seen as one critical and necessary strategy to meet the expected world demand for energy in the future that is sustainable, clean, and environmentally acceptable and the way to generate good paying jobs and social inclusion.

2. Climate change and the MENA region

The MENA region countries are already experiencing the ramifications of global climate change. Annual temperatures have increased by about 1.5°C in the last three decades, which is about twice the global average increase (0.70C) in temperature over the same period.[5] Annual precipitation has become more unpredictable than in other regions of the world. Precipitation volumes are noticeably declining in the region but particularly in Jordan, Lebanon, Iraq, Syria and Oman. The occurrence of global climate hazards has risen the fastest in the region with more frequent flash floods (Egypt, Iraq, Morocco, Tunisia and even in Dubai and Saudi Arabia). Climate hazards have become more intense with many extreme temperatures for more than 100 days (Bahrain, Mauritania and Sudan).

Since the turn of the century, the MENA region and the Central Asia region have suffered about 10% of all global climate disasters. Already the MENA region has suffered at least a total of $40 billion in climate damage, about 4% of affected people, and 9% of global fatalities.[6]

The characteristically high regional population growth rates, rapid urbanization and environmental pollution are compounding the impacts of climate change on many countries of the region. Add to this that eighteen MENA region countries are designated as water poor with less than 1000 m3 per capita and with severe accessibility and quality constraints. Freshwater usage in the region has exceeded 400 percent of their available renewable fresh water. Of special concern is the fact that 50% of the water in the region is shared water, but in Egypt, Bahrain, Kuwait and Palestine it is even over 97%. Water in the region is used mostly in agriculture (over 70% of the total) and quite often very inefficiently.[7]

In more than one sense the MENA region is a microcosm of the world. The region is home to major global fossil fuels' producers and exporters as well as being home to a few fossil fuels importers. There is a relative imbalance in the adaptive capacity and resilience between rich and poor countries of MENA. Rich countries are in a greater position to dampen the economic effects of climate change through policy and adaptation strategies. They have some of the major Sovereign Wealth Funds (SWF) with huge investible funds such as Saudi Arabia, the United Arab Emirates (UAE), Qatar and Kuwait. The region includes also some of the poorest countries of the world such as Yemen and Somalia.

The poor, agrarian, and raw materials based economies in the Region are particularly vulnerable to climate shocks, and possess less adaptive capacity, fewer resources, and weaker economic and institutional capacity bases. A few of these countries are also buffeted by political turmoil and violence such as the Sudan, Lebanon, Libya, Yemen, Syria, and Iraq; a few of which have causal connections to climate change (i.e., Syria).[8]

Issues of sustainability, cleaning the environment, diversification of the economy, creation of adequate jobs, and inclusive development are now common objectives for all countries of the region. The transition to renewable energy has emerged as a winning strategy capable of addressing these objectives simultaneously and effectively. The real challenge is now about surmounting barriers, accessing finance, building the requisite infrastructure, developing the needed skills, energizing the private sector through the engagement of micro, small and medium enterprises and aligning public policy and the governance systems to speed and deepen the transition.

[4] C. McGlade and P. Ekins. 2015. The geographical distribution of fossil fuels unused when limiting global warming to 2 °C. Nature 517: 187–190. https://www.nature.com/articles/nature14016?utm_source=newsletter&utm_medium=email&utm_content=2019-09-08&utm_campaign=greenbuzz

[5] MENA region warming at nearly twice the global average. 2022. Greenpeace Middle East and North Africa.

[6] https://www.imf.org/en/Blogs/Articles/2022/03/30/blog-without-adaptation-middle-east-and-central-asia-face-crippling-climate-losses.

[7] Marco. Neira, et.al. 2023. Climate change and human health in the Eastern Mediterranean and Middle East: Literature review, research priorities and policy suggestions. Environmental Research. Vol 1, 216:114537.

[8] https://greenly.earth/en-gb/blog/ecology-news/does-climate-change-make-conflict-more-likely.

Mitigation and adaptation call for a determined move toward a low-carbon future. For good reason, many are concerned that the region's economy, particularly in the non-oil producers, cannot bear the cost of this transition while the regional oil exporting countries are worried about the resulting shift in GDP given the region's heavy dependence on energy and natural resources sectors. But all countries in the region recognize that inaction or delayed action will in fact be more costly, this is why both the public and private sectors in all of the countries of the region have set ambitious targets to achieve net-zero emissions by 2050 or sooner, in line with recommendations from climate scientists and in line with international agreements.

Fossil fuel producers of the MENA region, as mentioned earlier, include some of the world's largest oil and gas producers and exporters. Actually, OPEC Member Countries in MENA together have 840 billion barrels of proven crude oil reserves. They also have around 80 trillion cubic meters of proven gas reserves. This represents about 58% and 43% of global totals, respectively.[9] For most of these countries, oil and gas also form the backbone of their economies and trade. In 2020, oil alone accounted for more than one-third of their combined GDP. It also represented more than two-thirds of their total exports.[10]

In addition, the oil exporting countries in the MENA region also supplied nearly one-third (29%) of global liquefied natural gas (LNG) exports in 2022, according to data from the International Group of Liquefied Natural Gas Importers.[11] The share of global LNG exports coming from the region's exporters—Qatar, Oman, the United Arab Emirates (UAE), Algeria, and Egypt—declined from 47% in 2013 to about 30% by 2020 because of growing LNG exports from Australia and the United States and on account of the slowing down of the world economy caused by the Pandemic.

The fact that the use of fossil fuels for energy is responsible for 75% to 90% of anthropogenic greenhouse gas emissions[12] that are singled out as the main determinants of global warming and climate change, means that there is no viable pathway to limiting global warming without a fundamental, effective and sure way of transitioning away from use of fossil fuels to renewable and green energy such as solar, wind, hydro, thermal, green hydrogen and nuclear. This global transition however, carries the risk of rendering fossil fuel assets of the region into stranded assets which will have a drastic negative impact on the countries of the region that rely on the revenues from the export of oil and gas to run their economies as well as on other countries in the region that benefit indirectly from trade, investment, remittances and aid from the region's oil and gas exporters.

Long-term demand trends of declines in the demand for fossil fuels will most likely bring down their prices; threaten the macroeconomic stability of the producers, whose undiversified economies have varying levels of resilience to the overall decline in oil and gas revenues. It is also a fact that the MENA oil and gas producers boast of the lowest cost of production. Actually, most fossil oil and gas producers in the region can still make profits at very low prices and therefore are likely to be the last producers to be forced to exit the industry. Equally relevant is the fact that these countries are considering carbon capture technologies and diverting their fossil fuel resources to non-energy uses such as plastic, petrochemicals, fertilizers and batteries. But all, without exception, are determined to shore up their production of renewable and green energy capitalizing on their huge endowments of solar, wind and hydrogen. The latter energy source fits well with the region's scarce water constraint by using electrolyzes to separate hydrogen from oxygen and to use hydrogen to drive their water desalination plants.

3. The motivations for the transition to renewable energy: the cost and benefits of the transition and the crucial role of MSMEs.

A rich theoretical framework underpins the study of energy transitions, particularly as they relate to sustainable development and the special role of MSMEs. Ecological Modernization Theory (EMT) is among the most central of these perspectives. It proposes an alignment of environmental sustainability with economic growth and asserts that technological innovation is the key to achieving eco-efficiency (Mol, 2002)[13] and that this alignment can best be achieved through technological advancements spearheaded by firms (Jaffe et al., 2002).[14]

[9] https://www.opec.org/opec_web/en/2211.htm#:~:text=OPEC%20Member%20Countries%20in%20_MENA,%25%20of%20global%20totals%2C%20respectively.

[10] Ibid.

[11] www.giignl.org

[12] Fossil fuels – coal, oil and gas – are by far the largest contributor to global climate change, accounting for over 75 per cent of global greenhouse gas emissions and nearly 90 per cent of all carbon dioxide emissions. https://www.un.org/en/climatechange/science/causes-effects-climate-change.

[13] A.P.Mol. 2002. Ecological Modernization and the Global Economy. Global Environmental Politics. Vol.2. No.2, PP:92-115.

[14] A.B.Jaffe, R.G. Newell and R.N. Stavins. 2002. Environmental Policy and Technological Change. Environmental and Resource Economics, Vol. 22(1-2), PP: 41-69.

Another key theory along these lines is Transition Management Theory (TMT), which emphasizes the governance aspect of sustainable transitions. It advocates a multi-level perspective in which MSMEs act as niche players capable of driving innovation in sustainable practices (Kemp et al., 2007) through experimenting with and scaling up new energy solutions. This positions MSMEs as leading actors in the transition to sustainable energy systems.

Two additional theoretical perspectives have been framed around the critical role of MSMEs in the transition. The first is developed around a Resource-Based View (RBV) of the firm drawing on internal resources and capabilities of MSMEs as sources of competitive advantage (Barney, 1991).15 In the context of energy transition to renewable resources, MSMEs' agility, adaptability, and innovative capabilities are viewed as key strategic resources that can be leveraged to navigate and capitalize on the changing energy paradigm (Hart, 1995).[16] The second perspective is anchored on the Institutional Theory that emphasizes how regulatory frameworks, societal norms, and cognitive structures influence organizational firm strategies in adapting to and engaging with energy transition policies (Scott, 1995).[17] This theory highlights the importance of the institutional environment in shaping MSMEs' responses to the challenges and opportunities of the energy transition.

Given the low socioeconomic resiliency, limited adaptation programs, inadequate material, financial[18] and institutional infrastructure, poor governance structures and high dependency on rain-fed agriculture, a few countries in the MENA region, particularly the poorer ones, find themselves to be highly exposed to climate disasters that are only exceeded by their high vulnerability to these climatic conditions. The transition to RE has to be seen in the context of their under development and their struggle to modernize, restructure and develop sustainably.

Put against the fact that the region's contribution to emissions, particularly that part that does not export oil and gas, is far below its population shares and pales in comparison to their vulnerability and likelihood to suffer from the onslaught of climate change.[19] This is despite the fact that some of MENA countries, particularly those in the GCC countries have some of the highest per capita emissions, but their small populations moderate their contributions to global emissions.

There is no question about the fact that the expected climate disasters will extenuate the region's already high socio-political instability, financial and economic imbalances, inequality of opportunities and outcomes and will further reduce per capita income, employment opportunities and growth accentuating their developmental challenges.

The region's stakes in limiting emissions and managing efficiently its energy use are quite high and urgent. But more importantly is the fact that the natural endowments of the region, with some of the highest solar radiation rates, large open deserts, and a few locations with strong and continuous wind flows, puts it in a very favorable position to make credible, profitable and meaningful transition to renewable and green energy. Actually, the MENA region is endowed with wind and solar potential whereby MENA's solar energy potential per square kilometer is equivalent to energy produced by 1-2 million barrels of oil annually, this means that MENA solar energy producers could meet at least 50% of global electricity demand.[20] Furthermore, 75% of MENA countries have average wind speeds exceeding the minimum threshold for utility-scale wind farms.[21]

But more importantly, this transition is also seen as a great opportunity to put into effect a few positive restructuring programs that would help re-base the economy and society on productive structures, spurring sustainable development and inclusive growth including:

- Diversifying their lopsided economies, extricating themselves from the damaging negative consequences of the rentier structures that their dependence on the rent from natural resources has engendered.
- Availing themselves of the large employment

[15] J. Barney.1991. Firm Resources and Sustained Competitive Advantage. Journal of Management, Vol. 17(1),PP: 99-120.

[16] S. L. Hart.1995. A Natural-Resource-Based View of the Firm. Academy of Management Review, Vol. 20(4),PP: 986-1014.

[17] W.R. Scott.1995. Institutions and Organizations. New York: Sage.

[18] This is only true for MENA countries that are non-oil or gas exporting and suffer debilitating political instability.

[19] The MENA region contribution to global emissions is put at less than 8.7%. World Bank Group.2023, Middle East and North Africa Climate Roadmap (2021-2025). https://thedocs.worldbank.org/en/doc/6f868d4a875db3ef23ef1dc747fcf2ca-0280012022/original/MENA-Roadmap-Final-01-20.pdf

[20] Ibid.

[21] Ibid.

opportunities that this transition will offer.
- Exploiting the chance to address the prevailing inequities of income and wealth distributions.
- Promoting an inclusive growth strategy giving their women, youth and marginalized communities a better chance to benefit, participate and lead the development of the economy and society.
- Re-basing their economies away from the dirty and nonrenewable factors of production and assets and anchoring a promising future on new, sustainable and productive comparative advantages and exports,
- Invigorating the private sector, particularly empowering the MSMEs to lead the transition, to adopt the most appropriate technologies, to innovate and develop local capacities and skills that can expedite the transition and increase its speed, depth and benefits.
- MSMEs in the region are emerging as the choice agents of change that can lead the transition to a cleaner and sustainable future. Given their widespread geographical distribution, they are well-positioned to contribute to a more decentralized, secure and resilient energy system. By engaging in decentralized energy production and storage, MSMEs can support the region's green energy transition and also reduce their operational costs and carbon footprint.[22]
- Unlike large-scale energy projects that are often constrained by the national grid's capacity and spread, decentralized systems anchored on MSMEs do allow energy generation closer to consumption nodes thereby reaching under-served regions, reducing transmission losses, enhancing efficiency, exploiting cheaper and cleaner energy alternatives and improving the competitive advantage of the economy.
- MSMEs often act as *prosumers*—by being both producers and consumers of energy. By feeding excess energy back into the grid or sharing it within local micro-grids, MSMEs can alleviate the load on the national grid during peak consumption periods. Their wide geographical dispersal allows them to reduce energy poverty in remote areas, alleviate access constraints, reduce infrastructural development costs and provide new revenue streams to local MSMEs.
- The impact of MSMEs often goes beyond the economic sphere. Operating across various ethnic, social, and sectarian lines, as is the case in Lebanon and Sudan, they are credited with fostering a sense of unity and inclusivity within the Lebanese and Sudanese societies. These businesses acted as neutral platforms for dialogue and interaction, fostering social cohesion in diverse and sometimes fragmented environments.[23]
- MSMEs create multiple benefits simultaneously by creating green wealth, green jobs and addressing environmental concerns.

4. The transition to renewable energy and the integrated energy system plan

In most energy policy studies, the energy sector is often viewed in isolation from the remainder of the economy and society, and the analysis is performed without consideration of broader impacts. The employment structure, its level or other macroeconomic indicators are taken as given – as though they are not affected by the energy sector. This is not satisfactory, for there is a considerable two-way interdependence with the remainder of the economy. Social opportunities and outcomes are also influenced by energy policy and these are crucial determinants of the sustainability, political feasibility and the equity of energy policies.

As a rough measure of the benefit or cost of a given energy activity or policy, it is often sufficient to calculate the impact upon aggregate output (Gross Domestic Product (GDP)) and employment. But this is not sufficient or comprehensive. Many other aspects of impacts need to be ascertained and even quantified. The IDRC transition to renewable energy project in the MENA region, of which this report is only a part, was conceived from the outset as a social project seeking broad and profound social and economic reformation objectives as well as a major component of a broad Integrated Energy System Plan (IESP).

There are typically four program areas in any IESP. These include: energy efficiency, demand management, fuel switching and customer-based generation. The net avoided cost, which is the difference between energy cost savings and the cost of equipment and programs to attain these savings, was calculated by the author in 2022 dollars over a 20 year period from 2022 to 2042 for the Province of Ontario in Canada. The results of the study are used here to situate appropriately the transition to

[22] A few of these advantages are well explained and documented in Ibrahim Saif and Ahmad Awad. 2024. Empowering MSMEs in Jordan: Driving Sustainable Economic Growth through Renewable Energy Transition. ERF Publications.

[23] Lebanese Center of Policy Studies (LCPS). 2024. The Role of MSMEs in Fostering Inclusive and Equitable Sustainable Economic Growth in the Context of the Clean Energy Transition in MENA: The Lebanese Case Study, Draft of July 15th, 2024

Renewable Energy within this broad context. Two of the four programs of the IESP are components of the Transition to Renewable energy (Fuel Substitution and Customer Based Generation). When the avoided costs of these programs were quantified and normalized by megawatt (MW), their rankings are presented in Figure 1.

The net savings when normalized by the MW of power saved; the rank order is displayed in Figure 2. The highest energy saving per MW is realized by fuel switching although the scale (the MWs saved or replaced) of this activity is limited. Second highest is energy efficiency with a large scale (over 3482 MW) savings (Figure 2). This is substantially lower than the per MW savings realized by fuel switching. The lowest per MW savings are realized by customer based generation per MW. These estimates are for an advanced economy (Ontario's economy), they are presented here to identify the methodology we were able to use in the ERF and Partners study to position renewable and green energy development within a total program of a rational energy strategy.

The impact on production, personal incomes, employment, and government revenues are identified as the secondary benefits or costs of the conservation alternatives. An important finding of a similar analysis undertaken by the author in Ontario found that energy conservation activities in Ontario will have positive and substantial impacts on employment and other macroeconomic indicators.[24]

This result is counterintuitive in the sense that reducing the operation of a given activity results in added economic performance. These added economic benefits derive from the savings that reduced production releases to the various sectors of the economy which, in turn, re-spend them on other goods and services. When consumers do not spend on electricity, they can spend the saved money on other consumer bundles, and when businesses do not spend on electricity, they can distribute the saved costs to shareholders as dividends to be spent by households, or businesses can spend it directly on the expansion of their capital stock (investment). The economy benefits when the savings reduce economic activity by less than the added activities generated by the expenditure of the savings by the various sectors realizing them. Other benefits accrue directly on new investment in and production of alternative energy, particularly those that have high local content, are labor- and knowledge-intensive, and

Figure 1. Total net benefits of energy conservation 2007-2027

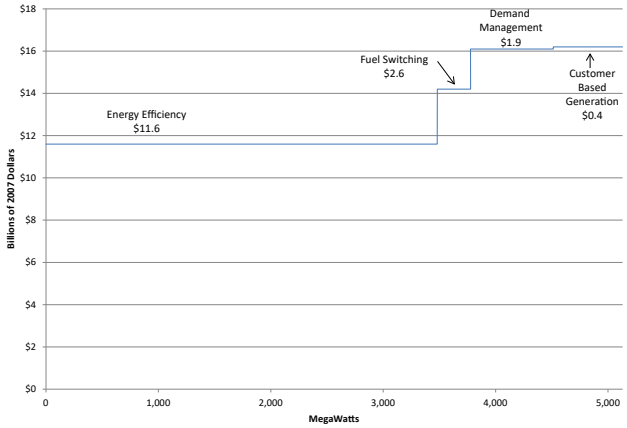
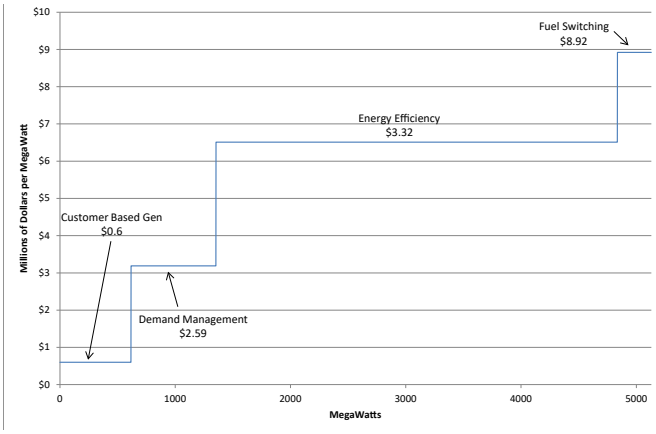


Figure 2. Net benefit per MW of power conserved 2007-2027



involve strong backward and forward linkages to key sectors of the domestic economy. All of these it turns out are tightly connected to the development and expansion of renewable and green energy.

5. A transition to renewable energy in the MENA region or a transition to a productive, inclusive and green economy

One of the fortuitous advantages embedded into the development of renewable and green energy in the region is the evident inherent comparative advantages of developing these alternatives in a few countries in the region given their natural endowments of high solar radiation over much of the year and having strong wind nodes. Add to this the following general considerations listed below:

- About 80 percent of the global population lives in countries that are net-importers of fossil fuels.[25]

[24] A. Kubursi. 2008. Comparative Economic Impacts of Conservation and Demand Management. Programs in Ontario. Report Submitted to INDECO and Ontario Ministry of Energy.

[25] International Day of Clean Energy. 2024. Forestry, fisheries and the Environment, Republic of South Africa. https://www.dffe.gov.za/events/international/idce

- In contrast, renewable energy sources are available in all countries, and their potential is yet to be fully harnessed.
- The International Renewable Energy Agency (IRENA) estimates that 90 percent of the world's electricity can and should come from renewable energy by 2050.[26]
- Renewable energy actually is the cheapest power option in most parts of the world today and particularly in the MENA countries.[27]
- Prices for renewable energy technologies are dropping very rapidly.
- The cost of electricity from solar power fell by 85 percent between 2010 and 2020.[28]
- Cheap electricity from renewable sources could provide 65 percent of the world's total electricity supply by 2030. It could decarbonize 90 percent of the power sector by 2050, massively cutting carbon emissions and helping to mitigate climate change. If for no other reason, these considerations make the transition to renewable and green energy a dominant option.[29]
- Renewable energy creates jobs. This is a crucial consideration given the characteristically high unemployment rates in the MENA countries, particularly those rates for the youth, women, girls and disadvantaged minorities.[30]
- Every dollar of investment in renewables creates three times more jobs than in the fossil fuel industry. The IEA estimates that the transition towards net-zero emissions will lead to an overall increase in energy sector jobs: while about 5 million jobs in fossil fuel production could be lost by 2030, an estimated 14 million new jobs will be created in green energy.[31]
- According to the World Health Organization (WHO), about 99 percent of people in the world breathe air that exceeds air quality limits and threatens their health, and more than 13 million deaths around the world each year are due to avoidable environmental causes, including air pollution. Whether you live in Cairo, Beirut or Khartoum you are breathing highly polluted air and much of it is produced by car emissions or electricity generators. Transitioning to clean energy is critical for cleaning the air they breathe.

It follows from the above that the market for renewable energy is large and the potential for exporting it is high and lucrative. The cost of producing renewable energy, particularly for electricity, is low and getting lower out-competing alternatives. This translates into major savings and great environmental benefits.

The above factors constitute necessary conditions, but they are not sufficient in the sense that they highlight the potential that could be reaped and actualized but there a few conditions and policies that need to be established to guide the transition and to cement it on firm grounds capable of affording MENA countries the potential to reap the benefits of the transition.

5.1. The perspectives of Hausmann and Collier on what it takes to capitalize on the transition to renewable energy

While a few economists (Ecological Modernization Theory, Transition Management Theory, and Institutional Theory, etc. referred to earlier) have considered the benefits and risks of capitalizing on transition strategies to renewable energy and even the broader context of transitioning to a green economy, two distinguished economists in particular have focused their attention on the potential of the MENA region of making an effective transition and reaping its potential broad economic benefits. One of the seminal contributions in this area is that of Professor Ricardo Hausmann (December 2022),[32] who argued that it would be a grave mistake for developing countries not to consider climate change as an important aspect of their development strategies. This is because climate change disasters are already imposing a heavy toll on the global economy and many countries are recognizing that the world must slash emissions to prevent a climate catastrophe. More importantly, in his view is the realization that decarbonization will usher in several structural changes that will present new opportunities and threats as the demand for dirty goods and services declines and the demand for those

[26] Global Energy Transformation: A Roadmap to 2050. 2018. IRENA.

[27] Renewable Energy –Powering a Safe Future. https://www.un.org/en/climatechange/raising-ambition/renewable-energy.

[28] Renewable Power Generation Costs in 2020. June, 2021. IRENA. Ibid.,

[29] Steps toward cleaner air: A closer look at the air quality and climate benefits of renewable energy. June 2023. Clarity. https://www.clarity.io/blog/steps-toward-cleaner-air-a-closer-look-at-the-air-quality-and-climate-benefits-of-renewable-energy

[30] A. Kubursi and H. Abou-Ali. 2024. Employment Generation Capacity of Renewable Energy in MENA. ERF Publications.

[31] https://www.un.org/en/climatechange/raising-ambition/renewable-energy

[32] https://www.imf.org/en/Publications/fandd/issues/2022/12/green-growth-opportunities-ricardo-hausmann

that are cleaner and greener increases. This realization will raise the question as to what can be done to reduce every country's emissions, in addition to how countries, particularly poor developing countries in the MENA region, can supercharge their development by breaking into fast-growing industries that will help the world reduce its emissions and reach net zero and offer greater employment opportunities and new export lines.

Drawing on the experience of successful Southeast Asian economies, Hausmann points out that these countries have basically sustained decades of high growth by upgrading their areas of comparative advantage, from garments to electronics to machinery and chemicals. They did not remain stuck in industries bequeathed by the past. Developing countries, including MENA countries, can create jobs that pay higher wages, but they have to find new industries that can grow and export competitively even with higher wages.

At its core, transitioning to a green economy with green energy will create new opportunities – especially for those that move fast. The paths that are opening up have not been trodden by many predecessors. A few are still virgins and transitioning into the green economy will require significant Greenfield investments, and plants will have to find new places to locate. This could be a great opportunity for MENA countries with their solar endowments and huge spatial deserts that are scarcely inhabited, but to realize it, they must understand the changing landscape, leverage their existing comparative advantages, and more importantly develop new ones.

There are many uncertainties embedded in this transitioning strategy as we do not know what technologies will power the low-carbon global economy, what materials and manufacturing capabilities will be needed, or what regulatory regimes the world is likely to adopt. These uncertainties will most likely be resolved by those countries that play an active and early role and master the capabilities that will underpin their future comparative advantage. However, MENA countries should bear in mind the six themes listed below as they explore and exploit the new opportunities and deal with the new threats.[33]

5.1.1. Embrace global electrification

Fossil fuels – coal, oil and gas – are by far the largest contributors to global climate change, accounting for over 75 per cent of global greenhouse gas emissions and nearly 90 per cent of all carbon dioxide emissions.34 To decarbonize, the world needs to electrify the things that currently use fossil fuels and generate electricity from green sources such as wind, solar, hydro, green hydrogen and biomass. Doing so will require massive amounts of solar panels, wind turbines, electrical cables, and capacitors as well as mechanisms to store energy, such as lithium-ion batteries. At the same time, electrolyzers and fuel cells will be needed to convert electricity into hydrogen and back. All these products intensively use metals and rare earth elements. The production of these minerals will have to expand by several multiples, if the world is to achieve net zero.[35]

The future is likely to demand that the energy used in mining be green, especially since mining is energy-intensive. Mining also has local environmental impacts and is water-intensive; the latter is in short supply in most MENA countries unless green energy is used in desalination. Most countries fail to implement a regime that is open to investment but adequately manages these risks and conflicts of interest.

In addition, it is to be recognized that these minerals must be processed into the capital goods needed by the electrification process. This involves long manufacturing global value chains. Today, many mega-factories are being built to produce lithium-ion batteries, mostly in China, Europe, and the US. A good question to ask is why none are being developed in MENA countries? The MENA region must quickly and extensively develop what it takes to host them. If not, MENA countries must acquire the missing capabilities and resources.[36]

Transitioning into the green economy would result in some industries growing but others shrinking. MENA countries, individually but (hopefully) cooperatively, must deal with the many fossil fuel-dependent export industries that will face headwinds because they are high emitters or supply high-emitting value chains. MENA countries, especially oil and gas exporters, could struggle with declining exports and sources of finance sooner than they think, as capital markets will fear that the assets they fund will be stranded.

[33] These themes are those discussed by Hausmann and are used here in the order he had posted them.

[34] Causes and Effects of Climate Change. United Nations. https://www.un.org/en/climatechange/science/causes-effects-climate-change

[35] IEA. The Role of Critical Minerals in Clean Energy Transitions. 2021. https://www.eqmagpro.com/wp-content/uploads/2021/05/TheRoleofCriticalMineralsinCleanEnergyTransitions-113-140.pdf

[36] In Morocco for example, LFP (Lithium Iron Phosphate) batteries technology is being pursued as an alternative to Li-ions technology Batteries. https://www.lgcorp.com/media/release/26808.

MENA oil and gas exporters are the lowest-cost producers, and this will help delay (but not avert) the expected demise of the industry. In addition, the circular carbon economy will give these countries the opportunity to re-purpose their oil and gas reserves to produce petrochemicals, fertilizers, and a host of new products that innovators can produce. The sooner this re-purposing is accomplished, the higher the returns and benefits.

5.1.2. Capitalize on proximity to renewable energy

The sun shines and the wind blows in many countries, but some MENA countries are blessed with abundant opportunities and endowments that few regions can match. In addition, oil and coal products are incredibly energy-dense, meaning they contain a lot of energy per unit of weight and volume, making them cheap to transport. It costs less than USD 4 to ship a barrel of oil that is worth about USD 100 at the well halfway around the world.[37] As a consequence, oil and coal made the world flat from an energy perspective. Fossil fuel-poor countries could become competitive in energy-intensive products. China, Japan, and Germany, for example, are major steel exporters but energy importers.

This is unlikely to be the case with the alternatives to oil. Thus, countries with a lot of sunshine produce solar energy for less than USD 20 a megawatt hour, but to move the energy a long distance, it must be stored in a molecule such as ammonia.[38] This conversion will increase the cost of energy six-fold (not counting the cost of transport). This creates enormous incentives to use renewable energy in situ. Energy-intensive industries will likely move toward places rich in green energy. This will make the MENA region a desirable hub for energy-intensive production.

5.1.3. Keep the cost of capital low

Hausmann notes that the sun shines, the wind blows, and the rain falls for free, but most of the cost of renewable energy production is, however, the fixed cost of the equipment, including the cost of the capital to buy it. Germany may be able to obtain funding at a cost of two percent, while in Morocco, it may be seven percent. Therefore, although Morocco is sunnier than Germany, this does not translate into cheaper solar energy. This is a major issue because the sun is strong in the Middle East, but capital markets shun these regions, potentially reversing their comparative advantage.[39] Good institutions and macroeconomic management that keep country risk low are critical determinants of the cost of capital and hence the ability of MENA countries to be competitive in green energy. Subsidizing borrowing rates for energy equipment stands out as a key strategic factor in developing a regional competitive edge in renewable energy.

5.1.4. Manage technological risks

Technological uncertainty is a defining characteristic of the world today. "Who would have thought the smartphone would displace the alarm clock, the camera, the CD player, and even the personal computer? Today one megawatt hour of solar energy when the sun is shining, or the wind is blowing is cheaper than the fossil fuel needed to generate the same megawatt using a thermal plant. This was unthinkable a decade ago."[40]

At this time, it is difficult to predict which technologies will win the race; there are many technologies in the running. MENA countries should be aware of the bets being placed across the world. While technological surveillance is done regularly by industry, few governments do enough of it. Governments in the region should emulate the success of Singapore in appointing their chief scientists in their economy ministries to anticipate changes that may be coming and decide the most promising R&D bets. Chile's government is investing in a lithium research center with a consortium of global universities so that it can be on top of the technologies that might reduce costs and enhance the use of lithium while tracking those that may displace it.[41]

5.1.5. Explore carbon sinks – net zero is not gross zero

A few countries in the MENA region have not adopted carbon prices in an appropriate manner and a few do not price carbon (e.g., Saudi Arabia). The region does not have large forests and it is not likely to benefit much

[37] https://www.imf.org/en/Publications/fandd/issues/2022/12/green-growth-opportunities-ricardo-hausmann

[38] https://commercialsolarguy.com/lowest-solar-power-prices-in-the-world/

[39] With the exception of some of the GCC countries. For example, Saudi Arabia is still able to finance mega renewable energy projects (NEOM) at attractive capital costs.

[40] Solar Power Got Cheap. So Why Aren't We Using It More? https://www.popsci.com/story/environment/cheap-renewable-energy-vs-fossil-fuels/

[41] https://www.energypolicy.columbia.edu/chiles-new-lithium-strategy-why-it-matters-and-what-to-watch-for/

from carbon sinks. However, it may be worthwhile to consider leasing these to create the credible offsets they need to prolong the life of their huge deposits of fossil fuels as an interim strategy.

There are other sinks, too. There may be geological formations in the deserts that could be ideal for storing carbon that has been captured. MENA countries should figure out where these are and certify that they are safe and sealed. Property rights must be defined on these geological formations so that investment can take place and countries in the region can collect rent from storage space.

5.1.6. Plan to learn

It is reasonable to suggest that no country today excels at the technologies and industries that will shape the future. However, Hausmann believes some will learn and others will not. MENA countries should plan to be in the first group. "Too often countries are told to shun things they don't do well and focus on things they are good at. But growth has never been just about focusing on current areas of comparative advantage. Growth can be anchored on evolving that advantage. France has a long history of being good at wine and cheese, but it also became good at commercial aircraft and high-speed rail." Why cannot MENA countries seek to develop the capacity to manufacture electrolyzers competitively? Who will transform their sunshine and wind into a source of advantage? It will be the countries that focus on attracting strategic investments and global talent, and on facilitating technological adoption by supporting research programs at universities and beyond.

5.2. Collier's recommendations: transition from a centralized rent-seeking society to a decentralized productive society

Another seminal contribution in this area was made by Professor Paul Collier in a paper presented at the 2019 ERF Annual Conference and published subsequently in ERF's Middle East Development Journal.[42] In it Professor Collier argued that the challenge facing the MENA region is all too obvious. One way or another, most countries of the Arab World depend on or have benefitted from the oil rents, whether directly by extracting and exporting oil and gas or indirectly through remittances sent by Arab workers in the oil-producing and exporting countries. They also benefited by being recipients of development aid from the Arab oil exporters, or from the exports of goods and services to these countries, or from the investments made by these countries into the economies of the Arab non-oil producers. This web of strong economic ties between the two groups (the oil-producing countries and the non-oil producing of the Arab World), powered by oil rents and its derivatives, means that every country in the MENA region will be drastically affected by oil and gas becoming stranded assets as concerns over climate change and emissions escalate. The analysis and recommendations made by Collier below emanate from his acceptance of these deep connections and the intricate web of dependence on oil rents in the entire MENA region.

5.2.1. How MENA countries can re-base the growth of their economies[43]

Collier's basic premise is that as oil rents are set to wane, and asset values of fossil fuel deposits are set to be transformed into stranded assets, the legacy of four decades of MENA countries' dependence on fossil fuel rents is an economic structure that did not generate mass opportunities for employment that are sufficiently productive to sustain the living standards that the population in the region has come to expect. It is now an opportune time to restructure and reform the MENA region's economies and to wean the region out of this dependence on non-renewable assets.

5.2.2. MENA countries need a social transformation and a new development strategy

The real question for now (and for the near and mid-term) is about what can be done about transitioning from this dependence on fossil fuels to developing renewable sources of income and wealth. Collier is suggesting the formulation of a new development strategy and a whole new set of policies that can be put urgently in place. Whether you call this development strategy a new industrial policy or not, or a refocusing of its aims and means or not, is not the issue because the bare bones of building productivity at 21st century levels are not mysterious. Collier urged the region to build new clusters of firms capable of innovation and linked to vocational training that equips a workforce with the skills that firms need. This transformation is not about a "grand scheme" or a "master plan." Rather, it is about a "social project"

[42] Paul Collier.2019. Re-basing Economic Growth in the MENA Region. Middle East Development Journal. Volume 11 - Issue 2.

[43] This section is based almost entirely on Paul Collier's ideas and recommendations contained in his article, Re-basing Economic Growth in the MENA.

or even a "cultural revolution" that should involve all aspects and sectors of the society and the economy working together to achieve this transformation quickly and cumulatively. This project is far more complex and comprehensive than a transition to renewable energy and a green economy.

"The scale of the change from a rent-seeking economy to a skill-based economy is massive. It requires both cultural and institutional changes, and the changes are too large to be planned in any detail: it is a transformation." This is a serious transformation of a society, which is a complex process and a unique event and so, by its nature, it cannot be planned in detail; any set of proposals will need to be responsive to unanticipated future events and resilient to shocks.

Unique events such as the ones tendered here by Collier are, by their nature, subject to radical uncertainty. The way to navigate such uncertainty will involve building a process of rapid social learning based on experimentation, not by insisting on implementing a highly specified plan. He envisages a process whereby as society adapts and experiments, new opportunities will open, and the next steps will become clearer. What is needed and recommended is creating an adaptable framework along paths used successfully in other regions and countries such as those used by China and some of the Southeast Asian countries.

5.2.3. Local networks and local jobs

He recommends, first and foremost, that people in the MENA region must become productive workers, but this does not happen automatically and will require a series of conditions that have to be met. The most elementary requirement is to lay down the conditions that allow the potential for economies of scale and economies of specialization to be realized. However, for that to happen, he recommends that workers be organized into teams. This cannot happen without establishing firms, as the most fundamental function of the firm is the organization of workers.

In the MENA region, many workers are forced to work solo as there are too few firms; too much of the labor force in the region is either in small informal enterprises or in the public sector. In the most advanced economies, however, one level up from the firm is the cluster. Firms cluster together partly to reap further scale economies that accrue at the sector level rather than within the firm.

The most crucial factor supporting the transition to productive employment is to organize the training of the local workforce to equip them with the skills needed by the firms in the city. "The labor market does not do this automatically because neither individual firms nor individual workers have sufficient incentives to invest in training. If a firm invests in a general skill, the rational action is for the newly productive worker to quit for a rival firm that can afford to pay him more since it does not need to recover the costs of training. If a worker invests in a firm-specific training, the rational action is for the firm to exploit his new productivity."

5.2.4. Workers should invest in general skills and firms should invest in specific skills

How best to accomplish this? Collier suggests that the best way to address this issue is for workers to invest in general skills and for firms to invest in firm-specific skills, but in practice, efficient training will often intertwine general and firm-specific skills. Given that workers face much higher costs of borrowing than firms, they tend to under-invest even in general skills. It follows that we need public policy to generate the required level of investment in skills.

In general, it is the case that state-provided training is unlikely to be successful because it is too detached from the changing needs of employers. To make sure that training is pertinent, firms must be directly involved in the provision of training, usually in collaboration with local colleges and institutions so that an integrated balance of firm-based and classroom-based methods evolves. This calls for a nuanced public policy that imposes a levy on firms that forces them to finance skill acquisition, and partly to broker the marriage of college-based and firm-based facilities.

5.2.5. Organize and structure authority at the level of urban clusters

The fourth requirement is to organize the structure of authority so that it corresponds to the decisions that need to be taken at the level of the urban cluster. However, this has opposite implications for business and government. Businesses are organized to compete with each other. But for the provision of city-wide training, they need to cooperate. Locally based businesses need to come together, forming associations that can

work as a counterpart to local government, both for appropriate training and as a lobby for appropriate urban infrastructure. Conversely, government needs to be decentralized from national to city-level authority so that training colleges and centers can be organized, as they are pertinent for the changing array of firms located in the cluster.

5.2.6. Equip firms with the skills needed for international competition

The final requirement is not to equip the workforce with skills; rather, it is to equip firms with the skills needed to remain abreast of the international competition. This necessitates the development of direct linkages of firms and workers to university research departments, although the flow of knowledge is not simply from universities to firms but also a flow of new knowledge back to universities. This arrangement requires the decentralization of government; universities need sufficient local autonomy to be able to collaborate with local government in financing the research pertinent to the type of firms that the city hopes to attract.

5.2.7. A Nexus approach to skill development, finance, research, and education

At the heart of all of this is the development of a nexus of firms and activities that promote high productivity by combining firms, local governments, and local tertiary education that work together to create and maintain a cluster of high performance. This brings firms that are spatially clustered together by products and interdependence, and organizationally bound into collaboration by business associations and government training levies. The local governments should be guaranteed sufficient financial and policy autonomy to invest in the infrastructure that enhances the productivity of the firms that it seeks to attract to the city. The tertiary education sector should be organized to train the workforce that the firms need and to conduct the research that keeps firms competitive. The whole system is designed to respond flexibly to change; each part has an incentive to spot emerging problems and work within the system to prepare appropriate responses.

5.2.8. Can MENA countries erect similar structures that successful cities used?

The development of some major cities in the US and Europe has followed this mode of development. American cities such as Boston, some European cities such as Munich and Edinburgh, and some Asian cities such as Singapore could not have developed their productive structure and excelled if they had not developed and exploited these productivity-enhancing levels. Can MENA countries erect similar structures? They already have major cities, they already have well-equipped universities, and they already have some capable large firms. However, they need and require a huge shift from the rent-seeking style of life that has been endemic. As carefully documented by Diwan, Malik, and Atiyas (2019), firms have relied on crony capitalism to prosper rather than on productivity.[44] Perhaps more damaging is the fact that educated young workers in the region have used their education to acquire credentials for entry to the public sector or seek opportunities overseas, rather than to acquire skills that would make them productive in a domestic sustainable private sector activity.45 Equally problematic is that governments in MENA have been organized around command-and-control by highly centralized authority, rather than into decentralized structures of authority designed according to functional pertinence and trusted to fulfill purposes that they have fully internalized.

5.2.9. Transformation under radical uncertainty: learning by doing

Shifting from a centralized rent-seeking society to a decentralized productive society is such a major transformation that it cannot be fully planned in advance. It will be subject to radical uncertainty; as such, it will depend upon igniting rapid social learning so that the society error-corrects as it attempts to change. This is, in essence, the strategy that Deng adopted in transforming China. It was summarized in two images that he used:

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[44] I. Diwan, A. Malik, and I. Atiyas (2019). Crony Capitalism in the Middle East: Business and Politics from Liberalization to the Arab Spring. Oxford: Oxford University Press.

[45] D. Salehi-Isfahani. 2012. Education, jobs, and equity in the Middle East and North Africa. Comparative Economic Studies 54: 843-861 and World Bank: https://openknowledge.worldbank.org/entities/publication/1f1fe72d-bf6d-50b8-81e5-7f280bf8b72d.

'Feeling your way across a river, stone by stone' and '…It doesn't matter whether a cat is black or white as long as it catches mice.' These advanced the notion that the process involved radical uncertainty and that it permitted experimentation.

5.2.10. MENA countries are starting from a very different situation than the Asian tigers

Embarking on a radically uncertain process inevitably arouses fears, but apprehension is compounded because MENA countries are starting from a situation very different from that which characterized East Asian countries at the onset of their successful transformations. East Asia started from low incomes and strong states, whereas MENA countries are starting from incomes that are quite high because of oil rents, and states that have become somewhat fragile. The East Asian economic transformation was a simple one of pulling people out of low-wage/low-productivity occupations (such as primitive agriculture) toward more productive, higher-wage manufacturing. In MENA, wages are too high to ignite such a process. The East Asian transformation was implemented by states that were effective and purposive.

5.2.11. MENA countries classical features of fragility

MENA states are characterized by some of the classic features of fragility: a weak private sector, a low level of political legitimacy, and limited state capacities.[46] The state is built on a top-down basis, rather than on a set of reciprocal obligations between rulers and citizens that implicitly form a social contract in which citizens pay broad-based taxes in return for public services. The MENA oil countries developed an authoritarian bargain where citizens receive generous benefits from the ruler in exchange for acquiescence and political docility.[47]

The present structure is unsustainable, and therefore there needs to be a change. Oil revenues will rapidly wither, and the working-age population will rapidly increase. Continuing along an unsustainable path is far more dangerous than embarking on uncertain change since it can only end in crisis. Transformation, albeit uncertain, will succeed as long as strong mechanisms for rapid social learning and error-correction are put in place. The overarching objective is for the growing inflow of young job seekers to find productive employment in the knowledge clusters discussed above instead of working in low-productivity bureaucracy, low-productivity crony capitalism, and low-productivity informality.

Underpinning the change from centralized bureaucracy and crony capitalism to decentralized government, purposive tertiary education, and market-disciplined firms are two profound transformations, one in institutions and the other in norms and cultural practices. The first of these has been discussed extensively in the contemporary literature (Acemoglu and Robinson, 2012), but the latter has received much less attention. However, the two are deeply complementary; many institutional innovations succeed only when the people who work in the institutions bring cultural practices that are well-suited to their operation. Changing these requires a change in mindset and ideas across the society.

5.2.12. Political leaders and governments can lead but cannot affect the success of the transformation

Political leaders rarely have enough power to implement the huge task of transforming their society simply by issuing commands. If people are reluctant to comply, they can usually find a myriad of ways to inhibit change. Hence, leaders need to gain a degree of willing compliance from their citizens. For this reason, they need to go beyond issuing orders: they need to change minds. People's minds are filled with the ideas they get from their social networks such as families, from organizations such as their places of work and prayer, and from the media. The few people who are at the hub of these networks and organizations are vitally important as communicators. Political leaders are not just the Commanders-in-Chief, they are the Communicators-in-Chief; by communicating effectively and consistently, they can gradually reset the ideas that people hold. They have two means of communicating: what they say and what they are seen to do. By far, the most effective form of speech is narrative: most people find stories easy to understand and remember. The use of visible actions to reinforce credibility is analyzed rigorously in the Theory of Signaling.

When well-used, narratives and signaling actions fit together, complementing each other. By using appropriate

[46] Timou. Kivimäki. 2021. The Fragility-Grievances-Conflict Triangle in the Middle East and North Africa (MENA): An Exploration of the Correlative Associations. Social Science.10 (4), 120. https://doi.org/10.3390/socsci10040120.

[47] R.M. Desai, A. Olofsgård, and T.M. Yousef. 2009. The Logic of Authoritarian Bargains. Economics & Politics 21.1: 93-125.

narratives, leaders can convey the meaning of an idea to people clearly and memorably. By matching this with visible behavior that is consistent with the idea, the leader's message becomes more credible: he 'walks the talk.' While the narrative needs to be aspirational, it is also important to stress the necessity of change by allusion to potential outcomes without transformation. One of the hardest steps is to convince a population to embrace change. Indeed, this is hard in any society, as the recent experience of France has shown.

5.2.13. Do not overload the reform agenda

A key principle of charting a path is not to overload the reform agenda. When an economy has many distortions, it is tempting to deal with all of them (and reform strategies are spoilt for choice). However, a long wish list is unwise. A step-by-step process involves focusing on tangible short-term wins. By acknowledging uncertainty, the leader gradually builds a culture of experimentation in which a range of options are tried and carefully monitored to see what works.

In the process, there is a shift in the source of self-respect from being to doing. Prestige is reconnected to achievement. Prestige becomes attached to doing something that is productive for society, not merely being in a position or close to those in power. Given that prestige currently comes from being in the public sector, it might sometimes be necessary, especially in the Gulf, to make this transformation in two stages. First, shift the source of prestige to working productively in the public sector and only later take the second step of shifting it to working productively in the private sector. Hence, the first step might involve creating more productive opportunities within state-owned enterprises. However, any state-owned enterprises need to be subject to genuine market tests; only then will they create sustainable change. Infant industry arguments along these lines would require careful management along a transition path toward self-sufficiency. It is unlikely that these enterprises can compete in world markets and consideration should therefore be given to entering sectors with less exposure to foreign competition.

5.2.14. China's use of scaffolding and narratives

Narratives are most effective when they are culturally specific and credible. The pace of change is not going to be rapid: no MENA country is going to become Singapore. Each country is unique, and so it cannot adopt a narrative that amounts to becoming a replica of somewhere else. Such a narrative could be more dangerous than helpful. It amounts to looking at someone else's finished building rather than erecting the scaffolding to build your own house. The learning from other countries should focus on the scaffolding – the process of how transformation was achieved. The scaffolding used by China had four components:

- An overarching narrative spread around the population, mainly to rebuild a prestigious, proud China.
- A political leadership that encouraged intensive, rapid social learning to understand what would work within the local context.
- To evaluate the performance of those who held positions of authority and hold them to account for success and failure.

Use decentralization to foster a yardstick competition across jurisdictions, further encouraging experimentation on a local scale.

Rapid social learning can only happen if policymakers and decision-makers acknowledge that there are many aspects of the reform program that they do not yet understand: that they know that they do not know. Success lies in a step-by-step approach and learning from the steps. In China, the political leaders enforced the need to experiment and changed the perception of failure so that it became seen as a positive learning experience. Local leaders were forced to experiment; if companies, institutions, and bureaucracy did not innovate, they were judged to be failures. Bureaucracy changed as leaders encouraged experimentation. Hence, running a series of social experiments should be a core element of the actions to be taken in support of the narrative. The experiments should be done on a small scale; large experiments are too risky.

5.2.15. Development of institutions

Institutional change is not sufficient, but it is important. The development of institutions can create convincing signals, making cultural change credible. Articulating new rules can also facilitate a shared understanding of the steps that need to be taken and can create incentives to do so. Institutional reform can also provide a context for bringing new people into the policy process with different mentalities, goals, and ambitions.

5.2.16. Institutions and culture co-evolve

Just as institutional rules signal the formal norms, culture embodies the informal norms. The culture of an institution becomes established when its leaders and its people become willing and competent in what the institution is tasked to do. This requires the appropriate level of staffing and analytical resources. There are many examples of institutional reforms in the real world which have been able to change norms and practices as well as create new rules. A good example is having an Independent Office for Budget Responsibility as established in Britain in 2010. It has the potential to instill discipline, particularly around spending, based on realistic long-term projections for the price of oil. This would avoid the current situation of public expenditure following oil prices in a pro-cyclic fashion. Improving the framework for budgetary forecasting can be used to change narratives around public management, forcing policymakers to pay attention to longer-term goals. It also injects an element of independent thinking and analysis into policy. However, the details of institutional design matter. It is important that the institutional goals are carefully specified, that the system of accountability is specified, and that there are sufficient human and financial resources for the body to do its job to a high level. Institutions can be set up to fail. Similarly, attempting to implant Western-style cultures and institutions into MENA will not work.

The importance of not overloading the narrative carries into implementation. Failure is most commonly due to trying to do too many things at once. The fear of failure and the reality of failure are demoralizing. Visions are grand leaps. However, actions and initiatives in support of the narrative should not take the form of leaps. Rather, they should be considered more akin to scaffolding. Scaffolding supports the construction of a building, but when it is taken away on completion, the building stands on its own. The scaffolding of actions and narratives for transformation is the gradual change in institutions and ideas that pave the path along which the local knowledge clusters that enable a workforce to be productive get built.

China discovered the scaffolding that it needed for transformation from experiments within its regions. Since these experiments were conducted within an area bounded by a common culture and institutions, the lessons from one place were likely to be pertinent for others. MENA is even better placed to undertake experiments within its own region of cultural and institutional similarities because it consists of many sovereign states. In China, the central government had to convince regional leaders that they would not be punished for branching out from what had been nationally imposed policies.

The MENA region is fortunate that it does not have a MENA-wide central government; experimenting is much easier. In China, however, once experiments got underway, it was easy to spread. MENA's strength in being able to experiment is its weakness in spreading the learning from them. What have been missing in MENA are the institutional structures designed to learn from experiments in other countries within the region. What MENA needs is not regional power structures, but regional knowledge networks capable of evaluating experiments and spreading the lessons from them. All new experience is valuable; societies can learn not only from successes but from failures. ERF is such a network; as the region's premier social science knowledge network, its role in speeding the transformation of the region is exceptionally important. The first 25 years of the ERF have gradually built an organization that can be truly valuable in the decisive period of the next 25 years.

Of course, the real question here is how such clusters of firms can be built. What is the scale of the change from a rent-seeking economy to a skill-based economy that is likely to be needed? The challenges are not purely economic; this transformation requires both cultural and institutional changes, and the changes are going to be too large to be planned in any detail or to be served by an industrial policy or a program of energy transformation. The transformation of a society is a special and unique event and so, by its nature, it cannot be planned in detail; any set of proposals will need to be responsive to unanticipated future events and resilient to shocks. Just as the old strategy of diversification downstream and upstream in the region is no longer feasible or sufficient, so is looking for sunrise industries to replace sunset industries. The MENA region needs to broaden its diversification perspective to include a cultural transformation aspect that encompasses all sectors and activities and not only those in renewable energy.

Even in the case of adopting a narrow perspective focused on a diversification strategy premised on renewable energy and a transition to a green economy, there are broader considerations to keep in mind and many aspects, choices, requirements and agents of change to analyze, consult with and gather their perspectives on the transition. Below, we present a few details and insights garnered from the many field interviews, focus groups, survey data and regression analysis in the six chosen countries in this project, particularly as concerns the barriers, drivers, and interventions that could promote or hinder the transition to renewable and green energy.

6. The drives of the transition to renewable and green energy: the qualitative and quantitative analyses

The literature on the relative importance of drivers of renewable energy (RE) adoption by MSME firms is in general scant, particularly in developing countries like those in the MENA region. Several important drivers of RE are identified in the literature (See, Asenta et. al., (2021), Seggarra-Blasco and Jove-LLopis, (2019), Rahbauer et. al., (2018), and Siewers, Samuel et. al., (2019);[48] including the perceived responsibility for the environment, reliability of RE, their relative prices, firms' customers' willingness to pay a price premium for goods produced with RE, competitive pressures, the age and size of the firm, adequacy of the energy infrastructure, availability of technical skills, access to finance, government support programs, and government regulations.

Several gaps have been; however, identified in the literature dealing with the transition drivers to renewable energy in the context of developing countries; a gap that the present ERF-IDRC study targets to deal with through surveys, case studies, focus groups and quantitative studies. Of particular importance in this regard are a few factors that are strongly associated with development challenges in the region such as access to credit, limited regional cooperation and international support, deficient trade regimes, political instability, inadequate infrastructure, shortages of technical and professional skills, and high exposure to climate hazards. These and other factors have been flagged as major barriers that delay the transition or limit its realization.

Among the most critical drivers are access to credit and sufficient resources available to MSMEs to support their plans to decarbonize. These two factors stand out as the most important constraints facing MSMEs in developing countries and have made adoption of RE technologies very difficult, particularly at the early stages of the transition as upfront capital costs are often too high or too difficult to access. By rendering imported capital and equipment more expensive, tariffs, depreciating exchange rates along with complicated custom clearance procedures were also highlighted in most of the qualitative studies conducted in Sudan, Egypt, Lebanon, Jordan, Morocco and Tunisia as potential constraints on RE adoption.

A general finding of the surveys and focus group meetings in these countries focused on the fact that adopting RE technologies requires specific skills like engineering knowledge and a host of technical skills. Since these RE technologies are relatively new, the required skills are more likely to be acquired by the younger generations and hence firms that adopt renewable energy have tended to employ a larger share of youth in their firms. At this time, awareness of the environment is almost lacking in many of the countries that were surveyed, but this lack of awareness is fading slowly as younger generations are becoming more educated and more engaged. In the absence of pressure from environmentally aware consumers and in the face of the dominance of environmentally lax governments, pressure for environmental protection is more likely to come from employees. The empirical and anecdotal evidence from the MENA region has shown that a young labor force is one of the crucial drivers that facilitate the adoption of RE at the firm level.

Empirical evidence gleaned from many studies in several developing countries reveals that women are more concerned about environmental issues compared to men. Atif et al (2021)49 find that gender diversity on firm boards increases RE adoption. This suggests that women entrepreneurs might be more inclined to employ RE compared to their male counterparts. This fact was also confirmed by empirical evidence in Egypt for the year 2023 that showed that SME owned by women and those

[48] Dennis Asante; He, Zheng; Ampaw Enock; Gyamerah, Samuel; Twumasi, Martison; Opoku-Mensah, Evans; Kyere, Francis; Asante, Bismark and Akyia, Ellen. 2021. Renewable Energy Technology Transition among Small and Medium Scale Firms in Ghana. Among Small-and- Medium Scale Firms in Ghana. Renewable Energy, 178:549-559. Segarra-Blasco, Agusti and Jove-LLopis, 2019. Determinants of Energy Efficiency and Renewable Energy in European SMEs. Economics of Energy and Environmental Policy, 8(2):117-139. Rahbauer, Sebastian; Menapace, Luisa; Menrad, Klaus and Lang, Hannes. 2018. Determinants of the adoption of green electricity by German SMEs-An Empirical Examination. Energy Policy, 123:533-543.

[49] Atif, Mohammed; Hossain, Mohammed; Alam, Samsul and Georgen, Marc. 2021. Does Board Gender Diversity Affect Renewable Energy Consumption? Journal of Corporate Finance, 66:1-29.

that employ a large share of youth in their labor force are more likely to consider adopting RE.[50] Furthermore, research in five MENA countries, (Algeria, Egypt, Lebanon, Morocco, and Tunisia) revealed a positive correlation between gender (being a woman), age (being young), and income levels (having high income) on one hand and seeking a better environment on the other (Dibeh et al., 2021).[51] These findings suggest that removing impediments to hire more women entrepreneurs and youth with technical skills would raise the likelihood of adopting RE by the MSMEs in Egypt and in the region at large.

6.1 the empirical country studies on drivers to adoption of RE by MSMEs in MENA

In what follows we will draw on the special empirical investigations of the drivers of the adoption of RE by MSMEs in Egypt that was carried out by Abeer Elshennawy and Mohammed Bouaddi (2024)[52] and in Egypt, Jordan and Morocco by Ali and Ramadan (2024).[53]

6.1.1. Elshennawy and Bouaddi study of Egypt

Elshennawy and Bouaddi (2024) used a random sample of 1002 MSMEs drawn from all sectors of economic activity in Egypt. They prepared a questionnaire that they used to collect the needed information from all firms in the sample through telephone interviews in 2023. The data is representative of the yellow pages in Egypt; thus the sectors' distribution in the sample represents the distribution in the yellow pages. The average size of the firm was 8.8 employees and the largest firm employed 60 employees, while the minimum was 2 employees. Respondents to the phone survey were asked the following question "Have you personally considered using clean energy (solar/wind) in your business" which served as the dependent variable in the model. In answering this question, respondents had to choose between "Yes", "No" or "I am using it". Due to the very small number of respondents answering "I am using it", they excluded this category from the sample.

The study explored the interrelationship between RE adoption and its various drivers at the firm level, they used quantile regression which was first introduced by Koenker and Bassett's (1978).[54] As compared to linear regression where the coefficients capture the average effect of any explanatory variable on the dependent variable, the quantile regression captures the effect in different levels of the distribution of the dependent variable. The coefficient in the linear regression captures the average effect. However, the explanatory variables may have different effect across different firm sizes with different levels of RE adoption. Quantile regression technique is more flexible in the sense that it can capture heterogeneous effects (see Appendix A).

The following is a summary of the salient and highly informative results of this study and several other qualitative and quantitative studies covering the six target countries:

1. A statistically significant and positive coefficient for gender of the owner of the firm, lending support to the contention that females tend to be more environmentally conscious compared to males.
2. The share of youth in the firm's labor force renders firms more likely to consider employing RE as evident from the positive and highly significant coefficient of this variable for the 50th, 75th and 95th quantiles but this variable is insignificant for the 5th and 25th quantiles.
3. Of all the variables considered in the model, three variables consistently appear with positive and highly significant coefficients across all the quantiles of the distribution. These are ICT, awareness, and access to information about technology.
4. Affordability of RE seems to matter only for firms in the 50th and 75th quantiles while the coefficient is insignificant for the remaining quantiles.
5. Lower cost of RE compared to other sources of energy is a significant variable.
6. The availability of credit/finance encourages firms to consider employing RE as evident from the positive and significant coefficient of this variable.
7. Certification positively influences firm's tendency to consider employing RE, but this effect is insignificant for the 5th quantile.
8. Except for firms in the 75th quantile, firms that are

[50] Abeer Elshennawy and Mohammed Bouaddi. 2024. Drivers of Renewable Energy Adoption in Egypt's SME. ERF Publications.

[51] G. Dibeh, A. Fakih, W. Marrouch, & G. Matar. 2021. Who cares about environmental quality in the MENA region?. Social Indicators Research, 157(2), 603-629.

[52] Abeer Elshennawy and Mohammed Bouaddi. 2024. Ibid.

[53] Nada Ali and Racha Ramadan.2024. Gender and Climate Change in the MENA Region: Would Women's Participation in MSMEs Accelerate Transition to Clean Energy?

[54] Koenker, R., and G. Bassett (1978) 'Regression Quantiles', Econometrica, 46: 33-50, and Koenker, R., and K.F. Hallock (2001) 'Quantile Regression', Journal of Economic Perspectives 15(4): 143-56.

inserted in Global Value Chains do not consider employing RE. In general, one can conclude from this observation that environmental laws are lax in Egypt.

9. The coefficient of location is insignificant for the 5th, 25th and 50th quantiles but appears with a negative sign and is significant for the 75th and 95th percentiles. This provides evidence that firms who are likely to consider using RE are mainly located in rural areas where there is in general more space to install RE.
10. Except for the 95th quantile where the coefficient of ownership is negative and significant, foreign firms are more likely to consider using RE given that the coefficient of ownership is positive and significant for all other quantiles.
11. Apart from the 5th quantile where the coefficient of age is insignificant, estimation results for all other quantiles show that older firms are more inclined to consider the adoption of RE.
12. Formality enters with a negative and significant coefficient for all quantiles. Formal firms must abide with laws and regulations and it could be the case that to employ RE they have to go through lengthy and cumbersome procedures, all of which can be avoided by informal firms.
13. Firm size as measured by the number of employees has no effect on the tendency of firms to consider employing RE for the 5th and 50th quantiles. For the 25th, the larger the size of the firm, the more likely they are to consider RE. For the remaining 75th and 95th quantile the effect of firm size is negative and significant. These results point to the fact that it is small firms that are more likely to employ RE.
14. The share of skilled labor in firm's labor force exerts a negative and statistically significant effect on the likelihood that the firm adopts RE. This could be explained by the fact that skills provided by the education system fall short of that required for RE.
15. The top skills required for the green transition include knowledge of mathematics, mechanical engineering, design, building and construction, engineering and technology, computer and electronics. Several factors constraint demand for and supply of these skills in Egypt.
16. On one hand, the enforcement of environmental regulations remains weak. On the other hand, despite that fact the government has recently made an effort to provide training for these skills, the link between policy making in the area of the environment and education, and training policy making still remains rather weak.
17. Female managers seem to discourage the use of RE. Several other managerial characteristics influence the likelihood that firms consider employing RE. Except for 5th and 95th quantiles, managers' experience influences positively this likelihood. Apart from the 5th quantile where the effect of managers' age is insignificant, the results for the 25th, 50th, 75th and 95th quantiles show that the older the manager, the more the likely the firm would consider employing RE.
18. Managers' education positively influences the tendency of firms to consider RE, but the effect is insignificant for the 5th quantile.
19. Government incentives positively influence firms' attitude for all but the 5th quantile.
20. Feed-in tariffs were initially introduced to promote renewable energy generation and were later replaced by competitive bidding auctions.
21. Government incentives were significant at all percentiles except the 5%. These incentives were not disaggregated by type. This is why the confirmation of the positive influence of policy on RE adoption came primarily from the in-depth qualitative study.

6.1.2. Ali and Ramadan study of Egypt, Jordan and Morocco

In another ERF study conducted by Ali and Ramadan (2024)[55] using both a qualitative approach and a quantitative Logit Model that they applied to survey data for Egypt, Jordan and Morocco, they found that the age and education of top managers are key factors in facilitating the transition to clean energy. Additionally, they also found that economic and institutional context of the country also plays a significant role in the transition to clean energy.

1. Among the many interesting conclusions they reached from examining the survey data is that the use of clean energy and presence of women in top levels of decision making varies between the three countries. In Egypt, almost none of the firms had used clean energy, while 21% of the firms are considering shifting to clean energy. On the other hand, 5% and 4% of the firms in Jordan and Morocco are using clean energy, respectively. In each of the two countries, 37% of the firms are considering a shift to clean energy.

[55] Nada Ali and Racha Ramadan. 2024. Gender and Climate Change in the MENA Region: Would Women's Participation in MSMEs Accelerate Transition to Clean Energy? ERF Publications.

2. They also noted that understanding the profiles of firms using clean energy and those considering using renewable and clean energy can inform policy for energy transition in the region. In Egypt, 32% of the firms have female top managers, mainly concentrated in the retail sector, followed by the garment and textile sectors.
3. Also interesting is their finding that firms in sectors such as construction, wood products and furniture have only male top managers. In Jordan, only 11% of the firms are managed by women. Among these firms, 62% are concentrated in the health and education sectors. In Morocco, 17% of the firms have a female top manager. More than 10% of these firms are in the retail, wholesale, information and communication, education, or health sectors.
4. As to female ownership, the surveys show that in Egypt, Jordan and Morocco, 61%, 83% and 60% of the firms have no female ownership at all, respectively.
5. They also observed that the decision to consider using clean energy might be associated with the familiarity with the term "clean energy". In Egypt, 93% of the firms considering the use of clean energy are familiar with the term. This share is 67% in Jordan and 74% in Morocco. While only 15% of the firms in Egypt, 33% in Jordan and 35% in Morocco are managed by women and these are considering using clean energy.
6. The quantitative analysis56 shows that gender diversification in MSMEs measured by the sex of the top manager, female ownership and the share of female full-time employment has no significant effect on the decision of using clean energy in all three countries. This is inconsistent with the findings of Dibeh, et.al., (2021) and Abeer Elshennawy and Mohammed Bouaddi (2024); however, the interaction between the sex of the top manager and other characteristics, such as age and education, have a significant effect on the clean energy decision.[57]
7. In Morocco, a firm managed by a woman aged between 18 and 59 has higher odds to use clean energy compared to elderly top managers aged more than 60 years old. While in Egypt, female top managers with diploma or university degree firms are less likely to consider using clean energy. This might be explained by the field of study. Having a university degree in other fields than STEM might hinder the decision to use clean energy. For the education level in general, only top managers with diploma in Morocco are significantly more likely to consider transition to clean energy, compared to managers with primary education or lower levels.
8. In Egypt and Jordan, youth managers aged between 18 and 29 years old and those aged between 30 and 59 years old are more likely to consider using clean energy compared to older age groups.
9. These findings reveal that not only the characteristics of the top managers' matter, but the characteristics of the firms and the countries where they operate affect the decision to consider clean energy. In Egypt, small firms have higher probability to consider the use of clean energy, compared to micro firms. While in Morocco, medium firms with more than 20 workers are more likely to consider using clean energy, compared to micro firms. Both small and medium firms have higher likelihood to use clean energy in Jordan. This might be expected as bigger firms can invest in the technology required to clean energy transition.
10. An interesting finding of this quantitative model is that the share of electricity bills in the total operational costs has no significant effect on the decision to consider using clean energy. This means that the decision might not be driven by the operational costs, but by other factors as policies and incentives regarding energy transition in the different countries. Considering the country effect, the global model with the three countries shows that firms in Jordan and Morocco are more likely to consider using clean energy. This explains the statistics that only 51% of firms in Egypt plan to invest in renewable energy, compared to 63% and 65% in Jordan and Morocco, respectively.
11. The reasons why firms will consider using clean and renewable energy vary among the three countries. The first reason for considering investing in renewable energy in Egypt and in Morocco is the improvement of the firms' energy efficiency. In Egypt and in Morocco, 73% and 88% of the firms that consider using clean energy (strongly) agree that adopting renewable energy technologies would improve their energy efficiency, respectively. While in Jordan, the first reason is that the use of renewable energy technologies would reduce the energy costs, with 90% of the firms (strongly) agreeing with this statement.

[56] A logit model is estimated where the dependent variable is the answer to the following question: "Have you personally considered using clean energies?". The variable takes the value 1 if the answer is yes and 0 otherwise. Several versions of the model were estimated with different explanatory variables. Gender diversification is measured by the sex of the top manager, having female ownership and share of female full-time employment, in addition to other control variables. For further details about the survey and the methodology used, see Ali and Ramadan. 2024. Gender and Climate Change in the MENA Region. ERF Policy Report.

[57] This suggests that other intervening variables are important consideration in the transition ti renewable energy and gender.

6.2. The qualitative results of the Tunisian case study

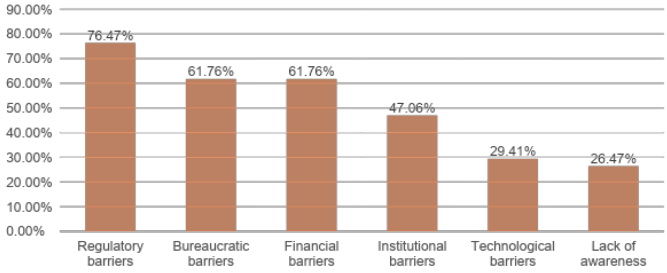
In the case of Tunisia the qualitative research also used advanced data analysis tools and methodologies such as NVIVO version 14 that employs advanced lexical analysis and frequency assessment of phrases, concepts and terms.58 The Tunisian qualitative research was specifically tailored to explore the intricate perspectives and lived experiences of MSMEs in these countries as they navigated and lead the complex and complexities of the transition to RE.

The Tunisian Report[59] presented a comprehensive accounting of the multifaceted challenges of renewable energy implementation in Tunisia, based on extensive feedback from many stakeholders but the results gleaned from the interviewed professionals across different sectors, provided a deeper and nuanced understanding of the barriers faced by each group. Below we use the summary of these views given their wide relevance to the entire region, given their orderly presentation and the shares of the views by barrier category.

1. The following barriers were highlighted and their shares were quantified.

- Regulatory barriers: A dominant concern, cited by 76.47% of respondents, underscores the widespread problem with existing regulations.
- Financial barriers: Recognized by 61.76% of respondents, these barriers highlight the economic challenges of transitioning to renewable energy.
- Institutional barriers: Identified by 47.06% of respondents, these point to deep-rooted organizational and systemic problems in the transition to renewable energy in Tunisia.
- Technological barriers: Cited by 47.06% of respondents, suggesting a few gaps in the requisite technology and expertise for effective implementation of renewable energy solutions in Tunisia.
- Bureaucratic barriers: Experienced by 61.76% of respondents, point to the inefficiency and complexity of administrative processes that are faced by MSMEs.
- Lack of awareness: Mentioned by 26.47% of the total respondents, highlights a significant gap in understanding and communication within the renewable energy sector. This barrier underscores the necessity for enhanced education and information dissemination to bridge the knowledge gap.

Figure 3. Proportion of identified barriers to renewable energy implementation (% of total occurrences) among all respondents in Tunisia



2. In addition to these interviews and results, the Tunisian Report delved into the unique perspectives of each professional group, trying to shed light on their specific challenges in implementing renewable energy solutions. The results as displayed in Figure 3 reflect the views of all respondents which appear to be consistent with what was expressed by the professionals and suggest that the same issues are faced by all stakeholders.

6.3. The qualitative results of the Lebanese and Sudanese case studies

The qualitative studies of Lebanon and Sudan have shown that both countries are not prepared to face climate change threats and are very vulnerable to its negative consequences. According to the Notre Dame Global Adaptation Initiative Country Index, Lebanon ranked 116 and Sudan ranked 183 out of 192 countries.[60]

1. Lebanon is particularly vulnerable to urban heat island effect, drought, SLR and water scarcity risks, and faces adaptation issues due to financial crises, weak institutions, corruption, social unrest and exposure to spillovers from conflict.[61]
2. Climate change impacts are also expected to impede service provision (especially in energy and water) which will affect the agricultural and tourism sectors.[62]
3. Similarly, Sudan faces severe environmental risks,

[58] Adel Ben Youssef, Mounir Dahmani and Walid Hadhri. 2024. Perceptions of Energy Transition by Tunisian SMEs: What is Going Wrong. ERF Publications.

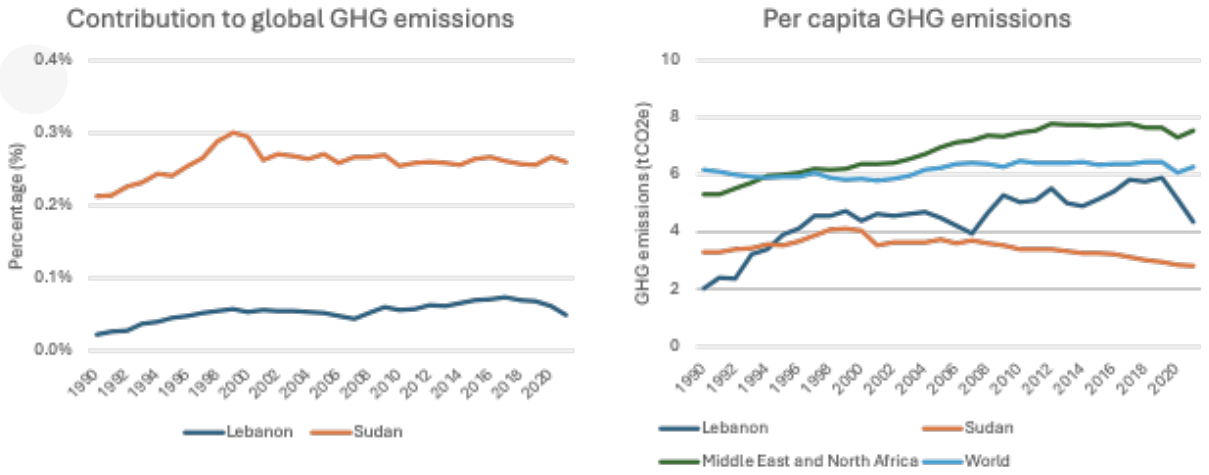
[59] Adel Ben Youssef, et. al., Ibid., 2024.

[60] Notre Dame Global Adaptation Initiative. Rankings. https://gain.nd.edu/our-work/country-index/rankings/

[61] World Bank Group. 2024. Lebanon Country Climate and Development Report. p.II.

[62] Ibid., p.II.

Figure 4. Contribution to global GHG and per capita emissions



Source: Climate Watch. 2024. World Resources Institute.

including increased incidences of drought and water scarcity, and increased desertification, while also lacking the necessary institutional infrastructure to adapt.

4. Sudan's reliance on agriculture and livestock sectors makes climate change a primary threat to economic stability and growth. Finally, the contribution of both countries to global greenhouse gas emissions is negligible (see, Figure 4), and, on a per capita basis, both emit significantly less than the global and regional average.[63]
5. Given that both Lebanon and Sudan are net importers of energy, and sustain huge balance of trade deficits it is clear that renewable energy could have several positive contributions. Lack of dependence on energy imports reduces vulnerability to volatile global energy markets and depletion of foreign currency reserves.
6. Besides off-grid systems provide opportunities for expanding economic activities to under-served regions, which could alleviate existing equity concerns regarding energy access for under-served regions.
7. The ills of the energy sector in Lebanon are symptomatic of "elite capture of the State's resources for private gains".[64] Politicians have used the dysfunctions of the electricity sector as a space to exercise and perpetuate clientelism practices through doling out jobs at EDL and profit from contracts made at the state's expense.[65]
8. In 2019, Lebanon experienced one of the worst three economic and financial crises in modern history,[66] whereby GDP contracted by around 40 percent.[67] More than 15 years of economic growth had been erased; the severe economic contraction and deterioration in service provision led to increases in unemployment, poverty, and brain drain.[68] The limited supply of power deteriorated further as the financial crisis progressed.[69]
9. Compounding this fragile state, the Beirut Blast on August 4 2020 caused damages to the distribution network and administrative and transmission assets of EDL.[70]
10. Post war reconstruction and privatization schemes failed to ameliorate the problems of the electricity sector in Lebanon.[71] Even prior to the 2019 financial crisis, EDL supplied only 55 percent to 64 percent of Lebanon's electricity needs (approximately 12-14 hours per day on average until 2018) due to a 1,500 MW long standing capacity deficit.[72]

[63] Climate Watch. 2024. Washington, DC: World Resources Institute.

[64] The World Bank, Lebanon Public Finance Review: Ponzi Finance?, p. 80. Cited in Human Rights Watch, p. 84.

[65] Human Rights Watch. 2023. p.7.

[66] World Bank. 2021. Lebanon Economic Monitor, Spring 2021: Lebanon Sinking (to the Top 3). https://documents1.worldbank.org/curated/en/394741622469174252/pdf/Lebanon-Economic-Monitor-Lebanon-Sinking-to-the-Top-3.pdf

[67] World Bank Group. 2024. Lebanon Country Climate and Development Report. p.II.

[68] World Bank Group. 2024. Ibid., p.II.

[69] World Bank Group. 2024. Ibid., p.6.

[70] World Bank Group. (2020). Lebanon Reform, Recovery and Reconstruction Framework (3RF) cited in Marc Ayoub, P. Rizkallah, and C. Abi Haidar, p.6.

[71] Ziad Abu-Rish. On Power Cuts, Protests, and Institutions: A Brief History of Electricity in Beirut. https://www.jadaliyya.com/Details/30564

[72] World Bank Group. 2024. Lebanon Country Climate and Development Report. p.1.

11. Lebanon's power sector has taken a toll on both the country's economy and environment. Over the last decade, annual budgetary transfers to EDL averaged 3.8 percent of GDP.73 These transfers accounted for close to half of the country's overall deficit.[74]
12. The cost of electricity to consumers is among the highest in the MENA region and is a major source of air pollution and carbon emissions.[75] Despite this reality, the state-owned utility has been financially deficient since 1992, relying on advances from the ministry of finance to fund its fuel and other costs in foreign currency.[76] According to Ayat (2021), the cumulative costs of transfers to EDL ($22 billion) including interest ($21 billion) over the period of 1992-2020 that add up to a total of $43 billion.[77]
13. Furthermore, vested interests in Lebanon's lucrative generator and fuel economy contribute to entrenching Lebanon's oil dependency.[78] Diesel generator networks have thrived on account of the failings of EDL, as have the fuel importers and distributors who are politically connected.
14. The electricity supply deficit left by the state-owned utility has resulted in the emergence of an informal distributed generator sector that has been, for the most part, resistant to regulation and controlled by mafia like groups.
15. The diesel generator sector is very harmful to the environment and to people's health. In 2018, it is estimated that diesel generators contributed to 39% of the total electricity Greenhouse Gases Inventory (GHI).[79] Diesel generators contribute to high levels of fine particulate matter (PM) which has serious impacts on human health.[80]
16. While subscribing to diesel generators has emerged over the years as a coping strategy to the country's failing power sector, the fuel crisis has recently pushed many households and enterprises into utilizing solar energy installations in what was an individual and crisis driven, bottom-up, transition. Even prior to the energy crisis, Lebanon was well known to be endowed with solar and wind potential that spurred a new autonomous transition.[81]
17. In Sudan, the secession of South Sudan in 2011 can be characterized as a sudden stop, introducing a balance of payments crisis, a severe trade deficit, a massive devaluation of the local currency and an economic recession. Sudan which was a net exporter of oil was transformed overnight into a net-importer of fossil fuels.[82]
18. In order to control fuel price increases, the government introduced a subsidy regime for fossil fuels, wheat and medicine. Two attempts to remove subsidies in 2012 and 2013 led to large scale protests.[83]
19. In parallel, political instability at the margins, especially civil wars in Darfur, Blue Nile and South Kurdofan, have resulted in higher defense and security expenditures accounting for almost 80% of total government expenditure.[84]
20. Between 2011 and 2018, government spending on security, like the subsidy regimes for certain commodities, were instituted for political reasons, mainly to keep the regime in power.
21. During this period, installed electricity generation capacity increased significantly but access to electricity remained modest due to the limited coverage of the national grid.[85] Even in areas with access, economic distortions, reliance on thermal power generation and cost recovery issues meant that power outages were frequent.[86]
22. These crises culminated in the Sudanese revolution of December 2018.[87] While the spark for the protests

[73] World Bank Group. 2024. Lebanon Country Climate and Development Report. p.6.

[74] Ibid, p.6.

[75] Ibid, p.6.

[76] Carol Ayat. 2021. Bridging the Banking Crisis to Crowdfund Electricity Reform in Lebanon. Issam Fares Institute for Public Policy and International Affairs. https://www.aub.edu.lb/ifi/Pages/publications/research_reports/2020-2021/20211020_comprehensive_solution_to_the_lebanese_electricity_sector_report_pdf.aspx. p.15.

[77] Carol Ayat. 2021. Ibid., p.15.

[78] Human Rights Watch. 2023. p.29.

[79] Ibid, p.8.

[80] Ibid, p.8.

[81] A. Ahmad P.17; J. Khoury, R. Mbayed, G. Salloum, and J. Guerrero. 2016. Review on the integration of photovoltaic renewable energy in developing countries – special attention to the Lebanese case. Renew. Sustain. Energy Rev. 57, 562–575. Cited in L.Moore, Henrietta., Collins, Hannah. p.3.

[82] LDK. 2019. Electricity Sector Recovery Plan: Sudan Electricity Sector Diagnostic Study. World Bank Group. Washington, DC.

[83] L. James. 2014. Recent developments in Sudan's fossil duel reform process. International Institute for Sustainable Development (IISD) and Global Studies Initiative (GSI).

[84] I. Elbadawi and Z. Alhelo. 2023. The Sudan Syndrome: State-Society Contests and the Future of Democracy After the December 2018 Revolution. ERF Working Paper Series No. 1644. Cairo.

[85] World Bank. 2024. Electricity access (% of population): Sudan. World Bank Group. Washington, DC.

[86] LDK. 2019.

[87] Elbadawi and Alhelo. Ibid., 2023.

was caused by increases in the price of bread as a result of removing subsidies from wheat, broader social, economic and political discontent manifested in a wider social movement that brought about the end of the regime.

23. The compounded and multifaceted crises in Sudan as in Lebanon have resulted in dysfunctional energy sectors characterized by political capture, low energy access and low reliability.
24. As a consequence, in both cases a transition took shape away from centralized, fossil-fuel dominated energy systems to decentralized, sustainable energy. While the primary motivation is access and sustenance, there are several positive implications in terms of energy security and energy equity. Despite the obvious differences in geography, demographics and history, the respective economic and political crises in both countries and their implication for the energy sector make a comparative study of the energy transition that transpired in these different contexts a useful lesson.
25. Without exception these country studies proved helpful and instrumental in unraveling the nuanced layers of participants' perceptions, attitudes, understandings and experiences that are often embedded in their narratives and are not readily accessible through quantitative studies.[88]

6.4. A summary of the results of the qualitative and quantitative case studies

By way of summary the surveys and the quantitative country studies confirmed most of the findings above and added a few more country specific considerations that will be detailed below. Among the most salient results are the following:

1. Free training had a positive impact on the transition to RE, particularly those supported by local governments and MSMEs in all of the surveyed countries.
2. Fuel subsidies represent a massive fiscal drain on strained public finances in many countries in the region as they contribute negatively to the environment and reduce sustainability by engendering high consumption levels of nonrenewable fossil fuels with the consequent high emission levels. They also contribute to derailing efforts and reverse incentives to transitioning to RE.
3. Macroeconomic mismanagement reflected in currency devaluations, inflation had a negative impact on the transition to RE by raising the capital cost of equipment and infrastructure, but particularly in countries that suffer from continuous devaluations of domestic currency like Lebanon, Egypt, and Sudan.
4. Red tape and inconsistent regulations added a few barriers to an orderly and adequate transition in all of the six case studies, but especially in the Sudan, Lebanon, Egypt and Jordan.
5. A few participants in the qualitative studies emphasized the insufficient infrastructure as a major factor thwarting the transition, particularly that infrastructure that is available for storage or for connecting to the electricity utility. This unavailable infrastructure forces firms to revert to fossil fuels at night.
6. One of the primary challenges faced by businesses in Lebanon, but this is also an issue shared by other countries in the region, is the significant skill gap. In Lebanon about 41% of MSMEs believe that their employees' education does not match their current roles.[89] This mismatch makes it difficult to find skilled professionals such as accountants or financial advisors, crucial for providing strategic financial advice and accessing funding from financial institutions that require certified expertise. In regions like Beirut and Mount Lebanon, businesses struggle due to inadequate support services, hindering research for business plans and marketing strategies. The absence of essential resources like training and mentorship programs further complicates decision-making and market intelligence gathering, ultimately hampering growth and competitiveness.[90]
7. Infrastructure deficits in all six target countries, especially those in rural areas, have impeded operational efficiency, hindered market expansion, and restricted adoption of digital and new technologies.
8. Limited market access compounds the challenges faced by MSMEs, increasing uncertainty about international market standards. Smaller enterprises face special difficulties marketing their products, especially those that remain in the informal economy.
9. Smaller MSMEs tend to remain small and unable to

[88] Adel Ben Youssef, et. al., Ibid.

[89] J. Matta. April, 2018. M/SMEs in Lebanon. jmatta@economy.gov.lb, Status, strategy and outcomes Ministry of Economy & Trade http://www.economy.gov.lb/media/11222/smes-inlebanon-180412-19-website.pdf

[90] 'Market Overview of Small and Medium Enterprises in Beirut and Mount Lebanon a Report by Building Markets for the International Rescue Committee (IRC)' (2016) https://www.rescue.org/sites/default/files/document/656/ircandbuildingmarketssmemarketoverviewlebanonrelease.pdf

take advantage of economies of scale and scope. They tend to face difficulties connecting with larger firms and establishing larger clusters on their own.

10. Environmental pressures, including climate change and urbanization, demand optimal resource management solutions. However, challenges in adopting clean technologies and attracting investment funds persist, compounded by difficulties in securing loans and credit, forcing the MSMES to rely on unsustainable financing sources.
11. Kafalat, Lebanon's financial services company, has historically supported MSME growth, guaranteeing loans totaling USD 515 million by the end of 2019, with 37% allocated to the agro-food sector, but this example is not widely available in other economies.[91]
12. Political uncertainty and political upheavals presented serious bottlenecks to growth and even survival of a few MSMEs in Lebanon and Sudan. In Lebanon, the combined negative effects of the civil war and persistent political instability have not allowed MSMEs to thrive during the reconstruction era (post-civil war), and since then, things even got worse.
13. Also relevant, important and well documented in the literature and validated by the country surveys is the contribution of the ease with which MSMEs can access and adopt information and communication technologies and are aware of backup technology.[92] These factors were found to strongly influence the likelihood of firms to adopt RE. This suggests that raising awareness regarding the benefits of RE is an effective means by which the adoption of RE by firms in the MENA region can be encouraged, but hitherto remains missing. In a similar vein, access to information about backup technology that can reduce the risk stemming from the intermittency of RE has been found to encourage its adoption.
14. Most of the survey respondents and participants in the focus groups noted the limited current government support and policies that can promote the transition to RE and its adoption by particularly the MSMEs or by the public at large. Invariably they suggested that there is a large room for governments to play an active and effective role in incentivizing MSMEs to adopt clean and green technologies. They also noted that a few government policies were put in place to encourage the adoption of RE in Egypt and Morocco, and that these have set an example of what works, what is feasible and the shortcomings of some of measures.[93] A strong recommendation was voiced by the participants that governments assume a greater role and that the different countries in the region can learn from the successful programs of Morocco, the UAE, Saudi Arabia and Egypt.
15. These measures include feed-in tariffs which were later replaced by competitive bids, and the ability to deduct the cost of renewable energy consumption from an entity's electricity bill whether this entity is a household, or commercial, or an industrial firm. Among the several other policies introduced by the Egyptian government to encourage investment in RE, is a circular from the Central Bank of Egypt requesting banks to put in place sustainable development financing policies. This step; however, fell short of providing credit guarantees. Empirical evidence has confirmed the success of these policies in influencing the likelihood firms employ RE.[94]
16. On the other hand, several challenges facing renewable energy adoption are identified in the literature which include the i) liability of newness which stems for example from uncertainties about costs and applications, ii) techno-economic challenges which relates to the ability to deliver low costs and competitive products using renewable energy and finally iii) political feasibility as dictated by the regulatory regime. The intermittency of renewable energy is also a major challenge facing the wide scale adoption of this type of energy.
17. In fact, empirical evidence in Egypt for the year 2023 shows that SME owned by females and those that employ a large share of youth in its labor force are more likely to consider adopting RE. Removing impediments facing women entrepreneurs should be a priority for policy makers in Egypt since they are more likely to consider the adoption of RE. Since youth were found to be important drivers of RE adoption, it follows that providing this group with the necessary skills through education will serve to enhance this role even more. Such results provide impetus for NGO eager to advance the role of women and youth in society. In another respect they provide firms seeking to adopt RE with guidance as to the ideal composition of their labor force to include more females and youth.
18. Firms inserted into Global Value Chains (GVC) defined as those that import and export at the same

[91] Barbara, Daoud.2019. Financing Lebanon's Agro-food Sector: An analysis of the Sector Before and After October 2019. https://pdf.usaid.gov/pdf_docs/PA00XDCT.pdf

[92] Lee Chiang, Chen Mei-Ping and Yuan Zihao. 2023. Is Information and Communication Technology a Driver for Renewable Energy? Energy Economics, 124:1-12

[93] Rasha Hassan. 2023. Accelerating the Energy Transition in Egypt. An In-depth Analysis of the Adoption of Renewable Energy among Micro, Small and Medium Enterprises. ERF Publications.

[94] Rasha Hassan, Ibid., 2023.

time were not found to be more likely to consider the adoption of RE. This could be explained by the lax environmental standards in Egypt. Encouraging the adoption of RE requires more efficient institutions in the form of stricter environmental standards along with stronger enforcement of these standards.

19. The lack of skills necessary to make possible the deployment of RE represent a major constraint facing firms in Egypt and in all of the six target countries. This could be explained by the fact that skills provided by the education system fall short of that required for RE. Integrating the necessary skills into the educational sector, whether private or public, is considered crucial for a smooth and rapid green transition.

This rich suite of results covering the six target MENA countries empirical and qualitative results represent only a sample of the complex issues, a myriad of the challenges and achievements made so far by the sample of the countries of the MENA region. In what follows we will highlight the trail blazers of the region that succeeded and leading the RE transition.

7. Trail blazers: the tale of two regional successful transitions

Two countries in the MENA region stand out as trail blazers in the transition to Renewable and Green energy; both Morocco and the United Arab Emirates (UAE) have made or planning to make considerable investments in developing their green and renewable energy industries (e.g. Worley's FEED for green ammonia project)[95] and have been seriously considering the development of several downstream and upstream complementary industries such as green hydrogen, green ammonia, and significant electric vehicles' production and exports. This is why the two countries' example is singled out for a detailed analysis and review of what explains their success and the suite of policies, investments and plans they have put in place that could explain their success. Other countries in MENA region may find their example useful in managing their transitions to renewable and green energy.

Morocco and UAE are not the only countries in the MENA region that are making significant and productive transitions to the green and sustainable economy, a few other countries in the region are making determined efforts to build the appropriate ecosystems that could support a meaningful transition to renewable energy. The list includes Saudi Arabia (particularly through NEOM), Egypt, Tunisia and Algeria and the list is expanding.

The choice of singling out Morocco and the UAE for the extended analysis is also motivated by the fact that each represents a different set of circumstances and attributes. Morocco is an example of a country that imports oil and gas and did not possess significant domestic energy resources but has initiated and succeeded in achieving modest diversification into agricultural, food and fertilizers production and exports, while the UAE represents a country with huge deposits of oil and some gas, but limited success in its diversification efforts. The fact that both have opted to make a concerted effort to develop their renewable energy potential is an instructive and significant example for other countries in the region and beyond to follow.

7.1. Morocco is the leader in MENA[96]

There is no question about Morocco being the leader in the development of renewable energy among the countries of the Middle East and North Africa region. The distinguishing feature of Morocco's renewable energy sector is that its accelerating growth is occurring within the Kingdom's development of a dynamic green energy ecosystem, in which renewable energy is starting to be incorporated into the major sectors of the economy. Morocco has formulated a national strategic plan that emphasizes the development of green activities in key economic sectors ranging from agriculture and mining to fertilizer production and electric vehicle (EV) manufacturing.

Renewable energy sources are increasingly being substituted for fossil fuels such as coal, gas and oil in electricity generation and the powering of a number of industries that hold the potential to expand production, exports and employment opportunities for women, youth, and rural populations. The expansion of green industrial manufacturing and agricultural production in Morocco are envisaged to become the new engines of sustainable human development.

[95] Worley to begin FEED for green ammonia projects in Morocco in 2024. https://renewablesnow.com/news/worley-to-begin-feed-for-green-ammonia-projects-in-morocco-in-2024-867201/#:~:text=The%20project%20in%20southern%20Morocco,by%20wind%20and%20solar_%20energy.

[96] This section summarizes primarily the findings of Michael Tanchum's study for ERF. Renewable Energy and Morocco's New Green Industries: How Morocco's Green Energy Ecosystem can Expand Women Youth Employment through Sustainable Development. August, 2024.

In 2022, Morocco ranked as the world's most attractive renewable energy market for investment, when normalized by GDP, according to the Renewable Energy Country Attractiveness Index (RECAI) published by international accounting firm EY (Ernst & Young).[97] In 2023, Morocco retained its score but was ranked as the second most attractive market, following Denmark's major advances concerning green hydrogen utilization.[98] It is also true that no other MENA country was placed among the top 10 renewable energy markets in the 2023, RECAI rankings. Actually, no other Arab country ranked among the top 25 renewable energy markets, except for Jordan.

Morocco's success in developing renewable power generation, storage, and transportation infrastructure is the result of its emerging, multi-faceted green energy ecosystem that is giving rise to its integration into the international renewable energy export supply chains based primarily on its planned production of green hydrogen, in the form of green ammonia, as well as the planned production of phosphates, other minerals and metals, fertilizers, agri-food products, and electric vehicles – the production of which is increasingly powered, in part or entirely, using renewable energy sources.[99]

Building on its accomplishments in the renewable energy, Morocco's government has placed a national focus on achieving sustainable development with the explicit priority of expanding employment opportunities among women, youth, and rural populations. While renewable energy is playing an increasingly important role in the Moroccan economy, the question remains as to how renewable energy operating within the framework of Morocco's green energy ecosystem can create appropriate formal employment in the private sector. The case study undertaken by Professor Michael Tanchum for ERF explored this question through examining current and planned efforts to expand Morocco's renewable energy and green energy sectors. It assessed the opportunities and challenges in using Morocco's new green industries as drivers of long term employment, particularly among women, youth, and rural populations. It did not address sufficiently the fact that Morocco is currently limited by the current capacity of the grid to evacuate the added green energy. A major project under consideration is the building of transmission lines from the Moroccan Sahara to the center of the country to monetize the reservoir of sun and wind that exist in that vast southern territory.

Of particular significance is the Report finding a synergistic convergence between Morocco's efforts to expand its already significant renewable energy sector and its objective to expand the number of women, disadvantaged and young people engaged in formal employment, particularly those in the MSMEs. These MSMEs account for about 95% of private sector activity in Morocco and 50% of job creation. The study's analysis rests on two sources of data: qualitative data from field research and quantitative survey data. Qualitative research on Morocco's renewable energy sectors, its green energy ecosystem, and its employment training ecosystem were conducted by Michael Tanchum. They included on-site visits and extensive interviews with key stakeholders. This data was augmented by the results of a telephone survey of 1,008 MSMEs in Morocco conducted by the Economic Research Forum.

Within Morocco's green energy ecosystem, climate smart and green technologies are emerging as a foundation of Morocco's innovation ecosystem of start-up MSMEs and the incubators and accelerators to support them. While this innovation ecosystem plays an important role overall in Morocco's green energy ecosystem, Tanchum's study finds the majority of employment opportunities are to be found in green industrial manufacturing and the adjacent and complementary retail services and sales industries. This finding is crucial and novel as it looks at the entire supply chain, and not only at its initial stages. Beyond providing employment opportunities, MSMEs in these segments of the green energy ecosystem can also provide and hone soft skills that are increasingly vital to long-term employment in Morocco's transition to renewable energy and sustainability. The Tanchum Report stressed that a wider economic transformation resulting in a greater scale of private sector employment could occur if, and only if, support mechanisms for adjacent retail services and sales start-ups are included in the initiatives to support sustainable development and green industrialization.

A significant finding of the study suggests that the

[97] The normalized score is obtained by taking the RECAI "raw" score and dividing it by the log of GDP. EY, "Renewable Country Energy Attractive Index (RECAI), 60th edition", EY, November 2022, p. 20, https://assets.ey.com/content/dam/ey-sites/ey-com/en_us/topics/energy-resources/ey-recai-60-report-november-2022.pdf

[98] INSME (2023) The Innov Invest Fund in Morocco, INSME. https://www.insme.org/the-innov-invest-fund-in-morocco/

[99] The country does not produce yet green hydrogen. 3 projects were short listed to be considered for further development as of Oct 2024. Same for green ammonia, the country does not produce yet that molecule, a recent (2024) joint venture between OCP and Fortescue Energy was established to study the production of the molecule. https://www.chemanalyst.com/NewsAndDeals/NewsDetails/ocp-fortescue-to-forge-partnership-for-green-energy-hydrogen-ammonia-in-morocco-27247.

extent to which Morocco's current approach to achieving a developed economy through sustainable green industries and energy will depend on the new employment opportunities for women, youth, rural and disadvantaged populations and also on the extent to which Morocco's green energy ecosystem encourages entrepreneurship among young people and women as a bottom-up phenomenon. Morocco's development success has hitherto been conducted through a state-directed, top-down approach. The creation of MSMEs for green industrial manufacturing and sustainable solutions which started at the beginning of the current decade represents a new third wave of development in Morocco's start-up ecosystem. In this new phase of development, the study finds that these top-down institutions need to adapt their approach to generate and support a self-sustaining bottom-up dynamic where green industry and MSMEs in adjacent sectors create sufficient opportunities for employment and soft skill development to stimulate the development of more MSMEs that will, in turn, do the same sustaining a virtuous and dynamic cycle.

Another major finding of Tanchum's study is that in achieving the goal of generating and supporting a self-sustaining, bottom-up dynamic domestic economy, Morocco's fertilizer manufacturing giant the OCP Group (Originally, Office Chérifien des Phosphates) and its constellation of subsidiaries and associated entities should play a central and critical role. The hub for most of these OCP-affiliated entities is OCP-funded Mohamed VI Polytechnic University (UM6P), which houses sustainable development 'next industries' investor and developer InnovX, the Green Energy Park platform for renewable energy testing, research, and innovation, and Al Moutmir organization for extension services to farmers, among several other smaller yet important initiatives such as the Startgate innovation and entrepreneurship laboratory and the 1337 school for coding. InnovX is emerging as a central coordinating mechanism as the company serves as the strategic instrument to fulfill Morocco's ambition to become a global provider of sustainable development solutions. Reflecting InnovX's central role, the pioneering start-up support and venture capital investor UM6P Ventures has been made a subsidiary of the holding company.

InnovX is also a central partner for Al Moutmir in the development and diffusion of technological innovation in the agricultural sector. Al Moutmir is a key institution in reaching women and young people in rural areas through its assistance to farmers with innovative technologies and best practices to transition to sustainable agriculture as well as to providing entrepreneurship training to encourage young people and women to run their own businesses through retail services and sales connected to the agricultural sector. One positive indicator concerning how the OCP/UM6P constellation's orientation toward expanding women and youth employment is that the qualitative field research conducted for this study found out that OCP and its associated entities, many of which are now housed at UM6P, have across the board registered impressive achievements for diversity and inclusion in their own organizations, as will be discussed below. In 2019, just prior to OCP's reorganization of the constellation of its affiliated entities to develop the company's green industrial manufacturing and sustainable solutions businesses, OCP had already raised the percentage of women in senior management positions to 32%, across the company.[100]

Renewable energy activities on account of their empowering the green industrial manufacturing and sustainability solutions' sectors will expand employment opportunities in Morocco. The extent to which these opportunities will be extended to women, youth, and rural populations depends to a large extent on the coordination between Morocco's green energy ecosystem and its training ecosystem. To broadly expand employment opportunities through the new third wave of MSMEs created through the OCP-constellation, other holding companies, or as independent start-up ventures, will require training ecosystems that help overcome the particular challenges facing women and youth in low income urban and rural areas.

7.2. Renewable energy and Morocco's green energy ecosystem

In 2022, when Morocco was rated as the most attractive renewable energy investment market, renewable power accounted for only 38% of Morocco's installed power generation capacity, but even at this level, Morocco outpaced other countries in the region. Solar and wind power accounted for a combined 21.3% of the Kingdom's 2022 total installed electricity generation capacity, with hydroelectric power supplying 16.7% of the total.[101] While Morocco's 2022 wind power capacity stood at 1.77 GW and solar was at 1.43 GW, still it is expected that solar power capacity will soon surpass wind power in the Kingdom. Morocco's solar power development program consists of

[100] https://ocpsiteprodsa.blob.core.windows.net/media/2021-06/K_OCP%20Factsheet%20Diversity%20&%20Inclusion_G.pdf

[101] N.A., "Renewable Energies", Ministry of Energy Transition and Sustainable Development, n.d., https://www.mem.gov.ma/en/Pages/secteur.aspx?e=2

a cluster of "Noor" solar power projects spread across the country, with its flagship Noor I, II, and III projects are slated to have a combined installed capacity of 1.6 MW.[102] Morocco's wind power program is distributed over nine projects across the country.[103] With an emphasis on solar power development, Morocco is planning to add a major 6.5 GW of solar and wind by power 2027. The $5.6 billion construction effort, will most likely, help Morocco meet its 2030 target of renewables comprising 52% of its power generation capacity.[104]

Beyond these projects, the development of newer renewable power megaprojects is being directly driven by the demands of Morocco's green energy ecosystem and international renewable energy supply chains. As an example, Morocco's largest wind power facility is being developed by Total Eren, a wholly-owned subsidiary of French energy giant TotalEnergies,[105] as part of the company's $10 billion green ammonia megaproject in Morocco's Guelmim-Oued Nour region.

The dedicated 5 GW wind farm, along with a dedicated 5 GW solar power complex, will take advantage of the region's near constant nighttime winds to provide virtually 24-7 renewable power to the green ammonia envisaged plant.[106] Similarly, the ambitious Morocco-to-UK X-links interconnector involves the construction of 11.5 GW of dedicated renewable power. The $20 billion project is planning to develop 8 GW of solar power and 3.5 GW of wind power in the Guelmim-Oued Nour region to supply the UK with near 24/7 electricity via a 3.6 GW under the sea interconnector between the two countries.[107] Despite the technological challenges involved with laying undersea, high voltage cables that will need to traverse the formidable distance of 3,800 km, the Xlinks project is on track to be completed in 2030 and would supply about 8% of the UK's power demand.[108]

Morocco's development of infrastructure for the generation and storage of power from renewable energy sources is conducted as an integral part of the country's efforts to develop sustainable and high value added industrial and agricultural production. The four key state pillars of Morocco's efforts are managed under the Ministry of Energy Transition and Sustainable Development (formerly the Ministry of Energy Mines and the Environment): MASEN (Morocco Agency for Sustainable Energy); IRESEN (Institute for Research for Solar Energy and New Energies); ONEE (National Office of Electricity and Potable Water); and OCP, the world's largest producer of phosphate products and the world's fourth largest exporter of fertilizers.

With the exception of OCP that was re-organized in 2008, the state institutional framework of Morocco's green energy ecosystem was initiated in 2010 with the creation of MASEN as a private company with public funding to oversee the development of Morocco's massive, muti-phase Noor solar energy power generation project. IRESEN was also created in 2011 as the research arm of Morocco's national energy program across the entire spectrum of the value chains within Morocco's green energy ecosystem, including solar energy systems, green hydrogen systems, and electric mobility.[109] IRESEN oversees a network of green energy research and innovation platforms and funds of applied research and collaborative innovation projects, helping to propel Morocco toward the forefront of next-generation green energy technology development.[110] IRESEN's board includes members from Ministry of Energy Transition and Sustainable Development, MASEN, ONEE, and OCP as well as several other key state institutions including the mining sector's National Office of Hydrocarbons and Mines, and the privately-held mining company Managem, which is owned by Al Mada Company.[111] IRESEN's flagship institute the Green Energy Park is

[102] https://www.masen.ma/en/projects; https://www.masen.ma/en/projects/noor-midelt-i; https://esfccompany.com/en/articles/solar-energy/noor-ouarzazate-the-world-s-largest-concentrated-solar-power-plant-csp-built-in-morocco/; N.A., "Morocco set to award new solar power deal: report", Zawya, 2 August 2023, https://www.zawya.com/en/projects/utilities/morocco-set-to-award-new-solar-power-deal-report-cuf64g7u; Ahmed Eljechtimi, Angus McDowall and Jonathan Oatis, "Morocco tenders for 400 MW solar plant in Atlas Mountains", Reuters, 9 August 2023, https://www.reuters.com/business/energy/morocco-tenders-400-mw-solar-plant-atlas-mountains-2023-08-09/

[103] https://www.masen.ma/en/projects; N.A., "Programme Eolien Intégré - 850 MW", ONEE, n.d., http://www.one.org.ma

[104] https://www.moroccoworldnews.com/2023/07/356723/morocco-has-invested-5-6-billion-in-renewable-energy-projects

[105] https://www.agenceecofin.com/energies-renouvelables/2607-110644-energies-renouvelables-apres-5-annees-d-alliance-strategique-totalenergies-acquiert-entierement-total-eren

[106] https://www.moroccoworldnews.com/2022/02/346892/total-eren-to-launch-green-hydrogen-megaproject-in-morocco; https://gwec.net/wp-content/uploads/2023/10/Status-of-Wind-in-Africa-Report-V4.pdf

[107] https://xlinks.co/morocco-uk-power-project/; https://gwec.net/wp-content/uploads/2023/10/Status-of-Wind-in-Africa-Report-V4.pdf

[108] https://www.agbi.com/energy/2023/07/morocco-invests-6bn-in-clean-energy-projects/

[109] https://iresen.org/institut/

[110] https://iresen.org/institut/

[111] https://iresen.org/institut/

located adjacent to the UM6P campus and is involved in supporting OCP's deployment of solar power infrastructure. Following IRESEN, ONEE was formed in 2012 through integration of the National Office of Electricity (created in 1963 and the National office of Drinking Water (created in 1972), reflecting Morocco's ambition to manage its energy system to provide sufficient water for human consumption as well as its growing industrial and especially agricultural sectors. Several of the smaller solar projects across the Kingdom were or are being developed by ONEE.[112]

Water shortages in Morocco are presenting it with crucial challenges as these are likely to become more acute under climate change conditions. To cope with these shortages, Morocco has prioritized water desalination, creating greater impetus for the deployment of renewable power generation infrastructure. Since agriculture accounts for upwards of 89% of water consumption in Morocco, the establishment of the country's green energy ecosystems has emerged through effort to use renewable energy to ensure the resilience of the agri-food production. This entails ensuring a sufficient water supply for agriculture, as well as for human consumption, in the face of increasing water stress due to climate change. Morocco has adopted a $40 billion National Water Plan 2020-2050 that includes the construction of more desalination plants. Morocco's additional desalination plants will ultimately require new power generation capacity from renewable energy sources (or possibly nuclear power). In 2024, OCP undertook an initiative to develop and deploy modular desalination plants to supply its operations and to supply drinking water to local populations.

Morocco's green energy ecosystem is anchored in the food-water-energy nexus, with OCP playing a central role because of its phosphate mining and fertilizer production operations. Morocco sits on 73 per cent of the world's phosphate rock reserves from which the phosphorus used in synthetic fertilizers is derived.[113] Prior to the 2021 natural gas price shocks, OCP's total revenue in 2020 amounted to $5.94 billion,[114] accounting for about 20% of the Kingdom's export revenues.[115] Due to a global upsurge in demand, the fertilizer giant's revenue stood at $9 billion in 2023. The sustainability of OCP's operations through achieving energy transition is a matter of Moroccan high national interest and has placed OCP increasingly at a very prominent role in leading the development of Morocco's green energy ecosystem and Morocco's capabilities as a global sustainable development solutions provider.[116]

OCP covers 89% of the energy needs for its phosphate and phosphorus fertilizer production through co-generation (re-using exhaust energy to create cleaner and cheaper power from fossil fuels) and renewable sources and heading toward covering 100% of its energy needs in this manner.[117] To ensure its transition beyond fossil fuels, OCP established OCP Green Energy SA in 2022, as a wholly owned subsidiary to develop the company's renewable energy generation activities, committing an investment of $13 billion during the period of 2023 to 2027.[118] Dedicated solar plants are being built in the mining towns of Benguerir and Khouribga, home to Morocco's largest phosphate reserves, as well as in other locations.

OCP's central role in renewable energy and green tech development has been boosted by Morocco's attempt to rise as a global leader in green hydrogen production, prompted by the objective to use its derivative green ammonia to supply the OCP's lucrative fertilizer manufacturing. Morocco's lack of natural gas reserves places a limiting factor on the resilience of OCP's fertilizer production, which requires ammonia, now produced from natural gas-derived hydrogen. The process to produce conventional hydrogen from natural gas discharges considerable amounts of carbon dioxide (CO2) into the atmosphere and is termed 'gray' hydrogen. In contrast, green hydrogen is produced by using electricity generated from renewable sources to split water into its hydrogen and oxygen components, creating a carbon-free (hence, "green") hydrogen which can then be combined with nitrogen from the atmosphere to produce green ammonia. Prior to the 2022 outbreak of the Russia-Ukraine war,

[112] https://www.masen.ma/en/projects; http://www.one.org.ma/

[113] M. Garside, "Phosphate rock reserves worldwide in 2021, by country", Statista, March 15, 2022, https://www.statista.com/statistics/681747/phosphate-rock-reserves-by-country/

[114] OCP, "Sustainability Report 2020", OCP, August 2021, https://ocpsiteprodsa.blob.core.windows.net/media/2021-08/OCP-Sustainability_report_2020-GRI_certified.pdf

[115] N.A., "Fitch Revises Outlook on OCP to Stable; Affirms at 'BB+'", Fitch Ratings, October 28, 2020, https://www.fitchratings.com/research/corporate-finance/fitch-revises-outlook-on-ocp-to-stable-affirms-at-bb-28-10-2020

[116] https://www.mei.edu/publications/moroccos-new-challenges-gate-keeper-worlds-food-supply-geopolitics-economics-and

[117] https://www.moroccoworldnews.com/2022/06/349881/ocp-group-green-hydrogen-ammonia-is-the-future-of-energy

[118] https://www.ocpgroup.ma/news-article/ocp-group-launches-its-new-green-investment-program-2023-2027

OCP needed to import 1.5 to 2 million tons of ammonia per year to meet its production.[119] Since the war, OCP is eyeing a 58% increase in its production capacity to fill European and global fertilizer supply shortfalls.[120] To create sustainable and resilient production for exports, Morocco will ultimately need to replace its imported ammonia made from gray hydrogen with green ammonia produced locally powered by its solar and wind energy resources.

One of OCP's highest priorities is transitioning fertilizer production away from using ammonia synthesized from natural gas-derived grey hydrogen as its basic input to using green ammonia produced using Morocco's solar energy and wind energy resources. In 2023, OCP announced plans to construct its own $7 billion green ammonia plant to help the company replace its annual import of $2 billion of grey ammonia with domestically produced green ammonia.[121] With an initial annual production capacity of 200,000 tons by 2026, OCP is aiming to raise its own green ammonia production to 1 million tons by 2027 and reach 3 million tons by 2032.[122] In February 2024, InnovX launched its Hydrojeel subsidiary to develop OCP's green ammonia production to ensure the sustainability of OCP's fertilizer manufacturing.[123]

Green hydrogen, when transported in the form of seaborne shipments of green ammonia, is a versatile energy carrier for the export of renewable energy. Green hydrogen may be used directly as a fuel or feedstock for industrial manufacturing processes or can provide on-demand, climate-smart power by reversing the electrolysis process in a fuel cell, which generates electric current by recombining green hydrogen and oxygen back into water. Beyond supplying fertilizer production, Morocco and its European partners are eyeing the export of green ammonia to Europe for industrial manufacturing processes and as fuel ammonia. In addition to the abovementioned TotalEren green ammonia project, there are several other private sector development projects backed by Portugal, the Netherlands, and the EU.[124] Morocco's largest green ammonia project under consideration is the Irish-Portuguese HEVO facility, which is slated to have an initial annual capacity of 183,000 tons by 2026, equivalent to approximately 10% of OCP's production input requirements.[125] Rabat signed a memorandum of understanding (MoU) with Dutch Oil trading giant Vitol to market the green ammonia in Europe.[126]

The Netherlands, the world's second largest food exporter and the EU's largest fertilizer consumer per hectare, itself provided loan guarantees in 2022 for the Dutch green hydrogen firm Proton Ventures to build a green ammonia plant at Morocco's Jorf Lasfar port.[127] Also in 2022, the Netherlands initiated the development of a new green ammonia import terminal in Rotterdam's Maasvlakte port to handle green ammonia imports to Europe starting in 2026.[128] With the completion of the projects currently under development, Morocco could export over 1-3 million tons of green hydrogen or its green ammonia equivalent to Europe annually.[129] Since fertilizers and hydrogen imports form two of the six initial sectors targeted under the EU's Carbon Border Adjustment Mechanism (CBAM),[130] the development of green ammonia capacity is a matter of urgency for both Morocco and its EU Member State customers to address

[119] Julie Chaudier, "Will Hydrogen fuel Morocco's industrial projects of the future?", The Africa Report, September 6, 2021, https://www.theafricareport.com/124184/will-hydrogen-fuel-moroccos-industrial-projects-of-the-future/

[120] Rédactions Medias24, "Exportations d'engrais: une double opportunité pour le Maroc", Medias24, 5 July 2022, https://medias24.com/2022/06/05/engrais-une-double-opportunite-pour-le-maroc/

[121] https://www.reuters.com/sustainability/climate-energy/moroccos-ocp-plans-7-mln-green-ammonia-plant-avert-supply-problems-2023-06-20/

[122] https://www.reuters.com/sustainability/climate-energy/moroccos-ocp-plans-7-mln-green-ammonia-plant-avert-supply-problems-2023-06-20/

[123] https://innovx.ma/newsroom/innovx-announces-the-launch-of-hydrojeel-a-new-subsidiary-dedicated-to-green-hydrogen-and-green-ammonia/

[124] https://www.iai.it/sites/default/files/iaip2306.pdf

[125] https://www.mei.edu/publications/moroccos-new-challenges-gatekeeper-worlds-food-supply-geopolitics-economics-and

[126] https://www.argusmedia.com/en/news/2235820-morocco-outlines-plans-for-new-green-ammonia-project

[127] https://medias24.com/2022/09/04/le-projet-pilote-de-production-dammoniac-vert-ouvre-de-grandes-perspectives-pour-le-maroc/ ; Rianne, "UM6P and Proton Ventures sign an agreement for the construction of the Green Ammonia Pilot in Jorf Lasfar", Proton Ventures, July 25, 2021, https://protonventures.com/press-release/um6p-and-proton-ventures-sign-an-agreement-for-the-construction-of-the-green-ammonia-pilot-in-jorf-lasfar/

[128] https://energycapitalpower.com/chariots-3-5-billion-mauritania-based-green-hydrogen-project-secures-european-export-route/

[129] https://www.thenationalnews.com/opinion/comment/2023/12/13/africas-maritime-hydrogen-highways-could-enrich-the-continent-and-save-the-world/

[130] https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en#sectoral-information

the complications that may arise under CBAM.

On April 8, 2024, OCP signed a joint venture agreement with Forescue Energy, the green hydrogen arm of Australian energy, mining, and metals processing giant Fortescue to partner in the development of "large-scale integrated green ammonia and green fertilizer production capacity" in Morocco to supply Morocco, Europe, and other international markets.[131] The agreement also articulates the goal to develop facilities in Morocco for "manufacturing of green technology and equipment" with the involvement of OCP-affiliated InnovX. Observing that the agreement "intend[s] to create in Morocco one of the world's leading integrated renewable energy, manufacturing, and technology enterprises," Fortescue Energy's CEO asserted that the joint-venture partnership will create "thousands of jobs and industries in Morocco."[132]

In addition to green hydrogen, Morocco's agri-food and automotive exports to Europe could form the basis of Morocco-to-Europe renewable energy supply chains, with production powered, in part or entirely with electricity generated from renewable energy resources. Morocco's agri-food sector now accounts for about 21% of its exports by value.[133] Rabat's Green Generation 2020-2030 plan seeks to enhance the sustainability of agricultural production through the expanded production and use of renewable energy, particularly to power seawater desalination to provide sufficient water for the sector.[134] Seawater desalination typically requires 10 times the amount of energy to produce the same volume of water as conventional surface water treatment,[135] meaning additional desalination plants will require new power generation capacity from renewable energy sources or possibly nuclear energy.[136] The basic inputs for Morocco's agri-food production – water and fertilizer – will be increasingly produced using renewable energy, greening Morocco's agri-food exports to Europe and elsewhere.

Green mobility, in the form of electric vehicle manufacturing, constitutes a rising industrial pillar of Morocco's green energy ecosystem. Morocco's automotive industry accounts for about 25% of the Kingdom's GDP.[137] With the Kingdom's annual production capacity to top 1 million vehicles by 2025,[138] Morocco is eyeing the production of 250,000 electric cars per year.[139] European automakers Groupe Renault and Groupe PSA (now part of the Stellantis conglomerate) operate manufacturing plants in the Kingdom that are supplied by 250 international firms from the United States, Europe, Japan, China and elsewhere, each operating their own local manufacturing plants in Morocco to supply automotive components. Some of the specialty component factories are SMEs. The European market accounts for 90% of Morocco's exports,[140] with Europe's two best-selling car models — the Peugeot 208 and Renault's Dacia Sandero — made in Morocco.[141] The manufacture of their EV versions on Moroccan soil is a near-term likelihood.[142] Already, Germany's Opel and Italy's Fiat have begun the production of EV models in Morocco.[143]

The European Commission's July 2021 directive to phase out all fossil fuel-powered vehicles in the European Union by 2035; makes green mobility another Moroccan

131 https://fortescue.com/news-and-media/news/2024/04/08/ocp

132 https://fortescue.com/news-and-media/news/2024/04/08/ocp

133 European Training Foundation, "Summary Note – The future of skills: A case study of the agri-food sector in Morocco", Europen Training Foundation, 2021, https://www.etf.europa.eu/en/publications-and-resources/publications/future-skills-case-study-agri-food-sector-morocco

134 Lahcen Mokena, "Morocco's King Launches 'Green Generation 2020-2030'", Asharq al-Awsat, February 15, 2020, https://english.aawsat.com/home/article/2132676/moroccos-king-launches-green-generation-2020-2030 ; MAP, "Head of Government: 2020-2050 National Water Plan, Roadmap to Face Challenges for Next 30 Years", Kingdom of Morocco, December 25, 2019, https://www.maroc.ma/en/news/head-government-2020-2050-national-water-plan-roadmap-face-challenges-next-30-years

135 https://www.iai.it/sites/default/files/iaip2306.pdf

136 https://www.mei.edu/publications/moroccos-nuclear-option-russian-vs-us-technological-cooperation-power-its-water

137 https://northafricapost.com/73455-moroccos-neo-motors-launches-its-cars-in-the-market.html; https://www.morocconow.com/automotives/?_gl=1*xd72og*_up*MQ..*_ga*ODA1NDQ5OTU1L-jE3MDU3MzIzNDU.*_ga_7X4V48JH6W*MTcwNTczMjM0NC4xLjEuMTcwNTczMjcxNi4wLjAuMA

138 https://www.mei.edu/publications/moroccos-green-mobility-revolution-geo-economic-factors-driving-its-rise-electric

139 https://www.mei.edu/publications/moroccos-green-mobility-revolution-geo-economic-factors-driving-its-rise-electric

140 https://medias24.com/2022/08/10/voici-a-quoi-pourrait-ressembler-la-premiere-gigafactory-de-batteries-au-maroc/

141 https://www.autocar.co.uk/car-news/new-cars/best-selling-cars-europe-2022

142 https://www.mei.edu/publications/moroccos-green-mobility-revolution-geo-economic-factors-driving-its-rise-electric

143 https://www.thenationalnews.com/weekend/2023/08/25/brics-north-africa/

national priority.[144] The use of renewable energy in any aspect of production would lower the carbon footprint of Moroccan EV exports. Morocco's rise as an EV manufacturing giant hangs on the local manufacture of lithium ion batteries, which represent 30% to 40% of the cost of the average EV.[145] Morocco's massive phosphate reserves again come into play as the EV industry is shifting away from lithium batteries using nickel, manganese, and cobalt to lithium iron phosphate (LFP) batteries.[146] By manufacturing LFP batteries, Morocco would enjoy a cost advantage of upward of 70% per kilogram.[147] Morocco would need to expand its phosphate and phosphoric acid production to make LFP EV batteries, especially to avoid demand pressure competition from fertilizer production requiring OCP's additional output of phosphates and phosphoric acid to be powered by renewable energy sources. Morocco's renewable power also provides another competitive advantage as it helps automakers meet their own targets for reducing the carbon footprint of their operation. Renault, for example, has set carbon reduction goals for its EV batteries of 20% by 2025 and 35% by 2030, compared to 2020 levels.[148]

Morocco was successful in luring several Chinese manufacturers to invest in EV battery production in the Morocco automotive ecosystem. China appears to be motivated by expanding its market share in the European EV sector without having to face the restrictions that Europe may exact on them. In early June 2024, China's Gotion High Tech signed an agreement with the Moroccan government to build Morocco's first EV battery giga-factory.[149] The $1.3 billion facility to be built near Peugeot's plant in in Kenitra will have initial battery capacity of 20 GWh with a future capacity expansion to 100 GWh that would raise the total investment to $6.5 billion.[150] In addition to complete batteries, the plant will also produce cathode and anode components for export, further cementing Morocco's position in the EV battery supply chain. Morocco's rich phosphate deposits are of course a factor in attracting these Chinese manufacturing giants.

The Gotion deal follows the May 2024 announcements by Chinese auto battery manufacturers Hailiang and Shinzoom of their respective plans to set up two separate plants in Tangier automotive manufacturing region. Hailing plans to build a $450 million copper plant spanning 30 hectares while Shinzoom will construct $460 million anode plant over 20 hectare region.[151] These plans were preceded by Chinese electric battery maker BTR New Material Group's agreement with the Moroccan government to build a $300 million cathode manufacturing plant with an annual production capacity 50,000 tons, with an initial production phase of 25,000 tons to become operational in September 2026.[152] BTR's EV cathode factory is expected to employ 2,500 Moroccans.[153] Subsequently in August 2024, BTR agreed to open a second $364 million plant in Tangier to produce 60,000 tons of anodes.[154]

The spate of 2024 agreements are building on the foundational September 2023 agreement between China's CNGR Advanced Materials and Morocco's Al Mada holding company to form a comprehensive joint venture to Cathod Active Material (CAM) precursors for EV batteries as well as LFP batteries and recycle black mass from used batteries.[155] With Al Mada's 50.03% stake and CNGR holding a 49.97% stake, phased production is slated to begin in Q4, 2024 and ultimately reach an annual production of 120,000 tons of CAM precursors, 60,000

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[144] https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/071421-eu-set-to-sideline-ice-vehicles-by-2035-with-tougher-car-emissions-proposal

[145] https://www.mei.edu/publications/moroccos-green-mobility-revolution-geo-economic-factors-driving-its-rise-electric

[146] For example, Tesla announced in its Q3 2021 report, "For standard range vehicles, we are shifting to Lithium Iron Phosphate (LFP) battery chemistry globally." https://tesla-cdn.thron.com/static/TWPKBV_TSLA_Q3_2021_Quarterly_Update_SI1AKE.pdf?xseo=&response-content-disposition=inline%3Bfilename%3D%22TSLA-Q3-2021-Quarterly-Update.pdf%22

[147] https://www.quantumscape.com/resources/blog/lithium-iron-phosphate-on-the-quantumscape-solid-state-lithium-metal-platform/

[148] https://www.latribune.fr/entreprises-finance/industrie/automobile/voiture-electrique-renault-securise-ses-approvisionnements-de-cobalt-au-maroc-920283.html

[149] https://www.reuters.com/business/autos-transportation/chinas-gotion-high-tech-set-up-13-billion-ev-battery-gigafactory-morocco-2024-06-06/

[150] https://www.reuters.com/business/autos-transportation/chinas-gotion-high-tech-set-up-13-billion-ev-battery-gigafactory-morocco-2024-06-06/

[151] https://www.reuters.com/business/autos-transportation/chinas-hailiang-shinzoom-build-auto-battery-plants-morocco-2024-05-15/

[152] https://www.reuters.com/business/china-ev-battery-maker-btr-build-cathode-plant-morocco-2024-03-29

[153] https://www.moroccoworldnews.com/2024/08/364587/chinas-btr-group-announces-366-million-lithium-ion-battery-plant-in-morocco

[154] https://en.yabiladi.com/articles/details/153079/invest-million-anode-materials-plant.html

[155] https://battery-news.de/en/2023/09/21/cngr-to-build-battery-materials-factory-in-morocco/

tons of LFP, and 30,000 tons of black mass recycling.[156]

Morocco's recycling of end-of-life EV batteries can significantly lower Morocco's carbon footprint of EV battery production. In 2022, Global mining and metal trading giant Glencore entered into a partnership with Morocco's privately held mining company Managem, a subsidiary of Al Mada to produce recycled cobalt from disused lithium-ion batteries at Managem's hydrometallurgical refining facilities operated by its subsidiary Compagnie de Tifnout Tighanimine (CCT).[157] Glencore will provide CCT with black mass, processed from dismantled and shredded Li-ion batteries. In addition to cobalt, the partnership is also seeking to extract lithium carbonate from the black mass supplied by Glencore. If the recycling processes of any Morocco's black mass recycling partnerships are powered with renewable energy, Morocco could further lower the carbon footprint.

Beyond EV battery metals, Morocco could also develop other green metal production for automotive components and car bodies. In December 2022, steelmaker Sonasid, jointly owned by ArcelorMittal and Al Mada, produced the country's first consignment of green steel with 100% percent of the material recycled in Morocco and 85% of the processing powered by renewable energy.[158] While Morocco has not yet produced green aluminum, it has advanced in aluminum recycling with the 2024 inauguration of an aluminum waste recovery plant.[159]

Green mining, metals processing, and manufacturing powered by renewable energy will require components and equipment that can be manufactured by SMEs or serviced by them. Similarly, the components involved in the storage and transport of green hydrogen and green ammonia, such as short distance pipes, compressors, pumps, and heat exchangers can be manufactured or serviced by SMEs in Morocco. Morocco's MSMEs have already started to undertake the manufacture of components for solar energy production and utilization to start solar cell and solar panel manufacturing in Morocco. These developments indicate that adjacent sectors of retail services, such as installation and maintenance, as well as retail sales will become a robust source of employment opportunities as part of the new third wave of development of Morocco's start-up ecosystem.

7.3. Renewable energy developments in the UAE: an emerging hub for the green economy in the MENA region

Primary energy consumption in the UAE is the third-largest in the MENA region and its economy is one of the most energy-intensive economies worldwide. Its consumption of most forms of energy, fossil fuels and renewable sources, is only set to grow. The Energy Institute figures show that total fossil fuels' consumption in the UAE grew by 13.8% from 2012-2022, which is second only to Egypt across the MENA region.[160] Although GDP growth is expected to moderate towards the mid-decade point after a windfall year of high oil prices in 2022 that pushed Emirati growth to 7.4%, its economic progress is expected to remain solid.[161] UAE remains a preferred investment destination in the GCC sub-region, and although it is facing increased competition from nearby Saudi Arabia, its strong record of attracting foreign investment is likely to serve it well for the remainder of the decade, pointing to limited downside risks in energy demand growth.

Despite its enormous fossil fuels wealth, the UAE today is already home to one of the most rapidly developing green energy ecosystems in the entire MENA region. The country has signed the 2015 Paris Climate Accord and is committed to achieve net zero by 2050. This is confirmed by the fact that it has been investing extensively in the energy transition, both at home and abroad since around the time of its ratification of Kyoto Protocol in 2005. The UAE's cumulative investment in clean energy projects from 2005 to 2023 now totals over $40 billion.[162] Outside of the country, the UAE has invested in renewable energy projects in 70 countries whose cumulative value

[156] https://battery-news.de/en/2023/09/21/cngr-to-build-battery-materials-factory-in-morocco/

[157] https://www.glencore.com/media-and-insights/news/glencore-and-managem-set-up-partnership

[158] https://www.sonasid.ma/fr/fibre-en-acier; https://lematin.ma/economie/sonasid-premier-siderurgiste-marocain-a-obtenir-la-certification-epd/203911

[159] https://www.afrik21.africa/en/metal-waste-recovery-alucop-inaugurates-a-new-plant-in-morocco/

[160] Institute, "Home."

[161] https://www.imf.org/en/Publications/REO/MECA. Regional Economic Outlook for the Middle East and Central Asia."

[162] N.A., "UAE Net Zero", 15 June 2023, United Arab Emirates Government Portal, https://u.ae/en/information-and-services/environment-and-energy/climate-change/theuaesresponsetoclimatechange/uae-net-zero-2050, [Date Accessed: 27 September 2023].

exceeds $16.8 billion.[163] The UAE's extensive foreign investments reflect the Emirati approach that regards its own green energy ecosystem as a central node in a nexus of international green energy ecosystems. The ultimate objective of the UAE is to position itself to become a hub for inter-regional and international, renewable energy supply chains.

The UAE is accelerating its development of power generation from renewable energy, a process that in the short term frees up natural gas for industrial use and export to help maintain favorable foreign trade balances and robust GDP growth while the country implements its energy transition. The UAE's forward-leaning policies have succeeded in making the UAE home to the largest renewable energy power generation capacity in the Arab Middle East. In 2022, the UAE boasted installed solar power capacity of 3.04 GW, accounting for over 99% of the Emirates' renewable energy capacity (Figure 4).[164]

In July 2023, the UAE announced its Updated National Energy Strategy aiming to achieve an energy mix of 44% renewable energy, 38% natural gas, 12% "clean coal", and 6% nuclear energy by 2050.[165] With the interim goal of tripling the share of 'clean energy' in the Emirati power mix by 30% in 2030, the UAE is embarking on massive $54.5 billion investment in renewable energy.[166] The UAE is aiming to generate a 19.8 GW 'clean energy' power capacity,[167] including 14.2 GW of renewable energy, which translates into quadrupling its 2022 renewable energy capacity.[168] Most of the 14.2 GW will come from the expansion of the UAE's solar energy capacity, with a combined 470 MW that would come from waste-to-energy and pumped-storage hydropower.[169]

The Emirati efforts to develop its green energy ecosystem have benefited from leveraging of the country's experience in oil, natural gas, and petrochemicals production and export, encouraging collaboration between its national oil companies, and those engaged in renewable energy development such as Masdar (Abu Dhabi Future Energy Company), and the country's various power authorities in the different emirates. This collaboration has been facilitated by the bureaucratic integration of state-owned enterprises across the country's seven emirates. In 2018, the UAE's four power authorities – The Abu Dhabi Water and Electricity Authority (ADWEA), the Dubai Electricity and Water Authority (DEWA), the Sharjah Electricity and Water Authority (SEWA) and Etihad Water and Electricity (EWE), which supplies electricity in Fujairah, Ras al-Khaimah, Ajman and Umm al-Quwain were integrated into the then newly created national Ministry of Energy and Infrastructure.[170] The consolidation served to streamline strategic planning by bringing state-owned energy companies into a national framework. For example, the integration of ADWEA saw the Abu Dhabi National Energy Company (TAQA) – 74.1% of which was owned by ADWEA – and ADWEA's then 10 power and water desalination plants come under the authority of the Ministry of Energy and Infrastructure.[171]

An important coordinating role has been played through the country's various sovereign wealth funds such as the state-owned holding companies Mubadala Investment Company (known simply as Mubadala) and the Abu Dhabi Developmental Holding Company (ADQ). Masdar has emerged as one of the premier developers of clean energy projects and green hydrogen. Active in the UAE and over 40 countries, Masdar's cumulative global investments in 2022 totalled over $30 billion.[172] In a continuing bureaucratic rationalization of the UAE's development

[163] N.A., "UAE Net Zero", 15 June 2023, United Arab Emirates Government Portal, https://u.ae/en/information-and-services/environment-and-energy/climate-change/theuaesresponsetoclimatechange/uae-net-zero-2050, [Date Accessed: 27 September 2023].

[164] https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2023/Mar/IRENA_RE_Capacity_Statistics_2023.pdf?rev=d2949151ee6a4625b65c82881403c2a7

[165] N.A., "About UAE's energy sector", n.d., https://u.ae/en/information-and-services/environment-and-energy/water-and-energy/about-uae-energy-sector, [Date Accessed: 25 July 2023].

[166] Gulf biz or strategy itself

[167] https://gulfbusiness.com/uae-to-generate-19gw-clean-energy-2030-almazrouei/

[168] https://www.eiu.com/n/uae-raises-targets-for-sustainable-energy-in-2030/

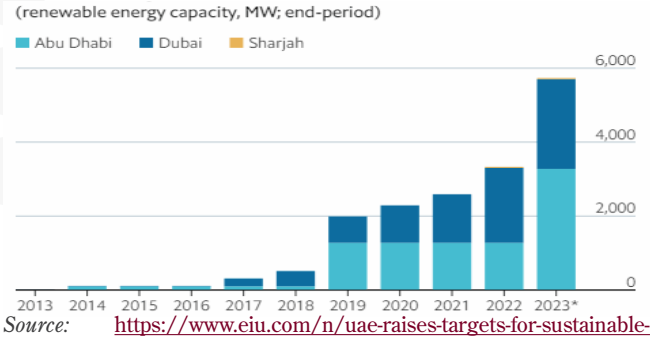
[169] A 220 MW wastetoenergy plant at Dubai's Warsan landfill and a 250-MW pumpedstorage hydro-electric power project under construction at the Hatta Dam in the Dubai area; N.A., "Hydroelectric Power Plant in Hatta", Dubai Electricity and Water Authority, 2023, https://www.dewa.gov.ae/en/about-us/strategic-initiatives/hatta-project, [Date Accessed: 27 September 2023].

[170] https://www.reuters.com/article/emirates-adwea-idUSL8N1R7040; EWE replaced the Federal Electricity and Water Authority (FEWA), supplies electricity in Fujairah, Ras al-Khaimah, Ajman and Umm al-Quwain." And N.A., "UAE's Power Sector: Transitioning to a clean and smart grid", REGlobal, 14 September 2021, https://reglobal.co/uaes-power-sector-transitioning-to-a-clean-and-smart-grid/, [Date Accessed: 25 July 2023].

[171] https://www.reuters.com/article/emirates-adwea-idUSL8N1R7040

[172] https://www.forbesmiddleeast.com/lists/the-middle-easts-sustainable-100/abu-dhabi-future-energy-company-masdar/

Figure 5. UAE ramping up renewable energy capacity



Source: https://www.eiu.com/n/uae-raises-targets-for-sustainable-energy-in-2030/

of its green energy ecosystem, TAQA, Mubadala, and ADNOC, became the shareholders of Masdar in December 2022.[173] As part of the 2018 consolidation, the Emirates Water and Electricity Company (EWEC) was formed to succeed the Abu Dhabi Water and Electricity Company to be the sole procurer of water and power within the Emirate of Abu Dhabi and beyond through partnering with plants across the UAE.[174] In February 2023, it met 80% of its power demand using renewable and clean energy from its solar and nuclear plants, equivalent to 6.2 GW.[175] The achievement reflects that fact that EWEC is wholly owned by ADQ, one of the UAE's primary long-term investors in the country's non-fossil fuel economy.

The high degree of integration is reflected in the multiple positions held by various national government ministers involved with the development of the UAE's renewable energy infrastructure. The current Minister of Energy and Infrastructure is also the Chairman of the Board of EWE and the Emirates General Petroleum Corporation (Emarat) as well as a board member of ADNOC and Mubadala.[176] The current Minister of Infrastructure and Advanced Technology is also the CEO of ADNOC and previously served seven years as the CEO of Masdar, which he had helped create while serving as the CEO of Mubadala's energy platform.[177] Replicated across many key positions, this phenomenon contributes to institutional cohesion in the formation and implementation of a coherent energy transition strategy.

Among the UAE's seven emirates, Dubai and Abu Dhabi account for at least 90% of the country's renewable energy capacity.178 In 2022, DEWA operated an installed capacity 1.627 GW of power generation from renewable energy.[179] The massive $13.6 billion Mohammed bin Rashid Al Maktoum (MBR) solar complex is the UAE's flagship renewable energy project, located around 50 km south of the city of Dubai.[180] Touted as the "largest single-site solar park in the world," MBR is slated to have an installed capacity of 5 GW by 2030.[181] The project has six development phases: Phase I with a PV installed capacity of 13 MW became operational in 2013; Phase II with a PV installed capacity of 200 MW was developed by a consortium led by Saudi Arabia's ACWA Power and became operational in 2017; Phase III with a PV installed capacity of 800 MW was developed by a consortium led by Masdar became operational in 2020; Phase IV with a 900MW installed capacity (750 of which is CSP with a molten salt technology tower) is being developed by a project company led by DEWA (51%) with ACWA Power (25%) and the Silk Road Fund (24%); Phase V with a PV installed capacity of 900 MW developed by DEWA (60%) and a consortium (40%) led by ACWA Power and the Kuwaiti Gulf Investment Corporation; Phase VI with a PV installed capacity of 1.8 GW is under construction and expected to be fully operational by 2026.[182] The participation of companies from Saudi Arabia and Kuwait in MBR's development serves to develop regional stakeholder interest in the Emirati approach to develop the UAE as hub in a wider MENA green energy ecosystem.

Abu Dhabi's two major solar power mega-projects, by contrast, have focused on developing partnerships in Asia and Europe, further widening international stakeholder interest. EWEC's major renewable energy facility is the Noor Abu Dhabi solar power complex in Sweihan in

[173] N.A., "TAQA, ADNOC, and Mubadala Complete Landmark Transaction for Stake in Masdar Clean Energy Powerhouse", TAQA, 8 December 2022, https://www.taqa.com/press-releases/taqa-adnoc-and-mubadala-complete-landmark-transaction-for-stake-in-masdar-clean-energy-powerhouse/, [Date Accessed: 13 October 2023].

[174] https://www.ewec.ae/en/power-plant/al-dhafra-solar-pv

[175] https://www.forbesmiddleeast.com/lists/the-middle-easts-sustainable-100/emirates-water-and-electricity-company-ewec/

[176] https://www.moei.gov.ae/en/about-ministry/about-minister.aspx

[177] https://moiat.gov.ae/en/his-excellency-dr-sultan-bin-ahmed-al-jaber

[178] https://www.trade.gov/energy-resource-guide-united-arab-emirates-renewable-energy

[179] https://www.forbesmiddleeast.com/lists/the-middle-easts-sustainable-100/dubai-electricity-and-water-authority-dewa/

[180] https://www.pv-tech.org/uae-inaugurates-900mw-fifth-phase-of-mohammed-bin-rashid-al-maktoum-solar-park/

[181] N.A., "Mohammed bin Rashid Al Maktoum Solar Park (MBR) Solar Park", Masdar, 2023, https://masdar.ae/Masdar-Clean-Energy/Projects/Mohammed-bin-Rashid-Al-Maktoum-Solar-Park-Phase-3, [Date Accessed: 25 July 2023].

[182] https://www.dewa.gov.ae/en/about-us/strategic-initiatives/mbr-solar-park

the Al Ain region. The 935MW PV facility has been operational since 2019. TAQA owns a 60% stake in Noor Abu Dhabi with Japan's Marubeni and China's JinkoPower each holding 20%.[183] The major project in the Emirate of Abu Dhabi is the 1.5GW Al Dhafra solar complex currently under construction. Located in the Dhafra region about 35 km from the city of Abu Dhabi, the facility is touted as the world's largest single-site PV solar facility and will raise Abu Dhabi's installed solar capacity to 2.5GW. Al Dhafra's leading stakeholder is TAQA (40%) with Masdar, France's EDF Renewables and JinkoPower each holding 20%.[184]

The UAE's Updated National Energy Strategy has adopted a green energy ecosystems approach with a National Hydrogen Strategy that calls for the UAE to become a leading producer and exporter of low-carbon hydrogen, with the target of producing 1.4 million tons per year by 2031 and 15 million tons by 2050.[185] The UAE's strategy aspires to a 25% market share of the major hydrogen markets in Europe and Asia.[186] As seen above in the discussion of the UAE's green ammonia activities in Egypt, the advancement of renewable energy and green hydrogen has been incentivized through the UAE's chemicals and fertilizers industry. In contrast to hydrocarbon-poor Morocco that has focused exclusively on green hydrogen, The UAE's strategy includes a major role for blue hydrogen whose value in combatting climate change, as discussed previously, has been contested. The UAE has also floated the idea of producing so-called pink hydrogen, in which nuclear energy is used to generate the electricity to power the Electrolyzers that split water into its oxygen and hydrogen components.[187] The UAE's National Hydrogen Strategy calls for the establishment of two "hydrogen oases" by 2031 and five by 2050.[188]

The production of green hydrogen within the UAE itself will be about half of the green hydrogen produced by Emirati green hydrogen investments globally. While the MBR solar power complex includes a pilot green hydrogen plant constructed by DEWA and Germany's Siemens,[189] Masdar is spearheading most of the UAE's green hydrogen development. Masdar's 2030 target is to produce a combined total 1 million tons of green hydrogen and derivatives from its various operations across the MENA region.[190] By leveraging ADNOC's infrastructure and experience in the petrochemicals industry, Masdar seeks to make the UAE a central international node in the nexus of green hydrogen value chains, both in terms of production and export flows. The UAE's annual green hydrogen demand is forecast to be 200,000 tons.[191] The remaining 300,000 tons produced locally and the 500,000 tons produced outside the UAE will be exported internationally.[192]

Masdar via ADNOC and the Emirati-Dutch joint fertilizer platform Fertiglobe are already involved in sizable green ammonia operations in Egypt, as discussed above, as well as in Mauritania, located directly south of Morocco. In March 2023, Masdar, through the Emirati-Egyptian joint venture Infinity Power Holding, partnered with Germany's Conjuncta to construct a $34 billion green hydrogen complex in Mauritania that will produce 8 million tons of green hydrogen or its green ammonia equivalent.[193] While possessing solar and wind energy resources similar to Morocco's resources, Mauritania's population of about 5 million is 7 times smaller, enabling the sparsely inhabited nation to more easily serve export markets while providing for the green energy needs of its own population.[194] Masdar has expressed interest in both Egypt and Morocco regional export hubs.[195] The combined export volumes of green ammonia from Morocco and Mauritania transported via Morocco's

[183] https://www.ewec.ae/en/power-plants/noor-abu-dhabi

[184] https://www.ewec.ae/en/power-plant/al-dhafra-solar-pv

[185] https://gulfbusiness.com/uae-to-generate-19gw-clean-energy-2030-almazrouei/

[186] https://gulfbusiness.com/uae-completes-first-phase-of-national-hydrogen-strategy/

[187] See comments by Sharif Al Olama, Under-Secretary of the Ministry of Energy and Infrastructure for Energy and Petroleum Affairs

[188] https://u.ae/-/media/MoEI-recent-docs/Updated-UAE-Energy-Strategy-2050-Eng.ashx

[189] The pilot project is able to produce 20.5 kilograms an hour of hydrogen at 1.25 MWe of peak power supplied during daylight hours from MBR; N.A., "UAE's Power Sector: Transitioning to a clean and smart grid", REGlobal, 14 September 2021, https://reglobal.co/uaes-power-sector-transitioning-to-a-clean-and-smart-grid/, [Date Accessed: 25 July 2023].

[190] N.A., "Masdar accelerates green hydrogen ambitions after joining forces with UAE energy champions", Masdar, 09 January 2023, https://masdar.ae/en/news/newsroom/masdar-accelerates-green-hydrogen-ambitions, [Date Accessed: 12 October 2023].

[191] Ibid.

[192] Ibid.

[193] https://www.ntu.edu.sg/cas/news-events/news/details/can-singapore-unlock-africa-s-green-hydrogen-potential

[194] Ibid.

[195] N.A., "Masdar accelerates green hydrogen ambitions after joining forces with UAE energy champions", Masdar, 09 January 2023, https://masdar.ae/en/news/newsroom/masdar-accelerates-green-hydrogen-ambitions, [Date Accessed: 13 October 2023].

already existing export infrastructure would provide commercial advantages that would advance a western Maghreb and West Africa green hydrogen supply chain. Masdar is looking at other "key geographies," such as Oman and Saudi Arabia, in the latter of which Masdar enjoys strong partnerships through ACWA Power's role in constructing the UAE's solar power infrastructure.[196]

With its focus on low-carbon hydrogen, the UAE is developing green hydrogen and blue hydrogen production capacity in tandem. In 2021, Masdar signed a "strategic alliance agreement" with France's multinational utility giant ENGIE to explore the co-development of a "UAE-based green hydrogen hub."[197] As the core of the hub, the two companies are eyeing a $5 billion investment to develop a minimum capacity of 2 GW by 2023.[198] Also in 2021, BP signed framework agreements with Masdar and ADNOC for the development "clean" hydrogen hubs in the UK and the UAE based on a mix of green hydrogen and blue hydrogen, by utilizing the UAE's position as an investor in UK offshore wind power projects for green hydrogen while developing joint collaboration in greenfield carbon capture and underground storage for blue hydrogen.[199] Subsequently in 2022, ADNOC acquired a 25% stake in the design stage of BP's H2Teeside blue hydrogen project, being ADNOC's first UK investment.[200] The H2 Teeside project is slated to construct two 500MW hydrogen production units by 2030. Concurrently, Masdar signed an MoU to acquire a stake in BP's proposed green hydrogen project, HyGreen Teeside, intended to reach 500 MW by 2030.[201]

The UAE's National Hydrogen Strategy emerged from the need to coordinate low-carbon hydrogen projects into a coherent program for the emergence of the UAE as a regional hydrogen hub. Similar to the early role Germany played in the original development of Morocco's green hydrogen program, the Emirate's National Hydrogen Strategy arose out of the prominence of Emirati-German cooperation the low-carbon hydrogen and green energy sectors. In 2022, the UAE's Ministry of Energy and Infrastructure contracted the multinational technical services firm GHD, in partnership with the Germany-based FraunhoferGesellschaft the parent entity of the Fraunhofer Institute, which helped initiate Morocco's green hydrogen development, to develop the UAE's National Hydrogen Strategy.[202]

In 2022, Germany received its first consignment of Emirati-produced blue hydrogen. The consignment was delivered in the form of blue ammonia produced by Fertiglobe at its Fertil plant in the Ruwais industrial complex in Abu Dhabi.[203] Although produced by the UAE's fertilizer sector, the blue ammonia exported to Germany was intended to serve as proof-of-concept for the use of blue hydrogen in industrial manufacturing, with the demonstration cargo being delivered to Aurubis, a European leader in the production of non-ferrous metals. The Hamburg-headquartered company plans to utilize the Emirati blue ammonia in its wire rod plant. Blue hydrogen used as a proof-of-concept could pave the way for the eventual use of green hydrogen, delivered as green ammonia, in the energy-intensive manufacturing processes used in multi-metal production. Aurubis is one of the world's largest copper recyclers. Beyond copper, Aurubis also produces a variety of battery metals. The company's use of low-carbon hydrogen also increases the prospects for the circular production of new green energy infrastructure, in which the metal and other inputs are supplied from recycled infrastructure and the recycling process being fueled by green hydrogen produced from renewable energy.

The circular production of green energy infrastructure would mostly like begin with the UAE's aluminum industry, the world's fifth largest aluminum producer.[204] In 2021, the UAE started the world's first green aluminum production, when DEWA began the transmission of 560,000 MWh annual supply of solar energy from the MBR solar

[196] Ibid.

[197] N.A., "ENGIE and Masdar form US$5 billion strategic alliance to drive UAE's green hydrogen economy", ENGIE, 3 December 2021, https://www.engie.com/en/journalists/press-releases/engie-and-masdar-form-us-5-billion-strategic-alliance-to-drive-uae-s-green-hydrogen-economy, [Date Accessed: 13 October 2023].

[198] Ibid.

[199] N.A., "ADNOC, bp and Masdar agree to expand UAE-UK new energy partnership", ADNOC, 17 September 2021, https://www.adnoc.ae/en/news-and-media/press-releases/2021/adnoc-bp-and-masdar-agree-to-expand-uae-uk-new-energy-partnership, [Date Accessed: 13 October 2023].

[200] N.A., "Abu Dhabi's ADNOC and Masdar to join BP's UK hydrogen projects", bp, 24 May 2022, https://www.bp.com/en/global/corporate/news-and-insights/press-releases/abu-dhabis-adnoc-and-masdar-to-join-bps-uk-hydrogen-projects.html, [Date Accessed: 13 October 2023].

[201] Ibid.

[202] https://www.ise.fraunhofer.de/en/press-media/news/2022/fraunhofer-ise-and-ghd-are-developing-the-national-hydrogen-strategy-of-the-united-arab-emirates.html; https://www.ghd.com/en/about-ghd/news/28-07-2023-ghd-and-fraunhofer-join-forces-with-uaes-ministry

[203] https://adnoc.ae/en/news-and-media/press-releases/2022/adnoc-sends-first-low-carbon-ammonia-shipment-from-the-uae-to-germany

204 https://investingnews.com/daily/resource-investing/industrial-metals-investing/aluminum-investing/aluminum-producing-countries/

complex to the state-owned aluminum manufacturer Emirates Global Aluminum (EGA).[205] Jointly owned by Mubadala and the Investment Corporation of Dubai, EGA is the UAE's largest manufacturing company outside the oil and gas sector and a world leader in premium aluminum production.[206] The amount of solar power supplied by MBR was sufficient for EGA's smelter to produce 40,000 tons of aluminum.[207] The first consignment of aluminum produced with solar power, marketed under the brand name CelestiAL solar aluminum, was sold to German automaker BMW.[208] In 2022, EGA signed an agreement with Austrian-headquarted Hammerer Aluminum Industries to supply CelestiAL solar aluminum from which Hammerer will manufacture aluminum automotive components for German carmaker Mercedes-Benz.[209] In late 2022, EGA purchased Clean Energy Certificates for 1.1 million MWh of electricity from EWEC supplied by the Noor Abu Dhabi solar power plant for the production of about 80,000 tons of CelestiAL solar aluminum.[210]

The UAE's aviation industry is also participating in the UAE's green energy ecosystem as an offtake market for green hydrogen. A global leader, the UAE's aviation sector is an important pillar of the Emirati economy, earning about $47 billion[211] and accounting for about 13% of GDP.[212] Masdar is spearheading an initiative in partnership with French energy giant TotalEnergies, Germany's Siemens Energy and Japan's Marubeni to develop and produce sustainable aviation fuel (SAF) from green hydrogen.[213] The UAE's Etihad Airways and Germany's Lufthansa are also partners in the collaboration. In early 2023, Masdar, ADNOC, and Etihad Airways, along with Tadweer (Abu Dabi Water management Company) are also partnering with BP to explore the development of SAF using municipal solid waste and green hydrogen.[214]

Beyond green fuels for aircraft and shipping, green mobility is also emerging as an important component of the UAE's green energy ecosystem. The Updated National Energy Strategy calls for hybrid and electric cars to constitute 53% of passenger vehicles by 2050 and electric and hybrid buses to constitute 60% of all Emirati buses in service. With 879 charging stations expected to be in place by the end of 2023, the Updated Strategy has targeted the installation of 30,000 charging stations by 2050.215 In October 2022, the UAE's M Glory holding company opened the Al Damani Electric Vehicle Factory, the country's first electric car manufacturing plant. The $408 million facility will have an initial production capacity of 10,000 EVs per year.216 With capacity expansion, the Al Damani plant is expected to produce 55,000 EVs annually for sale in the UAE as well as for export to GCC and African markets.217 The existence of EV manufacturing in the UAE opens the possibility of local circular green production. Electric vehicles are currently composed of 25-27% more aluminum than their internal combustion engine counter parts,218 and is likely to greatly increase as manufacturers seek to reduce

[205] https://www.pv-magazine.com/2021/01/18/uae-says-mohammed-bin-rashid-solar-park-is-powering-aluminum-production/

[206] https://www.pv-magazine.com/2021/01/18/uae-says-mohammed-bin-rashid-solar-park-is-powering-aluminum-production/

[207] Ibid.

[208] Ibid.

[209] https://media.ega.ae/ega-to-supply-celestial-solar-aluminium-to-parts-maker-hammerer-aluminum-industries-tier-1-supplier-of-a-premium-car-manufacturer/

[210] https://media.ega.ae/ega-purchases-clean-energy-certificates-for-11-million-megawatt-hours-of-electricity-supplied-by-ewec-to-support-production-of-celestial-solar-aluminium/

[211] https://www.businesstraveller.com/features/the-rising-fortunes-of-commercial-aviation-in-the-middle-east/

[212] https://www.thenationalnews.com/business/2021/11/28/uae-at-50-aviation-industry-flies-towards-sustainable-and-tech-driven-growth/

[213] N.A., "Masdar, TotalEnergies, Siemens Energy and Marubeni to certify a novel pathway to make Sustainable Aviation Fuel (SAF) from methanol", Masdar, 25 January 2023, https://news.masdar.ae/en/News/2023/01/25/11/17/Novel-pathway-to-make-SAF-from-methanol, [Date Accessed: 13 October 2023].

[214] N.A., "Masdar, ADNOC, bp, Tadweer, Etihad to explore SAF production in UAE", Gulf Business, 21 January 2023, https://gulfbusiness.com/saf-production-in-uae-to-be-explored/, [Date Accessed: 13 October 2023].

[215] https://u.ae/-/media/MoEI-recent-docs/Updated-UAE-Energy-Strategy-2050-Eng.ashx

[216] https://www.thenationalnews.com/business/road-to-net-zero/2022/10/05/m-glorys-electric-vehicle-manufacturing-plant-opens-in-dubai/

[217] Ibid.

[218] https://www.mining-technology.com/contractors/project-management-and-consultancy/cru-group/pressreleases/evs-aluminium-demand/

EV weight and production times.219 Domestically produced green aluminum such as CelestiAL solar aluminum, could provide a significant advantage for the further development of EV manufacturing in the UAE.

While the Emirate's embryonic EV manufacturing industry currently does not warrant the creation of an EV battery manufacturing sector, it could emerge through EV battery recycling. In 2023, Beeah Recycling, a subsidiary the Sharjah-based Beeah Group focused on waste recycling, signed an agreement with the Ministry of Energy and Infrastructure to open the UAE's first recycling plant for end-of-life EV batteries.[220] Beeah Group jointly runs a waste-to-power facility with Masdar. With the UAE EV market expected to grow at 30% compounded annual growth rate through 2028,[221] domestic EV battery recycling will form a significant part of the UAE green energy ecosystem if the recycling process is powered by renewable energy. The availability of affordable renewable energy could also see the UAE become a regional hub for battery recycling.

In addition to the renewable energy supply chains that emerge from the many facets of the UAE's expanding green energy ecosystem, electricity exports via inter-regional undersea interconnectors represents a further possible mechanism to reach offtake markets for renewable energy produced in the UAE. The Emirates' National Grid is interconnected via GCC regional grid system to the national grid of Saudi Arabia,[222] which in turn is interconnected with Egypt's national grid. Once the Euro-Africa Interconnector between Egypt and Greece is completed, UAE-produced renewable energy could theoretically reach the European continent. The UAE is increasing its investment footprint in inter-regional electricity interconnectors. In 2023, TAQA invested $31.1 million in the X-links project to transport renewable energy produced in Morocco to the UK via undersea HVDC cables.[223] In January 2023, India announced that it was in serious negotiations with the UAE to establish an underwater electricity interconnection across the Arabian Sea for the transport of renewable energy.[224] Utilizing the time difference between the two countries, electricity produced from solar energy during daylight hours in each country could be traded with the other. [225] In April 2023, it was reported that the drafting of the India-UAE agreement for the interconnector was in its final stages.[226] India is also reviewing the possibility of interconnection with Saudi Arabia.

8. Jobs, more jobs and better jobs: the RE Employment creation potential in the MENA region

The region's stakes in limiting emissions at home and abroad, managing efficiently its energy use, creating sufficient jobs for its growing population, dealing with its historical high unemployment rates of youth and women, improving and expanding its resiliency to deal with natural disasters and the expected high economic costs of climate change are leaving the region with no option but to expedite its transition to renewable energy.

Factoring in the increased likelihood of fossil fuels becoming stranded assets as countries and industries abandon fossil fuels, the MENA region is at the threshold of a major economic crisis if it delays its transition away from its heavy dependence on fossil fuels. The region remains home to the highest world levels of unemployment and particularly youth unemployment. It is also a region where low participation of women in the labor force and their under representation in leadership and high-paying positions are defining characteristics. The transition to renewable energy has been conceived, right from the outset, as a social project to capitalize on the net socioeconomic and environmental benefits of a speedy and careful and "just" transition plan to renewable and

219 https://www.metalswarehouse.co.uk/the-use-of-aluminium-in-the-ev-market/

220 https://www.beeahgroup.com/beeah-recycling-uae-ministry-of-energy-infrastructure-and-american-university-of-sharjah-to-launch-uaes-first-ev-battery-recycling-facility/#:~:text=The%20EV%20battery%20recycling%20facility,highest%20in%20the%20Middle%20East.

221 Ibid.

222 N.A., "UAE's Power Sector: Transitioning to a clean and smart grid", REGlobal, 14 September 2021, https://reglobal.co/uaes-power-sector-transitioning-to-a-clean-and-smart-grid/, [Date Accessed: 25 July 2023].

223 https://www.thenationalnews.com/business/energy/2023/04/26/abu-dhabis-taqa-invests-31m-in-british-start-up-xlinks-first/

224 Rachna Uppal, "India, UAE close to deal on renewable electricity grid link, Indian minister says", 15 January 2023, https://www.reuters.com/business/energy/india-uae-close-deal-renewable-electricity-grid-link-indian-minister-2023-01-15/, [Date Accessed: 31 July 2023].

225 Shilpa Samant, "India, UAE hold talks to link grids through subsea cables", The Economic Times, 16 June 2023, https://economictimes.indiatimes.com/news/india/india-uae-hold-talks-to-link-grids-through-subsea-cables/articleshow/101027556.cms?from=mdr, [Date Accessed: 31 July 2023].

226 https://www.arabnews.com/node/2292666/business-economy

green energy.[227] This is increasingly becoming possible as international and regional funding opportunities for a more environmentally friendly development that is capable of sustaining credible alternative income dividend streams, new exports, creating sufficient jobs for the growing populations and the expanding labor supply. The transition to renewable energy is also promising to ensure energy sufficiency and potentially meeting social objectives of inclusiveness and equity, but more importantly is promising to create substantial net jobs and better paying jobs in manufacturing, engineering and R&D.

Below we present a list of where these jobs are likely to be created and the numbers to be expected in the region.

8.1. Job creation in renewable energy sector

The adoption of green energy technologies, such as solar power, wind energy, biomass, hydropower, and green hydrogen necessitates the establishment of new supporting and downstream industries, leading to job creation across various sectors. The MENA region, with its abundant solar irradiation and wind resources, has immense potential for renewable energy projects. As a result, the construction, installation, maintenance and decommissioning of the renewable energy infrastructure will require a skilled workforce, contributing to direct job opportunities in engineering, manufacturing, construction, business and project management.

8.2. Research, development, and innovation

Investments in green energy initiatives in several developed and developing countries have stimulated research and development (R&D) activities, fostering innovation and technological advancements. Their experience suggests that this could be expected in the MENA region. Governments and private entities in the MENA region are increasingly investing in clean energy R&D, aiming to develop efficient and cost-effective renewable energy systems. This will create employment opportunities for scientists, engineers, and technicians specializing in renewable energy research and development. The growth of R&D centers and innovation hubs promotes knowledge transfer and enhances the region's technical expertise.

8.3. Supply chain and manufacturing

It is to be expected that green energy projects would entail the production and installation of renewable energy equipment, such as solar panels, wind turbines, and energy storage systems. Establishing a robust local supply chain and manufacturing capabilities can significantly contribute to job creation. By supporting the production of renewable energy components within the region, a few examples are already being established; MENA countries can reduce their dependence on imports and develop a competitive advantage in the global green energy market.

This will lead to employment opportunities in manufacturing, assembly, logistics, and related support services. Add to this the expanding potential of moving downstream and off-stream to the manufacture of Electric Vehicles (EVs), a prospect that is already being rooted in several countries in the region including Morocco, Egypt, Algeria, UAE and Saudi Arabia.

8.4. Energy efficiency and retrofitting

Promoting energy efficiency measures and retrofitting existing infrastructure for improved energy performance can also generate employment opportunities. As the countries of the region seek to optimize energy consumption and reduce greenhouse gas emissions, there will be greater demand for professionals specializing in energy audits, building retrofits, and energy management. Industries involved in the production and installation of energy-efficient equipment, such as lighting systems and HVAC (heating, ventilation, and air conditioning) solutions, will witness growth and create additional jobs.

8.5. Skills Development and Training

The transition to green energy necessitates a skilled workforce capable of meeting the demands of the evolving energy landscape. Governments and educational institutions in the MENA region can play a vital role by providing training programs and vocational courses focused on renewable energy technologies and energy efficient systems and products. By equipping individuals with the necessary skills, the region can enhance its human capital, fostering employment opportunities and sustainable development in the green and renewable

[227] B. Baruah and S. Biskupskai-Mujanovic.2021. Closing the Gender Gap in Energy Sector Recruitment, Rentention and Advancement. In Webb, Janette, Tingey, Margaret and Wade, Faye (Eds.), Research Handbook on Energy and Society. Edward Elgar Publishing.

energy sector.

8.6. Energy intensive industries agglomeration potential

Unlike fossil fuels, green energy is not easily transportable. Energy intensive industries can no longer be separated easily and cheaply from the sources of energy. This could give the region a comparative cost advantage to attract these energy intensive industries in heavy metals, chemicals, and energy to locate in the region thereby creating manufacturing hubs that generate substantial jobs for all types of skills and occupations.

8.7. The potential employment embedded in decommissioning of fossil fuel and RE assets potential [228]

Fossil fuel industries have produced several other negative environmental externalities besides their negative contributions to climate change. These include primarily their localized problems with polluted or abandoned production sites, including mines, oil and gas wells, and pipelines and other decommissioned assets. The example of leaking methane from improperly decommissioned natural gas wells and pipelines is cited to make a significant (and often undocumented) contribution to Canada's overall emissions of greenhouse gases.[229]

The impact of decommissioning these assets will require considerable work to repair their environmental damage. Repairing and decommissioning the fossil fuels assets and sites could create large employment opportunities that make hiring displaced fossil fuel workers to perform that work an obvious and fitting contribution to employment transitions. Reemploying fossil fuel workers in cleaning up previous sites could be a logistically and geographically convenient transition measure. Already a start in this task was made in Canada with a new federal government program (during the COVID-19 economic crisis) that provided a total of $1.7 billion in financial support for remediation of abandoned wells in Alberta, Saskatchewan, and B.C. Early estimates suggest that the program will support several thousand jobs. Given the huge fossil fuels infrastructure in the MENA region, these new employment opportunities would be a welcome offset to the expected declines in overall employment in the petroleum and gas sector in the region.

It is also to be expected that the future decommissioning of the renewable energy assets from wind turbines, to solar panels, to batteries, and to pipelines, transport vehicles and storage facilities would create significant jobs opportunities in the region. There are no reliable estimates of the number of jobs but a crude estimate would put these in the hundreds of 1000 jobs.

8.8. A summary note and a cautionary note

A summary of the findings shows the potential employment impacts of green and renewable energy in the MENA region are multifaceted and promising. Embracing renewable energy technologies presents an opportunity for the region to diversify its economy, mitigate the possible negative impacts of digitalization and AI on existing jobs, reduce its carbon footprint, and create significant levels of employment across various sectors. By investing in renewable and green energy infrastructure, research and development, local manufacturing, energy intensive manufacturing, energy efficiency measures, and skills development, the MENA region can unlock the full potential of the green energy sector, leading to a greener future and a more sustainable, efficient, diversified and well-paid workforce.

While describing the immense potential for employment generation in RE, it is also important to note that RE labor productivity issues will most likely become more complicated in the future and a few issues will arise to reduce this potential. It is expected that as RE industries become more mature, reap the gains of economies of scale and scope, navigate learning curves and turn more to automated processes (including AI), there is increased likelihood that fewer people may be needed for some of the tasks performed by labor. In most countries, the levels of precarity in RE jobs have tended to be high as firms figure out ways to save labor. This is raises the challenge to make employment in RE more secure and stable particularly in contexts where social security nets are weak to begin with as is the case in many MENA countries.[230]

[228] J. Stanford. 2021. Employment Transitions and the Phase-Out of Fossil Fuels. Centre for Future Work. January. https://centreforfuturework.ca/wp-content/uploads/2021/01/Employment-Transitions-Report-Final.pdf

[229] R. Chesnaux. 2020. Climate Change Nightmare: Canada Has a Gas Leak Problem, The National Interest (blog), March 4.

[230] I thank Dr. Bipasha Baruah for this point received in private correspondence.

8.9. Actual and projected employment impacts of energy production by type of fuel in the six selected countries and the MENA region

Although there are a few references that can be used to estimate the potential future employment generation capacity of renewable energy, only the elasticity coefficients generated by the IMF are used here. Of course the other coefficients in the various tables in the previous section are useful and can be used for this purpose if only for comparison purposes. The choice of the IMF employment elasticity coefficients is based on five advantages these elasticity coefficients have over the other parameter estimates discussed in the previous section. First, the elasticity coefficients are presented for all types of energy inputs, a fact that allows the estimation of gross and net employment impacts. For example the use of the employment elasticity of 1.5 associated with solar PV per GWh generates the gross employment impacts of solar PV. Given that the employment elasticity coefficient per GWh of natural gas is 0.21 means that it is possible to estimate the net employment elasticity coefficient of solar PV. This is equal to 1.29 calculated by subtracting the employment elasticity of natural gas from that of solar PV.

Thus (1.5 – 0.21) is the estimate of the net employment elasticity of solar PV when it is assumed that solar PV will displace natural gas in electricity generation. Second, the elasticity coefficients include the indirect and at times even the induced effects while other similar estimates often include only the direct effects. Third, the elasticity coefficients take into account a large set of countries at different stages of development that have made different strides into renewable energy, whereas the other contending estimates are only for a particular region at a particular time and may therefore be inappropriate to represent the expected future employment generating potential of renewable energy for MENA. Fourth, the IMF elasticity coefficients include the employment generation capacity on realized energy efficiency which most other studies have excluded. Fifth, employment generating potential of the elasticity coefficients take into account most of the value chains involved in generating electricity such as construction, installation, manufacturing and operations and maintenance.

In what follows a set of six tables are presented that benchmark the existing employment generated by electricity generation in each of the six target countries. These estimates are used to present and anchor the renewable energy employment projections in 2030 and 2050 using the NDCs of the respective countries of their plans to expand the production and use of renewable energy in their in future targets for generating electricity.

The actual employment associated with renewable energy in the six target countries use the data presented in Table 1. The installed electricity generation capacity is the driving factor; it is used to estimate the actual employment in 2021 for most countries and for 2022 for Egypt and Tunisia. The actual calculation of the employment numbers involves multiplying the installed capacity for a particular energy type by 1,000 to convert from MW to GW, then multiplying by a confidence factor. For example, the employment for electricity produced using biomass in Egypt is calculated by multiplying 0.12 by 2.38 then multiplying by 1,000 to convert from 2.38 jobs per MW to 2,380 jobs per GW, resulting in the jobs number of 286 in Table 2.

The average target of renewable energy share in 2030 is 30 percent which has been set in all of the six countries. Energy efficiency targets are set at 15 percent in all of the six countries except Morocco that set that target at 30 percent. The 2050 targets are estimated as the shares that guarantee net zero emissions which are set at between 50 and 60 percent share of renewable energy in total energy use.

A total of 1.2 million jobs can be generated in the six countries from simply increasing the share of renewable energy to 30 percent. These employment figures in Table 8 are gross employment estimates with 611,423 person years in 2030 and 1,222,845 in 2050. Net total employment that takes into account that renewable energy will displace an equal share of that electricity generated by natural gas will be about 525, 824 person years in 2030 and 1,051,647 person years in 2050. This needs not be the case as renewable energy can be thought of fully incremental and in that case the entire 1.22 million person years could be the expected employment sustained by the renewable energy in the six countries.

The employment generation capacity of energy efficiency is not large but will still contribute a total of 89,377 in 2030 and almost twice this level in 2050 when the share of energy efficiency is 30 of total energy generated (Table 8 and Figure 6).

When the entire MENA region is the focus of estimating the total employment that could be generated and sustained by a 30 percent share for renewables in total energy supply in 2030, a large total emerges of about 2,539,384 person years in 2030 and over 5,076,728 person

years in 2050.[231] These figures are the total employment generation capacity of both generation of electricity including all of the value chains involved and from realized efficiencies.

In 2030, the relative contributions of renewable energy generation exceeded 2,240,633 person years and that of efficiency is put at 298,751 person years. The total installed electricity generating capacity in the MENA region in 2020 was estimated at about 420 GW. This is expected to increase by 40 percent by 2030 reaching 589 GW (Figure 7). The projected employment generation capacity in 2030 are based on a 30 percent renewable energy share in electricity generation for the regional as a whole and the use of the IMF elasticity coefficients.

These employment projections indicate a massive increase in employment generation capacity in the region particularly against the backdrop of high

[231] This is the sum of the direct, indirect and induced employment values in 2050 for renewable energy.

Table 1. Installed capacity for electrivcity generation by fuel type (GW)

Fuel	Egypt	Lebanon	Morocco	Sudan	Tunisa	Jordan	Total
Bioenergy	0.12	0.01	0.01	0.2		0.01	0.35
Coal			4.26				4.26
Gas	53.47	1.6	0.87	0.37	5.78	3.45	65.54
Hydro	2.83	0.28	1.31	1.48	0,07	0.01	5.98
Nuclear							0
Other Fossil	1.33	3.03	0.78	1.93		0.38	7.45
Other Renewables							0
Solar	1.72	0.19	0.85	0.14	0.2	1.52	4.62
Wind	1.64		1.47		0.25	0.62	3.98
Total	61.11	5.11	9.55	4.12	6.3	5.99	92.18

Source: https://ember-climate.org/data-catalogue/yearly-electricity-data/
Note: Data for Egypt and Tunisia are for 2022, the rest are for 2021.

Table 2. Employment in the electricity-producing sector - Egypt, 2022

Fuel Type	Mean	Geometric Mean	Average	O&M	Direct Jobs	Indirect Jobs	Induced Jobs	Grand Total
Bioenergy	286	265	278		265	196	311	772
Gas	8,021	7,730	7,486		7,730	8,834	8,834	25,398
Hydro	1,429	1,360	1,302		1,360	1,005	1,597	3,962
Other Fossil	1,835	1,835	1,835		1,835	2,097	2,097	6,029
Solar	740	735	740	516	735	543	863	2,141
Wind	320	320	394	328	320	237	376	933
Total	12,631	12,245	12,035	844	12,245	12,912	14,078	39,235

Table 3. Employment in the electricity-producing sector - Jordan, 2021

Fuel Type	Mean	Geometric Mean	Average	O&M	Direct Jobs	Indirect Jobs	Induced Jobs	Grand Total
Bioenergy	24	22	23		22	16	26	64
Gas	518	499	483		499	570	570	1,639
Hydro	5	5	5		5	4	6	15
Oil	524	524	524		524	599	599	1,722
Solar	654	649	654	456	649	480	762	1,891
Wind	121	121	149	124	121	89	142	352
Total	1,846	1,820	1,838	580	1,820	1,758	2,105	5,683

Table 4. Employment in the electricity-producing sector - Lebanon, 2021

Fuel Type	Mean	Geometric Mean	Average	O&M	Direct Jobs	Indirect Jobs	Induced Jobs	Grand Total
Bioenergy	24	22	23		22	16	26	64
Gas	240	231	224		231	264	264	759
Hydro	141	135	129		135	100	158	393
Other Fossil	4,181	4,181	4,181		4,181	4,778	4,778	13,737
Solar	82	81	82	57	81	60	95	236
Total	4,668	4,650	4,639	57	4,650	5,218	5,321	15,189

Table 5. Employment in the electricity-producing sector - Morocco, 2021

Fuel Type	Mean	Geometric Mean	Average	O&M	Direct Jobs	Indirect Jobs	Induced Jobs	Grand Total
Bioenergy	24	22	23		22	16	26	64
Coal	1,491	1,415	1,406		1,415	4,447	3,234	9,096
Gas	131	126	122		126	144	144	414
Hydro	662	630	603		630	466	740	1,836
Other Fossil	1,076	1,076	1,076		1,076	1,230	1,230	3,536
Solar	366	363	366	255	363	268	426	1,057
Wind	287	287	353	294	287	212	337	836
Total	4,037	3,919	3,949	549	3,919	6,783	6,137	16,839

Table 6. Employment in the electricity-producing sector - Sudan, 2021

Fuel Type	Mean	Geometric Mean	Average	O&M	Direct Jobs	Indirect Jobs	Induced Jobs	Grand Total
Bioenergy	476	442	464		442	327	519	1,288
Gas	56	53	52		53	61	61	175
Hydro	747	711	681		711	526	835	2,072
Other Fossil	2,663	2,663	2,663		2,663	3,043	3,043	8,749
Solar	60	60	60	42	60	44	70	174
Total	4,002	3,929	3,920	42	3,929	4,001	4,528	12,458

Table 7. Employment in the electricity-producing sector - Tunisia, 2022

Fuel Type	Mean	Geometric Mean	Average	O&M	Direct Jobs	Indirect Jobs	Induced Jobs	Grand Total
Gas	867	836	809		836	955	955	2,746
Hydro	35	34	32		34	25	40	99
Solar	86	85	86	60	85	63	100	248
Wind	49	49	60	50	49	36	58	143
Total	1,037	1,004	987	110	1,004	987	110	1,004

Table 8. Expected employment in renewable energy- person-years

	2030			2050
	Direct and Indirect	Energy Efficiency	Total	Net Zero
Egypt	360,020	72,480	432,500	865,000
Jordan	36,956	2,086	39,042	78,084
Lebanon	25,000	5,910	30,910	61,821
Morocco	69,277	5,460	74,737	149,475
Sudan	12,083	1,971	14,054	28,107
Tunisia	18,710	1,469	20,179	40,358
Total	522,046	89,377	611,423	1,222,845

Source: Authors calculations
*Note: *: Estimated independently by IRENA*

Figure 6. Employment impact of renewable energy and efficiency, 2030

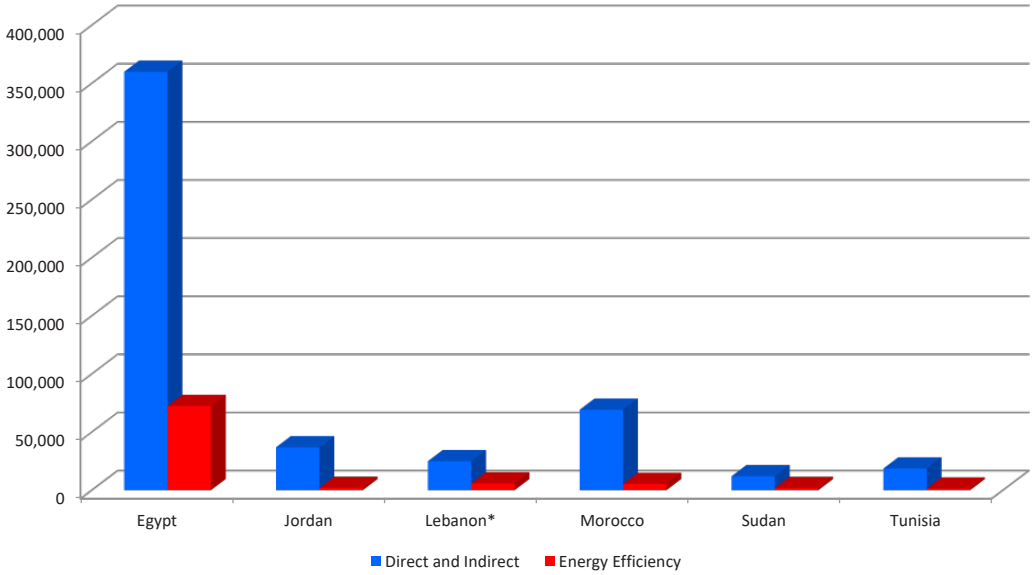
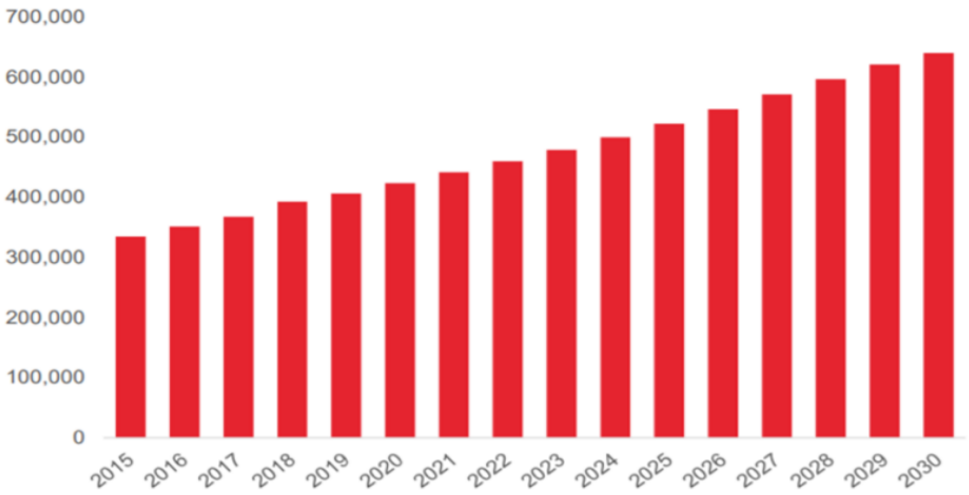


Figure 7. Projected installed generating capacity needs in the MENA region (GW)



unemployment rates characterizing the region. But these estimates pale in comparison to the expected employment generation capacity once we include the great opportunities renewable energy have engendered in the region as it opened the gates for rooting a viable and highly productive electric vehicles in the region. Already Morocco is producing a million EVs, Saudi Arabia has partnered with Lucent industries and is targeting a similar volume, UAE has teamed with a Chinese firm that is producing currently 55,000 vehicles that could ramped up to multiples of this volume and so is Egypt is on the course to produce a large number of EVS for home use and exports. It is not possible to believe that these opportunities could have existed without renewable energy and a determination of the region to realize their NDC commitments.

9. Government, governance, regime imperatives and the political economy of the transition to RE

Oil production, distribution, pricing and exploration involve complex issues of economics but they are by no means wholly determined by the market. Natural resources mainly belong to governments. Decisions concerning the pace of exploration and development and rates of extraction are now assumed by governments in the producing states. Regulation and taxation of the oil industry is a matter of political policy. And a wide margin of fluctuation in the price of oil is brought about principally by political instability and the periodic crisis situations that involved either the threat or actual disruption of supply. The list of these crises is long but familiar: Mosaddeq in 1951, Suez in 1956, Arab-Israeli war of 1967, October war of 1973, the Iranian revolution in 1979, the Iran-Iraq war of 1980-88, the Iraqi invasion of Kuwait in 1990 and more recently the US invasion of Iraq and Israel's genocidal war on Gaza.[232] Hence matters of oil are by no means purely economic questions and to view them in terms only of theoretical and practical economics is to adopt a distorting and misleading perspective; the analysis of oil is more properly a matter of political economy.

How Important is Arab Oil?

Oil, as Daniel Yergin (1991) has chronicled its history, is the prize sought by the great powers and control of the Middle East region has been critical for the relative position of the great powers among themselves.[233] The transition to renewable energy in the region cannot be divorced from the global implication that this transition would entail.

Ali Al-Saffar, Abeer El-Shennawy and Adeel Malik (2024) have prepared a background paper for the IDRC-ERF project on these issues that will be used here to inform the analysis of the political economy of the transition to RE in the MENA region.[234] The MENA region remains an outlier in regards to the high fossil fuels energy intensity, particularly in the prominent oil and gas producing countries of the region. This is attributed by the authors to two prominent and enduring features of the oil and gas-dominated economies of the region: the dominance of the public sector, and the excessive use of fossil fuel subsidies.

The predominance of the public sector in the oil and gas producers has contributed to relative declines in labor productivity over time, which has fallen across all of the region's producer economies since the 1970s (IEA, 2018) in stark contrast to labor productivity growth in non-oil MENA economies (Figure 8).

Oil rents were used to support public sector employment and paying high wages that in most instances far exceeded labor productivity.[235] The gap between average public and private wages in the GCC countries is often between 150% and 250%.[236] This resulted in dampening enterprise growth in the high-productivity activities, and skewed economies towards dependence on high-energy/ high-emissions sectors. Moreover the heavy subsidization of fossil fuels prices that totaled over $2.4 trillion between 2010 and 2020 (Atlantic Council, 2022) has encouraged excess demand for fossil fuels and delayed the development of renewable energy.

The MENA region is characteristically mired in complex political and geopolitical dynamics, including conflicts, super powers rivalry, regional rivalries, regime insecurity, and shifting alliances. These factors have impacted energy transition

[232] Robert Mabro.1990. Political dimensions of the Gulf Crisis" Oxford Institute for Energy. Studies, Gulf and World Oil Issues Series: Paper 1.

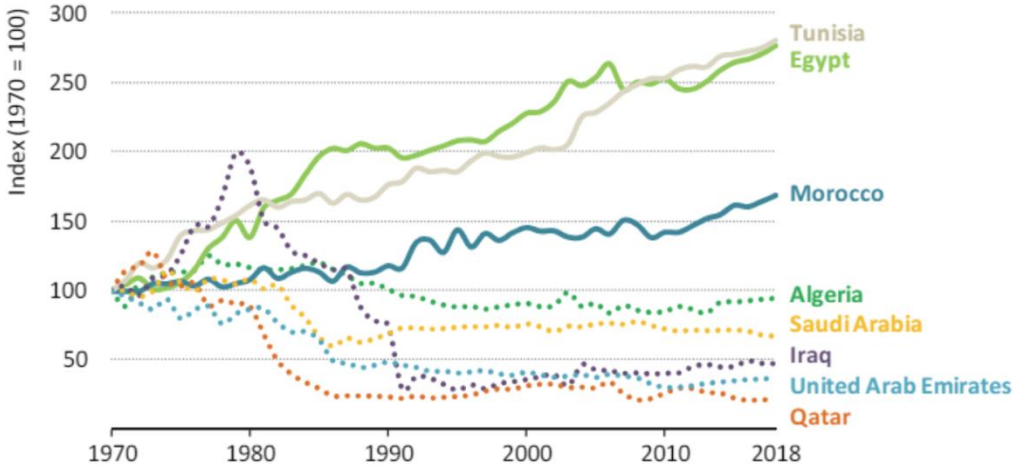
[233] D. Yergin. 1991. The Prize: The Epic Quest for Oil, Money & Power (New York: Simon & Schuster.

[234] Ali Al-Saffar, Abeer El-Shennawy and Adeel Malik. 2023. The Political Economy and Energy Transition in MENA. ERF Publications.

[235] World Bank, 2004, Unlocking the Employment Potential in the Middle East and North Africa: Toward a New Social Contract (World Bank, Washington, DC).

[236] Al-Saffar, et. al., 2024. Ibid.

Figure 8. Labor productivity changes in the MENA region, 1970-2018



Source: Outlook for Producer Economies, IEA, 2018 and The Conference Board Total Economy Database, March 2018.

efforts by affecting investment climates, cross-border cooperation on energy projects, and the stability of energy infrastructure. One overriding dynamic with very serious political economy implications is the dominance of regime durability as a core concern. This dominance affects the prospects for transition to renewable energy which will be inherently viewed through the prism of what the transition might mean for regime survival and stability. The essential question that MENA regimes face is whether energy transition can potentially disrupt the existing status-quo or create new economic opportunities that can be usefully harnessed to maintain economic and therefore, political stability.

Past reforms in the region have often been externally imposed but typically mediated by domestic political considerations. Political regimes tend to pursue these reforms in ways that do not upend the status-quo. "Often, regimes selectively pursue reforms to shield strategic actors and economic arenas from the negative fall-out from reforms." It is common to observe that politically connected sectors are shielded from competition by preserving tariffs, entry restrictions or alternative trade policy instruments in the wake of trade reforms.

Managed and selective liberalization is a routine feature of post-liberalization economic landscape in developing countries, including MENA states (Malik and Eibl, 2019).[237] It is to be expected that MENA regimes will all likely to cherry pick from the transition menu a course that will deliver political mileage -or, at least, is less politically disruptive to the interests of the regime and their allies.

The challenges and opportunities entailed by the energy transition will be perceived by most countries in the region through its anticipated political economy impact. Whether resource-rich or resource-poor, political order in MENA states is overwhelmingly reliant on oil and gas revenues. In the oil-rich MENA states, hydrocarbon exports finance national budgets and sustain social contracts.

In the relatively resource-scarce states, such as Jordan, Lebanon and Egypt, remittances, aid inflows from oil-rich neighbors, exports to these oil rich markets and other support schemes (Saudi Arabia keeps large US dollar deposits at the central banks of Egypt, Jordan and Lebanon to stabilize the exchange value of domestic currencies) and these constitute important state resources that are key to financial—and, therefore, political—stability. "Few other regions in the world exhibit such a tight correspondence between natural resource intensity, economic structures, and political order."

This is why the global energy transition is likely to have a profound impact on the region. The specter of turning fossil fuel assets into stranded assets as the world gradually shifts away from fossil fuels will have profound and destabilizing consequences on future revenue streams of the fossil fuels producers. These revenue streams are primarily captured by the state and have constituted the main public revenue streams. In the GCC countries oil rents contribute a high share of the countries' GDP (over 40%) and this is only the direct share. It is hard to believe that other shares of GDP are not supported by oil revenues. The banking sectors and other service sectors are sustained by the oil rents. The direct and indirect GDP contributions of oil could easily exceed 80%.

[237] A. Malik and Eible. 2019.

A unique characteristic of the GCC region is the bloated public sector employment and the generous public welfare support packages offered by the government. In few countries of the GCC citizens do not pay any taxes, or for electricity, water or communication. These have been referred to as the "authoritarian bargain" where the state provides its citizens with these generous programs in return for political acquiescence and support. Contractions of oil rents if not quickly substituted by other rents could threaten this political stability built on these bargains.[238]

It is interesting to note that the region's capital-surplus nations have pushed for integrating energy transition projects into their ongoing economic diversification efforts, a recognition that their natural solar and wind endowments can serve as a new export node and can gain them a huge financial surplus to replace oil rents. It also points out that this favorable national response shows that the rulers' incentives can generally be aligned with the energy transition to RE. "Several reasons can help to explain this." One is earning brownie points for rulers and bolster their international legitimacy for supporting a global public good; a few GCC regimes have recently championed many climate initiatives such as COP 28, but the real spur is coming from other corners: the realization that their dependence on oil rents has engendered an unproductive and an unsustainable economy and thus for the GCC oil exporters, certain paths of energy transition are well-aligned with the objective of weaning domestic economies away from excessive dependence on oil. Energy transition is therefore not purely a climate agenda but also a crucial ingredient for economic transformation. Besides, being at the helm of the transition gives them a voice and a role in influencing its direction and pace.

10. Conclusions

10.1. A synopsis of the summarized results

The Economic Research Forum and its partners at the Middle East Institute in Washington, D.C., and at the Lebanese Policy Centre in Beirut have assembled a distinguished group of experts and researchers that teamed together to author over 40 country studies focused particularly on six specific countries in the region (Morocco, Tunisia, Egypt, Sudan, Lebanon and Jordan) but also considered several other countries in the GCC region and a few studies focused on the MENA region as a whole. The project also produced over 20 thematic reports and a large number of policy briefs that together constitute a compendium of reference studies on development issues in the region but more specifically on the regional energy landscape and transition plans to renewable energy.

This report represents an attempt to summarize the seminal reports and briefs mentioned above focusing on the MENA region challenges, opportunities, barriers, drivers, MSMEs, strategies and accomplishments of a just transition to renewable energy. We rely heavily on these studies as they have collected large sets of original data using mixed-methods that integrate both quantitative and qualitative data. The researchers used interviews, surveys, focus groups and expert panels to gather insights from MSMEs, industry, entrepreneurs, academic experts, government policy groups, and international organizations' experts in many different sectors and occupations. These insights and methodologies proved valuable in understanding the many different perspectives, motivations, and constraints faced by the countries in the region as well as the great opportunities and benefits that a just transition awaits the region.

The MENA region stands at the threshold of a transformative opportunity to become a global leader in green energy production, exports and investment. Leveraging its abundant renewable resources, large empty deserts, strategic location straddling three continents, major global sovereign wealth funds (SWFs) and international partnerships, the region can drive both its own transition and the global transition to a sustainable and low-carbon energy future while addressing water scarcity and building a more diversified economy.

Blessed with an abundance of solar and wind resources, countries like Egypt, Morocco, Jordan, Lebanon, Tunisia, Saudi Arabia, the United Arab Emirates (UAE) and others have some of the world's highest solar irradiance and wind potentials, providing a robust foundation for green energy production.

Achieving this potential will; however, require substantial investments, robust policy frameworks, political will, tapping into available international funds and financial facilities the recent COPS have organized and a commitment to bolster technological innovation. By embracing green and renewable energy, the MENA region can play a pivotal role in shaping the global energy

[238] D. Acemoglu, and J. A. Robinson. 2001. Inefficient Redistribution. American Political Science Review. 95, 649–661, and Raj. M. Desai, A. Olofsga, and T. M. Yousef. 2009. The Logic of Authoritarian Bargains. Brookings. Washington, D.C.

landscape, creating a new comparative advantage, phasing out its dependence on oil rents, re-basing its economies on productive activities and engendering a more inclusive development strategy and contributing to a more sustainable and environmentally responsible world.

The region; however, also faces significant water scarcity challenges. It is here where green hydrogen assumes its most important rationale: it can be produced through the desalination of seawater by electrolysis, offering the dual benefit of producing hydrogen and fresh water simultaneously.

Unlike other forms of green energy, green hydrogen is easily transported. This is primarily in the form of cost-effective seaborne shipments of green ammonia, which is a promising and versatile carrier for the export of renewable energy. Green hydrogen may also be used directly as a fuel or feedstock for industrial manufacturing processes. In addition, it can provide on-demand, climate-smart power by reversing the electrolysis process in a fuel cell, which generates an electric current by recombining green hydrogen and oxygen back into water.

Recently, potential Arab developers of green hydrogen (Egypt, Morocco, Jordan, Saudi Arabia and the UAE) have successfully formed international partnerships in investment and production, and are already on their way to developing profitable green hydrogen projects.

Collaborations with European countries and Japan, among others, have the potential to attract substantial investments and wider access to export markets. The richly endowed SWFs in the region's oil-exporting countries have substantial funds that could be tapped to support investments in this potentially very profitable sector. Indeed, the Saudi and UAE SWFs already have plans to invest in multiple projects spanning the entire five continents.

The findings of the above mentioned studies revealed a rich and diverse landscape of awareness of trends and opportunities, and a varying and differing levels of engagement and intensity of different policy actors and business agents with renewable energy initiatives. A few MSMEs demonstrated proactive visions and actions; however, many still exhibit limited understanding of possibilities and technologies and a smaller group have implemented or have initiated the drive to sustainable energy practices, indicating a need for targeted educational programs and support mechanisms. The qualitative data gathered by the country studies highlighted a few perspectives on the adoption of renewable energy, with many participants citing financial, regulatory, technological and lack of trained workers or skilled labor to effect change and solidify the transition.

Invariably the participants identified economic, environmental and technological factor as the primary decision drivers, with operation and equipment costs and returns on investment weighing heavily against sustainability goals. In particular, red tape, administrative inefficiencies and lack of political will were consistently cited as barriers to faster innovation and effective adoption of renewable energy. The study's mixed-methods approach, combining survey data, interviews and quantitative econometric methods, underscored the complexity of these challenges and revealed the need for nuanced and specifically tailored solutions to address the many different needs and varying circumstances that address the specific situations in the different countries of the region, the different groups' experiences, expertise, preferences, and the different endowments, barriers, enablers and constraints they have faced and will face over time as they embark on a just transition to renewable energy.

Sector-specific strategies emerged as a clear recommendation from the study experts. Different industries face unique constraints, and a one-size-fits-all approach is not only insufficient, it is not appropriate or feasible. Financial resources, skills requirements and technological barriers remain significant, with many MSMEs lacking access to adequate financing, modern energy technologies and the requisite skills. The research methodology, which combined triangulated survey responses with in-depth interviews and sophisticated econometric techniques, confirmed the need for more robust financial support systems, accommodating policies, eliminating red tape, streamlining objectives and directives and building the appropriate technological infrastructure are critically needed in order to enable a successful transition.

Without exception, a consensus emerged about the importance of government smart interventions and sufficient financial resources and inducements. Both the qualitative and the quantitative studies highlighted the role of effective policies, simplified regulatory frameworks, administrative streamlining and economic incentives and support as critical factors to accelerating the transition. The centrality of the role of government

in spurring, guiding and financing the adoption of renewable energy was a common theme of the majority of the country studies.

The research results suggest that targeted and flexible approaches to transition to renewable and green energy necessitate the reliance on MSMEs as the most efficient and effective agents of change that can be relied upon to lead and govern the transition. Perhaps the most relevant part of these studies is the practical, structured, smart and rich set of detailed recommendations advanced by the researchers, the experts and stakeholders interviewed that will be summarized in the next section.

10.2. Recommendations[239]

Building on the findings from the previous sections on perceptions, barriers, and opportunities in the MENA region energy transition, this section presents a summary of the structured set of recommendations. These recommendations constitute a set of workable measures gleaned from the experiences of many countries but particularly the successful Southeastern Asian tigers.

10.2.1. Improve government policies, strategies, governance and planning

Flexible, accountable, strategic and transparent government policies are the cornerstones of MENA's successful energy transition. The recommendations offered highlight the need for a multifaceted approach to policy reform, emphasizing accountability, transparency, regulatory adaptation, and a commitment to aligning MENA's energy goals with global sustainability imperatives.

Adopt accountable and transparent policies: To build trust and drive change, MENA governments must adopt transparent policies that hold government entities accountable for their environmental impact, ensuring that sustainability is not just a business goal, but a national priority.

Tailor industry-specific solutions: A one-size-fits-all approach to renewable energy policy is ineffective in addressing the diverse needs of Tunisia's industries. Different sectors face unique challenges, from technological requirements to financial constraints, and government policies need to be adaptable to these realities.

Clarify the energy transition vision: Tunisia needs to articulate a clear, long-term vision for its energy future that is consistent with national and international climate commitments. MENA's energy roadmap should include specific targets for reducing carbon emissions, increasing renewable energy capacity, and improving energy efficiency. It should also detail the pathways through which these goals will be achieved, integrating short-, medium-, and long-term targets that provide benchmarks for success.

Encourage competition in the energy market: A competitive energy market would encourage private sector investment, driving down costs and spurring the development of innovative renewable technologies. Regulatory reforms that open the market to new entrants, particularly renewable energy, would diversify energy sources, improve grid resilience, and ultimately benefit consumers through lower prices and more reliable service.

Encourage cooperation among MSMEs by forming clusters of firms in the energy market: MSMEs are often too small to adopt and develop innovative solutions and technologies. Even a country like Canada found out that the preponderance of small enterprise has militated against growth in productivity and failed to adopt the most effective technologies that could spur productivity growth. Southeast Asian tigers opted to promote productive cooperation among their enterprises.

When market failures are rampant, individual pursuit of self-interest does not lead to public good. The government must step in to reconcile private interest with the public good. The East Asian countries recognized early on that firms have better information about investment than they do, but that this information base can be expanded and improved. Japan, for instance, developed formal and informal business councils that brought business and government together. These functioned well because they were long term and depended on developing sustainable relations and reputation that raised the long term returns on cooperation over the short term gains from pursuing self-interest. Few tried to cheat and free ride knowing that they could be ostracized. Many cite cultural factors here as the main reason for the success of the cooperative effort. This Stiglitz argues that it is not true because many countries with similar cultures to Japan have not

[239] This section draws heavily on the paper of Adel Ben Youssef, Mounir Dahmani and Walid Hadhri. 2024. Under Which Conditions Tunisian MSMEs Can Shift to a Successful Energy Transition? ERF Publications.

been equally successful.[240] The government rewarded honesty and punished dishonesty. Cooperation created rents that the government appropriated and distributed as rewards to cooperative behavior and reduced bankruptcies giving businesses long-term security. Restricting credit raised the value of credit to those who could access it. The stability of the political system gave more value to long term associations and to reputation and the effectiveness of incentives. The "recession cartels" that the government created during recessions to avoid the problem of excess capacity in capital-intensive industries, are excellent examples of using cooperation to deal with difficult problems where individual action could produce disastrous outcomes for all. We need now 'renewable energy cartels' that work together to share information, to develop joint clean technologies, to avoid harmful competition, and to harmonize efforts to safeguard the sustainability of life on this planet.

The labor and capital markets provide other examples of the importance of cooperation. Long term employment prospects and bonuses created the necessary cooperative framework that allowed workers to feel as if they were co-owners of the enterprise, which reduced shirking and monitoring costs. Besides, basing wages on group performance instead of individual performance allowed each worker to monitor his or her peers and signaled the importance of cooperative behavior. When workers feel that their interests coincide with those of owners, they are not likely to resist long-term productivity innovations that raise profits or even those that involve labor-saving techniques. This is crucial in the case of renewable energy adoption as the rewards may not be immediate or individualized.

The fact that banks were allowed to own shares of industries encouraged their involvement in the affairs of these firms when they faced trouble. This reduced the risks inherent in credit financing and created a coincidence of interest between lenders and borrowers. The lessons here for MRNA countries undergoing a risky transition cannot be exaggerated.

Streamline access to subsidies for energy transformation projects: Simplifying these processes would encourage wider participation by businesses and individuals in the energy transition. Focus should be on improving transparency in the allocation of funds, eliminating red tape and ensuring that subsidies are effectively targeted to maximize their impact.

[240] J. Stiglitz.1996. Some Lessons from the East Asian Miracle. The World Bank Research Observer, August, Vol. 11(2):PP.151-74.

Implement existing energy policies: Ensuring continuity in policy implementation while adapting these plans to the evolving energy landscape will help the MENA region to stay on track to meet its renewable energy goals.

Expand access to energy technologies: Ensuring that advanced energy technologies are accessible to all sectors of society, especially MSMEs, is essential for an inclusive energy transition. Government initiatives should focus on reducing the capital cost of these technologies, particularly at the initial stages of the transition by providing financial incentives for adoption, and supporting research and development to drive innovation.

Digitize administrative processes: Digitizing energy-related administrative processes would significantly increase efficiency and reduce the time and cost of project approval and implementation.

Stabilize the energy policy framework: A predictable policy environment is critical to attracting investment in renewable energy. Clear, consistent policies give investors the confidence they need to commit to long-term projects.

Encourage private sector participation: The private sector plays a critical role in driving innovation and investment in the energy transition. Encouraging greater private sector participation, particularly through public-private partnerships (PPPs), can help accelerate the development of renewable energy infrastructure.

10.2.2. Tailoring strategies to sector-specific needs

Achieving an effective energy transition in the MENA region requires a nuanced approach that considers the specific needs of different sectors and countries: Each sector, whether in agriculture, manufacturing, or services, faces different barriers to the adoption of renewable energy technologies. A tailored approach is needed to ensure that the transition to sustainable energy practices meets the special needs of each sector in the short and long terms. The same is true for the different countries in the region; they face different challenges and have different capabilities and resources. The rich oil countries worried about their fossil fuel wealth may become stranded assets can adopt different strategies than the oil importing countries of the region. They can re-purpose their oil and gas wealth towards non-energy burning uses such as fertilizers, pharmaceuticals, plastics, etc. They can invest

in carbon capture technologies and reprocess carbon for beneficial uses

Improving access to finance for MSMEs: The energy transition requires significant investments, and access to finance is especially challenging for many MSMEs, particularly in the non-oil exporting countries of the region. Public-private partnerships, green investment mechanisms, green banks and green bonds are essential to provide the financial support needed for energy transition projects. Equally relevant and necessary are collaborative effort between government and the private sector to create financial instruments specifically designed for MSMEs. In many cases, small businesses have difficulty accessing traditional loans, which are often designed for larger businesses with more collateral. By creating innovative financing options, such as low-interest loans or green bonds tailored to smaller businesses, MENA countries can facilitate broader participation in the energy transition.

Align the banking sector with energy financing needs: The financial sector must evolve to support the unique needs of energy projects. A responsive banking system designed to meet the financing needs of renewable energy investments is essential to facilitating the energy transition by developing specialized financial products, such as green bonds and low interest renewable energy loans. These products can provide the initial capital needed for developing clean energy projects.

Promote regional cooperation and facilitate the involvement regional SWF in financing regional renewable energy projects: The MENA region is home to some of wealthiest global SWFs. These can finance and profit from the region's endowments of solar, wind and green hydrogen potential. The new projects renewable energy projects in Egypt, Morocco and Jordan are very promising and have already attracted the attention of many countries across the globe; they offer lucrative vents for the Arab SWFs surpluses.

Take advantage of international environmental financial facilities and carbon prices: Damage and loss provisions and facilities that rich polluting countries have pledged to support countries in the global south that are most vulnerable to the damages of climate change should be accessed by the MENA countries that are most exposed to the expected losses of climate change, particularly the damages caused by SLR (Egypt, Tunisia, Lebanon, Syria, Morocco, Libya, Algeria and Morocco).Another source of funding can be tapped relates to the carbon offsets the region can offer polluting countries, but this requires setting up carbon prices and natural protective areas.

Encourage renewable energy companies: Developing proactive industrial policies that support and promote renewable energy companies through targeted incentives, protection, including tax benefits and favourable status, will pay handsome dividends given the precipitous declines in the capital and operational costs of renewable energy. This type of policy framework has already been used successfully in countries such as Morocco, where favourable policies have led to significant investment in solar energy projects.

Promoting energy efficiency and technological innovation: The transition to energy-efficient buildings and industrial processes has been identified as critical components of the energy system transformation. This transformation requires both technological advances and sector-specific approaches. By adopting innovative technologies such as energy-efficient insulation, smart grid systems, and renewable energy sources such as solar panels, wind turbines and green ammonia, industries and households can significantly reduce their energy consumption. Promoting energy-efficient buildings, combined with incentives for industry to adopt these technologies, will lead to long-term energy savings, competitive cost advantages and reduced environmental impact.

Streamline certification of new technologies: The ability to quickly certify and approve new energy technologies is essential to fostering innovation. A streamlined certification process will encourage the adoption of advanced technologies, particularly those provided by investors and innovators.

Integrate renewable energy into industrial processes: Modifying industrial processes to incorporate renewable energy is a key strategy for improving energy efficiency in the MENA region. This integration requires both financial incentives and technological support to help industries make the transition without disrupting their operations. MENA countries can look to China Scaffolding approach discussed earlier, where renewable energy has been successfully integrated into manufacturing processes, leading to significant reductions in emissions.

Collaborating with international renewable energy companies and experts: MENA countries should form partnerships with global renewable energy industries and specialists. This will be needed for acquiring knowledge and technical expertise as well as access to international markets.

Addressing the needs of the informal economy: The large informal economy, in most of the MENA countries, calls for targeting the integration of the informal economy

into the energy transition.[241] This integration would ensure that all segments of society can benefit from the transition to renewable energy. Many informal businesses operate without access to reliable energy sources, making it difficult for them to adopt renewable energy technologies.

Support workforce development and skills training: A comprehensive skills development strategy is essential to prepare the region's workforce for the demands of the renewable energy sector. Tailored vocational training programs can help workers acquire the technical skills needed to install, maintain and operate renewable energy systems. This focus on skills training is particularly important for marginalized groups, such as women and youth, who are underrepresented in the energy sector.

Establish a business feedback mechanism: Developing a feedback mechanism that allows businesses to report their experiences with the administrative system is critical for continuous improvement. One business consultant emphasized that "a feedback mechanism is essential for the continuous refinement of administrative processes in the energy sector". Such a mechanism would allow the government to identify and address recurring bottlenecks and inefficiencies in a timely manner, ensuring that the administrative system evolves to meet the needs of the energy transition.

Periodic review of energy regulations: Regular review and updating of energy regulations is necessary to keep pace with technological advances and evolving market dynamics. Regulations that may have been appropriate in the past can quickly become outdated as new energy solutions emerge. Regular review of these regulations will ensure that they remain relevant and supportive of the energy transition.

10.2.3. Promoting awareness and educational initiatives

Public awareness, education, community engagement and media campaigns play key roles in advancing MENA countries' energy transition. These elements were identified as fundamental to fostering a deep-rooted understanding of renewable energy practices and ensuring the participation of different segments of society in the transition to sustainable energy. Effective awareness and education efforts are critical to creating a supportive environment that enables the countries in the region to achieve their sustainability goals.

Increase public awareness and education: The energy transition cannot be achieved without broad public support and understanding. These efforts should target not only businesses, but also households, educational institutions, and civil society organizations. Developing education and awareness initiatives will help build a society that is more open to adopting sustainable energy practices. This approach has been effective in countries such as Sweden, where public awareness initiatives have contributed to the widespread adoption of renewable energy

Strengthen communication efforts: Improving communication about the energy transition and its benefits is critical to ensuring public support and active participation. Clear, accessible information that explains the social, economic, and environmental benefits of the transition to renewable energy is essential to raise awareness among citizens, businesses, and policymakers.

Integrate renewable energy education into schools: Incorporating renewable energy education into early school curricula is a long-term strategy to instill the values and importance of sustainability in future generations. By teaching young students about the benefits of renewable energy, energy conservation, and environmental stewardship, the MENA region can build a generation of citizens well versed in sustainable practices.

Raise public awareness of environmental issues: Public awareness of environmental and energy challenges must be an ongoing effort to foster societal acceptance of sustainable practices. Initiatives to educate the public about the environmental impacts of fossil fuel dependence and the need to adopt renewable energy are essential to building a societal ethos that values sustainability. This strategy aims to make sustainability a core component of public awareness.

Launch targeted education and awareness campaigns: Tailored campaigns designed to reach different segments of society are essential to increase understanding of renewable energy and the benefits of the energy transition. These campaigns should target different stakeholders, including businesses, policymakers and the general public, but particularly youth, students and women in order to ensure that each group is well informed and actively engaged in supporting sustainable energy practices. Such campaigns are critical to building broad support across sectors.

[241] In the MENA region, informality is pervasive, representing an estimated 64.9% of total employment in 2022 (ILO (2023), "New standards, increased visibility: improving measurement of the informal economy", ILOSTAT, https://ilostat.ilo.org/new-standards-increased-visibility-improvingmeasurement-of-the-informal-economy/.) and a GDP share of 20% or more in 2020 (Elgin, C. et al. (2021), "DP16497 Understanding Informality", CEPR Discussion Paper, No. 16497, CEPR Press, Paris & London, https://cepr.org/publications/dp16497).

Build media partnerships to raise public awareness: Media partnerships are strategic in the attempt to reach a broad audience and disseminate information about renewable energy initiatives. Working with television, radio, online platforms, social media, and print media ensures that messages about the benefits of the energy transition reach all corners of society.

Business-focused awareness programs: The business sector has a critical role to play in advancing the energy transition, and business-focused awareness programs are essential to encourage their participation. These initiatives should focus on educating business leaders about the economic benefits of renewable energy, such as cost savings, efficiency gains, and profits to be derived on improved market competitiveness.

Inform about support mechanisms: Educating stakeholders about the range of support mechanisms available, including subsidies, incentives, low interest loans and technical assistance, is critical to ensuring that businesses and individuals have access to the resources they need to make the transition to renewable energy.

Training the Trainers: When educational resources are limited, an effective way of reaching the widest circles of trainees would be to train a select few with the right qualifications and skills and these can be relied upon to train others in ever expanding circles of trainers.

Promoting diverse solutions: Promoting a diverse range of renewable energy technologies and solutions is necessary to meet the varying energy needs of different regions and sectors. Flexibility in the choice of technologies, from solar and wind to energy efficiency improvements, will ensure that MENA countries' energy transition is inclusive and adaptable.

Incentivize clean energy adoption: Educating businesses about the incentives and benefits of adopting clean energy is a critical strategy for encouraging broader participation in the energy transition. By demonstrating both financial savings and environmental benefits, businesses will be more motivated to invest in sustainable energy solutions.

Launch targeted business campaigns: Organizing targeted campaigns to educate businesses about the practicalities of the energy transition, including funding opportunities, technology solutions, and best practices, is critical to their active engagement.

Foster community involvement in renewable energy projects: Community engagement is essential to building grassroots support for renewable energy projects. Initiatives that involve local communities in energy projects, such as educational workshops, community energy cooperatives, and participatory decision-making processes, can build trust and local buy-ins.

Promoting corporate sustainability practices: Corporate training programs focused on sustainability and energy efficiency practices are important to ensure that enterprises adopt greener operating models. These programs should provide practical guidance on how to reduce energy consumption and incorporate renewable energy solutions.

Strengthen youth leadership in sustainability: Engaging youth in leadership initiatives related to energy and environmental stewardship is essential to building future leaders committed to sustainability. Youth forums, innovation contests, and leadership programs can inspire a new generation of sustainability advocates.

Partner with academic institutions: Collaboration between the energy sector and academic institutions can advance both renewable energy research and education. Academic programs focused on renewable energy technologies and systems of innovative solutions are critical to building a skilled workforce capable of leading the energy transition. Synergy between the energy sector and academic institutions is critical to fostering innovation and advancing knowledge in renewable energy.

10.2.4. Integrating the informal sector in the energy transition

Given the large share of the informal economy in the economies of most countries in the MENA region and the significant role they play in employing large proportions of the populations that operate outside formal regulatory frameworks, suggests that it is critical for the success of the transition to renewable energy to effectively integrate the informal sector into the region's energy transition. This requires a multifaceted approach that combines financial incentives, capacity-building initiatives, and streamlining the regulatory processes.

Tailored financial incentives for informal businesses: To facilitate the adoption of renewable energy and energy efficiency measures, tailored financial incentives should be designed specifically for informal enterprises. Microfinance options, low-interest loans, and grant programs could enable small informal enterprises to invest in renewable technologies such as solar power or energy-efficient appliances. By reducing the initial financial barriers, these programs can help informal businesses transition to cleaner energy solutions, thereby

reducing their carbon footprint and operating costs. For example, informal markets and workshops could benefit from solar panels and energy-efficient lighting, leading to lower electricity bills and more sustainable practices.

Providing tax incentives for businesses that transition to formal status and adopt sustainable energy practices is another effective recommendation. Simplifying the business formalization process, such as reducing the complexity of registration and compliance requirements, can encourage informal businesses to become part of the formal economy. Once formalized, these businesses can access government subsidies and financial support to promote the use of renewable energy.

Capacity building initiatives and energy literacy: Capacity building initiatives are critical to ease the informal sector transition to renewable energy and energy conservation. Energy literacy programs, workshops, and awareness campaigns should be designed to target informal workers and business owners. These initiatives can focus on communicating the practical benefits of adopting renewable energy technologies, including cost savings, reduced dependence on grid electricity, and increased business resilience. This decentralized approach can facilitate widespread dissemination of knowledge and foster a greater understanding of the economic and environmental benefits of renewable energy.

Monitoring and evaluation framework: To ensure the effectiveness of initiatives targeting the informal sector, the government should establish a comprehensive monitoring and evaluation framework. This system would track the adoption rates of renewable energy technologies, energy efficiency measures, and the formalization of informal enterprises.

10.2.5. Policy roadmap for the MENA region's transition to renewable energy

The research findings are used to propose a suite of recommendations that will inform and guide the region's effort towards a just and inclusive transition to clean and renewable energy as part of a social project to clean the regional environment and help re-base the economies of MENA on solid, productive and diversified activities that are sustainable and inclusive.

The study proposed a policy roadmap to guide the region's energy transition, with a particular focus on ensuring the active participation of the informal sector, the private sector and particularly the MSMEs in this critical and unique transition. This roadmap has outlined some key milestones, policy interventions, stakeholder responsibilities, and concrete measures that sought to provide a clear path for achieving regional and national renewable energy targets. By including the informal economy in this framework, and by emphasizing the targeting of the empowerment of women and the youth of the region, this road map could be relied upon to promote an inclusive and just transition that benefits all segments of society.

In a nutshell the roadmap prioritizes reducing regulatory and financial barriers faced by MSMEs, providing targeted support to informal businesses, developing public-private partnerships and cooperative clusters of firms to facilitate the adoption of renewable energy technologies across sectors. It also focused on raising public awareness, improving energy literacy, energy efficiency and building a supportive ecosystem for businesses to transition to clean energy solutions.

The regional and international cooperative initiatives envisaged in this social transformative project are developed with the objective to realize the region's transition targets and to set an example for other regions to follow. The MENA region is poised to become a leader in green energy and sustainable development and propel the world to a better and sustainable energy future.

Appendix A: The Quantile Regression Model

The quantile regression model is given by:[242]

$$y_i = \beta'_q X_i + \varepsilon_{qi} \quad (1)$$

Where y is the dependent variable, X is the vector of explanatory variables, β is the vector of parameters and ε is the error term. The dependent variable is a binary variable that takes the value of 1 if the firm considered using RE in its business and zero if not. The main explanatory variables of interest included a rich array of factors such as female ownership, share of youth in firm's labor force, awareness of RE, access to information about backup technology, insertion in Global Value Chains (GVC) measured by engagement in two-way trade, certification and affordability of RE. A second set of explanatory variables were used to capture the different characteristics of firm managers including age, education and experience. A third set of explanatory variables included access to credit, ICT measured by whether the firm has access to internet and the role of government incentives and policies. They also controlled for a variety of firm characteristics including location (urban/rural), ownership (foreign/domestic), formality, share of skilled workers in the firm's labor force, age and size measured by number of employees.

The conditional quantile minimizes the following objective function:

$$\frac{1}{n}\sum_{i=0}^{n} f_q(\varepsilon_{qi}) \quad (2)$$

Where n is the number of firms in the sample (sample size) and $f_\delta(\varepsilon_{\delta i})$ is given by:

$$f_q(\varepsilon_{qi}) = \begin{cases} (1-q)\varepsilon_{qi} & if\ \varepsilon_{qi} < 0 \\ q\varepsilon_{qi} & otherwise \end{cases} \quad (3)$$

The minimization problem (2) becomes:

$$\frac{1}{n}\Big[\sum_{q=0}^{n}(1-q)\left|y_i - \beta'_q X_i\right| I_{y_i<\beta'_\delta X_i} + \sum_{q=0}^{n} q\left|y_i - \beta'_q X_i\right|(1 - I_{y_i<\beta'_q X_i}) \quad (4)$$

Where $I_{y_i<\beta'_q X_i}$ an indicator that is a function equal to one if $y_i < \beta'_q X_i$ and zero otherwise.

All firms at different quantiles will be covered by increasing continuously from 0 to 1.

[242] This section is taken verbatim from Abeer Elshennawy and Mohammed Bouaddi (2023).

About the Author

Atif Kubursi is a Professor Emeritus of Economics at McMaster University. He is also President of Econometric Research Limited. In 1982, he joined the United Nations Industrial Organization as Senior Development Officer. Since then he worked as a team leader of several UNIDO missions to Indonesia, Thailand, Saudi Arabia, Kuwait, Sudan, and Egypt. In 2006, he was appointed as the Acting Executive Secretary of the United Nations Economic and Social Commission for Western Asia (UN-ESCWA). He has published extensively in the areas of macroeconomics, economic development strategies, international trade, Ecological economics, impact analysis and regional planning with special emphasis on the environment, tourism and industrial development. He has frequently lectured on globalization issues, economic development, oil and industrialization, impact of tourism on provincial and local economies, political economy of development, Arab affairs and on environment-economy linkages. He has published 13 books and over 300 journal articles and technical reports. Dr. Kubursi also taught economics at Purdue University in Indiana, USA, was a senior visiting scholar at Cambridge University, UK., and lectured and consulted at Harvard University.

ERF at a Glance: *The Economic Research Forum (ERF) is a regional network dedicated to promoting high-quality economic research for sustainable development in the Arab countries, Iran and Turkey. Established in 1993, ERF's core objectives are to build a strong research capacity in the region; to encourage the production of independent, high-quality research; and to disseminate research output to a wide and diverse audience. To achieve these objectives, ERF's portfolio of activities includes managing carefully selected regional research initiatives; providing training and mentoring to junior researchers; and disseminating the research findings through seminars, conferences and a variety of publications. The network is headquartered in Egypt but its affiliates come primarily from different countries in the region.*

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