ECONOMIC RESEARCH FORUM

Egypt Qualitative Report

Accelerating the Energy Transition in Egypt

An In-depth Analysis of the Adoption of Renewable Energy Among Micro, Small, and Medium Enterprises (MSMEs) for Development

Rasha Hassan

Country Qualitative Reports provide a deeper look into qualitative analysis and narrative of the qualitative survey conducted under the project. To complement the quantitative findings, the project team conducted qualitative surveys, including in-depth interviews with experts and relevant stakeholders, alongside focus group discussions specifically with MSMEs. These qualitative reports offer insights into local challenges, sustainable practices, and employment opportunities, emphasizing inclusivity and gender equity. The qualitative data reports for Egypt, Jordan, Tunisia and Sudan provide a focused perspective on the contributions of MSMEs to an equitable clean energy transition across the MENA region.

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By: Rasha Hassan

Keywords: Renewable energy, MSMEs, Gender and skills.

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1- Introduction

In Egypt, the annual increase in energy usage ranges from 6.5% to 10%. However, the country's heavy reliance on depleted gas reserves and other traditional energy sources, exacerbated by rapid population growth and economic expansion, poses a significant threat to Egypt's energy sustainability. Consequently, there is a pressing need for Egypt to address its carbon emissions. Despite Egypt's abundant wind and solar resources, tapping into RE presents a promising avenue for mitigating these challenges. Moreover, the lack of electricity access in rural and remote areas further underscores the urgency of transitioning to RE, not only as a means to address energy scarcity but also as a catalyst for economic empowerment. Against this backdrop, Egypt has set ambitious targets to transition to RE, aiming to achieve 20% of total energy capacity from renewable sources by 2022 and 42% by 2035 (NREA, 2023).

This study, conducted as part of the IDRC-funded ERF NPIO project, seeks to provide a comprehensive understanding of Egypt's energy transition landscape. Specifically, the study focuses on formulating evidence-based strategic policies to promote sustainability, efficiency, equity, and resilience in the energy sector. It involves an in-depth analysis of existing regulatory and policy frameworks to assess their impact on RE adoption and recommend policy enhancements where necessary. Additionally, the study explores concepts of energy equity and security, investigating their interplay with the objectives of the energy transition. The role of Micro, Small, and Medium-sized Enterprises (MSMEs) as drivers of the transition is examined, along with the challenges they encounter in adopting RE sources.

Furthermore, the study aims to evaluate how the transition to clean energy affects the performance of MSMEs and identify both incentives and barriers to their adoption of RE. It is also analyzing the impact of MSMEs' transition to clean energy on employment generation, particularly among women and youth, providing valuable insights for informed decision-making and policy development.

To achieve these objectives, the study employed a qualitative approach, conducting an in-depth analysis of current policies related to RE adoption. Special attention was given to understanding the perspectives and experiences of policymakers and entrepreneurs regarding the transition to RE usage, as well as identifying the reasons behind the reluctance of some business owners to make the transition.

1.1 Renewable Energy Policies and Regulations in Egypt

The Egyptian government's attention to the necessity of integrating RE sources began in the late 1970s. Decision No. 1093 was issued in 1979, establishing the Supreme Council of Energy, tasked with developing Egypt's energy strategy and general plan from 1980 to 1990. Subsequently, in 1986, Law No. 102 established the New and Renewable Energy Authority (NREA), aimed at fostering the use of RE and promoting the local manufacturing of related equipment (ESCWA,2019).

In 2011, the Supreme Council of Energy (SCE) issued Decision No. 3/11/5/12, exempting components and spare parts of RE systems from customs duties and sales tax for government projects. Additionally, the Renewable Energy Support Fund (RESF) was established on May 16, 2011. Also, Cabinet Decision No. 20/06/12/11 of 2012 was issued, approving the financing of the RESF with the equivalent fuel savings for energy-intensive industries (ESCWA,2019). In January 2013, the Egyptian Government initiated the development of a new 20-year strategy known as the Integrated Sustainable Energy Strategy (ISES) spanning the period from 2015 to 2035. Subsequently, in October 2016, the SEC agreed to new energy strategy for Egypt, aligned with the Total Arab Resource Energy Strategy (TARES) approved in 2016. (NREA, 2023).

Starting in early 2014, the Egyptian government aimed to transition towards implementing a green economy in response to the provisions of the 2014 Egyptian Constitution, particularly Article 32. This mandated the State's commitment to optimizing RE sources, promoting investment in them, and encouraging related scientific research. Additionally, it emphasized efforts to enhance manufacturing processes and increase their value added based on economic feasibility.

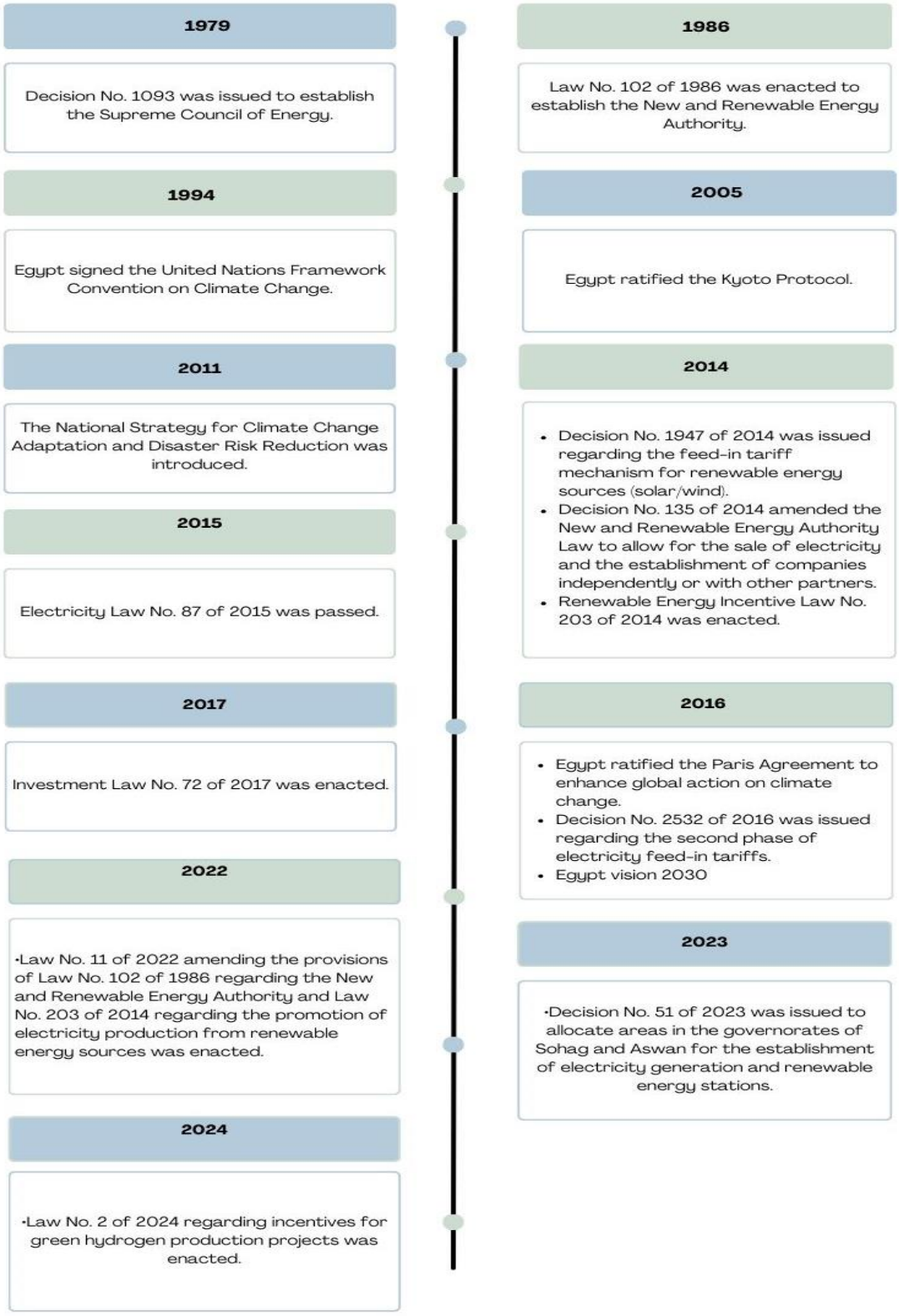
Consequently, the Ministry of Electricity and Energy was renamed the Ministry of Electricity and Renewable Energy (MERE), pursuant to Decision No. 135 of 2014. In line with the aim of fostering a conducive environment for the utilization of RE, the government approved a Feed-in Tariff (FIT) scheme on 17 September 2014. This scheme aimed to stimulate investment in electricity generation from renewable sources, specifically wind and solar energy, by actively involving the private sector in market development (IRENA, 2018). By the end of 2014, RE Law No. 203 was enacted to create a supportive environment for attracting investment in RE. This allowed for the development of RE projects through competitive tenders, electricity feed-in tariffs, power purchase agreements, and projects developed by the NREA. In 2015, Electricity Law No.

87 was issued, granting permits and licenses for various electricity projects, including RE sources. It also included regulations for selling electricity from these sources and utilizing transmission and distribution networks.

Subsequently, in 2016, the second phase of the feed-in tariff for energy produced from renewable sources was issued, following a review of the advantages and disadvantages of the initial phase, and the establishment of a feed-in tariff unit at the Egyptian Electricity Transmission Company (EETC) to facilitate related investment procedures. In 2017, Investment Law No. 72 was issued to complemented the RE Law by offering financial incentives for RE investment. These incentives included tax exemptions for new investments in RE for a specified period. In October 2019, the feed-in tariff for electricity from biomass projects was introduced. (NREA, 2023).

Aligned with previous legislation and policies, the modified version of Egypt's Vision 2030 (MOPED, 2016) emphasized the importance of transitioning to RE across all sectors to achieve natural resource security and promote equitable resource utilization. This necessitated providing financing through incentive policies directed towards private sector investment and production. Support for the private sector in the RE sector continues, aiming at developing production and exports based on green and circular economy principles. This includes enhancing infrastructure to meet all energy needs and increasing reliance on RE sources. Measures include grid capacity enhancement, monitoring energy storage technology, promoting small-scale RE in various sectors, incentivizing private sector participation in RE projects, and deploying energy efficiency technology to reduce consumption. Finally, at the beginning of 2024, Law No. 2 was issued regarding incentives for green hydrogen production projects. This law offers various tax incentives, including the "Green Hydrogen Incentive," aimed at promoting investment in green hydrogen production projects and expansions.

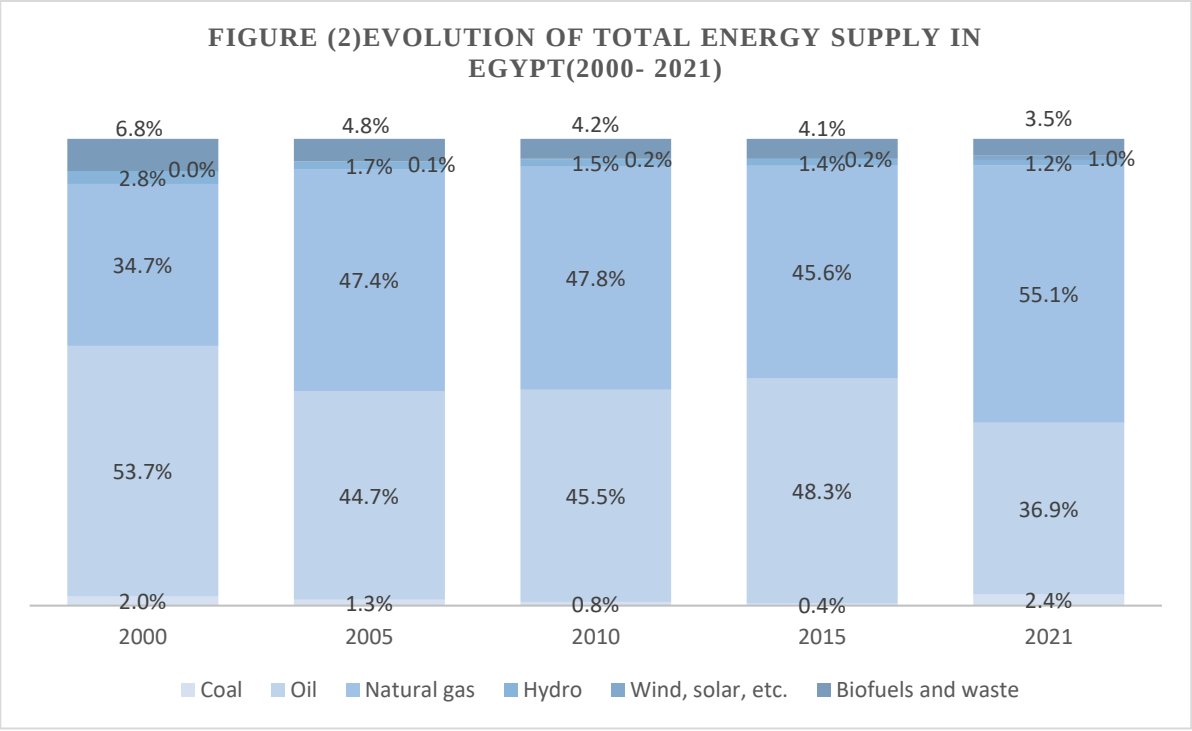
Figure 1: Renewable Energy Policies and Regulations in Egypt (1979-2024)



- *Developed by the author*

1.2 The Evolution of Egypt's Renewable Energy Landscape

The Egyptian energy sector plays a pivotal role in driving the socio-economic development of Egypt, representing around 13% of current GDP. Hence, the economic growth of Egypt heavily relies on the security and stability of its energy supply. An analysis based on International Energy Agency data (IEA), Figure 2, shows significant shifts within Egypt's energy sector over the past two decades, indicating notable changes in the percentage contributions of various energy sources. Of significant note is the substantial increase in the percentage contribution of natural gas, rising from 34.7% in 2000 to 55.1% in 2021. This remarkable growth underscores Egypt's strategic focus on harnessing its abundant natural gas resources to meet escalating energy demands and drive economic development. Conversely, the contribution of oil to Egypt's energy supply has declined over the years, ranging from 53.7% in 2000 to 36.9% in 2021. Additionally, coal energy consistently represents the smallest percentage contribution across the years, reflecting efforts to shift away from traditional fossil fuels toward more sustainable RE alternatives.



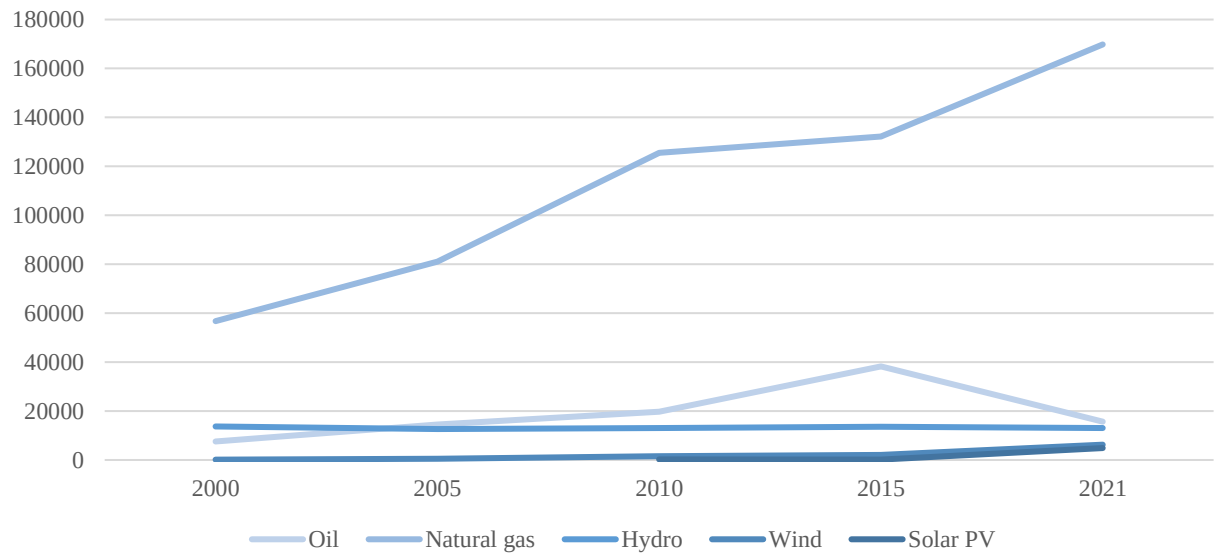
Source: https://www.iea.org/countries/egypt/energy-mix#what-is-the-role-of-energy-transformation-in-egypt

RE sources, including hydro, wind, solar, as well as biofuels and waste, have experienced a gradual but consistent rise in their percentage contributions. Despite starting from modest levels, these sources have shown promising growth, reaching a combined highest percentage of 5.7% in 2021. Although biofuels and waste have maintained a notable share in Egypt's energy mix, contributing

between 3.5% to 6.8% across the years, they continue to play a crucial role in Egypt's energy strategy, bolstering energy security and promoting environmental sustainability.

Egypt is working towards cultivating a more diversified and sustainable energy portfolio, placing notable emphasis on RE sources. Continuous investments in RE infrastructure and the implementation of supportive policies are pivotal for propelling Egypt's energy transition agenda forward, bolstering energy security, and attaining its sustainable development objectives. Additionally, as depicted in Figure (3), there has been a remarkable surge in electricity generation from wind and solar photovoltaic (PV) sources. Wind power generation has experienced exponential growth, soaring from a mere 137 GWH in 2000 to 6,251 GWH in 2021, indicating substantial investments in wind energy infrastructure. Similarly, solar PV generation has emerged as a significant contributor to electricity production, escalating from 206 GWH in 2010 to 4,875 GWH in 2021, reflecting the increasing adoption of solar technologies and favorable government policies supporting RE.

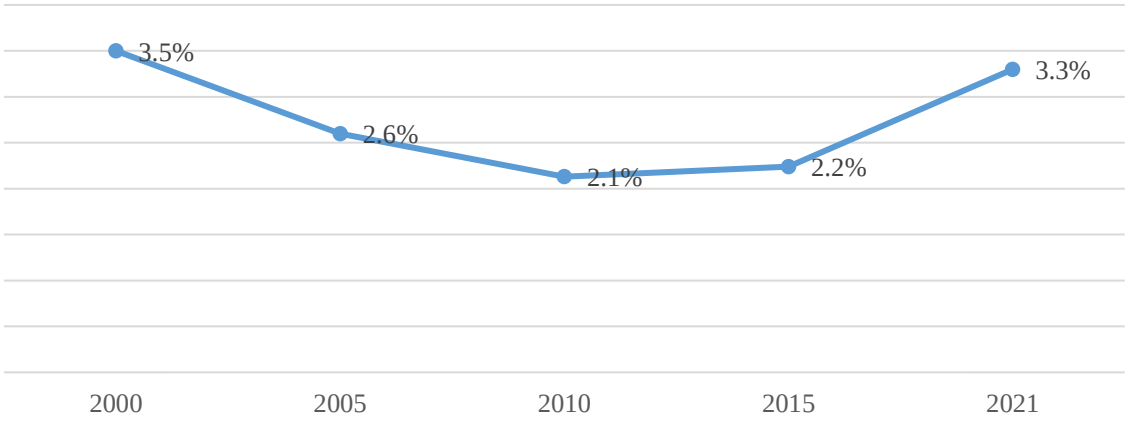
Figure (3) Evolution of electricity generation sources in Egypt (2000- 2021)



Source: Egypt - Countries & Regions - IEA

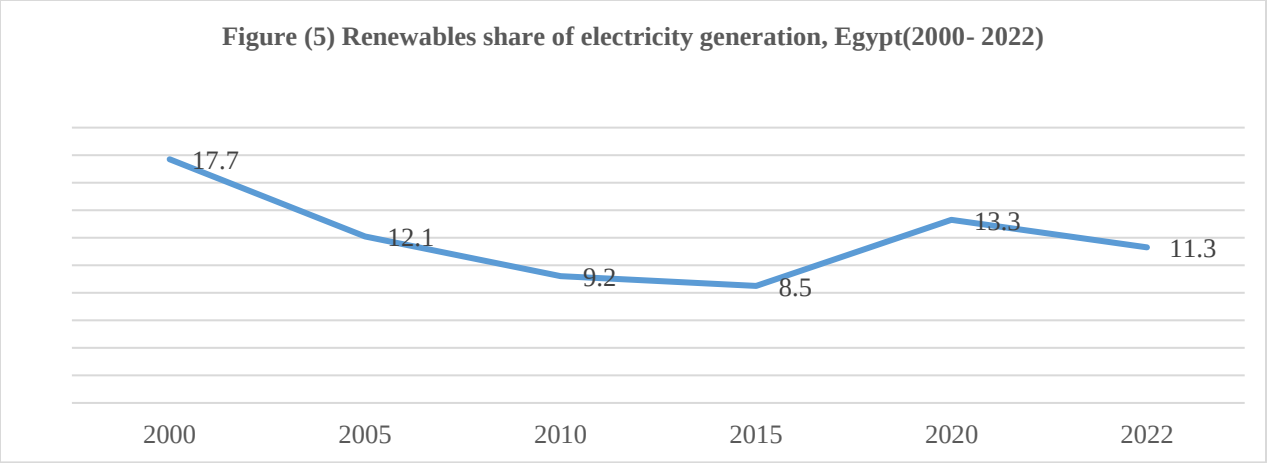
Furthermore, data indicates the share of modern renewables in final energy consumption in Egypt across different years. From 2000 to 2021, there's a fluctuating trend in the share of modern renewables, starting at 3.5% in 2000, declining to 2.1% in 2010, and then gradually increasing to 3.3% in 2021 (Figure 4).

Figure (4) Share of modern renewables in final energy consumption, Egypt



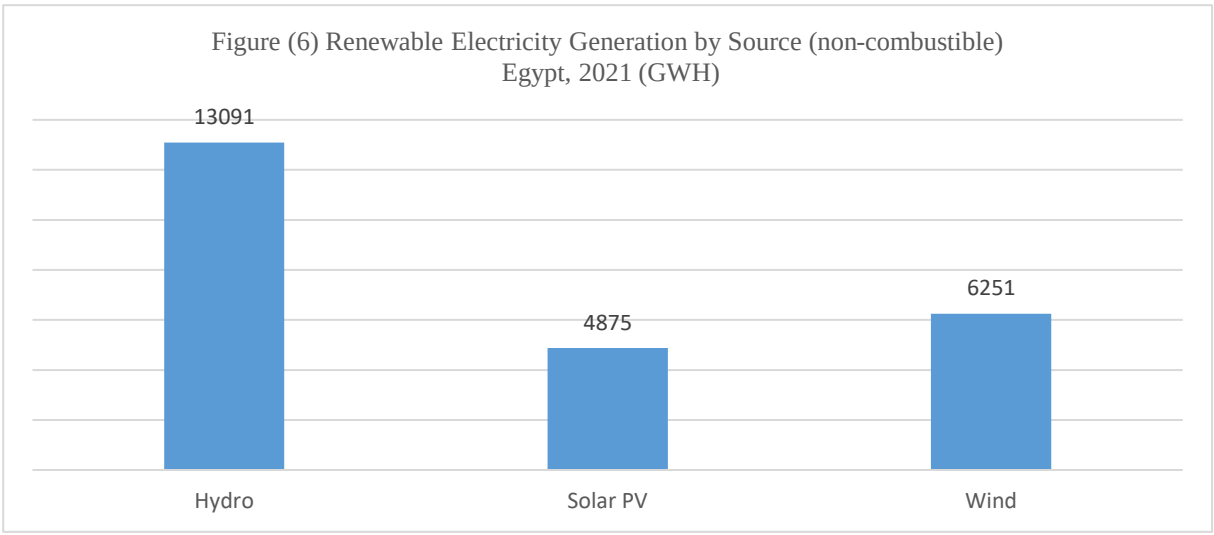
Source: IEA data, 2023

Similarly, Figure (5) shows that between 2000 and 2022, there's a noticeable fluctuation in the share of renewables in electricity generation. In 2000, renewables accounted for 17.7% of electricity generation, which then decreased to 12.1% by 2005. There was a further decline to 9.2% in 2010, followed by a slight decrease to 8.5% in 2015. However, there seems to be a reversal in this trend in more recent years. By 2020, the share of renewables in electricity generation increased to 13.3%, indicating a potential resurgence in the adoption and utilization of RE sources. However, in 2022, there was a slight decrease to 11.3%. This data reveals a fluctuating pattern in the integration of renewables into Egypt's electricity generation mix, showing varying levels of adoption and utilization over the years. This fluctuating pattern could be attributed to some factors related to the current changes in government policies and regulations regarding RE incentives and subsidies, as outlined in the previous section. Additionally, fluctuations in economic conditions, such as changes in investment flows, along with challenges related to grid stability and flexibility in accommodating intermittent RE sources, may contribute to fluctuations in their integration.



Source: IEA data, 2023

When looking at renewable electricity generation during the year 2021, especially non-combustible energy, we find that hydroelectric power generation is the largest contributor, with a total generation of 13,091 gigawatt-hours in 2021. Immediately following is wind power, which produced 6,251 gigawatt-hours. Solar photovoltaic energy comes last, contributing 4,875 gigawatt-hours. (Figure 6)



Source: IEA data, 2023

In general, the evolving energy sector in Egypt, marked by a shift towards greater dependence on natural gas and an increasing focus on RE alternatives. To propel this transition forward, continuous investments in RE infrastructure and the implementation of supportive policy measures will be crucial. These endeavors are vital for advancing Egypt's energy transition agenda, bolstering energy security, and realizing sustainable development goals, particularly in alignment

with the National Energy Plan's target of elevating the proportion of electricity generated from renewable sources to 42% by the year 2030.

2- Methodology

This study aims to explore Egypt's energy transition landscape, focusing on the formulation of evidence-based strategic policies to promote sustainability, efficiency, equity, and resilience within the country. This involves analyzing existing Regulatory and Policy Frameworks to understand their impact on RE adoption and propose policy enhancements. Additionally, the study delves into concepts of energy equity and security, examining their relationship with the energy transition's objectives. It also investigates the role of Micro, Small, and Medium-sized Enterprises (MSMEs) as catalysts for the transition and the challenges they face in adopting RE sources. The research further evaluates how the energy transition affects MSMEs' performance and explores incentives and barriers to clean energy adoption. Lastly, it examines the impact of MSMEs' transition to clean energy on employment generation, particularly among women and youth, contributing insights for informed decision-making and policy development.

To achieve the above objectives, this research relies on employing a qualitative approach aimed at delving into the in-depth analysis of current policies related to the transition towards RE adoption, with a particular focus on Micro, Small, and Medium-sized enterprises (MSMEs). This includes deepening the understanding of both policymakers' and entrepreneurs' perspectives and experiences in transitioning to RE usage and identifying the reasons behind the lack of transition among business owners who have not yet made the transition.

2.1 Study Sites

Upon reviewing previous studies, the author encountered a lack of official updated data regarding the scale of SMEs enterprises within Egypt. Consequently, the current study relied on the most recent data released by the Central Agency for Public Mobilization and Statistics (CAPMAS) in 2015 to determine the study sites.

According to CAPMAS's 2015 study on "The Reality of Small and Medium Enterprises in Egypt during the period 2009-2015" (CAPMAS, 2015), the total number of SMEs enterprises reached 2.3 million establishments during the years 2012 to 2013. Notably, the Greater Cairo region emerged as the primary hub for these enterprises, with Cairo hosting 315.6 thousand

establishments, Giza with 199.6 thousand establishments, and Qalyubia with 126.6 thousand establishments. In the Lower Egypt region, Dakahlia Governorate claimed the top spot with 183.2 thousand establishments, while Minya Governorate led in terms of the number of establishments among the Upper Egypt region's governorates, totaling 106.7 thousand establishments. Consequently, the three qualitative study areas selected were Greater Cairo, Dakahlia, and Minya governorates given the geographic distribution of Micro and Small enterprises among the governorates

2.2 Sample and Data Collection

Data collection took place with three different populations. In-depth interviews (IDIs) were carried out with stakeholders, totaling twenty-six IDIs. At the start of the project, stakeholders mapping was conducted to identify key players involved in the transition to RE in Egypt, with a particular focus on SMEs. These stakeholders included governmental organizations, non-governmental organizations, international organizations, experts and researchers, and the private sector (Table 1).

An IDI guide was developed, including a consent form, organizational and personal data sections, and five thematic sections covering stakeholders' perspectives and experiences regarding current policies and programs related to SMEs transition to RE, the dynamics of supply and demand in the RE sector, the empowerment of young people and women in RE, existing opportunities and barriers for SMEs transitioning to RE, and finally, future perspectives and recommendations aimed at accelerating the transition.

Table 1: Type of Stakeholder who participated in IDIs

Type of organization	No of IDIs
Governmental Organization	8
Non-governmental organizations	5
International Organizations	4
Experts and Researchers	5
private sector	4
Total	26

In addition to the In-Depth Interviews (IDIs), a total of 17 focus group discussions (FGDs) were conducted with employers across the three studied governorates. Among these, 8 FGDs were held with SMEs employers who had adopted RE in their enterprises, while the remaining 9 FGDs involved SMEs employers who had not yet made the transition. The data in Table 2 display the geographic allocation and background of the 104 participants who took part in the 17 FGDs.

Purposive sampling was utilized to ensure a diverse representation in terms of gender, age, education, sectors, adoption of RE, and type of energy used among those already transitioning.

Two separate FGD guides were developed, one for SMEs employers who had not yet adopted RE and another for those who had. The FGD guide for non-adopters encompassed employers' perceptions and views regarding the transition, existing barriers to such transition, their perspectives on the energy sector demand and supply dynamics, engagement of women and young people in the energy sector, the impact of reduced price-support for electricity and gas on their businesses, and their decision-making ability to affect a transition. It also addressed their awareness of current policies and incentives aimed at encouraging SMEs to transition to RE, along with their recommendations for accelerating the RE sector in Egypt overall, with a specific focus on SMEs. Similarly, these questions were posed to employers who had adopted RE, drawing on their real-life experiences post-adoption, as well as the motivations behind their transition.

Table 2: Characteristics of employers who participated in FGDs

Characteristics		Gov			Total
		Dakhahlia	**Greater Cairo**	**Menya**	
Gender	Females	0	23	3	26
	Male	35	10	33	78
Age	24-34	6	8	7	21
	35-45	12	21	10	43
	46-55	9	2	12	23
	56+	8	2	7	17
Education	Preparatory or less	10	8	21	39
	secondary	16	19	12	47
	University	9	6	3	18
sector	Agricultural	16	7	36	59
	Commerce	19	26	0	45
Adopting RE	No	19	21	19	59
	Yes	16	12	17	45
Type of energy	Solar	16	12	11	39
	Biogas and biomass			6	6

2.3 Qualitative Fieldwork and Analysis

The IDI and FGD guides were developed under the supervision of the project Principal Investigators (PIs). Data collectors training sessions were conducted by the author on November 2023, covering various aspects such as the project objectives, RE issues in Egypt, particularly focusing on the importance of transitioning for Small and Medium-sized Enterprises (SMEs). The training sessions also included detailed discussions on interview guides, role-playing exercises, interview techniques, and effective communication strategies with respondents. Data collection activities were conducted in December 2023 under the supervision of the author and a research assistant.

Participants in the FGDs were recruited in collaboration with local non-governmental organizations (NGOs) operating within the three governorates. Interviews and FGDs took place either at the NGO premises or at a location chosen by the respondents. Written or oral consent was obtained from each participant based on their preference. All interviews were recorded and transcribed into Egyptian Colloquial Arabic. The quality of transcription was ensured through a review process conducted by the author and the research assistant.

An inductive approach was utilized to develop the codebook, with codes derived directly from the content of the IDIs and FGDs. The author reviewed and coded the transcripts using open coding techniques, resulting in the identification of 24 code families encompassing over 128 sub-codes. Examples of code families included 'barriers,' with sub-codes such as economic barriers, bureaucratic hurdles, lack of awareness, and skills mismatch. The research assistant who was a sociology student, was trained by the author on data coding procedures. She continued the coding process using the initial codebook and introduced new codes as necessary. Coding activities were carried out in March 2024 using the Dedoose qualitative program that providing a systematic and efficient framework for organizing, coding, and analyzing our qualitative data, thereby enhancing the rigor and reliability of the study's findings.

3- Results

3.1 Driving Renewable Energy Adoption and SME Growth

Data indicates that several policies and strategies have been adopted by the State to transition to RE. Some participants referred to the initiative that began in the 1970s following the assignment of the Tbilisi Declaration in 1977, which focused on environmental education. During this period, the Egyptian State, represented by the Ministry of Environment, collaborated with the Ministry of Education to integrate environmental issues into the education curriculum, particularly at the primary stages. In alignment with the State's efforts, non-governmental organizations also partnered with schools to raise student awareness of environmental issues and RE.

"We initiated our work on RE 20 years ago, through a funded project aimed at providing educational materials on various types of energy and how to adopt renewable and clean energy in our everyday life. Additionally, we implemented a program to train school students on generating energy from wind, water, and solar sources. We were one of the pioneering NGOs in Egypt to focus on solar heaters and their adoption in governmental schools" (IDI with NGO)

As previously mentioned, in 1984 the NREA was established, and government efforts were limited to implementing some policies related to environmental awareness. However, in early 2014, and with the change in the name of the Ministry of Electricity to the Ministry of Electricity and Renewable Energy, and Egypt's ratification of several international agreements related to climate change, including the Paris Agreement for example, government efforts were reactivated through developing a few national policies and strategies to encourage the private sector to transition to the use of RE.

The majority of our participants reported the importance of Decision No. 1947 of 2014 regarding the feed-in tariff, which played a crucial role in attracting private sector investment to the RE sector. Initially, the feed-in tariff was set at 14.3 cents for stations ranging from 20 to 50 megawatts, and 13.6 cents for stations ranging from 500 kilowatts to 20 megawatts. However, by the end of 2016, these prices had declined to 7.8 cents for enterprises or stations from 500 kilowatts to 20 megawatts, and reached 8.4 cents for stations ranging from 20 to 50 megawatts. Despite this decline in prices, the decision successfully attracted numerous local and international investors, contributing to the strengthening of the RE sector in Egypt.

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"When Dr. Shaker was the previous Minister of the Ministry of Electricity and Energy (MOEE), experts advised him to focus on infrastructure and the establishment of RE stations like solar and wind stations, similar to what Abu Dhabi, Saudi Arabia, and Jordan had done, while utilizing the 'Power Purchase Agreement.' He acted upon this advice, incorporating it into tenders. This imitative encouraged both local and international companies to participate. The 'Power Purchase Agreement,' which involves generating energy and connecting it to the electricity grid, initially set the price at 13 cents per unit, which was considered very favorable. Subsequently, in the second phase, the price dropped to 11 cents, then to 10 cents. In the third phase, it decreased to around 6 or 7 cents. Consequently, within a year, the price dropped from four to five cents, representing a reduction of 50% or 40%, for instance. This development led to highly favorable commercial prospects." (IDI with an expert)

In order to prioritize state support for small, medium, and micro-enterprises and further incentivize their transition to RE utilization, some participants raised the question about the importance of tax incentives to bolster green projects. Specifically, they highlighted initiatives provided by both the MESMEDA and the Agricultural Bank of Egypt (ABE), which offer loans and financing for agricultural projects through an initiative led by the Central Bank to support micro, small, and medium enterprises in general, as well as initiatives targeting green projects specifically.

"The government has launched a program that implemented by the Central Bank in partnership with the Agricultural Development Bank, providing subsidized financing for green enterprises. although these imitative may not be widely recognized among the entrepreneurs, they do exist, and the program remains notably active.". (IDI with Governmental institution)

Some participants in the study, particularly from the private sector, highlighted the importance of incentivizing policies, particularly tax credits, for projects utilizing RE. This positively impacts the encouragement to transition towards RE usage. Additionally, they reported on the significance of the new investment law and the law targeting incentives for green hydrogen projects. They expressed optimism about the government's willingness to encourage private sector investment in green hydrogen as a primary energy source in the future.

"Entrepreneurs in RE need to obtain a letter from the New and Renewable Energy Authority (NREA) to confirm their eligibility to operate in the field and import RE equipment. Once they acquire this letter, they approach clients, offering them a discount. This discount, often significant, ranges from 14 to 19 percent, inclusive of a 5 percent additional discount. Furthermore, in conjunction with banking facilities provided by the bank, entrepreneurs can benefit from installment payment plans spanning 5 to 10 years." (IDI with the Governmental institution)

Furthermore, some participants confirmed on some policies including net metering that allows businesses generating their own electricity, typically through renewable sources like solar panels, to feed excess electricity back into the grid. In return, they receive credits or compensation for the

electricity they provide, which can offset their electricity bills. Essentially, it enables consumers to "trade" electricity with the utility company, ensuring fair compensation for the energy they contribute to the grid .

Regarding training and raising awareness about the importance and methods of transitioning to RE, some participants, whether from the government, international organizations, or civil society, highlighted the role of certain government entities in supporting and capacity-building the private sector. For instance, NREA provides necessary training for private sector entities interested in operating within the RE sector. Upon completion of these training programs, companies are awarded certificates, which vary depending on the scale of the projects they undertake in RE.

> "NREA offers training programs tailored for both companies and individuals interested in entering the RE sector. These initiatives aim to ensure that participants are adequately qualified, trained, and equipped with the necessary expertise to proficiently install, operate, and obtain certification in this field. Such certification serves as an official document recognized by government entities. Notably, this training program is provided free of charge, underscoring its commitment to supporting learning initiatives. Essentially, through the Ministry of Electricity, our authority endeavors to empower Egyptians with this knowledge, irrespective of whether they intend to directly engage in RE-related work. (IDI with Governmental institution)

Moreover, within the framework of partnerships between various government entities, civil society, and international organizations, several programs and development projects are implemented to support small and medium-sized projects transitioning to RE.

> "Allow me to explain our approach to this issue. Directly pressuring the government may not yield the desired results. Instead, our strategy focuses on raising awareness and fostering understanding across various levels of government, including those involved in day-to-day operations and decision-making. By doing so, we aim to gradually influence legislative processes over time, recognizing that these individuals are pivotal players in effecting change...." IDI with INGO

As a result, the majority of participants in our study confirmed the alignment between current policies and Egypt's Vision 2030, as well as ratified conventions, positioning Egypt at the forefront of RE adaptation. Egypt consistently ranks highly due to its robust policies and regulations aimed at achieving its ambitious RE agenda.

3.2 Exploring Barriers of Adopting Renewable Energy

Despite the aforementioned factors and incentives expressed by participants in the study, which have accelerated the transition to RE usage, the study's findings indicate the presence of numerous challenges still facing small and medium-sized projects in transitioning to RE. These barriers include:

- ***Economic Barriers***: The most significant challenges include economic barriers, which can be grouped into two fundamental challenges: the cost of systems used to transition to RE, such as solar panels, wind power generators, or biomass energy, and the limited access to financing.

The majority of participants in the study, whether policymakers or business owners, emphasized that economic challenges are among the primary obstacles hindering the transition to RE. Participants from stakeholders highlighted the impact of economic crises and subsequent measures related to currency devaluation on investment in general, and investment in the RE in particular. The increase in the value of the US dollar against the Egyptian pound has led to higher prices of materials used, including batteries, solar panels, water turbines, and even some materials used for the maintenance and installation of RE devices. As for the difficulty in accessing financing, the majority of participants from business owners and some stakeholders, mentioned that with the rise in prices, increases in the interest rates on financing, and the government retreating from providing incentives specifically for projects transitioning to RE have created disincentives to transitioning to RE.

"Unfortunately, we are currently going through a very bad period, so even if all the attractive policies in the world are implemented, it won't actually work unless the economic conditions allow it. If there are no good economic conditions, why would people act differently? Even if you provided incentives under such awful economic conditions, nothing will happen. Importation is practically halted today, so people don't even know how to import!" (IDI with private sector).

- ***Infrastructure deficiencies:*** The challenges arising from infrastructure deficiencies are identified as a second significant barrier, according to the study's findings. Despite the importance of certain policies, such as net metering, which enables businesses to generate their own electricity—typically through renewable sources like solar panels—and feed excess electricity back into the grid, many participants highlighted challenges related to energy storage. This is particularly evident due to inadequate infrastructure linking their businesses to the Electricity Distribution Company (EDC). Consequently, they partially rely on RE, especially solar energy. This dependency stems from insufficient infrastructure that would enable them to connect their projects to the EDC. Therefore, they resort to using RE during daylight hours when solar radiation is high. However, during nighttime periods, they revert to fossil fuels, resulting in the loss of stored solar energy.

Some stakeholders confirmed that under power purchase agreements between business owners and electricity companies, excess energy is supplied to the EDC during the day, which then provides

electricity through the grid continuously. Consequently, business owners utilize electricity as needed. This was indeed the case in the past when the electricity grid could absorb any increase in demand by integrating the surplus into the grid, benefiting the electricity company from this surplus. However, at present, some issues have developed, rendering the electricity grid incapable of meeting demand at certain times due to insufficient electricity production.

"After the economic crisis, several initiatives, including net metering, underwent reversal. Net metering, originally a highly successful government program, involved generating solar energy during the day for consumer use, with credits applied to their meters for nighttime consumption, presenting an attractive alternative to battery investments. However, following the economic downturn in 2022, this program encountered numerous restrictions and eventually ceased operation. For instance, generating more than twenty-five megawatts for a company became prohibited post-crisis, indicating a shift in regulatory dynamics as businesses expanded and aimed for growth, leading to new challenges." (IDI with private sector)

As a result, study participants perceive these infrastructure-related problems as increasing the cost of transitioning to RE. The majority of participants from businesses adopting RE, especially those utilizing solar energy, reported that they had to rely on batteries to store excess energy generated during peak production periods for use during times of low or no generation. However, they raised several questions and issues about battery usage. Firstly, the cost of batteries is very high, particularly for high-quality batteries capable of efficiently storing large amounts of energy. Additionally, battery storage systems require regular maintenance and monitoring to ensure optimal performance, adding to the operational costs and complexity for firms.

“Everyone desires to transition to using solar energy, yet the primary concern persists regarding electricity storage and its associated cost, particularly in areas lacking access to grid power. Batteries prove to be costly, as I would need one to store energy, which entails a considerable expense. For instance, if I intend to store energy on a 20-acre farm today, the battery costs alone would be substantial. Additionally, these batteries necessitate yearly maintenance, leading to further financial burdens” (FGD with users, Minya Governorate)

- ***Bureaucratic barriers*** are also considered as one of the main challenges facing business owners when adopting RE. They reported that this was attributed to the multiplicity of government entities and institutions responsible for decision-making or obtaining specific permits. Whether it's related to equipment imports, establishing RE stations, or due to insufficient knowledge of laws among those responsible for implementation, these hurdles pose obstacles to business owners in implementing some of their projects.

“We had an experience with one of the hotel schools where we tried to renovate all their kitchens and replace conventional electricity with solar energy, among other things. Despite allocating a significant budget after

considering the financial risks, we ultimately couldn't execute the plan due to our reliance on the State utility for electricity we needed. The solar energy unit we wanted to establish required approvals from various governmental and security entities, including the city council and others. These procedures were very lengthy, and different governmental entities had conflicting opinions on what should and shouldn't be approved. Additionally, we needed to change the entire neighborhood's electrical connection to accommodate the electrical appliances we brought in. So, in the end, the project couldn't be implemented" .(IDI with an NGO)

- ***Lack of awareness:*** data revealed that the majority of respondents from business owners who didn't adopt RE in their firms, reported that lack of awareness on who to oversee the transition and what are the benefits of transition as well as the usage of RE were the main challenges for not adapting RE until now,

"Since RE wasn't accessible, we didn't consider it. I mean, if there's an alternative accessible somewhere when you need something, you can try to get it. However, if it's not accessible, we didn't even try to find it. ... Where can we access it? How can we obtain it? The responsibility lies with the State or the government, particularly in the electricity sector. They should be the ones providing knowledge it to us, similar to how they introduced the prepaid electricity meter. They brought it to our attention, and we were aware of it, correct? The state should introduce similar initiatives, providing us with accessible options". (FGD with non-users, Minya)

The lack of awareness is not only limited to business owners transitioning to RE usage, but also among service providers, including those responsible for issuing permits or granting tax or customs exemptions for importing RE-related products. This is making some procedures difficult for business owners and even preventing them from taking advantage of the incentives provided by the State for firms using RE. Additionally, some participants pointed out that certain banks or institutions offering easy loans to project owners lack awareness of green projects. Due to the novelty of the field, banks sometimes perceive such projects as having high risks, leading to the rejection of loan applications from project owners.

"The intermediary entity (such as banks) must be aware of the ideas related to clean energy projects and understand that they differ from traditional projects. They should not perceive them as risky ventures and refuse to provide loans for such projects. Many people face difficulty obtaining loans from banks because they perceive these projects as high-risk and therefore cannot deal with them properly. Either their loan requests are rejected, or they receive less funding than their financial needs". (IDI with Governmental institution)

- ***Technology Evolution:*** Many stakeholders and business owners view industrial localization as a formidable hurdle in the adoption of RE. While strides have been taken to produce RE materials domestically, the swift evolution of technology presents a formidable challenge to the effectiveness of existing production methods. Participants express apprehensions regarding

Egypt's capacity to keep abreast of technological advancements and stress the imperative of sustained investment in research and development. They highlight the necessity of establishing domestic manufacturing capacities for diverse components of RE systems, including batteries, solar cells, and wiring, to mitigate the risks associated with dependence on foreign markets and outdated technologies. In essence, respondents underscored the pivotal role of industrial localization in tackling the cost-effectiveness and sustainability challenges inherent in Egypt's transition to RE.

"One of the main obstacles facing RE in Egypt is the issue of industrial localization. For example, the high costs associated with wind or solar energy, whether in terms of material expenses or the specific components like solar cells and wind turbines, may hinder their utilization. Hence, there's a pressing need to foster a culture of industrial localization aimed at cost reduction. Producing materials and components locally, such as batteries, solar cells, and wires, would significantly decrease the expenses linked with RE." (IDI with a Governmental institution)

- ***Lack of skilled specialists:*** Some participants, particularly business owners, pointed out that one of the current challenges they face is the lack of trained technical labor to maintain RE equipment, especially those related to solar energy or biogas units. Some mentioned that due to the absence of trained technical labor, they have completely abandoned the use of RE and reverted to using fossil fuels. Consequently, this has incurred them high costs, both when transitioning to RE and when reverting to fossil fuel use.

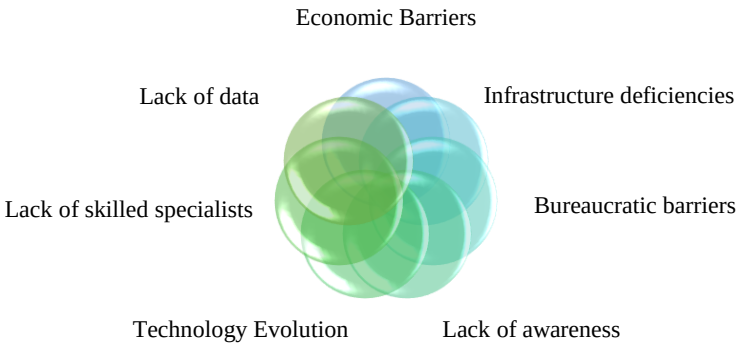
"I had some experience working with solar energy in the past, but I didn't continue with it for long. Although it does provide cost savings, I stopped because of the lack of expertise and inadequate follow-up support. As a result, I switched back to using natural gas….Even though the company installed biogas units for us, there was a lack of ongoing support, leading to the breakdown of the units. Despite our efforts to contact the company, we received no response. Additionally, the gas cylinder malfunctions every two days, refusing to ignite, and we're uncertain about the cause" (FGD with users, Minya Governorate)

- ***Lack of data:*** Despite current policies supporting the RE sector and encouraging small and medium-sized enterprises to adopt it, the many participants in the study, including policymakers, pointed out that the lack of data and studies related to this sector is one of the key challenges preventing the development of appropriate policies. Most participants from governmental entities confirmed the absence of a database that includes small and medium-sized projects that have already transitioned to RE use. Consequently, there is a lack of understanding of the opportunities and challenges facing this sector. Additionally, experts among the participants emphasized that the

absence of nationally classified surveys of businesses according to the type of energy used is also a significant challenge, hindering knowledge of the sector's size in Egypt.

"No studies have been conducted, and the majority of available data on the labor market in Egypt lacks information about the renewable energy sector and the green economy overall. Consequently, we are unable to identify individuals employed in this sector. The existing data does not provide insights into the number of workers in this specific field, their professions, or their roles across different job sites. Therefore, it is essential to include additional questions in the current Labor Force Survey (LFS) and Labor Market Panel Survey (LMPS) to accurately identify individuals working in the green economy sector" (IDI with an Expert)

Figure 6: Barriers of Adopting Renewable Energy



3.3 The Transition Costs to Renewable Energy Adoption

To understand the cost of transition to RE, we have asked our participants about the reasons prompting them to transition, how was their experience in reaching RE services, which sectors are the most popular in adopting RE and finally what are the returns on adopting RE. In what follows, we will explore the real experience of both stakeholders and business owner in adopting RE.

- ***Reasons of transition***

Participants in our qualitative study were asked about the reasons of transition, the majority of stakeholders reported that current incentives encourage business owners to transit, they highlighted those policies including feed in tariff and flexible loans for the green projects which encouraged several business owners to invest in RE or even adopt it in their firms.

"Our journey with solar energy projects began with Egypt's announcement of its solar energy initiatives, starting around 2014 with the starting of the Feed-in Tariff (FiT) program. This program marked a significant milestone as it was among the first initiatives globally that attracted widespread attention, with many countries. During this period, Egypt emerged as a prime destination for investors, drawing significant interest from stakeholders worldwide". (IDI with private sector)

The government's shift towards providing suitable incentives for green projects or projects transitioning to RE use, along with reducing support for fossil fuels, has been a key driver for the majority of small and medium-sized business owners to adopt RE. Most participants in the study, business owners included, indicated that the real driver for considering transitioning to RE is the fact that the cost of using RE compared to relying on fossil fuels is significantly lower. This is especially true when the availability of concessional loans or grants from various supporting entities, whether governmental or international, are available and accessible to small investors to transition to RE use.

Some point out that obtaining a concessional loan to purchase RE equipment is a significant advantage. Initially, the investor may incur a financial burden, but afterwards, they will obtain energy free of charge, in exchange for paying a monthly amount on electricity bills.

"Installing solar panels is expensive than electricity (from fusel foul). For example, I'm willing to pay 1000 Egyptian pounds for electricity each month and not purchase a solar panel for 50,000 or 60,000 pounds. So, what are they doing to encourage people to use it? The companies that install and provide solar cells, which come in various types, have started offering some facilitations. Like install it for you, pay a portion upfront, and then pay the rest in installments. Consequently, the installment becomes like paying regular electricity bills each month, while at the same time, you benefit from the solar cell. Let's say I end up paying 2000 pounds each month. So, for example, within a year or a year and a half, I will have paid off the cost of the solar cell". (FGD with users, Greater Cairo)

Additionally, some participants, business owners from Minya Governorate, mentioned that they transitioned to using RE due to the availability of a grant for installing biogas units from an international organization. Interestingly, the study results indicate that raising awareness and sharing successful experiences among business owners were among the main reasons for encouraging them to transition to RE. This was highlighted by some participants in the study from Dakahlia and Qalyubia Governorates, small business owners, who mentioned that transferring experiences and knowledge from their peers in the region who have already transitioned or used some solar energy devices, such as solar lamps or panels, also influenced their decision to transition .

This was particularly evident among some female entrepreneurs, where one participant who owns a poultry farming project mentioned that initially, she relied on electricity, especially inefficient lamps, for heating the poultry. However, after a neighbor advised her to purchase solar-powered lamps that operate during the day and store energy for nighttime use, she quickly purchased those lamps. They significantly aided her project's growth and development.

Finally, some participants also noted that due to the lack of electricity coverage in some remote areas, especially in the desert regions, they were inclined to use RE as a means to adapt to this challenge.

"Here in the desert, especially in mountainous areas, investment opportunities abound, with numerous wells supplying water. But how does one extract water? Currently, I'm interested in cultivating and reclaiming land where there are no services or electricity. Connecting to the grid is expensive, so we turned to RE. You'll find people with one or two acres using solar panels, while others with ten acres have installed them and operate three kilowatts, along with a small submersible pump that powers the well, drawing water efficiently. This is the essence of agriculture here. We face a significant energy challenge, yet no one seems concerned or talks about it". (FGD with users in the Minya Governorate)

- **Sectors in transitions**

The study results indicate that the agricultural sector is one of the leading sectors in terms of RE usage, especially among micro, small, and medium-sized enterprises. The majority of interviewed policymakers emphasized that investors in the agricultural sectors, particularly in remote areas, whether rural or desert regions, are among the most significant beneficiaries of RE.

Some attribute this trend to the government's and certain international institutions' focus on collaborating with local NGOs in rural areas. They provide assistance, grants, and incentives to support the transition to RE. Additionally, analyzing the characteristics of small and medium-sized project owners interviewed during the study reveals that the majority are engaged in the agricultural sector. Out of the 104 participants, 59 are involved in agriculture, compared to 45 participants working in the commercial sector.

"We are directing our attention to rural areas, particularly in Upper Egypt. These communities are distant from Cairo and centralized services. When discussing initiatives like wheat or rice recycling, it's crucial to engage provinces in the Delta, as their perspectives may differ from those of urban residents. There are considerable opportunities present in these rural areas. Additionally, the youth in rural areas exhibit even greater enthusiasm; however, their main challenge is the lack of resources. Unlike Cairo, they do not have access to the same level of environment and resources." – (IDI with an INGO)

- **Benefits of Energy Transition**

The transition towards RE sources brings a multitude of benefits across economic, social, and environmental spheres. The majority of study participants, including business owners and stakeholders from the private sector, reported that economically, transitioning to RE fosters job creation and economic growth. It stimulates investment in new industries while reducing reliance

on fossil fuels, thereby enhancing energy security and stability. Additionally, most participants indicated that the RE sector has the potential to generate new jobs and introduce new disciplines, as further explored in our next section on "Skills and Occupational Needs in RE." Moreover, many participants, especially those utilizing biogas, highlighted how transitioning to RE has not only saved them time and effort but has also provided natural fertilizers for agriculture.

Furthermore, some emphasized that their shift to RE has facilitated the expansion of their businesses and the protection of their lands and properties, especially in rural areas. For instance, participants from the governorates of Minya and Dakahlia noted that solar panels operating at night significantly contributed to safeguarding their agricultural land from theft or animal damage to crops. Similarly, another participant from Greater Cairo mentioned that power outages resulted in substantial losses in her poultry farming venture, with chickens falling ill or dying during these periods. However, with continuous electricity supply on her farm, her project has thrived and achieved success.

"We conceived the idea of using this dynamo in poultry farming when electricity prices surged, and we found ourselves burdened with high electricity bills. Implementing this solution led to a significant reduction in our electricity consumption. Previously, I used to spend around 500 or 600 Egyptian pounds on electricity for my entire household and for the chicks. Now, my electricity bill has decreased to only 300 or 270 pounds. The dynamo ensures a continuous power supply, even during power outages. Unlike before, when power outages would cause the chicks to become cold and sick, resulting in significant mortality rates, now the constant illumination from the light bulb keeps the chicks warm around the clock." FGD with non-users in Greater Cairo Governorate

Socially, RE promotes equity and inclusivity by providing access to affordable and clean energy for all, particularly in vulnerable communities. Owners of MSMEs have been able to access energy despite the lack of suitable infrastructure in some poor villages. The poor have managed their projects with simple resources and easy loans that helped them secure suitable energy for their projects. Study participants, whether farmers or owners of small businesses, reported that the presence of modern RE technology, such as solar-powered lights or water generators, has helped them continue and succeed in their endeavors. Moreover, some participants emphasized that their reliance on RE sources has provided them with safety and protection from the risks associated with fossil fuel electricity, which sometimes led to electrical hazards, especially during winter rains, resulting in crop loss and sometimes human casualties.

"We don't have to worry about being in a situation where someone calls me to report an electrocution due to rain. For instance, about two years ago, it rained at the farm while we had electricity (non-renewable), and suddenly all the power was cut off. In such a scenario, if someone was indoors and there was a short circuit, it could have led to a

disaster. Everything requires money, effort, and time. Therefore, any savings provide us with peace of mind. With our current setup, we can sleep soundly knowing that there won't be any electrical short circuits causing fires or accidents, even during heavy rain. It's a reassuring feeling." (FGD with users in Greater Cairo Governorate).

In addition to the economic and social benefits, RE sources offer significant environmental benefits, primarily by reducing carbon emissions and mitigating climate change. Unlike fossil fuels such as coal, oil, and natural gas, which emit large amounts of carbon dioxide when burned for energy production, RE sources such as solar, wind, and hydroelectric power generate electricity with minimal to zero emissions. Some participants from the stakeholders reported that replacing fossil fuels with clean, RE sources, can significantly decrease the carbon footprint. In addition to the direct environmental benefits, some participants highlighted an indirect advantage of RE adoption by companies. They noted that some companies are embracing RE to obtain global certificates that certify their low carbon footprint. These certificates not only demonstrate the commitment of these companies to sustainability but also enhance their reputation in the global market. By aligning with RE practices, businesses can showcase their environmental responsibility and contribute to the collective effort in combating climate change on a global scale.

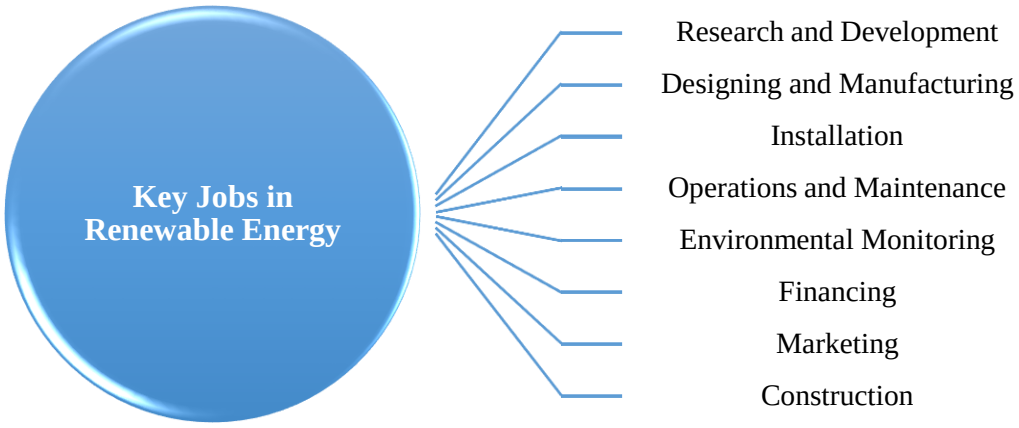
"One of the government's most notable initiatives aimed at promoting investment in RE and fostering broader adoption of environmentally friendly practices is centered around the implementation of strategies to mitigate pollution. A key aspect of this effort is the establishment of a carbon credits exchange in Egypt, enabling companies that successfully reduce pollution to reap benefits. For instance, suppose you operate a tourism company with diesel buses and opt to transition all these vehicles to electric ones. This transition eliminates harmful emissions previously released into the atmosphere. By making this shift from diesel to electric, you effectively achieve a substantial reduction in pollution. Consequently, you have the opportunity to engage with international organizations specializing in environmental matters. By informing them of your transition to electric vehicles and the resulting emissions reduction, you may receive certificates known as carbon credits. These certificates hold tangible value in the market. Companies unable to reduce their own emissions, such as cement manufacturers and other significant polluters, may purchase these credits from you. This dynamic illustrates the essence and significance of carbon credits" (IDI with an NGO)

3.4 Employment, Education and required Skills in Renewable Energy

The RE sector is instrumental in creating new job opportunities that align with the future of work. Study findings indicated the pivotal role played by this sector in fostering novel job specializations. Despite Egypt's current limited move towards comprehensive manufacturing, data shows that companies engaged in supply, installation, and maintenance require a diverse range of specialized skills. The majority of participants including experts and those in the private sector, highlight that

this sector has indeed opened up employment avenues in installation, maintenance, and various technical domains that includes roles in designing and building RE stations, as well as those using specialized studies to assess environmental conditions such as sunlight intensity and wind patterns, along with studies concerning the installation of biogas units. Additionally, positions related to financing and marketing RE products are emerging. Furthermore, experts emphasize that the State's strategic focus on establishing large-scale national projects in RE—like the Benban solar energy project, and Zafarana, Jebel El-Zeit, Ras Ghareb, for wind energy projects—has been instrumental in creating new job opportunities within the RE sector.

Figure 7: Key Jobs in Renewable Energy



Source: Developed by the author based on the research results.

- **Demanded skills in Renewable Energy sector.**

The study findings emphasize the importance of having a diverse range of technical and technological skills, along with proficiency in language and soft skills. Most of participants confirmed the significance of technical expertise. In the RE sector, there is a demand for both specialized professionals and skilled technicians, especially in fields such as electrical, mechanical, and construction engineering. The relevance of these disciplines varies depending on the type of energy source used, whether it's wind, solar, or biogas. Stakeholders, especially those in the environmental sector, highlight the sector's ability to create new job opportunities, as seen in roles like environmental monitoring. Significant concerns about the potential impact of wind turbine installations on migratory bird routes highlight the need for environmental monitoring in coastal areas to protect bird populations from harm or extinction. However, despite the critical

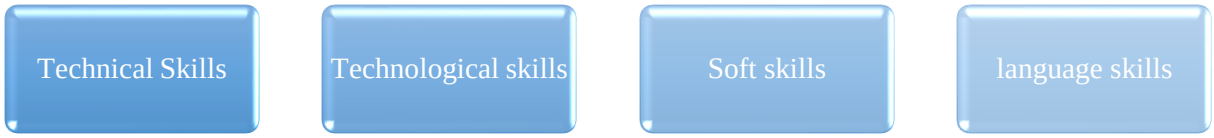
importance of technical expertise, some stakeholders express concerns about the lack of adequately trained personnel in emerging specialties, particularly among blue-collar workers.

"Currently, the challenges lie not with the White Collars or specialized engineers in new and RE, but rather with the Blue Collars, particularly the technicians. The scarcity of institutions providing adequate training for technicians in the field of new and renewable energies is the root cause of this issue" (IDI with the private sector)

Following technical competencies, proficiency in technological skills ranks prominently in the employment landscape. Select participants from the private sector accentuate the pivotal role of specialized technological proficiencies, including expertise in software utilized for the design of RE infrastructure, as well as programs facilitating wind movement and intensity assessment. Moreover, emphasis is placed on the significance of linguistic proficiency and soft skills, particularly within the realms of marketing, persuasion, and international corporate engagement. Such competencies serve to augment the commercial viability of RE equipment offerings.

"Language and soft skills play a crucial role in communication with international companies. Even for domestic enterprises, possessing strong soft skills can offer significant advantages. For example, within the real estate sector, individuals involved in property sales frequently emphasize their initiatives to reduce electricity and water consumption, as well as their efforts to recycle water for garden irrigation, thereby decreasing dependency on expensive clean water. This demonstrates a profound understanding of resource efficiency" (IDI with an NGO)

Figure8: Demanded skills in Renewable Energy sector



Source: Developed by the author based on the research results.

- **Education and Skills development**

To explore and identify the linkage between the demanded skills in the RE job market, participants were queried about education's role in fostering a workforce adept for this sector, as well as the current educational and training policies aimed at enhancing the development of the requisite skills. The study results reveal a governmental inclination towards integrating RE topics into certain academic curricula, as evidenced by national policies and strategies such as the technical education strategy and the ministry of labor strategy, along with the national climate change

strategy. Nevertheless, these policies remain partially implemented, with some participants noting the lack of comprehensive information regarding RE in academic curricula.

Moreover, there is an absence of dedicated disciplines in solar energy, notably within government educational institutions, encompassing both technical and university education. Some respondents highlighted those specific disciplines in RE that are currently limited to private or international universities, as well as technical schools owned by the private sector. These findings suggest potential inequalities in educational opportunities, particularly within the RE sector, where graduates from private institutions are directed towards these disciplines, while government institutions lag behind. Addressing these disparities calls for further prospective studies, a topic we will delve into subsequently.

To bridge the gap between demand and supply of the required skills, some governmental institutions resort to MOUs among themselves to provide necessary training. This training is offered to both students and young graduates. Study participants highlighted the role played by the New and RE Authority (NREA) since its establishment in providing essential training services, whether for technical school students, university students, or graduates in general. This is achieved either through cooperation protocols between NREA and the Ministry of Education and Technical Education, as well as the Ministry of Higher Education, or through the NREA's website, which periodically announces the availability of training courses (some of which are offered in the form of free scholarships) specialized in the field of RE.

In addition to governmental efforts, some participants from the private sector in the study indicated that collaboration takes place between their companies and the Ministry of Education, Technical Education, and Higher Education. This collaboration includes providing training to students in certain departments, whether in technical schools or engineering faculties, to impart practical experience to students during their academic studies.

"Formal education has yet to officially revise its curriculum, but there's a noticeable trend where various international and private universities, such as the British University, are integrating dimensions of RE into their educational frameworks. Nonetheless, this trend doesn't impede certain governmental institutions, such as Ain Shams University and the National Institute for Planning, as well as specialized research centers, from providing courses to students and graduates. This reflects a governmental policy direction, indicating a gradual integration of these dimensions into educational curricula, encompassing aspects related to RE and environmental studies, thereby fostering a more comprehensive educational landscape". (IDI with Governmental institution)

3.5 Promoting Gender Inclusion in the Renewable Energy Sector

Studies to date confirm that women are underrepresented in the RE sector. According to IRENA, 32% of the renewable energy workforce comprises women, with women representing only 21% of the workforce in the wind energy sector. In the solar PV industry, women make up 40% of the workforce. However, this figure still falls short of the global average of women in the overall economy, estimated at 45.9% (IRENA, 2019). Overall, the RE sector offers more opportunities for women compared to the conventional energy sector. Women are generally more drawn to the multidisciplinary dimensions of RE than to traditional energy.

Therefore, this study aims to assess the opportunities available to women in Egypt to work within the RE sector and identify the primary challenges they may face in securing decent jobs. The study revealed a consensus among stakeholders regarding the inclusion of women in the workforce, particularly in professional roles. Women, including entrepreneurs and those with higher qualifications such as engineers, have ample opportunities for employment in this sector. Participants in the study, whether from private sector, government, or experts, reported that the RE sector provides viable job options for women and ensures they receive equitable training opportunities compared to their male counterparts.

Some attributed this to the commitment of certain companies to adhere to international standards in promoting women's integration into the workforce within this sector. These companies are often compelled by international organizations to create job openings for women or emphasize gender equality in hiring practices, thereby earning international certifications that confer additional benefits. Additionally, some participants highlighted the importance of financial institutions allocating specific quotas to encourage female participation in this sector, significantly enhancing opportunities for women to enter the RE workforce.

> "In today's context, it is important for us to integrate a female component into our projects to adhere to the international standards set by funding agencies. This entails ensuring the involvement of female engineers, which has become a norm. While we may have overlooked this aspect in the past, it has now become crucial. For example, when applying for carbon credits, organizations inquire about this factor. They engage with us as engineers rather than technicians" (IDI with private sector)

Based on the previous quote, it's evident that participants emphasized the importance of providing job opportunities for women in white-collar professions. The majority emphasized women's roles in administrative and advanced specialized positions. However, some expressed reluctance

regarding women in blue-collar jobs, citing the challenging work environments at RE stations, whether wind or solar-based. These stations are often located in remote areas, requiring extended periods away from home, which may be less conducive for women. While some participants acknowledge available opportunities for women, they also note that the sector's working conditions could hinder their active participation. This is sometimes attributed to cultural norms that discourage women from extended absences from home. Others mentioned that women's lives after marriage, and sometimes pregnancy, prevent them from continuing in their jobs, so they had to find alternative solutions to encourage their continued participation.

"I am interested in participating in site visits and being present during the installation phase, but it presents challenges as it requires staying overnight at the site for 3 or 4 days. Although the company doesn't have an issue with this, my parents at home are completely opposed to it" (IDI with Private sector)

In addition to jobs opportunities, some stakeholders highlighted the lack number of girls wo applying to the RE specializations and course in some university, particularly that there is a common culture among students that theses discipline "for males only" which may prevent women and girls to participate in this sector.

"In the engineering field as a whole, including my university studies, I teach both engineering and business courses. It's worth noting that in engineering classes, approximately 80% of the students are male, while only 20% are female, or even fewer. Their representation in this field is notably limited, presenting a significant challenge" (IDI with an expert)

Looking at the data from the focus group discussions conducted with business owners, we found a significant opportunity for women's involvement in entrepreneurship within micro, small, and medium-sized projects. Some women interviewed have already implemented RE in their projects, with the majority reporting growth in their business as a result of transitioning to RE. However, analyzing the data, particularly concerning women entrepreneurs who have not yet adopting RE, compared to male participants in the non-user groups, the results indicate a significant lack of awareness among women.

Several female participants expressed unfamiliarity with RE, unlike their male counterparts, who demonstrated a higher level of awareness and experience in RE fields, including various forms of energy, utilization, and associated costs. This suggests a lack of accessibility to information on RE for women compared to men in the study's society, highlighting an indicator of inequality in data provision. Cultural norms, especially those related to mobility freedom, may hinder the exchange

of experiences and information. Further studies may be needed to develop appropriate policies to address this issue.

"I heard about this on television, that they want to install solar panels on tall buildings to harness the sun's energy and provide savings, but we don't have the resources to do that…. I didn't fully understand it, but what I got is that it's costly or something…. They should run awareness campaigns to help us understand how to use RE on TV and online, so we can learn more about energy….. Yes, we want to learn how to access these energy sources like wind, solar, and others, but there are people in the country who have done it, with big business. but ours are small…. We need them, but we can't reach them. And it's always available in cities, not in rural areas….. "FGD with females employers, non-users, rural area, Greater Cairo

3.6 Future outlook and recommendations

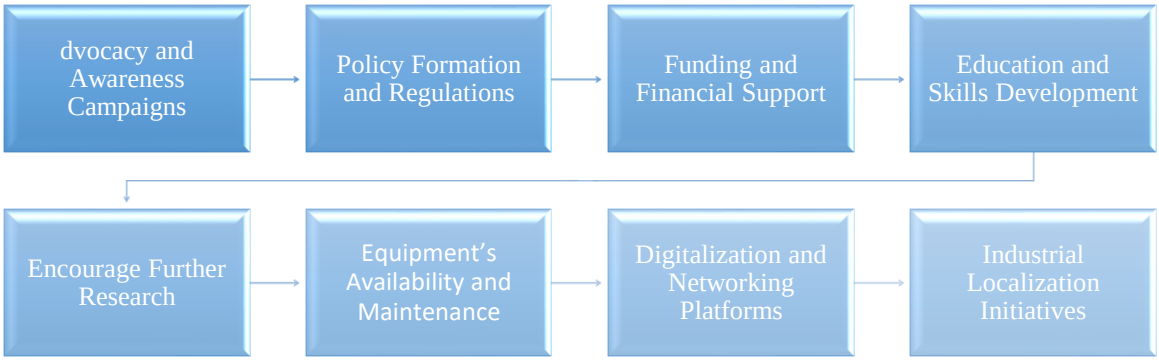
The majority of the study participants expressed great optimism regarding the future prospects of RE in Egypt. They emphasized the promising trajectory, attributing it to the government's heightened awareness and commitment to combat climate change. This commitment is reflected in the implementation of supportive policies and incentives aimed at expediting the transition to RE. The overarching goal is to curtail carbon emissions and achieve sustainability objectives. Furthermore, many participants underscored the noticeable reduction in state support for fossil fuels, prompting numerous investors to pivot towards RE as a cost-effective solution. The escalating investment in RE projects, coupled with declining costs, is propelling substantial growth in the sector. This growth trajectory is not only fostering the creation of new job opportunities but also yielding significant economic benefits.

However, some participants emphasized that for Egypt to accelerate its transition, it must address its economic crises, especially considering the global economic and political crises.

"Egypt has significant potential for solar energy, with one of the highest levels of solar radiation globally, available year-round. This makes it an ideal location for high productivity in solar energy stations. Our desert areas need substantial infrastructure development, but with solar energy, there's no need for electricity extension in remote areas; stations can operate independently. Despite challenges like the dollar crisis, resolving these issues could propel Egypt to a new level in solar energy." (IDI with Private Sector)

To accelerate the transition to RE, the participants in the study emphasized several recommendations that the state should take to achieve its goals and vision for sustainable development. Below, we address each of these recommendations in order of their frequency among participants. Figure 10 illustrate the frequency of each category of recommendations.

Figure 10: Analysis of Recommendation Categories Frequency for Energy Transition



Developed by the author based on the research results.

- **Policy advocacy and awareness campaigns**

Policy advocacy and awareness campaigns play a crucial role in shaping public perception and driving policy changes in various domains, including RE. The study results indicated that data accessibility is essential in accelerating SMEs' transition to RE. The majority of our participants, particularly non-users' employers, reflected a lack of awareness about how to transition and what current incentives are available for doing so. However, they expressed willingness to transition based on the benefits they had heard about. Similarly, participants from users' employers confirmed this issue. Additionally, stakeholders emphasized the importance of policy advocacy and awareness campaigns not only for employers but also for policymakers, including governmental organizations, financial institutions, the private sector, and the general public. These campaigns aim to educate stakeholders about the benefits of RE adoption and the urgency of transitioning towards sustainable energy sources.

"All goes back to awareness. I mean, no one talks about the topic you're discussing at all. You're the first ones to bring it up. If there were awareness, you'd find my wife saying as soon as I come home from work, 'We want solar energy, it saves us.' People are now willing to get the rechargeable lantern that powers the whole house." (FGD with non-users in Cairo Governorate)

The study results indicate that such awareness can be achieved through launching awareness campaigns using various means, including workshops with both government and private sector stakeholders to educate them about current incentives, regulations, and laws supporting the RE sector in Egypt. Some participants stated the importance of awareness seminars in local communities, especially rural and remote areas, where these seminars can be led by community leaders such as local council members or religious leaders. Others highlighted the importance of

conducting these seminars through civil society or agricultural cooperatives in rural areas, for example. Moreover, some mentioned the distribution of awareness materials through various social media platforms or printed media. Furthermore, stakeholders from NGOs stressed the importance of utilizing arts as methods for environmental awareness and education. By implementing comprehensive awareness strategies targeting different population groups, communities can empower employers and individuals to make decisions to transition to RE use.

"They should organize lectures in every rural area, where people gather in communal spaces like mosques or community centers. These gatherings would allow for announcements and advertising to reach all villagers. Additionally, utilizing online platforms for dissemination would be beneficial. It's crucial that awareness begins with government initiatives, followed by engagement with local civic organizations across the country. For instance, my awareness of solar energy initiatives came only after hearing about them on television. There needs to be a concerted effort starting from the government, extending to civil society groups nationwide" (FGD with non-user, Dakahlya)

Furthermore, some study participants confirmed the importance of highlighting role models, especially within the private sector, and showcasing successful initiatives by entrepreneurs who have adopted the green economy. These examples serve to inspire and educate others on the benefits and feasibility of transitioning towards RE, ultimately fostering the growth of businesses and the wider adoption of sustainable practices.

We often encounter advertisements from the private sector promoting compounds and new cities. Are these individuals considering aspects such as what we've seen in the New Administrative Capital, where all buildings incorporate PV rooftop systems? If real estate developers are indeed considering such initiatives, it suggests the need for awareness campaigns and workshops targeting these entities. For instance, take the New "City of Nour" by Talaat Moustafa Group, marketed as the first green city. Enhancing awareness about these concepts could greatly benefit them in marketing their properties effectively. Therefore, there's a clear need for increased awareness, as developers may lack understanding of terms like "green buildings" or "PV systems," and other aspects of Integrated Design Initiatives (IDI with a Governmental institution)

- **Policies and regulations**

The study participants highlighted the importance of having certain regulatory and guidance policies to support, facilitate, and reform the RE sector in Egypt. Participants put forward a number of proposals for these policies, including:

  - *Having a national plan implemented by the government to incentivize both businesses and individuals to transition to RE sources*: The majority of participants stressed the necessity of the government adopting a nationwide initiative for shifting towards a green economy. This entails enacting laws and regulations aimed

at promoting the adoption of RE practices on a national scale. Stakeholders and business owners cited various examples, including the promotion of energy-efficient light bulbs, and the transition from traditional energy billing to prepaid card systems. Furthermore, participants highlighted the government's successful initiative to introduce natural gas into all Egyptian households. Particularly, business owners in rural areas noted the effectiveness of this initiative and urged the government to pursue a similar approach in promoting RE awareness within local communities.

"The state should be the one providing these services for us in our communities. How are we supposed to know about it in our neighborhoods? The government is responsible for electricity, just like when they introduced natural gas and changed the billing meters to card-based ones. We only knew about these initiatives because the government introduced them. They should continue to introduce similar initiatives to benefit us". (FGD with non-user in Cairo Governorate).

- *Addressing bureaucratic obstacles and facilitating procedures* related to imports and obtaining permits and approvals for establishing RE units are crucial steps. Several participants emphasized that dealing with government agencies remains a major challenge for SMEs, leading to increased transaction costs. This bureaucratic burden disproportionately affects smaller projects compared to larger ones, as noted by several business owners.

"The Investment Authority assured investors of streamlining procedures with entities such as the Ministry of Finance, with which we have multiple dealings. This includes matters like value-added tax, commercial and industrial profit taxes, and property taxes. We interact with numerous entities to the extent that procedures can become somewhat challenging, but we recognize the importance of facilitating these processes for individuals." (IDI with private sector)

To address this bureaucracy, especially among government entities, some participants emphasized the importance of establishing a unified committee to coordinate between the various entities involved in RE investment fields. This committee delineates the tasks of each entity individually and coordinates between them. Some have also suggested the importance of having a unified window to facilitate procedures for the private sector, especially for small, medium, and micro projects.

"Committees should be established, with each entity forming its own committee, to develop a work plan and maintain an organized structure. Each entity should have a defined role, and there shouldn't be isolation in operations. While I handle my responsibilities, the Ministry of Environment and industrial production should do the same. We shouldn't operate separately; there should be unity in our approach and a common goal" (IDI with Governmental institution)

- *Monitoring, and providing environmental incentives:* Several participants stressed the significance of establishing a governmental body to oversee environmental standards for SMEs. This entity would appoint an environmental auditor, similar to a financial auditor, responsible for monitoring and evaluating the environmental aspects. Consequently, positive incentives would be awarded to projects transitioning to RE or reducing carbon emissions. Conversely, negative incentives would be applied to projects exacerbating carbon emissions. Some cited the government's initiative to replace vehicles and shift from diesel to electric as an illustrative example.

- *Developing regulations for construction sector:* Some participants have reported on the importance of initiating the promotion of a transition to RE through real estate development and construction. For instance, the Ministry of Housing could impose specific requirements on real estate developers, mandating the allocation of rooftop spaces for RE units, similar to the obligation to provide parking garages.

"I hope that the government, particularly the Ministry of Housing, which allocates lands for property developers, imposes a condition among the real estate developers, such as requiring them to build an underground garage for parking and to leave the rooftop space available for installing solar panels, as this could provide up to fifty percent of the required energy." (IDI with an expert)

- **Funding and financial support**

Access to sufficient funding is frequently highlighted as a major obstacle for SMEs, especially in emerging economies. several stakeholders and business owners in the study acknowledge the significance of backing SMEs through diverse initiatives like grants and loans. They indicated the necessity of sustaining the Central Bank's efforts in supporting projects aiming to shift towards green energy usage by offering accessible loans to project proprietors.

Some project owners in the agricultural sector have also suggested the importance of having an intermediary between them and the banks when dealing with loans. Some of them proposed agricultural associations or the General Authority for Agricultural Reform for their mutual trust between farmers and these entities.

> "This project could be implemented through the General Authority for Agricultural Reform, similar to the covered drainage system they provided for people. This project could be solar energy-based, structured like the sewage system, with people paying installments over time." (FGD with non-users in Minya Governorate)

- **Education and skills development.**

Providing accessible and high-quality education equips individuals with the knowledge and skills necessary to thrive in today's evolving workforce, especially in the RE sector. Many participants in our study emphasized that continuous skill development is essential for individuals to adapt to the changing demands and technological advancements within the RE industry. They also highlighted the importance of integrating RE topics into all educational levels. Additionally, some suggested offering RE training programs accessible to everyone, similar to previous initiatives for mobile phone maintenance, which were inclusive of individuals from various study backgrounds. This approach would help cultivate a skilled workforce capable of RE installation and maintenance.

Furthermore, some employers recommended that individuals receive technical training on the use, cleaning, and maintenance of RE units before installation. This proactive measure would address the shortage of skilled workers in their communities and ensure effective utilization and upkeep of RE infrastructure.

> It's possible to offer specialized training courses in solar energy, similar to the ones many people attend, like those for mobile phone maintenance. Currently, you have to wait for at least three years to graduate skilled individuals from technical schools. To speed up this process, training courses can be provided for those interested in PV maintenance. It doesn't matter if the course doesn't require a qualification related to my degree. For example, I have a Bachelor of Arts degree and want to learn about electricity, so I'll take a course in electricity, even if it's not related to my major. (FGD with users in Greater Cairo)

- **Encourage Further Research**

Experts and employers participating in the study highlighted the significance of conducting surveys and studies to comprehend Egypt's RE sector. They stressed the necessity of

investigating both demand and supply, analyzing the costs associated with each energy form, assessing the scale of enterprises embracing RE, and delving into current opportunities and challenges. Furthermore, some participants emphasized the importance of aligning survey findings with decision-makers' considerations.

> It is clear that there is an urgent need to activate the role of research centers and enhance their efforts to achieve more effective results in the field of RE. We need to examine their progress and assess their contributions more significantly in developing technologies and raising awareness of the benefits of solar energy and other RE sources….Decision-makers should also make greater use of research and technological aspects to develop policies and strategies that promote the use of solar energy and maximize its benefits for society as a whole. (FGD with users in Dakahlia)

- **Equipment's Availability and Maintenance**

Ensuring the availability of equipment and maintaining RE systems emerged as a primary challenge highlighted by participants. This challenge encompasses not only acquiring the required equipment but also ensuring its continuous functionality through regular maintenance. Many participants, both users and non-users, emphasized the significance of equipment availability, especially batteries, to maximize the efficiency and lifespan of RE systems, thereby contributing to sustainable energy practices.

> The most important thing is that maintenance is available, spare parts are reasonably priced, and there is a warranty for a certain period from the company for devices and batteries because the most common problem we face is maintenance, and the batteries supposed to charge and provide electricity at night require maintenance periodically. They used to say it would last for four years, but it didn't even complete a year. (FGD with Users in Dakahlia)

- **Digitalization and Networking Platforms**

Some experts in the study emphasized the critical need for the government to fully embrace digitization and leverage technological tools to streamline bureaucratic processes and simplify routine procedures for business owners. Furthermore, it was suggested that digitization, including the use of electronic wallets, could facilitate access to financing and easy loans. Additionally, some participants advocated for the development of a dedicated mobile application for green initiatives. This application would furnish business owners with essential information, ranging from necessary approvals and permits for installing RE units to guidance during maintenance intervals. Regular updates to the application would

enable project owners to continually enhance their understanding of modern technological advancements.

- **Industrial Localization Initiatives**

The cost of solar energy equipment was reported as one of the challenges by some participants in the study. Therefore, some recommended the importance of localizing the RE industry in Egypt. This will help reduce the costs of importing raw materials.

> One of the major challenges facing RE in Egypt is the concept of industrial localization. For example, we may not be able to utilize wind or solar energy because their costs are high, both in terms of monetary investment and the cost of the materials needed for solar cells and wind turbines. Therefore, it is necessary to promote a culture of industrial localization to reduce costs. We need factories for battery storage and production, factories for solar cells and wires, and manufacturing of filters used in solar cells. All components must have local producers, highlighting the importance of industrial localization as both a challenge and a solution in general (IDI with NREA).

4- Conclusion

This study aims to explore Egypt's energy transition landscape, focusing on formulating evidence-based strategic policies to promote sustainability, efficiency, equity, and resilience in the energy sector. It involves an in-depth analysis of existing regulatory and policy frameworks to assess their impact on RE adoption, exploring concepts of energy equity and security, and examining the role of Micro, Small, and Medium-sized Enterprises (MSMEs) as drivers of the transition. Additionally, the study evaluates how the transition to clean energy affects the performance of MSMEs and identifies incentives and barriers to their adoption of RE, with a specific focus on employment generation among women and youth. To achieve the study objectives, a qualitative approach was employed by conducting in-depth interviews (IDIs) and focus group discussions (FGDs) with stakeholders from governmental organizations, NGOs, international organizations, experts, researchers, and the private sector. FGDs were conducted with SME employers in three governorates representing different regions of Egypt, ensuring diverse representation and perspectives.

Key Findings:

Driving Renewable Energy Adoption and SME Growth

Egypt has made significant strides in promoting RE, supported by various initiatives dating back to the late 1970s. Key policies, such as feed-in tariffs and tax incentives, have successfully attracted investment and facilitated the growth of the RE sector. Qualitative data indicate that the adoption of RE offers numerous benefits across different domains. ***Economically***, transitioning to RE stimulates job creation, encourages investment in emerging industries, and bolsters energy security. For instance, businesses utilizing biogas not only benefit from natural fertilizers but also experience reduced operational costs. ***Socially***, it promotes equity and inclusivity by providing affordable and clean energy, particularly in marginalized communities. This energy access sustains small businesses and agricultural projects, shielding them from infrastructure deficiencies. Moreover, ***environmentally***, RE significantly reduces carbon emissions and helps mitigate climate change. Businesses embracing RE can attain global certifications for low carbon footprints, thereby enhancing their market reputation and actively contributing to global sustainability efforts.

Key Barriers of Adopting Renewable Energy

The study results convey optimism regarding the future of renewable energy (RE) in Egypt, emphasizing the government's dedication to addressing climate change and the growing investment in RE projects. Nonetheless, significant barriers persist, such as ***economic challenges*** like the high costs of RE systems and limited access to financing. Economic crisis and currency devaluation worsen these challenges, driving up material prices and loan interest rates, thereby discouraging RE investment. Moreover, ***inadequate infrastructure***, especially for energy storage and grid integration, impedes RE's efficient utilization. Businesses often face additional burdens due to the high costs and maintenance requirements of batteries used for energy storage. Additionally***, bureaucratic complexities*** and inefficiencies in obtaining permits and approvals for RE projects hinder progress. Widespread ***lack of awareness*** about RE benefits and procedures among business owners and service providers, including financial institutions, leads to loan rejections. Technological advancements require sustained investment in research and development to keep production methods current, especially for RE components. Furthermore, ***the scarcity of skilled specialists*** for RE equipment maintenance pushes some businesses back to fossil fuels, incurring extra expenses and undermining the transition to RE. Lastly, ***the absence of comprehensive data and studies*** on the RE sector restricts policy development, compounded by the lack of centralized databases and nationally classified surveys, hampering SMEs' understanding of RE adoption opportunities and challenges.

Employment Opportunities and Skills Development

The RE sector in Egypt serves as a significant catalyst for employment opportunities, generating numerous job openings, particularly in installation, maintenance, and technical capacities. These roles encompass designing and constructing RE facilities, evaluating environmental conditions, and installing biogas units. Additionally, emerging job functions in financing and marketing RE products underscore the sector's extensive employment potential. Consequently, there is a heightened demand for ***technical skills*** in electrical, mechanical, and construction engineering, necessitating specialization based on the type of RE. Proficiency in ***technological skills***, such as utilizing software for designing RE infrastructure and assessing wind patterns, is essential. Moreover, skills related to ***environmental monitoring*** play a vital role in evaluating the impact of RE projects on migratory bird routes and other ecological factors. Lastly, proficiency in ***languages***

and soft skills, including marketing, persuasion, and international engagement, are pivotal for enhancing the commercial viability of RE products.

Addressing the gap between demand and supply in the RE field, the study findings indicate governmental efforts to integrate RE topics into academic curricula, supported by national policies and strategies. However, these initiatives are only partially executed, and there exists a deficiency of comprehensive information on RE in current academic programs. Additionally, RE-specific disciplines predominantly almost exist in private or international universities and private technical schools, potentially leading to educational inequalities. Government institutions lag in offering dedicated RE programs.

Gender Inclusion

The findings of the study underscore the opportunities available for women within Egypt's RE sector, particularly in professional capacities such as engineering and entrepreneurship. Some companies are aligned with international standards advocating for gender equality, thereby creating job openings and providing equitable training opportunities for women. Additionally, financial institutions that allocate specific quotas further enhance the prospects of women in the RE workforce. However, women face various challenges, including reluctance towards blue-collar jobs due to demanding working conditions in remote areas, as well as cultural norms that discourage extended absences from home. Furthermore, women entrepreneurs encounter limited awareness and access to information compared to men, which impedes their participation in the RE field. These challenges are exacerbated by cultural norms and mobility restrictions. Despite these barriers, women have significant entrepreneurship opportunities within micro, small, and medium-sized RE projects, which can lead to business growth and success.

Recommendations and Key Policies:

- ***Policies and Regulations***: To accelerate the transition to RE, robust policies and regulations are crucial. National plans should incentivize businesses and individuals to adopt RE sources, while bureaucratic hurdles must be streamlined to facilitate the process. Monitoring and providing environmental incentives for carbon emission reduction projects are imperative. Additionally, mandating the integration of RE into construction projects through regulations would further drive sustainability efforts.

- ***Education and skill development:*** Integrating RE topics into all levels of education, especially in governmental schools, is vital. Accessible training programs should be made available for skill enhancement in RE. Additionally, technical training on the use, cleaning, and maintenance of RE units should be provided to ensure proficiency in this field.
- ***Funding and Financial Support***: Sustain efforts to support SMEs with accessible loans for RE projects. Facilitate access to loans by providing intermediaries for project owners, particularly in the agricultural sector.
- ***Encourage Further Research***: Conduct surveys and studies to understand the RE sector, analyzing demand, supply, costs, and challenges and align research findings with policymakers' considerations.
- ***Industrial Localization Initiatives***: Promote industrial localization of the RE industry to reduce costs associated with importing raw materials.
- ***Equipment Availability and Maintenance:*** Ensure availability of equipment, especially batteries, and emphasize regular maintenance for efficient RE systems.
- ***Policy Advocacy and Awareness Campaigns***: Launch comprehensive awareness campaigns targeting various stakeholders to educate them about RE benefits and available incentives. Conduct workshops, seminars, and utilize social media and printed media for dissemination of information. Highlight successful initiatives and role models to inspire others.
- ***Digitalization and Networking Platforms***: Embrace digitization to streamline bureaucratic processes and simplify procedures for business owners. Develop a dedicated mobile application for green initiatives to provide essential information and guidance.
- ***Promoting Women's Participation***: Encourage companies to adhere to international standards promoting gender equality. Address cultural norms and mobility restrictions that hinder women's access to information and the exchange of experiences in the RE sector. Develop appropriate policies and conduct further studies to understand and mitigate underlying factors contributing to gender inequality in data provision.

By implementing these recommendations and policies, Egypt can further advance its RE transition while ensuring inclusive participation and sustainable growth.

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