

ERF

Policy Research Report

Under Which Conditions Can Tunisian MSMES Shift to A Successful Energy Transition?

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Summary

Background

This case study of Tunisia places emphasis on the ongoing energy transition, underscoring its pivotal role in attaining sustainability and climate objectives. Tunisia has pledged to reduce its primary energy demand by 30% and generate 35% of its electricity from renewable sources by 2030. Its long-term objective is to achieve climate neutrality by 2050. This transition is not merely a matter of shifting energy sources; rather, it signifies a more profound socio-economic transformation. This necessitates a balancing act between neoliberal green extractivism, which places an emphasis on resource exploitation, and a more community-centered, just energy approach. The study focuses on elucidating the challenges and opportunities confronting Tunisia's MSMEs (micro, small, and medium enterprises), which occupy a pivotal role in the private sector and in job creation. The objective of the research is to examine the factors influencing the energy transition, including financial access, skill demand, and regulatory frameworks.

Methodology:

The study employed a mixed-methods approach, combining qualitative and quantitative methodologies, with the objective of gaining a comprehensive understanding of the subject matter. Quantitative data were gathered via the Economic Research Forum (ERF) survey, which encompassed 300 MSMEs across a range of economic sectors and regions in Tunisia. This data collection is part of a broader study conducted in six Middle East and North Africa (MENA) countries, which explores the role of MSMEs in fostering inclusive and sustainable economic growth amid the clean energy transition. In order to gain a deeper understanding of the subject matter, 34 key stakeholders were interviewed. These included researchers, finance professionals, NGO representatives, government officials, and MSME managers. The interviews were subjected to analysis using NVIVO software with a view to identifying recurring themes and perceptions pertaining to the energy transition.

Findings:

The findings of the study indicate that MSMEs in Tunisia are aware of the importance of the energy transition but face significant barriers to its implementation. These include high initial costs, limited financial resources, and a lack of targeted support mechanisms. Notwithstanding the fact that Tunisia's energy sector reforms and policies are oriented towards the promotion of renewable energy sources, the existence of bureaucratic inertia and regulatory complexities is proving to be an obstacle to the desired progress. The study underscores the necessity for strategic planning, effective policy implementation, and financial support tailored to MSMEs' specific needs.

Recommendations:

The recommendations underscore the necessity of enhancing governmental policies to cultivate a more conducive atmosphere for the energy transition. This entails the formulation of sector-specific strategies, the provision of financial incentives, the

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streamlining of administrative procedures, and the promotion of awareness and educational initiatives. The study posits that the realization of a successful energy transition hinges on a collaborative endeavor involving government entities, private enterprises, and international stakeholders. Furthermore, it advocates for a reassessment of the social contract to guarantee equitable benefits and inclusive involvement in the transition process.

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1. Introduction

Tunisia is at a critical juncture in its energy transition, which aims to mitigate the effects of climate change while promoting sustainable economic growth. The country's ambitious targets, which include reducing primary energy demand by 30 percent and generating 35 percent of its electricity from renewable sources by 2030, underscore its proactive stance on environmental protection and its commitment to aligning with global sustainability goals. In addition, Tunisia has committed to reducing greenhouse gas emissions by 45 percent from 2010 levels by 2050, with the ultimate goal of achieving climate neutrality. These commitments reflect not only a response to global environmental concerns but also a strategic move to ensure a sustainable future for Tunisia's economy and society.

However, the path to this energy transition is far from straightforward. It involves a fundamental transformation that extends beyond a mere shift in energy sources and affects the country's economic, social, and political fabric. Tunisia is caught between two competing narratives. On the one hand, there is a strong drive rooted in neoliberal green extractivism, which emphasizes the exploitation of resources primarily for export in order to generate revenue and stimulate economic growth. On the other hand, there is a growing movement advocating a just, democratic, and community-centered approach to energy projects, where local communities have a say in how resources are managed and used. This dichotomy poses a significant challenge for policymakers, who must find a balance that ensures economic viability while promoting social equity and environmental sustainability.

Tunisia's energy sector, historically dependent on fossil fuels, is now at the crossroads of these competing visions. The transition to renewable energy (RE) sources, such as solar and wind, is a critical step in reducing the country's carbon footprint and achieving its climate change goals. However, this transition requires significant financial investment, in addition to a shift in the sociopolitical dynamics that have traditionally governed the energy sector. The concept of a "just transition" becomes critical in this context, as it seeks to ensure that the benefits of the energy transition are shared equitably across society, addressing issues of gender, race, class, and other forms of social inequality that have historically been overlooked. The concept of a "just transition" is central to Tunisia's energy transition process. It is not only about shifting from fossil fuels to RE but also about ensuring that this transition contributes to broader social and economic justice. A just transition envisions an economic

transformation that is both environmentally sustainable and socially just, addressing the historical and contemporary injustices that have been exacerbated by the current economic system.

This approach emphasizes the need for a multidimensional form of justice—procedural, redistributive, and restorative—that recognizes the varying ways in which different groups in society are affected by the energy transition. Procedural justice focuses on the processes by which decisions are made, ensuring that all stakeholders, especially those most affected by the energy transition, have a voice in the decision-making process. Redistributive justice concerns the equitable distribution of the benefits and costs of the energy transition, ensuring that marginalized groups are not left behind. Restorative justice seeks to address past injustices by providing reparations and support to those who have been historically disadvantaged. In Tunisia, where issues of social inequality are deeply rooted, the concept of a just transition provides a framework for addressing these challenges in the context of the energy transition.

The just transition framework is essential for navigating the complexity of stakeholder interests in Tunisia's energy sector. It ensures that the energy transition does not exacerbate existing inequalities but rather contributes to the creation of a more just and equitable society. This requires a holistic approach that goes beyond technical and economic considerations to include social and political dimensions. The success of Tunisia's energy transition will depend on its ability to integrate these different dimensions into a coherent and inclusive strategy.

Economically, Tunisia has faced fluctuating growth rates over the past decades, with a significant slowdown following the 2010 revolution, exacerbated by the COVID-19 pandemic. These economic challenges have had a profound impact on the energy sector, where energy consumption patterns have remained inefficient despite declining economic growth. This inefficiency is particularly pronounced in the micro, small, and medium enterprises (MSMEs) sector, which is the backbone of the Tunisian economy. MSMEs, which account for a significant share of the private sector and job creation, have struggled with limited investment in energy efficiency and face challenges in scaling up sustainable practices. This disconnect between economic activity and energy use highlights the need for targeted interventions to improve energy efficiency and support the sustainable growth of MSMEs.



Politically, Tunisia has a long history of proactive energy management, dating back to the mid-1980s when the government began implementing policies and legal frameworks to support investments in energy efficiency and RE. These efforts were further strengthened with the creation of the National Agency for Energy Management (ANME) and the launch of the Tunisian Solar Plan (PST) in 2009. The PST, which focuses on harnessing solar energy as a key renewable resource, represents a significant step toward diversifying Tunisia's energy sources and reducing its dependence on fossil fuels. However, despite these efforts, the path to a truly sustainable energy landscape in Tunisia remains fraught with challenges, including bureaucratic inertia, limited public and private investment, and a complex international context.

Bureaucratic inertia, characterized by slow decision-making processes and a lack of coordination between different government agencies, has been a major obstacle to energy policy implementation. This has been compounded by limited public and private investment in the energy sector, which has limited the development of RE projects and hindered progress toward Tunisia's climate change goals. In addition, Tunisia's energy transition is taking place in a complex international context, where global energy markets, technological advances, and geopolitical considerations all play a significant role. Addressing these challenges requires a coordinated approach that brings together multiple stakeholders, including government agencies, private sector actors, and civil society organizations (CSOs).

As part of the joint Economic Research Forum (ERF) and the project on "*The Role of MSMEs in Fostering Inclusive and Equitable Economic Growth in the Context of the Clean Energy Transition in MENA*" funded by the International Development Research Centre (IDRC), this case study of Tunisia seeks to unravel the complex dynamics affecting the energy transition, with a particular focus on MSMEs. These enterprises are an important part of the Tunisian economy, contributing significantly to private-sector employment and economic activity. The study aims to explore the impact of factors such as access to finance, demand for skills, and the regulatory framework on the ability of MSMEs to participate in and benefit from the energy transition. By examining these factors, the study seeks to identify the challenges and opportunities that MSMEs face in the context of the energy transition and to provide policy recommendations that can support their participation in this critical process.

1.1. Concepts and definitions

1.1.1. Clean energy

The energy transition involves a complex interplay of concepts such as clean energy, RE, and energy security. Clean energy refers to energy production methods that release minimal to no greenhouse gases, such as nuclear, hydroelectric, wind, and solar power.¹ These energy sources are considered "clean" because they produce energy without emitting the pollutants that contribute to climate change and other environmental problems. The transition to clean energy is a key component of Tunisia's broader strategy to reduce its carbon footprint and meet its climate change goals.

1.1.2. Energy security

According to the International Energy Agency (IEA), energy security is the uninterrupted availability of energy sources at an affordable price. This concept encompasses both long- and short-term dimensions. Long-term energy security requires timely investment in energy supplies to meet future demand and ensure that energy is available at a reasonable cost. This involves developing a diverse and resilient energy mix, including both renewable and non-renewable sources, and investing in infrastructure and technology to ensure reliable energy delivery. Short-term energy security, on the other hand, focuses on the energy system's ability to respond quickly to sudden changes in the supply-demand balance, such as those caused by natural disasters, geopolitical conflicts, or other disruptions.² Ensuring energy security is a critical challenge for Tunisia as it transitions to a more sustainable energy system.

1.1.3. Renewable energy

RE is derived from natural processes that are continuously replenished, such as sunlight, wind, and water. Unlike fossil fuels, which are finite and contribute to environmental degradation, RE sources are sustainable and have a much lower environmental impact.³ The global energy transition involves a shift from fossil fuel-based energy production and consumption systems,

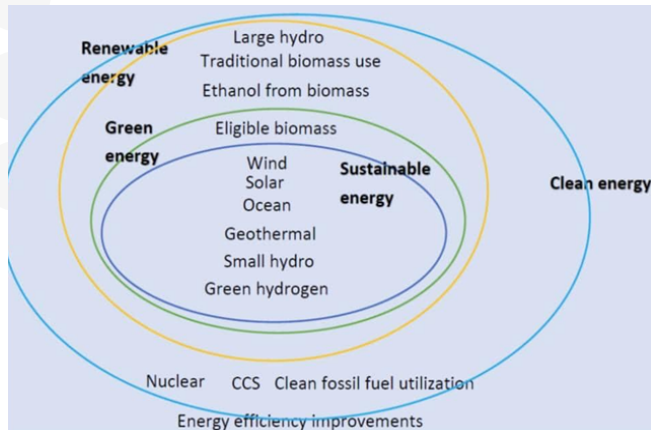
¹ <https://www.iaea.org/bulletin/what-is-the-clean-energy-transition-and-how-does-nuclear-power-fit-in>

² <https://www.iea.org/topics/energy-security>

³ <https://www.un.org/en/climatechange/what-is-renewable-energy>



Figure 1. Different concepts of energy



such as those dependent on coal, oil, and natural gas, to RE sources.⁴ This transition is driven by the need to reduce greenhouse gas emissions and mitigate the effects of climate change. In Tunisia, RE plays a key role in the country's strategy to diversify its energy mix and reduce its dependence on fossil fuels.

1.1.4. Green energy

Green energy, often used interchangeably with RE, refers specifically to energy produced from sources that do not pollute the atmosphere when used. While all green energy is renewable, not all RE is green.⁵ For example, some forms of biomass energy, which is derived from organic materials, can produce pollutants when burned, making it less “green” than other renewable sources such as wind and solar. Green energy is considered environmentally friendly because it produces energy without emitting harmful pollutants, making it a key component of Tunisia's strategy to reduce its environmental impact.

1.1.5. Sustainable energy

Sustainable energy is energy that meets current needs without compromising the ability of future generations to meet their own needs. It typically involves the use of renewable resources and emphasizes the importance of energy efficiency and conservation. Sustainable energy is not only about producing energy from renewable sources but also about using energy more efficiently and reducing overall energy consumption. In Tunisia, the transition to sustainable energy is essential to achieving long-term environmental and economic sustainability. This includes increasing the share of RE in the energy

⁴ <https://www.spglobal.com/en/research-insights/articles/what-is-energy-transition>

⁵ <https://www.twi-global.com/technical-knowledge/faqs/what-is-green-energy>

mix, promoting energy efficiency, and reducing energy waste.⁶

1.2. Tunisia's international and regional commitments

1.2.1. Agenda 2030 and Sustainable Development Goals

Tunisia's adherence to international and regional agendas, such as Agenda 2030 for Sustainable Development, demonstrates its commitment to addressing global challenges, including poverty eradication and environmental protection. Agenda 2030, which includes 17 Sustainable Development Goals (SDGs), provides a comprehensive framework for promoting sustainable development at the global level. Tunisia has made significant progress toward achieving these goals in areas such as education, health, and gender equality. However, the country still faces disparities across the SDGs, particularly in economic growth, infrastructure, and environmental sustainability. These challenges have been exacerbated by the setbacks caused by the COVID-19 pandemic, which had a profound impact on Tunisia's economy and society. Despite these challenges, Tunisia remains committed to its sustainability goals, recognizing the interdependence of sustainable energy goals and the need for collective action to achieve them.

1.2.2. Nationally determined contributions

Tunisia's nationally determined contributions (NDCs) reflect its commitment to reduce carbon intensity by 45 percent by 2030 compared to 2010 levels, with the energy sector playing a critical role in this effort. The NDCs, which are part of Tunisia's commitments under the Paris Agreement, outline the country's strategy for reducing greenhouse gas emissions and transitioning to a low-carbon economy. Projections suggest that the energy sector could contribute up to 73 percent of the total mitigation potential by 2030, but achieving these goals will require significant investment, estimated at USD 20 billion. Tunisia's proactive approach to climate action, coupled with its ambitious NDCs, positions the country as a key player in the global fight against climate change. However, the successful implementation of these commitments will require a coordinated effort across different sectors, including energy, transport, agriculture, and industry, as well as the active engagement of all stakeholders, including government agencies, private sector actors, and CSOs.

⁶ <https://energy.sais.jhu.edu/articles/renewable-energy-vs-sustainable-energy/>



1.3. National commitments

1.3.1. Strategic planning for low-carbon development

Tunisia's long-standing commitment to integrating climate and environmental considerations into its strategic planning is evidenced by the adoption of strategies aimed at low carbon development and achieving carbon neutrality by 2050. The National Strategy for Low Carbon Development and Resilience to Climate Change by 2050 (SNBC-RCC), finalized in October 2022, outlines a significant reduction in greenhouse gas emissions and promotes development adapted to climate impacts, particularly in the most vulnerable sectors. This strategy is Tunisia's most ambitious framework for achieving a sustainable and resilient economy. It provides a coherent vision for the country's structural transformation, aligning climate, environmental, social, and economic objectives. The SNBC-RCC includes a comprehensive set of measures to reduce carbon emissions in various sectors, including energy, transport, agriculture, and industry. These measures are designed to promote the adoption of clean technologies, improve energy efficiency, and enhance the economy's resilience to the impacts of climate change.

1.3.2. Energy management and re initiatives

Since the mid-1980s, Tunisia's energy sector has been the focal point of its sustainable development efforts. The establishment of ANME laid the foundation for a comprehensive approach to efficient energy management, with an emphasis on energy efficiency and RE sources. ANME has played a critical role in promoting energy efficiency measures in various sectors, including industry, transportation, and buildings. These measures have helped reduce energy consumption and improve the overall energy performance of the economy. The launch of the PST in 2009 further underscores the country's commitment to RE and its goal to diversify energy sources by focusing on solar energy. The PST is a key component of Tunisia's strategy to reduce its dependence on fossil fuels and increase the share of RE in its energy mix. The plan includes a number of initiatives to encourage the development of solar energy projects, including the establishment of regulatory frameworks, the provision of financial incentives, and the promotion of public-private partnerships. Through these initiatives, Tunisia aims to harness its abundant solar resources to meet its growing energy needs and reduce its carbon footprint.

1.4. Research objectives and methodology

1.4.1. Quantitative research methodology

This study adopts a mixed-methods approach, integrating qualitative and quantitative research paradigms to thoroughly explore the experiences and perceptions of MSMEs in Tunisia regarding the energy transition. The quantitative component of this research is based on data collected through an ERF survey that includes responses from 300 MSMEs across 17 different economic sectors in different Tunisian governorates. This survey is part of a broader study conducted in six MENA countries (Jordan, Sudan, Morocco, Egypt, Tunisia, and Lebanon) as part of ERF's project entitled "The Role of MSMEs in Fostering Inclusive and Equitable Economic Growth in the Context of the Clean Energy Transition in MENA." The quantitative data collected through this survey provides a comprehensive overview of the current state of the MSME sector in Tunisia and its role in the energy transition. For a detailed examination of the ERF survey data and its implications, please refer to section 4.1 of this report.

1.4.2. Qualitative research methodology

The qualitative component of the study is based on interviews conducted with 34 key stakeholders, comprising engineers from key sectors of the Tunisian economy. The gender distribution of the participants includes 26 men and eight women. These stakeholders are divided into five distinct groups: researchers and experts (23.53 percent); banking and finance professionals (14.71 percent); representatives of non-governmental organizations (NGOs) (5.88 percent); government officials (8.82 percent); and MSMEs, including very small enterprises (VSEs) (47.06 percent). This diverse pool of participants ensures a rich and varied collection of insights, enhancing the depth and breadth of the research findings. The interviews were analyzed using NVIVO version 14, a leading qualitative data analysis software that facilitates in-depth examination of textual data. The methodology includes a lexical and frequency analysis of transcriptions, which allows for the identification and quantification of prevalent themes, phrases, and terms. This technique is central to unpacking the complex narratives that emerge during the interviews and providing a granular understanding of the nuanced perspectives surrounding Tunisia's energy transition.



1.4.3. Research integration and objectives

By harmonizing qualitative findings with quantitative data, this research aims to provide a comprehensive overview of the current state and future prospects of the energy transition in the Tunisian MSME sector. The integration of these two strands of research allows for a holistic understanding of sector dynamics and the multiple challenges and opportunities facing Tunisian businesses in the context of global and local sustainability initiatives. This dual approach not only enriches the academic discourse on sustainable development but also informs policymaking and strategic planning, thereby contributing to the advancement of Tunisia's economic and environmental goals. The results of the study are expected to provide valuable insights that can guide the design and implementation of policies to support the energy transition and promote sustainable economic growth in Tunisia.

2. Literature review

The literature on Tunisia's energy transition is extensive and diverse, reflecting the complex nature of the challenges and opportunities at the intersection of economic development, environmental sustainability, and social equity. Researchers have long recognized that Tunisia's energy transition is not merely a technical shift from fossil fuels to RE but a profound transformation of the country's economic, political, and social landscape. Existing research provides a rich tapestry of insights, drawing from multiple disciplines and methodologies to provide a comprehensive understanding of how Tunisia can navigate this transition.

Much of the literature focuses on the macroeconomic dynamics underpinning Tunisia's energy transition. Belloumi's (2009) seminal work serves as a foundational study in this area. Using the Johansen cointegration technique and the vector error correction model (VECM), the author examines the bidirectional causal relationships between energy consumption and economic growth. His findings suggest that energy consumption is not only a driver of economic growth but also a consequence of it, highlighting the interdependence of energy and economic development. This study set the stage for subsequent research that sought to unravel the complexities of Tunisia's energy landscape.

Building on Belloumi's findings, Jebli and Youssef (2015) introduce an environmental dimension to the analysis by incorporating CO₂ emissions into their models. Using Autoregressive Distributed Lag (ARDL) models, they examine the impact of renewable and

non-renewable sources on the economy, highlighting the dual challenge of promoting economic growth while mitigating environmental degradation. Their work highlights the tension between economic development and environmental sustainability, a theme that resonates in the broader literature on Tunisia's energy transition.

Furthering this line of inquiry, Lieu et al. (2023) focus on the relationship between electricity prices and economic growth using an ARDL model, a variance decomposition, and an impulse response analysis. Their study pinpoints the critical need for Tunisia to transition away from fossil fuels to align with global environmental goals and stabilize the economy against the volatility of global energy markets. This sentiment is echoed in the work of Brini et al. (2017), who examine the interplay between RE consumption, international trade, and economic variables. The authors identify bidirectional links between these factors, highlighting the direct impact of oil price fluctuations on RE consumption. Their findings reinforce the notion that Tunisia's economic policies must be strategically aligned with global energy market trends in order to successfully navigate the energy transition.

As the discourse on Tunisia's energy transition has evolved, researchers such as Farhani and Ozturk (2015) delve deeper into the environmental implications of economic growth. By challenging the environmental Kuznets curve hypothesis, they reveal the intricate relationships between CO₂ emissions, GDP, energy consumption, financial growth, and urbanization. Their use of ARDL models coupled with ECM techniques provides a more nuanced understanding of how these variables interact, highlighting the multifaceted nature of Tunisia's energy challenges. This research underscores the importance of an integrated policy approach that simultaneously addresses economic, environmental, and social objectives.

The nexus between economic growth and environmental sustainability is further explored in the literature through the lens of RE and non-RE consumption. Dahmani et al. (2023) provide a comprehensive analysis of these dynamics within the broader MENA region, including Tunisia. Using the Cross-Section Augmented Autoregressive Distributed Lag (CS-ARDL) technique, their study reveals the dual impact of energy consumption on economic growth. They highlight the potential of RE and information and communication technology (ICT) as key drivers of sustainable development, while also pointing out the complexities introduced by financial development, which sometimes has counterintuitive effects on economic growth.

Similarly, Ben Mbarek et al. (2015) use sophisticated



statistical models to examine the long-term relationships between economic growth, RE use, and CO2 emissions. Their findings reinforce the idea that energy consumption has immediate economic effects, which, in turn, influence long-term environmental outcomes. This body of work sheds light on the critical role that RE can play in decoupling economic growth from environmental degradation, an issue that is central to discussions about sustainable development in Tunisia.

Technological progress, or lack thereof, plays a critical role in determining the trajectory of Tunisia's energy transition. Saadaoui et al. (2024) provide important insights into this area through their use of the Nonlinear Autoregressive Distributed Lag (NARDL) model. Their research examines the impact of technological progress on Tunisia's green initiatives and finds that while technological progress can significantly advance green energy efforts, disruptions or setbacks can pose serious challenges. The study highlights the dual nature of technology as both an enabler and potential obstacle to sustainable development, depending on how effectively it is managed and integrated into broader energy policies.

The role of institutional and sociopolitical factors in shaping Tunisia's energy transition has also received considerable attention in the literature. For example, Akermi and Triki (2017) examine the contributions of CSOs to the RE movement in Tunisia. Through a qualitative analysis, they identify the various motivations that drive CSO advocacy, including environmental concerns, economic opportunities, and social justice. Their work also highlights the significant challenges these organizations face, such as financial constraints and institutional barriers, which limit their ability to effectively influence energy policy.

The political landscape in Tunisia has had a profound impact on energy policy, particularly in the wake of the 2011 revolution. Alimi et al. (2017) use the Smooth Transition Autoregressive (STAR) method to analyze how the RE sector responded to political upheaval, finding that periods of political stability tend to support the advancement of RE projects, while instability can lead to setbacks. Rocher and Verdeil (2013) further examine the interaction between political events and energy policy, finding that the revolution disrupted the monopolistic control of the Tunisian Electricity and Gas Company (STEG), opening up new opportunities for RE initiatives. This shift underscores the importance of political stability and institutional reforms in facilitating a successful energy transition.

The economic framework and the quality of institutions

are also critical determinants of Tunisia's ability to adopt RE solutions. Research by Ben Khaled et al. (2024) and Saadaoui and Chtourou (2023) suggests that the quality of institutions plays a critical role in shaping energy policy outcomes. These studies argue that coherent and supportive regulatory frameworks are essential to overcome barriers to the adoption of green technologies. They also highlight the potential for financial development to accelerate the energy transition, provided that it is accompanied by transparent and effective institutional governance.

Decoupling carbon emissions from economic growth remains a key concern in the literature on Tunisia's energy transition. Dahmani et al. (2021) make a significant contribution in this area by analyzing Tunisia's greenhouse gas emissions using an extended STIRPAT model, the Tapio decoupling model, and the ARDL bounds test approach. Their results confirm an inverted U-shaped relationship between GDP and greenhouse gas emissions, indicating that Tunisia has the potential to achieve long-term emission reductions through the adoption of RE. This is consistent with other studies that have used the Tapio decoupling model to explore similar dynamics in different contexts. For example, Tang and Jiang (2023) and Rajabi Kouyakhli (2022) show that effective decoupling requires strategic shifts in both energy and industrial policies, lessons that are highly relevant to Tunisia's efforts to reduce its carbon footprint.

The Logarithmic Mean Divisia Index (LMDI) decomposition method has been widely used in the literature to provide a more detailed analysis of Tunisia's CO2 emissions. Studies by Essaber (2023) and Ben Hammamia and Dhakhlaoui (2023) use this method to identify the main drivers of emissions, such as GDP growth and energy intensity. Their work provides a detailed understanding of how economic activities contribute to environmental outcomes and offers valuable insights into the strategies needed to mitigate these effects. The LMDI methodology's ability to disaggregate the contributions of different factors to changes in emissions makes it a powerful tool for policymakers seeking to design effective interventions.

The literature also highlights the critical role of MSMEs in Tunisia's energy transition. Lehr et al. (2016) and Gazzo et al. (2024) examine the economic impact of RE and energy efficiency, with a particular focus on job creation and technological advancement in these sectors. Their findings suggest that initiatives such as the PST have created significant employment opportunities, particularly in solar and wind energy. However, challenges remain, particularly in terms of upgrading the skills



of the workforce and ensuring that the benefits of the energy transition are shared equitably across different segments of society. This highlights the importance of inclusive policies that address the specific needs and capacities of MSMEs, which are often overlooked in broader economic strategies.

Despite the wealth of macro-level analysis, there is a noticeable gap in micro-level studies, particularly those that focus on the experiences of individual firms within the MSME sector. Current research tends to emphasize sectoral differences in adoption and capabilities but lacks detailed examinations of the specific challenges and opportunities faced by firms on the ground. Filling this gap, this study provides a micro-level analysis of the energy transition within firms, particularly MSMEs, and offers insights that are critical for understanding the broader implications of Tunisia's energy transition.

In addition to economic and institutional factors, the literature also examines the impact of climate change on different sectors of the Tunisian economy. Ben Youssef et al. (2023) use advanced modeling techniques such as the LMDI-II decomposition method and the Kaya identity to examine how climate change will affect key sectors such as agriculture, tourism, and health. Their research highlights the complex relationship between population growth, energy consumption, and economic activities, pointing to the need for targeted adaptation strategies to mitigate the adverse effects of climate change.

The agricultural sector in particular is highly vulnerable to climate change due to its dependence on water availability and temperature stability. Soltani and Mellah (2023) study farmers' adaptation strategies to water scarcity in Tunisia and find significant differences in the capacity of different agricultural systems to cope with environmental change. Their findings emphasize the need for tailored policy interventions that address the specific vulnerabilities of different sectors and ensure that energy transitions contribute to broader goals of food security and economic stability.

International perspectives provide a valuable comparative context for understanding Tunisia's energy transition. Studies that examine how other countries have managed their transitions to RE offer important lessons that can inform Tunisia's approach. For example, Han et al. (2022) and Wang et al. (2023) examine the experiences of China and countries in the European Union (EU), highlighting the importance of policy coherence, technological innovation, and financial investment for a successful energy transition. These studies suggest that while Tunisia faces unique challenges, it can benefit from the experiences of other countries by adopting best practices and avoiding common pitfalls.

By integrating these different strands of literature, this review highlights the multifaceted nature of Tunisia's energy transition. It underscores the need for a holistic approach that considers the economic, environmental, social, and political dimensions of the transition, and emphasizes the importance of both macro-level strategies and micro-level interventions. The findings from the existing body of research provide a solid foundation for the present study, which seeks to fill the gaps in the literature by focusing on the micro-level experiences of MSMEs and their role in Tunisia's broader energy transition.

3. The current situation in Tunisia: from economic situation to energy transition

3.1. The economic situation

Tunisia's economic landscape in 2023 continues to be influenced by a variety of challenges that have collectively hampered the country's recovery and growth prospects. The severe drought that has persisted for several years, coupled with unpredictable financing conditions, has significantly worsened Tunisia's already fragile economic situation. The agricultural sector, a cornerstone of the Tunisian economy, has been particularly affected, with real value-added contracting by nine percent in the first half of 2023 compared to the same period in 2022. This contraction is a direct result of six consecutive years of below-average rainfall, highlighting the vulnerability of the Tunisian economy to environmental factors (World Bank, 2023).

These problems have contributed to a significant slowdown in economic growth, with Tunisia's GDP increasing by only 1.2 percent in the first half of 2023. This rate is significantly lower than the 2.4 percent growth achieved in 2022 and the 4.4 percent growth in 2021, highlighting the ongoing challenges in regaining pre-pandemic economic momentum. Structural inefficiencies in the Tunisian economy, particularly the heavy reliance on VSEs and microenterprises, have further complicated recovery efforts. While these businesses are critical to the economy—contributing about 50 percent of GDP and providing nearly 70 percent of private sector employment—they are often unable to achieve economies of scale or implement energy efficiency measures due to high operating costs and limited access to capital (Arouri et al., 2018).

Tunisia's economic environment remains constrained by regulatory barriers that stifle growth and innovation. Restrictive entry requirements in various sectors, strict foreign exchange controls, and the entrenched positions



of established market players create a challenging landscape for new and existing businesses alike. These regulatory hurdles not only inhibit competition but also discourage much-needed investment in key sectors, including RE, which is critical to the country's long-term economic sustainability.

Tunisia's economic stagnation reflects broader trends in the MENA region, where many economies face similar challenges. However, Tunisia's situation is particularly acute because of the interplay between economic stagnation, environmental degradation, and social unrest. Failure to address these interrelated issues could have far-reaching consequences for Tunisia's social and economic stability, making it imperative for policymakers to implement comprehensive and coordinated strategies that address these challenges holistically.

3.2. Energy situation and demand

Tunisia's energy sector is undergoing a period of significant transition, driven by the twin imperatives of maintaining energy independence and meeting growing domestic energy demand. By the end of November 2023, Tunisia's primary energy resources had declined by five percent compared to the previous year, a decline that is largely attributable to lower domestic production of crude oil and natural gas. Despite this decline, fossil fuels continue to dominate Tunisia's energy mix, with domestic oil and gas production accounting for 73 percent of the country's primary energy resources. However, the contribution of renewables remains disappointingly low, with only one percent of primary energy resources coming from renewables, mainly from STEG (Tunisian Ministry of Industry, Mines, and Energy, 2023).

The demand for primary energy has also undergone significant shifts. Between February 2023 and February 2024, there was a six percent decrease in total primary energy demand, mainly due to a 13 percent decrease in natural gas demand. This decrease is largely the result of restrictions on Algerian gas imports, which have forced Tunisia to increase its reliance on electricity imports to meet national demand. This strategy underlines Tunisia's continued dependence on external energy sources and highlights the vulnerability of the current energy system (Tunisian Ministry of Industry, Mines, and Energy, 2024).

At the same time, demand for petroleum products increased slightly by two percent, indicating that fossil fuels continue to play a dominant role in Tunisia's energy consumption patterns. This continued reliance on fossil fuels, despite government efforts to promote RE, reflects

the challenges of transitioning to a more sustainable energy system in the context of economic constraints and regulatory inefficiencies.

Electricity production in Tunisia remains heavily dependent on natural gas, with STEG continuing to dominate the sector, accounting for 96 percent of national production. Despite a nine percent decline in natural gas generation, the contribution of RE to electricity generation remains marginal at just five percent of total production. This limited uptake of RE highlights the significant barriers to scaling up RE projects in Tunisia, including the high cost of renewable technologies, the lack of adequate infrastructure, and the slow pace of regulatory reforms (Tunisian Ministry of Industry, Mines, and Energy, 2024).

Moreover, Tunisia's energy trade deficit continues to grow, rising from 1,788 million Tunisian dinars (TND) at the end of February 2023 to TND 1,878 million in February 2024. This five percent increase in the deficit is primarily driven by the increased value of energy imports, further underscoring the urgency of accelerating Tunisia's energy transition to reduce its dependence on imported fossil fuels and enhance energy security. The rising energy trade deficit also highlights the economic costs of the current energy system, which relies heavily on volatile international markets for its energy needs (Tunisian Ministry of Industry, Mines, and Energy, 2024).

3.3. Fossil resources and the implementation of a clean transition

Tunisia's dependence on fossil fuels is a complex and multifaceted challenge, deeply intertwined with the country's socioeconomic and environmental realities. Despite globally ranking 48th in oil production and 53rd in natural gas production, Tunisia has experienced a steady decline in energy self-sufficiency since the late 1990s. With reserves estimated at approximately 400 million barrels of oil and nearly 65 billion cubic meters of natural gas, Tunisia's domestic production has increasingly fallen short of meeting national demand. This has led to a growing dependence on energy imports and a widening energy trade deficit, posing significant risks to the country's economic stability and energy security.

The dominance of state-owned companies such as STEG and the Tunisian Petroleum Activities Company (ETAP) has historically shaped Tunisia's energy landscape. These companies, which have long controlled the production and distribution of fossil fuels, have been slow to embrace the transition to RE. The monopolistic



structure and significant market power of these entities have significantly hindered the deployment of RE projects, as the existing infrastructure and market dynamics are heavily skewed toward fossil fuels. This dominance has also led to a lack of competition and innovation in the energy sector, further slowing the pace of the clean energy transition.

Despite these challenges, the need for a clean energy transition is increasingly recognized, driven by both environmental imperatives and the economic unsustainability of continued reliance on fossil fuels. The 13 percent decline in natural gas demand between February 2023 and February 2024, coupled with a slight increase in petroleum product consumption, suggests that Tunisia is beginning to explore alternative energy sources, albeit slowly (Tunisian Ministry of Industry, Mines, and Energy, 2024). However, the contribution of RE to the overall energy mix remains minimal, highlighting the significant hurdles that Tunisia must overcome to achieve its energy transition goals.

The Tunisian government has set ambitious targets for increasing the share of RE in the national energy mix, aiming to reach 35 percent by 2030 and 50 percent by 2035. These targets are supported by a number of policies and incentives to attract investment in RE projects. For example, the government has launched several international tenders to attract investment in solar and wind energy and has introduced feed-in tariffs to ensure stable prices for energy from renewable sources. However, the implementation of these policies has been hampered by regulatory challenges, including complex permitting processes, inconsistent enforcement, and resistance from incumbent market players.

Private sector involvement in Tunisia's energy transition is critical to advancing the country's clean energy agenda. Initiatives such as the SUNREF credit line, established in partnership with international investors and local stakeholders, have begun to encourage investment in RE projects, particularly solar and wind power. These efforts are critical to reducing Tunisia's dependence on fossil fuels and promoting the development of sustainable energy sources. However, the regulatory environment remains a significant barrier to private sector participation. Existing laws and decrees require greater transparency and alignment with investor interests to fully unlock the potential of the private sector in advancing the clean energy transition (Ben Youssef et al., 2024).

In addition to these challenges, Tunisia faces significant infrastructure constraints that hinder the deployment of

RE projects. The country's energy infrastructure, including transmission and distribution networks, is outdated and inadequate to support the integration of RE sources into the national grid. Upgrading this infrastructure is essential to achieve the government's RE targets but will require significant investment and coordinated efforts between the public and private sectors.

3.4. Social implications of the energy transition: toward a new social contract

The energy transition in Tunisia has profound social implications, presenting both opportunities and challenges that require a redefinition of the social contract between the state, businesses, and citizens. As Tunisia moves toward a more sustainable energy future, the potential for economic empowerment through job creation and community-driven energy projects is significant. The transition to RE has the potential to create thousands of new jobs, particularly in the construction, installation, and maintenance of RE infrastructure. In addition, decentralizing energy production could empower local communities, giving them greater control over their energy resources and fostering economic development in disadvantaged regions.

However, this transition also risks exacerbating existing social inequalities if not managed in an inclusive and equitable manner. One of the key social challenges of the energy transition is the uneven distribution of its benefits. While the RE transition has the potential to create between 7,000 and 20,000 jobs, these opportunities are largely temporary and concentrated in the construction and installation phases of energy projects. Without strategic efforts to localize the production of RE technologies and reduce dependence on imports, the long-term employment benefits may remain limited. In addition, the potential for land acquisition and exploitation in disadvantaged regions raises concerns about equity and social justice.

The energy transition also has the potential to disrupt existing social and economic structures, particularly in rural areas where the economy is heavily dependent on traditional forms of energy production. For example, the installation of wind turbines and other RE infrastructure in rural areas has sometimes led to conflicts between local communities and energy developers, particularly where there has been inadequate consultation and compensation. In regions such as Borj Salhi, where wind turbines have been installed, inadequate community engagement has led to environmental degradation and social unrest, highlighting the need for more inclusive decision-making processes.



To address these challenges, Tunisia's energy transition must be guided by principles of social justice and equity. This includes ensuring that the benefits of RE projects are widely shared and that marginalized communities are actively involved in planning and implementation. Strengthening legal frameworks to protect community rights and prevent the concentration of benefits in the hands of a few powerful actors is essential to promoting a just and inclusive energy transition.

Decentralizing energy production is a promising way to empower local communities. By promoting community-led energy projects and increasing local ownership of energy resources, Tunisia can create a more inclusive and democratic energy sector. This approach requires a redefinition of the social contract, in which all stakeholders are involved in the energy transition to ensure that it is not only environmentally sustainable but also socially equitable.

3.5. The role of the private sector in Tunisia's energy transition

The private sector in Tunisia is playing an increasingly important role in the country's energy transition, particularly as the government seeks to diversify its energy mix and reduce dependence on fossil fuels. Private companies have begun to take the lead in developing RE projects, such as solar and wind power, through partnerships with international investors and local stakeholders. These initiatives are critical to addressing Tunisia's energy challenges, particularly in light of declining domestic fossil fuel production and increasing energy imports (Ben Youssef et al., 2024).

Private sector involvement is not limited to energy generation; it extends to improvements in energy infrastructure, including the development of transmission and distribution networks. These efforts are essential for integrating RE into the national grid and ensuring a reliable supply of energy. In addition, private companies are driving research and development in clean energy technologies, positioning Tunisia as a potential hub for RE innovation and expertise.

However, the success of private sector involvement depends on overcoming significant regulatory and operational challenges. Existing regulations, including those governing public-private partnerships, require greater transparency and alignment with investor interests to create an enabling environment for investment. In addition, the dominance of STEG and union opposition remain significant barriers to energy

sector liberalization. For example, the bureaucratic hurdles associated with obtaining permits and approvals for RE projects can result in significant delays and increased costs, deterring potential investors.

Despite these challenges, the private sector has shown resilience and innovation in navigating the complexities of the Tunisian energy market. Enterprises are increasingly exploring innovative business models, such as energy-as-a-service and leasing arrangements, to overcome financial barriers and accelerate the adoption of RE technologies. These models allow companies, especially MSMEs, to adopt RE without the burden of high upfront costs, thereby reducing financial risks and encouraging broader participation in the energy transition (Ben Youssef et al., 2024).

The private sector also plays an important role in fostering local capacity and expertise in RE. By investing in training programs, research collaborations, and technology transfers, private companies are helping build a skilled workforce capable of supporting Tunisia's transition to a sustainable energy future. These efforts are essential if Tunisia is to meet its ambitious RE targets and position itself as a leader in the regional energy market.

As such, private sector engagement in Tunisia's energy transition is essential to achieving the country's sustainability goals. By fostering a more supportive regulatory environment and encouraging collaboration between the public and private sectors, Tunisia can accelerate its sustainable energy transition. Private sector involvement in research and development, particularly in areas such as energy storage and smart grid systems, will be critical to achieving the country's ambitious RE targets and positioning Tunisia as a regional leader in energy transition.

4. MSMEs and the energy transition

This section examines the key role of Tunisian MSMEs in the country's energy transition, highlighting the challenges and opportunities they face in adopting RE technologies and energy efficiency measures.

Historically, the participation of MSMEs in Tunisia's energy transition has been constrained by several factors, including regulatory hurdles, limited access to financing, and a general lack of comprehensive understanding of RE technologies beyond solar and wind. Despite these constraints, MSMEs are a cornerstone of the Tunisian economy, contributing more than 50 percent of the country's GDP and employing 70 percent of the private



sector workforce. Their involvement in the energy transition is therefore critical to ensuring sustainable economic growth.

Over the past decades, Tunisia's RE mix has stagnated, with renewables accounting for only two to three percent of the total energy supply. This slow progress can be attributed to several key barriers, including the high cost of RE technologies, a lack of supportive policies, and limited awareness among MSMEs of the benefits and opportunities of energy efficiency. While studies on RE adoption in Tunisia have highlighted these barriers, the specific dynamics influencing MSME participation in the energy transition have not been sufficiently explored. Moreover, no comprehensive survey has yet been conducted to examine the rate of adoption of RE and energy efficiency practices by Tunisian MSMEs.

Recent developments, however, suggest that this situation is beginning to change. New projects aimed at expanding RE capacity are being implemented both at the national level and within individual companies. The results of the ERF survey provide valuable insights into the factors that promote or hinder MSME participation in the energy transition. The survey, complemented by qualitative interviews with key stakeholders, provides a more nuanced understanding of the challenges that MSMEs face and highlights emerging trends that could reshape their role in Tunisia's energy landscape. These insights are critical for formulating strategies to accelerate the adoption of RE and improve energy efficiency within the MSME sector, which is increasingly focused on sustainability.

4.1. MSME landscape

4.1.1. Overview of MSMEs in Tunisia

Tunisia's economy is characterized by a significant presence of MSMEs, including a significant proportion of MSMEs. Despite their importance, MSMEs often struggle to improve energy efficiency due to several persistent challenges. Limited financial capacity, the complexity of the regulatory framework, and a lack of awareness of energy-saving practices are significant barriers. Most MSMEs in Tunisia operate on a small scale, which limits their ability to take full advantage of economies of scale and makes it difficult for them to allocate resources to energy-efficient technologies.

For MSMEs in particular, energy efficiency remains a low priority due to the high upfront costs of investing in RE and the perceived complexity of transitioning to more sustainable business practices. In addition, these companies often face difficulties in accessing finance

tailored to energy efficiency investments, which further exacerbates their limited capacity to adopt new technologies. Despite these constraints, MSMEs are critical drivers of job creation and innovation in the Tunisian economy. Their collective impact on the national energy landscape is significant, but unrealized potential remains due to the structural constraints they face (Arouri et al., 2018). Tailored financial instruments and regulatory frameworks that facilitate access to energy-efficient technologies could help unlock this potential, enabling MSMEs to become key actors in Tunisia's energy transition.

4.1.2. Sectoral distribution of MSMEs

The sectoral distribution of MSMEs in Tunisia, highlighted in the ERF survey, provides a detailed picture of the diverse economic activities across different industries. This distribution provides insight into the unique challenges and opportunities faced by different sectors, particularly in terms of energy use and sustainability. The agriculture, fishing, and mining sectors account for 11.33 percent of MSMEs, making them significant contributors to the economy. These sectors are directly linked to natural resources and are highly dependent on energy, both in terms of consumption and production. As such, they represent key areas where energy efficiency measures could have a significant impact on reducing environmental impacts.

The textile and clothing industry (which accounts for 5.67 percent of MSMEs) and the food processing industry (which accounts for 9.67 percent) demonstrate Tunisia's strength in traditional manufacturing sectors. These industries are labor-intensive and have varying degrees of energy efficiency, often hampered by outdated technologies and limited financial resources for modernization. Energy-efficient processes in these industries could reduce operating costs, increase competitiveness, and improve their contribution to sustainable growth.

The mechanical, electronic, and allied industries represent five percent of the MSME landscape and are particularly important as they embody the potential for technological advancement. These sectors are central to the adoption of energy-efficient processes, which could be leveraged to drive innovation and sustainability in other industries. Meanwhile, the chemical, petroleum, and plastics industries account for 7.67 percent of MSMEs and stand out as energy-intensive sectors. Their environmental impact underscores the urgent need for targeted sustainability practices and incentives to promote energy-efficient technologies.

Other important sectors include construction and utilities, which account for 11.33 percent of MSMEs, and retail and



wholesale trade, which respectively account for 13.67 and 9.33 percent. These sectors are integral to the urban economy and influence energy consumption patterns through their widespread activities. The service sectors, such as those related to electricity and water (six percent and 1.33 percent, respectively), are directly linked to energy distribution and consumption, making them crucial in the energy transition discussion.

Less represented sectors, such as transport and storage (1.67 percent), accommodation and food services (3.33 percent), and ICT (2.67 percent) are essential niche markets that contribute significantly to the energy ecosystem despite their size. This is due to their potential for digitalization and energy savings.

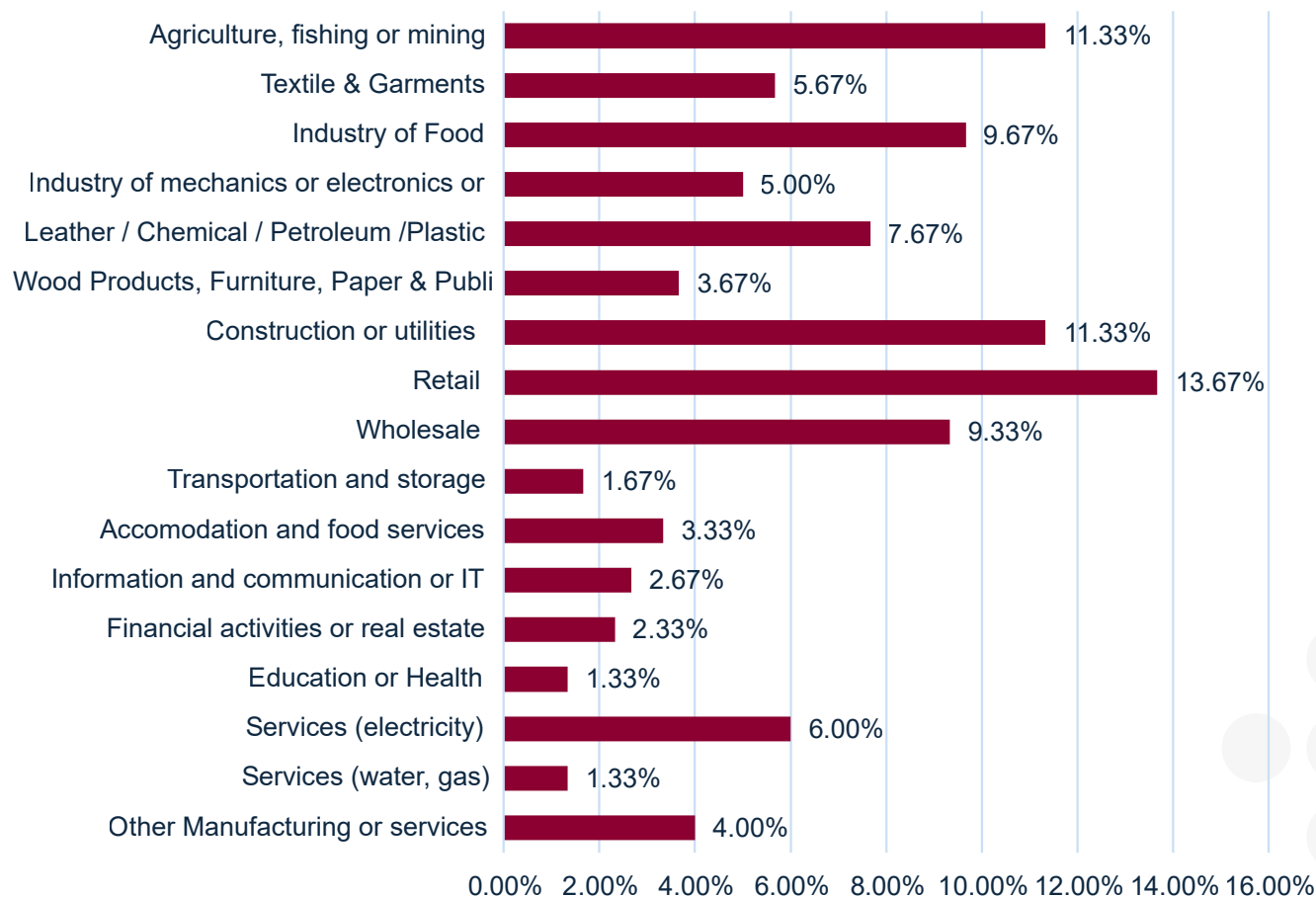
This sectoral diversity illustrated in Figure 2 highlights the need for sector-specific energy transition strategies. These strategies must address the unique challenges faced by each sector to ensure that Tunisia's MSMEs can fully participate in the country's transition to a more sustainable and energy-efficient economy. By identifying sectors with the greatest potential for energy efficiency improvements, stakeholders can develop targeted interventions that contribute to Tunisia's broader economic and environmental goals.

4.1.3. Geographical and business environment

The geographical distribution of MSMEs in Tunisia reveals significant regional disparities in business activity, with a pronounced concentration in coastal and urban areas. According to the ERF survey, most MSMEs are concentrated in Greater Tunis, which includes the governorates of Tunis, Ariana, Manouba, and Ben Arous. This region is an important economic hub and home to 14.67 percent of the businesses surveyed. It benefits from well-developed infrastructure, access to financial institutions, and a dense urban population, all of which drive demand for goods and services. The concentration of businesses in Greater Tunis underscores the importance of the region in Tunisia's economic landscape and highlights the need for targeted energy efficiency policies that can maximize the region's potential for sustainability.

Besides Greater Tunis, other coastal areas such as the Cape Bon region (Nabeul governorate) and the Tunisian Sahel, comprising the governorates of Monastir, Mahdia, and Sousse, are also critical to the MSME landscape. These areas thrive on their proximity to the coast and benefit from tourism and its associated services, which, in turn, drive business activity in sectors such as retail and hospitality. For example, Sousse and Monastir together account for approximately 11.66 percent of the

Figure 2. Sectoral distribution of Tunisian MSMEs



MSMEs surveyed, demonstrating their importance as commercial hubs. These regions also offer opportunities for energy efficiency improvements, particularly in energy-intensive industries such as tourism and food processing. Sfax, located in southeastern Tunisia, is known for its industrial base and strategic port, which supports both local and international trade. This region accounts for 13.00 percent of the MSMEs surveyed, reflecting its economic importance. However, energy efficiency in Sfax-based industries remains a challenge, as many companies still rely on energy-intensive processes.

In contrast, inland regions such as Gafsa, Kasserine, Tataouine, and Le Kef have significantly lower concentrations of MSMEs, largely due to underdeveloped infrastructure, limited access to markets, and fewer educational and financial resources. For example, Tataouine and Kébili each account for less than one percent of the MSMEs surveyed, highlighting the stark economic disparities between coastal and inland regions. Businesses in these areas face many challenges, and improving energy efficiency is often a lower priority compared to more immediate economic concerns. Nevertheless, these regions could benefit from targeted policies that improve infrastructure and provide incentives for the adoption of energy-efficient technologies.

Figure 3 provides a visual representation of the geographic distribution of MSMEs in Tunisia, showing the dense concentration of businesses in the more economically developed coastal regions compared to the sparsely populated interior. The survey also shows that 85.33 percent of MSMEs are located in urban areas, indicating a significant urban-rural divide in business activity. This urban concentration exemplifies the need for policies that promote more balanced regional development, particularly through investments in infrastructure, technology, and access to finance for rural MSMEs.

Addressing these geographic disparities is critical to promoting inclusive economic growth in Tunisia. By providing region-specific support, such as improving access to energy-efficient technologies in underserved areas, policymakers can ensure that the benefits of the energy transition are shared more equitably across the country. Regional development policies that focus on improving the business environment in rural and interior regions are essential to achieving a more balanced and sustainable economic future for Tunisia.

4.1.4. Workforce characteristics

The workforce characteristics of MSMEs in Tunisia are critical to understanding their operational capacity and the challenges they face, particularly in terms of energy efficiency and sustainability. As shown by the ERF survey, the vast majority of these enterprises are classified as VSEs and rely heavily on minimal staffing structures. This reality shapes their strategic capabilities, limits their operational efficiency, and hinders their ability to adopt innovative technologies, including energy-saving solutions.

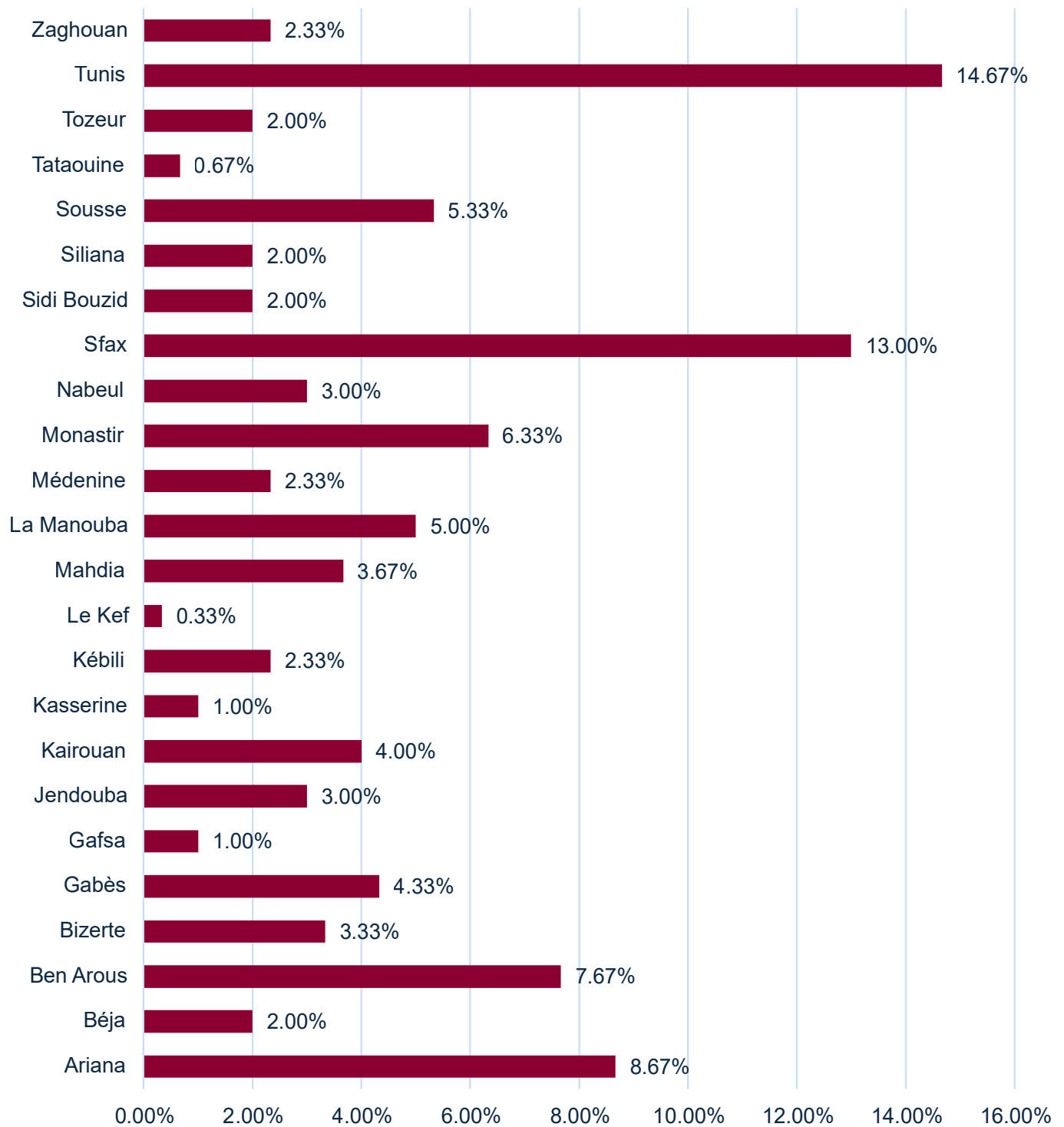
According to the ERF survey, 63.33 percent of MSMEs in Tunisia employ fewer than five people, a clear indication of their status. This categorization restricts these companies to a limited operational scale, reducing their capacity to invest in larger projects or to adopt comprehensive energy-efficient technologies. Furthermore, the lack of a significant workforce limits productivity and the company's ability to diversify its operations or scale up production. This limitation has a direct impact on their participation in Tunisia's energy transition, as smaller firms are less likely to have the financial or human resources necessary to implement energy efficiency measures.

This is followed by 27.33 percent of enterprises employing between six and 19 workers, further demonstrating the prevalence of small enterprises within the Tunisian MSME landscape. Only 9.33 percent of the surveyed companies support a workforce of 20 to 29 employees, indicating that medium-sized companies, which could potentially lead in terms of innovation and energy transition efforts, remain a minority. This workforce distribution underscores the need for targeted support programs to help MSMEs overcome their size-related barriers to energy efficiency. A key characteristic of the workforce in these MSMEs is the predominance of full-time employment. Approximately 74.50 percent of the MSMEs surveyed employ their workforce exclusively on a full-time basis. This reliance on stable, full-time employees reflects a business environment that values operational consistency, but it also limits flexibility. The rigid employment structure may prevent these businesses from adapting to fluctuating market conditions or investing in energy-efficient technologies that require specialized skills or temporary expertise.

Conversely, the use of part-time workers is particularly low, with 74.50 percent of MSMEs reporting no part-time employment at all. For those MSMEs that do employ part-time workers, the proportion is minimal, suggesting that while some firms recognize the potential benefits of a flexible workforce, the majority either lack the capacity to



Figure 3. Geographical distribution of MSMEs by governorate



integrate such employment practices or do not prioritize them. This inflexibility may further exacerbate the challenges these MSMEs face in the energy transition, as they are less likely to bring in external expertise or adapt their workforce to meet the demands of new energy-efficient technologies.

Interestingly, only 7.57 percent of MSMEs rely exclusively on part-time workers, suggesting that most enterprises prefer the stability of a full-time workforce despite the potential benefits of flexibility. This reliance on a predominantly full-time workforce underscores the challenges of transitioning to more adaptive and innovative



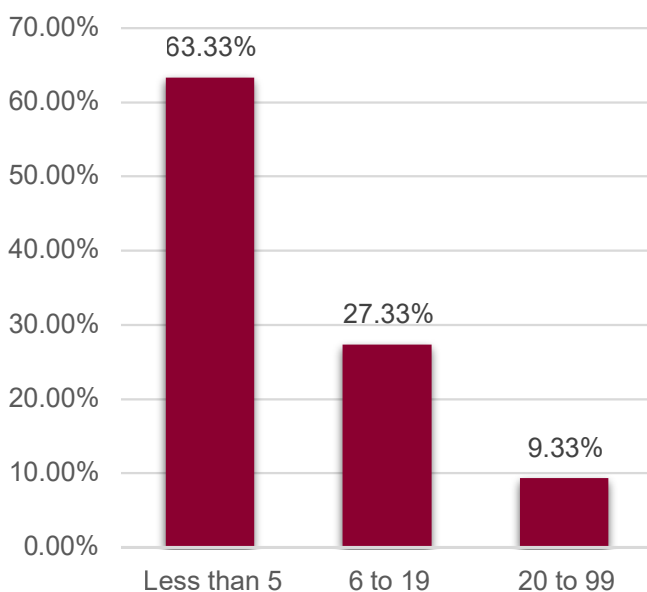
business practices, particularly in the context of adopting energy-efficient technologies that may require changes in workforce management or specialized skills.

The predominance of VSEs in the Tunisian MSME landscape, coupled with their rigid employment structures, poses significant barriers to their ability to invest in energy efficiency and technology upgrades. The operational constraints imposed by such small workforces mean that even when financial resources are available, these firms may lack the human capital necessary to effectively implement energy-saving initiatives or scale up operations in a way that incorporates sustainable practices.

Figure 4 illustrates the workforce distribution within Tunisian MSMEs. This figure highlights the dominance of VSEs in the sector and displays the scale-related constraints that these enterprises face, both in terms of operational capacity and strategic growth.

The detailed analysis of workforce characteristics in MSMEs provided by the ERF survey paints a comprehensive picture of the operational challenges facing the sector. The reliance on minimal staffing levels and the predominance of full-time employment reflect a business environment that favors stability over flexibility. This situation plays a critical role in shaping the operational scope of MSMEs and their ability to adopt new technologies, such as energy-efficient solutions, which often require a more dynamic and adaptable

Figure 4. Workforce size distribution in Tunisian MSMEs



workforce. The limited size of the workforce further constrains the ability of these businesses to innovate and grow, ultimately affecting their participation in Tunisia's broader energy transition.

Addressing these constraints requires tailored support mechanisms that strengthen both the financial and human capital capacities of MSMEs. Such efforts would enable them to better adapt to the demands of sustainable business practices and energy efficiency initiatives.

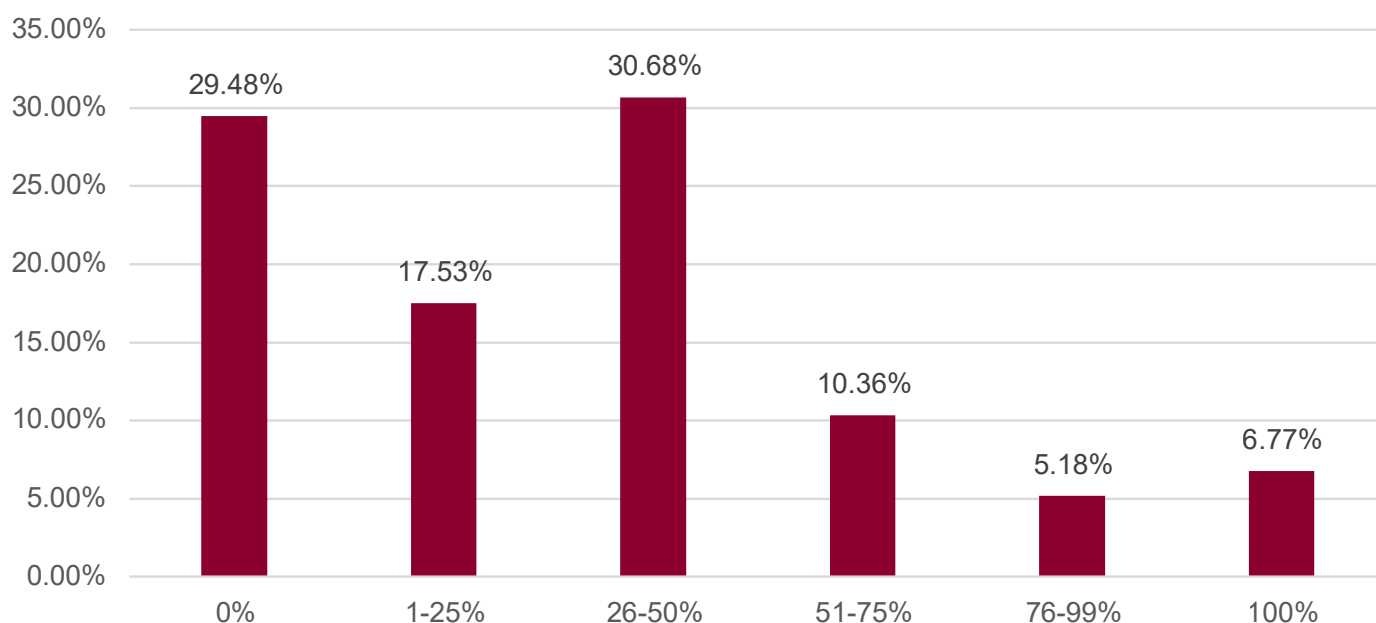
4.1.5. Demographic composition of the workforce

The demographic composition of the workforce in Tunisian MSMEs reveals a significant proportion of young workers, highlighting both opportunities and challenges for these enterprises. According to the ERF survey, 30.68 percent of employees are between the ages of 18 and 29, indicating the potential of this demographic to contribute to technological innovation and the adoption of energy-efficient practices. Younger workers tend to be more adaptable and open to new ideas, making them valuable assets for MSMEs seeking to integrate modern energy-saving technologies. However, despite this potential, structural limitations within MSMEs can prevent the full utilization of this younger workforce.

There are significant differences in how young workers are integrated across firms. While some MSMEs benefit from the energy and technological skills of younger workers, 29.48 percent of surveyed firms do not employ anyone in this age group. This disparity may be due to differences in business models, industry requirements, or firm hiring practices. Enterprises that are reluctant to hire younger workers or lack the resources to train them may be missing opportunities to harness the innovation and adaptability that younger workers bring to energy transition efforts.

Figure 5 shows the distribution of young workers across Tunisian MSMEs and highlights the varying degrees to which firms capitalize on this demographic. Some firms rely heavily on younger workers, taking advantage of their adaptability and lower wage expectations. These enterprises may find it easier to implement energy-efficient solutions or adopt new technologies. In many cases, however, MSMEs lack the financial resources and infrastructure to take full advantage of this young workforce, especially when it comes to providing the necessary training for technological or energy-related advances.



Figure 5. Distribution of young workers in Tunisian MSMEs

Another critical issue is the existence of financial constraints that limit MSMEs' ability to attract and retain talented young workers. While younger workers may initially accept lower wages, their expectations for career advancement often exceed what MSMEs can offer. This situation leads to high turnover rates as young workers seek better opportunities, either with larger companies or abroad. High turnover can destabilize MSMEs, especially when maintaining a skilled workforce capable of driving technological change or improving energy efficiency.

Moreover, the absence of young workers in nearly one-third of MSMEs reflects deeper labor market problems. Without young talent to drive innovation and adaptability, these businesses may struggle to keep pace with technological advances, including energy-efficient solutions. Bridging this gap would require concerted efforts to support the recruitment and development of younger workers, enabling MSMEs to remain competitive and contribute to Tunisia's broader energy transition goals.

The presence of a youthful workforce presents a significant opportunity for MSMEs to embrace digital transformation and improve energy efficiency. Younger workers who are familiar with emerging digital technologies could play a critical role in implementing smart energy solutions and other efficiency-enhancing practices. However, this potential remains underutilized due to limited investment in workforce training and

development, which is essential for equipping young workers with the skills needed to drive energy-related improvements.

This demographic composition highlights the strategic importance of young workers to the future of MSMEs, particularly in terms of technological advancement and sustainability efforts. However, the lack of resources and training programs to develop these young talents poses a significant challenge to achieving these goals. Figure 5 presents the demographic trends and varying degrees of integration of young workers, pointing to the need for more targeted policies that focus on workforce development and energy efficiency within MSMEs.

4.1.6. Gender dynamics

Gender dynamics within Tunisian MSMEs reveal significant inequalities that affect both the overall business environment and the potential for these enterprises to transition to sustainable energy practices. The ERF survey provides a detailed view of gender disparities in ownership, management, and workforce composition that reflect the broader social and structural barriers women face in the Tunisian business landscape. These disparities are critical to understanding the role that gender plays in shaping the ability of MSMEs to innovate, grow, and adopt energy-efficient technologies.

According to ERF data, a staggering 72.73 percent of MSMEs in Tunisia are not owned by women at all. This



highlights the significant challenges women face in accessing capital, entrepreneurial networks, and the resources necessary for business creation and ownership. In contrast, only 16.50 percent of MSMEs are wholly owned by women, with another 10.78 percent indicating partial female ownership. The barriers to female ownership in Tunisian MSMEs can be linked to broader socioeconomic factors, including gender-specific financial barriers, limited access to formal and informal business networks, and possible cultural biases that discourage or limit women's participation in entrepreneurship. The significant lack of female ownership in the sector reduces the diversity of perspectives in business strategy and decision-making processes, which are critical elements in fostering innovation, particularly in the area of sustainable practices and energy efficiency.

Women remain underrepresented in leadership roles, with only 16.67 percent of MSMEs reporting women in top management positions. This limited representation of women in leadership is indicative of deeper systemic barriers that prevent women from advancing to leadership positions. Gender bias in promotion and hiring processes, combined with a lack of mentorship and networking opportunities, are some of the factors contributing to the lack of women in high-level decision-making positions. The demands of balancing work and family responsibilities without sufficient support mechanisms can also hinder women's progress in leadership. The absence of women in these key roles limits the strategic thinking and innovative potential of the sector, as companies with diverse leadership teams are often better equipped to explore new opportunities, including those related to sustainable energy transitions. The underutilization of women in leadership thus represents a missed opportunity for the MSME sector to fully realize its potential for growth and innovation.

Gender disparities extend to the employment structures of Tunisian MSMEs. The ERF survey shows that 39.04 percent of MSMEs do not employ women on a full-time basis. Of the MSMEs that employ women, most have a workforce where women make up less than 25 percent. This figure indicates that the inclusion of women in operational roles remains limited and that the Tunisian MSME sector has yet to fully embrace gender inclusiveness in its workforce. The low level of female employment may be the result of several factors, including limited flexible work arrangements, which are often necessary to accommodate women's roles both inside and outside the workplace. The lack of part-time employment opportunities, as reflected by the 84.86 percent of MSMEs that do not employ part-time female workers, exacerbates this problem, as part-time work can provide women with the flexibility needed to balance

work and family responsibilities. This lack of flexibility in employment structures limits the talent pool available to MSMEs and hinders their ability to integrate diverse perspectives and skills into their operations.

Interestingly, only 4.38 percent of MSMEs have an entirely female full-time workforce, indicating that female-dominated employment is extremely rare. Part-time employment, often seen as a flexible option that could attract more female workers, is also underutilized. The survey data shows that 7.67 percent of MSMEs rely exclusively on part-time workers, but women are conspicuously absent from these roles in most cases. This suggests a mismatch between the availability of part-time work and women's employment needs, further limiting women's participation in the sector.

Figures 6 and 7 provide a graphical representation of gender disparities in ownership and management within Tunisian MSMEs. Figure 6 illustrates the proportion of MSMEs with female ownership, while Figure 7 shows the gender distribution of top management positions across the sector. Both figures highlight the critical gaps in gender inclusiveness and draw attention to areas where policies aimed at increasing women's participation in business could have a significant impact.

When examining the gender dynamics within MSMEs, it becomes clear that these disparities have far-reaching implications for the sector's ability to innovate and adopt sustainable practices. The underrepresentation of women in ownership, leadership, and employment not only limits the diversity of perspectives needed to drive innovation but also reflects a broader underutilization of talent. Promoting greater gender inclusion in the MSME sector could help unlock new opportunities for growth and sustainability, as

Figure 6. Share of female ownership in Tunisian firms

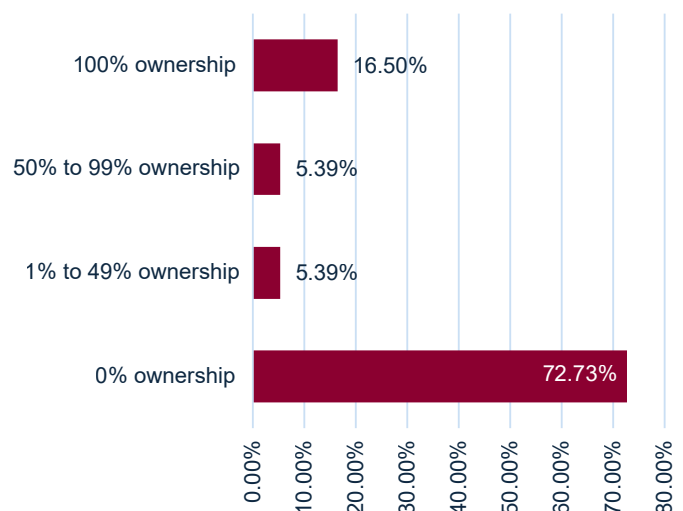
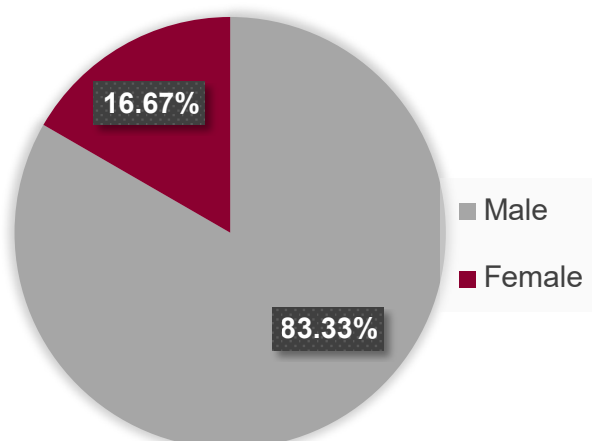


Figure 7. Gender distribution of top managers in Tunisian enterprises



businesses with diverse teams are often more resilient and adaptable to change, particularly in adopting new technologies such as energy-efficient systems and processes.

Gender dynamics play an important role in shaping the potential of Tunisian MSMEs to transition to sustainable business practices. By addressing the systemic barriers that prevent women's full participation in ownership, leadership, and employment, the MSME sector can create a more inclusive environment that fosters innovation and growth. As Tunisia moves toward a greener and more sustainable future, the integration of women into all aspects of business operations and decision-making will be essential to ensuring the success of the energy transition

4.1.7. Economic viability and resource allocation

The economic viability of Tunisian MSMEs plays a crucial role in determining their capacity to adopt energy efficiency measures and RE technologies. The ERF survey shows that a significant number of MSMEs operate with limited financial resources, which creates barriers to implementing the necessary technological investments for the energy transition. Specifically, 35.33 percent of MSMEs report annual revenues of less than TND 50,000, indicating a high level of financial vulnerability. This low-revenue segment reflects the limited capacity of these firms to make substantial investments in energy-efficient technologies, which often require significant up-front capital.

Conversely, only 10 percent of MSMEs report annual revenues of more than TND 500,000, indicating that a small proportion of firms have the financial strength to be potential leaders in adopting energy-efficient practices. These high-revenue firms are likely better positioned to make significant investments in RE and energy-saving technologies, giving them a competitive edge in sustainability. However, the overall revenue distribution of MSMEs, as seen in the survey, reflects an economic landscape in which the majority of businesses operate on thin margins, limiting their ability to make long-term energy investments without external financial support.

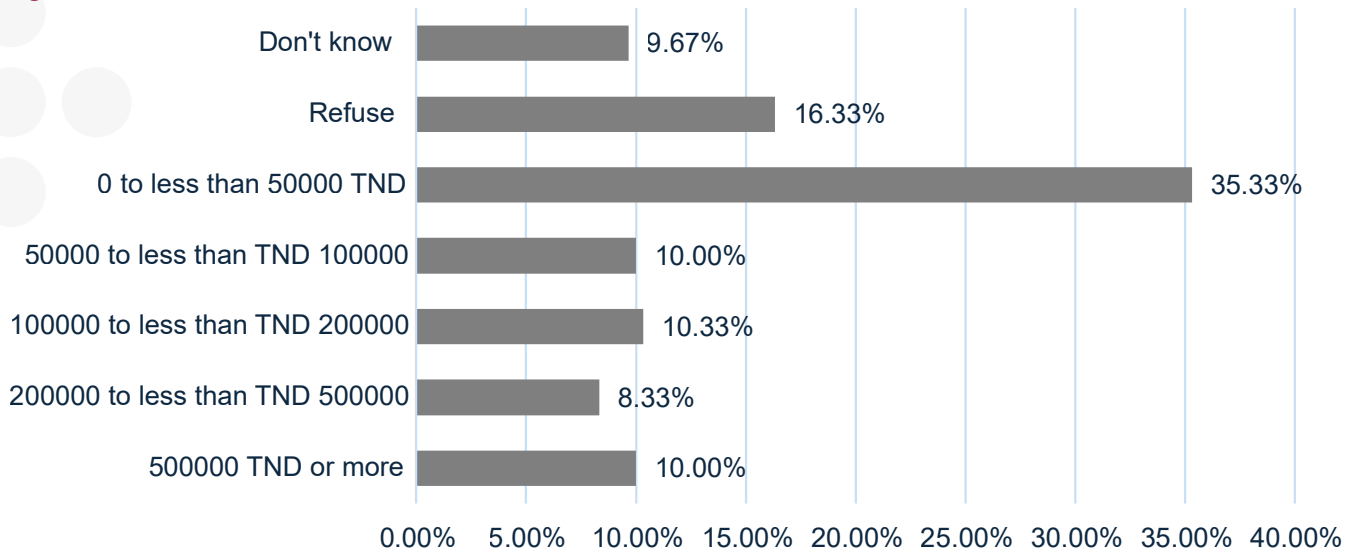
In addition to revenue challenges, the survey highlights another critical factor in the economic viability of MSMEs, which is the ownership status of business premises. A significant 57 percent of MSMEs operate from rented premises, reflecting a reliance on leased infrastructure that may limit these firms' ability to invest in structural energy efficiency improvements. Renting premises can limit the ability to make physical changes to buildings, such as installing solar panels or retrofitting energy-efficient systems. Also, firms that lease their space may be reluctant to invest in long-term energy-saving infrastructure due to the uncertainty of leases and the inability to fully capture the return on investment.

On the other hand, 42.33 percent of MSMEs own their premises, giving them greater stability and control over potential energy efficiency upgrades. Ownership of the premises allows these businesses to make long-term investments in sustainable technologies and building modifications that could reduce energy consumption and operating costs over time. Companies that own their facilities are better positioned to implement comprehensive energy transformation strategies because they can plan for long-term returns without the constraints of temporary occupancy.

The financial constraints and resource allocation challenges faced by MSMEs are shown in Figure 8, which provides a clear breakdown of the annual revenue distribution of these firms. The figure highlights the economic hurdles faced by low-revenue MSMEs, particularly in terms of resource allocation for energy transition initiatives. The significant proportion of low-revenue firms exemplifies the need for targeted financial interventions such as government subsidies, low-interest loans, or incentive programs to help MSMEs adopt RE technologies.

Beyond revenue and premises, the survey reveals inconsistent financial reporting practices among MSMEs.



Figure 8. Annual revenue distribution of Tunisian MSMEs

Approximately 16.33 percent of firms refused to disclose revenue information, and another 9.67 percent were unsure of their revenue, suggesting a lack of financial transparency or limited financial literacy in certain sectors. This lack of financial clarity could further hinder MSMEs' ability to secure external financing for energy efficiency projects, as financial institutions may be reluctant to provide loans or grants to firms with incomplete or unreliable financial records. Improving financial literacy and promoting transparent reporting practices could play a critical role in improving the economic viability of these businesses and unlocking access to finance for sustainability initiatives.

Reliance on limited financial resources and rented premises suggests that the majority of MSMEs in Tunisia may struggle to allocate sufficient resources to energy transition efforts. Without external support in the form of financial assistance, subsidies, or incentives, many firms may not be able to afford the upfront costs of adopting energy-efficient technologies. In addition, the predominance of small, low-revenue companies in the sector means that these companies are more vulnerable to economic shocks, making long-term investments in sustainability more difficult.

Addressing the economic and resource allocation challenges faced by MSMEs requires a multifaceted approach. Improving access to finance, offering targeted subsidies for energy efficiency improvements, and creating policy frameworks that support the adoption of RE are critical steps to ensure that these businesses can participate in Tunisia's energy transition. Promoting partnerships between MSMEs and financial institutions to provide training in financial management and resource

allocation could also help improve the economic viability of these enterprises, enabling them to invest in sustainable practices that reduce operating costs and contribute to environmental goals.

4.1.8. Energy consumption and costs

Energy consumption and its associated costs are a critical issue for Tunisian MSMEs, affecting their overall operational efficiency and ability to adopt sustainable practices. According to the ERF survey, energy costs are a significant burden for many MSMEs, with a substantial number of businesses spending substantial amounts on electricity each month. For example, 30.33 percent of MSMEs report monthly energy expenditures exceeding TND 1,001, reflecting a significant financial burden. These energy costs often represent a large portion of operating expenses, limiting the ability of these businesses to invest in other areas, such as expanding operations or improving energy efficiency.

A breakdown of energy expenditure patterns shows that 14.67 percent of MSMEs report spending between TND 1 and 100 per month on electricity. This relatively low level of energy consumption may indicate either highly efficient operations or very small firms with limited energy needs. However, the largest segment of MSMEs, representing 39.33 percent of the surveyed firms, report monthly electricity costs between TND 101 and 500, which is more in line with typical small to medium enterprises. A smaller proportion, 15.67 percent, spent between TND 501 and 1,000, which could reflect either higher energy consumption or less efficient energy use. This tier of energy spenders could potentially benefit the most from energy efficiency improvements.



The survey also shows that energy costs represent a significant portion of the total operating budget of MSMEs. For 36.67 percent of MSMEs, electricity costs represent between zero and five percent of total operating costs, indicating either highly efficient energy use or a large overall budget. However, for a more vulnerable 11.33 percent of MSMEs, electricity costs represent between 16 percent and 25 percent of total costs, with a further seven percent of enterprises allocating between 26 percent and 40 percent of their budget to energy. Such high costs put pressure on the financial health of these enterprises, limiting their ability to allocate resources to growth, innovation, or investment in energy-saving technologies.

Energy consumption is closely linked to business operations, with 53.33 percent of MSMEs reporting that they use electricity for five to eight hours per day, reflecting standard working hours. However, 20 percent of enterprises use electricity for nine to 12 hours, and 12 percent use more than 13 hours per day, likely due to the nature of their operations, such as manufacturing or energy-intensive processes. These enterprises may be particularly vulnerable to rising energy costs, making energy efficiency improvements critical to maintaining financial stability.

Figure 9 provides a clearer perspective on where energy costs are concentrated, and how these costs can affect companies' ability to invest in sustainability initiatives.

The economic burden of energy costs, coupled with the long hours of electricity use in certain sectors, underscores the importance of improving energy efficiency across the MSME landscape. High energy

costs directly impact the financial flexibility of these businesses, reducing their ability to invest in growth, development, or sustainability initiatives. The adoption of energy-efficient technologies or RE solutions could provide significant cost savings, freeing up resources that could be reinvested in other areas of the business while contributing to broader environmental goals.

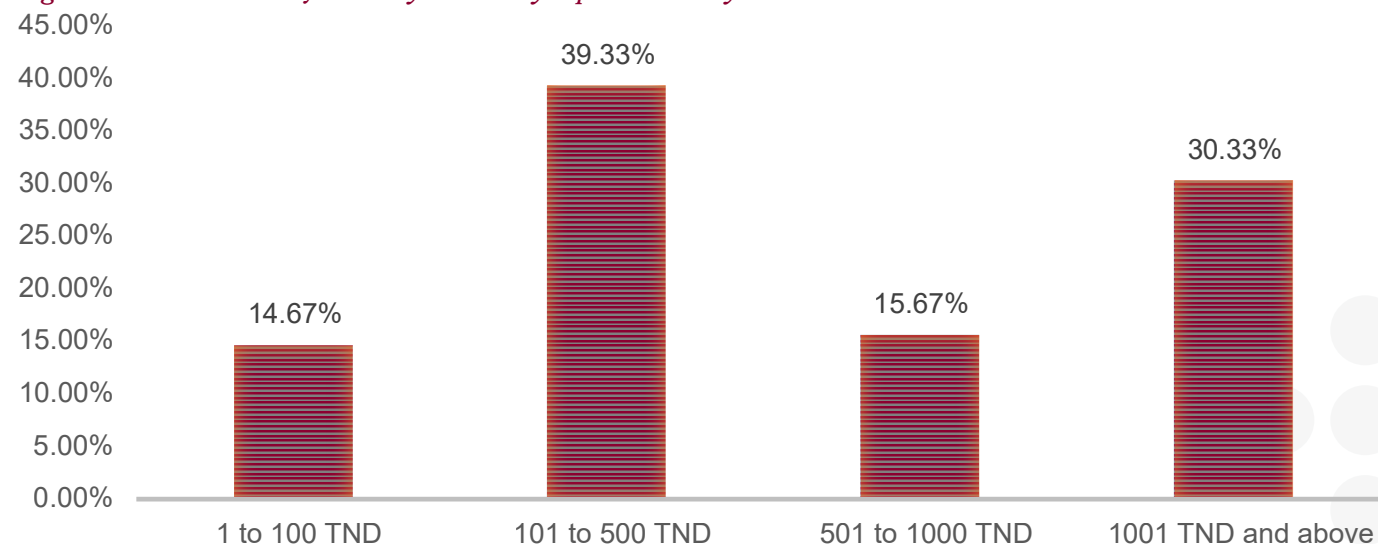
Given the high proportion of MSMEs facing significant energy costs, targeted interventions such as government-backed subsidies for energy-efficient technologies or access to low-interest financing for RE investments could help alleviate financial pressures. Furthermore, capacity-building programs that help MSMEs optimize their energy use and integrate more sustainable practices into their operations would likely yield both financial and environmental benefits. By addressing the twin challenges of high energy consumption and associated costs, MSMEs could improve their economic viability while contributing to Tunisia's broader energy transition strategy.

4.2. MSMEs' awareness of the energy transition

4.2.1. MSMEs' knowledge of energy and sustainability

The level of awareness of the energy transition and sustainability among MSMEs in Tunisia reveals a mixed understanding of key concepts and programs. A detailed examination of the ERF survey data shows a clear pattern of familiarity with certain institutions and initiatives, while highlighting significant knowledge gaps in other areas critical to the energy transition.

Figure 9. Distribution of monthly electricity expenditures by MSMEs



Among the key institutions involved in energy management in Tunisia, ANME is characterized by a high level of awareness, with 94.12 percent of respondents aware of its role and activities. This reflects ANME's central role in shaping Tunisia's energy landscape and broad reach across different sectors. ANME's high visibility can be attributed to its longstanding efforts to promote energy management practices, policy development, and collaboration with the public and private sectors. This level of visibility means that ANME's initiatives are well integrated into the national energy discourse and reach a wide range of stakeholders, including government agencies, MSMEs, and NGOs.

In contrast, the National Fund for Energy Management (FNME) is known by only 44.12 percent of respondents, with significant differences in awareness among different groups. Researchers and experts show higher awareness (62.5 percent), likely due to their direct involvement in energy management and policy issues, while only 31.25 percent of MSMEs are familiar with the FNME. This discrepancy suggests that FNME's impact or visibility is more pronounced in circles directly involved in energy management, but has not sufficiently reached the broader MSME sector, which may not be aware of the fund's resources or initiatives. This pattern of awareness is critical, as MSMEs represent a significant portion of the economy and their engagement in energy management initiatives is essential to broad-based energy transition efforts.

The Energy Transition Fund (ETF), an entity specifically designed to support Tunisia's transition to RE, shows a similar variation in awareness. While 47.06 percent of respondents are aware of the ETF, this awareness is highly concentrated among researchers (75 percent) and NGOs (100 percent), with a much lower figure of 18.75 percent among MSMEs. This low level of awareness among MSMEs suggests that the ETF's outreach and engagement strategies may need to be more effectively targeted at the private sector, particularly MSMEs, which stand to benefit significantly from support in transitioning to sustainable energy practices. The ETF's focus on broader policy advocacy and larger projects may explain its higher visibility among NGOs and researchers who are more directly involved in policy implementation and analysis.

Compared to other countries in the region, Tunisia's situation is not unique. In Egypt, for example, the Renewable Energy and Energy Efficiency Fund (REEEF) plays a similar role to Tunisia's FNME and ETF, but also faces challenges in reaching MSMEs. Egyptian MSMEs have shown limited engagement with REEF initiatives,

prompting the Egyptian government to launch more targeted campaigns to increase awareness and participation among smaller enterprises. A similar challenge exists in Jordan, where the National Energy Research Center (NERC) is well known among large enterprises and researchers but has struggled to engage MSMEs in its energy efficiency programs. In Morocco, where the Moroccan Agency for Sustainable Energy (MASEN) has driven significant progress in RE, the challenge remains to ensure that smaller businesses are fully integrated into the energy transition. Despite Morocco's leadership in solar energy projects, many MSMEs remain unaware of the financial incentives available to them for energy efficiency improvements.

Returning to Tunisia, the Program for Energy Efficiency and Substitution (PEESE) is recognized by 35.29 percent of respondents, with the highest awareness among researchers (75 percent) and NGOs (50 percent). This awareness reflects the relevance of the program for those closely involved in energy policy and environmental advocacy. However, the relatively low awareness among MSMEs highlights a gap in communication and outreach. For a program designed to promote energy efficiency, low awareness among the businesses it is intended to support is a significant barrier to achieving its goals. The need for increased engagement with MSMEs becomes clear when comparing similar initiatives in Jordan and Egypt. In Jordan, the Green Growth Plan has had limited success in penetrating the MSME sector, largely due to inadequate communication channels. Similarly, Egypt's Energy Efficiency Program has faced significant obstacles in raising awareness among smaller enterprises, which typically do not view energy efficiency as a strategic priority.

Another important entity in Tunisia's energy management framework is the Energy Audit Program (PAE), but awareness is strikingly low, with only 14.71 percent of respondents recognizing its role. This figure indicates a significant gap in both the knowledge and outreach of the program, particularly among MSMEs, which could greatly benefit from energy audits to identify cost-saving opportunities. The lack of awareness among MSMEs (where only 10 percent of businesses are familiar with PAE) suggests that the audit program, while potentially valuable, is not being effectively marketed to smaller businesses that could use audits to optimize energy use. In Morocco, similar programs such as the Energy Audit Assistance Fund have struggled to gain traction among MSMEs despite the high potential for energy savings. This is mirrored in Egypt and Jordan, where energy audits remain underutilized by MSMEs despite government efforts to promote their benefits.



In Tunisia, survey results show a high level of awareness of RE among MSMEs, with 75.67 percent expressing familiarity with the concept. This high level of awareness is a promising sign, suggesting that past efforts to promote RE have successfully reached a wide audience. Figure 10 visualizes this data and clearly shows the robust awareness of RE among MSMEs. However, when it comes to other important concepts such as clean energy, only 48.67 percent of MSMEs are familiar with the term, revealing a gap that could hinder the adoption of broader energy solutions. Figure 11 illustrates this knowledge gap and highlights the need for targeted education initiatives that expand MSME understanding beyond RE to include clean energy technologies and practices.

Energy efficiency and savings concepts also show mixed results. Awareness of energy efficiency is 29.67 percent, while 59 percent of MSMEs are familiar with energy-saving practices. These figures suggest that while MSMEs may recognize the immediate benefits of energy-saving measures, they may not fully grasp the broader, long-term benefits of energy efficiency. Figure 12 provides a side-by-side comparison of these concepts, highlighting areas where further education and promotion is needed to increase understanding. Similar patterns can be seen in Egypt, Jordan, and Morocco, where MSMEs often prioritize cost savings over comprehensive energy efficiency strategies. In all three countries, government programs are beginning to address these gaps, but the pace of adoption among MSMEs remains slow.

Furthermore, only 31.67 percent of Tunisian MSMEs understand the concept of energy intensity, reflecting a significant knowledge gap on how energy use relates to production and operational efficiency. This figure mirrors similar findings in Egypt, Jordan, and Morocco, where MSMEs often lack the technical knowledge to fully understand how energy intensity affects both profitability and sustainability. Improving MSMEs' familiarity with such key concepts is essential not only for advancing the energy transition but also for enhancing their overall competitiveness in an increasingly environmentally conscious global marketplace.

Figures 10 through 12 illustrate these varying levels of awareness of different energy concepts and provide a visual representation of where the most significant gaps lie. Comparing Tunisia's MSME sector with those of Egypt, Jordan, and Morocco, it is clear that while some progress has been made, more focused efforts are needed to fully engage MSMEs in the energy transition.

Figure 10. Familiarity with “renewable energy” among MSMEs

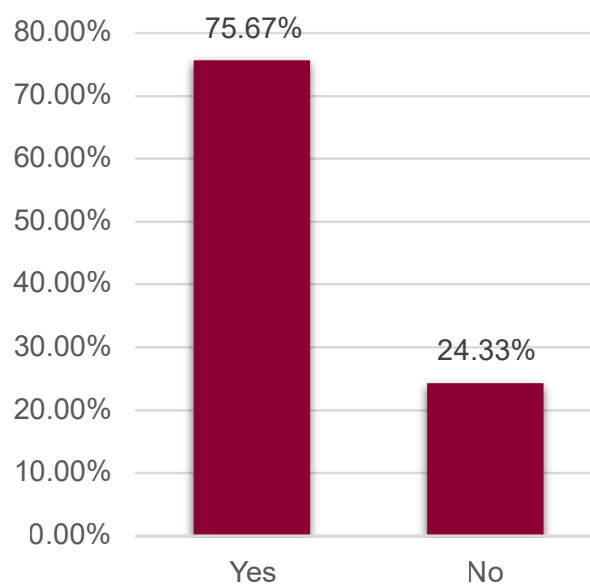
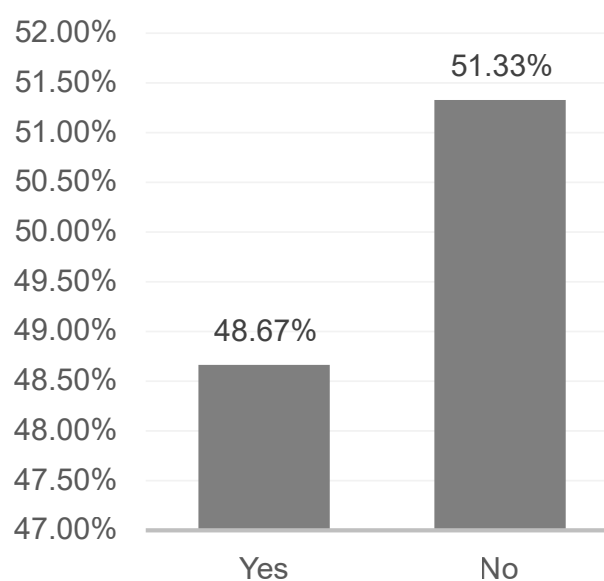


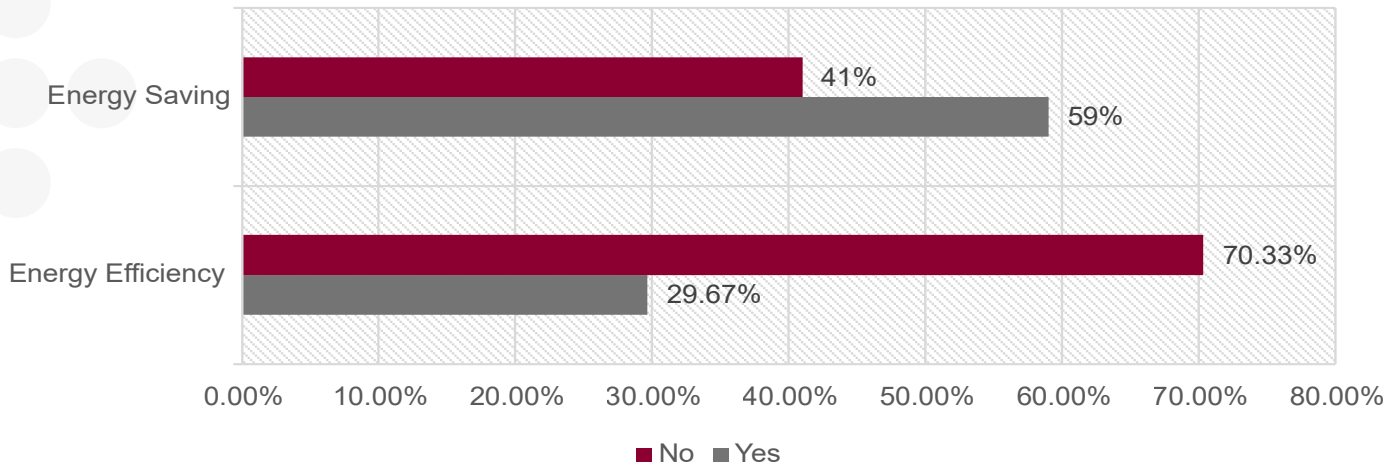
Figure 11. Awareness of “clean energy” among Tunisian MSMEs



To move forward, it is critical to develop and implement targeted communication and education strategies that address these knowledge gaps. In addition to needing awareness, MSMEs in Tunisia, Egypt, Jordan, and Morocco require a deeper understanding of how adopting energy efficiency and RE practices can improve their competitiveness and long-term sustainability.



Figure 12. Comparative awareness of “energy efficiency” vs “energy savings” among MSMEs



4.2.2. Understanding the characteristics of RE

The level of understanding of RE among MSMEs in Tunisia reflects different levels of familiarity with different types of RE sources. According to the ERF survey, solar energy emerges as the most recognized renewable resource, with 52.94 percent of respondents mentioning it as a key player in the energy landscape. This high level of recognition is in line with global trends, where solar energy has become one of the most accessible and cost-effective RE options. The scalability and declining costs of solar energy have contributed to its prominence in both public and professional discourse, making it an attractive option for MSMEs looking to reduce energy costs and meet sustainability goals.

Wind energy follows closely behind, with 41.18 percent of respondents acknowledging its importance. This figure reflects the growing role of wind energy in Tunisia’s RE portfolio. Although slightly less prominent than solar energy, wind energy remains an important component of the RE mix, particularly in regions with favorable wind conditions. The recognition of both solar and wind energy among MSMEs highlights the accessibility of these technologies, driven by falling technology costs and increasing government support for RE projects.

However, the survey also reveals a gap in awareness of other RE sources. Hydropower, geothermal, and biomass are significantly less recognized, with only 11.76 percent, 8.82 percent, and 5.88 percent of respondents, respectively, citing them as viable options. This limited awareness reflects a more concentrated focus on mainstream renewables such as solar and wind energy, which are easier to implement and more widely promoted. The lack of familiarity with other RE sources suggests that MSMEs may not fully understand the potential benefits these alternatives can offer, particularly

in specific regional contexts where resources such as biomass or geothermal energy may be more viable.

In contrast, researchers and experts show a deeper understanding of RE, with 62.5 percent mentioning solar energy and 50 percent recognizing wind energy. This higher level of awareness is to be expected given the technical knowledge and commitment required in academic and scientific circles. The banking and finance sector also shows significant recognition of solar energy (60 percent) and wind energy (40 percent), likely driven by the economic potential of these sources. Investments in RE projects have become increasingly attractive due to favorable market conditions and government incentives, making these sectors aware of the financial opportunities offered by solar and wind energy technologies.

NGOs and government officials show similarly high levels of recognition. NGO representatives unanimously recognize solar energy (100 percent), underscoring its importance in community projects and grassroots initiatives where ease of implementation and cost-effectiveness are essential. Government officials also show strong awareness of solar (66.67 percent) and wind (33.33 percent), reflecting the need for policymakers to be well-versed in different energy options in order to formulate effective strategies for national energy planning and transition efforts.

For MSMEs, the focus on solar (50 percent) and wind (43.75 percent) is particularly indicative of the growing accessibility of these technologies to SMEs. These two energy sources are often the most feasible for businesses operating on tight budgets, given the relatively low installation and operating costs associated with solar and wind technologies. However, the limited mention of other RE sources indicates a potential gap in knowledge or exposure, which could limit the variety of energy solutions that MSMEs are willing or able to explore.



Similar trends can be observed in other countries in the region. In Egypt, solar and wind energy are also the most recognized renewable resources among MSMEs, largely due to government initiatives aimed at expanding these sectors. Egypt's "feed-in tariff" program for RE has made significant strides in encouraging the adoption of solar and wind energy, particularly among smaller businesses looking to reduce operating costs. However, like Tunisia, awareness of other renewable resources, such as geothermal and biomass, remains low among Egyptian MSMEs, reflecting a concentrated focus on the most accessible technologies.

In Jordan, a similar pattern emerges, with solar energy leading the way in terms of MSME recognition. This was evident following the launch of the Jordan Renewable Energy and Energy Efficiency Fund (JREEEF), which has provided significant financial incentives for solar installations. Wind energy has also gained considerable recognition, especially in regions with favorable wind conditions. However, as in Tunisia, other renewable resources are less well known, reflecting the need for broader energy education programs.

In Morocco, where RE policy has focused heavily on large-scale solar projects such as the Noor Ouarzazate complex, solar energy is the dominant renewable resource recognized by MSMEs. Wind energy also enjoys a high level of awareness, especially in regions where Morocco has invested in large wind farms. However, the relatively low awareness of biomass and geothermal energy reflects the same issue as in Tunisia, Egypt, and Jordan: a focus on mainstream renewables at the expense of exploring more diverse energy options that could potentially meet different business needs and regional contexts.

The ERF survey also provides valuable insights into Tunisian MSMEs' understanding of the specific benefits of RE. A strong majority (69.86 percent) of respondents recognize the carbon reduction potential of clean energy, indicating an awareness of the environmental benefits of adopting RE technologies. This awareness is critical as it emphasizes the commitment of MSMEs to reduce their carbon footprint and contribute to national sustainability goals. In addition, 73.29 percent of MSMEs are aware of the improved air quality associated with the adoption of clean energy, reflecting a concern for the direct environmental and health benefits associated with the transition to RE sources.

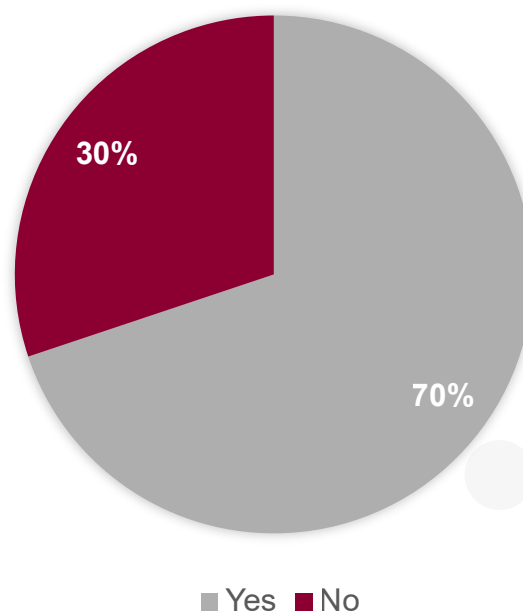
Energy independence is another important factor, with 60.96 percent of respondents recognizing the strategic and economic benefits of reducing dependence on imported fossil fuels. By adopting RE, MSMEs can

mitigate the risks associated with volatile energy prices and supply disruptions, which are particularly relevant in Tunisia's context of fluctuating energy costs and external dependence.

These findings on MSMEs' awareness of the benefits of RE are visually presented in Figure 13, which highlights the percentage of MSMEs familiar with each of the key benefits of clean energy. In addition to showing the strong awareness of immediate, tangible benefits such as carbon reduction and improved air quality, this figure sheds light on the strategic importance of energy independence for MSMEs seeking to improve their operational stability and competitiveness.

While awareness of solar and wind energy is widespread among Tunisian MSMEs, lower awareness of other renewable resources suggests the need for targeted education and outreach programs. Expanding the focus beyond solar and wind to include hydropower, geothermal, and biomass could help MSMEs diversify their energy strategies and take advantage of different resources based on their specific operational needs and regional contexts. Such diversification is critical for improving energy resilience and ensuring that Tunisia's RE transition is comprehensive and inclusive of all viable energy sources. A similar need to increase awareness of RE exists in Egypt, Jordan, and Morocco. In all three countries, MSMEs focus primarily on solar and wind energy due to their accessibility and government support, but there remains significant potential to expand the use of other renewable

Figure 13. Awareness of clean energy benefits among MSMEs



resources. Increasing the awareness and understanding of these alternative energy sources can enable MSMEs across the region to play a more active role in driving a diversified and sustainable energy transition.

Analyzing MSMEs' understanding of the benefits of RE and their recognition of different energy sources provides valuable insights into the challenges and opportunities for promoting energy transition in Tunisia. Strengthening education and outreach efforts, particularly in raising awareness of less mainstream renewable resources, will be critical to ensuring that MSMEs are fully equipped to contribute to Tunisia's energy goals.

4.3. Advantages and challenges of RE use

4.3.1. Economic and environmental considerations

The economic and environmental aspects of RE adoption in the Tunisian MSME sector reveal a complex landscape where opportunities for growth intersect with significant challenges. By analyzing the perspectives of different professional groups and drawing on comparative data from similar markets in Egypt, Morocco, and Jordan, it becomes clear that a multifaceted approach is needed to successfully integrate RE into MSME operations.

Economic incentives remain one of the most important drivers of RE adoption. According to the ERF survey, 58.82 percent of respondents believe financial incentives are critical to encouraging MSMEs to invest in renewable technologies. A 37-year-old consultant specializing in sustainable development notes that RE allows businesses to stabilize their energy costs and provides an opportunity to “decarbonize industry, gain autonomy, and create commercial assets.” This view reflects a growing understanding that RE, particularly solar and wind, can be a strategic asset for long-term profitability, providing resilience to fluctuating global energy prices and supporting sustainable growth.

This perspective aligns with broader economic benefits identified by MSMEs, including reduced operating costs and improved energy independence. RE can decouple businesses from dependence on imported fuels and provide greater control over energy costs, which is particularly beneficial in regions with unstable energy markets. As energy becomes a larger part of operating costs, MSMEs increasingly view RE not just as a green alternative but as an essential part of their business strategy.

Despite these clear benefits, 17.65 percent of respondents express concern about the high upfront costs of RE technologies such as solar and wind. For many MSMEs, the initial capital investment required for RE projects remains a significant barrier. Although there are long-term savings to be made, the financial outlay can be difficult for smaller businesses to justify, especially those operating on thin margins. This is a common concern not only in Tunisia but across the MENA region. In Morocco, for example, government-led initiatives have attempted to mitigate this barrier through targeted subsidies and tax incentives aimed at reducing the cost burden for MSMEs investing in RE.

The financial constraints faced by Tunisian MSMEs are exacerbated by a complex regulatory environment. A commercial director from the manufacturing sector highlights the bureaucratic obstacles involved in obtaining permits and accessing incentives for the adoption of RE. These administrative challenges slow down the process and discourage many companies from pursuing RE projects. This sentiment echoes findings in Egypt, where policy reforms have sought to streamline the regulatory process, making it easier for MSMEs to access financing and regulatory approvals for RE investments.

Another critical economic consideration is the role of financial institutions in facilitating RE investments. In Tunisia, banking and financial sector representatives recognize the potential of RE to stimulate economic growth, with 60 percent of respondents from this sector highlighting the economic benefits of RE adoption. However, there is still a need for more accessible financial products, such as green loans and low-interest financing, to help MSMEs make the transition. In comparison, public-private partnerships in Jordan have successfully provided MSMEs with access to financing for RE projects. These partnerships have provided affordable financing options and created a supportive ecosystem that includes technical assistance and policy advocacy.

Beyond the economic benefits, the environmental benefits of adopting RE are widely recognized across sectors. According to the ERF survey, 44.12 percent of respondents highlight the positive environmental impact of RE, with one young climate change negotiator highlighting the “dual benefit of sustainability in creating green wealth and addressing environmental concerns.” This awareness of the environmental impact of RE adoption is critical as companies and governments around the world face increasing pressure to reduce carbon emissions and adopt sustainable practices.



RE is seen as a key component of Tunisia's strategy to meet its environmental commitments, particularly under international frameworks such as the Paris Agreement. By transitioning from fossil fuels to cleaner energy sources, Tunisia can reduce its greenhouse gas emissions and contribute to global efforts to mitigate climate change. Solar and wind energy in particular are seen as essential tools for reducing the country's carbon footprint. However, despite the clear environmental benefits, 14.71 percent of respondents express concern about the practical challenges of integrating RE into existing systems. Many MSMEs lack the technical expertise to manage the transition from conventional energy to renewable alternatives.

Environmental awareness is particularly high among NGOs and government officials. NGO leaders unanimously recognize the dual economic and environmental benefits of RE, with one leader stating that it "reduces energy expenditures and improves competitiveness while protecting the environment." Government officials also emphasize the environmental benefits, with 33.33 percent of respondents acknowledging that RE helps reduce carbon emissions and improve air quality. These perspectives are critical to driving policy initiatives that support the broader adoption of RE, particularly in rural areas where energy access and sustainability are pressing concerns.

The survey also reveals that not all sectors address the environmental dimension of renewables equally. While MSMEs recognize the economic benefits of RE, they are less likely to prioritize its environmental benefits. Only 37.5 percent of MSMEs cite environmental factors as a key motivator for adopting RE, compared to 50 percent who focused on the economic benefits. This gap suggests that while the environmental narrative around RE is strong at the policy and NGO level, more work is needed to effectively communicate these benefits to the business community.

The experiences of Egypt, Morocco, and Jordan provide valuable insights into how Tunisia can address the challenges and maximize the benefits of RE deployment. In Egypt, the government has introduced financial support mechanisms, such as subsidies and low-interest loans, specifically designed to help MSMEs overcome the high upfront costs of RE technologies. This approach has been particularly successful in encouraging smaller firms to invest in solar and wind energy, which have become more cost-competitive because of these financial interventions.

Morocco, on the other hand, has made significant progress in integrating RE into both urban and rural economies. The country's investment in large-scale solar and wind farms, coupled with targeted tax breaks for MSMEs, has made it easier for businesses to adopt RE. The Moroccan government's focus on RE as a driver of rural development offers a model for Tunisia, where rural MSMEs often face greater barriers to accessing clean energy technologies. By promoting the adoption of RE in rural areas, Tunisia could address the urban-rural divide and create more equitable economic opportunities.

Jordan has implemented a successful model of public-private partnerships to promote RE deployment. These partnerships have provided both financial and technical support to MSMEs to help them pilot the complexities of RE integration. Jordan's educational programs aimed at raising awareness of the benefits of RE among business owners have also played a critical role in increasing adoption rates. Tunisia could benefit from a similar approach, combining financial support with targeted educational initiatives to ensure that MSMEs understand both the short- and long-term benefits of RE.

The ERF survey provides empirical support for the economic and environmental benefits of RE adoption. According to the survey, 85.33 percent of respondents agree or strongly agree that RE technologies offer significant environmental benefits, while 82.66 percent believe that these technologies can significantly reduce energy costs. This high level of agreement underscores the broad consensus across industries that RE is a viable solution for environmental sustainability and economic growth.

Figures 14 and 15 show the distribution of responses regarding the environmental and economic benefits of RE, providing a visual representation of the strong support for RE across professional groups. These findings are consistent with the qualitative findings from the interviews and provide a solid basis for policy recommendations aiming to promote the adoption of RE among MSMEs.



Figure 14. MSMEs’ perceptions of the environmental impact of RE technologies

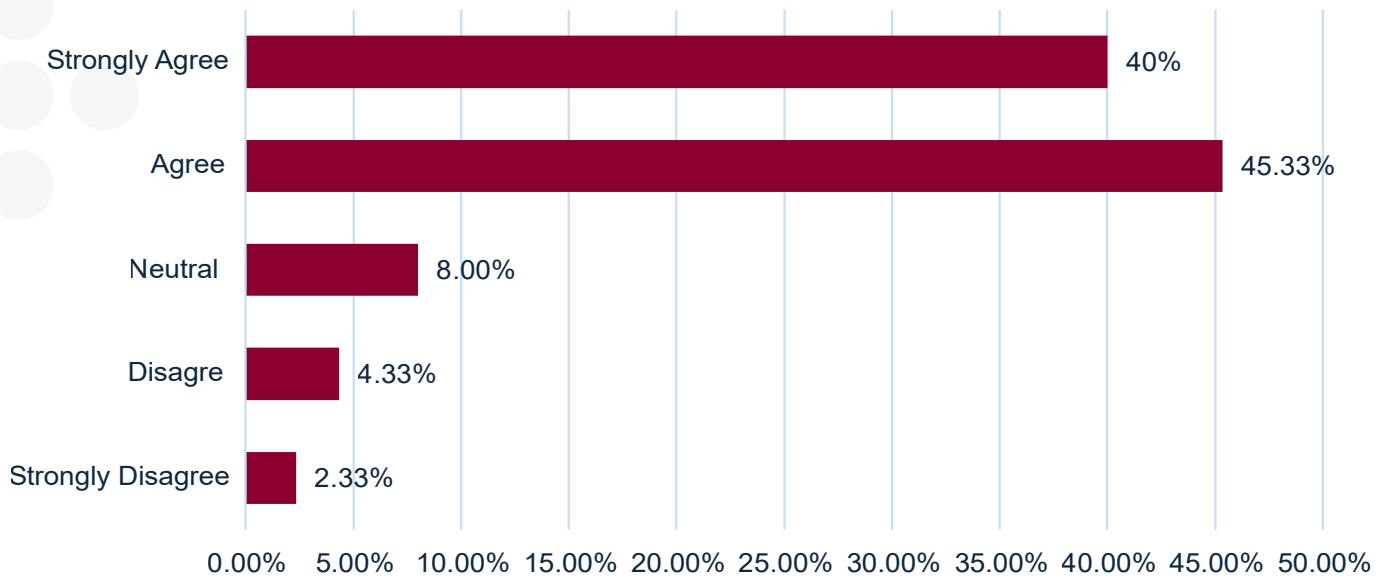
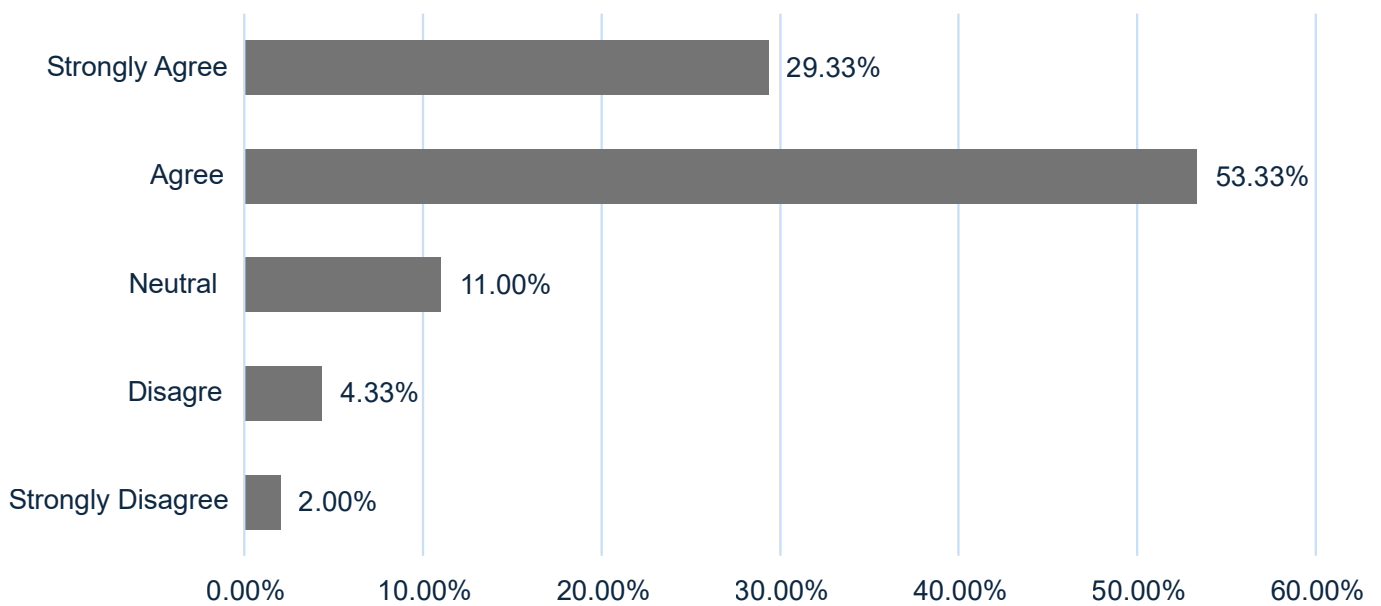


Figure 15. MSMEs’ opinions on the economic benefits of RE technologies



4.3.2. Barriers to implementation

The implementation of RE technologies in Tunisia faces several barriers that vary by sector, as detailed by respondents to the ERF survey and further enriched by feedback from experts, MSME leaders, and other professionals. These barriers are multidimensional and include regulatory, financial, technological, institutional, and awareness challenges. This detailed analysis preserves the original complexity of the situation while providing additional insights from different perspectives (see Figures 16, 17, and 18). Each group faces unique barriers to the effective deployment of RE solutions in Tunisia.

Regulatory Barriers

Regulatory barriers remain the most frequently mentioned obstacle, cited by 76.47 percent of respondents. The complicated and often outdated regulatory framework creates obstacles for companies wishing to invest in RE. As one 28-year-old climate change negotiator explains, “The barriers are mainly regulatory, institutional, technological and financial,” underscoring the pervasive nature of these challenges across multiple dimensions.

For MSMEs, navigating the regulatory environment is extremely difficult due to bureaucratic hurdles and the slow pace of reforms. Many MSMEs lack the legal



resources to fully understand or comply with complex regulatory requirements, further hampering their ability to adopt RE solutions. A lack of clear, supportive policy frameworks that encourage investment in RE exacerbates this problem.

Financial Barriers

Financial barriers are also a major obstacle, with 61.76 percent of respondents citing the high upfront costs of RE projects as a primary concern. MSMEs often face difficulties in securing financing for these projects due to lack of access to credit and lack of specialized financial products for RE investments. A 29-year-old PhD student in finance specializing in energy transition remarks: “The main opportunity lies in having a supportive, non-corrupt government with a clear energy transition strategy, but the financial barriers are a significant obstacle for MSMEs.”

In the ERF survey, 65.33 percent of MSMEs state that they lack the necessary financing to pursue RE projects despite the long-term cost savings these technologies can offer. This accentuates the need for targeted financial incentives, such as low-interest loans, subsidies, or tax breaks, to reduce the upfront costs of RE installations.

Technological Barriers

Technological challenges are cited by 47.06 percent of respondents, indicating gaps in both the availability of advanced RE technologies and the expertise required to use them effectively. A 63-year-old energy consultant specializing in the transition to RE points out that “with the introduction of ESG ratings by BlackRock, Tunisian companies are now forced to embark on an energy transition.” However, the technological gaps remain significant, especially in terms of equipment and expertise.

Many MSMEs, especially those in rural or underdeveloped areas, do not have access to the latest RE technologies. Even when such technologies are available, businesses often lack the technical expertise to install and maintain them. This creates a significant barrier to the adoption of RE solutions, as many businesses are reluctant to invest in technologies they do not fully understand or cannot properly manage.

Institutional and Bureaucratic Obstacles

Institutional barriers, cited by 47.06 percent of respondents, are deeply rooted in the governance structures that oversee the energy sector in Tunisia. This is exemplified by the perspective of a 38-year-old director of studies at CAMI Engineering, who highlights the significant challenges posed by installation costs and

the role of STEG in the transition process. She emphasizes that “installation costs and the role of the STEG are major challenges in the transition process,” highlighting the need for institutional reforms and support to facilitate a smoother transition to RE solutions.

These barriers are compounded by bureaucratic inefficiencies, cited by 61.76 percent of respondents. A 48-year-old co-manager of a company specializing in kitchen furniture manufacturing explains the frustration of dealing with the bureaucratic landscape: “The positive effects of the energy transition for Tunisian companies include reduced energy costs and improved brand image. However, the lack of investment funds, regulations, and bureaucratic procedures are major challenges.”

Many companies report that the involvement of government entities such as STEG adds layers of complexity to the implementation process. The bureaucratic red tape involved in securing permits, approvals, and necessary support from government institutions creates significant delays that discourage MSMEs from pursuing RE projects.

Lack of Awareness

Lack of awareness is identified as a barrier by 26.47 percent of respondents, particularly among MSMEs in rural areas. These businesses often lack sufficient information about the benefits of RE or the financial incentives available to them. A 56-year-old leader of the Ksar Hlal 2050 NGO highlights this issue, stating that “Tunisian companies face numerous opportunities in the energy transition field, particularly in solar and wind energy, thanks to the favorable climate. However, barriers like access to funding for energy transition projects are major. High initial installation costs necessitate accessible financing. Additionally, the lack of a binding legal framework mandating cleaner energy sources in companies or specific sectors is a significant barrier. Such a framework could stimulate sustainable energy practices by creating clear incentives and obligations.” This statement not only addresses the awareness issue but also highlights the interconnected challenges of financing and regulatory frameworks, which are pivotal in fostering a conducive environment for RE adoption in Tunisia.

The lack of a comprehensive RE education framework exacerbates this problem. Many companies are unaware of how RE can benefit their operations or how to access the resources necessary to implement such technologies.

Professional Group-Specific Barriers

Different professional groups face different barriers based on their specific roles in the RE ecosystem:



Figure 16. Key aspects and challenges of re deployment in Tunisia

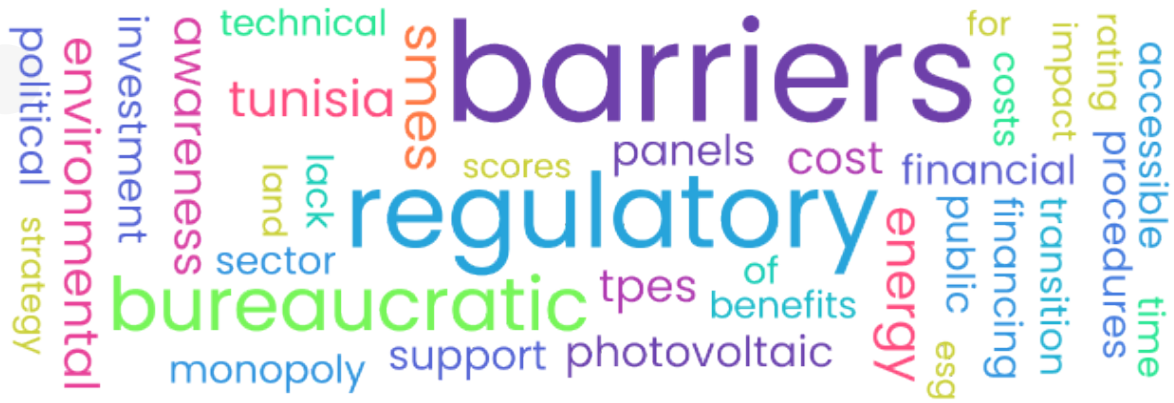


Figure 17. Awareness, technological, and bureaucratic barriers to RE (% of group-specific occurrences) among different professional groups in Tunisia

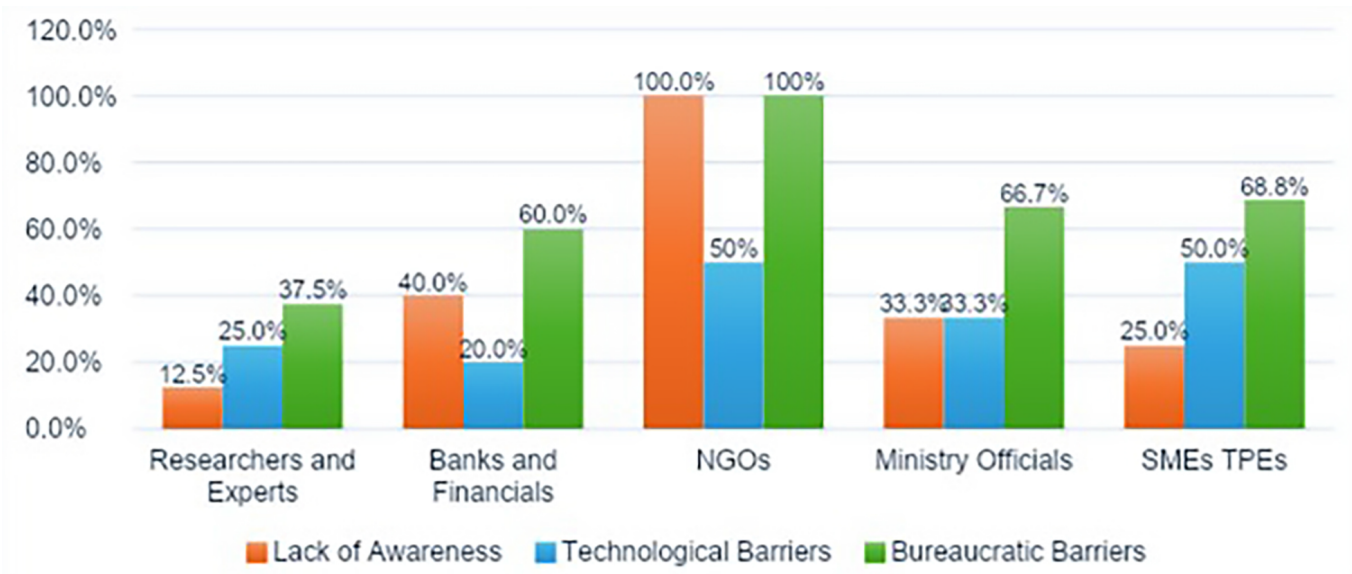
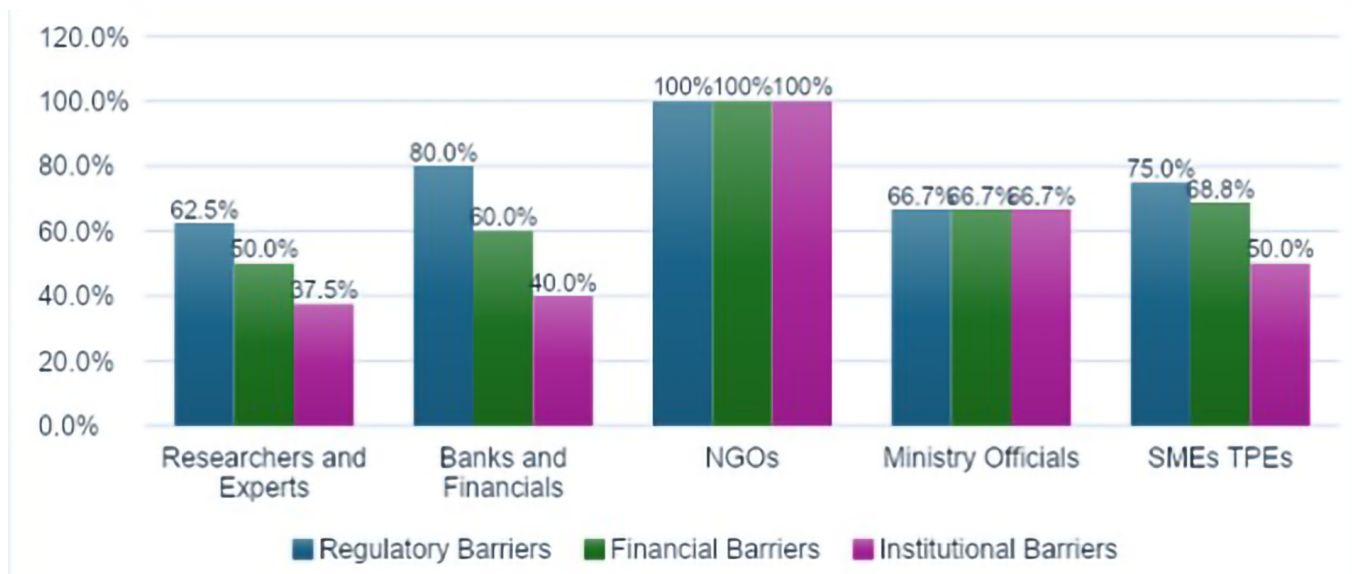


Figure 18. Regulatory, financial, and institutional barriers to RE (% of group-specific occurrences) among different professional groups in Tunisia



- **Researchers and experts:** This group highlights a combination of regulatory, financial, technological, and awareness challenges. A 37-year-old consultant at UTS-Palma notes: “The barriers are mainly regulatory, institutional, technological, and financial, which make it difficult for Tunisia to transition to RE.”
- **Banks and financial institutions:** Respondents in this group focus on financial and regulatory challenges. A representative of a public bank emphasizes that “land availability and high capital costs are major challenges for RE projects,” reflecting concerns about the economic viability of such investments.
- **NGOs:** NGO representatives stress the importance of raising awareness and simplifying bureaucratic processes. A 65-year-old CEO of an energy and climate consulting firm points out that “financial barriers, particularly access to funds, are among the most significant challenges.”
- **Government officials:** These respondents highlight strategic and financial barriers. A 54-year-old civil servant working in research and innovation notes: “Opportunities are hampered by the lack of a clear strategy and vision from the government.”
- **MSMEs:** This group expresses concerns about regulatory, financial, and bureaucratic barriers. A 55-year-old commercial director of a metallurgical company mentions that “the cost of electricity is a major constraint, and finding sustainable, low-cost energy sources is essential for long-term competitiveness.”

Exploring the multifaceted challenges to RE adoption in Tunisia reveals a complex landscape, underpinned by qualitative feedback and further substantiated by quantitative data from the ERF survey. This combination of insights provides a more comprehensive understanding of the barriers faced by MSMEs and other professional sectors when considering RE adoption. While the qualitative analysis highlights regulatory constraints, financial barriers, and institutional inefficiencies, the quantitative data adds depth by illustrating the specific areas in which these challenges manifest themselves and the extent to which they influence business decision-making.

Financial Constraints and Investment Challenges

One of the most significant constraints identified in the quantitative survey is lack of access to finance, with 65.33 percent of MSMEs reporting insufficient financial resources to invest in RE projects. This overwhelming majority indicates a systemic problem with the availability of capital for energy transition initiatives. Despite the

long-term cost savings associated with RE, the high upfront costs deter many MSMEs from making these investments, reflecting a broader issue of financing structures that do not adequately support sustainable energy transitions for smaller businesses.

Many MSMEs are unable to secure traditional loans due to strict credit requirements, lack of collateral, or the perceived risks associated with RE projects. This situation is further complicated by the limited availability of specialized financial products tailored to the energy sector, such as green loans or energy-specific credit lines. The lack of these financial tools makes it difficult for businesses to bridge the gap between immediate capital needs and the future savings that RE systems can provide. This financial barrier is not unique to Tunisia. Similar challenges have been reported in Egypt, where MSMEs have difficulty accessing financing for RE projects due to high interest rates and a lack of government-backed incentives. In Jordan, however, the government has introduced specific financing schemes that offer subsidized loans for RE installations, which have significantly increased the adoption rate among MSMEs. Morocco presents a hybrid model, where public-private partnerships have created more accessible financing options, allowing a greater number of MSMEs to participate in the energy transition.

Perception and Awareness of Renewables

A significant proportion of MSMEs in Tunisia report that they did not see a need for electricity from renewable sources, which may indicate a broader lack of awareness or misunderstanding of the benefits of RE. This is particularly concerning as it reflects a knowledge gap that could hinder the adoption of clean energy technologies, even in cases where financial barriers are not the primary issue.

The survey results show that this perception is prevalent among smaller businesses, especially those in rural areas where access to reliable information and energy consulting services may be limited. This finding suggests the need for targeted awareness campaigns to educate MSMEs about the potential cost savings, energy independence, and environmental benefits that RE can offer. The lack of perceived need for RE is also influenced by operating habits that rely heavily on traditional energy sources, making the transition seem unnecessary or overly complex.

In contrast, MSMEs in Morocco and Jordan have shown higher levels of awareness of the benefits of RE. This is partly due to government-led education programs and the presence of more active NGO involvement in energy



transition advocacy. These countries have focused on disseminating information through workshops, training programs, and media campaigns, which helped change perceptions and encouraged more businesses to explore RE options.

Rental and Ownership Issues

One of the more specific challenges identified in the ERF survey is the issue of ownership, with many MSMEs citing leases as a significant barrier to the adoption of RE. Some 16.33 percent of respondents report that their landlords do not approve of RE installations, preventing them from making significant changes to their rented properties. This challenge is particularly acute in urban areas, where the majority of MSMEs rent their premises and do not have the authority to make structural changes such as installing solar panels or other RE systems.

The property ownership issue points to the need for legal reforms or incentive structures that encourage landlords to support RE investments. One possible solution is to introduce tax incentives or subsidies for property owners who allow tenants to install RE systems. This would reduce the financial burden on MSMEs while encouraging property owners to participate in the energy transition.

This challenge is not unique to Tunisia. A similar problem exists in Egypt, where a significant proportion of urban MSMEs operate in rented premises and face resistance from landlords to energy-related changes. In Jordan, policy reforms have been enacted to address this issue by offering financial incentives to landlords who allow RE installations, helping to mitigate conflicts between tenants and property owners. Morocco has also taken steps to encourage property owners to participate in RE projects through tax benefits and government-backed guarantees that protect landlords' interests.

High Costs and Service Reliability Concerns

Cost remains one of the most frequently cited reasons behind the reluctance to adopt RE technologies. The ERF survey shows that a significant percentage of respondents find the monthly installments for RE systems too expensive, with many MSMEs stating that they cannot afford the payment. This financial burden, combined with concerns about the reliability of electricity services, is a significant deterrent to the adoption of RE. Businesses are often wary of investing in technologies that they perceive as expensive and potentially unreliable within the existing energy infrastructure.

In some cases, MSMEs express skepticism about the long-term viability of RE systems, particularly in regions

where grid stability remains an issue. Concerns that RE solutions may not provide consistent performance in areas prone to power outages or technical failures create a reluctance to commit to these investments.

To address these concerns, more robust guarantees and support mechanisms are needed to ensure the reliability of RE systems, particularly in areas with less developed infrastructure. Financial support in the form of subsidies or grants that cover more of the initial installation costs could also alleviate some of the burden on MSMEs and make these technologies more financially accessible.

In Morocco, government-led initiatives have provided significant subsidies for RE projects, making them more affordable for MSMEs. In Jordan, the government has implemented similar programs, along with measures to improve grid reliability, which has helped lessen concerns about service interruptions and encourage more businesses to invest in RE.

Implications for Policy and Strategy

These quantitative findings corroborate the feedback from industry experts and highlight specific areas where interventions could be most effective. In order for Tunisia to overcome the barriers identified, policymakers need to develop strategies that target the most pressing issues, such as improving access to finance, addressing property-related barriers, improving service reliability, and increasing awareness of the benefits of RE.

Collaborative efforts involving government, financial institutions, NGOs, and MSMEs are critical to creating a more supportive environment for RE adoption. For example, improving access to finance could include the introduction of government-backed loan schemes or the expansion of public-private partnerships that lower the cost of entry for MSMEs interested in RE projects. In parallel, reforms that facilitate the installation of RE in rented properties, such as offering incentives to landlords, could help address property-related barriers. Ensuring the reliability of electricity services through infrastructure investments would further reduce skepticism and build confidence in RE technologies.

By addressing these specific barriers through targeted interventions, Tunisia can significantly improve the adoption rates of RE technologies among MSMEs. The quantitative data from the ERF survey provides a roadmap for where these interventions should focus, emphasizing the financial, operational, and infrastructural challenges that must be overcome to facilitate a successful energy transition.



4.4. Assessment of energy transition progress

4.4.1. Current state and trends

The comprehensive assessment of the current state and trends of the energy transition among Tunisian MSMEs reveals a nuanced and multifaceted reality, where progress has been uneven and shaped by a variety of factors. Across sectors, professionals express concern about the sluggish pace of the energy transition, often describing efforts as insufficient to meet Tunisia's sustainability goals. A recurring theme of "weak progress" was observed in numerous interviews, with some respondents using phrases such as "in a state of standby" or calling for "significant improvement" to capture the current landscape. These reflections offer a candid snapshot of the challenges faced across the board, suggesting that the country's energy transition is moving far too slowly to address the urgent environmental and economic needs facing Tunisia today.

Researchers and experts are particularly vocal about these shortcomings. Several point out that non-multinational enterprises are lagging behind in their efforts to adopt RE technologies. A 29-year-old financial researcher from ESCT notes that there is a critical need for "significant improvement," particularly in non-multinational corporations where the gap between policy intentions and actual implementation is most pronounced. Similarly, a 37-year-old consultant from UTS-Palma expresses a more measured view, noting "tentative progress" that reflects a guarded and incremental approach to energy transition in many sectors. This cautious and often hesitant progress is indicative of the challenges Tunisian businesses face in embracing new technologies while navigating entrenched systems and economic constraints. A young climate change negotiator highlights another key obstacle: the lack of "decisive political support." This observation underscores the indispensable role of political commitment in fostering real change; without strong political backing, the energy transition is unlikely to gain the momentum needed to deliver transformative results.

The banking and finance sector offers a different perspective, focusing on operational challenges and the gap between policy and practice. One of the key issues identified is noted by a representative from a public bank who points out that "energy audits remain underutilized" because many enterprises lack the technical expertise to conduct them effectively. A 35-year-old PhD student in finance further highlights this gap, noting that many government policies related to energy transition are

"intangible," leaving businesses unsure of how to move forward. This feedback paints a picture of an energy transition process where government policies have not yet been translated into actionable steps for many businesses, leaving a large gap between theoretical frameworks and practical implementation. Another representative from the National Agricultural Bank (BNA) echoes these concerns, remarking that the underutilization of energy audits in Tunisia remains a critical issue, hampering the ability of enterprises to identify and implement energy efficiency strategies.

Feedback from NGOs reveals an even more critical attitude. Some respondents describe the energy transition as "deeply worrying and frustrating," reflecting a sense of urgency and impatience with the current pace of change. Another NGO leader comments that progress is "below average," reinforcing the perception that the country is falling short in its efforts to transition to RE. This frustration is particularly resonant given the environmental stakes, as NGOs often work at the forefront of environmental advocacy and sustainability, and their responses signal that they believe the transition is moving too slowly to mitigate the environmental impacts that Tunisia is already experiencing.

Government officials, meanwhile, are more measured. While they acknowledge the efforts made to date, they are also quick to acknowledge the gaps in implementation. One official notes that while the efforts could be described as "maximum," the results remain "mediocre," revealing a discrepancy between ambition and reality. This sentiment is echoed by others who note a "significant performance gap," highlighting the inconsistency between the country's energy policy and the results achieved to date. This perspective suggests that while there is strong political will and national effort behind the energy transition, implementation challenges—whether due to financial, regulatory, or technological constraints—continue to hold back substantial progress.

Perhaps the most diverse responses come from MSMEs, the largest group surveyed. Their feedback reflects both the structural and operational barriers that are slowing their efforts to adopt RE. Several respondents describe the progress as "unconvincing" or "too slow," often citing reliance on fossil fuels and limited support for the adoption of renewable technologies as key factors. The difficulty of securing adequate financing and technical assistance is a consistent theme among MSME respondents, with many highlighting the challenges they face in transitioning to RE without the necessary financial support. These responses paint a picture of a sector that is eager to engage in the energy transition but constrained by practical day-



to-day concerns such as cost, infrastructure, and limited government support.

Adding further nuance to this qualitative analysis, quantitative data from the ERF survey emphasizes the financial and operational challenges faced by MSMEs in Tunisia as they seek to navigate the energy transition. The survey results show that a significant proportion of MSMEs, around 30.33 percent, face monthly electricity costs exceeding TND 1,001, which represents a significant financial burden for many enterprises. This high level of energy expenditure is particularly limiting for smaller enterprises, which often operate on tight budgets and have little room to invest in long-term energy efficiency or RE projects. This financial pressure is compounded by the fact that many MSMEs do not have access to the necessary financing or subsidies to support such investments, further delaying their energy transition efforts.

The survey also examines the daily use of grid power by MSMEs and finds that 61 percent of enterprises rely on grid power for six to 10 hours per day. This level of reliance highlights the vulnerability of many businesses to grid disruptions, whether due to instability or rising electricity prices. Given the importance of a stable and affordable supply of energy to maintain day-to-day operations, these businesses face significant energy cost risks. This reliance on grid power underscores the urgency of transitioning to RE solutions, which could provide a more stable and sustainable source of energy for Tunisia’s MSMEs.

Figures 19 and 20 provide a visual representation of these key data points, offering a detailed look at the financial pressures that energy consumption places on Tunisian enterprises. Figure 19 illustrates the distribution of monthly electricity expenditures among MSMEs while Figure 20 highlights the percentage of operating costs attributed to electricity expenses. Together, these figures provide a clear and compelling visual representation of the energy challenges faced by businesses in the country and point to the importance of reducing energy costs through efficiency measures and the adoption of RE.

To effectively address these challenges, there is a growing consensus on the need for targeted education programs and skill development initiatives. Many experts note that upskilling young workers, improving technical expertise, and addressing gender disparities in the RE sector are critical to advancing the energy transition. By equipping the next generation of workers with the knowledge and skills necessary to manage and implement RE technologies, Tunisia can build a more proficient workforce capable of accelerating the transition. Integrating more women into the RE workforce would also help address gender inequality and promote more inclusive economic growth, ensuring that the benefits of the energy transition are shared more equitably across the population.

Ultimately, the findings suggest that a more integrated approach is needed to accelerate Tunisia’s energy transition. This approach must be based on reforms that address financial barriers, regulatory hurdles, and institutional inefficiencies while providing the technical

Figure 19. Distribution of monthly electricity spend across SMEs

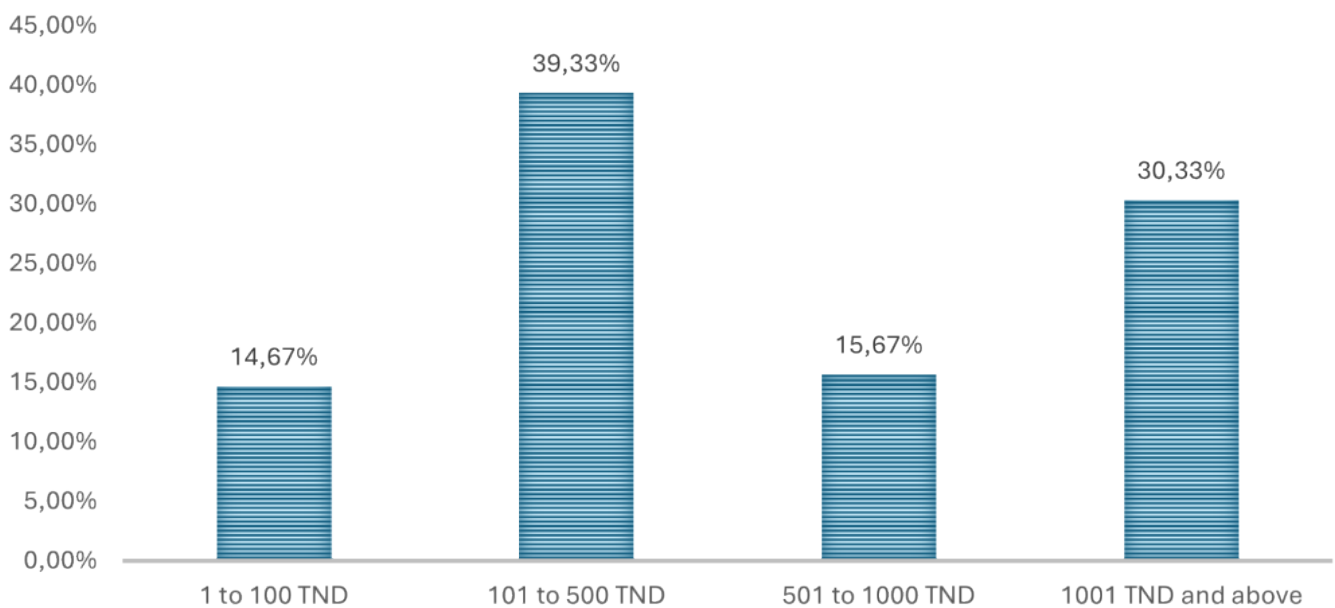
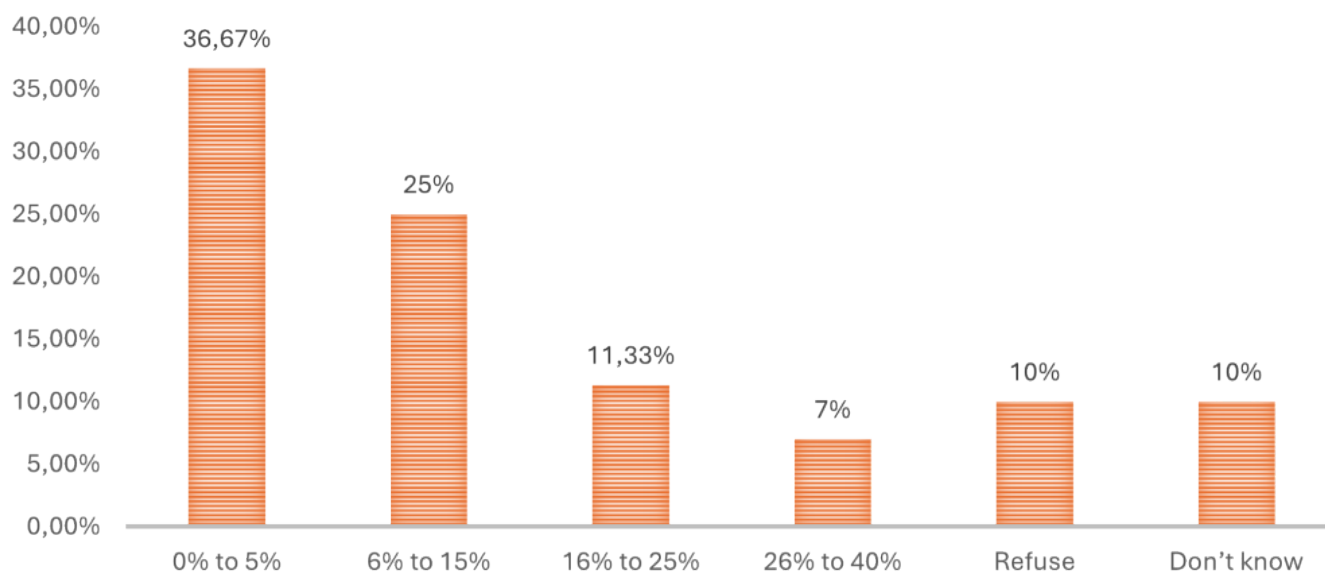


Figure 20. Operating cost burden of electricity spend

and operational support that MSMEs need to successfully adopt RE technologies. A holistic strategy that includes innovative financing models, capacity building initiatives, and targeted subsidies is essential to overcome the barriers identified in both the qualitative and quantitative analyses.

By fostering collaboration between the government, private sector, and civil society, Tunisia can address the multiple challenges of the energy transition and pave the way for sustainable economic growth.

4.4.2. Policy effectiveness and industry response

The evaluation of the state's energy policy for Tunisian enterprises, as perceived by a cross-section of professionals, reveals a comprehensive critique that reflects the complexity and inadequacies of the current policy framework. This analysis, which incorporates the views of the survey respondents, describes a landscape characterized by a consensus on the need to significantly improve both the clarity and the effectiveness of these policies. This analysis is further illustrated in Figure 21, which shows the factors identified and their weights, providing a visual representation of the predominant concerns in the policy framework.

A major concern cited by 23.53 percent of respondents articulates a significant problem with the lack of a clear strategy in the state's approach to the energy transition. This concern, as stated by a Doctor of Finance from the Tunis Higher School of Commerce (ESCT), reflects a fundamental gap in strategic direction. He notes that "there is no clear strategy for energy transition in Tunisia."

This sentiment resonates across different professional groups, underscoring a widespread perception of strategic shortcomings in the government's energy policy.

Nearly half of respondents (47.06 percent) express challenges related to policy clarity and implementation. This significant figure spotlights a widespread belief that while policies may be in place, their practical impact and implementation are lacking. Echoing this sentiment, a 37-year-old consultant at UTS-Palma highlights the "apparent lack of involvement of industry stakeholders," indicating a disconnect between policy formulation and industry needs. In particular, the MSME group expresses concern that policies are "neither clear nor effective," "unclear," and "in place but not applied," pointing to significant gaps in policy communication and implementation.

Specific challenges within the policy framework are identified by 11.76 percent of participants. For example, a 45-year-old management controller points to the problematic role of the STEG, which has a critical impact on the effectiveness of state energy policy. Other respondents raise issues such as the challenges of energy dependency, cumbersome mechanisms, and specific problems with STEG policies, highlighting areas where targeted policy reforms are urgently needed.

Inadequate stakeholder involvement is highlighted by 5.88 percent of respondents, particularly from the research and experts and banking and finance sectors. They emphasize the need for accelerated administrative procedures and greater involvement of industry stakeholders, suggesting a significant gap between policy development and the practical realities of industry.



The survey respondents advocate for proactive government involvement in energy transition projects. This is highlighted by 2.94 percent of respondents, including a 43-year-old engineer and Head of Strategy at the International Monetary Fund (IMF), Enda Tamweel. He proposes that all ministries, administrations, and public institutions should be equipped with solar systems, reflecting a desire for active government leadership in energy transition efforts.

Government officials, representing 8.82 percent of responses, offer a more tempered but still critical view. Some officials perceive the policies as “somewhat acceptable but complicated,” acknowledging the efforts made but also recognizing the prevailing challenges.

This cross-sectional analysis illustrates the urgent need for a more coherent, strategically focused, and effectively implemented energy policy in Tunisia. The consensus across sectors, as illustrated in Figure 21, underscores the urgency of re-evaluating and improving these policies to effectively address energy and environmental needs. The findings highlight the complexity of the energy policy landscape and call for a collaborative and inclusive approach to policy design and implementation. The diversity of perspectives, from critiques of strategic gaps and specific operational challenges to calls for greater stakeholder involvement and government leadership, exemplifies the multifaceted nature of the challenges in designing effective energy policies. This broad understanding of policy shortcomings accentuates the need for an approach that addresses the unique needs and insights of different stakeholders to ensure

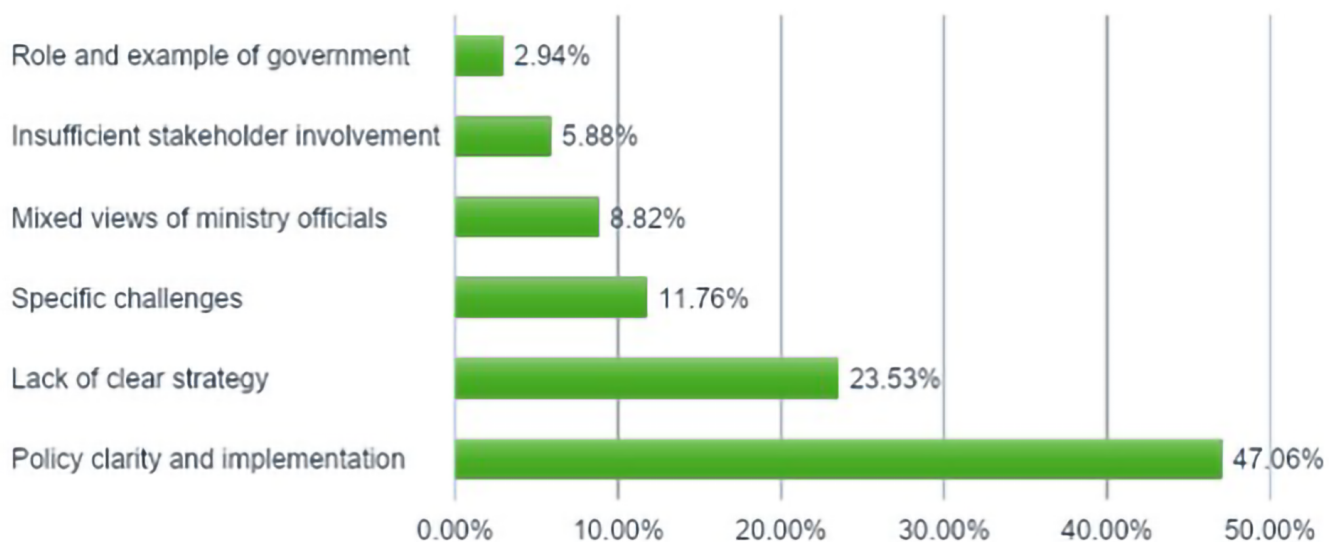
that future policies are not only strategically sound but also practically implementable and effective in advancing Tunisia’s energy transition.

By moving from a qualitative to a quantitative analysis, the ERF survey data provides a deeper insight into how these policies are perceived and their impact on the ground. This shift to empirical evidence allows for a comprehensive view of the effectiveness of energy policies in Tunisia as reported by business professionals from different sectors. The survey reveals nuanced views on government support for RE deployment. While 58.33 percent of enterprises agree or strongly agree that government support is adequate, a significant proportion (19.67 percent) disagree or strongly disagree, highlighting dissatisfaction with the level of support provided. These data suggest that while there is some recognition of government efforts, there remains a significant need for increased or more effective support.

Stakeholder preferences also reflect strong support for corporate adoption of RE. A combined 58.33 percent of respondents prefer companies that integrate sustainable practices, indicating strong support for RE adoption within the business community. This preference highlights the value placed on sustainability and the potential reputational benefits that companies can gain by adopting renewable technologies.

In addition, the business community’s stance on RE subsidies is overwhelmingly positive, with 84 percent supporting subsidies. This strong consensus underscores the perceived need for financial incentives to encourage

Figure 21. Identified factors and their weight in the effectiveness of the national energy policy in Tunisia



the adoption of RE solutions and reflects a broad recognition of the economic barriers that companies face in transitioning to RE sources.

The challenges and opportunities identified in the survey shed light on the need for a more coherent, strategically focused approach to energy policy. This approach should incorporate the practical realities and needs of industry in order to improve the effectiveness and implementation of policies. By addressing the specific challenges identified, such as the need for clearer strategies, better stakeholder engagement, and stronger government support, Tunisia can more effectively manage its energy transition and align its efforts with national and global sustainability goals.

4.5. Strategies and commitment to energy system transformation

4.5.1. Institutional strategies and commitment

The assessment of institutional strategies and commitment to the energy transition in Tunisia reveals significant disparities in terms of commitment between different sectors. Based on the qualitative insights provided by experts from different fields, there is a noticeable division between institutions that are actively engaged in the energy transition and those that are either not committed or are in the early stages of their approach to RE integration.

A significant number of institutions, representing 47.06 percent of respondents, demonstrate proactive engagement in the energy transition. This commitment is evident in organizations closely associated with RE research and climate-related initiatives. For example, a 37-year-old consultant at UTS-Palma clearly states: “Yes, our focus is on electrical energy research and its applications in the energy transition.” This illustrates the proactive role that certain research institutions and consulting firms are playing in driving energy innovation. Similarly, a 28-year-old climate change negotiator notes the following: “Our institution specializes in photovoltaic (PV) energy research, which contributes to the energy transition,” further stressing the strategic focus on RE technologies within these organizations.

On the other hand, 52.94 percent of respondents indicate that their institutions are either not engaged or in the early stages of engagement with energy transition initiatives. A 63-year-old energy consultant admits: “No, there is no commitment to energy transition or specific energy research in our institution,” reflecting a widespread lack of institutional engagement. This

trend is particularly prevalent in sectors less directly involved in energy research or policymaking, where RE is not perceived as a priority. Such institutions may face operational challenges, resource constraints, or a lack of strategic vision, hindering their ability to contribute meaningfully to Tunisia’s national energy transition goals. Responses from the banking sector show a mixed picture. Some institutions, such as the BNA, show a strategic interest in RE investments. A representative of the BNA describes how the bank is involved in financing RE projects, demonstrating a commitment to supporting businesses that are transitioning to clean energy. However, this contrasts with other parts of the financial sector. For example, one respondent from the home appliance industry notes that while their company outwardly supports RE initiatives in marketing campaigns, they are not fully committed to integrating these practices internally. This highlights a gap between public sustainability messaging and actual operational practices, an issue that undermines broader energy transition efforts.

NGOs, on the other hand, tend to be more engaged in the energy transition, especially in areas related to climate change and sustainable development. For example, a 56-year-old representative of the Ksar Hlal 2050 NGO expresses strong commitment, stating: “Our NGO is deeply committed to climate change, which is an important pillar of our activities.” This reflects the crucial role that CSOs play in advocating for and implementing RE projects, often at the grassroots level. NGOs like Ksar Hlal 2050 are instrumental in raising awareness and fostering community-level engagement, which is essential for building societal support for the energy transition.

The level of engagement within MSMEs is similarly diverse. Some MSMEs are actively working to integrate RE technologies into their business models. For example, a 65-year-old manager of an organic olive oil production company shares that his company has “developed a comprehensive energy strategy” aimed at reducing environmental impact and improving efficiency. This suggests that some smaller businesses are recognizing the long-term benefits of sustainability and are adopting RE technologies as part of their business strategies. For many MSMEs, however, energy transition remains a low priority. A 32-year-old hotel entrepreneur admits: “Our institution is not currently involved in energy transition and does not have a strategy,” mirroring the broader challenges faced by MSMEs, such as limited financial resources, competing business priorities, and lack of access to the necessary technologies.

A critical challenge highlighted by several interviewees is the lack of dedicated human resource strategies for the energy transition. A commercial director from Ksar Hlal



2050 notes that while the NGO is aware of the need for an energy transition, there is no dedicated HR strategy to recruit or train employees for this transition. This underscores a broader issue across sectors, where a lack of skilled workers and targeted training programs are preventing institutions from fully engaging in energy transition initiatives. Addressing this skills gap would require coordinated efforts from both the government and the private sector, including the development of specialized training programs and incentives for hiring and upskilling workers in energy-related fields.

Moving from qualitative insights to quantitative data, the ERF survey provides a clearer picture of institutional strategies and engagement in Tunisia's energy transition. The survey shows that 54.33 percent of MSMEs either agree or strongly agree that they are actively engaged in the adoption of RE technologies. This suggests that the majority of companies recognize the operational benefits of a RE transition, including improved energy efficiency, cost savings, and increased market competitiveness. These companies are increasingly aligning their business strategies with global sustainability trends, which not only helps reduce their environmental footprint but also positions them to take advantage of new market opportunities.

However, the survey also reveals that 13 percent of MSMEs do not support or actively resist the adoption of RE technologies. This reluctance is often due to financial constraints, as well as concerns about the reliability and cost-effectiveness of RE solutions. These businesses may view the initial investment required for RE technologies (such as solar panels or energy-efficient appliances) as prohibitively expensive, even though the long-term

savings and benefits are well documented. There is a need for more targeted financial support and incentives to encourage wider adoption among businesses that are reluctant to make the transition.

Perceptions of government support for RE adoption are similarly mixed. While 58.33 percent of respondents believe that the government provides adequate support for RE initiatives, there is a significant portion that is neutral or dissatisfied with the current level of support. This dissatisfaction is often linked to a perceived lack of clear guidelines, limited access to funding, and bureaucratic obstacles that slow down the adoption process. Strengthening government policies and providing more robust financial incentives, such as tax breaks, subsidies, and low-interest loans, could help address these concerns and drive higher adoption rates.

In terms of energy efficiency improvements, 78 percent of respondents agree or strongly agree that the adoption of RE technologies has led to measurable improvements in their energy efficiency. This shows that once businesses commit to RE, they begin to see tangible benefits not only in terms of reducing their environmental impact but also in improving operational efficiency and reducing energy costs. These improvements are particularly important for MSMEs, which often operate on thin margins and stand to benefit significantly from any cost savings associated with reduced energy consumption.

To better illustrate these findings, Figures 22 and 23 show SME intentions to adopt RE technologies and perceptions of government support, respectively. These figures help contextualize the strategic and operational dynamics shaping Tunisia's energy transition and highlight areas where further support and policy refinement are needed.

Figure 22. MSMEs' intentions to adopt RE technologies

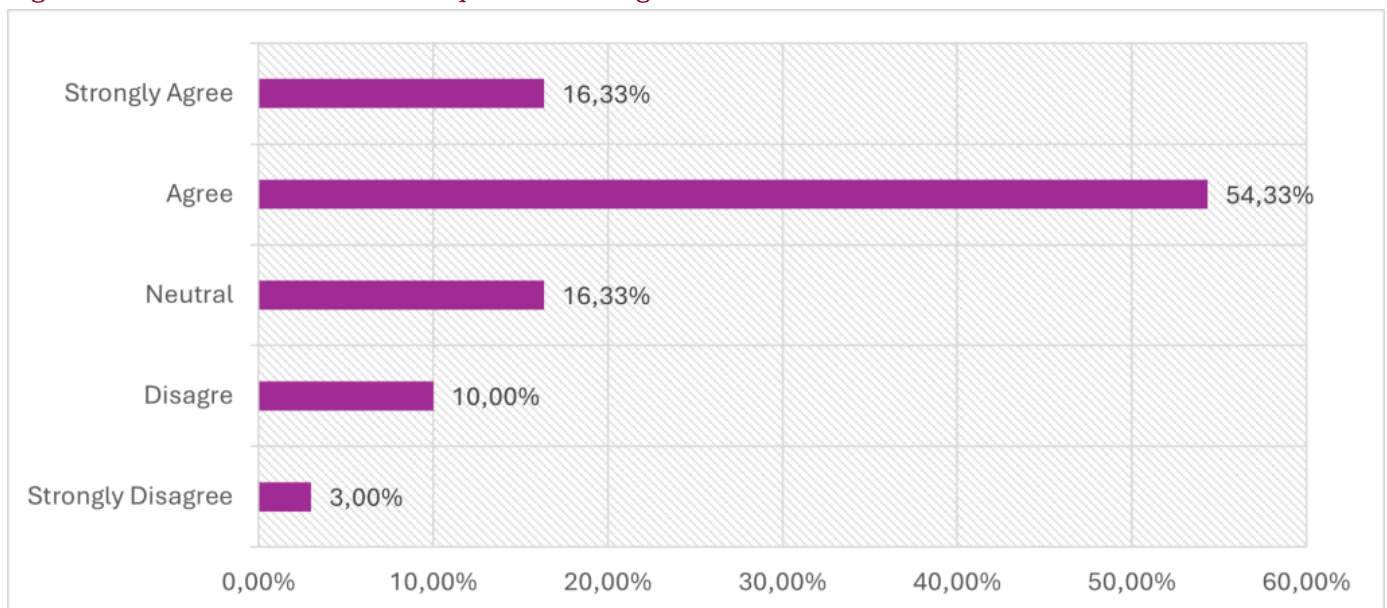
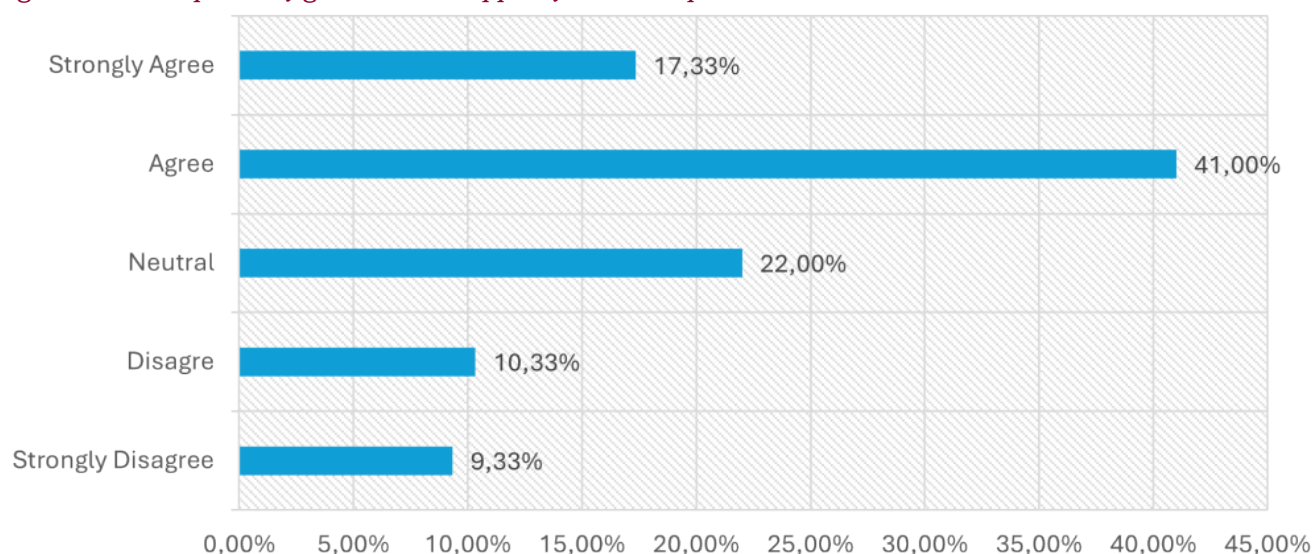


Figure 23. Perceptions of government support for RE adoption

The findings suggest that while there are clear areas of commitment and progress in Tunisia's energy transition, significant challenges remain. A more coordinated national strategy, combined with stronger financial and technical support from the government, is essential to accelerate the adoption of RE technologies across all sectors. Public-private partnerships, targeted education programs, and greater incentives for MSMEs can play a critical role in bridging the gap between intention and implementation. Through these efforts, Tunisia can ensure that its energy transition is both inclusive and sustainable, helping to secure long-term environmental and economic benefits for the country.

4.5.2. Adoption and use of RE

Our examination of the adoption and use of RE in Tunisia reveals a complex and multifaceted scenario. The analysis, supported by the interview data, reveals different drivers and barriers, each influenced by the specific conditions of different sectors. This complicated landscape reflects institutions' different approaches to RE and embodies the broader environmental, economic, and infrastructural dynamics in the country.

Of the total respondents, 44.12 percent report active use of RE at their institutions, signaling a positive shift toward sustainable energy practices. This adoption is primarily driven by a strong commitment to the energy transition, cited by 38.24 percent of respondents. A notable example is a 37-year-old consultant from UTS-Palma who states: "Yes, our institution is actively using RE, with a particular focus on electrical energy research." This highlights the strategic integration of RE within the operational framework of some organizations.

However, 55.88 percent of respondents indicate that they do not use RE, citing various challenges. A common obstacle, cited by 14.71 percent of respondents, is the lack of a clear strategic focus on the energy transition. A 63-year-old energy consultant says: "No, our institution does not use RE. Our current focus is not on energy transition," revealing gaps in strategic prioritization.

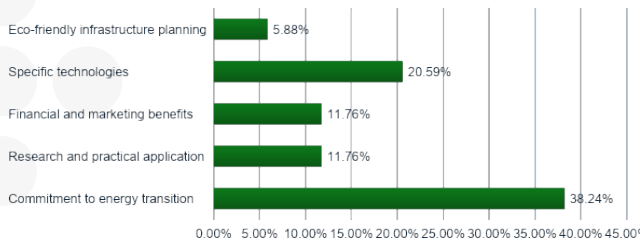
Financial and resource constraints are another significant barrier, cited by 17.65 percent of respondents. One young entrepreneur shares: "Our institution does not use RE due to several constraints, including limited decision-making autonomy and resources." This statement emphasizes the financial and operational challenges, particularly for MSMEs, which often face hurdles in overcoming the initial costs and logistical demands of adopting RE technologies. Operational and structural constraints, reported by another 17.65 percent of respondents, further complicate RE adoption. These constraints include infrastructure limitations and challenges in integrating renewable technologies with existing systems. For example, enterprises that rely on older energy infrastructure may find it difficult to retrofit their systems, even if they are motivated to switch to RE.

The banking and finance sector takes a more indirect approach to RE, focusing on financial support for projects rather than direct use. As a representative of the BNA explains: "Our institution actively invests in RE projects, but we do not directly use RE in our operations." This illustrates the role of the sector in facilitating the wider adoption of RE by providing the necessary financial mechanisms.

NGOs are taking a more direct and proactive approach. A representative from Ksar Hlal 2050 states: "Our NGO



Figure 24a. Key drivers for RE adoption in Tunisia



promotes RE, especially solar PV,” demonstrating the role NGOs play in advocating for and implementing renewable solutions.

Specific technologies and green infrastructure planning are among the key factors driving RE adoption, as highlighted by 20.59 percent and 5.88 percent of respondents, respectively. These findings suggest that technological advances and innovative infrastructure designs are critical to motivating institutions to adopt RE solutions.

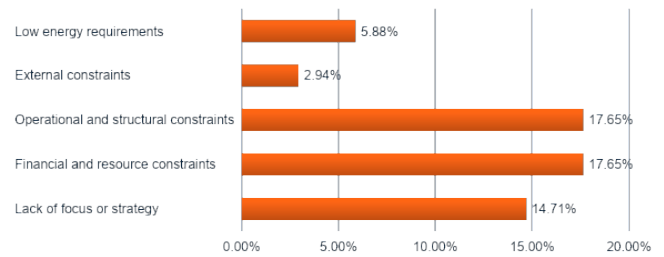
Conversely, external constraints and low energy needs, while less frequently mentioned, suggest that some institutions are inhibited by market conditions or the nature of their operations. For example, companies with low energy consumption may not prioritize RE adoption because the potential savings are small compared to the investment required.

These different patterns of RE adoption across sectors underscore the need for a tailored, multifaceted approach to advancing Tunisia’s sustainable energy agenda. Differences in adoption rates and motivations suggest that sector-specific strategies are essential to address the unique challenges and opportunities faced by each group. For example, MSMEs, which often lack resources or expertise, could benefit from financial incentives and technical support to overcome their specific constraints and encourage RE adoption.

In contrast, larger institutions and NGOs with more substantial resources may find it easier to adopt renewable solutions. However, they still face challenges that require strategies that address the availability of resources and maximize the use of existing capabilities to achieve long-term success in their RE efforts.

The role of collaboration is paramount. A synergistic approach involving government agencies, the private sector, and civil society is critical to creating an enabling environment for RE integration. These collaborations can combine policy support, financial mechanisms, and

Figure 24b. Barriers to RE adoption in Tunisia



technological innovation to facilitate a smooth transition to RE across all sectors.

The shift from qualitative insights to quantitative data provides further clarity on RE adoption patterns. According to the ERF survey, 54.33 percent of MSMEs agree or strongly agree that they are exploring the integration of RE technologies, signaling growing awareness and readiness for adoption. However, 13 percent of respondents remain skeptical, either disagreeing or strongly disagreeing with the adoption of RE, citing high costs, lack of access to financing, and operational risks.

The adoption of RE in Tunisia is characterized by different motivations, capabilities, and challenges across sectors. Recognizing these differences and addressing them through tailored strategies and collaborative efforts is key to advancing Tunisia’s RE goals. Such efforts will not only contribute to the country’s environmental sustainability but also to its economic resilience and competitiveness in the global market.

4.6. Support mechanisms and energy savings

4.6.1. Assessment of support mechanisms

The analysis of Tunisia’s support mechanisms for clean energy deployment reveals a multifaceted landscape of opportunities and challenges, as perceived by experts from different sectors. While support systems exist, their effectiveness, accessibility, and integration into broader energy transition strategies remain points of contention. Different sectors show varying levels of satisfaction with the current frameworks, ranging from those who find the mechanisms somewhat adequate to others who feel they are insufficient to meet the complex needs of the country’s clean energy ambitions.

Among researchers and experts, 50 percent express concern about the fragmented nature of current support systems. This fragmentation is seen as a significant barrier to achieving more cohesive and impactful energy



initiatives. As one RE consultant notes: “The disjointed nature of support mechanisms limits their effectiveness, leading to a situation where programs often operate in silos without sufficient coordination.” This reflects a broader sentiment among experts that while initiatives such as those led by ANME and energy efficiency programs (PEESE) are in place, they lack the strategic alignment needed to maximize their potential.

Additionally, 37.5 percent of professionals highlight financial constraints as a critical limitation of existing mechanisms. Although Tunisia has made progress in developing financial support for RE deployment, the amount of available funding is often insufficient to meet the needs of both large-scale projects and small and medium-sized enterprises (SMEs). As one researcher specializing in energy finance explains: “The available funding, while valuable, is not enough to facilitate the large-scale deployment of RE technologies, especially for MSMEs, which are the backbone of the Tunisian economy.” The problem of underfunding is exacerbated by complex application processes and eligibility criteria that often exclude smaller players.

Operational barriers also emerge as a recurring theme, particularly among MSMEs. A significant 62.5 percent of MSMEs report that existing support mechanisms are either unclear or overly complicated. As one director of a small manufacturing firm comments, “The complexity of the administrative procedures to access support often discourages businesses from even attempting to apply for these programs.” This sentiment resonates throughout the SME sector, where businesses struggle with financial constraints as well as the bureaucratic hurdles that accompany government support.

The banking and finance sector offers a more nuanced critique. While some in this sector acknowledge the potential of the support schemes, they point to a disconnect between the policy framework and the practical needs of financial institutions tasked with financing clean energy projects. As noted by a senior executive at a Tunisian bank: “The policy mechanisms are not well integrated with the financial instruments needed to support large-scale investments in RE. There needs to be more coordination between the financial sector and government agencies to ensure that projects do not stall due to financial bottlenecks.” This discrepancy underscores the need for greater collaboration between policymakers and the financial industry to create a more enabling environment for energy investment.

NGOs, which represent a critical voice in the clean energy landscape, are unanimous in calling for better communication and access to information.

One environmental NGO leader explains that “many companies, especially smaller ones, are unaware of the specific programs they can benefit from. Even when they are aware, the complexity of accessing these mechanisms prevents full engagement.” This lack of clarity and access to information limits the potential reach and impact of support systems, especially for smaller businesses and grassroots NGOs.

While government officials acknowledge the progress made in establishing support frameworks, they are critical of their implementation and monitoring. A total of 66.67 percent of government respondents point out that although policies exist, their practical application often falls short. One senior government official explains that “the challenge is not necessarily in policy design, but in implementation and monitoring mechanisms to ensure that support is delivered effectively.” This pinpoints a common theme across sectors: existing policies need to be backed up by more robust monitoring and evaluation frameworks to ensure that they are effectively addressing the needs of companies and institutions engaged in the energy transition.

In terms of quantitative analysis, the data from the ERF survey provides a deeper insight into how these mechanisms are perceived by Tunisian SMEs. The survey shows that 58.33 percent of respondents believe that government support for the adoption of RE is adequate. However, this positive view is tempered by the fact that 41.67 percent of SMEs remain neutral or dissatisfied with the level of support provided, indicating significant room for improvement. This suggests that while government initiatives are recognized, they may not be sufficiently tailored to the diverse needs of different industries and company sizes.

One of the key challenges identified in the survey is the accessibility of financing options for RE projects. Only 34.67 percent of MSMEs report that they find financing options accessible, a critical barrier to the widespread adoption of clean energy technologies. This is particularly problematic for smaller businesses, which often struggle to secure the upfront capital needed to invest in RE systems such as solar panels or energy-efficient appliances. A representative of a small agricultural business notes: “Financing for RE projects is difficult to access, especially for businesses like ours that operate on tight margins. There needs to be more accessible financial products tailored to the needs of small businesses.”

Apart from financial barriers, access to information remains a critical issue. Only 27.33 percent of SMEs report having access to information on electricity price changes, which is essential for energy planning and management.



A lack of clear and consistent information on electricity tariffs, grid stability, and energy prices hinders businesses from making informed decisions about their energy use and investments in RE technologies. This problem is exacerbated by the fact that less than half of respondents find information on power outage schedules and fuel price changes relevant or useful for their energy management decisions. This highlights the need for better communication and transparency from government agencies and utilities.

Despite these challenges, there are some positive developments. The survey shows that 53 percent of MSMEs find information about electricity rate changes useful, signaling a growing awareness of the importance of such data in energy decision-making. However, the survey also shows that information on the price of backup generation and financing options for energy management is less well understood, with only 24 percent of respondents finding this information useful. This suggests that more effort is needed to educate MSMEs about the full range of energy management options available to them, particularly with regard to backup generation and long-term financing solutions.

Finally, planned network maintenance is an area of concern. Only 24.33 percent of MSMEs report that they consider information on planned network maintenance to be necessary for their operations. This relatively low figure suggests that many businesses may not fully appreciate the impact of network reliability on their energy consumption, or that the current system for disseminating maintenance schedules is inadequate. Improving communication about network maintenance and its potential impact on business operations could help MSMEs better prepare for and manage disruptions, ultimately leading to more efficient energy use and reduced costs.

The findings from both the qualitative feedback and quantitative data thus highlight the need for a more integrated and coordinated approach to supporting clean energy uptake in Tunisia. While existing mechanisms are acknowledged, they are generally seen as insufficient to meet the diverse and evolving needs of the business community. Addressing these gaps would require stronger government support, more accessible financial products, and improved communication between stakeholders. By creating a more enabling environment for the energy transition, Tunisia can accelerate its progress toward a sustainable energy future that benefits all sectors of the economy.

4.6.2. Energy savings and efficiency

The landscape of energy savings and efficiency within Tunisian MSMEs reflects a diverse and evolving engagement with energy management strategies. A comprehensive assessment of energy-saving efforts reveals a variety of practices, each shaped by the unique operational realities of different sectors.

A total of 6.25 percent of respondents indicate that their businesses are not actively engaged in energy-saving efforts. These companies often cite early-stage development or conflicting operational priorities as reasons for not prioritizing energy efficiency. One young entrepreneur in the hotel industry notes: “Currently, our company is not actively pursuing energy savings because of our early stage of development.” This highlights missed opportunities to integrate energy efficiency into fundamental business strategies and points to the need for early interventions that encourage energy-conscious planning.

Another 6.25 percent of respondents demonstrate leadership in energy efficiency by actively implementing various energy-saving initiatives. These companies are characterized by a higher level of environmental awareness and a strategic approach to sustainable business practices. A 37-year-old consultant from UTS-Palma explains: “Our company’s energy-saving measures are aligned with long-term sustainability goals, and we have already achieved significant reductions in energy consumption.” This proactive behavior indicates Tunisian MSMEs’ growing recognition of the operational and environmental benefits of energy efficiency, including cost reduction and improved market competitiveness.

A significant portion of respondents, 12.5 percent, have begun to explore energy-saving opportunities, although many are still in the early stages. This emerging awareness of energy efficiency marks a positive shift in attitudes, although many companies have not yet translated these intentions into actionable strategies. The absence of responses related to “strategically improving energy efficiency” or “focusing efforts on financial savings” suggests that while awareness is increasing, there is still a lack of comprehensive understanding of energy management. Targeted education and support could help companies move from exploration to implementation.

Meanwhile, 6.25 percent of respondents have implemented modest energy conservation efforts, such as internal awareness campaigns and basic energy-saving practices. While these steps show a growing awareness of energy



efficiency, more structured and effective strategies are needed. A 56-year-old NGO representative from Ksar Hlal 2050 states: “While we are starting to implement energy-saving measures, we still lack the structured framework needed for long-term efficiency.” This reflects a broader challenge for businesses that have the desire but lack the expertise or resources to implement comprehensive strategies.

Conversely, 6.25 percent of respondents state that they have no energy efficiency measures in place. These companies often face high operating costs or lack awareness of the benefits of energy savings. As one commercial director of a small manufacturing company explains, “Saving energy has not been a priority for us due to the need to manage high operating costs.” This highlights a significant barrier to the wider adoption of energy-saving initiatives.

Companies that have achieved certifications such as ISO 14001, which represent another 6.25 percent of respondents, demonstrate a more advanced approach to energy management. These certifications demonstrate a commitment to sustainable business practices, with certified companies setting industry standards for energy efficiency. As clarified by one respondent from the organic farming sector: “Our ISO 14001 certification has formalized our commitment to energy efficiency and helped us reduce energy consumption by 20 percent over the past two years.” These companies provide a tangible example of how dedicated energy efficiency efforts can lead to significant operational and financial benefits.

Another 6.25 percent of respondents are engaged in ongoing efforts to improve their energy efficiency, demonstrating a dynamic and adaptive approach. These companies are constantly looking for new ways to reduce their energy footprint. A 42-year-old project manager in the RE sector remarks: “Energy efficiency requires continuous improvement. We are constantly looking for new technologies and methods to improve our performance.” This forward-thinking approach emphasizes the evolving nature of energy management. The varying levels of commitment to energy efficiency among MSMEs suggest the need for tailored strategies to address the specific challenges faced by different businesses. While awareness of energy efficiency is growing, the depth and consistency of implementation remains uneven. From minimal efforts to more comprehensive strategies, these different approaches reflect the operational realities of Tunisian MSMEs and stress the importance of recognizing these differences when designing support mechanisms for energy efficiency.

These different practices have broader implications for Tunisia’s energy efficiency goals. Addressing these differences is critical to promoting a more comprehensive and effective approach to energy management. While some companies demonstrate a strong commitment to energy efficiency, others need more support. These findings provide an opportunity for policymakers and industry leaders to design policies that encourage more consistent energy-saving efforts across the sector.

Quantitative data from the ERF survey complements these observations, highlighting key gaps in energy literacy among MSMEs. A significant 70.33 percent of respondents do not fully understand what “energy efficiency” means, creating a significant barrier to initiating energy-saving measures. This lack of understanding is compounded by the fact that 41 percent of MSMEs are unaware of basic energy conservation practices. As one representative of a small service company notes, “Energy conservation is something we know we should be doing, but we lack the knowledge and resources.” This sheds light on the need for accessible training programs to build energy literacy.

Training in energy conservation practices and ISO certification is also low, with only 13.94 percent of employees and managers receiving such training. “Without proper training, it is difficult for companies to effectively implement energy-saving measures,” explains one energy consultant. There needs to be a greater focus on equipping employees and managers with the skills needed for energy efficiency. This lack of training is a key barrier to the widespread adoption of energy-efficient practices.

Despite these challenges, some enterprises are managing their energy costs effectively. According to the survey, 36.67 percent of MSMEs spend only a small portion of their operating costs on electricity, indicating either low energy consumption or effective energy efficiency strategies. However, other businesses face much higher energy cost burdens, indicating that energy efficiency practices are not uniformly adopted.

The survey also shows that 53.33 percent of MSMEs rely on grid electricity for five to eight hours per day. However, 49.67 percent experience power outages once or twice a month, mostly for one to three hours. These disruptions impact business operations and highlight the need for more resilient energy strategies and backup generation solutions.

The data suggests that while MSMEs are increasingly aware of the importance of energy efficiency, the implementation of energy-saving measures remains inconsistent. Gaps in energy literacy, limited training,



and the operational impact of energy costs and grid instability are significant barriers. Addressing these issues requires a comprehensive approach that includes tailored education, increased financial support for energy efficiency projects, and more resilient energy strategies. Fostering an enabling environment for energy efficiency would help MSMEs reduce their energy consumption, lower operating costs, and contribute to Tunisia's broader energy transition goals.

5. Optimal future of the energy transition in Tunisia

5.1. Regional perspective and cooperation

Regional cooperation is not only a strategic advantage for Tunisia but also a necessity given the common energy challenges in North Africa and the Mediterranean. Tunisia's geographic location gives it access to vast renewable resources such as solar and wind, which are abundant throughout the region. By leveraging these natural advantages and fostering cooperation with neighboring countries, the country can significantly accelerate its energy transition and ensure a more resilient energy supply for the future.

Cooperation on cross-border energy projects has enormous potential. By creating interconnections with neighboring countries such as Algeria, Libya, and Mediterranean partners such as Italy and France, Tunisia can enhance its energy security. This integrated energy grid would allow for the efficient distribution of electricity generated from renewable sources across borders, especially during periods of excess generation. For example, during peak solar production hours, excess energy could be exported to neighboring countries facing energy shortages, thereby maximizing the efficiency of RE resources across the region.

Beyond energy distribution, regional cooperation can also facilitate joint investment in RE projects, research, and development. Tunisia can pool resources with its North African and Mediterranean neighbors to drive innovation in critical areas such as energy storage technologies, smart grid systems, and sustainable transportation infrastructure. This collaborative approach would foster innovation and help overcome the technological challenges that often impede the large-scale deployment of RE. For example, Tunisia could partner with European countries to integrate battery storage solutions, thereby ensuring that intermittent energy from solar and wind sources can be stored and used efficiently.

This cooperative framework could also help address common barriers to RE deployment, such as regulatory inconsistencies, investment challenges, and gaps in infrastructure development. Aligning regulatory frameworks and standards across borders would create a more conducive environment for international investment in RE projects. In addition, through regional partnerships, Tunisia could benefit from shared financing mechanisms, joint ventures, and foreign direct investment, making the energy transition more economically viable.

A regional perspective also offers socioeconomic benefits. By creating green jobs through the development of cross-border energy projects, Tunisia can stimulate the local economy while contributing to the overall development of the region. The RE sector, particularly solar and wind, has the potential to create thousands of direct and indirect jobs. For example, the construction and maintenance of large-scale solar farms in Tunisia could provide employment for engineers, construction workers, and technicians. In addition, the local manufacturing of RE equipment, such as PV panels and wind turbines, would contribute to industrial growth.

By fostering closer regional cooperation, Tunisia can position itself as a regional RE leader and potentially become an energy exporter to Europe. The EU's Green Deal, which prioritizes the import of green energy from neighboring regions, provides an opportunity for Tunisia to capitalize on this growing demand for clean energy. By developing strong regional partnerships, Tunisia can build the necessary infrastructure and regulatory framework to become a key player in the Euro-Mediterranean energy market.

5.2. Targets

Tunisia's commitment to RE is reflected in its ambitious targets, which are in line with its NDCs under the Paris Agreement. The country aims to increase the share of RE in its electricity generation mix to 35 percent by 2030 and 50 percent by 2035. Achieving these targets will require a significant increase in RE capacity, as well as strategic investments and policy reforms.

To achieve these goals, Tunisia has established a plan to mobilize an annual investment of around TND 900 million (approximately USD 294 million). These funds are earmarked for the development of RE projects, with a focus on solar and wind power. By 2030, Tunisia aims to add more than four gigawatts (GW) of RE capacity, with an average of 500 megawatts (MW) per year.



Key to this strategy are three international tenders that will facilitate the construction of two GW of RE capacity. These projects include large-scale solar PV plants of 100 MW each and two wind power projects of 75 MW each. In addition, the government plans to launch several other RE initiatives totaling 600 MW. This concerted effort will require a total investment of TND 5 billion (approximately USD 1.6 billion), signaling the government's strong commitment to advancing its energy transition agenda.

These initiatives are critical to reducing Tunisia's dependence on natural gas, which currently accounts for 86 percent of the country's installed capacity and 95 percent of its electricity production. By increasing the share of RE, Tunisia aims to diversify its energy mix and reduce its dependence on imported fossil fuels. In 2020, RE will account for only 13 percent of Tunisia's installed capacity and just five percent of its electricity production, underscoring the urgency of expanding the renewable sector.

Tunisia's energy transition goals are not only to increase capacity but also to create a more sustainable and resilient energy system. This includes reducing greenhouse gas emissions, increasing energy security, and meeting international climate commitments. The government's long-term goal is to achieve carbon neutrality by 2050, which will require the expansion of RE as well as the integration of energy efficiency measures and advanced technologies such as smart grids, green hydrogen, and carbon capture solutions.

To support the achievement of these goals, Tunisia is also focusing on developing the necessary regulatory and financial frameworks. This includes providing financial incentives for private sector investment in RE, streamlining project approval processes, and creating a more transparent and investor-friendly regulatory environment. The government is also working to strengthen public-private partnerships, which will be essential for scaling up RE projects and attracting foreign investment.

5.3. Constraints

While Tunisia has set ambitious goals for its energy transition, the country faces significant constraints that could hinder the realization of these goals. Political instability remains one of the biggest challenges, as frequent changes in government have disrupted the continuity of energy policy and delayed the implementation of key reforms. Since 2011, Tunisia has seen numerous changes in energy ministers, each with different priorities and approaches. This has created

uncertainty in the energy sector, making it difficult to attract long-term investment.

Another major challenge is the dominance of STEG, the state-owned electricity and gas company, which has a monopoly on electricity generation, transmission, and distribution. While STEG is responsible for implementing a significant portion of Tunisia's RE capacity, the company's financial difficulties and resistance to privatization have raised concerns about its ability to meet the country's energy goals. Unions, particularly those within STEG, have opposed RE projects, seeing them as a threat to their market power and public ownership of energy assets. This opposition has slowed the pace of reform and created uncertainty about the future direction of Tunisia's energy sector.

In addition to the challenges posed by STEG's monopoly, Tunisia's energy transition is also hampered by legislative and bureaucratic obstacles. The complex land acquisition process, regulatory red tape, and lack of clarity in the legal framework have delayed the development of RE projects, especially those involving foreign investors. Without significant reforms to streamline project approvals and simplify regulations, Tunisia will struggle to attract the investment needed to expand its RE sector.

The financial health of STEG is also a major concern. The company faces significant financial deficits that have limited its ability to invest in new RE projects. As a result, the part of the country's energy strategy that relies on STEG to install one-third of the required RE capacity is highly uncertain. The government will need to either reform STEG or find alternative ways to mobilize the necessary resources to meet its RE targets.

Tunisia's dependence on imported fossil fuels, particularly natural gas, is also a challenge. While the country has made efforts to diversify its energy mix, regulatory barriers and poor management have caused delays in the implementation of RE programs. The government has recognized these issues and is working to address them through new policies aimed at accelerating the deployment of RE projects.

Recent initiatives, such as the proposal to eliminate energy subsidies for citizens and encourage the use of solar panels, reflect the government's commitment to promoting RE. However, these efforts need to be supported by a sound legal and regulatory framework that provides incentives for investment and ensures the long-term sustainability of the energy sector.



5.4. Opportunities

Tunisia's energy transition represents a pivotal moment for the country's economic and environmental future. This transition is not only a way to achieve sustainability but also a means to promote economic growth, improve energy security, and reduce dependence on imported fossil fuels. The opportunities presented by this transition are diverse and include advances in RE technologies, partnerships in regional and international cooperation, and the socioeconomic benefits associated with job creation and investment.

One of the key opportunities for Tunisia is to be included in the European Green Deal, which provides a framework for fostering cooperation between the EU and its Mediterranean neighbors. Tunisia, with its abundant RE resources—especially solar and wind—can play a strategic role in providing clean energy to Europe. The ELMED project is a concrete manifestation of this potential and offers Tunisia the opportunity to become a major energy exporter to Europe. This subsea interconnection between Tunisia and Italy will enable the transfer of renewable electricity to the European grid while reducing dependence on fossil fuel-based electricity. The implementation of the project will not only bring economic benefits but will also improve energy security for both Tunisia and the wider Mediterranean region. This type of project stands to serve as a catalyst for foreign direct investment, as international investors will be attracted to infrastructure developments that support RE trade between Tunisia and Europe.

The energy transition also provides an opportunity for Tunisia to enhance regional cooperation. Countries across North Africa and the Mediterranean are increasingly recognizing the importance of joint energy projects, especially those related to RE production and grid interconnection. By leveraging its geographic position, Tunisia can take the lead in forming strategic alliances with other North African countries, particularly Algeria and Morocco, which are also investing heavily in RE. Collaborative regional initiatives could lead to cross-border energy markets where RE is efficiently produced and traded across borders, maximizing the potential of each country's resources. In addition, such regional cooperation could lead to technology transfer and shared expertise in RE innovation, benefiting all parties and increasing collective resilience to energy security challenges.

Domestically, the energy transition offers significant potential for economic diversification and industrial growth. Tunisia has an opportunity to develop its local manufacturing sector by producing the necessary

components for RE infrastructure, such as solar panels, wind turbines, and batteries. This would reduce dependence on imported technologies, build local capacity, and create manufacturing and engineering jobs. Green industries related to energy efficiency and sustainable practices can also emerge, helping to create green jobs and further diversify Tunisia's industrial base. This shift will stimulate innovation, promote entrepreneurship, and support the development of a green economy, which is expected to be one of the fastest-growing sectors globally in the coming decades.

A significant opportunity lies in the decentralization of energy production. Decentralized energy solutions, such as small-scale solar, can empower local communities, particularly in rural and underserved areas. By investing in decentralized solar systems, Tunisia can address energy poverty while relieving pressure on the national grid. These systems can provide reliable electricity to regions that have historically lacked access to electricity, thereby improving living conditions and enabling economic activities that rely on stable energy access.

The opportunities presented by digitalization in the energy sector are transformative. Digital tools, such as smart grids, enable more efficient energy management, reduce losses, and optimize the integration of RE into the national grid. Furthermore, digital platforms can support the development of energy marketplaces where households and businesses can trade surplus electricity generated from renewable sources. This creates a new economic model based on peer-to-peer energy trading and empowers consumers to take an active role in the energy system. Artificial intelligence (AI) and big data analytics can also be used to predict energy demand, optimize energy storage, and improve grid resilience.

5.5. Feasibility studies

Conducting thorough feasibility studies is imperative in fostering a successful transition to RE in Tunisia. These studies assess the economic, technical, and environmental viability of RE projects and provide the necessary data for strategic decisions.

From an economic perspective, feasibility studies help determine the financial viability of RE projects by estimating total investment costs, operating costs, and expected returns. They also identify potential sources of financing, such as public-private partnerships, multilateral development banks, or foreign direct investment. Tunisia, which has relied heavily on imported fossil fuels, faces significant challenges in diversifying its energy supply. Feasibility studies can help the government and private



sector identify cost-effective RE solutions that will reduce energy costs in the long term while increasing energy independence.

Feasibility studies also play a critical role in identifying the technical challenges associated with large-scale RE projects, such as solar and wind farms. These studies evaluate the technical feasibility of integrating RE into the existing energy grid and assess the capacity of local infrastructure to support large-scale deployment. They also consider resource availability—whether solar irradiance, wind speed, or water flow—to ensure that RE projects are built in the most appropriate locations. In addition, studies evaluate grid stability and determine whether the current infrastructure can handle the fluctuations in energy production caused by intermittent renewable resources.

Another critical aspect of feasibility studies is their ability to assess the environmental impact of RE projects. With the global push to combat climate change, Tunisia needs to ensure that its RE projects are in line with its commitments under the Paris Agreement. Feasibility studies provide a comprehensive assessment of the potential environmental benefits of RE, such as reducing carbon emissions, and the potential risks, such as impacts on local ecosystems or biodiversity. These studies ensure that projects are designed in an environmentally sustainable manner, minimizing any negative impact on the natural environment.

Social feasibility is also an important consideration. RE projects must consider the impact on local communities, particularly in terms of job creation, energy access, and equity. Feasibility studies assess the potential for projects to contribute to inclusive development by ensuring that marginalized communities are not excluded from the benefits of the energy transition. By providing jobs in construction, operation, and maintenance, RE projects can have a transformative impact on local economies. In addition, the decentralized nature of RE projects means that energy can be produced closer to where it is consumed, reducing energy costs for remote or rural areas.

Feasibility studies are essential for attracting investment. By providing detailed data on the risks and opportunities of RE projects, these studies give investors the confidence to invest in Tunisia's energy transition. Additionally, feasibility studies help identify regulatory barriers, such as land acquisition or environmental permits, and propose solutions to overcome these challenges. This ensures that RE projects are not only economically viable but also bankable, attracting the necessary financial support for successful implementation.

5.6. Agents of change

Agents of change play a critical role in driving Tunisia's energy transition, acting as catalysts for policy reform, social mobilization, and technological innovation.

At the forefront of this transformation is the Tunisian government, which acts as the primary agent of change through its regulatory framework and policy initiatives. The government sets the direction for the energy transition by setting national energy targets and creating an enabling environment for private sector investment. By implementing incentives such as tax breaks and subsidies for RE projects, the government encourages the growth of the RE sector. In addition, government programs, such as the PST, outline a strategic vision for increasing the share of RE in the national energy mix. The government's role is not limited to policymaking but also includes ensuring institutional coherence and regulatory stability to attract long-term investment in RE.

CSOs and environmental activists are also powerful agents of change. They raise public awareness of the environmental and economic benefits of the transition to RE and mobilize communities to demand cleaner energy solutions. CSOs often act as intermediaries between the government and the public, ensuring that energy policies are inclusive and equitable. These organizations play a key role in advocating for social justice in the energy transition, ensuring that marginalized groups, such as rural communities or low-income households, are not left behind in the transition to cleaner energy sources.

The private sector is another key player in Tunisia's energy transition. Energy companies, investors, and entrepreneurs are driving technological innovation and market development in the RE sector. The private sector brings the capital and expertise needed to scale up RE projects while fostering competition and innovation. Corporations are increasingly investing in renewable technologies such as solar PV systems, wind turbines, and energy storage solutions. By partnering with international investors and technology providers, Tunisian companies can accelerate the deployment of RE infrastructure.

Educational institutions and research centers are also important agents of change. By offering specialized programs in RE technologies and conducting cutting-edge research, these institutions are developing the human capital needed for the energy transition. They equip students, researchers, and professionals with the skills needed to lead the development and implementation of RE solutions. Universities can also act as incubators for clean energy start-ups, fostering entrepreneurship and innovation in the sector.



5.7. The potential of technological change

Technological change is a driving force behind Tunisia's energy transition, and emerging technologies have the potential to revolutionize the way energy is produced, distributed, and consumed.

AI is one of the most promising technologies for optimizing energy systems. AI can be used to analyze large amounts of data from energy grids and predict energy demand, enabling more efficient energy management. AI-powered systems can also integrate intermittent RE sources into the grid by balancing supply and demand in real-time. This ensures that energy from solar and wind farms is used efficiently, even when weather conditions are unpredictable.

Blockchain technology has the potential to disrupt traditional energy markets by enabling peer-to-peer energy trading. Blockchain can be used to create decentralized energy markets, where households and businesses generate RE and sell excess power directly to other consumers. This creates new economic models that empower individuals and communities to become active participants in the energy system, reducing their reliance on centralized energy providers.

Green hydrogen is another emerging technology with significant potential for Tunisia. Produced using RE, green hydrogen can serve as a clean fuel for sectors that are difficult to decarbonize, such as heavy industry and transportation. By investing in green hydrogen production, Tunisia can diversify its energy mix and reduce its dependence on imported fossil fuels.

However, the direction of technological change must be carefully managed to ensure that these technologies contribute to sustainability and social equity. While new technologies offer immense potential, they also pose challenges, such as high upfront costs and the need for skilled labor. Tunisia needs to invest in research and development to adapt these technologies to the local context and ensure that they are in line with the country's sustainability goals.

5.8. Role of the informal economy in the energy transition

The informal economy plays an important but often overlooked role in Tunisia's energy transition. According to various studies and expert analyses, the informal sector accounts for a large share of Tunisia's economic activity. It encompasses a wide range of industries, from

agriculture and manufacturing to small-scale retail and services, which often operate outside the formal regulatory and tax systems. The informal economy's contribution to total energy consumption, emissions, and waste production can be significant, yet these factors are rarely addressed in national energy strategies. Integrating the informal economy into the formal energy transition framework is critical to achieving the country's environmental goals and ensuring a just and inclusive transition.

5.8.1. Energy consumption in the informal economy

A major challenge for Tunisia's energy transition is the unregulated energy consumption within the informal economy. Many informal enterprises, particularly those involved in manufacturing and small-scale industrial activities, rely on energy-intensive practices that contribute to high levels of energy consumption and emissions. Without clear incentives or access to energy-efficient technologies, these businesses continue to use outdated and inefficient energy sources, including heavily subsidized fossil fuels.

Addressing energy consumption patterns in the informal sector is critical to achieving national carbon reduction targets. One approach is to provide energy audits tailored to informal businesses, which can help identify areas where energy efficiency can be improved. Coupled with subsidies or financing options for energy-efficient equipment, this will encourage informal businesses to switch to cleaner and more sustainable energy practices. In addition, integrating energy efficiency and RE programs into informal business networks can spread awareness and promote best practices, leading to gradual improvements in the sector's energy profile.

5.8.2. Barriers to integrating the informal sector

One of the main barriers to integrating the informal economy into Tunisia's energy transition is the lack of access to formal financing. Informal businesses often lack the necessary documentation, such as tax records and business licenses, to qualify for loans or government incentives to promote the use of RE or energy efficiency practices. This barrier prevents many informal businesses from investing in technologies that could reduce their energy costs and environmental impact.

Moreover, many informal sector workers work in small and fragmented enterprises, making it difficult to organize collective action or participate in government-led energy transition programs. A lack of formal education and awareness about energy conservation and RE technologies



also hinders progress. This presents an opportunity for the government and CSOs to develop targeted education and training programs that specifically target informal sector workers and equip them with the knowledge and skills necessary to adopt more sustainable energy practices.

Another obstacle is the legal ambiguity surrounding the informal economy. Many informal businesses operate without official registration, which places them outside the regulatory framework governing energy consumption and emissions. Formalizing these businesses would not only bring them under the umbrella of energy regulations but also allow them to benefit from government support programs, such as access to subsidies, grants, and technical assistance for the adoption of RE technologies.

5.8.3. Opportunities for the informal sector in the energy transition

Despite these challenges, the informal economy also offers significant opportunities for Tunisia's energy transition. Informal enterprises, particularly in rural areas, have a unique potential to adopt decentralized RE systems, such as small-scale solar power systems. These systems can provide reliable and affordable energy to businesses that are often excluded from the formal energy grid. In addition to reducing energy costs for informal businesses, decentralized RE solutions also contribute to energy security and emissions reductions at the national level.

Another opportunity lies in the informal recycling sector, which plays a crucial role in managing waste generated by households and businesses. Informal waste collectors and recyclers, who make up a large part of the informal economy, can be mobilized to support Tunisia's circular economy initiatives, particularly in relation to electronic waste and the recycling of solar panel and battery components. By formalizing this sector and integrating it into the broader energy transition strategy, Tunisia can strengthen its efforts to reduce waste, promote recycling, and create jobs in green industries.

The informal economy can also contribute to the energy transition by developing local, low-cost solutions for energy-efficient technologies. Informal enterprises have a reputation for innovation and ingenuity, often developing practical and affordable solutions to everyday challenges. This entrepreneurial spirit can be harnessed to create energy-efficient tools, appliances, and systems that are more accessible to low-income households and small businesses. Governments and development agencies can support these efforts by providing technical assistance and facilitating partnerships between informal innovators and formal sector enterprises.

6. Building the new jobs and skills for the energy transition

6.1. Overview of green jobs in the energy sector

The energy transition in Tunisia is expected to create a significant number of green jobs in various sectors. This is particularly true in the RE industry, where the need for specialized skills and workforce development is growing rapidly. As Tunisia continues to focus on sustainable energy, job creation in solar, wind, and other RE sectors is critical to the success of this transition.

Tunisia has already made significant progress in RE, particularly solar energy. Solar energy projects, including large-scale PV installations, have gained momentum, creating jobs not only in the manufacture of solar panels but also in their installation and ongoing maintenance. One RE industry professional explains: "Our company has invested in training programs for solar energy technicians, and we have seen an increased demand for skilled workers in this field." These efforts reflect the growing need for technically skilled workers to support the expanding solar energy infrastructure.

The demand for wind energy professionals is also growing, especially in Tunisia's coastal regions where wind resources are abundant. Jobs in wind turbine installation, maintenance, and optimization are growing, providing new opportunities for skilled technicians and engineers. A senior engineer at a wind energy company notes: "The coastal wind projects are a great opportunity for employment, especially in areas where job creation has been slow. We are actively training people in the technical aspects of turbine management."

However, the gender gap in Tunisia's green energy workforce remains a concern. While women make up a quarter of the country's workforce, they are predominantly concentrated in low-skilled clerical or administrative positions in the energy sector. This trend is mirrored across the region, where a World Bank study finds that women make up less than 10 percent of the workforce in technical or managerial positions in the energy industry. As one industry expert clarifies, "The energy sector is still male-dominated and we need to create opportunities for women to take on technical and managerial positions in RE projects." Addressing this gender gap is critical to ensuring an inclusive transition to a sustainable economy. The push for RE is also creating job opportunities in energy efficiency and conservation. Energy auditors, sustainability consultants, and conservation specialists are increasingly in demand. These professionals play a critical role in optimizing energy use in buildings, industry, and the transportation sector, reducing energy waste and



contributing to Tunisia's carbon reduction goals. "Our work focuses on helping companies reduce their energy consumption. As more companies become aware of the financial and environmental benefits of energy efficiency, we are seeing a surge in demand for our services," explains one sustainability consultant.

Tunisia's move toward green hydrogen, a cleaner alternative to traditional fossil fuels, also holds significant potential for job creation in both research and practical application. Countries such as Morocco, Saudi Arabia, and the United Arab Emirates have already initiated large-scale green hydrogen projects, and Tunisia is looking to follow suit. The development of hydrogen infrastructure will require specialized skills in chemical engineering, RE integration, and fuel cell technology, opening up new opportunities for skilled workers.

Moreover, the informal economy represents an often overlooked sector that could benefit from targeted skills training programs aimed at integrating workers into the formal green economy. Training programs in energy management and sustainable practices can enable workers in the informal economy to transition into formal roles, contributing to Tunisia's overall energy transition goals. One recommendation from the ERF qualitative study is to "develop vocational training programs that target informal sector workers and provide them with the skills needed to participate in RE projects."

In terms of educational infrastructure, the establishment of green job training programs, especially for youth and women, is essential. Collaboration between universities, vocational schools, and the private sector can ensure that training programs are aligned with the needs of the growing RE market. According to an RE training center in Tunisia, "Our graduates are in high demand, especially in the solar and wind energy sectors. We work closely with companies to ensure that our curriculum meets the needs of the industry."

Tunisia's energy transition is not only about creating new jobs but also about developing the skills needed for long-term economic sustainability. As investment in RE, energy efficiency, and environmental protection increases, the country must ensure that its workforce is adequately trained to meet the demands of this evolving sector. This requires a comprehensive strategy that includes educational initiatives, vocational training, and efforts to close the gender gap in the energy workforce.

6.2. The Impact of the energy transition on new jobs and skills

The energy transition presents both opportunities and challenges for the Tunisian labor market. As the country transitions to RE sources and adopts more sustainable practices, the demand for new skills and occupations will increase, fundamentally reshaping Tunisia's labor landscape. Based on insights from experts and stakeholders, as well as the data presented in Figures 25 and 26, this section explores the broad and nuanced impacts of the energy transition on employment, vocational training, and economic development in Tunisia.

The energy transition is widely seen as a key driver of employment growth. A total of 47.06 percent of the experts interviewed highlight the "creation of new job opportunities," particularly in the fields of RE, energy efficiency, and related technologies. A solar PV project manager highlights how this transition could lead to a wide range of new jobs, from technical engineering roles to hands-on positions in the installation and maintenance of RE systems. "We expect the RE sector to create thousands of jobs in the coming years," the respondent explains, highlighting the broad potential for job creation in Tunisia's growing green energy sector.

Further, 41.18 percent of respondents note a "positive impact on employment," reflecting a general optimism that the energy transition will positively reshape Tunisia's employment landscape. A banking sector expert highlights the broader financial opportunities associated with the energy transition, noting that investments in RE projects will have a ripple effect throughout the economy, stimulating growth in other sectors. The respondent adds: "The financial sector will play a critical role in structuring investment strategies and financing mechanisms for green energy projects." This sentiment echoes the broader expectation that investments in RE will not only create new jobs but also lead to improvements in employment conditions across multiple industries.

However, despite this optimism, some respondents (2.94 percent) express "uncertainty about the impact" on certain segments of the labor market. These concerns are particularly evident among professionals in traditional energy sectors, such as oil and gas, who are unsure about the long-term prospects for their industries in a post-transition economy. As one respondent from the engineering sector comments, "While RE will undoubtedly create new jobs,



the displacement of workers in traditional energy sectors will pose significant challenges.” This underscores the need for retraining and reskilling programs to help workers transition from declining industries to emerging green sectors.

The role of the government in leading the energy transition is also highlighted by 2.94 percent of respondents. Many experts point to the need for strong government leadership in setting regulatory frameworks, creating incentives for RE deployment, and fostering collaboration between the public and private sectors. “The role of the government is crucial in shaping the policy environment and providing the necessary support to ensure the success of the energy transition,” remarks one government official, emphasizing the importance of clear and stable energy policies to attract investment and create jobs in the RE sector.

The responses from government officials express mixed views (8.82 percent) on the extent of the employment impact of the energy transition. While many acknowledge the potential for job creation, there are concerns about whether the government is doing enough to prepare the workforce for these new opportunities. One senior official notes that “the energy transition will undoubtedly create jobs, but without targeted training programs and proactive labor market policies, we risk leaving many workers behind.” This emphasizes the need for comprehensive strategies to address workforce reallocation and sectoral adjustment.

In the context of Tunisia’s broader economic transformation, several key areas for growth are identified, including the creation of “green jobs” (23.53 percent) and the development of “specialized skills” (20.59 percent). Respondents point to the urgent need for technical skills in areas such as solar and wind energy, energy storage, and energy management systems. “The transition to RE will create demand for highly specialized roles, particularly in engineering, technology development and project management,” remarks one industry expert. This growing demand for specialized skills emphasizes the importance of investing in vocational training programs and educational infrastructure to equip Tunisia’s workforce with the knowledge and expertise needed to succeed in the green economy.

The energy transition is also expected to drive “sectoral growth” (11.76 percent) and contribute to broader “economic development” (14.71 percent). As RE projects become more prominent, they will attract both domestic and foreign investment, spurring economic growth across multiple sectors. An economist from a policy think tank emphasizes that “the energy transition

could be a catalyst for broader economic transformation in Tunisia, positioning the country as a leader in RE and driving long-term economic development.” This potential for sectoral growth highlights the strategic importance of the energy transition in shaping Tunisia’s future economy. However, these positive developments must be balanced with the need to manage “workforce reallocation” (8.82 percent) and the broader “evolution of the labor market” (8.82 percent). As traditional energy sectors shrink, it is essential to implement targeted reskilling initiatives to help displaced workers transition to new green jobs. “We must ensure that workers from the fossil fuel sector are not left behind,” notes one trade union representative, stressing the importance of proactive policies to support workforce redeployment and minimize unemployment during the transition period.

The analysis highlights the significant opportunities presented by Tunisia’s energy transition and the challenges that need to be addressed to ensure a smooth and inclusive transition. The creation of green jobs and the development of specialized skills are essential to achieving Tunisia’s ambitious energy transition goals, but these efforts must be accompanied by targeted training programs, proactive labor policies, and strong government leadership to ensure that all workers can benefit from the transition.

6.3. Social and inequality aspects

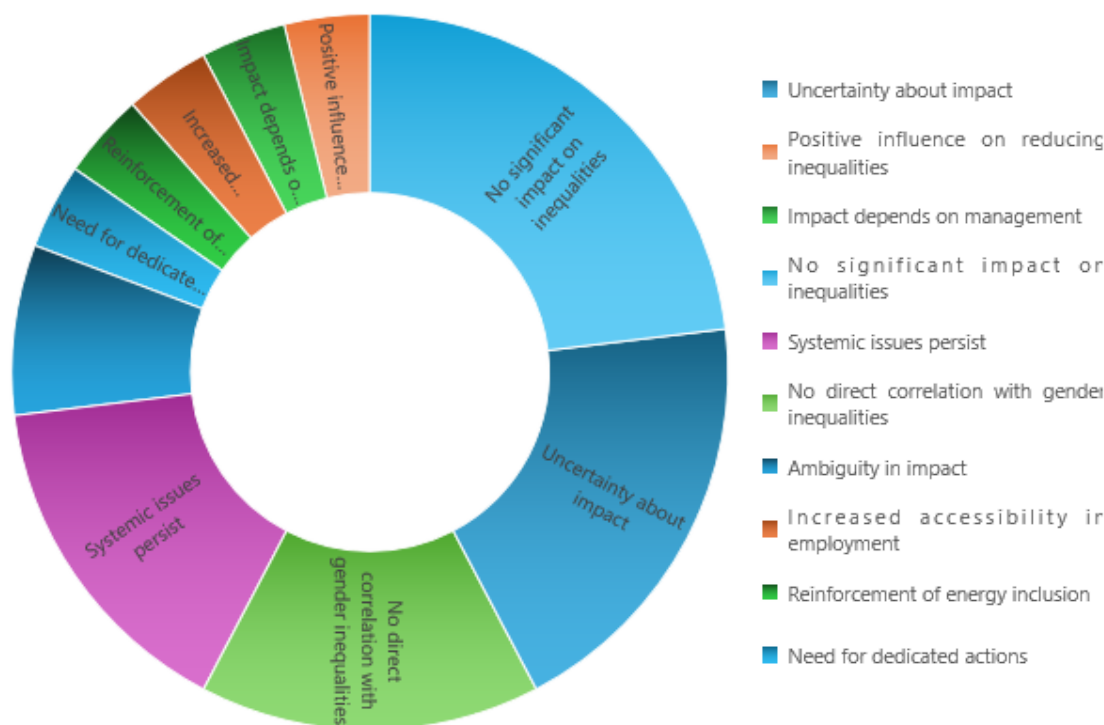
While the energy transition in Tunisia offers tremendous economic opportunities, it also poses significant challenges in terms of addressing social inequalities, particularly in terms of gender, income disparities, and access to opportunities. An analysis of the feedback from different professionals reveals a wide range of perspectives on how the transition will intersect with social and gender issues.

Uncertainty about the impact on inequalities: A significant proportion of respondents (19.23 percent) express uncertainty about the specific impacts of the energy transition on social inequalities and gender issues. This uncertainty is captured in the response of a 29-year-old doctoral student in finance from ESCT: “I am not sure about the impact of the energy transition on inequalities or gender issues.” Such responses underscore the lack of a clear understanding among many stakeholders of how energy policies will affect social dynamics. The ambiguity suggests that while there is optimism about the transition, more analysis is needed to determine its impact on vulnerable groups and how it might either reduce or exacerbate existing inequalities.

Optimism about reducing inequalities: A small but notable group (3.85 percent) is optimistic that the energy



Figure 27. Social and inequality dimensions of Tunisia's energy transition



transition will reduce inequalities, including those based on gender. One example comes from a 37-year-old consultant at UTS-Palma, who confidently states: “Yes, the energy transition is likely to have a positive impact on reducing inequalities, including gender inequalities.” This perspective suggests a belief that the broader economic transformation spurred by the transition could have a knock-on effect, improving access to opportunities for marginalized groups. This is consistent with the idea that RE projects can potentially empower underserved communities by creating jobs and stimulating investment.

Dependence on strategic leadership: Another 3.85 percent of respondents point out that the impact of the energy transition on inequalities would largely depend on how inclusively it is managed. “The impact will depend on how the transition is managed and how inclusive it is,” explains a 28-year-old climate change negotiator, suggesting that a well-planned transition could mitigate negative impacts while poorly executed strategies could exacerbate social divides. This spotlights the need for inclusive policies that specifically address the needs of vulnerable groups during the energy transition process and ensure that benefits are shared equitably.

No significant impact on inequalities: The largest group, representing 23.08 percent of respondents, expresses skepticism that the energy transition would have a direct impact on social or gender inequalities. A respondent

from the banking sector exemplifies this view by stating, “The energy transition will have no impact on inequalities, including gender inequalities.” This group believes that while the transition is important for economic and environmental sustainability, it does not inherently address the systemic issues that drive social inequalities. This perspective suggests that broader, more comprehensive social policies are needed to address these challenges, as the energy transition alone is unlikely to close the gap between different social groups.

Persistence of systemic problems: Further highlighting the limitations of the energy transition in addressing deep-rooted social problems, 15.38 percent of respondents note that systemic problems would persist regardless of changes in energy policy. One view is that without addressing the structural causes of inequality, such as unequal access to education and resources, the energy transition will have a limited impact on social justice. This perspective emphasizes the importance of parallel sociopolitical reforms to complement energy policies and ensure that the benefits of the transition reach all segments of the population.

Gender and employment: A total of 7.69 percent of respondents express uncertainty about the direct relationship between the energy transition and gender inequality. This view is summed up by a department head at the Order of Tunisian Engineers, who says: “It is difficult to determine whether the energy transition will have a



direct impact on gender inequality, but more research and attention needs to be paid to this issue.” This reflects the need for specific studies to explore how gender roles will evolve as Tunisia transitions to a greener economy, particularly in traditionally male-dominated sectors such as energy and engineering. However, some respondents (3.85 percent) report that the energy transition has increased access to jobs for both women and men. An executive from an international home appliance company shares that “the energy transition has made some jobs accessible to both women and men,” noting that opportunities in areas such as RE installation and project management are open to a broader workforce than traditional energy industries. This is significant as it suggests that the green energy transition may help break down some gender barriers in employment.

Inclusion of vulnerable groups: Another 3.85 percent of respondents stress that the energy transition could promote energy inclusiveness for vulnerable groups, including women and rural populations. A 43-year-old engineer at the IMF, Enda Tamweel, explains: “The transition is an opportunity to democratize energy access, especially for rural communities and women who have been historically marginalized in the energy sector.” This highlights the potential for the energy transition to deliver tangible social benefits, especially if efforts are made to increase access to RE technologies in underserved areas.

Need for targeted gender action: Some respondents (3.85 percent) highlight the importance of targeted actions to address gender inequalities in the energy transition. An energy and climate expert from APEX Conseil highlights that without specific measures, the energy transition could fail to close gender gaps in the workforce. They add: “The impact on gender equality depends on whether the government and the private sector take deliberate steps to ensure that women are included in the transition.” This points to the need for policies that actively promote women’s participation in the RE industry, particularly through education and training programs.

The varied responses to the potential social impacts of Tunisia’s energy transition show that it is a complex and multifaceted issue. While some stakeholders are optimistic about the transition’s ability to create jobs and reduce inequalities, others are skeptical or uncertain about its potential impact. The findings suggest that for the energy transition to have a meaningful impact on reducing social and gender inequalities, deliberate and inclusive strategies need to be adopted. These

should include targeted measures to ensure equal access to employment and training opportunities, as well as broader sociopolitical reforms to address the root causes of inequality in Tunisia.

The diversity of opinions underscores the need for a nuanced, multidimensional approach to policy design and implementation in Tunisia’s energy transition. Ensuring that vulnerable populations benefit from the transition would require a focus on economic growth as well as social equity and inclusion.

6.4. Skills needed for clean energy and energy efficiency

Tunisia’s energy transition to RE sources such as solar, wind, and biomass requires the development of a wide range of specialized skills across multiple sectors. This shift is driven by the country’s goal to reduce its dependence on imported fossil fuels, diversify its energy mix, and improve overall energy efficiency. In doing so, the energy sector is not only creating new job opportunities but also redefining the skills needed to support this transition.

Technical expertise in RE technologies: The backbone of Tunisia’s clean energy strategy lies in RE technologies, particularly solar, wind, and biomass systems. Skilled workers must have deep technical knowledge in these areas, including system design, installation, and maintenance. These specialized skills are essential to increasing Tunisia’s RE capacity and meeting its national energy goals. Engineers, technicians, and project managers must be able to integrate these technologies into existing energy grids and optimize them for maximum efficiency and sustainability. As RE continues to expand, knowledge of solar PV systems, wind turbine technologies, and biomass energy generation will be critical.

Adaptability and innovation: As the global energy landscape evolves, professionals in Tunisia’s energy sector must demonstrate adaptability and a keen understanding of emerging innovations. This includes staying abreast of breakthroughs in energy storage technologies, smart grids, and distributed energy systems. With energy storage playing a key role in ensuring the reliability of RE sources, professionals must be skilled in the installation and management of batteries and other energy storage solutions. Moreover, the adoption of smart grids, which improve the management of electricity distribution and consumption, requires professionals who can work with data-driven technologies and optimize energy flows



based on real-time information. Furthermore, emerging technologies such as AI and blockchain are transforming energy management. AI-powered analytics help optimize energy consumption and predict demand patterns, while blockchain technology ensures transparency in energy transactions and enables peer-to-peer energy trading. Professionals with expertise in these cutting-edge technologies will have a significant advantage in the energy market.

Energy efficiency skills: Beyond clean energy generation, there is a growing need for skills related to energy efficiency. Professionals who can conduct energy audits, identify areas for energy savings, and implement energy-efficient technologies are in high demand. Roles such as energy auditors, sustainability consultants, and building energy managers will be critical to ensuring that industries, households, and public institutions reduce their energy consumption and carbon footprint. Knowledge of energy-efficient building practices, such as using energy-efficient materials and optimizing HVAC systems, is also essential to Tunisia's green transition.

Intercultural communication and stakeholder engagement: The success of Tunisia's energy transition depends not only on technical expertise but also on the ability to work effectively with a wide range of stakeholders. Energy sector professionals must have strong communication skills to engage with local communities, government agencies, private sector companies, and international organizations. Effective cross-cultural communication is essential to navigating the different interests, priorities, and regulations that shape energy projects. These professionals must also be able to foster public-private partnerships, attract foreign investment, and manage relationships with international development agencies and donors supporting RE projects in Tunisia.

Regulatory knowledge and compliance: As Tunisia's energy sector becomes increasingly regulated to meet international sustainability standards, professionals must have a thorough understanding of the country's energy policies, regulatory frameworks, and compliance requirements. Navigating complex permit processes, ensuring that projects comply with environmental regulations, and leveraging government incentive programs are essential skills for advancing RE initiatives. This knowledge will enable professionals to overcome legal and regulatory challenges while ensuring that energy projects contribute meaningfully to Tunisia's national energy and environmental goals.

Capacity building and training: Tunisia's workforce must be equipped with the necessary skills to support the country's clean energy transition. This requires investment in educational infrastructure and vocational training programs that target both youth and women to ensure inclusivity in the energy sector. Educational institutions, in partnership with government agencies and private companies, must develop training programs that provide practical skills in RE technologies, energy management, and sustainability practices. That way, Tunisia can build a highly skilled workforce capable of driving its green economy forward. Training programs that focus on providing workers with hands-on experience in installing and maintaining RE systems would be particularly valuable. These programs must also address the specific needs of MSMEs, which play a critical role in Tunisia's energy sector. Providing MSMEs with access to training in energy management and renewable technologies would build the capacity of small businesses and encourage their active participation in the country's energy transition.

Gender and the informal economy: Another key aspect of building skills for the energy transition is addressing gender disparities in the energy workforce. Women remain underrepresented in the energy sector, particularly in technical and managerial roles. To address this gap, targeted training programs for women need to be developed to ensure that they have equal access to employment opportunities in RE and energy efficiency roles. In addition, vocational training initiatives that target the informal economy are essential for integrating informal workers into the formal RE sector. These programs should provide pathways for informal workers to obtain formal certifications and contribute to Tunisia's green economy. The skills needed for Tunisia's clean energy transition are diverse and multifaceted, ranging from technical expertise in RE systems to knowledge of regulatory frameworks and energy efficiency practices. By investing in education, training, and capacity building, Tunisia can develop a workforce that is well-prepared to meet the demands of its evolving energy sector. These efforts, combined with a focus on gender inclusion and the integration of informal workers, would keep Tunisia's energy transition economically viable and socially equitable.



6.5. Vocational training and capacity building for the informal economy

The informal economy plays an important role in Tunisia's overall economic structure. It employs a significant portion of the population, particularly in sectors such as agriculture, small-scale manufacturing, and services. As Tunisia advances its energy transition goals, integrating the informal economy into the formal sector is critical to ensuring that the benefits of the green transition are inclusive and widespread. Vocational training and capacity-building initiatives targeting the informal sector are essential strategies for achieving this integration, providing workers with the skills and knowledge necessary to participate in the clean energy transition and helping them shift to more formal, regulated, and sustainable jobs.

6.5.1. Identifying key sectors and training needs

The first step in developing training programs for the informal economy is to identify the sectors within it that have the greatest potential to support the energy transition. Sectors such as construction, small-scale agriculture, and transportation are heavily represented in the informal economy and are directly impacted by energy use and efficiency. These sectors can benefit significantly from targeted training programs that provide workers with the skills needed to adopt RE technologies, improve energy efficiency, and reduce emissions.

For example, workers in the informal construction sector can be trained in energy-efficient construction techniques, such as the installation of solar panels, energy-efficient insulation, and sustainable building materials. Similarly, informal agricultural workers can be trained in RE applications, such as solar-powered irrigation systems, which increase energy efficiency and reduce environmental impact.

6.5.2. Tailoring training programs to the needs of informal workers

Vocational training programs need to be tailored to the specific needs of informal workers, considering their educational background, financial constraints, and time availability. Many informal workers may not have formal education or technical training, so programs should be designed to be accessible, with clear and practical instruction that does not require advanced technical knowledge. Additionally, training programs

should be offered in flexible formats, such as part-time courses, on-the-job training, or mobile learning units that can reach workers in remote or rural areas. These flexible approaches would enable informal workers to participate without sacrificing their current livelihoods. In addition, training should be provided at little or no cost to participants, with financial support or subsidies from government, international development organizations, or private sector partnerships.

6.5.3. Certification and formal recognition of skills

One of the key challenges in integrating the informal economy into the formal energy transition is the lack of formal recognition of the skills that informal workers possess. Vocational training programs need to provide a clear path to certification and accreditation so that informal workers can gain formal recognition for their newly acquired skills. Certification would help workers access formal employment opportunities in the RE and energy efficiency sectors, improving their job security and earning potential.

In addition to certification, training programs should be linked to formal employment initiatives. This can include partnerships with energy companies, MSMEs, and government agencies that are actively involved in Tunisia's energy transition. By linking trained workers with formal employment opportunities, the programs can facilitate a smoother transition from the informal to the formal economy.

6.5.4. Leveraging partnerships and cross-sectoral collaboration

Building an effective vocational training and capacity-building framework for the informal economy requires collaboration across multiple sectors, including the government, the private sector, educational institutions, and CSOs. Partnerships with vocational schools, universities, and training centers can help design curricula and provide technical expertise. Government agencies can provide funding, regulatory support, and incentives for businesses to hire workers transitioning from the informal economy. Furthermore, partnerships with local NGOs and community-based organizations can play a critical role in outreach and engagement. These organizations are often more familiar with the needs of informal workers and can serve as a bridge to ensure that training programs are culturally appropriate and accessible to marginalized communities, including women and rural populations.



6.5.5. Gender-inclusive training programs

Gender inequality is a pervasive problem in Tunisia's informal economy, with women often occupying the lowest paid and least secure positions. Vocational training programs targeting the informal sector should prioritize gender inclusivity by ensuring that women have equal access to training opportunities in RE and energy efficiency. Women should be encouraged to participate in traditionally male-dominated sectors, such as solar panel installation and energy management. Programs can offer special support, such as childcare or flexible scheduling, to make participation more feasible for women. Moreover, outreach efforts should focus on raising awareness of the economic and social benefits of women's participation in the energy transition. By ensuring that women are fully integrated into the vocational training process, Tunisia can make significant strides in addressing gender disparities in the workforce while promoting a more inclusive energy transition.

6.5.6. Creating pathways to sustainable livelihoods

Vocational training programs that target the informal economy should focus on building technical skills and creating pathways to sustainable livelihoods. This includes training workers in entrepreneurial skills such as business development, financial literacy, and marketing. Many informal workers are self-employed or run small businesses; equipping them with the skills to formalize their businesses and participate in the green economy can increase their economic resilience and sustainability.

For example, informal workers trained in solar energy installation could be encouraged to start their own small solar businesses providing affordable solar solutions to underserved communities. By empowering informal workers to become green entrepreneurs, Tunisia can foster a vibrant small business sector that contributes to both job creation and the overall energy transition.

6.5.7. Monitoring and evaluation of training outcomes

To ensure the effectiveness of vocational training programs targeting the informal economy, establishing mechanisms for monitoring and evaluating the outcomes of these programs is imperative. This includes tracking the number of participants who successfully transition into formal employment or green entrepreneurship, as well as measuring the impact on income levels, job security, and social mobility. Ongoing feedback from

participants and employers can help refine training programs to better meet the needs of informal workers and the demands of the energy sector.

By integrating informal workers into Tunisia's energy transition, vocational training programs can play a key role in reducing poverty, increasing social equity, and promoting sustainable economic growth. These initiatives would ensure that the energy transition is not only a technical and environmental success but also a driver of inclusive development that leaves no one behind.

7. Conclusions and recommendations

7.1. Conclusions

This study provides an in-depth analysis of Tunisia's energy transition with a focus on MSMEs. It employs a mixed-methods approach that integrates both quantitative and qualitative data, wherein we use interviews and surveys to gather insights from industry experts and MSMEs in different sectors. This approach allows for a comprehensive understanding of the current landscape of RE adoption, as well as the challenges and opportunities presented by the transition.

The findings reveal a diverse landscape of awareness and engagement with RE initiatives. While some MSMEs demonstrate a proactive stance, many still exhibit limited understanding or implementation of sustainable energy practices, indicating a need for targeted educational programs and support mechanisms. The use of qualitative interviews highlights different perspectives on the adoption of RE, with many respondents citing financial and regulatory barriers as key obstacles.

Economic and environmental factors are primary decision drivers, with cost and return on investment weighed heavily against sustainability goals. However, red tape and administrative inefficiencies are consistently cited as barriers to faster innovation and adoption. Moreover, financial and technological barriers remain significant, with many MSMEs lacking access to adequate financing and modern energy technologies. There is a need for more robust financial support systems and technological infrastructure to enable a successful transition.

Our research also highlights the importance of government intervention. Effective policies, simplified regulatory frameworks, and administrative streamlining are critical to accelerating the transition. Both the interview and survey respondents emphasize the need for clear, supportive



policies that facilitate the adoption of RE, which spotlights the central role of the government.

Given the complexity of these challenges and understanding that generalized solutions may not address the specific needs of different MSME sectors, this study's recommendations include sector-specific strategies.

7.2. Recommendations

Building on the findings from the previous sections on the perceptions, barriers, and opportunities in Tunisia's energy transition, this section presents a structured set of recommendations.

7.2.1. *Improve government policies and strategic planning*

Government policies and strategic planning are the cornerstones of Tunisia's energy transition. This section received the most feedback, with 40.68 percent of respondents highlighting the importance of government leadership in driving the transition to RE. The recommendations below highlight the need for a multifaceted approach to policy reform, emphasizing accountability, transparency, regulatory adaptation, and a commitment to aligning Tunisia's energy goals with global sustainability imperatives.

Adopt accountable and transparent policies: Accountability is at the heart of effective governance, especially in environmental sustainability. The government must demonstrate its commitment to climate action and sustainable development and ensure that public policies are not only ethically sound but also workable. One respondent highlights the disconnect between business and government in this regard, stating: "It is profound to be a socially responsible business in a context where the government is not socially responsible." This sentiment points to the need for government integrity as a foundational element of the energy transition. To build trust and drive change, Tunisia must adopt transparent policies that hold government entities accountable for their environmental impact, ensuring that sustainability is not just a business goal but a national priority.

Tailor industry-specific solutions: A one-size-fits-all approach to RE policy is ineffective in addressing the diverse needs of Tunisia's industries. Different sectors face unique challenges, from technological requirements to financial constraints, and government policies need to be adaptable to these realities. As one respondent notes, "The mechanisms do not take into account the

specificities of Tunisian industries." To ensure the success of the energy transition, policymakers must engage directly with industry leaders to understand their specific needs and develop tailored strategies that facilitate the adoption of energy efficiency and RE. Sectoral roadmaps, developed in collaboration with industry stakeholders, would be an effective tool to guide the transition and ensure that each sector moves forward in a manner that is both economically viable and environmentally sustainable. **Increase public awareness and education:** Public awareness and education play a critical role in driving demand for RE solutions. The energy transition cannot be achieved without broad public support and understanding. One climate change negotiator emphasizes the importance of "increased awareness and education on RE," pointing to the need for ongoing public engagement campaigns. These efforts should target businesses, households, educational institutions, and CSOs to foster a culture of sustainability and encourage more proactive participation in the energy transition from all sectors of society.

Clarify the energy transition vision: Tunisia needs to articulate a clear, long-term vision for its energy future that is consistent with national and international climate commitments. A well-defined strategy is essential to provide direction to both the public and private sectors. One energy consultant stresses the need to "develop a clear vision for the energy transition," suggesting that the absence of such a framework creates uncertainty and hinders progress. Tunisia's energy roadmap should include specific targets for reducing carbon emissions, increasing RE capacity, and improving energy efficiency. It should also detail the pathways through which these goals will be achieved, integrating short-, medium-, and long-term targets that provide benchmarks for success.

Modernize STEG to lead the transition to RE: STEG plays a central role in Tunisia's energy transition, but it must undergo significant modernization and refocus its efforts on RE, as highlighted by respondents. One solar energy project manager stresses the importance of "modernizing STEG to focus on RE initiatives," highlighting the need for investments in infrastructure, technology, and workforce training. Transforming STEG is critical for expanding RE production as well as upgrading the national grid to accommodate distributed RE sources and ensure reliable and efficient energy distribution.

Bring competition to the energy market: Ending STEG's monopoly over the sale of electricity is a critical step in promoting innovation and efficiency in the energy sector. A competitive energy market would encourage private sector investment, driving down costs and spurring the development of innovative renewable technologies. As one private sector representative remarks, "Ending STEG's



monopoly on electricity sales to promote competition” is necessary for the long-term growth of the energy sector. Regulatory reforms that open the market to new entrants, particularly RE, would diversify energy sources, improve grid resilience, and ultimately benefit consumers through lower prices and more reliable service.

Streamline access to subsidies for energy transformation projects: Subsidies play a critical role in promoting the deployment of RE, but current processes for accessing these subsidies are often cumbersome and bureaucratic. Simplifying these processes would encourage wider participation by businesses and individuals in the energy transition. A respondent from CAMI Engineering recommends that Tunisia should “simplify subsidy processes and provide targeted support,” calling for a reassessment of the existing framework to make it more user-friendly. This reform should focus on reducing administrative barriers, improving transparency in the allocation of funds, and ensuring that subsidies are effectively targeted to maximize their impact.

Align the banking sector with energy financing needs: The financial sector must evolve to support the unique needs of energy projects. A responsive banking system designed to meet the financing needs of RE investments is essential to facilitating the energy transition. A senior government official points to the need for “a responsive banking system for energy projects,” suggesting that Tunisia’s current financial infrastructure may not be fully equipped to support the scale of investment required. This recommendation calls for collaboration between the government and financial institutions to develop specialized financial products—such as green bonds and RE loans—that can provide the capital needed for clean energy projects.

Implement existing energy policies: Tunisia has already developed strategic energy plans, but the challenge is to implement them. Leveraging the frameworks established since 2012 would ensure that the country’s energy transition moves forward in a coherent and effective manner. A strategy expert from CDC stresses the importance of “implementing the plans established since 2012,” suggesting that Tunisia can make significant progress by building on the work already done. Ensuring continuity in policy implementation while adapting these plans to the evolving energy landscape would help Tunisia stay on track to meet its RE goals.

Legislative reforms to support the energy transition: Enacting and revising laws that encourage the deployment of RE is a critical step in facilitating the energy transition. This includes removing outdated regulations that impede progress and introducing new

legislative measures that incentivize investments in clean energy. A legal expert in the tourism sector emphasizes the need for “government policies and legislative changes to promote the energy transition.” Legislative reforms should focus on creating an enabling regulatory environment for RE projects, including tax incentives, streamlined permit procedures, and investor protection.

Expand access to energy technologies: Ensuring that advanced energy technologies are accessible to all sectors of society, especially MSMEs, is essential for an inclusive energy transition. One expert highlights the importance of “democratizing technology adoption” and advocates for policies that make technologies such as solar panels, energy storage, and smart meters affordable and widely available. Government initiatives should focus on reducing the cost of these technologies, providing financial incentives for adoption, and supporting research and development to drive innovation.

Digitize administrative processes: Digitizing energy-related administrative processes would significantly increase efficiency and reduce the time and cost of project approval and implementation. One respondent from the gas engine sector suggests “streamlining administrative procedures” through digital platforms, highlighting the potential for technology to simplify bureaucracy. This initiative would involve digitizing licensing and permitting processes, improving data transparency, and creating online portals for project submission and tracking.

Stabilize the energy policy framework: A stable and predictable policy environment is critical to attracting investment in RE. Clear, consistent policies give investors the confidence they need to commit to long-term projects. As one solar energy expert notes, “It is essential to develop a favorable regulatory framework with clear, stable energy policies.” Policymakers should prioritize creating a transparent policy framework that provides long-term certainty for RE investments, ensuring that regulatory changes are predictable and aligned with national sustainability goals.

Encourage private sector participation: The private sector plays a critical role in driving innovation and investment in the energy transition. Encouraging greater private sector participation, particularly through public-private partnerships, can help accelerate the development of RE infrastructure. A participant from the home appliance industry suggests that “the state should divest from the energy sector and encourage private investors.” This recommendation underscores the need for a market-driven approach to the energy transition, where the government creates an enabling environment for private sector-led growth.



7.2.2. Tailoring strategies to sector-specific needs

Achieving an effective energy transition in Tunisia requires a nuanced approach that considers the specific needs of different sectors. As highlighted by 16.95 percent of respondents, it is necessary to recognize the different challenges faced by different sectors and develop strategies that address these unique needs. Each sector, whether agriculture, manufacturing, services, or others, faces different barriers to the adoption of RE technologies. A tailored approach is needed to ensure that the transition to sustainable energy practices is not only efficient but also sustainable over the long term.

Improve access to finance for MSMEs: The energy transition requires significant investments, and access to finance remains a critical challenge for many MSMEs in Tunisia. Public-private partnerships and green investment mechanisms are critical to provide the financial support needed for energy transition projects. One participant in the study explains that “public-private partnerships can unlock significant funding for energy transition initiatives, making them more accessible and viable.” This points to the need for a collaborative effort between the government and the private sector to create financial instruments specifically designed for MSMEs. In many cases, small businesses have difficulty accessing traditional loans, which are often designed for larger businesses with more collateral. By creating innovative financing options, such as low-interest loans or green bonds tailored to smaller businesses, Tunisia can facilitate broader participation in the energy transition.

Create a supportive regulatory environment: A well-designed regulatory framework is fundamental to the success of any energy transition strategy. Implementing policies that encourage the deployment of RE and provide clear incentives for investment is critical to driving growth in the sector. As one respondent mentions, “A regulatory framework that is supportive of RE will not only encourage deployment but will also attract investment in the sector.” Tunisia must ensure that its regulatory environment encourages innovation, reduces red tape, and provides the necessary incentives to make RE an attractive option for all industries. Countries such as Denmark have successfully implemented comprehensive regulatory reforms that have made the adoption of RE more accessible, particularly through subsidies, tax exemptions, and streamlined permitting processes.

Encourage RE companies: Supporting RE companies through targeted policies, including tax benefits and favorable status, is another key recommendation. These incentives are expected to stimulate growth and

innovation in the RE sector. One participant emphasizes the importance of such measures, stating, “Providing tax benefits to RE companies can significantly drive expansion and innovation in the sector.” Offering tax credits or reduced tax rates to companies involved in solar, wind, and other RE technologies would encourage entrepreneurship and investment in these areas. This type of policy framework has been used successfully in countries such as Morocco, where favorable policies have led to significant investment in solar energy projects.

Promote energy efficiency and technological innovation: The transition to energy-efficient buildings and industrial processes is a critical component of the energy system transformation. As one expert notes, “The transition to energy-efficient buildings requires a concerted effort and sector-specific technological advances.” In Tunisia, outdated building practices and a lack of modern infrastructure pose challenges. However, by adopting innovative technologies such as energy-efficient insulation, smart grid systems, and RE sources such as solar panels, industries and households can significantly reduce their energy consumption. Promoting energy-efficient buildings, combined with incentives for industry to adopt these technologies, would lead to long-term energy savings and reduced environmental impact.

Streamline certification of new technologies: The ability to quickly certify and approve new energy technologies is essential to fostering innovation. A streamlined certification process would encourage the adoption of advanced technologies, particularly those provided by investors and innovators. One respondent remarks on the importance of this approach, noting, “Investor-provided certifications should be trusted to encourage the adoption of new and efficient energy technologies.” By reducing the time and complexity of certifying these technologies, Tunisia can ensure that cutting-edge solutions are implemented more quickly, thereby accelerating the transition. International examples, such as the EU’s mutual recognition of technology certifications, provide a model for how Tunisia could reform its processes to encourage faster adoption of innovative energy technologies.

Improve public education and awareness: Public engagement is critical to the success of the energy transition. Developing education and awareness initiatives would help build a society that is more open to adopting sustainable energy practices. As one respondent comments, “Awareness campaigns play an important role in changing perceptions and encouraging the adoption of RE.” The Tunisian public needs to be well informed about the benefits of RE, the potential cost savings, and the long-term environmental benefits. Education campaigns can target schools, universities, and public forums to foster a



culture of sustainability. This approach has been effective in countries such as Sweden, where public awareness initiatives have contributed to the widespread adoption of RE.

Integrate RE into industrial processes: Modifying Tunisia's industrial processes to incorporate RE is a key strategy for improving energy efficiency. "Integrating RE into existing industrial processes is the key to a smoother transition and an immediate impact on energy consumption," explains one industry expert. Industries that rely heavily on fossil fuels must be encouraged to adopt RE solutions, such as solar and wind power. By doing so, they can reduce their carbon footprint and become more competitive in the global marketplace. This integration requires both financial incentives and technological support to help industries make the transition without disrupting their operations. Tunisia can look to countries like China, where RE has been successfully integrated into manufacturing processes, leading to significant reductions in emissions.

Develop sector-specific incentive programs: Creating incentive programs tailored to the unique needs of different sectors, such as agriculture, manufacturing, and services, would accelerate the adoption of RE technologies. As one expert in the study notes, "Sector-specific incentives are critical to encouraging the adoption of renewable technologies across diverse industrial landscapes." Offering targeted subsidies, tax breaks, and financial support can help each sector overcome its specific challenges. For example, the agricultural sector could benefit from solar-powered irrigation systems, while the manufacturing sector could be incentivized to adopt energy-efficient machinery.

Collaborate with international experts: Partnering with global RE specialists is crucial to sharing knowledge and technical expertise. One respondent emphasizes this point: "Working with global energy experts will bring advanced know-how and innovative practices to Tunisia's energy sectors." Tunisia can benefit from international partnerships that provide access to the latest technologies, best practices, and research in RE. Working with countries like Germany, which has a well-established RE infrastructure, can help Tunisia develop more effective strategies for its energy transition.

Address the needs of the informal economy: As discussed in previous sections, integrating the informal economy into the energy transition is critical to ensuring that all segments of society benefit from the transition to RE. Many informal businesses operate without access to reliable energy sources, making it difficult for them to adopt RE technologies. By offering training programs,

simplifying regulations, and providing financial incentives, Tunisia can encourage informal businesses to transition to cleaner energy. One participant notes: "Integrating the informal sector into the energy transition will ensure that the benefits of RE reach all levels of society."

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

7.2.3. Financial incentives and economic mechanisms

Financial incentives and robust economic mechanisms are fundamental to Tunisia's energy transition, as reflected by 15.25 percent of respondents. These mechanisms play a critical role in enabling investment in RE and sustainable practices across industries. By developing well-designed financial strategies, Tunisia can accelerate its transition to a greener economy.

Create dedicated RE subsidy programs: The need for dedicated subsidy programs, particularly for MSMEs, would ease the financial burden associated with the transition to RE. Many MSMEs struggle with the initial investment costs of green technologies, making targeted subsidies essential. As respondents indicated, "Subsidy programs need to be tailored to help businesses manage the upfront costs of adopting RE." Establishing these programs would ensure that the RE sector expands inclusively, enabling even smaller companies to make a significant contribution to the country's energy goals.

The design of these support programs should consider the different needs of different industries. Sectors with high energy consumption, such as agriculture and manufacturing, would require greater and more sustained financial support than service-oriented sectors. Lessons can be learned from successful international models that have used targeted subsidies to promote the adoption of RE, ensuring that similar frameworks are adapted to the Tunisian context.

Facilitate access to low-interest financing: A key to increasing the attractiveness of RE projects is the provision of low-interest financing. The introduction of low-interest loans for RE investments can significantly lower the



barriers to entry for many companies. As one banking expert notes, “Low-interest financing can fundamentally change the financial landscape for RE initiatives.” Such financial support mechanisms can be provided by both public and private institutions, ensuring that capital is available to MSMEs and other private entities seeking to invest in green technologies. These financing options should cover all phases of the project lifecycle, from installation to maintenance and eventual upgrading of RE systems. International development banks and local financial institutions can play a critical role in supporting these efforts by offering favorable loan terms for RE projects.

Optimize compensation for excess energy production: A key issue in promoting the deployment of RE is to revise the pricing structures for excess energy generated by private producers. Current models often undervalue the energy produced by small-scale RE systems, which discourages participation. One respondent emphasizes the importance of fair pricing, saying, “Fair pricing for excess energy is fundamental to the economic viability of RE efforts.” To address this issue, the compensation for excess energy fed back into the grid needs to be revised to accurately reflect market conditions. This would ensure that businesses and individuals are adequately compensated for the energy they produce, making investment in RE more attractive. Adopting a flexible, market-based pricing model can encourage further investment in renewable technologies, thereby increasing energy security and sustainability.

Encourage private sector engagement through reduced government intervention: Reducing government intervention in the energy sector to encourage greater private sector involvement can help accelerate innovation and efficiency. The private sector is a key player in advancing RE technologies; fostering an enabling environment for their participation is essential. “By stepping back, the government can pave the way for private sector ingenuity and drive in the RE sector,” according to the feedback from several respondents. This strategy requires regulatory reform that encourages competition and innovation. Public-private partnerships can also help bridge the gap between government initiatives and private sector capabilities, enabling a more dynamic and resilient energy sector.

Simplify administrative procedures and improve access to finance: A major barrier to the wider adoption of RE technologies is the complexity of administrative procedures. Simplifying these procedures is essential to enable faster project approvals and reduce delays. Respondents emphasize that “simplifying administrative

procedures and introducing accessible financial support are essential for the widespread adoption of sustainable technologies.” Streamlined administrative pathways should be coupled with accessible financing options, such as low-interest loans and grants. This would allow both large companies and MSMEs to pursue RE projects without being hampered by bureaucratic obstacles. By making the process more efficient, Tunisia can attract more investment in the RE sector and facilitate the transition to cleaner energy sources.

Strengthen government commitment and strategic clarity: A strong and clear government commitment to RE is critical to the success of the energy transition. As one participant notes, “A strong government commitment, backed by substantial funding and a coherent strategic direction, is essential to drive the energy transition forward.” This commitment needs to be translated into concrete actions, including increased public funding, the setting of clear targets, and the development of a comprehensive strategy that is consistent with national and international climate goals. The government’s role in leading the transition includes creating a stable policy environment that fosters investor confidence. Strategic clarity is key to ensuring that all stakeholders are aligned in their efforts, reducing the risk of delays and inefficiencies in the implementation of RE projects.

Encourage research and development (R&D) in green technologies: R&D in green technologies is essential to the long-term sustainability of Tunisia’s energy sector. Financial incentives to promote R&D in areas such as solar, wind, and energy storage can spur innovation and advance the country’s RE agenda. One industry expert explains that “Investment incentives for R&D in sustainable technologies are essential to stimulate innovation and promote sustainability in the energy sector.” Prioritizing R&D can enable Tunisia to develop homegrown solutions tailored to its specific energy needs while attracting foreign investment in advanced renewable technologies. These efforts would help position Tunisia as a regional leader in green innovation.

Tax incentives for RE investments: Tax incentives can be an effective way to encourage investment in RE, such as offering tax breaks, credits, or deductions to businesses and individuals who invest in green technologies. “Providing tax incentives for investment in RE can significantly accelerate the transition by making it financially attractive,” notes one respondent. These incentives can be particularly effective for large-scale projects and can be complemented by other financial mechanisms, such as low-interest loans and grants, to ensure that a wide range of stakeholders can participate in the energy transition.



Facilitate grants and financing for small-scale projects: Access to grants and specialized financing is critical for smaller-scale RE projects, particularly those led by MSMEs and community groups. These entities often face significant financial barriers that prevent them from engaging in RE projects. A respondent from the SME sector adds: “Access to grants and specialized financing is critical to fostering broader engagement in the energy transition, especially among smaller entities and local initiatives.” By providing targeted financial support, such as grants and low-interest loans, Tunisia can democratize the energy transition and ensure that businesses of all sizes can contribute to the country’s RE goals.

7.2.4. Simplify administrative procedures and minimize bureaucracy

Streamlining administrative procedures and minimizing bureaucracy is a key action to accelerate Tunisia’s energy transition, as highlighted by 15.25 percent of respondents. The consensus is that overly complex administrative systems are a significant barrier to the rapid and effective implementation of RE projects. Reducing these barriers would foster a more agile energy sector that can adapt to the rapidly evolving needs of the transition to sustainability.

Optimize administrative efficiency: A fundamental recommendation is to improve the administrative framework for RE projects. As one expert points out, “Efficient administrative processes are essential for the rapid implementation of RE projects.” Accelerating procedural timelines is critical to ensuring that project delays, often caused by bureaucratic inertia, are minimized. A streamlined administrative process allows both government agencies and the private sector to work together more seamlessly, creating an environment that encourages investment in RE projects.

Facilitating interactions with STEG: Another critical component is improving the interaction process with STEG. Simplifying the processes for grid access, power purchase agreements, and project approvals with STEG can significantly reduce project lead times. Many respondents note that dealing with STEG is one of the most time-consuming parts of the energy project approval process. One remarks that “simplifying the procedures with STEG can significantly speed up the development of energy projects.” Such reforms would make the entire project approval pipeline more transparent and efficient, thereby accelerating the deployment of RE.

Encourage the rapid deployment of new technologies: Streamlining the certification and permit approval process for new energy technologies is also a top priority. Removing bureaucratic barriers that delay the introduction of innovative solutions is crucial. As one expert comments, “Streamlining the certification process for new technologies is critical to their rapid adoption.” Simplifying this process would lower barriers to innovation and allow Tunisia to leapfrog into more advanced RE infrastructure. Digitize government processes: Transitioning to digital processes across government agencies is critical to improving both operational efficiency and transparency. Many respondents highlight the inefficiencies of paper-based or semi-digital systems currently used in the energy sector. Digitizing administrative processes would help reduce the time taken for projects to move from application to implementation. “Digitizing administrative processes is an important step to improve efficiency and transparency in the energy sector,” emphasizes one digital transformation expert. Digitization can also reduce human errors associated with manual processes, making the entire system more reliable.

Reduce bureaucratic complexity: Bureaucratic complexity is consistently cited as a key challenge in moving energy projects forward. Multiple layers of approvals, unclear regulations, and fragmented processes slow progress. As one respondent from the energy sector states, “Simplifying bureaucratic processes is critical to the smooth implementation of energy projects.” Addressing these complexities through clear, streamlined guidelines and simpler approval processes will make it easier for MSMEs and larger companies to engage in RE projects.

Facilitate digital transformation in businesses: In addition to modernizing government processes, it is important to help MSMEs and larger companies digitize their own operations. Through digital transformation, enterprises can manage energy projects more efficiently and align their operations with new, smarter energy infrastructure. As a Ministry of Energy official explains, “Supporting businesses to digitize their processes is essential to meet the technological demands of the energy transition.” This includes helping companies develop the capacity to monitor energy usage in real-time, improve energy efficiency, and adopt smart grid technologies.

Valuing certifications from new technology investors: Flexible regulations that recognize investor-provided certificates for new technologies can accelerate their deployment. Tunisia should consider adapting its regulatory framework to trust and accept investor-



provided certificates for technologies that have been successfully implemented elsewhere. This would reduce the time and cost of certifying each new technology through government channels. As one industry expert notes, “Trusting investor-provided certificates can accelerate the deployment of new technologies, thereby accelerating the energy transition.”

Develop centralized digital systems for project approvals: Creating centralized digital platforms to facilitate energy project approvals is a logical next step in improving government efficiency. Currently, companies often navigate different government agencies to obtain various approvals, resulting in delays and redundancies. “Integrated online platforms are critical to reducing the turnaround time for energy project applications,” says one expert. Centralized platforms would streamline the approval process, increase transparency, and allow project stakeholders to track progress in real-time.

Training government officials in RE technologies: Ongoing education and training for government officials on the latest RE technologies is another critical step. Many officials currently lack the technical knowledge needed to effectively evaluate new projects and technologies. As one training consultant notes, “Regular training for officials is essential to keep up with the rapid advances in RE.” This would ensure that decision-makers are well-informed and able to evaluate new technologies in a way that supports the overall energy transition.

Promote public-private partnerships for government innovation: Collaboration between the public and private sectors is critical to introducing innovative management solutions in the energy sector. Public-private partnerships can bring the expertise and efficiency of private sector management while ensuring that public interests are protected. “Public-private partnerships are essential for introducing innovative management solutions in the energy sector,” elaborates one policy analyst. These partnerships can play an important role in reforming outdated administrative practices and bringing in the technological know-how needed to streamline processes.

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

Conduct periodic reviews of energy regulations: Regularly reviewing and updating energy regulations would keep them relevant and supportive of the energy transition, in addition to keeping pace with technological advances and evolving market dynamics. Regulations that may have been appropriate in the past can quickly become outdated as new energy solutions emerge. “The regular review of energy regulations is necessary to ensure their effectiveness and prevent them from hindering the progress of energy projects,” suggests one regulatory expert.

Encourage efficiency in government processing: Efficiency incentives for government agencies can encourage faster processing of project approvals. Setting clear benchmarks for response times and providing rewards for meeting those benchmarks would create a more meritocratic culture of government. “Incentives for fast processing are essential to promote efficiency and minimize delays in the administrative handling of energy initiatives,” notes one government efficiency expert.

7.2.5. Promoting awareness and education initiatives

Public awareness, education, and community engagement play a key role in advancing Tunisia’s energy transition, with approximately 11.86 percent of respondents highlighting their importance. These elements were identified as fundamental to fostering a deep-rooted understanding of RE practices and ensuring the participation of different segments of society in the transition to sustainable energy. Effective awareness and education efforts are critical to creating a supportive environment that enables the country to achieve its sustainability goals.

Strengthen communication efforts: Improving communication about the energy transition and its benefits is critical to ensuring public support and active participation. Clear, accessible information that explains the social, economic, and environmental benefits of the transition to RE is essential to raise awareness among citizens, businesses, and policymakers. As one energy sector official points out, “Improving communication about the energy transition and its benefits is critical to generating broader support.” To ensure that the public understands the implications of the energy transition, effective communication must be a key focus.

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



suggests, “Incorporating RE issues into school curricula from an early age is fundamental to cultivating a culture of sustainability.” This strategy lays the groundwork for informed decision-making as young people grow into influential roles in society.

Raise public awareness of environmental issues: Public awareness of environmental and energy challenges must be an ongoing effort to foster societal acceptance of sustainable practices. Initiatives to educate the public about the environmental impacts of fossil fuel dependence and the need to adopt RE are essential to building a societal ethos that values sustainability. As one participant notes, “Educating the public on environmental and energy issues is essential to creating a supportive environment for the energy transition.” This strategy aims to make sustainability a core component of public awareness.

Launch targeted education and awareness campaigns: Tailored campaigns designed to reach different segments of society are essential to increase understanding of RE and the benefits of the energy transition. These campaigns should target different stakeholders, including businesses, policymakers, and the general public to ensure that each group is well-informed and actively engaged in supporting sustainable energy practices. One respondent explains that “specialized education and awareness campaigns tailored to different segments of society are needed to explain the benefits of the energy transition.” Such campaigns are critical to building broad support across sectors.

Build media partnerships to raise public awareness: Media partnerships are a strategic way to reach a broad audience and disseminate information about RE initiatives. Working with television, radio, online platforms, and print media ensures that messages about the benefits of the energy transition reach all corners of society. As one energy industry professional elaborates, “Media partnerships are fundamental to broadening public understanding of the benefits of the energy transition.” The role of the media in shaping public perceptions and fostering an informed dialogue on sustainability cannot be overstated.

Business-focused awareness programs: The business sector has a critical role to play in advancing the energy transition, and business-focused awareness programs are essential to encourage their participation. These initiatives should focus on educating business leaders about the economic benefits of RE, such as cost savings, efficiency gains, and market competitiveness. One respondent states that “it is imperative to raise awareness within the business community about the energy

transition,” underscoring the need to foster a sustainable business environment.

Inform about support mechanisms: Educating stakeholders about the range of support mechanisms available, including subsidies, incentives, and technical assistance, is critical to ensuring that businesses and individuals have access to the resources they need to make the transition to RE. “Awareness of the various support mechanisms for the energy transition is essential,” notes one expert, emphasizing the importance of informing stakeholders about the financial and technical support available to facilitate the adoption of sustainable energy.

Promoting diverse solutions: Promoting a diverse range of RE technologies and solutions is necessary to meet the varying energy needs of different regions and sectors. Flexibility in the choice of technologies, from solar and wind to energy efficiency improvements, would ensure that Tunisia’s energy transition is inclusive and adaptable. As one respondent points out, “Highlighting a range of solutions and technologies for the energy transition is essential for an adaptable deployment of RE,” spotlighting the need for technological diversity in the energy transition.

Incentivize clean energy adoption: Educating businesses about the incentives and benefits of adopting clean energy is a critical strategy for encouraging broader participation in the energy transition. By demonstrating both financial savings and environmental benefits, businesses will be more motivated to invest in sustainable energy solutions. One business representative explains that “educating businesses about the benefits and incentives of adopting clean energy is critical to their participation in the energy transition.” This would ensure that the business community is not only informed but empowered to make sustainable choices.

Disseminate targeted business campaigns: Organizing targeted campaigns to educate businesses about the practicalities of the energy transition, including funding opportunities, technology solutions, and best practices, is critical to their active engagement. “Targeted campaigns to educate businesses about the benefits of the energy transition are essential for their active engagement,” notes one business development expert. These campaigns aim to provide businesses with actionable insights that can help them effectively integrate RE into their operations.

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



actionable steps toward improved energy efficiency and the adoption of RE,” explains a corporate training employee. This training is critical to shifting corporate culture toward sustainability.

Strengthen youth leadership in sustainability: Engaging youth in leadership initiatives related to energy and environmental stewardship is essential to building future leaders committed to sustainability. Youth forums, innovation contests, and leadership programs can inspire a new generation of sustainability advocates. As one education expert notes, “Youth-led initiatives are fundamental to developing a generation committed to sustainable energy.”

Expand access to online educational resources: Creating online learning platforms that offer e-courses, webinars, and other resources on RE topics can democratize access to knowledge and facilitate widespread education. “Online educational platforms make RE knowledge accessible to a wide audience,” suggests one researcher, highlighting the potential of digital education to expand outreach.

Partner with academic institutions: Collaboration between the energy sector and academic institutions can advance both RE research and education. Academic programs focused on RE technologies and research into innovative solutions are critical to building a skilled workforce capable of leading the energy transition. As one academic liaison notes, “Synergy between the energy sector and academic institutions is critical to fostering innovation and advancing knowledge in RE.”

7.2.6. Integrating the informal sector in the energy transition

Effectively integrating the informal sector into Tunisia’s energy transition requires a multifaceted approach that combines financial incentives, capacity-building initiatives, and streamlined regulatory processes. The informal economy plays a significant role in Tunisia, employing a large proportion of the population and operating outside formal regulatory frameworks. Given its significant contribution to energy consumption, it is essential that the informal sector is included in national efforts to promote RE and energy efficiency.

Provide tailored financial incentives for informal businesses: To facilitate the adoption of RE and energy efficiency measures, tailored financial incentives should be designed specifically for informal enterprises. Microfinance options, low-interest loans, and grant programs could enable small informal enterprises to invest in renewable technologies such as solar power

or energy-efficient appliances. By reducing the initial financial barriers, these programs can help informal businesses transition to cleaner energy solutions, thereby reducing their carbon footprint and operating costs. For example, informal markets and workshops could benefit from solar panels and energy-efficient lighting, leading to lower electricity bills and more sustainable practices. Providing tax incentives for businesses that transition to formal status and adopt sustainable energy practices is another key recommendation. Simplifying the business formalization process, such as reducing the complexity of registration and compliance requirements, can encourage informal businesses to become part of the formal economy. Once formalized, these businesses can access government subsidies and financial support to promote the use of RE.

Promote capacity building initiatives and energy literacy: Capacity building initiatives are critical to educating the informal sector about the benefits of RE and energy conservation. Energy literacy programs, workshops, and awareness campaigns should be designed to target informal workers and business owners. These initiatives can focus on communicating the practical benefits of adopting RE technologies, including cost savings, reduced dependence on grid electricity, and increased business resilience. Community organizations, local business associations, and NGOs can play a critical role in delivering these programs. By partnering with these groups, the government can ensure that training programs reach the most vulnerable and isolated segments of the informal economy. This decentralized approach can facilitate the widespread dissemination of knowledge and foster a greater understanding of the economic and environmental benefits of RE.

Foster public-private partnerships for energy solutions: Establishing public-private partnerships can be an effective mechanism for integrating the informal economy into Tunisia’s energy transition. These partnerships can involve financial institutions, RE providers, and informal sector business networks. Such collaborations can provide informal businesses with access to affordable RE solutions, such as solar power installations or energy efficiency technologies. For example, solar energy companies could partner with informal businesses to facilitate the installation of solar panels in small workshops and markets. These partnerships would lower energy costs for informal businesses in addition to reducing emissions across the sector. Moreover, RE providers could develop financing models specifically designed for the informal economy, offering payment plans that match the cash flow patterns of small and unregistered businesses.

Conduct a monitoring and evaluation framework: To ensure the effectiveness of initiatives targeting the informal sector,



the government should establish a comprehensive monitoring and evaluation framework. This system would track the adoption rates of RE technologies, energy efficiency measures, and the formalization of informal enterprises. Such data would provide valuable insights into the progress of the energy transition within the informal economy, allowing policymakers to identify challenges and adjust strategies accordingly. Regular assessments of the impact of these initiatives would enable the government to make informed decisions about scaling up successful programs or removing barriers that may prevent informal enterprises from fully participating in the energy transition. This framework would help maximize the social and economic benefits of including the informal sector by ensuring that the transition is inclusive and equitable.

7.2.7. Policy roadmap for Tunisia's energy transition

A detailed policy roadmap is essential to guide Tunisia's energy transition, with a particular focus on ensuring the active participation of the informal sector. This roadmap should outline key milestones, policy interventions, and stakeholder responsibilities, in addition to providing a clear path for achieving national RE targets. By including the informal economy in this framework, Tunisia can promote an inclusive transition that benefits all sectors of society.

The roadmap should prioritize reducing regulatory and financial barriers for MSMEs, providing targeted support to informal businesses, and ensuring that public-private partnerships facilitate the adoption of RE technologies across sectors. It should also focus on raising public awareness, improving energy literacy, and building a supportive ecosystem for businesses to transition to clean energy solutions.

7.3. Suggestions for future research

Future research should focus on assessing the long-term impact of Tunisia's energy transition on MSMEs and the informal sector, examining economic, social, and environmental outcomes. Studies could evaluate the effectiveness of specific policies and financial incentives aimed at facilitating the energy transition for MSMEs, particularly in the context of the informal economy.

Research on the role of digital technologies, such as blockchain for energy management and AI-driven energy efficiency solutions, would provide valuable insights into how innovation can support the energy transition. Furthermore, comparative studies with other

countries undergoing similar energy transitions could provide lessons learned and best practices that Tunisia could adopt to accelerate its progress toward a sustainable energy future.

This comprehensive approach to policy development, combined with ongoing research and evaluation, would help ensure that Tunisia's energy transition is both inclusive and sustainable. Addressing the needs of the informal economy and providing targeted support to MSMEs can enable Tunisia to position itself as a leader in the region's transition to RE.

References

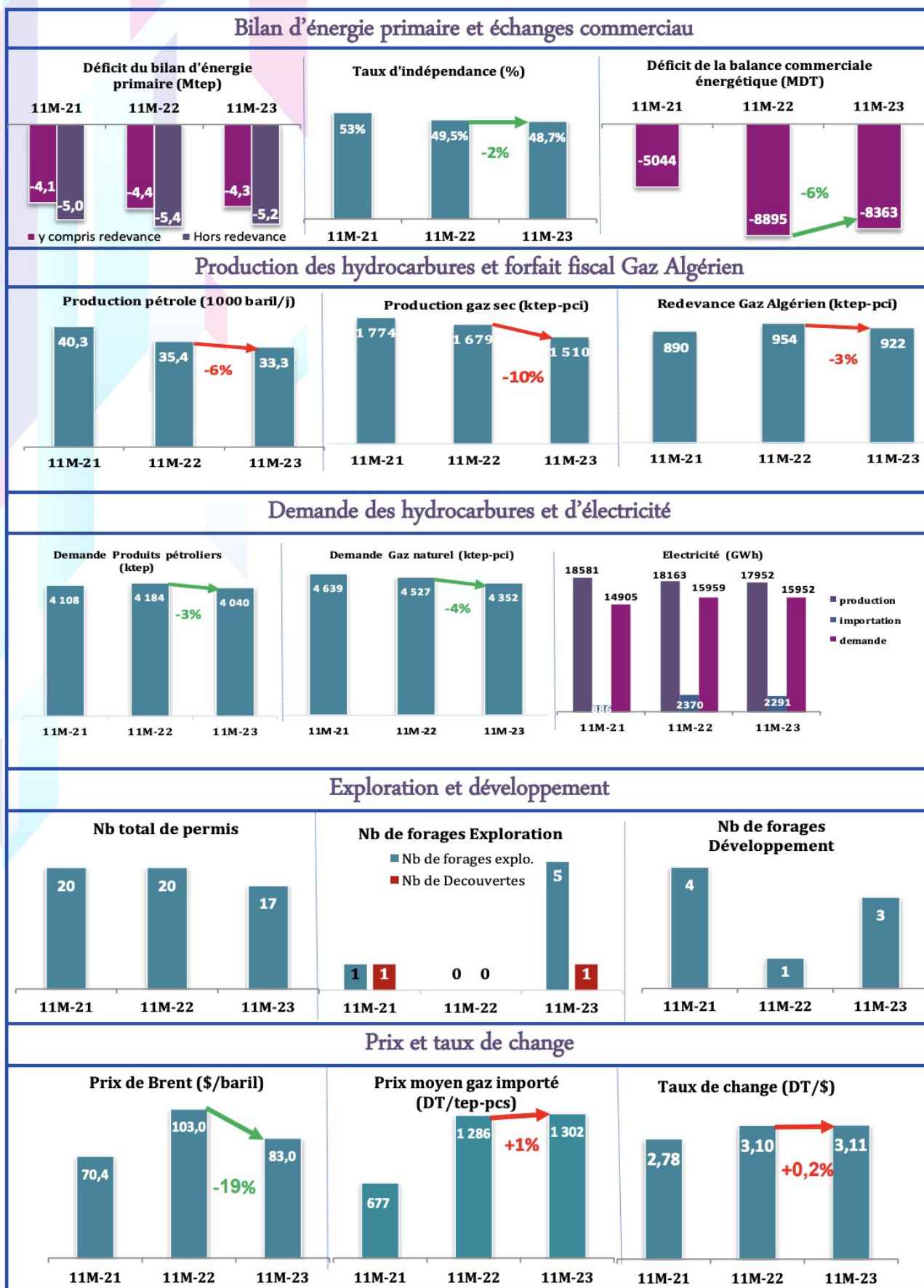
- African Manager (2023). Power-Tunisia Subsidizes the Green Transition of the Private Sector, <https://africanmanager.com/power-tunisia-signature-de-deux-conventions-pour-appuyer-la-transition-verte-du-secteur-prive/#:~:text=Le%20Programme%20d'Appui%20C%3%A0,fa veur%20de%20deux%20conventions%20sign%C3%A9es>.
- Akermi, R. and Triki, A. (2017). The Green Energy Transition and Civil Society in Tunisia: Actions, Motivations and Barriers. *Energy Procedia*, 136, 79-84.
- Alimi, M., Rhif, A., and Rebai, A. (2017). Nonlinear Dynamic of the Renewable Energy Cycle Transition in Tunisia: Evidence from Smooth Transition Autoregressive Models. *International Journal of Hydrogen Energy*, 42(13), 8670-8679.
- Ayyagari, M., Demirguc-Kunt, A., and Maksimovic, V. (2011). Small vs. Young Firms Across the World: Contribution to Employment, Job Creation, and Growth. In *Policy Research Working Papers*. The World Bank. <https://doi.org/10.1596/1813-9450-5631>
- Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, 17(1), 99-120.
- Beck, T., Demirgüç-Kunt, A., and Maksimovic, V. (2005). Financial and Legal Constraints to Growth: Does Firm Size Matter? *The Journal of Finance*, 60(1), 137-177.
- Belloumi, M. (2009). Energy Consumption and GDP in Tunisia: Cointegration and Causality Analysis. *Energy policy*, 37(7), 2745-2753.
- Ben Mbarek, M., Saidi, K., and Rahman, M. (2018). Renewable and Non-Renewable Energy Consumption, Environmental Degradation and Economic Growth in Tunisia. *Quality and Quantity*, 52, 1105-1119.
- Ben Youssef, A., Dahmani, M., and Mabrouki, M. (2024). Decoupling Carbon Emissions and Economic Growth in Tunisia: Pathways to Sustainable Development. In M. Arouri and M. Gomes (Eds.), *Handbook on Energy and Economic Growth* (pp. 103-127). Edward Elgar Publishing. <https://doi.org/10.4337/9781802204803.00012>
- Blok, V., Wesselink, R., Studynka, O., and Kemp, R. (2015). Encouraging Sustainability in the Workplace: A Survey on the Pro-Environmental Behaviour of University Employees. *Journal of Cleaner Production*, 106, 55-67.
- Brini, R., Amara, M., and Jemmali, H. (2017). Renewable Energy Consumption, International Trade, Oil Price and Economic Growth Inter-Linkages: The Case of Tunisia. *Renewable and Sustainable Energy Reviews*, 76, 620-627.



- Cohen, B. and Winn, M. (2007). Market Imperfections, Opportunity and Sustainable Entrepreneurship. *Journal of Business Venturing*, 22(1), 29-49.
- Dahmani, M., Mabrouki, M., and Ben Youssef, A. (2023). The ICT, Financial Development, Energy Consumption and Economic Growth Nexus in MENA Countries: Dynamic Panel CS-ARDL Evidence. *Applied Economics*, 55(10), 1114-1128.
- Delpuech, A. and Poletti, A. (2021). Borj Essalhi: The High Costs of Wind Turbines, *Inkyfada*.
- European Training Foundation (ETF) (2022). *Future of Skills: Energy Sector in Tunisia*, Summary of the Report
- Farhani, S. and Ozturk, I. (2015). Causal Relationship between CO2 Emissions, Real GDP, Energy Consumption, Financial Development, Trade Openness, and Urbanization in Tunisia. *Environmental Science and Pollution Research*, 22, 15663-15676.
- Fodha, M. and Zaghdoud, O. (2010). Economic Growth and Pollutant Emissions in Tunisia: An Empirical Analysis of the Environmental Kuznets Curve. *Energy Policy*, 38(2), 1150-1156.
- Gazzo, A. et al. (2024). *Job Creation and Skills Development During the Energy Transition: Tunisia (English)*, World Bank Group. United States of America. Retrieved from <https://policycommons.net/artifacts/11303659/job-creation-and-skills-development-during-the-energy-transition/12189151/> on 13 Apr 2024. CID: 20.500.12592/tmpg97p.
- Hart, S. (1995). A Natural-Resource-Based View of the Firm. *Academy of Management Review*, 20(4), 986-1014.
- The Mediterranean World Economic Prospective Institute (IPEMED) (2017). *Energy Challenges Facing Tunisia*, https://www.ipemed.coop/adminIpemed/media/fich_article/1501151082_14072017-leconomiste-maghrebin.pdf
- Institut Tunisien de la Compétitivité et des Etudes Quantitatives (ITCEQ) (2017). *ITCEQ Notes and Analysis: Working Document*.
- The Tunisian Institute of Strategic Studies (2022). *The Energy Transition in Tunisia*.
- Jaffe, A., Newell, R., and Stavins, R. (2002). Environmental Policy and Technological Change. *Environmental and Resource Economics*, 22(1-2), 41-69.
- Jebli, M. and Youssef, S. (2015). The Environmental Kuznets Curve, Economic Growth, Renewable and Non-Renewable Energy, and Trade in Tunisia. *Renewable and Sustainable Energy Reviews*, 47, 173-185.
- Kemp, R., Loorbach, D., and Rotmans, J. (2007). Transition Management as a Model for Managing Processes of Co-Evolution Towards Sustainable Development. *International Journal of Sustainable Development and World Ecology*, 14(1), 78-91.
- Khaled, M., Dahmani, M., and Ben Youssef, A. (2024). *Overcoming Barriers to Energy Transition in the MENA Region: New Institutional Dynamics*.
- Kubursi, A. and Abou Ali, H. (2024) *Potential Employment Generation Capacity of Renewable Energy in MENA*. Economic Research Forum.
- Lehr, U., Mönning, A., Missaoui, R., Marrouki, S., and Salem, G. (2016). Employment from Renewable Energy and Energy Efficiency in Tunisia – New Insights, New Results. *Energy Procedia*, 93, 223-228.
- Li, S., Cifuentes-Faura, J., Talbi, B., Sadiq, M., Mohammed, K. and Bashir, M. (2023). Dynamic Correlated Effects of Electricity Prices, Biomass Energy, and Technological Innovation in Tunisia's Energy Transition. *Utilities Policy*, 82, 101521.
- Mol, A. (2002). Ecological Modernization and the Global Economy. *Global Environmental Politics*, 2(2), 92-115.
- Pinkse, J. and Groot, K. (2015). Sustainable Entrepreneurship and Corporate Political Activity: Overcoming Market Barriers in the Clean Energy Sector. *Entrepreneurship Theory and Practice*, 39(3), 633-654.
- Rocher, L. and Verdeil, É. (2013). Energy Transition and Revolution in Tunisia: Politics and Spatiality. *The Arab World Geographer*, 16(3), 267-288.
- Saadaoui, H. and Chtourou, N. (2023). Do Institutional Quality, Financial Development, and Economic Growth Improve Renewable Energy Transition? Some Evidence from Tunisia. *Journal of the Knowledge Economy*, 14(3), 2927-2958.
- Saadaoui, H. and Chtourou, N. (2023). Does Improvement in Capital Intensity Facilitate the Transition to Renewable Energies? Evidence from Tunisia. *Environmental Science and Pollution Research*, 30(18), 54059-54072.
- Saadaoui, H., Omri, E., and Chtourou, N. (2024). The Transition to Renewable Energies in Tunisia: The Asymmetric Impacts of Technological Innovation, Government Stability, and Democracy. *Energy*, 130686.
- Schäfer, I. (2016). *The Renewable Energy Sector and Youth Employment in Algeria, Libya, Morocco and Tunisia*, African Development Bank.
- Scott, W. (1995). *Institutions and Organizations*. Sage.
- Talbi, B., Jebli, M., Bashir, M., and Shahzad, U. (2022). Does Economic Progress and Electricity Price Induce Electricity Demand: A New Appraisal in Context of Tunisia. *Journal of Public Affairs*, 22(1), e2379.
- Tractebel (2019). Chapter 1: Energy Context, in: *Renewable Energy Projects in Tunisia - Detailed Guide*, GIZ.
- Tunisian Ministry of Industry, Mines, and Energy (2023). *Conjoncture Énergétique*.
- Fanack (2023). *Tunisia's Plan for Renewable Energy: Chances and Challenges*.
- Vues d'Europe & d'Ailleurs (2022). *Energy Transition in Tunisia: What Conditions for a Just Transition?* http://volontaires.echanges-partenariats.org/2022/12/06/transition-energetique-en-tunisie-queles-conditions-pour-une-transition-juste/#_ftnref1
- Web Manager (2023). *Energy Transition – Gender: In Tunisia, Women Network to Accelerate Change*.
- World Bank (2023). *Migration Amid a Challenging Economic Context*.
- World Bank (2023). *Reforming Energy Subsidies for a Sustainable Economy*.



Annex 1: State of energy in Tunisia in 2023



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