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# ENERGY TRANSITION AND GREEN ECONOMY IN TUNISIA: STRUCTURAL BARRIERS, POLICY EFFECTIVENESS, AND PATHWAYS TO SUSTAINABLE DEVELOPMENT

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**ABSTRACT----------**
*This study analyses renewable energy and environmental policies and instruments to support a Green Economy transition in Tunisia. A descriptive and analytical approach is adopted in order to better understand links between energy systems, economic growth and environmental sustainability. There are considerable solar and wind resources in Tunisia, yet the energy sector remains largely dependent on fossil fuels. Currently, there are considerable structural barriers to the development of renewable energy in Tunisia, in particular with respect to financing, inadequate institutional and regulatory cooperation, and missing supportive infrastructure. Also the impact of path dependencies from current energy structures and existing investments in fossil fuel is discussed. A conceptual and causal model for explaining the transition to renewable energy, based on governance, investments and technological capabilities, is developed. Tunisia needs to adopt institutional reforms as well as green financing mechanisms and renewable energy technologies' quick development to reach renewable energy targets in a sustainable and rapid low-carbon transition.*
**KEYS WORD:** *Green Economy; Renewable Energy; Tunisia; Environmental Policy; Sustainable Development; Energy Transition; Climate Change; Green Investment*----------

## 1. INTRODUCTION

Environmental and energy challenges in developing countries like Tunisia are similar. Although natural gas still remains the main energy product consumed in Tunisia, the country is still heavily energy dependent. Until recently, Renewable energy has remained limited but is gradually increasing. The energy sector can affect the environment various ways; pollution, consumption of fossil fuels resources and emission of greenhouse gases increasing the climate change risks. In this context, the switch to new energy is necessary and strategic for Tunisia and it should be based on clean, efficient and renewable energy sources.

In response, the government adopted strategic measures to support this transition. The national energy transition plan for Tunisia includes among others: (To up the share of renewable energy in electricity to 35% by 2030) To see the installed capacity of renewable energy exceed 4 GW with the launch of major solar energy and wind projects.

In addition to this, Tunisia has recently launched a long-term energy strategy with a set of ambitious and inclusive objectives aimed at strengthening energy security, at reducing the share of hydrocarbons and at creating the conditions for a dynamic economy that would benefit from the huge potential of green investments. Energy sector reduction of $CO_2$ emissions set by national energy plans is of 36% for 2030 and 46% for 2035, in line with the country's aspiration to reach carbon neutrality in 2050.

Even with their relatively low levels, Tunisia\'s emissions are growing with economic growth and increasing energy demand. The production of renewable energy and clean hydrogen is also being explored, and Tunisia could become a significant energy provider for Europe: According to Tunisia\'s long-term vision, the production of green hydrogen should enable the country to produce the volumes of hydrogen needed for both export and domestic consumption. This will enable diversification of the economy of Tunisia as well as the reduction of carbon emissions. Transition towards a green economy represents one of the efficient mechanisms leading to sustainable development in Tunisia. The incorporation of environmental considerations into economic policies, through the development of renewable energy resources and better resource use, can not only enhance the competitiveness of the economy of Tunisia, but

also help in easing the ecological pressure on it. In this context, our research work will focus on the role of the green economy policies in supporting sustainable development in Tunisia. Thus, the objectives of this research are to study the environmental policies in Tunisia and analyze the transition to renewable energy as well as the reduction of greenhouse gas emissions in compliance with international environmental conventions.

Over the last few decades, Tunisia has been suffering from the consequences of Climate change, population increase and escalating energy needs are generating immense pressure on finite resources, and thus call for a re-examination of the unsustainable development model based on the consumption of finite resources and the extensive use of fossil fuels.

The country is characterized by a small budget, insufficient technical capabilities, a regulatory framework that is not favorable to the development of renewable energy and heavy dependence on imported energy products.
The problem that this work seeks to understand is: Is the transition to a green economy an effective strategy for achieving sustainable development in Tunisia? Based on this problem, other subsidiary questions emerge
• What are the environmental and economic challenges faced by Tunisia economy in terms of sustainable development?
•Can the different sources of renewable energy and environmental policies support sustainable economic growth in Tunisia? to what level?
•What are the major policies and strategies adopted by the Tunisian government to enhance, promote and accelerate the transition process to a green economy?
• What are the main constraints that Tunisia's economy has to face to accelerate the implementation process of a Green Economy?
**The paper explores interactions between energy, policy and economy towards sustainable development and analyses the role of renewable energy, institutional innovation and sustainable economic growth. In addition to discussing challenges such as structural, financial and institutional barriers to the expansion of renewable energy and the transition to a low-carbon economy, the paper outlines a practical approach for overcoming the barriers to renewable energy and for good governance of energy transitions. Theoretical insights are complemented by concrete policy recommendations for decision makers.**

### 1.1 Research Objectives
The main objective of this study is to examine the relationship between the Green Economy and sustainable development in Tunisia, while identifying the tools to be used to improve development policies. The following are the specific objectives of the study:
1. Identifying the most suitable renewable energy alternatives for Tunisia’s energy sector
2. Studying the environmental and economic challenges in Tunisia that are linked to energy consumption, pollution and climate change.
3. Evaluate the environmental and energy policies in Tunisia specifically on the subject of renewable energy and the reduction of greenhouse gases.
4. Exploring opportunities of using renewable energy and green investments to boost Tunisia’s economy and environment.
5. Investigate the main barriers that currently impede the transition to the Green Economy and present a set of policy recommendations to improve the sustainability plans of the region.
Achieving these objectives will allow the study to shed light on the challenges facing Tunisia in terms of realizing a green economy in the context of its medium-term and long-term sustainable development plans.

### 1.2 Research Methodology
This study explores through the descriptive and analytical approach the links between policies of green economy and sustainable development in Tunisia. The descriptive method has been used to explain the theoretical framework of the green economy and sustainable development concepts, whereas the analytical method has been used to assess Tunisia’s environmental policies and renewable energy plans. Based on the following sources, this study aims to provide a detailed analysis of the level of achievement of the green economy in Tunisia and to identify the obstacles that Tunisia must still overcome.
- World Bank
- International Monetary Fund (**IMF**)

- United Nations Environment Program (**UNEP**)
- International Energy Agency (**IEA**) Energy & Minerals Tunisian national reports and strategic documents Ministry of Energy and Mines; other government institutions
- Academic articles and scientific studies from the environmental economics and green development category.
- Energy, renewable energy and CO2 publications Statistical databases related to energy consumption, renewable energy production, carbon emissions.

## 2. THEORETICAL FRAMEWORK OF THE GREEN ECONOMY

### 2.1 Concept of the Green Economy

The green economy concept has become a major discourse to address the emerging environmental challenges posed by the conventional economic growth paradigm. The current economic growth model is neither efficient nor sustainable. Today's economy focuses on growth and development, with little regard for the environmental or social impacts of the economy's operations. The result has been rising levels of pollution, overuse of resources and increased impacts from climate change (World Bank, 2023; International Energy Agency, 2023). Many are aware of the problems that face our world and are trying to persuade others at the international level to find a new way of living: a sustainable economy.

The United Nations Environment Program, UNEP, explained in their publications "Towards a Green Economy: Pathways towards sustainable development in Africa and Southeast Asia" in 2011 and "SDG 12: Achieving the Sustainable Development Goals and the new progress towards the implementation of the Paris Agreement" in 2023, that a green economy is an economy that improves the well-being and the social justice of the present, while reducing the future environmental risks and ecological scarcities.

New publications Empirical validation of our framework has been provided in new peer-reviewed articles: Sustainable finance and eco-innovation as tools for reducing carbon emissions and promoting the low-carbon economy in Tunisia" is a new article published recently in Economies (Chibani & Henchiri, 2025) confirming among other aspects that sustainable finance and eco-innovation are effective drivers for reducing carbon emissions and promoting the low-carbon economy in Tunisia. In Energy, a study confirms that technology and economic factors are key drivers of RES adoption, whereas institutional barriers, especially political stability, remain the major constraints (Adebayo et al., 2024).

Discover Sustainability; Renewable energy, financial development and industrialization have positive long run effects on environmental sustainability in Tunisia, (Gharbi et al., 2025) - Discover Sustainability; The use of more efficient models such as ARDL and FMOLS confirm that renewable energy, foreign investment and technological progress have positive impacts on sustainable development and tourism (Zaghdoud, 2025) In addition, early work but still recent SSCI-indexed work highlighted long run relationship between renewable energy consumption, economic growth and environmental pollution in Tunisia and therefore renewable energy sources has a great role in the sustainable development (Ben Mbarek et al., 2018). Furthermore, Saadaoui & Chtourou (2023) found that capital formation and technical progress are the main drivers that foster the shift toward RE-based energy systems.

On the whole, the literature has concluded that a transition to a green economy through the use of renewable energy, the development of finance and the advancement of technology can achieve the purposes of not only improving environmental sustainability, but also realizing sustainable development and strong and steady economic growth.

### 2.2 Principles of the Green Economy

The concept green economy is based on some multiples principles that are aimed at guiding sustainable development.

- **Environmental Sustainability**

Protection of diversity One of the basic principles of the green economy is the protection and preservation of nature and natural resources. This means that all economic activities have to be adapted to the principle of environmental protection. Long-term sustainability has to be assured in the use of water resources, forests and biodiversity.

- **Efficient Use of Resources**

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Green economy is about using resources more efficiently and in a better way. It is about Boosting resource productivity, reducing waste, increasing reuse, recycling of materials.

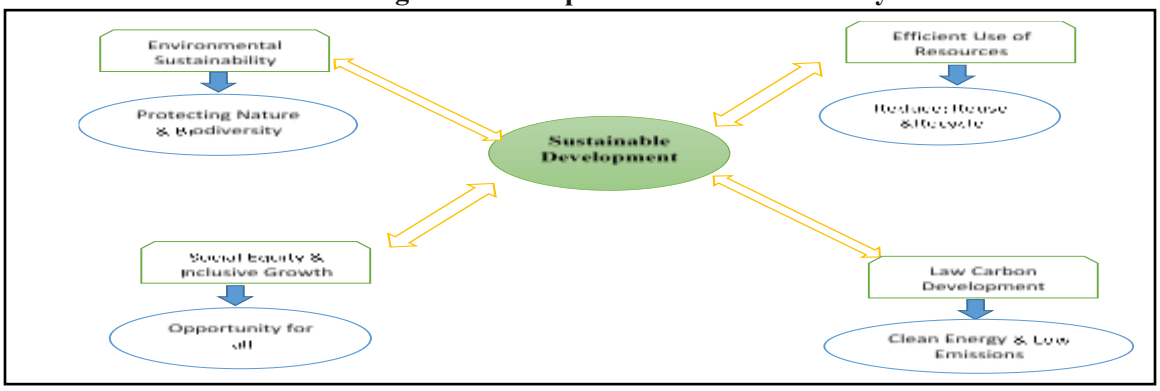
- **Social Equity and Inclusive Growth**

Green Economy must ensure two principal phenomes Social Justice and an Inclusive Growth Path. Sustainable development must be seen as an opportunity to minimize poverty rate, to improve the living standard of the population and to create jobs opportunities for all people, regardless of ethnic or social background.

- **Low Carbon Development**

The green economy is centered on one essential fact: the reduction of emissions. Renewable energy, higher energy efficiency and eco-friendly technologies are the essential elements.

**Figure 1. Principle of the Green Economy**




**Source: created by the author**

### 2.3 Relationship Between the Green Economy and Sustainable Development

Green economy is a determinant factor of the overall framework of sustainable development. This concept was first introduced to the world community through the Brundtland Report (1987). Sustainable development is an environment that satisfies the needs of present generations without encroaching on the ability of future generations to meet their needs too. Sustainable development is an overall and global framework. The green economy is a specific instrument for realizing the principles of sustainable development through the implementation of particular economic policies and decisions. The relationship between sustainable development and the green economy can be described in terms of the following dimensions:

First, the economic dimension: investment in environmental sustainability and efficiency to enhance productivity and economic growth; second, the environmental dimension: natural resource management: all ecosystems protected and no hazardous substances released to slow climate change; and third, the social dimension: to attain a higher standard of living for today and tomorrow through a more equitable distribution of financial gains. Transformation of the world economy and the achievement of sustainable development for all is at the heart of the transition to a Green Economy.

### 2.4 Key Sectors of the Green Economy

The green economy is a subset of economic activities through which several sectors contribute to ensuring environmental sustainability as well as realizing development.

- **Renewable Energy**

A green economy means integrating renewable energy into its overall development, since renewable energy is the lifeblood of a green economy. However, in many countries including those in Africa, the use of solar energy, wind energy and of hydropower is very restricted and mainly an alternative to the use of fossils for electricity and other energy purposes for which fossils emit greenhouse gases that affect the atmosphere.

- **Sustainable Agriculture**

Agriculture is a major sector of very large developing economies. The aim of sustainable agriculture is to increase production of food and crops for human consumption while ensuring that the land resources are maintained at high levels of productivity and have long-term stability. This also involves ensuring continuous use of the land and conserving water and crop biodiversity resources.

- **Green Industry**

The Green Industry is a specific kind of industry that uses any form of clean production technologies and efficient processes to minimize pollution, and to achieve higher energy efficiency within production methods.

- **Waste Management and Circular Economy**

Waste management and recycling activities are a determining factor of the green economy. They facilitate the process of reducing pollution of the environment and reusing resources in production processes.

**2.5 Economic Benefits of the Green Economy**

Green economy could provide several economic opportunities. The use of renewable energy and new ecological infrastructure could promote economic growth and provide new job opportunities for people in new green economy industries. Examples can be seen in multi-country studies showing that the expansion of renewable energy not only created millions of job in countries like Brazil, China and India but also contributed heavily to their GDP (Adebayo et al., 2024).

Resource and energy productivity (REP) is second among the three policy areas highlighted by the European Commission as critical to achieve sustainable development, and improve competitiveness. This paper draws upon numerous analyses confirming that improving resource and energy productivity not only preserves the environment, but is also a major opportunity to lower production costs and enhance competitiveness. As numerous researches indicate that the application of circular economy (CE) and resource efficiency (RE) leads to improved firm performance and green job creation, predominantly in small and medium-sized enterprises (SMEs) (Sulich & Sołoducho-Pelc, 2022;)0

A number of recent EU studies have found that investment in the bioeconomy and green finance can enhance environmental performance and growth (Adekoya et al. 2025. Third, well-designed environmental policies minimize the amount of financial losses imposed on citizens today and in the future due to the scarcity of resources, environmental damage, and climate change. Asian research has also documented firsthand the environmental degradation suffered by many Asian countries, and how spending on renewable energy and green technologies can mitigate environmental damage and support sustainable development goals.

This has been shown in countries such as China, Japan and India among others. This shows that with the right policy measures and technological advancements, countries in Asia can truly transition their economies to a green economy. Similar conclusions have been reached in other world regions, US research confirms the US transition to clean energy and green jobs boosts the economy. The work, part of a wider cross-ocean research project to investigate the impact of the transition on economies in OECD and North American countries found the switch to renewable energy and hi-tech products increases productivity and reduces emissions, which in turn supports sustainable economic growth (IEA, 2023; World Bank, 2024).

In addition, the bibliography explores the green economy discourse at the global level, identifying dominant trends, publication outlets and research networks in the main world regions, Europe and Asia, being the leaders in terms of quantitative terms, and the Americas, in terms of qualitative terms (more empirical and focused on policies). In this way, the green economy is a global paradigm (Roerth, 2016).

As far as the literature is concerned, internationally there is a broad consensus that the green economy is necessary for the ecological and at the same time a developmental, growth-oriented strategy for sustainable development, employment and long term development in all regions of the world.

**2.6 Challenges of the Green Transition**

Although the green economy has vast potential, its transition is being blocked by a number of structural and institutional obstacles, many of which continue to affect developing countries. Access to finance is one of the most important; it currently limits the implementation of large investments needed for green infrastructure and clean technologies, due to among other things market failures and pricing that is not competitive, a lack of technological development and low rates of innovation, a lack of government effectiveness and weak institutions characterized by a lack of coordination in the sector of the environment, low administrative and technical capacity and a legal framework that is often incomplete or not homogeneous, thus reducing policy and investment efficacy.

One reason for the high cost of the environmental transition to a low-carbon economy is the immediate expense of major investments needed to modernize the energy, transport and industry sectors. These costs correspond largely to investments in research and development, infrastructure, and skills to enable companies to innovate and implement eco-friendly technologies. Moreover, the long pay-off period of many eco-friendly investments, combined with the subjective feeling of higher risks, may dissuade private companies from implementing these solutions, at least as long as they are not accompanied by fiscal incentives or risk-sharing mechanisms.

Therefore, solutions have to be developed across policy areas. For this purpose, technology transfer, financing aid and capacity-building under international cooperation should be promoted via multilateral organizations and climate finance mechanisms. National structural policy reforms must also be introduced to improve the quality of regulation, enhance efficiency and create a corresponding investment climate for climate protection measures. High political awareness is also important, as it has to be taken into account in national development strategies and should secure the long-term success of the transformation towards a greener economy.

**2.7 Green Economy in Tunisia: Literature Review**

In academic and policy literature over the last two decades there has been extensive discussion of the green economy. A key aspect of such a Green Economy is that it can catalyze and facilitate sustainable development by improving human well-being and social equity while reducing environmental risks and ecological scarcities. This is the most widely cited definition within academic and policy literature by the United Nations Environment Program (UNEP, 2011). There are a large number of research papers and academic studies published on the need for green economic transformation particularly for developing countries facing environmental threats and heavy use of energy. Given the weather in Tunisia and its geography, the country has great potential in renewable energy. Several studies were conducted to know the opportunity available for solar energy to generate electricity in Tunisia.

This paper intends to review related researches to propose research directions. Tunisia has huge potential of solar and wind resources. The World Bank and IRENA assessed these resources and concluded that they represent great opportunities for development of renewable energy to ensure a greater diversification of energy resources and reduction of greenhouse gases (IRENA, 2023) (World Bank, 2024). Solar photovoltaic sector in North Africa, where Tunisia is located, has also a huge potential for growth due to the high solar irradiance levels in the region (International Energy Agency, 2023).

The Tunisian Solar Plan is in addition a national plan to support the production of renewable energy. The Ministry of Energy and Mining of Tunisia has the objective to reach around 35% of renewable energy production in the electricity sector by around 2030. With this measure the energy security will be improved by reducing the use of fossil fuels.

While great opportunities are seen, several challenges will also need to be addressed. As the World Bank (2024) and OECD (2022) point out, these include inter alia lack of funding, an overcomplicated administration, technical issues and lack of coordination between the relevant public institutions. Recent analyses have also highlighted governance deficiencies and a need for policy coherence and adequate funding, in order to move ahead with the transition (IEA, 2023).

Based on the literature, adopting new green economy policies in Tunisia will require a series of reforms; higher investment in renewable energy technologies as well as better coordination among governments, the private sector, and external donors (UNEP, 2023; IRENA, 2023).

This paper reviews current research on challenges to green economy and renewable energy in Tunisia. Table 1 provides an overview of selected studies on different challenges that hinder deployment of renewable energy in Tunisia, including their results, methods and recommendations for decision makers. After presenting the overview of studies, results of research on challenges to green economy and renewable energy in Tunisia will be analyzed and discussed in more detail.

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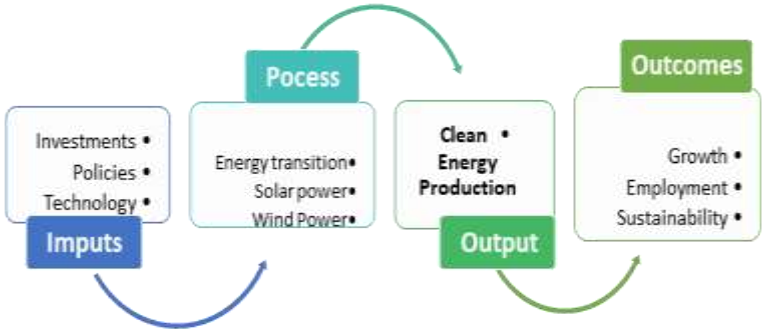
**Table 1. Summary of Key Studies on Green Economy and Renewable Energy in Tunisia**

| Study / Institution | Year | Focus Area | Key Findings | Policy Implications |
|---|---|---|---|---|
| United Nations Environment Program | 2011 / 2023 | Green Economy Concept | Green economy is about making rich enefits for people and the environment at the same time as reducing risks. | institutional framework that gives direction to ustainable development policies and strategies. |
| World Bank | 2023–2024 | Climate & Development Tunisia case | Renewable energy has strong potential. However, it still needs structural reforms. | Promote investment and institutional reforms |
| International Renewable Energy Agency | 2023 | Renewable Energy Potential | Tunisia is a country with high potential for solar and wind energy in the Mediterranean region. | Accelerate renewable deployment |
| International Energy Agency | 2023 | Energy Transition | North Africa is now seen as the region ost suited for solar energy development | Regional integration nd energy diversification |
| OECD | 2022 | Green Growth | Green investment boosts GDP and employment | Encourage green financing policies |

**Source: created by the author**

The synthesized literature was illustrated in a table summarizing the known determinants that affect investment in renewable energy in Tunisia. Building on this work, a conceptual model for the green economy transition in Tunisia has been developed, representing dynamic relationships between policy and institutions, investments, and renewable energy outcomes. The table and Figure 2 provide an overview of the synthesized studies on the green economy transition for Tunisia.

**Figure 2. Conceptual Model of Tunisia's Green Economy Transition**




**Source: Created by the author**

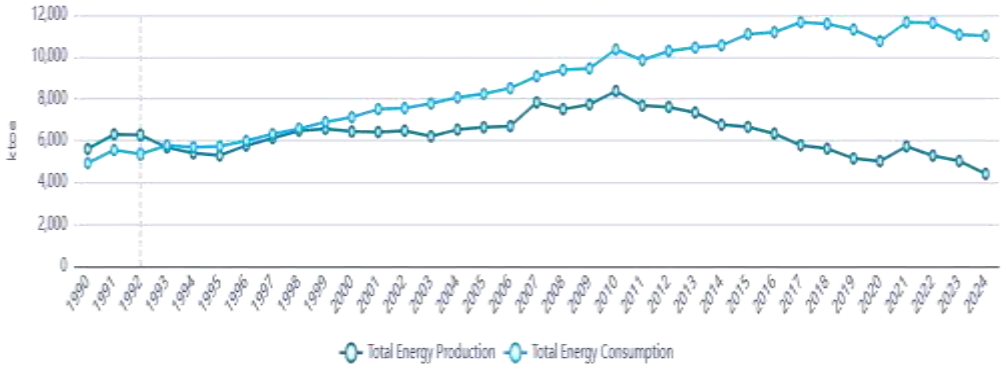
## 3. RENEWABLE ENERGY AND ENVIRONMENTAL POLICIES IN TUNISIA

### 3.1 Overview of the Energy Sector in Tunisia

Tunisia nearly exclusively uses natural gas for power generation, with electricity produced from renewable energy constituting about 3%. However, Tunisia's energy system, as with most of the Mediterranean region, is challenged regarding energy security, due to increasing imports for energy supply. Tunisia is running out of oil and gas rapidly, with production steadily decreasing in recent years, while the country's natural gas imports are almost entirely sourced from rival neighboring Algeria, eroding autonomy and introducing new supply risks. Tunisia's per capita energy consumption is estimated to reach 0.9 toe in 2024, less than the North African average and one third of the European average. The total energy consumption is estimated to grow at an average annual growth rate equal to 3.8%, from 6 Mtoe in 2000 to about 11 Mtoe in 2024. It falls by 5% in 2020 and grow by 8% in 2021 due to an economic recovery plan put in place to combat the "Covid-19" pandemic.

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**Figure 3. Evolution of Energy Production and Consumption in Tunisia (2000–2024)**




**Source: Enedeta**

While energy supply is increasing at a slow rate, consumption of energy is increasing at a greater rate because of high growth rates of population and economy. Rapid development of renewable energy systems is required in Tunisia in order to meet future energy needs and to reduce dependence on oil.

### 3.2 Current Status of Renewable Energy in Tunisia

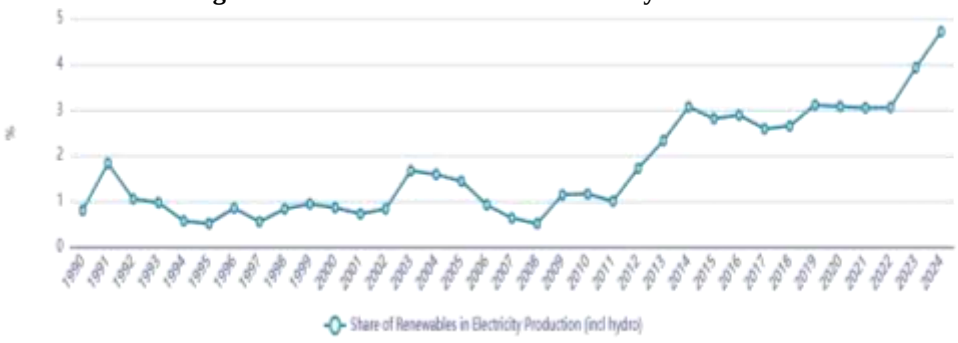
The sector of renewable energy in Tunisia case is growing slowly, in relative terms, when compared with several other emerging countries in the MENA region. Lack of efficient regulation and/or policies and inadequate private sector financing are cited as barriers to the development of renewable energy sources, in tandem with the region's dependence on hydrocarbons.

In addition, even if Tunisia has good solar and wind resources, the country has so far limited capacity to innovate in its energy sector, a factor that may also hinder the development of renewables. Finally, the inefficient pricing practices also pose a barrier to increasing the share of renewable energy.

According to the latest figures, renewable energy represents today around 5–6% of the electricity production in Tunisia, in 2025 (International Renewable Energy Agency, 2023; Tunisian National Energy Observatory, 2024). The share of fossil energy, mostly natural gas, is still dominant in the energy mix in Tunisia and dependency to energy sources is still existing.

Solar energy represents the greater proportion of renewable energy resources that are used actually for electricity generation process, in preference to wind energy and hydro energy, although their percentages are marginal. medium-term energy sector strategy for 2035 (2023) aims to increase the generation of renewable electricity to 8,530 MW by 2035, including setting a target of 4,850 MW for 2030.

**Fig4. Tunisia Renewable in % Electricity Production**




**Source: Tunisia energy report Enedeta**

Although renewable energy still represents a limited share of Tunisia's energy mix, Tunisian authorities has made significant strides in developing solar energy from the decentralized sector. According to the National Energy Observatory (2024), the installed rooftop photovoltaic capacity in Tunisia country had reached approximately 400 MW by the end of 2025. This exponential increase in rooftop solar power capacity, points to the fast-growing decentralized sector in Tunisia's energy strategy.

Recent Scopus empirical research aims to shed light on the dynamics of this process. Indeed, energy policy and renewable energy published few empirical researches which analyze the reasons behind the low pace of the development of renewable energy sector in Tunisia. For instance, Saadaoui & Chtourou (2023) identified the renewable energy potential of Tunisia and elaborated the obstacles which are facing the transition to renewable energy that still impede the full exploitation of this sector due to the uncertainty of energy policies. This positive correlation between renewable energy resources and their uses use was also proven by Adebayo et al. (2024) in the case of Tunisia. The barriers to the use of renewable energy in this country are essentially institutional and financial, while the policies currently in force do not encourage enough investment in this field. In addition, Chibani and Henchiri (2025) proved that the lack of green finance and the lack of effectiveness of the regulatory incentives for supporting renewable energy projects hinder the process of renewable energy investment in Tunisia.

Solar PV potential varies between DREs, with MENA generally enjoying the highest shares, while South Asia tends to have the lowest. Intra-regional comparative analysis points to large divergences in each country's ability to develop solar energy, with Tunisia displaying lower capacity than Morocco even though the two countries possess similar solar resource endowments. In addition to the technology and related cost developments, the overall policy, governance and investment environment will influence the outcomes of the energy transformation.

**3.3 Renewable Energy Potential in Tunisia**

Tunisia, African emerging country located in the north of the continent, offers many advantages to the development of renewable energy due to geographical and climate conditions. Therefore, this country can develop its:

- High solar irradiation levels across most regions
- Strong wind resources, particularly in coastal and southern areas
- Large desert areas suitable for solar power plants

From an international energy perspective, the studies calculate that the solar potential in Tunisia is about 320 GW, which is much higher than current needs for electricity in the country.

This huge potential gives Tunisia many opportunities to become a green energy production hub in the region and to be a key player in the production of green hydrogen in the long term.

**3.4 National Renewable Energy Strategy**

Energy security, high dependence on imported fossil fuels as well as the ratification of the Paris Agreement on Climate Change have recently motivated the Tunisian government to develop an energy strategy plan that shall promote the rapid development and integration of renewable energy systems in Tunisia. This Tunisian strategy shall revise the energy mix and minimize GHG emissions toward a sustainable future for Tunisia economy and its new generations.

The energy policy in Tunisia which we propose hereafter is mainly based on the Tunisian Solar Plan (PST) which was developed for the first time in 2009 and modified and improved in 2015.

The aim of this plan is to ensure through a concrete implementation the transition towards a new energy policy for Tunisia by bringing renewable energies, in particular solar photovoltaic, wind and concentrated solar power, into the large-scale electricity production sector of the Tunisian electricity system.

This NDC implementation strategy is framed in line with Tunisia's Nationally Determined Contributions (NDCs), which are centered around the reduction of global carbon emissions while promoting sustainable development and green growth.

To operationalize and concretize these strategic objectives, Table 2 identifies key targets for Tunisia's national energy strategy including new generation capacities to be built, emissions reduction targets and timeline for implementation.

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**Table 2. Key Targets of the Tunisian Energy Strategy**

| Indicator | Target |
|---|---|
| Renewable share of electricity | 35% by 2030 |
| Renewable installed capacity | > 4 GW |
| Solar energy capacity | ~1,510 MW |
| Wind energy capacity | ~1,755 MW |
| Concentrated solar power | ~450 MW |

**Source: National Energy Strategy Reports; recent energy transition analyses**

Clean Energy Research Targets for Tunisia These research targets have been derived for Tunisia based on an advanced low carbon development plan as well as the outcomes of an international research project. Scopus publications confirm the potential of Tunisia in renewable energy, with high levels of solar irradiation (≈3000 hours/year) and good wind resources, positioning Tunisia as a hub for renewable energy in North Africa.

Research published in Energy Strategy Reviews demonstrates that at the regional level, implementing solar and wind energies at a large scale across MENA countries, including Tunisia, is technically and economically feasible with levelized costs ranging between 40–53 €/MWh.

As well as this, several further scientific analyses have been carried out to assess the role of new technologies such as concentrated solar power (CSP) and hybrid systems in terms of the reliability of the power supply and their overall efficiency in terms of life cycle emissions. For example, the life cycle assessment (LCA) of a CSP–biomass hybrid plant found overall life cycle emissions to be in the range of 22–77 $gCO_2$-eq/kWh. The study therefore concludes that CSP–biomass hybrid plants can also be an option for Tunisia's energy future.

Tunisia renewable energy strategy objectives go further than energy generation. They aim also to endow the young economy with a vision and strategy for reaching net-zero emissions by 2050, energy independence, sustainable economic growth and competitiveness. The transition is also expected to:

- Reduce reliance on imported natural gas
- Stimulate private sector investment through public–private partnerships
- Enable emerging sectors such as green hydrogen production

International organizations such as the World Bank consider that a renewable energy capacity of 35% of electricity production in 2030 could amount to a significant contribution to Tunisia's pledged reductions as well as a significant reform of the energy sector.

### 3.6 Structural Barriers to Renewable Energy Transition in Tunisia

Although important steps have been made in terms of renewable energy (RE) deployment and policy-making, Tunisia is still characterized by a large number of structural and institutional barriers hindering the energy transition process. These barriers are identified in the literature and correspond to the national energy transition challenges faced by developing countries. The energy sector in Tunisia is highly reliant on fossil fuels with natural gas constituting the main fuel for the country's electricity production. There is little room for the growth of renewables and the sector is highly vulnerable to price and supply issues in the oil and gas market. A large number of empirical studies have been published in Energy Policy and Energy Strategy Reviews to identify possible lock-in barriers hindering the reduction of fossil fuel consumption in North African countries. The Empirical results confirm the presence of lock-in effects due to existing infrastructures, subsidies and long-term purchasing contracts that act as an obstacle to a reduction in the use of fossil fuel in North Africa. Results are demonstrated on an illustrative example concerning the case of Tunisia, where ancient energy structures still constitute an obstacle for the future implantation of large renewable energy systems.

- **Energy Import Dependency and Economic Vulnerability**

With approximately a proportion of 85% the natural gas being imported from outside the country, Tunisia economy is extremely exposed to foreign gas price volatility, for this matter the energy security represent a very important goal for the country deciders. Tunisia has a high dependence on a limited number of external sources with a heavy bias in direction towards Algeria. The World Bank and the International Energy Agency have stated that the increasing level

of energy import dependence is adding to the fiscal burdens of subsidies and worsening the balance of payments. This points out the great importance from the macroeconomic point of view of the need to speed up the development of renewable energy at the domestic level.

- **Investment Constraints and Financing Gaps**

The Solar and wind energy could be key clean energy technologies to drive towards sustainable development in Tunisia. Large-scale projects require large investment which is still a challenge for Tunisia. Moreover, access to long term financial resources is also insufficient, and high perceived risks along with underdeveloped financial markets are additional hurdles in realizing such projects. A very large study published in peer reviewed international and locally indexed journals identifies exchange rate volatilities, regulatory risks and non-bankability of renewable energy projects as one of the key challenges to clean energy financing in developing countries. There has been much effort by some institutions such as the African Development Bank and the European Investment Bank trying to accelerate clean energy financing in last years. Mobilizing private debt finance however is still a major challenge.

- **Administrative and Regulatory Barriers**

Tunisia country has made a very strong and continuous evolution in recent years towards streamlining regulations, including the passage of a law on renewable energy in 2015. Nevertheless, persistence of obstacles such as bureaucratic bottleneck, complex procedures, regulatory uncertainty, and administrative fragmentation hampers potential investors. Regulatory stability and transparency are among the few determinants that influence investment flows towards renewable energy. Regulatory stability and transparency are determinants of investment in renewable energy. In Tunisia country lack of stability and transparency of laws and regulations and administrative bottleneck to issue permits and authorizations prevent reaching the goals of renewable energy production.

- **Infrastructure and Grid Integration Limitations**

Energy production from intermittent renewable sources such as solar and wind power requires the extension of the grid infrastructure including transport, storage and reserve capacity. The Tunisian network has some technical limitations which do not allow it to absorb renewable energy production. IRENA highlights the urgent need of modernization and digitalization to rich higher shares of renewable energy. Sessions will also address smart grid, energy storage, and regional interconnection. The conference will showcase innovative approaches to ensure a reliable and flexible energy supply and demand system. While the energy transition in Tunisia comes with significant structural challenges, the process has to be socially acceptable, technically efficient and economically manageable. This will require a whole range of different views and a multi-scale approach, and thus a policy that considers all the different aspects involved at different scales.

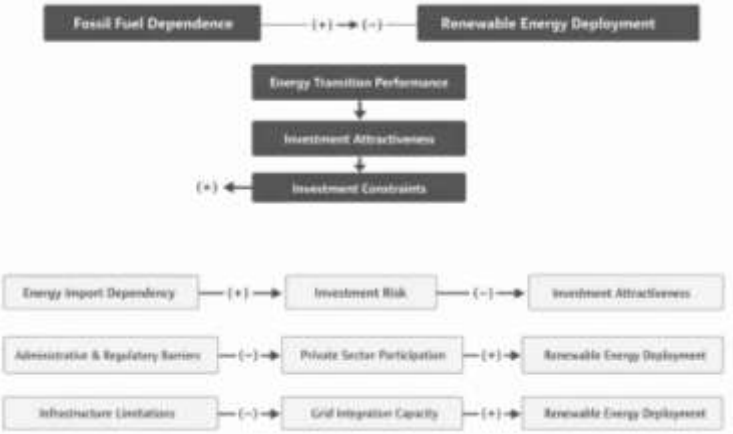
- for small- and medium-scale enterprises, farmers and rural households.
- a long-term perspective with the intention of maximizing global energy access.
- Gradual transition away from fossil fuels towards a renewable energy future.

The case of Tunisia allows us, from a scientific perspective, to illustrate the complex relationships between governance, financial mechanisms and technological elements that occur in the context of energy transitions. In fact, the literature explains that the overcoming of the barriers facing the energy sector is a fundamental condition to achieve the national energy saving objectives, as well as to adhere to the international climate obligations resulting from the Paris Agreement.

Within this analytical framework, Fig. 5. Structural barriers to renewable energy transition in Tunisia, illustrates the different structural barriers and links between them in order to have a global vision of the structural determinants hindering the energy transition process in Tunisia.

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**Figure 5. Structural Barriers to Renewable Energy Transition in Tunisia**




**Source: Created by the author**

These graphs illustrate the multiple barriers to energy transition, and how they interact through institutions, finance, technology, and infrastructure. However, penetration of renewables is limited by the existence of fossil fuel lock-in and rigidity of the grid. Currently, regulatory and financial barriers including a lack of long term finance to support integration are impeding investment as uncertainty prevails. Small businesses face a number of obstacles and these need to be addressed through a systemic approach on the part of policies currently. Taking a good governance approach, incorporating financial innovation and upgrading infrastructure are some of the key elements that need to be combined in order to help these enterprises.

### 3.7 Role of Renewable Energy in Advancing Sustainable Development in Tunisia

The use of renewable energy instead of the classic energy sources is the most important element to achieve sustainable development in Tunisia country, affected by environmental, energy and economic constraints. The change to consumption patterns based on renewable energy to accomplish the goals of sustainable development offers very large benefits.

- **Environmental Sustainability and Emissions Reduction**

Projects based on renewable energy have the potential to reduce CO2 emission. In Tunisia economy energy sector heavily relies on fossil fuels polluting the atmosphere with high levels of CO2 emission. The use of other forms of energy (wind and solar energy) contributes significantly on mitigation of the effects of climate change. as well as the reduction of local air pollution. Renewable energy can reduce global energy-related CO2 emissions by approximately 70% by the end of 2050 (IRENA, 2022). Switching to renewable energy form is strictly imperative to fulfill the commitments announced by Tunisian deciders in the Paris Agreement.

- **Energy Security and Reduced Import Dependency**

Short-term projections suggest that Tunisia will be increasingly reliant on energy imports which is likely to be exposed to external price shocks and supply disruptions. Long-term development of renewable energy resources will improve energy security by allowing the country to take advantage of the use of clean domestic energy resources, the predominant forms of which are solar and wind energy. As indicated in the World Bank report (2021:111), countries that invest in their renewable energy sectors will significantly reduce their exposure to global fuel market price shocks. Redressing the energy balance and achieving a higher level of energy independence in the long term, in a context of a rapidly growing demand, remain a major challenge for Tunisia.

- **Economic Resilience and Job Creation**

Renewable energy has the potential to support growth and jobs. Investments in renewable energy projects – including infrastructure such as grids and storage – as well as manufacturing, installation and maintenance will generate new jobs for people at all levels. The sector could create 24.3 million green jobs globally by 2030 (ILO, 2018). In Tunisia, the scaling up of renewable energy activities will contribute to the development of the economy of local sectors and will reduce unemployment, therefore, they can be a vector for inclusive economic growth.

- **Technological Innovation and Industrial Development**

The development of renewable energy has always led to new inventions and capacity building. In this context, it becomes essential for Tunisia to carry out more investment in the field of research, development, and technology

transfer with a view to consolidating the innovation system at the national level. The country should consider cooperation with foreign countries and the implementation of modern energy solutions, including the creation of a smart grid, and energy storage systems in order to optimize the efficiency of the energy system. As stated in the annual report by the International Energy Agency (IEA, 2023), global innovation in clean energy technologies will be required to support the timely realization of the transition to cleaner, efficient, and competitive energy systems and to accelerate the energy transition in emerging markets.

- **Integrated Impact on Sustainable Development**

The approach has the advantage of addressing several goals simultaneously: reducing greenhouse gases, enhancing energy security, creating new jobs and stimulating new technologies for sustainable development of Tunisia. Improving energy efficiency and increasing development of renewable energy resources in Tunisia will help to reduce energy subsidies, improve the balance of trade, reducing carbon emissions and contributing to long term sustainable development.

## 4. RESULTS AND DISCUSSION

This section presents the main findings of the study regarding the role of renewable energy and environmental policies in supporting the transition toward a green economy in Tunisia.

### 4.1 Limited Contribution of Renewable Energy

Despite repeated warnings about the environment and calls for increased renewable energy, a new empirical study finds fuel-poor Tunisia will continue to run on oil well into 2025, with natural gas powering 94-97 per cent of the country's power, while renewables will account for less than 5-6 per cent. The penetration of solar energy in Tunisia is presently low due to imbalances in the national energy system resulting from a long history of fossil fuel subsidies as well as the national energy mix's dependence on imports. In contrast, renewable energy represents more than 20% of Morocco's power mix, surpassing that of Tunisia. Although the challenge appears more than financial, institutional and policy-wise, this also is in line with other studies which stress the relevance of good governance quality and a sound investment climate in the context of renewable energy projects.

### 4.2 Strong Renewable Energy Potential

Although renewable energy sources have so far played a marginal role in Tunisia's energy balance, there is huge potential waiting to be developed, primarily solar and wind energy. While the center and the higher plateaus of the country receive every year more than 2000-3000 hours of solar irradiation, the coastal regions and the south of Tunisia have wind corridors which are suitable for big wind farm projects. The total theoretical solar potential of Tunisia is calculated to about 300 GW and is clearly several times higher than the actual energy requirements. Tunisia thus has excellent prerequisites to become a net energy exporter and a regional energy hub, provided the suitable framework conditions and investments are put in place. Renewable energy resources are massive but their potential is not translating into installed capacity due to a variety of financial, infrastructure and regulatory barriers. While resources are abundant, effective instruments for their implementation are missing.

### 4.3 Effectiveness and Limitations of Environmental Policies:

The Tunisian government has developed planning tools like the Tunisian Solar Plan and the so called Nationally Determined Contributions (NDCs) aiming for 35 % renewable energy up to 2030, as well as substantial reductions of Green House Gas emissions until 2035. While many of the currently used instruments like emissions trading schemes, renewable energy targets, carbon pricing, free allocation, carbon offsetting schemes, nuclear power, low emission zones, green certificates and clean development mechanisms correspond to several of the key international climate change goals, there is a large implementation gap concerning their environmental impact. Weak enforcement mechanisms Administrative Fragmentation Insufficient financial mobilization Delays in project execution The way policies are conceptualized is advanced, yet their poor application remains a major hurdle.

### 4.4 Major Structural Barriers

The energy transition in Tunisia is blocked by a set of interlinked structural barriers affecting deployment of renewable energy across institutional, financial, technical and infrastructure segments. The existing energy planning and decision-making institutions are fragmented across energy, investment, and environmental sectors. These institutions are furthermore constrained by financial barriers related to high upfront costs, limited fiscal space, and perceived

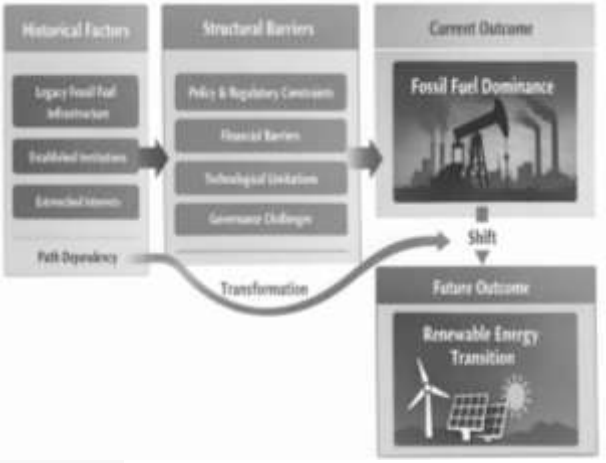
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investment risks impeding access to long-term finance for renewable energy projects. The existing grid segment faces technical barriers linked to lack of energy storage facilities and smart grid systems required to manage and integrate solar and wind power into the electricity grid. The Tunisian energy sector is also impacted by continued fossil fuel lock-in related to long-term contracts, fossil fuel consumption subsidies, and existing fossil fuel-based infrastructure. The energy transition in Tunisia thus is not limited to the energy sector, but requires a holistic transformation of governance, finance, and technology systems.

This, they argue, supports the path dependency theory that existing energy infrastructure can 'lock' countries into a fossil fuel-based development path, even when cheaper and cleaner renewable energy alternatives are available.

While Figure 2 provides a framework for understanding the energy transition based on existing literature, Figure 5 offers a causal interpretation of empirical results and illustrates the ways in which structural barriers and path dependence shape the energy transition in Tunisia.

**Figure 6. Energy Transition Causal Model in Tunisia**




**Source: created by the author**

### 4.5 Economic and Environmental Implications

Developing renewable energy in Tunisia opens new avenues of environmental, economic and social opportunities and benefits. Firstly, renewable energy can significantly reduce greenhouse gases emissions and improve air quality enhancing thus Tunisia's international commitment to the fight against climate change. Secondly, pursuit of renewable energy will help the country to achieve energy autonomy and reduce vulnerability to petroleum products price volatility on the global market with further positive implications for macroeconomic stability. Finally, renewable energy can generate employment in the installation, maintenance and manufacturing sectors, as well as in other sustainable environmental-friendly services contributing thus to sustainable growth and development. Realizing these opportunities requires the removal of some structural barriers that obstruct energy transition mainly related to efficiency of governance and access to green finance.

### 4.6 Overall Assessment

Tunisian decision makers are losing out from the transition to a green economy, although they have set ambitious renewable energy targets and possess numerous opportunities, a report reveals. The transition process can be described as an emerging but constrained energy transformation, not yet sufficient to alter the national energy structure. Energy transition in Tunisia will not be based on the availability of resources but on:

- Institutional reform
- Investment mobilization
- Grid modernization
- Policy consistency

The findings are consistent with theoretical work on energy transitions in developing economies and highlight the quality of energy governance as the primary determinant for successful transitions, potentially outweighing other critical factors.

## 5. CONCLUSION

While a study on the role of renewable energy and environmental policies has shown that policies and strategic plans are effective, the transition to a green economy in Tunisia is in its infants' stage, because the share of renewable energy in the energy mix is low, contrasted with the huge potential for renewable energy particularly solar and wind energy. Although national goals in this regards are ambitious (35% renewable electricity by 2030) and politically-well supported, they face institutional, financial, and structural barriers.

Environmental policy in Tunisia is aligned with the global standard as encapsulated in the Paris Agreement but lacks effective implementation, transparency, and government coordination, thus impeding efforts to achieve sustainable environmental outcomes a boost economic performance. In order to lower greenhouse gas emissions, enhance energy security, and diversify Tunisia economy, he country has vast untapped potential for increased use of renewable energy. Harnessing decentralized solar energy and promoting clean hydrogen could position Tunisia at the forefront of the region's clean energy sector.

The shift to a green economy will thus necessitate greater political ambition, i.e. better access to financing, strengthening of institutional capacity, as well as successful implementation. The difference between the level of ambition of policies and outcomes will continue to exist until these basic issues are addressed. Tunisia has a possible roadmap towards sustainable development through the shift to a green economy. It will be achieved only through the translation of the strategic vison into actual action on the social, economic and environmental levels.

## 6. POLICY RECOMMENDATIONS

This study informs policy makers with an assessment of the investment needs to achieve a green economy in Tunisia, and uses the findings to develop a set of integrated policy recommendations to support a transition to a green economy.

### 6.1 Strengthening Regulatory and Institutional Frameworks

The same bureaucratic obstacles that slow the process of obtaining authorization to build conventional power generation plants in Tunisia, seem to also be hampering the development of renewable energy initiatives. Simplification of procedures for investment as well as the guarantee of stability and transparency of regulations over a long term are additional requirements for making the investment procedures faster and more trusting. An independent regulatory body could also play a decisive role in supervising activities of renewable energy markets, ensuring fair competition and consistency of decisions. Stronger coordination is also needed among institutions in charge of energy, environment and investment policies to avoid duplication of procedures, reduce time losses and achieve a coherent vision to support Tunisia's shift to a green economy.

### 6.2 Scaling Up Green Financing Mechanisms

Tunisia country should seek alternative sources of funding, including innovative financing tools such as green bonds and climate funds. The country should also make use of blended finance and strengthen its cooperation with the World Bank and regional development banks and financial organization. The government should extend greater fiscal incentives to the private sector in order to encourage it to finance and develop Renewable Energy Projects through tax breaks, subsidies and guarantees. Building on PPPs to channel massive investments to energy infrastructure and moving towards a Green Economy without overburdening the treasury.

### 6.3 Investing in Energy Infrastructure and Technology

Developing Tunisia's aging power grid to admit greater shares of renewable energy and energy efficiency measures will require significant investment in smart grid, energy storage, and digital energy management systems. Moreover, Tunisia needs to enhance its R&D capabilities and reinforce collaborations between universities, research centers and international stakeholders in order to produce local know-how related to renewable energy. It is equally important to promote technology transfer and local manufacturing of renewable energy components by reducing dependence on imports and cutting down manufacturing costs. The sector is expected to also create new job opportunities in Tunisia's green economy.

### 6.4 Promoting Energy Diversification and Innovation

Tunisia should quickly start solar and wind energy projects, mostly in areas with great potential to develop electricity generated from clean energy in order to minimize its dependence on fossil fuels. The country has to also support the emerging activities of the sector of green hydrogen, with prospects for exports to the Middle East and Europe and creating important added value to boost its development. Increasing decentralized energy systems, including rooftop solar, can promote universal energy access, boost energy independence, and ease the pressure on the grid. Tunisia also needs to promote ecosystems of innovative startups and spin-offs of clean technologies and access to finance and technical assistance for scaling up solutions for a Sustainable Future, through innovative approaches and thinking in order to reach a green economy more quickly.

### 6.5 Enhancing Human Capital and Public Awareness

Education and vocational training in Tunisia should also focus on preparing the qualified labor needed to develop renewable energy and green technology. In addition to equipping public institutions with technical and managerial skills required to design, implement and follow up environmental and energy policies and strategies, there is a need to raise public awareness about energy efficiency in daily life and in businesses as well as communities. Community involvement in designing renewable energy projects is essential in order to gain public trust and acceptance. The outcome will be positive and beneficial for citizens in economic and environmental terms.

### 6.6 Integrating Climate and Economic Policies

Integrating energy strategies within the broader economic and industrial strategy is essential for Tunisia Climate objectives need to be integrated in national development plan and reflected in public budgeting. Moreover, monitoring and evaluation systems must be strengthened to better assess the development of renewable energy and sustainability, identify constrains and improve policy effectiveness. Tunisia could also look into regional cooperation opportunities in North Africa as well as opportunities for cooperation with European countries in order to move toward energy integration and offer access to large markets, in addition to new investment and exports of clean energy opportunities.

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