

## Renewable Energy Policy; Assessing the Impact of Renewable Energy Policy on Solar Energy Development in Morocco

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### ABSTRACT

This study examines Morocco's renewable energy policy framework, focusing on the country's contribution to the growth of solar energy initiatives, notably the Noor Solar Complex. As a promising market in the Sahara region, the Moroccan economy has witnessed huge investments over the past decades due to its favorable regulations, incentives, and international partnerships, enabling large-scale solar investments. With national energy strategies, these policies are focused on reducing fossil fuel dependency and increasing renewable energy's share in the national energy grid. The study's main aim is to analyze the effectiveness of these policies in meeting national energy targets, explore the challenges in infrastructure and financing, and assess the potential. Renewable energy policies and the efforts have contributed to energy security, job creation, and economic diversification leading to the strengthening of the local economy. Further, Morocco's position among the top African economies in the renewable energy sector presents valuable insights for other developing economies interested in sustainable energy transitions. This study also examines the lessons from Morocco's success in addressing policy adaptability, economic viability, and sustainable growth. As a result of this study, it was revealed that Morocco has made great progress in achieving its national targets in renewable energy production. This analysis presents a framework that can guide similar projects in Africa and beyond, highlighting renewable energy as a roadmap for economic growth and environmental sustainability.

**Keywords:** Renewable Energy, Solar Energy, Policy

**JEL Code:** Q28, Q42, Q48

## 1. Introduction

The energy sector is a vital element, in its performance conditions, that of the rest of the economy, and the well-being of society. Indeed, it is the key factor of economic and social development. The supply of energy (all forms combined), and in the best conditions (continuity, quality, price) drives the productivity and competitiveness of companies and social balance. On the other hand, the energy deficit and the sector's fragility will have an opposite impact. (Laroussi & Bouayad 2020).

Morocco's energy deficit prompted it to adopt an energy plan to minimize dependence on conventional energy, reduce the energy bill and budget deficit, and eliminate the trade deficit. (Laroussi & Bouayad 2020).

The government of Morocco took steps to realize the set goals through policy formation and implementation. The country has been at the forefront of the energy transition in the last decade. This was illustrated through the ambitious climate pledges presented in COP16 in Paris and Glasgow in COP21, which are among the most ambitious globally, with the establishment of a 52% renewable energy target for 2030, and the launching of the world's largest Concentrated Solar Power (CSP) plant. (Fragkos 2023).

Morocco's abundant sunshine, low humidity and large tracts of unused land near road networks and power lines make it an ideal place for solar energy in general and for concentrated solar power plants in particular. Morocco launched its most ambitious solar program, the Solar Plan Initiative aiming to enhance the nation's energy security by diversifying the energy mix, promoting productivity and competitiveness in the energy sector, protecting the environment, and consolidating cooperation with the EU. This \$9bn initiative included the installation of 2000 MW in five sites by 2020. These sites were the 500 MW Ouarzazate, the 400 MW plant next to Ain Beni Mathar, a 500 MW plant in Foum Al Oud, a 500 MW plant in Boujdour, and a 100 MW plant in Sebkhat Tah. (Bahgat 2013).

The objective of the Noor-Ouarzazate Concentrated Solar Power Plant Project for Morocco is to increase installed capacity (megawatts) and electricity output (megawatt-hours), especially during peak hours, of the Noor-Ouarzazate Solar Complex. (World Bank 2024)

The national energy strategy in Morocco, focusing on improving energy efficiency, became the most important national concern, making Morocco one of the most ambitious countries in the world in terms of promoting sustainable development. Consequently, Morocco has been the center of significant investments in energy efficiency, mainly due to the high availability of energy resources. (El Iysaouy et al 2019).

The Solar Plan Initiative's main challenges in its earlier stages included the shortage of indigenous professionals and skilled laborers and funding uncertainties. However, the country's power interconnections and integration within the EU energy space made it possible to attract investment and provide opportunities for the project's growth. (Bahgat 2013).

This study examines Morocco's renewable energy policy framework, focusing on the country's contribution to the growth of solar energy initiatives, notably the Noor Solar Complex. This project was chosen as a reference because of its importance in Morocco's renewable energy landscape and its success from its implementation stages to its current state.

## 2. Literature Review

This section provides an understanding of the renewable energy policies and their impacts on solar energy development as it reviews key studies from existing literature as follows.

Fragkos's (2023) study on assessing the energy system impacts of Morocco's nationally determined contribution and low-emission pathways analyzed the energy system, emission, and cost impacts of meeting Morocco's targets for 2030 and assessed long-term Paris-compatible strategies. In the study, he used a sophisticated country-level energy system model to analyze various scenarios with different climate policy settings. The analysis showed that the policies in

Morocco need significant strengthening to meet the targets outlined in its Nationally Determined Contribution for 2030. Fragkos also provided insights on the challenges to achieving deep decarbonization of the Moroccan economy and the opportunities from energy sector restructuring like the reduction of fossil fuel imports and boosting clean investment.

Lu et al. (2020), in their study, *A Critical Review of Sustainable Energy Policy for the Promotion of Renewable Energy Sources*, present a review of sustainable energy policy for the promotion of renewable energy by introducing the development history of energy policy in the United States, Germany, the United Kingdom, Denmark, and China. From this study, it is observed that an energy-efficiency standard is one of the most popular strategies for building energy saving, which is dynamic and renewed based on the current available technologies.

Šimelytė (2020) *Promotion of renewable energy in Morocco* study analyzed the problems of renewable and fossil-based energy consumption, emphasizing the promotion of renewable energy technologies. The article focused on the obstacles and barriers to implementing renewable energy promotion plans in Morocco revealing that Morocco faced a lack of financing sources and the risk of implementing small projects, social-economic problems, a lack of transparency, and lobbyism.

El Iysaouy et al. (2019) in their study on energy efficiency, case of Morocco, presented the then state and outlook of energy efficiency in the transport, residential, and industrial sectors, as well as its policy for each sector in Morocco. The study also reviewed and discussed new strategies implemented by the government for sustainable development. As a result of the study it was reported that the country had achieved energy efficiency in transport, residential, and industrial sectors, and emphasized that the swift transition to energy efficiency was the main challenge for the Moroccan government.

Usman and Amegroud (2019) conducted a study to draw lessons from power sector reforms with a focus on Morocco. The study analyzed Morocco's experience with power sector reforms from 1990 to 2017. It described the chronological timeline of reform, examined the sector's performance along the security of supply, electricity access and affordability, utility efficiency and financial viability, and tariffs, and cost recovery. As a result of the study, the lessons for developing countries from Morocco's experience included an incremental approach that can be pursued in an environment where legacy entities can obstruct sudden, radical, and 'big-bang' reforms. Second, institutional arrangements in Morocco are different from those prescribed by the 1990s power sector reform model, but perform the necessary functions in practice, and third, the ability to pursue socio-economic objectives in the power sector is contingent on having a strong and growing economy.

In their study, Choukri & Hayani (2017) found that Morocco has implemented an important energy strategy that supports the country's transition to renewable energy and energy efficiency that generalizes across all consumer sectors of the economy (housing, transport, industry). The study also points out that government and public institutions that were created to accompany Morocco's energy vision are committed to driving the development of projects in the priority areas of renewable energy and energy efficiency. Further, the study highlights some of the barriers that the country still needs to deal with as barriers related to the policy, financial, and technical frameworks.

Moore (2017) conducted a study evaluating the energy security of electricity interdependence with perspectives from Morocco. He argued for utilizing a multidimensional energy security framework for evaluating electricity integration by evaluating perceptions of the energy security for shallow and deep electricity integration in Morocco. He concluded with policy recommendations that technological integration should have a strong political foundation, policymakers should distinguish between dependence and interdependence and prioritize the latter, and, decision-makers should approach energy security, human security, and sustainable development as inseparable challenges, given the urgency of climate change, pollution, and energy poverty challenges.

Kousksou et al. (2015) studied Renewable energy potential and national policy directions for sustainable development in Morocco. The study presented the potential of renewable energy and the progress of the national strategy to pursue low-carbon opportunities in Morocco. The study revealed the country had achieved significant progress and taken various measures to manage long-term energy security, to facilitate the sustainable development of renewable energies (RE) and energy efficiency (EE) throughout the country. The study also highlighted the possible barriers that could retard the growth of RE and EE implementation as financial, technical, regulatory/institutional, and information/educational barriers suggesting that they should be addressed for feasible development in Morocco.

Steinbacher (2015) addressed policy transfer between Germany and Morocco in the field of renewable energy. In his study, he explores what principles and policies diffused through channels established between Germany and Morocco and concentrates on how Morocco's policy objectives shaped the result of this transfer process. Findings showed that differing objectives did not preclude transfer, but shaped its outcome concerning instrument selection.

Ghezloun and Oucher (2014) in their study of Energy policy in the context of sustainable development found that Morocco gives priority to the development of renewable energy and sustainable development. In addition, Morocco has considerable potential in wind energy with the regulatory frameworks that promote investment in this sector. They recommended that to reduce the electric deficit and the energy dependence, Morocco must engage itself in vast wind energy programs, for the provisioning of electricity, to accompany the development of renewable energies and energy efficiency in the country.

Hashim and Ho (2011) studied renewable energy policies and initiatives for a sustainable energy future in Malaysia. The study assessed the progress and achievement of renewable energy over the past 10 years and discussed the key policies for renewable energy programs, funding, schemes, and incentives that the government of Malaysia has introduced to develop and promote the utilization of renewable energy. The recent renewable energy mechanisms under the Tenth Malaysia Plan (2011–2015) were also highlighted.

### **3. Approach and Analysis**

This study focuses on implementation, challenges, and successes to assess policy effectiveness in Morocco. The data collected and analyzed include policies, energy output data, and the project's economic impact.

#### **3.1. Policies, Strategies and Implementation**

Moroccan authorities formulated various policies, strategies, and laws for an efficient transition into renewable energy sources, to combat the challenge of satisfying energy requirements in its most suitable form, especially with the population and economic growth that causes a sharp increase in energy demand. (Kousksou et al., 2015). These policies have led to the country scaling up its energy production levels.

“Dahir” (Royal Decree) 1-16-60 of 17 Shaaban 1437 (24 May 2016). Enacting Law 48-15 related to regulating the electricity sector and creating the national electricity regulation authority. (Benbba et al., 2024). Law no.13-09 promulgated on 11 February 2010 by Dahir (Royal Decree) 1-10-16, dated 26 Safar AH 1431, corresponding to 11 February 2010 (B.O. No. 5822 of 18 March 2010), allowed for the opening of the generation to competition, access to the electricity grid, the export of green electricity, and the construction of a direct line for export. Law no. 57-09 created the Moroccan Agency for Solar Energy (MASEN) setting out a specific framework for solar projects (January 14, 2010). MASEN became the most important actor in the Moroccan solar energy sector working as an independent body. Law no. 47-09 relating to energy efficiency dated 29 September 2011, aimed to increase the efficiency of energy resource consumption, reduce energy costs on the national economy, and contribute to sustainable development. Law no. 16-09 created the National Agency for the Promotion of Renewable Energy and Energy Conservation (ADEREE) (January 13, 2010). This law defined the reorganization and renaming of the existing

Center for the Development of Renewable Energy (CDER). The ADEREE is primarily active in the Corporate Energy Efficiency Program. The Public-Private Partnerships (PPPs) law. This was strongly inspired by the French Ordinance of 17 June 2004 on PPPs; it also followed the approach used by the UK Private Finance Initiative experience. The government also formulated national strategies aimed at energy security and low-carbon growth. This led to the formation of the National Energy Strategy (NES) of Morocco, launched in 2009, and the National Plan of Priority Actions (PNAP). (Kousksou et al., 2015). NES's four principal objectives were to strengthen the security of supply, generalize access to energy at competitive prices, control demand, and, lastly, preserve the environment. (Benbba et al., 2024).

With these legal reforms, reinforcement was a key step in the realization of the goals, thus the government formed institutions charged with this vital responsibility. The Office National de l'Electricité et de l'Eau Potable (ONEE) is in charge of the production, transportation, and distribution of electricity. The Institute for Research in Solar Energy and New Energies (IRESEN) plays a key role in research-related policies. A fully government-owned fund, Fond de Développement de l'Energie (FDE) was also set up to assist Morocco in its efforts to increase energy security and reduce its vulnerability to oil price shocks. The Ministry of Energy, Mines, Water, and Environment (MEMEE) was charged with the coordination duties to ensure all the funds and the institutions were operating in harmony. The government also consolidated other funds including the Société d'Investissements Energétiques (SIE) investment fund and the Clean Technology Fund (CTF). These funds provided support for an institutional transformation creating a lasting funding mechanism that significantly increased investment strategy to enhance energy security. (Kousksou et al., 2015).

### **3.2. Challenges and Successes**

Morocco and the Middle East and North Africa (MENA) region in general experience the pressing demand to accelerate the energy transition due to the urgent need to mitigate the impacts of climate change, ensure energy security, and comply with international objectives. These challenges include financial, technological, institutional, and legal barriers. (Benbba et al., 2024). The complex interaction between formal institutions, legal and policy frameworks, and informal institutions in Morocco are some of the challenges witnessed in the project. (Wael et al., 2024). Additionally, The Middle East and North Africa (MENA) region has low electricity prices and high subsidies for fossil fuels, which worsen profitability issues. Furthermore, RE projects require significant initial investments and are subject to various risks, including political and regulatory uncertainties. As a result, commercial banks and private investors hesitate to finance these projects. (Benbba et al., 2024).

Similarly, Šimelyte, 2019 conducted a detailed study on the obstacles in the Moroccan energy sector. The study found that terms of financing, institutional coordination, technical capacity, and social acceptance were some of the challenges the government faced. She also identified various barriers influencing decision-making relating to investments in the renewable energy sector, unclear energy policy, and the high level of taxation.

Further, Technological and Industrial barriers are still hindering the growth of the project. There are weak industrial base in Morocco for solar energy systems. For example PV modules, BOS, solar water heaters, concentrators, and monitoring systems. In addition, the absence of additional sources of flexibility in the national electric power system like supply and demand-side management, smart grids, and cross-sector coupling through the development of power-to-X poses a big challenge. Moreover, the lack of government incentives and subsidies for RE systems like PV, and water heating, and the slow implementation of regulations are some of the political barriers to the project. (Benbba et al., 2024)

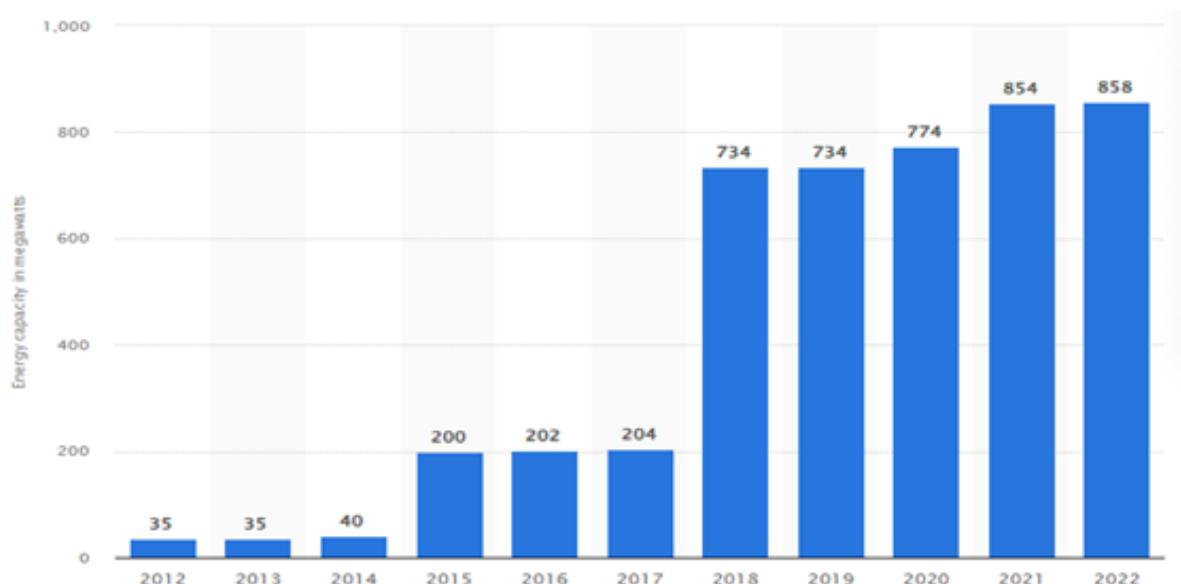
Despite these challenges, Morocco has implemented measures to attract private investments and ensure adequate financing for RE projects. As a notable success in the project, the government managed to disintegrate the electricity sector. Nowadays, Morocco's electricity market has a hybrid structure, combining a regulated market dominated by ONEE, independent

power producers (IPPs), and MASEN's public-private partnerships, with an open market welcoming RE producers and self-generators. The various public and private players are involved in activities such as generation, transmission, and distribution to meet electricity needs. (Benbba et al., 2024)

Building experience from the last two decades, Morocco is committed to giving new impetus to the energy transition and playing a vital role in the fight against global warming and the resulting climate changes in Africa. The country revised and submitted its Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change in June 2021. It also has the potential to be a role model in decarbonized energy production and, as such, expand its experience to neighboring markets. In addition, Morocco aspires to become a world leader in new clean technologies, including green hydrogen. (Benbba et al., 2024)

### 3.3. Outcome and Economic Impacts

The policies and the strategies employed by Morocco have led to increased electricity production and an overall increase in the national grid. In addition, the percentage of solar electricity generation has seen an increase over the years and is still expected to rise in the coming years as shown in figure 1 below. The National Energy Strategy (NES), which focused on large-scale projects considering Concentrating solar-thermal power systems (CSP) as the first choice, the new forecasts express the kingdom's orientation toward more PV (15% by 2030) against CSP (9% by 2030) through projects at various scales. (Benbba et al., 2024).



Source: Statista Research Department, May 2, 2024.

**Figure 1. Solar energy capacity in Morocco from 2012 to 2022(in megawatts)**

The National Energy Strategies have led to increased economic impacts on the Moroccan economy. Among the economic impacts, include infrastructure developments. The World Bank-funded projects to improve urban transport efficiency, through better governance and increased infrastructure energy performance. (Kousksou et al., 2015). The policies have also led to the creation of more job opportunities in the economy, as more solar energy industries have been set up. These industries engage in the production of Solar Energy products serving the local market in Morocco and the MENA region. Additionally, there is improved energy security in Morocco because of the increase in the production of renewable energy, which also reduces the dependence on non-renewable sources of energy like fossil fuels popular in the MENA region. Further, Morocco has witnessed improved economic diversification with an increased involvement of the private sector in the production and process of scaling up renewable energy production levels.

According to a report done by the World Bank (2018) on the Noor-Ouarzazate complex, early results had great impacts; it had generated 160 MW capacity, impacted 347,780 direct beneficiaries, reduced greenhouse gases by 254,800 MT, and contributed to the scale-up of CSP technology and subsequent verified reductions in the technology's costs.

#### **4. Observations**

From this study, it can be inferred that Morocco has made great steps toward its goal of achieving energy security and reducing its dependence on non-renewable sources of energy. These have been achieved with great efforts employed by the government and the private sector parties involved. Among the reasons for the success, include strategic national strategies like the National Energy Strategy (NES) of Morocco, launched in 2009, and the National Plan of Priority Actions (PNAP), which were key in goal realization. Also, the country formulated favorable legal reforms that led to the amendment of previous laws, the introduction of new laws and by-laws, and the formulation of favorable policies, both playing a vital role in the transition process. Additionally, the formation of institutions like MASEN, ADEREE, and IRESEN played a key role in the implementation of the projects, providing essential expertise and guidance to the process. These institutions also ensured effective coordination of the various policies and links between the key parties involved in the transition process. Moreover, funding was an integral part of the project. The government was able to mobilize adequate funding for the projects, setting aside funds and creating investment funds like SIE and CTF. These provided the needed capital to finance the projects as the initial capital was a significant amount. Further, the Government involved the parties in the private sector and had partnerships with organizations like the WBO, EU, and MENA, which played vital roles in the transition process.

However, there has been a slow implementation of regulations due to political and technological barriers, and the absence of rules for small/medium-scale RE, particularly solar energy e.g., access to low-voltage public grids. (Benbba et al., 2024).

#### **5. Conclusion and recommendations**

With national energy strategies focused on reducing fossil fuel dependency and increasing renewable energy's share in the national energy grid, Morocco has made great progress in achieving its national targets in renewable energy production and general economic growth. The country has witnessed increased infrastructure development, local economic growth, and energy security.

Improving institutional and regulatory frameworks can overcome the barriers to solar energy development in Morocco. In addition, enacting the National Electricity Regulatory Authority and effective coordination between the different players in this field (ONEE, MASEN, and the Ministry of Energy and Mines) will accelerate the implementation of the transition. (Benbba et al., 2024).

Other policies that can be implemented to overcome the existing barriers and speed up the race toward the goals are as follows. The provision of subsidies on solar energy products and prices to the consumers in the local market to encourage more consumption of solar energy, and more investment in solar energy research-related projects to provide more expertise needed and improve the weakness areas. Additionally, the government should conduct regular reviews and monitoring of the policies and the strategies put in place to ensure they remain relevant to the constantly changing needs of the market and the environment. This can also help to increase the pace of policy implementation. Moreover, increased funds mobilization and allocation towards the RE sector can boost investments in solar energy production and overall energy security. This can stimulate economic growth, create new jobs, and become a pillar for the development of manufacturing and service industries.

This study is expected to provide helpful information to researchers and policymakers in renewable energy-related fields. It presents well-designed and implemented ideas that have resulted in tremendous success.

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