European Journal of Sustainable Development Research
2027, 11(1), em0449
e-ISSN: 2542-4742
https://www.ejosdr.com/

MODESTUM

Research Article **OPEN ACCESS**

Energy transition, economic growth and foreign direct investment: Pathways to unemployment reduction in Morocco

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Citation: Badi, A., Effina, D., Badi, A., Biad, S., & ElMorabet, S. (2027). Energy transition, economic growth and foreign direct investment: Pathways to unemployment reduction in Morocco. *European Journal of Sustainable Development Research, 11*(1), em0449. https://doi.org/10.29333/ejosdr/20004

ARTICLE INFO

Received: 30 Jun. 2026

Accepted: 07 Sep. 2026

ABSTRACT

This article examines the impact of renewable energy, economic growth, and investment development on employment in Morocco using the ARDL (Autoregressive Distributed Lag) model, based on data covering the period from 1990 to 2022. The conclusions of these estimates reveal that, in the short term, the lags of GDP and Investment have a positive impact on employment. Meanwhile, the integration of renewable energy production has no significant impact on green job creation. This can be explained by the need for at least three years of highly qualified human capital and for the implementation of structural reforms to meet the demands of this production. However, in the long term, a 1% increase in GDP and in installed renewable energy capacity contribute, respectively, to increases 0.07% and 0.29% in urban employment in Morocco. Moreover, a 1% increase in investment is associated with a 0.02% decrease in employment. This should prompt the Moroccan government to strengthen public policies aimed at promoting renewable energy and implement supporting measures to maximize the socioeconomic benefits of this energy transition.

Keywords: GDP, error-correction, renewable energy, error correction model, employed labor force, FDI, ARDL

INTRODUCTION

Renewable energy (RE) plays a crucial role in the global energy transition, providing solutions to the climate and economic challenges of our time. In Morocco, its development is part of an ambitious national strategy to meet growing energy needs while reducing dependence on imported fossil fuels. This transition is driven by several objectives: diversifying energy sources, reducing energy bills, strengthening energy independence, and reducing the country's unemployment rate. These economic, environmental, and social challenges make renewable energy an essential lever for sustainable and inclusive development.

Morocco possesses considerable potential in RE, particularly thanks to its abundant solar and wind resources. Recognizing this asset, the country launched an ambitious National Energy Strategy in 2009, based on four objectives and five strategic directions (National Electricity Regulatory Authority, 2022). These objectives revolve around strengthening energy security and availability in order to radically transform the country's energy mix. The goal is to increase the share of renewable energy to 52% of installed capacity by 2030, split between solar (20%), wind (20%), and hydroelectric power (12%), and to 60% by 2035 (International Energy Agency, 2023). Flagship projects such as the Noor solar complex in Ouarzazate, one of the largest in the world, and the wind farms in Tarfaya and Tangier demonstrate this commitment. These infrastructure projects are accompanied by institutional reforms and massive investments aimed at encouraging public-private partnerships and attracting international financing.

In this context, renewable energy is not limited to its environmental or energy roles but also serves as an important driver of job creation. This link between renewable energy and employment is particularly evident in the concept of green jobs, which refers to positions that contribute to the preservation or restoration of the environment. According to the International Labour Organization (ILO), "The transition to a green economy could generate up to 24 million additional jobs globally by 2030" (International Labour Organization, 2018). In Morocco, green jobs occupy an important place in public policies, with initiatives such as the "Green Jobs" program, which promotes training and retraining in renewable

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energy sectors. Despite these efforts, the country faces structural employment challenges, with the employment rate hovering around 42–43% of the working-age population.

The share of installed renewable energy capacity in the energy mix, which represented approximately 38% in 2022, raises questions about its real impact on the economy and employment. Historically, the development of renewable energy has shown significant potential for economic transformation. Investments in this sector stimulate not only the creation of direct jobs in infrastructure construction, installation, and maintenance but also indirect jobs across local value chains.

The emerging question is therefore: What is the impact of the increase in installed renewable energy capacity on employment trends in Morocco? Understanding this relationship is essential for assessing the economic benefits of the energy transition and for guiding public policies to maximize those benefits.

From this standpoint, this article examines the link between installed renewable energy capacity and urban job creation in Morocco through several axes. First, it provides an overview of relevant prior theories and studies on the link between renewable energy production through installed capacity and the creation of green jobs through the progressive increase in the employed population in urban areas. Second, it highlights the evolution of the strategies, policies, and action plans established by the Moroccan government to increase installed renewable energy capacity and boost employment. Third, it presents the hypotheses, conceptual framework, and limitations of the ARDL econometric model. Fourth, it discusses the empirical results obtained. The objective is to provide a thorough analysis of the economic impacts of the energy transition and to help guide public policies to maximize the socio-economic benefits of renewable energy. Finally, the article presents the policy implications of the energy transition and the main conclusions of the paper.

LITERATURE REVIEW

The relationship between energy transition and unemployment reduction is of interest to many researchers and theorists. Some argue that the shift to renewable energy is not directly responsible for a reduction in the unemployment rate. Others suggest that economic and social gains only appear in the medium and long term.

The relationship between the energy transition and unemployment reduction is of interest to many researchers and theorists. Some argue that the shift to renewable energy is not directly responsible for a reduction in the unemployment rate. Others suggest that economic and social gains only appear in the medium and long term.

In this regard, several studies have used input-output models to examine the relationship between energy transition and unemployment.

Wei et al. (2010) conclude, for the United States of America, that the transition to green energy and the achievement of energy efficiency generate significantly more jobs for each unit of production compared with coal and gas. They also suggest that solar photovoltaic energy is the most job-creating of all renewable energy sources.

Tourkolias and Mirasgedis (2011), by integrating the dimensions of direct, indirect, and induced employment into input-output models, examine the relationship between renewables and job creation in Greece. They show that massive investment in renewable energy leads to greater social gains in terms of job creation than investment in fossil fuels. This finding is highly dependent on national procurement and production policies.

Markandya et al. (2016), using a sample of European Union countries, propose a multi-regional input-output model for the period 1995–2009 and conclude that low-carbon technologies create direct and indirect jobs. This finding is highly dependent on factors related to imports, value chains, and substitution effects between different economic sectors.

Garrett-Peltier (2017), using an input-output model combining energy efficiency, renewable energy, and fossil fuel components for the United States, concludes that, in the short and medium term, a shift in investment toward renewable energy or energy efficiency results in greater job creation than investment in fossil fuels.

Černý et al. (2021), using long-term scenarios extending to 2050 for European Union countries, suggest that massive capital investments can increase labor demand. This outcome depends on the type of renewable energy and the region considered when directing investments.

This research suggests that investments in renewable energy throughout the entire production value chain generate more jobs than investments in fossil fuels. However, the authors mention the concept of job sustainability, both directly and indirectly. Indeed, construction-related jobs are temporary and end after the infrastructure installation period. In contrast, maintenance-related jobs are more sustainable in the medium term.

Other macroeconomic research addresses the link between the elements discussed in our article. This research relies on panel data analysis using appropriate macroeconomic variables and econometric models. It suggests that the results are heterogeneous across countries, thereby explaining the varying levels of development in the renewable energy sector.

Apergis and Salim (2015), studying 80 countries between 1990 and 2013, conclude that, in some countries, the transition to renewable energy reduces unemployment. However, this result is not universal, which explains the differences in renewable energy consumption and production levels between countries.

Khodeir (2016), using the ARDL model for Egypt between 1980 and 2013, estimates that renewable energy, through its impact on electricity production, has a negative effect on long-term unemployment. This finding highlights the need to direct investments and public policies toward a sector that does not currently occupy a major place in the Egyptian economy.

Similarly, Ibrahiem and Sameh (2020), using the ARDL and VECM models for the period 1971–2014, suggest that renewable energy has a negative effect on long-term unemployment.

Khobai et al. (2020) present the same result as Khodeir (2016) and Ibrahiem and Sameh (2020), using the ARDL method for South Africa over the period from 1990 to 2014 and demonstrating that African countries are in the process of introducing renewable energy sectors to address the unemployment crisis.

Yılancı et al. (2020), using a sample of 10 countries, suggest that the relationship between renewables and unemployment differs across the sample. Indeed, in some countries in the sample, renewable energy undermines efforts to reduce unemployment, while in others, it has a positive effect.

Azretbergenova et al. (2021), using the ARDL model for European Union countries, suggest that, in the long term, renewable energy production has a positive impact on job creation.

El Moummy et al. (2021), using a vector autoregressive (VAR) model for Morocco, demonstrate a potential link between unemployment reduction and the widespread adoption of renewable energy.

Omarova et al. (2025), using data from eight developed countries between 2000 and 2024, suggest a negative relationship between renewable energy consumption and unemployment. Specifically, they estimate that a 1% increase in green energy consumption leads to a 0.52% decrease in unemployment. The results of this research indicate that renewable energy production or consumption can reduce unemployment and create jobs only in certain cases. Such unemployment reduction and job creation cannot be achieved unless renewable energy production or consumption is associated with countries possessing adequate infrastructure, a skilled workforce, and targeted public policies.

Another part of the literature addresses energy systems as sources of externalities related to environmental preservation, socioeconomic development, and technological development.

In the case of solar energy, photovoltaic systems are highly dependent on climatic conditions, which can influence the profitability of energy production and the intensity of maintenance requirements. This observation highlights the importance of adopting climate and environmental strategies (Allahrabbi Shirazi et al., 2026a, 2026b).

The development of renewable energy is considered a double-edged sword. On the one hand, the use of photovoltaic panels supports environmental protection by reducing pressure on resources and limiting evaporation. It promotes socioeconomic development through job creation and local wealth generation. However, this development can adversely affect aquaculture and biodiversity and increase corrosion, necessitating appropriate environmental strategies to mitigate these impacts (Allahrabbi Shirazi, 2024).

Furthermore, the water-energy nexus is directly linked to the sustainability of energy systems. Indeed, with low energy consumption, decentralized water supply is possible through fog water harvesting. Developments in materials, biomimetic design, nanotechnology, and artificial intelligence can improve this supply system (Allahrabbi Shirazi et al., 2026a, 2026b).

Moreover, the use of the ISO 50001 standard enables systematic management of energy consumption and the monitoring and improvement of energy performance (Ebrahimizaker et al., 2026).

The use of forecasting models also enables the estimation of relationships among economic development, climate change, and social variables, thereby providing better guidance for energy and environmental decisions and policies. For example, results from East and West Asia have demonstrated the value of using such predictive models (Moezzi et al., 2026).

More broadly, the use of artificial intelligence and machine learning technologies is considered essential for efficiency, energy forecasting, maintenance, troubleshooting, resilience, and optimization of the water-energy nexus. However, the use of these forecasting techniques raises cybersecurity concerns, affects data quality, and complicates the translation of forecast results into real-world applications (Saifoddin et al., 2026).

This wealth of literature shows notable progress in addressing such issues. It suggests that achieving economic, social, and environmental progress depends heavily on the direction of energy and environmental policies, the integration of new technologies, and the attractiveness of sector-related investments. The empirical literature is rich in findings and conclusions. Indeed, most research finds that investments in renewable energy create more jobs than investments in fossil fuels, since renewables require a workforce for installation, construction, and maintenance. From a macroeconomic perspective, some studies are consistent with the economic logic that renewable energy reduces unemployment. Others, however, show that the impact of this relationship is neither significant nor favorable.

This literature does, however, acknowledge some limitations. Indeed, some authors consider foreign direct investment (FDI) to be green investment. Yet, it would be appropriate to consider all such investments, as they can serve as an asset for decarbonizing sectors that rely on fossil fuels and are major emitters of greenhouse gases. Furthermore, research focusing on Morocco as a developing country does not include all the dimensions necessary to explain the relationship between the energy transition and unemployment reduction.

In this context, our article addresses this limitation by examining the relationship between renewable energy and unemployment, as well as other macroeconomic variables in Morocco, using the ARDL model to capture both short- and long-term relationships over the period from 1990 to 2022.

EVOLUTION OF ENERGY POLICY IN MOROCCO

This section addresses the constraints related to the evolution of energy policy in Morocco, completed and ongoing projects, the strategies adopted by the country, and its long-term energy transition objectives. Furthermore, it explores energy efficiency and its application in Morocco. Finally, we will identify the consequences of high energy dependence and the solutions planned to reduce it.

Energy Strategies and Projects in Morocco

To achieve its energy efficiency goals, Morocco has adopted several energy strategies to improve its economic situation, encourage investment, and reduce unemployment.

In the wake of the 2008 financial crisis, Morocco recognized the energy-related challenges that affected its trade balance and increased its budget deficit. Indeed, Morocco is dependent on fossil fuel imports, which accounted for 90.4% of its total in 2021, according to the Ministry of Energy Transition and Sustainable Development (METSD). However, this increased dependence has contributed to achieving a significant rate of rural electrification in Morocco, and the country is targeting an ambitious energy dependency rate of 40% by 2035, according to its National Sustainable Development Strategy (NSDS) 2035.

Morocco's National Energy Strategy (NES), adopted in 2009, aims to improve the security, availability, and affordability of the energy supply by leveraging renewable energy resources. This strategy revolves around the large-scale production of green energy, meeting high energy demand through energy efficiency, and advanced regionalization through the generalization of energy access across the Kingdom’s 12 regions.

In addition, the National Sustainable Development Strategy (NSDS) has set ambitious targets for the energy transition, namely a share of renewable energy in installed capacity of more than 52% by 2030, divided into 20% solar, 20% wind, and 12% hydropower, and a share of 60% by 2035.

Based on estimates from the International Energy Agency (IEA), to reach the target of 52% renewable energy capacity by 2030, the country needs to mobilize 10 GW—4.56 GW of solar, 4.2 GW of wind, and 1.33 GW of hydroelectric power—between 2018 and 2030 (International Energy Agency, 2019).

According to the Ministry of Energy Transition and Sustainable Development, Morocco reached 5.44 GW of installed renewable energy capacity in 2024, representing more than 50% of the IEA’s 10 GW target (National Electricity Regulatory Authority, 2025). This demonstrates the country's commitment to achieving its energy objectives amid rising energy demand, industrialization, urbanization, and the digital transition.

In this context, Morocco launched the Moroccan Solar Plan and the Moroccan Wind Power Program, which demonstrate its ambition to pursue a green transition.

Several projects have been launched in various renewable energy sectors. To promote the wind sector, the Moroccan Agency for Sustainable Energy (MASEN) launched the Midelt-PEI project, with a capacity of 210 MW; the Taza-PEI Phase 1 project, with a capacity of 87 MW; and the Koudia Al Baida repowering project in Tetouan, with an installed capacity of 100 MW (Ministry of Energy Transition and Sustainable Development, n.d.-a, n.d.-b, n.d.-c, n.d.-d; Moroccan Agency for Sustainable Energy, 2023). In the hydropower sector, the Abdelmoumen pumped-storage power station in Taroudant was launched with a capacity of 350 MW. In the solar sector, the Noor Midelt I power plant was launched with an installed capacity of 800 MW.

With the current acceleration of projects, Morocco is well positioned not only to successfully complete its energy transition but also to become an international leader in the field of renewable energy.

Application of Energy Efficiency in Morocco

In a context marked by the adverse effects of climate change, Morocco recognizes that fossil fuels accounted for 80% of its electricity mix in 2020. This observation demonstrates that the Moroccan economy requires significant decarbonization, a reduction in the share of coal in the energy mix, which stands at approximately 66%, and substantial efforts to decouple economic growth from greenhouse gas emissions in the long term (Badi & Effina, 2026).

According to Morocco's Long-Term Low-Carbon Strategy, the country envisages a decarbonization trajectory toward 2050, with renewable energy potentially accounting for 80% of its electricity mix, both in terms of generation and installed capacity (Ministry of Energy Transition and Sustainable Development, 2021).

Furthermore, the National Strategy for Energy Efficiency 2030 (NSEE) aims to achieve energy savings of 20% by 2030 (Ministry of Energy Transition and Sustainable Development, 2020). It targets the transport, industry, buildings, and public lighting sectors.

This strategy is therefore a major lever for reducing the country’s fossil fuel imports and lowering its energy bill. In other words, reducing energy consumption also contributes to reducing fossil fuel imports.

Consequences and Solutions of Energy Dependence

Morocco, like any other developing country seeking to accelerate industrialization and boost economic growth amid regional and continental competition, remains dependent on fossil fuel imports.

In terms of cost, the latest figures from the Exchange Office for 2024 indicate that energy imports amounted to 113.8 billion dirhams (MMDH), representing 15% of total imports, compared with 122.0 billion dirhams in 2023 (Office des Changes, 2025). This represents an absolute decrease of 8.2 billion dirhams. Despite this decrease, Morocco still faces an energy trade deficit of 108.7 billion dirhams in 2024, exposing the country to international price shocks, higher production costs, and fragile energy security.

The adoption of renewable energy and energy-efficiency measures can significantly reduce energy dependence. To achieve this goal, Morocco must invest further in renewable energy infrastructure, including the electricity grid, transmission systems, and storage capacity.

In this context, Morocco aims to invest 27 billion dirhams in the electricity grid between 2025 and 2030. This investment aims to strengthen networks and interconnections. For example, a 700 MW electricity interconnection project is planned with Spain, while a 1,000 MW interconnection project is planned with Portugal.

Morocco considers climate change a key component of sustainable development. Indeed, the effects of climate change are driving the country to further develop renewable energy sectors and reduce energy intensity and dependence in

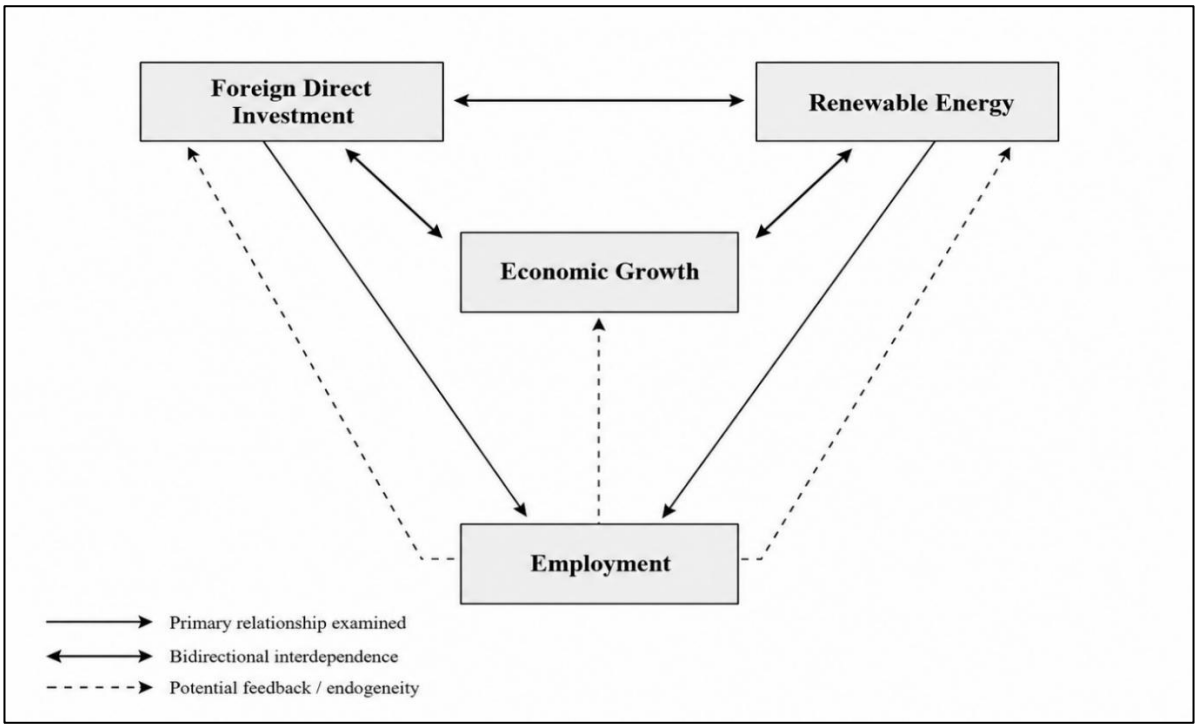


Figure 1. Conceptual framework of the different types of relationships between investment, renewable energy, economic growth, and employment (Source: Authors' own elaboration)

order to ensure energy security and a sustainable environment for future generations.

METHODOLOGY

To better understand the relationships among the selected variables, we propose a conceptual framework that illustrates the interactions among installed renewable energy capacity, gross domestic product, foreign direct investment, and urban employment (See **Figure 1**).

Indeed, the link between the aforementioned variables discussed in this paper is the subject of several empirical studies. This relationship goes beyond a simple econometric framework and encompasses a macroeconomic relationship in which several factors interact. More specifically, according to endogenous growth theory, investment, technology, and human capital are factors that promote and sustain long-term production. Clearly, we observe the role of foreign direct investment in creating economic wealth through the transfer of skills (human capital) and innovation (technology). However, we can also consider the possibility of an inverse relationship. In fact, the competitiveness and attractiveness of investments increase in economies characterized by competition (Borensztein et al., 1998; Dunning, 1988; Romer, 1990).

Thus, we can highlight the link between the energy transition, investment, and economic development. Indeed, green investments tend, both theoretically and empirically, to increase renewable energy production, thereby ensuring energy security by meeting energy demand amid urbanization and rapid population growth. All other things being equal, economic development also leads to increased energy consumption. This confirms the hypothesis presented in our literature review regarding the mutual influence between the energy transition and economic development (Apergis & Payne, 2010; Omri & Kahouli, 2014).

Employment, as a key variable in our paper, is largely linked to the other variables. Indeed, an increase in economic productivity is accompanied by an increase in human capital. This reflects Okun's relationship, according to which growth creates employment and vice versa (production–employment) (Okun, 1962). Furthermore, employment can be fostered by increased investment flows and the creation of new employment sectors. Similarly, the transition to renewable energy creates jobs in installation, maintenance, the construction of renewable energy production facilities, and throughout the renewable energy production value chain. However, it must be emphasized that this job creation depends on several factors, including countries' commitment to the transition, their production capacities, their progress in research and development, and the development of new skills (Bali Swain et al., 2022; Jude & Pop Silaghi, 2016).

However, it is crucial to emphasize a key point regarding the comprehensiveness of the variables, the conceptual framework addressing our research question, and the relationships presented above. Indeed, other variables can also contribute to reducing unemployment. These variables include demographics, as increased population growth can cause disruptions in the labor market, while increased renewable energy production is accompanied by an increase in the number of employers responsible for this production throughout the value chain; education, through the development of new specializations and skills, as well as research and development, which allow the workforce to adapt to the demands of an evolving labor market; inflation, through changes in production costs and wages, which can affect companies' recruitment decisions; and technology, as

technological progress can lead to the destruction or creation of certain jobs. From this perspective, our article focuses on pathways to reduce unemployment in Morocco, rather than on its complete elimination, using a limited selection of explanatory variables.

Variables and Data

The choice of the study period was not random, as the global economy has undergone historically significant developments in the energy and environmental sectors. Two main phases can therefore be identified. The first followed the period of oil shocks between the 1970s and the late 1990s. The Kyoto Protocol was subsequently adopted in 1997 at the Third Conference of the Parties (COP3) for environmental reasons, to alert states to the harmful consequences of greenhouse gas emissions from fossil fuels and to contribute to creating a sustainable world for future generations. The second phase, which remains a major topic and began in the 2000s, aims to transform countries' energy policies toward a green energy transition. From a climate perspective, it primarily promotes the reduction of greenhouse gas emissions by integrating the concept of sustainable development, particularly in the countries that emit the most greenhouse gases. From a socioeconomic perspective, it promotes the creation of green jobs, which represents a major issue and the subject of this paper.

The selected study period is therefore consistent with the chronology of developments in the global economy in relation to economic growth, energy, and the environment. It also captures the evolution of employment in the energy sector. The data used for the EMPLOYMENT and ENERGY variables are national data obtained from the Moroccan High Commission for Planning (HCP), covering the period from 1990 to 2022 (High Commission for Planning, n.d.-a, n.d.-b).

The data for the INV and GDP variables come from the World Bank and cover the same period (1990–2022) (World Bank, n.d.-a, n.d.-b). The variables used to address this issue are:

- **EMPLOYMENT:** The number of employed persons aged 15 years and over in urban areas;
- **ENERGY:** Installed renewable energy capacity in kilowatts;
- **GDP:** Gross domestic product in current USD;
- **INV:** Foreign direct investment, net inflows in current USD (total FDI and not only FDI in the energy sector).

The choice of variables was not random. On the one hand, there was a discussion about which indicator would best represent our dependent variable, EMPLOYMENT. The candidate indicators for this article were the unemployment rate, the number of employed persons aged 15 and over in urban areas, and the total number of employed persons aged 15 and over in urban and rural areas. Our selection focused on the number of employed persons aged 15 and over in urban areas. Indeed, the unemployment rate, which is the ratio of unemployed persons to the labor force, does not accurately capture the concept of unemployment in the context of our study. In other words, this rate can vary with the size of the total labor force, which can affect its accuracy and prevent it from reflecting the true impact in the analysis and predictions. Therefore, the indicator relating to the total employed population aged 15 and over in urban and rural areas was not selected because it encompasses two entirely different structures. In Morocco, the rural labor market generally depends on agriculture, which, in turn, is highly vulnerable to climatic hazards, including periods of drought. Therefore, during such periods and under various climatic conditions, rural workers employed in agricultural occupations may face unemployment. Consequently, the inclusion of the rural component could distort our dependent variable. Given these factors, the choice was made to use the number of employed urban workers aged 15 and over. This choice is justified by the exclusion of unemployment dynamics specific to rural areas and by the fact that the development of renewable energy relies on a workforce that is generally concentrated in urban areas.

Although this study focuses on urban employment, the energy transition can also reshape rural areas in several ways. Solar and wind projects are often located in sparsely populated regions, where they may affect land use, infrastructure, access to electricity, and the organization of local economic activities. Better access to energy can support services such as irrigation, water pumping, cold storage, and small-scale processing, which are particularly important for rural communities. At the same time, large renewable-energy projects may place pressure on agricultural or pastoral land, especially when local communities are not sufficiently involved in planning and decision-making. The benefits may also be uneven if local residents and businesses have limited access to training, procurement opportunities, infrastructure, or project revenues. For this reason, community consultation, transparent land-use arrangements, support for local suppliers, and fair benefit-sharing mechanisms are essential to ensure that rural areas benefit more fully from the energy transition. Since this study uses urban employment as the dependent variable, these broader rural effects are not directly captured by the model and should be explored in future research using regional or project-level data.

On the other hand, the choice of explanatory variables is related to the variable to be explained.

First, the ENERGY variable was chosen to capture the effect of the increase in installed renewable energy capacity on employment. This variable measures the stock of total installed renewable energy capacity, representing the cumulative renewable energy capacity available in an economy each year. The choice of this indicator is well justified and appropriate for the specifications of our long-term empirical model. Indeed, the available and operational renewable energy stock allows for the generation of economic and social gains in terms of wealth and employment, respectively, over a long-term horizon. This is of particular interest within the framework of our study, as we primarily seek to analyze the long-term relationships among our variables. In this context, the non-selection of the indicator related to renewable energy capacity flows, which represent annual additions resulting from individual projects, is also relevant. In fact, several projects may not become operational until later years, leading to inconsistencies and disparities in flow levels from one year to the next. Based on the above, we considered the variable related to the stock of renewable energy capacity more appropriate in the context of our study than the variable

related to the flow of additional capacity for estimating the cumulative and long-term relationship between the energy transition and employment.

Second, GDP was selected because it is a cross-cutting variable that contributes to wealth and job creation.

Third, the INV variable was included in the model because it represents the volume of investment across sectors, rather than investment in the energy sector alone. However, this is considered as a limitation. This choice was mainly due to the lack of consistent sector-level FDI data covering the full study period for Morocco. Therefore, total FDI includes investment in sectors that differ considerably in terms of labor intensity, technology, local sourcing, and job-creation potential, the estimated coefficient should be interpreted with caution. It reflects the relationship between overall FDI and urban employment rather than the specific employment effect of green investment. Further research could address this limitation for another country where data on FDI in the energy sector are available.

Stationarity Test

Before examining the potential relationships among the variables, it is necessary to test their stationarity. Since the analysis uses time-series data, it is important to determine whether the variables are stationary at level, I(0), or become stationary after first differencing, I(1). For this purpose, the Phillips–Perron (PP) test (Phillips & Perron, 1988) is used to determine the order of integration of the variables and identify the appropriate econometric model.

The interpretation of this test is based on the acceptance or rejection of the following two hypotheses:

H0: The null hypothesis states that the variable is non-stationary, i.e., the series has a unit root.

H1: The alternative hypothesis is that the variable is stationary, meaning that the series does not have a unit root.

The p-value of the PP test for each variable is compared with the 5% significance level, which is the threshold most commonly used. The null hypothesis, H_0, is rejected if the p-value of the PP test is less than 5%, leading to the conclusion that the time series is stationary. Conversely, if the p-value is greater than 5%, the null hypothesis cannot be rejected, and the time series is considered non-stationary. In this case, the time series is differenced to make it stationary, and the appropriate model is selected based on the results obtained.

Pesaran Bounds Test for cointegration or Bounds Test

Pesaran et al. (2001) proposed an approach based on the bounds test, which detects the presence or absence of a cointegration relationship among the variables under study and subsequently identifies potential short- and long-term relationships. The observed F-statistic from this test is compared with the two bounds of the theoretical F-statistic at significance levels of 1%, 5%, and 10%. According to the theory, three cases arise:

- If the obtained F-statistic is greater than the upper bound of the theoretical F-statistic at a given significance level, the existence of a long-term relationship among the variables can be concluded;
- If the obtained F-statistic is lower than the lower bound of the theoretical F statistic at a given significance level, it can be concluded that there is no long-term relationship among the variables;
- If the obtained F statistic lies between the lower and upper bounds of the theoretical F-statistic at a given significance level, the result is inconclusive.

Econometric Model

Several models can be used to examine economic relationships among variables, including the relationship discussed in this article. However, the key question is: What is the appropriate model for examining the relationship presented in this article? For this purpose, interpreting the results of the stationarity tests is particularly important when selecting the most appropriate model for our case study.

When the variables are integrated of the same order, in other words, when all the variables become stationary after first differencing, I(1), several models can be used to examine short- and long-term relationships. These include the Vector Error Correction Model (VECM), which uses the Johansen cointegration test to determine whether a long-term relationship exists among the variables. When the variables are integrated of different orders, for example, I(0) and I(1), the Autoregressive Distributed Lag (ARDL) model is particularly suitable. It is a flexible and robust econometric model for analyzing the dynamic relationships between a dependent variable and one or more independent variables. It is distinguished by its ability to examine short- and long-term relationships within a single modeling framework.

This model, which is flexible and suitable for small samples, assumes that the relationships among the variables are linear. However, it is not applicable if one or more variables are integrated at an order greater than one, that is, if they are integrated of order two, I(2).

It is also important to emphasize that the ARDL model and Pesaran's bounds test address cointegration rather than causality. Indeed, the cointegration test allows us to determine whether the variables included in the model evolve together in the long term. In contrast, the coefficients estimated using the ARDL model represent the short- and long-term relationships among the variables studied. Therefore, the term "relationship" used in this paper refers only to the interpretation of the empirical results and does not imply causality.

The model is then written in the following form:

$$\Delta \boldsymbol{y_t} = \boldsymbol{\alpha_0} + \sum_{i=1}^{p} \boldsymbol{\alpha_i} \Delta \boldsymbol{y_{t-i}} + \sum_{j=1}^{q} \boldsymbol{\lambda_j} \Delta \boldsymbol{x_{t-j}} + \boldsymbol{\beta_1} \boldsymbol{y_{t-1}} + \boldsymbol{\beta_2} \boldsymbol{x_{t-1}} + \boldsymbol{\varepsilon_t} \quad (1)$$

Defining the terms of Eq. (1), the first left-hand side of the equation $\sum_{i=1}^{n} \alpha_i \Delta y_{t-i} + \sum_{j=1}^{m} \lambda_j \Delta x_{t-j}$ represents the short-term (ST) relationship. While the right-hand side of the relationship $\beta_1 y_{t-1} + \beta_2 x_{t-1}$ represents the long-term (LT) relationship. Further explaining the different variables in this equation:

- y: denotes the dependent or explained variable;
- x: denotes the independent or explanatory variables;

Table 1. Descriptive analysis of variables

Variable	EMPLOYMENT	ENERGY	GDP	INV
Mean	4 819 523	1 992 074	81 134 082 687	1 679 444 215
Median	4 777 840	1 843 000	81 415 868 294	1 695 717 346
Maximum	6 432 800	4 671 600	144 417 103 250	3 544 387 229
Minimum	3 203 215	619 700	30 179 954 775	165 122 978
Skewness	0.1197406	0.77	0.06	0.12
Kurtosis	-1.09	-0.49	-1.63	-1.45
Coefficient of variation	0.19	0.56	0.47	0.65
Jarque-Bera	1.42	3.89	3.43	2.70
Probability	0.55	0.14	0.18	0.26
Observations	33	33	33	33

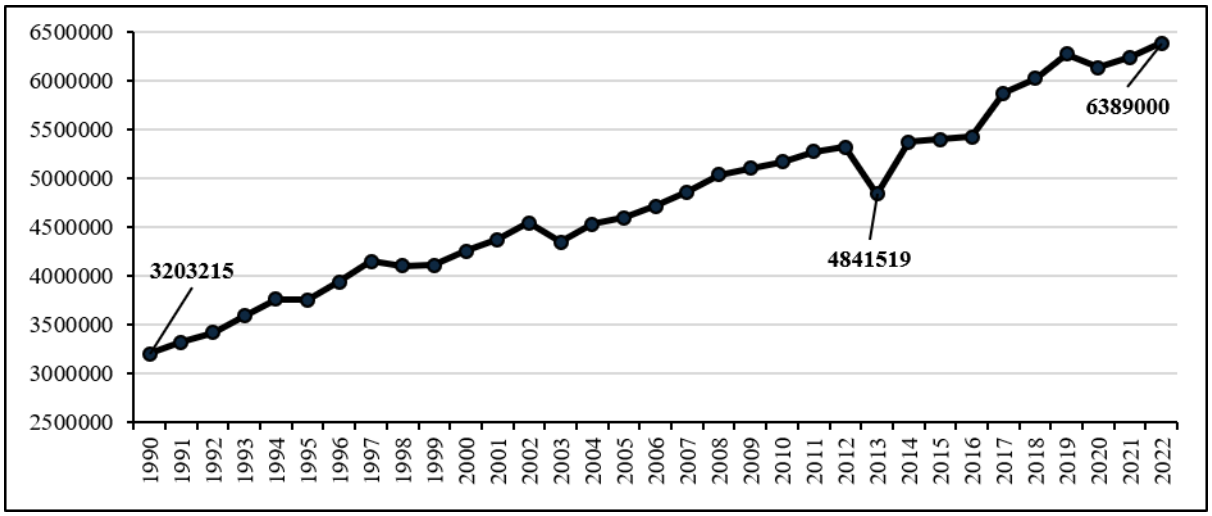


Figure 2. Number of employed urban labor force (Source: Authors' own elaboration)

- α_i *and* λ_i: are the ST coefficients;
- β_1 *and* β_2: are the LT coefficients of the ARDL;
- p *and* q : the respective lags of the variable to be explained and the explanatory variable(s) of the ARDL model;
- ε_t: the error term.

In parallel, the optimal lags p and q of the ARDL model are obtained using the AIC or BIC information criteria.

The ARDL Prediction Model

After obtaining the empirical results from our ARDL model, we estimate long-term projections using the ARDL prediction method. This method relies on the estimated coefficients, the lagged values of the dependent variable, and the lagged and current values of the independent variables to predict the dependent variable's future values. More specifically, the prediction of the dependent variable uses its autoregressive lags along other variables in the model. This involves a loop that is generated simultaneously with a one-year prediction and then used to make the following year's prediction. The outcome of these projections depends on the predicted values of the independent variables and is based on several fundamental assumptions:

- Stability of the estimated coefficients over the estimation period;
- The structure of the lags in the ARDL model is considered dynamic;
- Validity of the trajectories of the independent variables;
- Absence of major changes among the explanatory variables in the model;
- Zero error term and residuals of the model over the forecast horizon.

RESULTS AND DISCUSSIONS

Descriptive Statistics

Before proceeding with the econometric analysis, let us first present a statistical description of our selected variables (See **Table 1**).

The p-values from the Jarque-Bera test (Jarque & Bera, 1980) for both variables are well above 5%, indicating that the variables are normally distributed.

Evolution of the Variables

EMPLOYMENT: This variable refers to the number of employed in the urban labor force over the age of 15. According to the High Commission for Planning, this population includes all people aged 15 and over who contribute to the production of goods and services, even for a minimum of one hour, during a specific reference period. It also includes individuals with a regular job but temporarily absent due to an impediment. This concept encompasses a wide range of employment, including part-time, casual, or irregular work (See **Figure 2**).

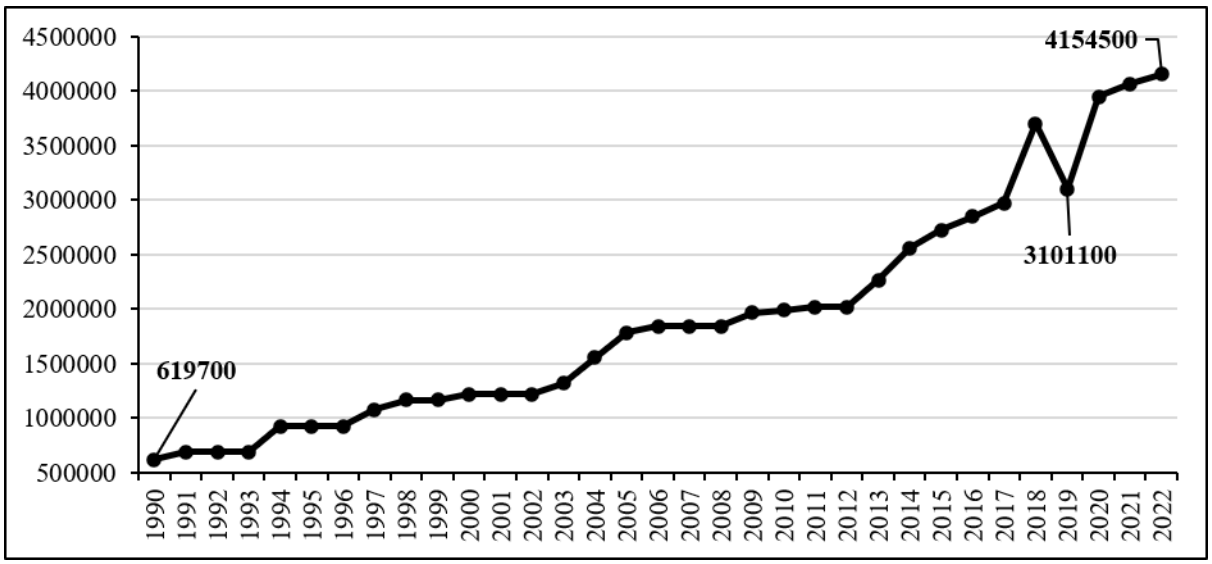


Figure 3. Installed renewable energy capacity in kW (Source: Authors' own elaboration, based on data from the High Commission for Planning (HCP, 1990-2022))

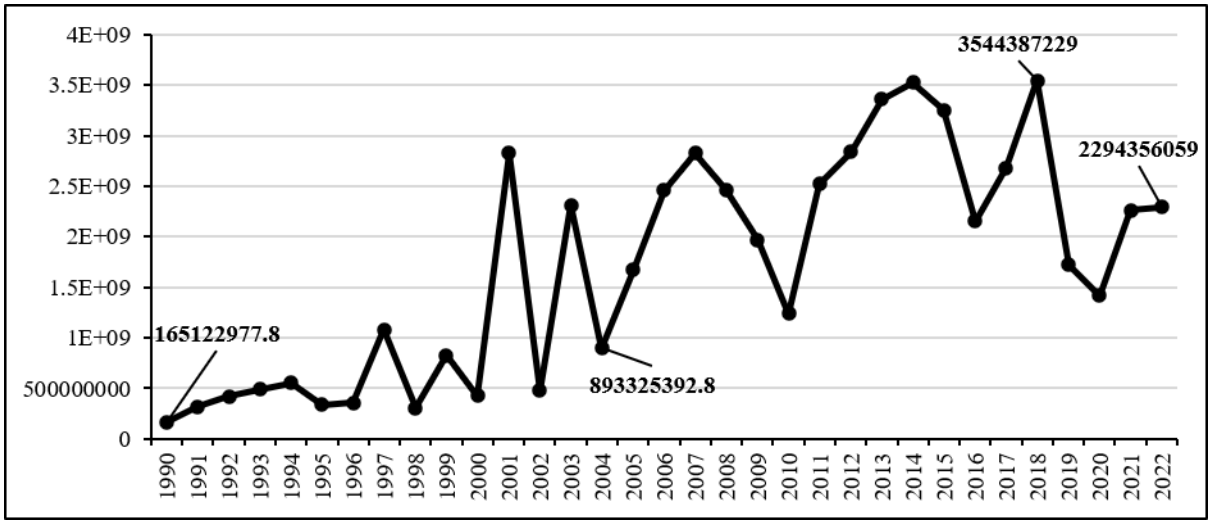


Figure 4. Foreign direct investment, net inflows in current USD (Source: Authors' own elaboration, based on World Bank Data, World Development Indicators, 1990-2022)

From 1990 to 2022, an overall upward trend is evident, indicating a steady increase in the number of employed people in urban areas. This growth appears linear, with periods of stagnation or slowdown.

More specifically, between 1990 and 2008, the employed population grew steadily, with no major disruptions. Between 2012 and 2014, a significant shock was observed, with a sharp decline in employment around 2013, followed by a rapid recovery. This could be attributed to national economic factors or policies that temporarily affected employment. Meanwhile, the period from 2019 to 2022 shows continued growth, with a slight slowdown in 2020 linked to the COVID-19 pandemic, followed by a sharp recovery.

ENERGY: Installed renewable energy capacity in kW is the production capacity of energy sources, including wind, solar, and green hydrogen (See **Figure 3**).

Between 1990 and 2003, installed renewable energy capacity remained below 1 500 000 kW. Beginning in 2012, rapid growth was observed, reflecting intensified efforts to increase installed renewable energy capacity. Capacity increased from 2,000,000 kW in 2012 to over 3,500,000 kW in 2018, marking a significant turning point.

A temporary drop was observed in 2019, with a notable decrease in installed capacity. This decline can be interpreted as a shock linked to the decline in green jobs. After the 2019 shock, installed capacity rebounded sharply, reaching a historic peak of 4,300,000 kW in 2022. This phase indicates a vigorous recovery in investment and an acceleration of renewable infrastructure projects.

INVESTMENT: According to the World Bank, "Foreign direct investment is the net inflow of investment to acquire a lasting interest (10% or more of the voting shares) in a firm operating in an economy other than that of the investor. It is the sum of equity, reinvested earnings, other long-term capital, and short-term capital recorded in the balance of payments." (See **Figure 4**). Furthermore, we should acknowledge that it is the total of foreign direct investment, not only investment related to the energy sector.

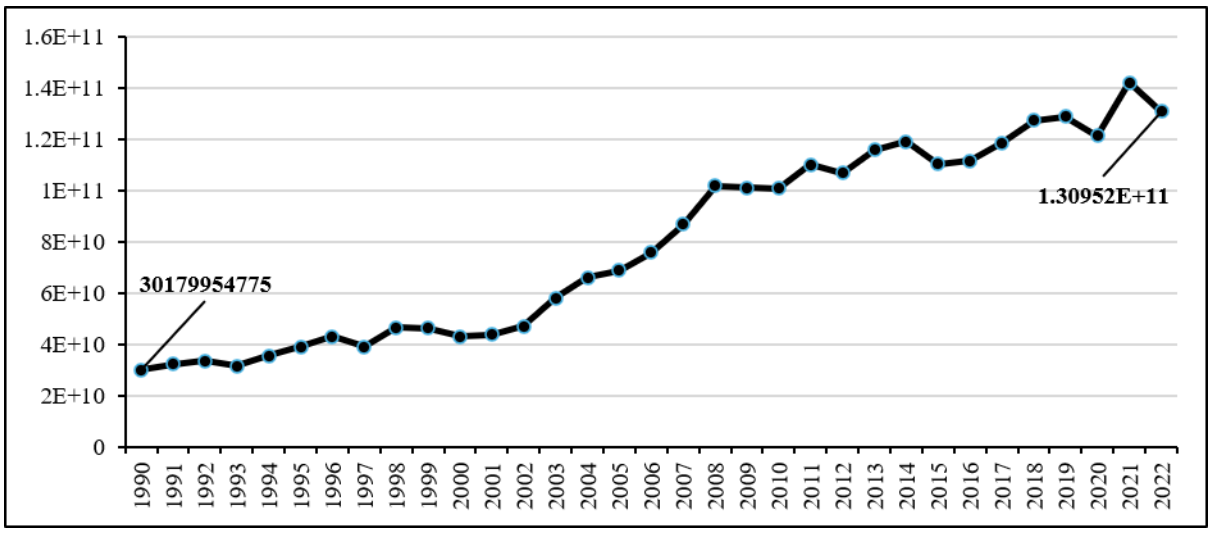


Figure 5. Gross domestic product in current USD (Source: Authors' own elaboration, based on World Bank Data, World Development Indicators)

Between 1990 and 1999, foreign direct investment (FDI) was low, hovering below USD 500 million. However, between 2000 and 2009, there was an increase in investment, with notable declines, for example, in 2002, due to economic reforms and policies issued by Moroccan government authorities. Thus, between 2010 and 2019, FDI continued to increase, without exceeding 3,5 billion USD. This period demonstrates the country's commitment to improving the industrial, energy, and services sectors. Finally, the period between 2020 and 2021, or the Covid-19 period and/or the resumption of activities, was characterized by border closures and activity shutdowns.

GDP: According to the World Bank, gross domestic product at buyers' prices is the sum of gross value added by all resident producers in an economy plus all product taxes and less subsidies not included in the value of the products. It is calculated without making any deductions for the depreciation of manufactured goods or the loss in value or degradation of natural resources. Data is in the current US dollars (See **Figure 5**).

Between 1990 and 1999, GDP growth was moderate, corresponding to the Structural Adjustment Program (SAP) phase, marked by structural reforms and economic openness. Between 2000 and 2009, GDP grew rapidly, driven by FDI, tourism, and agriculture. Between 2010 and 2019, GDP partially stagnated, reflecting the country's economic maturity or structural changes that slowed growth. Finally, the infamous Covid-19 period (2020-2022) was characterized by a decline in GDP due to border closures.

Overall, GDP increased more than fivefold between 1990 and 2022, demonstrating the Kingdom's efforts to expand and diversify its most profitable sectors.

The aforementioned variables will subsequently be transformed into logarithms to reduce volatility and numerical scale. Variables such as GDP and INV are transformed into logarithms to reduce scale and facilitate the interpretation of elasticity coefficients. Furthermore, standardization is not necessary in this case, regardless of the scale used.

Model Results

Recalling that the proposed model is written in our case as follows:

$$\begin{aligned}\Delta LOGEMPLOYMENT_t &= \alpha_0 \\ &+ \sum_{i=1}^{p} \alpha_i \Delta LOGEMPLOYMENT_{t-i} + \sum_{j=1}^{q1} \lambda_j \Delta LOGPOWER_{t-j} \\ &+ \sum_{h=1}^{q2} \lambda_h \Delta LOGGDP_{t-h} + \sum_{k=1}^{q3} \lambda_k \Delta LOGINV_{t-k} \\ &+ \beta_1 LOGEMPLOYMENT_{t-1} + \beta_2 LOGPOWER_{t-1} \\ &+ \beta_3 LOGINV_{t-1} + \beta_4 LOGGDP_{t-1} + \varepsilon_t\end{aligned} \quad (2)$$

With:

- $\boldsymbol{LOGEMPLOYMENT}$ **:** The logarithm of the variable EMPLOYMENT, which is the number of employed urban labor force aged over 15 years old;
- $\boldsymbol{LOGPOWER}$**:** The logarithm of the variable ENERGY, which is the installed capacity of renewable energies in kilowatts;
- $\boldsymbol{LOGGDP}$**:** The logarithm of the variable GDP, which is the gross domestic product in current USD;
- $\boldsymbol{LOGINV}$ **:** The logarithm of the variable INV, which is foreign direct investment, net inflows in current USD;
- $\boldsymbol{\alpha_i \text{ and } \lambda_i}$**:** are the ST coefficients;
- $\boldsymbol{\beta_1, \beta_2, \beta_3 \text{ and } \beta_4}$**:** are the LT coefficients of the ARDL;
- $\boldsymbol{p, q1, q2, q3 \text{ and } q4}$**:** the respective lags of the variable to be explained and the explanatory variables of the ARDL model;
- $\boldsymbol{\varepsilon_t}$ **:** the error term.

To demonstrate that the increase in installed ENERGY or capacity, economic growth, and investment volume are among the reasons behind the change in the number of employed workers in urban areas, we will use the ARDL model shown in the Eq. (2), and more specifically that of Pesaran and Shin (1999), which estimates both the probable short- and long-term relationships between the dependent variable and the independent variables.

Table 2. Stationarity test using the PP test

Phillips-Perron (PP) stationarity test				
Variable	**P-value at level**	**P-value after differentiation**	**Level of stationarity**	**Observations**
LOGEMPLOYMENT	0.0846	0.01	I(1)	Stationary after 1st differentiation
LOGENERGY	0.01776	-	I(0)	Stationary at level
LOGGDP	0.7904	0.01	I(1)	Stationary after 1st differentiation
LOGINV	0.01	-	I(0)	Stationary at level

Table 3. Boundary cointegration test

Pesaran et al. (2001) Cointegration test				
Critical threshold	**I (0)**	**I (1)**	**Observation**	**Decision**
1% critical value	5.198	6.845	F > F(I (1))	There is a cointegration relationship between the variables.
5% critical value	3.615	4.913	F > F(I (1))	There is a cointegration relationship between the variables.
10% critical value	2.958	4.1	F > F(I (1))	There is a cointegration relationship between the variables.

F-statistic = 7.86066110800026

Stationarity Test

The first step before moving on to stationarity is to transform the variables into time series. Then, to ensure the linearity condition, we took logarithms of the variables to standardize units and facilitate their use.

Indeed, stationarity is a crucial step in determining the optimal model choice for managing potential short- and long-term relationships. **Table 2** presents the results of the stationarity test.

According to the PP test, the variables LOGENERGY and LOGINV are stationary at level I(0) with respective p-values of 0.01776 and 0.01, which are well below the critical threshold of 5%. However, the variables LOGEMPLOYMENT and LOGGDP are stationary after first difference I(1), with p-values lower than 1% after differentiation.

Choice of the Optimal Model

The stationarity results lead us to choose the ARDL model to address this case, where the integration orders differ.

According to the AIC criteria, and based on a maximum lag order (p,q) = (15,15), the optimal model selected is ARDL(3,5,6,2).

Based on the above, the original dataset comprises 33 annual observations covering the period 1990–2022. Because the largest lag retained in the selected ARDL(3,5,6,2) specification is six, estimation requires the loss of the first six observations needed to construct the lagged variables. The effective estimation sample therefore contains 27 observations. Although the maximum lag order of 15 was used only as an upper boundary for the automatic model search, the final specification remains relatively parameter-intensive in relation to this effective sample. This reduces the available degrees of freedom and may increase coefficient uncertainty, sensitivity to individual observations, and the risk of fitting sample-specific dynamics. The results will consequently be interpreted cautiously and as conditional relationships within the selected model.

Boundary Cointegration Test or Limit Test

Table 3 represents the boundary cointegration test.

The F-statistic significantly exceeds the critical values of I(1), and we conclude that the null hypothesis H0 of no cointegration is rejected. This indicates the presence of a long-term cointegration relationship between the variable to be explained and the explanatory variables.

Error Correction Model (ECM)

After identifying a cointegration relationship between the variables using the Pesaran bounded cointegration test, the correction model presents the short-term dynamics and the error-correction term. **Table 4** presents the results obtained.

The model is statistically significant overall, with an R^2 of 93.75%, indicating that a substantial proportion of the total variance is explained and that the model has a strong goodness of fit. The adjusted R^2 is 83.74%, indicating that the model retains considerable explanatory power after accounting for the number of variables included. Furthermore, the F-statistic of 79.371, with a p-value of 0.0005213, confirms the overall significance of the model and leads to the rejection of the null hypothesis that all slope coefficients are jointly equal to zero.

The analysis of the model's short-term dynamics across the different coefficients shows that:

- The constant is positive and statistically significant, representing the intercept of the short-run equation when the explanatory variables and the other dynamic terms are equal to zero;
- The error correction term: The negative and statistically significant coefficient of -2.325 confirms that deviations from the estimated long-term relationship generate a corrective response in urban employment. However, we should be cautious in its interpretation, because it doesn't automatically mean that 232.5% is eliminated within one year. In this ARDL(3,5,6,2) specification, the short-run dynamics include two lagged first differences of the dependent variable; consequently, the adjustment process is distributed across multiple periods, and the coefficient does not imply that 232.5% of any disequilibrium is corrected within a single period. That said, the interpretation should follow the remaining short-term autoregressive dynamics and account for the lags of our dependent variable. Based on the above, the coefficient should be interpreted as evidence of strong error correction within a higher-order dynamic process rather than as a simple annual adjustment percentage;

Table 4. Results of the error correction model

Variable to be explained: LOGEMPLOYMENT				
	Coefficients	**Standard Error**	**T-value**	**P-value**
Constant	9.89	1.38	7.13	3.14e-05 ***
ECT (-1)	-2.325	0.32	-7.13	3.17e-05 ***
dLOGENERGY.t	-0.18	0.05	-3.51	0.005 **
dLOGENERGY.1	-0.81	0.12	-6.32	8.61e-05 ***
dLOGENERGY.2	-0.61	0.10	-5.66	0.0002 ***
dLOGENERGY.3	-0.30	0.08	-3.47	0.006 **
dLOGENERGY.4	-0.11	0.05	-2.00	0.07 .
dLOGGDP.t	0.11	0.05	2.13	0.05 .
dLOGGDP.1	0.14	0.04	3.54	0.005 **
dLOGGDP.2	0.04	0.05	0.86	0.40
dLOGGDP.3	-0.14	0.06	-2.33	0.04 *
dLOGGDP.4	0.005	0.05	0.09	0.92
dLOGGDP.5	-0.44	0.07	-5.64	0.0002 ***
dLOGINV.t	0.02	0.01	2.16	0.05 .
dLOGINV.1	0.04	0.008	4.58	0.001 **
dLOGEMPLOYMENT.1	1.10	0.24	4.56	0.001 **
dLOGEMPLOYMENT.2	0.74	0.22	3.35	0.007 **

Significance level: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 0.006457 on 10 degrees of freedom
R^2: 93.75% R^2 adjusted: 83,74%
F-statistic: 9.371 on 16 and 3 DF p-value: 0.0005213

Table 5. Long-term relationship

Variable to be explained: LOGEMPLOYMENT				
	Coefficients	**Standard Error**	**T value**	**Pr(>|t|)**
Constant	4.25	0.10	39.41	1.761943e-09
LOGENERGY	0.29	0.02	14.91	1.459059e-06
LOGGDP	0.07	0.02	3.23	1.443553e-02
LOGINV	-0.02	0.007	-3.24	1.409683e-02

- Changes in LOGENERGY in the current and across the first four lags show negative short-run associations with urban employment, although the fourth-lag coefficient is significant only at the 10% level. After reaching its largest magnitude at the first lag, the negative association gradually weakens across the subsequent lags. This pattern may reflect a delayed labor-market adjustment associated with the relatively recent development of the renewable energy sector and the time required to develop the necessary technical skills, which may delay the association between renewable energy expansion and urban employment;
- Changes in LOGGDP show mixed short-run associations with urban employment. The contemporaneous and first-lag coefficients are positive, while the third- and fifth-lag coefficients are negative; the remaining coefficients are not statistically significant;
- Changes in LOGINV show positive and statistically significant short-run associations with urban employment in the current period and at the first lag;
- The lagged changes in LOGEMPLOYMENT are positive and statistically significant, indicating that current employment dynamics are associated with previous changes in employment.

Long-Term Relationship

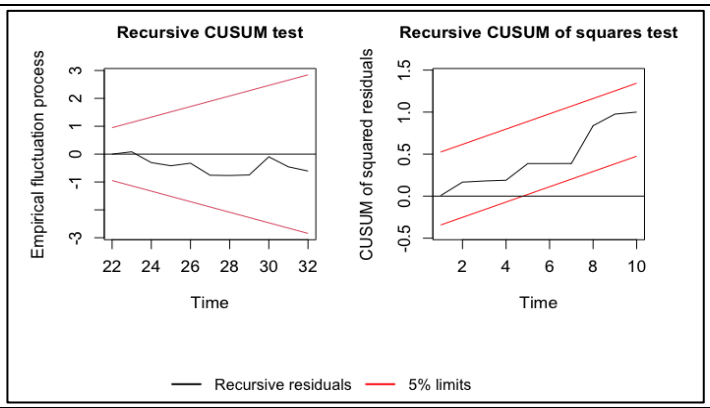
Table 5 presents the long-term relationships among the variables LOGEMPLOI, LOGPUISSANCE, LOGPIB, and LOGINV.

The results suggest that the coefficients of the constant et all the explanatory variables are significant at the 5% level, confirming that the explanatory variables have statistically significant relationships with the number of employed persons in the urban labor force.

Over the long term, a 1% increase in installed renewable energy capacity is associated with a 0.29% increase in the number of employed persons in the urban labor force. Similarly, a 1% increase in GDP is associated with a 0.07% increase in urban employment.

Furthermore, a 1% increase in investment is associated with a 0.02% decrease in urban employment. However, the associated coefficient is relatively small, and the variable covers total foreign direct investment rather than investment specifically related to the energy sector. It is important to note that the INV variable is an aggregate measure that combines several types of investment. Therefore, this coefficient should not be interpreted as evidence of a negative relationship between renewable energy investment and employment. The small negative long-run coefficient associated with total FDI should not discourage policies aimed at promoting foreign investment. Rather, it suggests the need to channel FDI toward renewable energy and other employment-intensive sectors while strengthening local recruitment, domestic sourcing,

Table 6. Validation tests for the ARDL model

Validation tests for the ARDL model		
Test Validation	**Statistic and p-value**	**Interpretation**
Residual autocorrelation test		
Breusch-Godfrey test for residual autocorrelation	LM test = 0.76 p-value = 0.41	The p-value of both tests is well above 5%, which allows us not to reject the null hypothesis and confirm that there is no autocorrelation of the residuals.
Ljung-Box test for residual autocorrelation	$X^2 = 2.31$ p-value = 0.12	
Residual heteroscedasticity test:		
Breusch-Pagan test for residual homoscedasticity	BP = 15.54 p-value = 0.68	The p-value is greater than 5%, which allows us to reject the null hypothesis and confirm that there is no residual heteroskedasticity.
Residual normality test:		
Shapiro-Wilk test for normality	W = 0.96 p-value = 0.58	The p-value is well above 5%, which allows us to fail to reject the null hypothesis and confirm that the residuals follow a normal distribution.
Stability test		
CUSUM and CUSUM of Squares tests for stability		In this case, and when interpreting both graphs, the black line remains within the 5% bounds, indicating that the model does not exhibit significant instability or structural disruptions during the observed period. Therefore, the model is stable.

skills development, and technology transfer. Moreover, some new investments focus on acquiring technologies, such as artificial intelligence-based machinery, to increase production and efficiency and may not be accompanied by a corresponding increase in employment. In summary, the estimated coefficient indicates a weak negative relationship between employment and aggregate investment. It does not allow us to evaluate the specific relationship between green investment and employment because of the lack of disaggregated data on the INV variable in Morocco over the entire study period.

It is also essential to consider the development of local content and the integration of value chains into the expansion of renewable energy in Morocco. Supporting the local manufacturing of equipment and the development of dedicated industrial sectors may increase the domestic employment opportunities associated with renewable energy expansion. Such an approach would not only allow Morocco to fully benefit from the investments made but also strengthen the resilience of its economy to fluctuations in international markets.

Model Validation

To validate the results obtained, four diagnostic tests were conducted: Residual autocorrelation test, residual heteroscedasticity test, residual normality test, and stability test (See **Table 6**).

Although the study period includes events that may have affected Morocco's economic and energy dynamics, the CUSUM and CUSUM of Squares tests (Brown et al., 1975) show that the model parameters remain stable within the critical bounds. For this reason, no additional structural-break dummy was included in the final specification. Nevertheless, given the limited sample size, the possibility that some structural changes were not fully captured by the model cannot be entirely excluded.

Model Projections

Based on the forecasting approach presented earlier in the methodology section, we therefore project the employed population in Morocco's urban areas (See **Figure 6**).

The projections suggest that urban employment could rise in 2029. This may partly reflect the temporary demand for labor generated by infrastructure and construction projects in preparation for the 2030 World Cup. However, the model does not identify the World Cup itself as the cause of this increase, and other economic factors may also influence the projected trend. Employment is then expected to decline in 2030, possibly because some of these construction-related jobs are temporary and may disappear as major projects are completed.

From 2031 onward, the projected path broadly reflects the employment and sustainability ambitions of the 2035 National Sustainable Development Strategy. These forecasts should nevertheless be read together with the 95% prediction intervals shown in **Figure 6**. The intervals illustrate the range of outcomes that may reasonably occur around the central projection and widen over time as uncertainty increases.

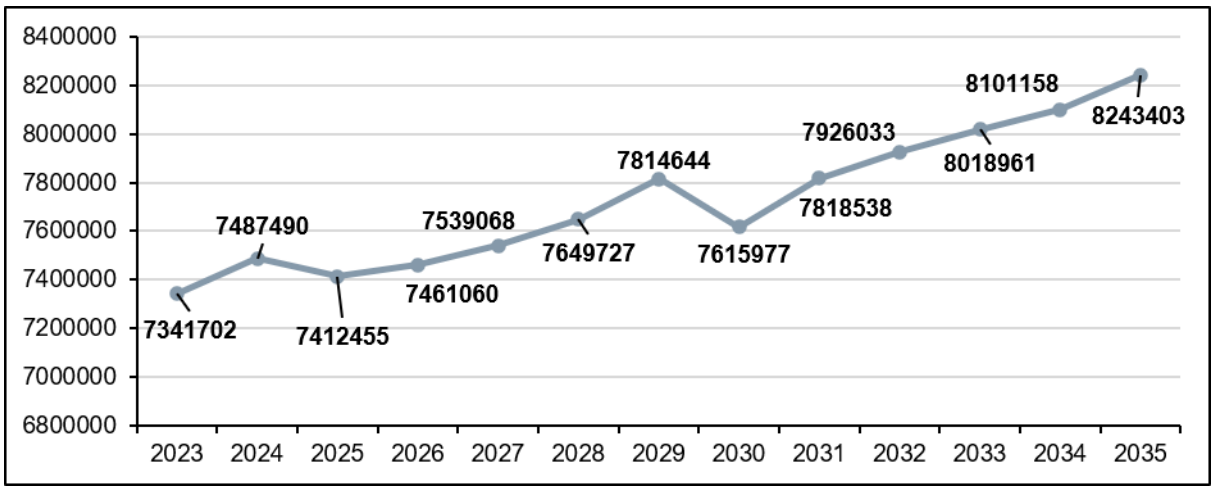


Figure 6. Projections of urban employment (Source: Authors' own elaboration, based on ARDL model estimates using employment data from the High Commission for Planning (HCP))

These projections are based on the assumption that the relationships observed during the historical period remain broadly stable and that renewable-energy capacity, GDP, and total FDI follow the paths used in the forecasting exercise. Actual employment outcomes may differ because of unexpected economic, political, institutional, technological, geopolitical, or climatic developments. The projections should therefore be viewed as indicative scenarios rather than precise forecasts of future urban employment.

POLICY IMPLICATIONS

The policy implications for Morocco can be organized into six key areas. While the first two recommendations are directly supported by the empirical findings, the remaining four represent normative policy extensions derived from these findings.

Energy Transition in the Service of Employment

Based on the above, the development of renewable energy will create jobs and reduce unemployment in the long term. This outcome remains dependent on the public policies adopted concurrently in the education and industrial sectors. Indeed, promoting this sector requires several industrialization projects related to construction, transport, and logistics. Furthermore, strengthening the education system will facilitate young graduates' access to a modern and dynamic labor market.

In this regard, the World Bank concluded that Morocco could create up to 25,000 net new jobs per year between 2020 and 2050 through investment specifically directed toward renewable energy and energy efficiency, thereby addressing an annual job loss of 8.5%. The study also noted that start-ups and small and medium-sized enterprises (SMEs) are the largest creators of short-term jobs in this sector, owing to their involvement across the entire renewable energy value chain, from production and distribution to consumption and maintenance (World Bank, 2024).

National and Local Job Creation

The renewable energy development cycle encompasses the construction and installation phases. This implies that countries must adopt and develop technologies using local and national expertise in order to promote employment and avoid excessive reliance on imported green energy technologies and installations.

In this regard, sustainable jobs generally cover the entire value chain, including construction, assembly, wiring, installation, operation, maintenance, engineering, control, and the recycling of various types of equipment, such as batteries.

This recommendation is particularly relevant in light of the empirical finding of a small negative long-run coefficient between total FDI and urban employment. Strengthening local sourcing, domestic skills, and technology transfer involving Moroccan firms can help maximize the local value added and employment benefits generated by foreign-financed projects.

Technical Training for a Smoother Transition

With the growth of SMEs specializing in renewable energy, the need for technical skills in this field is increasing.

In this context, Morocco must direct its policies toward training and supporting young people in the technical specializations required by the labor market. These policies must be aligned with the needs of businesses and the labor market by integrating new digital technologies and developing partnerships with academic institutions to keep pace with international trends.

Principle of Advanced Decentralization

The principle of advanced decentralization aims to reduce regional disparities by directing renewable energy investment toward all regions of the country. Decentralization will create jobs in regions with high unemployment.

Renewable energy investment projects should focus on the least developed regions and rural areas to reduce the cost of transmitting electricity from renewable sources and expand access to rural electrification, thereby strengthening energy security.

These projects can also help ensure water security in regions with limited access to water resources. Water stress is currently a major challenge for the country, and seawater desalination technologies aim to address it. Current policies follow this trend across the country's main regions. These policies should further accelerate the territorialization of this approach to ensure water security in the context of climate change, drought, and declining agricultural production.

Improving Purchasing Power and Competitiveness

Energy costs pose a real challenge for households in an inflationary environment. These costs can be reduced by implementing energy-efficiency measures in residential buildings and adopting new energy technologies that reduce consumption and increase household purchasing power.

For businesses, implementing energy-efficiency measures in their buildings can reduce energy bills by lowering energy consumption. This reduction can improve the competitiveness and profitability of businesses.

Based on the above, the country must establish support mechanisms and provide subsidies to companies that integrate energy-efficiency technologies in order to promote decarbonization.

Integrating a Gender Perspective

Current employment policies do not sufficiently incorporate a gender perspective. To ensure an energy transition that integrates gender considerations, Morocco must include women in continuing education and the labor market, particularly in the least developed regions.

Although consistent sex-disaggregated data on employment specifically in Morocco's renewable energy sector are not available, women may remain underrepresented in the technical, managerial, and entrepreneurial activities associated with the energy transition. Their limited participation should be considered not only an equity concern but also an economic efficiency issue, since excluding women from training and employment opportunities reduces the available talent pool, may intensify skills shortages, and could slow renewable energy deployment and limit the potential employment gains from the transition.

Public policies must establish mechanisms to support green SMEs, create specialized training programs for women to facilitate their integration into the labor market, promote women's inclusion, and mainstream the gender perspective across the country's regions.

CONCLUSION

The energy transition represents a major opportunity for Morocco because of its potential to stimulate economic growth and investment while addressing environmental and social challenges. However, as the existing literature highlights, empirical data on green jobs remain limited, and the impacts of climate policies on labor markets remain insufficiently explored. This lack of high-quality data hinders a thorough understanding of the dynamics between renewable energy investment and job creation.

Green growth policies, which aim to reconcile economic development with environmental sustainability, offer promising prospects. By integrating renewable energy, these policies can generate multiplier effects throughout the economy, stimulate strategic investment, and promote the creation of low-carbon jobs. However, this transition requires structural reforms and a skilled workforce capable of meeting the demands of modern technologies.

This article has highlighted the positive impact of the expansion of renewable energy on urban employment in Morocco, based on an econometric analysis using the ARDL model. The results show that, in the short term, the integration of renewable energy does not immediately generate green jobs because of specific skill requirements and the time lags associated with technology adoption. However, in the long term, the expansion of renewable energy contributes significantly to job creation, thereby strengthening the socioeconomic potential of the energy transition. Morocco can establish itself as a key player in renewable energy development through ambitious reforms and the gradual diversification of its energy mix. Flagship projects such as Noor Ouarzazate in the solar sector and the Tarfaya wind farm demonstrate this commitment. These initiatives not only strengthen the country's energy security but also offer opportunities to reduce unemployment, particularly in urban areas.

Future research could further analyze the impacts of the energy transition on employment in rural areas and examine the implications of climate change and carbon footprint reduction. Furthermore, the emergence of technologies such as energy storage and smart grids warrants particular attention, given their potential for job creation and their role in optimizing energy resources.

However, the development of renewable energy relies on the availability of appropriate skills, particularly in the areas of installation, maintenance, and energy infrastructure management. In Morocco, strengthening dedicated training programs and integrating specialized modules into technical and university curricula would help to better meet the sector's needs. This approach would improve the employability of young graduates and create sustainable employment opportunities.

In conclusion, Morocco has unique potential to become a regional model for renewable energy development. Decision-makers must continue to invest in coherent public policies and skills development to maximize the economic, social, and environmental benefits of the energy transition.

Author contributions: AB: conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, software, validation, visualization, writing – original draft, writing – review & editing; DE: Supervision, validation, visualization, writing – review & editing; AB (Author 3): Data curation, formal analysis, investigation, methodology, visualization, writing – original draft, writing – review & editing; SB: Data curation, methodology, visualization, writing – review & editing; SE: Data curation, methodology, visualization, writing – review & editing. All authors agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Ethical statement: The authors stated that the study did not require ethical approval, as it is based exclusively on publicly available open-access secondary data. No human participants were directly involved, and no personal or sensitive data were collected. Therefore, intormed consent was not applicable.

AI statement: The authors stated that generative Al tools were used only to assist with language editing and improving readability. The authors confirm that all scientific content, analysis, results, and conclusions are entirely original and developed independently by the authors. The use of Al-based tools did not influence the research design, data analysis, interpretation of results, or the scientific integrity of the work. The authors take full responsibility for the authenticity, originality, and accuracy of the manuscript.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from corresponding author.

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