



The Impact of Economic Conditions and Policy Decisions on Renewable Electricity Deployment in Algeria (1980-2021).

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Received :29/01/2024

Accepted :22/05/2024

Abstract

In response to the imperative of sustainable development and environmental protection, many countries have established renewable energy targets and implemented a variety of policy instruments. Using the auto-regressive distributed lag (ARDL) model, the study aims to investigate the impact of economic conditions (oil price and economic growth) and policy instruments (national renewable energy and energy efficiency program) on renewable energy deployment, in the Algerian electric power sector, over the period 1980-2021.

The outcomes of causality tests show, in both short and long terms, the existence of a unidirectional link running from gross domestic product per capita to renewable electricity generation. Moreover, the short-run findings reveal a unidirectional link going from economic

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conditions and policy decisions to renewable electricity production, indeed, the presence of a unidirectional link going from economic conditions to policy decisions. Furthermore, the long-run results illustrate two bidirectional relationships, the first, among oil price and renewable electricity generation, the second, between oil price and national renewable energy program. These outcomes highlight the importance for the Algerian government to improve its energy policies, support renewable energies, and reduce dependence on fossil fuels for sustainable economic growth.

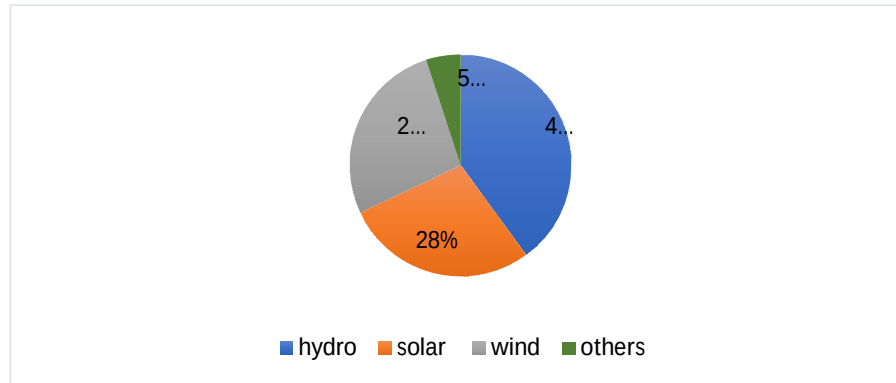
- ✓ Oil price. Economic growth. National renewable energy program. Renewable electricity generation. Causality tests. Algeria.

1. INTRODUCTION

In light of the ever-growing energy demand and the urgent need to achieve sustainable development goals, several countries have embraced renewable energy sources by establishing targets for their deployment and adopting a range of policy measures to facilitate their realization (SDG7, 2022). According to the International Renewable Energy Agency (IRENA, 2015) 164 countries have adopted at least one category of renewable energy. Renewable energy sources replenish themselves naturally without being depleted in the earth, they include bioenergy, hydropower, geothermal energy, solar energy, wind energy, and ocean energy (Edenhofer et al., 2011). Due to the limited supply of fossil fuels, growing global fossil fuel prices, and diminished environmental repercussions, they should ensure the sustainable growth of a nation. Meaning they represent a way out of import dependency, allowing countries to diversify their economies and protect themselves from unpredictable fluctuations in fossil fuel prices (Strielkowski et al., 2021). At the same time, they promote inclusive economic growth, the creation of new jobs, and the reduction of poverty (Zhao et al., 2022). Indeed, IRENA, (2019) estimates that 90% of the world's electricity can and should come from renewable energy by 2050. Especially since renewable energy is the cheapest energy source in most parts of the world today. For example, the cost of solar electricity has decreased by 85% between 2010 and 2020. Onshore and offshore wind power costs decreased by 56% and 48% respectively.

According to (IRENA, 2022), the global renewable energy output reached 3064 GW at the end of 2021. With a 1230 GW capacity, hydropower constituted a significant proportion of the overall global electricity production. The remaining energy was split equally between solar and wind power, with capabilities of 849 GW and 825 GW. The other renewable sources were 524 MW of marine energy, 143 GW of bioenergy, and 16 GW of geothermal energy (Fig. 1).

Fig.1. Renewable generation capacity by energy source

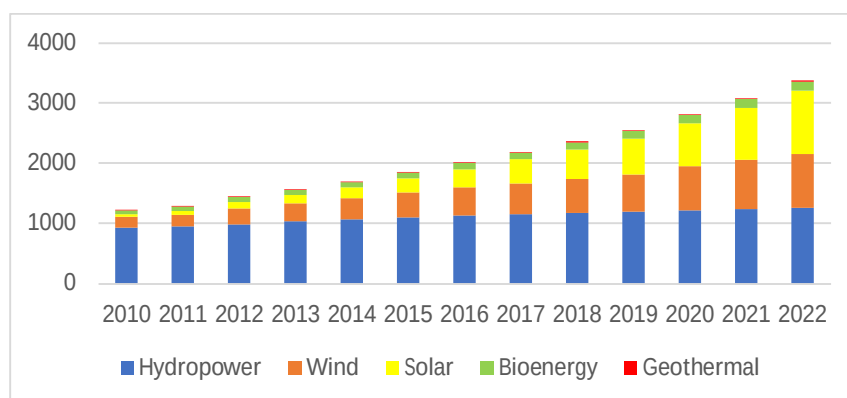


Source: Renewable capacities highlights- IRENA 2022

In 2022, the capacity of renewable power generation increased by 296 GW (+9.6%). With a growth of 192 GW (+22,2%), solar energy maintained its lead in capacity expansion, followed by wind energy with 75 GW (+9%). Bioenergy capacity increased by 8 GW (+5,4%) while hydropower capacity grew by 21 GW (+2%). 0,2 GW (+1,2%) of geothermal energy was produced. The highest level of electricity consumption ever was seen globally, economic activity recovered from the Covid-19 crisis-related depression, and droughts in certain places restricted hydropower generation, all of which contributed to the slow development in the share of renewable energy sources.

Solar and wind power continued to lead renewable capacity expansion accounting together for 90% of all net renewable energy additions in 2022. This expansion in wind and solar, along with the greater development of geothermal, resulted in a significant annual rise in the capacity of renewable energy sources (Fig. 2).

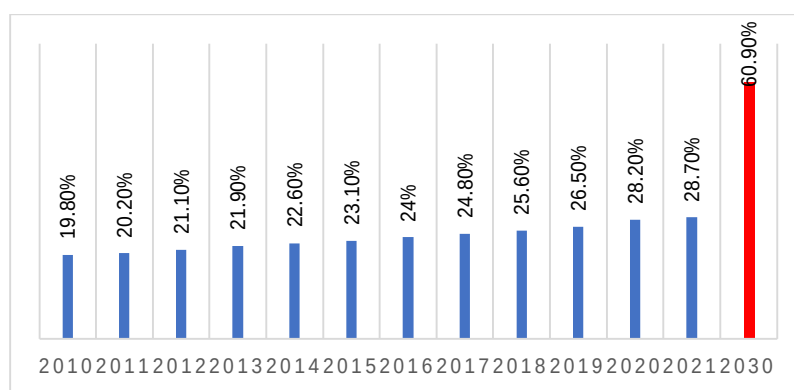
Fig.2. Renewable power capacity growth by main sources



Source: Renewable capacities highlights- IRENA 2022

It was determined that nuclear and renewable energy sources accounted for 39% of the world's electricity production in 2022 (Meredith, 2023). In order to achieve the net zero scenarios between 2022 and 2030, renewable energy generation must continue to increase by more than 12% annually (IEA, 2022). Despite a historic rise in renewable energy capacity, generation growth in 2021 was still considerably behind the net zero scenario target. All renewable technologies will need to be deployed much faster over the world (Fig. 3).

Fig.3. Renewables share of power generation in the Net Zero Scenario, 2010-2030



Source: International Energy Agency- IEA 2022

Based on the findings of the (WBG, 2021), Algeria's economy continues to be heavily dependent on the fossil fuel industry, particularly oil, and gas, which between 2016 and 2021 accounted for 38% of budget revenues, 93% of goods exports, and 19% of GDP. The average price of a barrel of Sahara Blend (Algerian oil) fluctuated from 113 USD in mid-2014 to 31 USD in early 2016, before rising to 65 USD in 2019 and falling again during the health crisis to 42 USD in 2020. This fluctuation in hydrocarbon prices, which has since been favored by the impact of the global recovery and the war in Ukraine, has generated a considerable increase in export revenues and budgetary revenues. The Algerian economy recovered in 2021 with a GDP growth rate of 3.5%, driven by the recovery of hydrocarbon prices -the price of a barrel of Sahara Blend jumped by 69% between 2020 and 2021, reaching 72 USD/b in 2021- (CEIC,2021). Between 2020 and 2021, Algerian oil production climbed by 12% annually, or about 11,000 b/d. The overall budget deficit decreased in 2021 from 12 to 7.2 percent of GDP as a result of greater hydrocarbon revenues, a recovery in tax revenues, higher dividends from the Bank of Algeria, and low spending growth. The surge in exports, driven by higher hydrocarbon prices (Trading Economics, 2022). Furthermore, Algeria is the third largest CO₂ emitting country in Africa, after South Africa and Egypt. It emitted 143 MtCO₂ in 2021

(Enerdata, 2023). Important to realize, fossil fuel consumption and its changes over time are the primary causes of the global increase in CO₂ emissions (Omri, 2013).

In order to reduce dependence on oil and gas for fossil fuels and to reduce CO₂ emissions, Algeria is currently focusing more and more on developing the renewable energy sector. In terms of renewable energy potential, Algeria has great potential in solar energy. With an average annual sunshine of 2000 h and a territory composed of 86% of the Sahara Desert, its solar power is estimated at about 1700 KWh/m²/year in the north and 2650 KWh/m²/year in the south, which corresponds to a capacity 8 times greater than the country's natural gas reserves, and the largest solar fields in the world (Bouraiou et al., 2020). It is estimated that only one twentieth of the surface of the Sahara covered with solar panels could supply the entire planet in electricity (Bélaïd and Youssef, 2017). The potential of alternative renewable energy sources, such as hydropower and wind when wind speeds are only 2 to 6 m/s, is less significant. It is estimated that biomass has a potential of 1.33 Mtoe/year, which includes the recycling of waste from human activities, urban trash, and agricultural waste. As explained by geothermal has a better outlook with 200 hot springs listed (Abada and Bouharkat, 2018).

However, fossil fuels remain the main source of electricity output in Algeria. Indeed, in 2020, fossil fuels contributed significantly to electricity generation in Algeria. According to statistics from the Algerian Ministry of Energy, fossil fuels, primarily natural gas, accounted for approximately 96% of the country's electricity generation (Ministry of Energy | Algeria). Adjacent to, Algeria does not have a lot of hydroelectric power generation capacity. With 92% of non-hydro RE, solar PV is the leading source of electricity generation from RE with 84% connected to the grid and 8% off-grid. Solar thermal and wind power represent respectively 6% and 2% of the RE excluding hydropower. Although Algeria has no nuclear power plants, the government is working to increase the country's non-hydroelectric renewable energy capacity (IEF, 2020).

In fact, many countries have launched policies and programs to support and encourage the spread of renewable energies. Algeria, for its part, has embarked the ambitious National Renewable Energy and Energy Efficiency Program -NREP- which was adopted by the government in February 2011 and revised in May 2015 and placed as a national priority in February 2016 during the Restricted Council of the government (LSE, 2023).

According to the Ministry of Energy and Mines, Algeria aims to install 12,000 MW of electricity generation capacity from renewable energy sources by 2030 to cover 40% of its domestic demand (37% solar, 3% wind), and an additional 10,000 MW for export under certain conditions, including access to the European market and external sources of financing (Ministry of Energy | Algeria). The production of such a lot renewable energy means a saving of more than 300 billion m³ of natural gas, which represents eight times the country's usage in 2014. In fact, the primary goal of the RE program is to increase the share of RE in overall electricity production to approximately 27 percent by 2030. Two sets of targets have been created for this program. The first one boasts promoting of renewable sources of energy, while the second one involves energy efficiency. These are planned to be implemented over two eras (2015–2020 and 2021–2030), which will substantially encourage investment in all renewable energy sources (Table. 1).

Table 1. Renewable energy goals for the electricity generation in Algeria's national program of renewable energy and energy efficiency (2015–30).

Electric Power						
Energy Sources	2015-2020		2021-2030		Total (MW)	%
	MW	%	MW	%		
Photovoltaic	3000	66.3	10575	60.52	13575	61.70
Wind	1010	22.32	4000	22.89	5010	22.77
Concentrated solar power			2000	11.44	2000	9.09
Biomass	360	7.95	640	3.66	1000	4.55
Cogeneration	150	3.31	250	1.43	400	1.82
Geothermal	5	0.11	10	0.06	15	0.07
Total	4525		17475		22000	

Source: The Algerian Ministry of Energy

To our knowledge, there are no previous studies examining the nexus between renewable energy implementation and both economic conditions and policy decisions in Algeria. The main objective of our study is to measure the impact of economic conditions, mainly the variation of oil prices and economic growth as well as political decisions (NREP) on the production of renewable electricity in Algeria, over the period 1980-2021.

This paper is organized as follows: Section 2 highlights the literature review. Section 3 describes the data and methods. Section 4 provides the main results and debates, and Section 5 integrates the conclusions and policy implications.

2. Literature Review

Several recent studies have examined the relationship between economic conditions (oil prices and economic growth) and renewable energy deployment. The favorable correlation between oil prices and the generation of renewable energy has been highlighted in many studies, for instance, Dogan et al., 2021 demonstrated that 1% increase in energy prices leads to an increase in RE of between 0.07% and 0.99% across a range of indicators, indeed, the magnitude of the income and oil price impacts are much smaller when RE is represented by RE consumption than when it is represented by RE production. (Lee and Huh, 2017) showed that higher global oil prices resulted in faster diffusion rates for renewable energy. Additionally, The results of (Zhao et al., 2021) reveal that an increasing international oil price can advance the outputs and investment of renewable energy. According to (Özdurak, 2021), when oil prices decrease, the renewable investments also tend to decrease. This has been confirmed by Sahu et al. (2022).

By the same token, Apergis and Payne conducted several studies on the factors that influence the consumption of renewable energy in various geographical locations. First, they examined the case of seven Central American countries from 1980 to 2010 (Apergis and Payne, 2014a), then they looked at 25 OECD countries from 1980 to 2011 (Apergis and Payne, 2014b), and finally, they examined 11 South American nations from 1980 to 2010 (Apergis and Payne, 2014c). Given that the elasticity estimates for real oil prices, real GDP per capita and carbon emissions per capita, are all positive and statistically significant over the long term, all three studies proved that high oil prices led to a rise in the use of renewable energy sources. Thus, Granger causality analysis in quantiles conducted by Troster et al. (2018), also confirms the existence of a lower tail dependence between changes in oil prices and changes in renewable energy consumption. Furthermore a short-term positive unidirectional relationship between renewable energy and oil prices is demonstrated by the dynamic correlations of (Brini et al., 2017). And according to Eder et al. (2018), a 1% change in hydrocarbon prices results in a 1.05% change in renewable energy consumption.

In contrast to these findings, other research contends that the consumption of renewable energy is unaffected by and/or negatively impacted by increasing oil prices.

By concentrating on oil prices, Omri et al. (2015) explored the factors influencing renewable energy consumption. They discovered a modest correlation between the use of renewable energy and real oil prices and claimed that, in the short term, renewables may be a supplement but not a perfect

solution for crude oil. Payne (2012) studied the causal dynamics between renewable energy consumption, real GDP, carbon emissions, and real oil prices, and he found that real oil prices had no causal impact on renewable energy penetration. Using data from 64 countries. In addition, For the G7 countries, Sadorsky (2009) provides an empirical model of renewable energy consumption. The results obtained show that increases in oil prices have a smaller, although negative, impact on the consumption of renewable energy. According to Mukhtarov et al. (2020), there is a long-term and statistically significant negative effect of oil prices on renewable energy consumption and a positive impact on economic growth in the case of Azerbaijan, for the period studied.

As identified by other studies, there is a positive correlation between economic growth and the production of renewable energy. For instance, (Bamati and Raoofi, 2020) proved that GDP per capita has a positive impact on renewable energy production per capita for developed and developing countries. Zeb et al. (2014) indicated that GDP has a positive impact while carbon dioxide emission has a negative impact on energy production. Notably, Chang et al., (2009) showed that high-economic growth nations can respond to high energy prices by using more renewable energy, whereas low-growth nations are often indifferent to changes in energy prices when it comes to their use of renewable energy. Pao and Fu, (2013) concluded that economic growth is essential to provide the resources for sustainable development. According to Ntanos et al., (2018) there is a stronger correlation between renewable energy consumption and economic growth in countries with higher GDP than in countries with lower GDP. According to Inglesi-Lotz (2016), use of renewable energy or its contribution in the overall energy mix has a positive and statistically significant impact on economic growth. Nevertheless, Ohler and Fetters (2014) demonstrated that there is a bidirectional relationship between total renewable energy production and real GDP, meaning that biomass, hydropower, waste, and wind power have a positive long-term impact on GDP.

On the contrary, many studies treat the opposite case, as an illustration, (Matei, 2017). The renewable sources are negatively influenced by an increase in the real GDP growth in 34 OECD countries. Tambari and Failler, (2020) indicated that investments in renewable energy instantly responded favorably to oil crises. However, investments in renewable energy continued negatively correlated with Africa's GDP. Furthermore, In the opinion of Li et al. (2023), GDP has a negative and considerable impact on the growth of renewable energy consumption both in the short and long term.

However, a significant number of researchers have examined how policy choices affect the development of renewable energy, and the majority of them contend that policies have a significant

impact on the markets for renewable energy. As an illustration, Biresselioglu and Zengin Karaibrahimoglu (2012) demonstrated that there is a strong and favorable association between the use of renewable energy and the policy priorities of the nation. The study conducted by Uzar (2020) thus leads to the conclusion that institutional quality has a long-term favorable impact on the use of renewable energy.

A combination of complementary policies and instruments is required because recent research shows that one policy is insufficient. For instance, del Río and Mir-Artigues (2014), Fagiani et al. (2014), and Yoon and Sim (2015) have all observed that the employment of a variety of policies is crucial to promoting the development of renewable energy sources.

Additionally, it has been asserted that government policies based on investment can be more successful than those based on production, but the two could complement one another to create a sustainable renewable energy microgrid market (Wang et al., 2020). Therefore, Yang et al., (2019) suggest that the Chinese government should intensify policy support in regions with high economic costs of the energy transition, encourage renewable energy investment in large enterprises, play a guiding role in policy, and concentrate on enhancing subsidies for medium, small and micro enterprises.

On the other hand, Stokes, (2013) examines the case of Ontario's feed-in tariff policies between 1997 and 2012 to investigate how the political process affects the design and implementation of renewable energy policies. The case study reveals the major political tensions that emerge during implementation, it emerges that governments need to critically recognize the dimension of renewable energy policies in order to gain sustainable political support.

According to the results of (Smirnova et al., 2021), the main factors affecting the market for renewable energy include expanding access to finance for renewable energy sources, reducing the utilization rate of traditional energy sources, and providing public-private support for renewable energy projects. In a similar study conducted by (Gallagher, 2013), the author explored four factors that may influence a government's decision to adopt pro-renewable energy policies: economic incentives; high endowment of renewable resources and/or low endowment of non-renewable sources; the political system; and cultural factors and attitudes.

As a result, existing research indicates that there are regional and temporal variations in the relationship between economic conditions and the deployment of renewable energy (short and long

term). Additionally, it emphasizes that institutional quality is a crucial strategic decision in the promotion of the use of renewable energy sources and the resolution of environmental issues. Therefore, in our study we do not only quantify the influence of policies but also the impact of oil prices and GDP on the diffusion of renewable electricity, in the medium and long term in Algeria.

3. Data and methodology

3.1 Model specification

We perform the autoregressive distributed lag (ARDL) model to study the renewable energy deployment in the Algerian electric power sector, considering both economic conditions and policy decisions.

The mentioned approach above, by using the single equation model of (Pesaran and al, 2001), has several benefits including the ability to estimate both short- and long-term effects simultaneously. It can also solve the endogeneity problem for the variables.

Although it doesn't need that all the variables under consideration be integrated in the same order, it does allow for robust estimations when the sample size is small.

Our ARDL model is:

$$\Delta REG_t = \beta_0 + \sum_{j=1}^{l_1} \beta_{1j} \Delta REG_{t-j} + \sum_{j=0}^{l_2} \beta_{2j} \Delta OILP_{t-j} + \sum_{j=0}^{l_3} \beta_{3j} \Delta GDP_{t-j} + \sum_{j=0}^{l_4} \beta_{4j} \Delta NREP_{t-j} + \eta_1 REG_{t-1} + \eta_2 OILP_{t-1} + \eta_3 GDP_{t-1} + \eta_4 NREP_{t-1} + \eta_5 break_t + \varepsilon_t$$

(*)

Where $l_1 - l_4$ are the lag length of each variable respectively, $break$ is the break years, β_0 is the constant parameter, and Δ is the first difference.

We considered a no cointegration hypothesis ($H_0: \eta_1 = \eta_2 = \eta_3 = \eta_4 = \eta_5 = 0$) against a cointegration one ($H_1: \eta_1 \neq \eta_2 \neq \eta_3 \neq \eta_4 \neq \eta_5 \neq 0$).

The previous hypothesis is examined by contrasting the estimated F-statistic with the two crucial values, as proposed by (Pesaran et al., 2001). The alternative hypothesis is accepted if this

value has a greater significance than the upper bound value. The null hypothesis is accepted if the specified value is less than the lower bound value. We cannot support any hypothesis if the estimated F-statistic lies between the two crucial levels.

We look at the Granger causality test after identifying the long-term relationship. We employ the VECM, or vector error correction model, for this.

$$\begin{aligned} \Delta REG_t = & \varphi_0 + \sum_{i=1}^{l_1} \varphi_{1i} \Delta REG_{t-i} + \sum_{i=0}^{l_2} \varphi_{2i} \Delta OILP_{t-i} + \sum_{i=0}^{l_3} \varphi_{3i} \Delta GDP_{t-i} + \sum_{i=0}^{l_4} \varphi_{4i} \Delta NREP_{t-i} \\ & + \alpha_1 ECT_{t-1} + \varepsilon_{1t} \end{aligned}$$

(1)

$$\begin{aligned} \Delta OILP_t = & \eta_0 + \sum_{i=1}^{l_1} \eta_{1i} \Delta OILP_{t-i} + \sum_{i=0}^{l_2} \eta_{2i} \Delta REG_{t-i} + \sum_{i=0}^{l_3} \eta_{3i} \Delta GDP_{t-i} + \sum_{i=0}^{l_4} \eta_{4i} \Delta NREP_{t-i} + \\ & \alpha_2 ECT_{t-1} + \varepsilon_{2t} \end{aligned}$$

(2)

$$\begin{aligned} \Delta GDP_{t-i} = & \xi_0 + \sum_{i=1}^{l_1} \xi_{1i} \Delta GDP_{t-i} + \sum_{i=0}^{l_2} \xi_{2i} \Delta REG_{t-i} + \sum_{i=0}^{l_3} \xi_{3i} \Delta OILP_{t-i} + \sum_{i=0}^{l_4} \xi_{4i} \Delta NREP_{t-i} + \\ & \alpha_3 ECT_{t-1} + \varepsilon_{3t} \end{aligned}$$

(3)

$$\begin{aligned} \Delta NREP_t = & \psi_0 + \sum_{i=1}^{l_1} \psi_{1i} \Delta NREP_{t-i} + \sum_{i=0}^{l_2} \psi_{2i} \Delta REG_{t-i} + \sum_{i=0}^{l_3} \psi_{3i} \Delta OILP_{t-i} + \sum_{i=0}^{l_4} \psi_{4i} \Delta GDP_{t-i} \\ & + \alpha_4 ECT_{t-1} + \varepsilon_{4t} \end{aligned}$$

(4)

We employ ECT_{t-1} term (lagged error correction) and the Wald test of the lags of each equation, respectively, to examine the long- and short-run effects.

3.2 Data

Our dependant variable is the renewable electricity generation (REG) measured in GWh for Algeria. This variable is collected from the Statistical Review of World Energy and covers the period 1980-2021.

The explanatory variables used in this study incorporate the oil price (OILP, measured in US dollars per barrel), the domestic product per capita (GDPc, expressed in constant 2010 US \$), and the dummy variable in the model indicates the presence of the national renewable energy program in Algeria (NREP). In other words, when NREP has been implemented (2011-2021), a value of one is assigned, while the zero is attributed in the other case. The first and second variables are collected from World Bank Indicators during the 1980-2021 period.

4. RESULTS AND DISCUSSION

We employ the following procedures in our paper. First, we analyze the statistical data that describes the relevant variables. Next, we look at the variables stationarity. Thirdly, we investigate whether there is a long-term relationship between the factors. Fourth, we estimate the long- and short-term coefficients and test the model's stability using the ARDL approach. To examine the causation between all variables, we then use the Granger causality approach.

4.1 Statistics analysis

Some descriptive statistics and data descriptions for the used variables are included in (Table 2). Our variables variability are shown by the coefficient of variation statistic. The REG registers the largest fluctuation, while the GDPc registers the lowest.

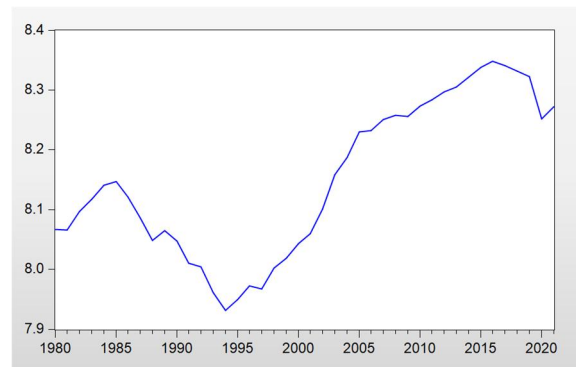
Table 2. Summary statistics

	Renewable electricity generation	Oil price	Gross Domestic Product per capita
Maximum	835	11.669	4224.037
Minimum	21.000	12.715	2783.155
Mean	239.881	44.033	3490.316
Standard deviation	225.714	29.728	454.6713
Coefficient of variation	0.940	0.675	0.130

Source: Eviews 10 software outputs

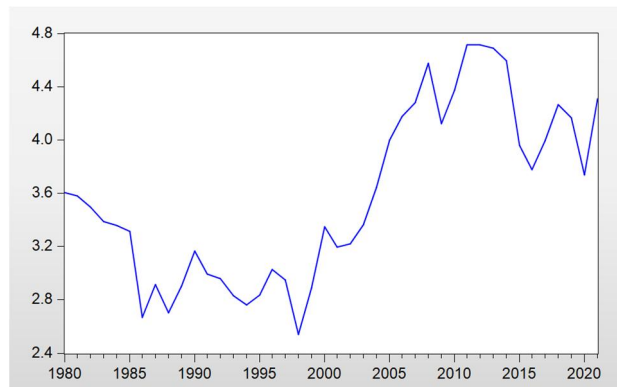
Figs. 4–6 show how our variables have changed over time. In contrast to a rather linear increase GDPc, there is a fluctuation trend for the variables measuring the generation of renewable energy and oil price.

Fig.4. Evolution of Domestic Product per Capita



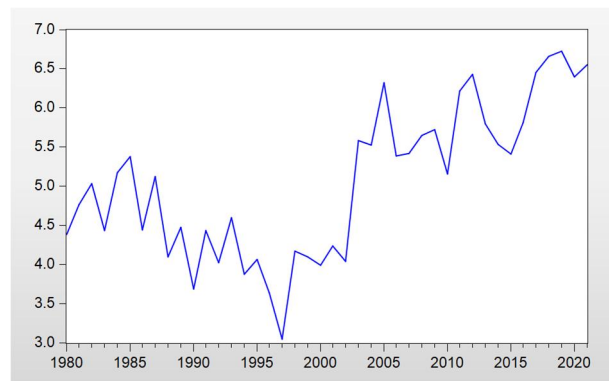
Source: Eviews 10 software outputs

Fig.5. Evolution of oil price



Source: Eviews 10 software outputs

Fig.6. Evolution of renewable electricity generation



Source: Eviews 10 software outputs

4.2 Stationary Tests

We perform a variety of tests, including (Dickey and Fuller, 1979), (Augmented Dickey and Fuller, 1979), and (Phillips and Perron, 1988) to prove that the variables are stationary. In models with intercept and models with intercept and trend, the unit root test is applied. The results shown in (Table 3) and demonstrate that all variables are I(1) at level. The variables at the first difference, however, are stationary.

Table 3. Linear Unit Root tests

Variables	Augmented Dickey–Fuller test statistic		Dickey-Fuller GLS test statistic		Phillips-Perron test statistic	
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend
RELEC	-1.4883(0)	-2.9721(0)	-1.4137(0)	-3.0025(0)	-1.1038(5)	-2.9019(3)
OILP	-1.4114(0)	-2.3607(0)	-1.4248(0)	-2.2143(0)	-1.4114(0)	-2.3607(0)
GDPc	-1.4055(3)	-2.2807(2)	-1.4130(3)	-2.4830(3)	-0.8275(4)	-1.5750(4)
Δ RELEC	- 7.3847(0)* **	- 6.0657(4)** *	-7.3756 (0)***	- 7.5320(0)* **	- 10.0114(27) ***	- 20.4728(39) ***
Δ OILP	- 5.8628(0)* **	- 5.7861(0)** *	- 5.8995(1) ***	- 5.8025(0)* **	- 5.7983(4)** *	- 5.7107(4)** *
Δ GDPc	- 4.0540(0)* **	- 4.0094(0)**	- 4.0955(0) ***	- 4.1109(0)* **	- 4.1587(3)** *	- 4.1092(3)**

***refers to the significance at 1% level;

**refers to the significance at 5%;

* refers to the significance at 10%

Source: Eviews 10 software outputs

Traditional unit root tests like the ones discussed above are inappropriate for time series data with structural breaks. Several researchers Jiménez-Rodríguez and Sánchez, (2005), Narayan and Smyth, (2005), Apergis and Tsoumas, (2011) employed the (Zivot and Andrews, 2002) unit root test , which can incorporate one break point in the data, to prevent the occurrence of biased findings. With the structural break, in specifications with intercept, trend, and both intercept and trend, Zivot and Andrews, (2002) tested the non-stationary hypothesis (presence of unit root) against the stationary hypothesis (non-existence of unit root). The last test's outcomes (see Table 4) supported those of the previously, more established tests. In fact, the stationary hypothesis is approved for all variables at first difference whereas the non-stationary one is accepted for all variables at level.

Table 4. Nonlinear unit root test

Variables	Zivot-Andrews unit root test			
	Intercept	Break year	Intercept and trend	Break year
RELEC	-3.8998(0)	1988	-4.4422(0)	2003
OILP	-3.5482(0)	2004	-3.5783(0)	2005
GDPc	-3.5281(3)	2002	- 2.8526(3)	1991
Δ RELEC	-6.5118(4)**	2009	-7.1161(4)**	2013
Δ OILP	- 6.6500(0)** *	2013	- 6.9420(0)***	2014
Δ GDPc	- 5.5727(0)** *	1995	-5.8581(0)***	1995

***refers to the level;
**refers to the 5%;
* refers to the 10%

Source:
software

significance at 1%
significance at
significance at

Eviews 10
outputs

According to the two types of unit root tests, renewable electricity generation, oil price, gross domestic product per capita are all expected to have I(1) in level and I(0) in first difference. Additionally, there is no variable that I(2). These findings give us the green light to examine the long-term correlation between the variables we studied.

4.3 Cointegration tests

The second step in the analysis focuses on testing long-run relationship between variables (or cointegration). We used the autoregressive distributed lag approach proposed by (Pesaran and al, 2001) to examine cointegration.

As shown in (Table 5), The outcomes of ARDL cointegration test indicate the appearance of a cointegration link between the gross domestic product per capita, oil price, national renewable energy program and the renewable energy generation. In fact, the computed F-statistic (15.00874) is higher than the upper critical bound value at 1% (5.00).

Table 5. Bound test cointegration results

Model	
$REG_t = f(OILP_t, GDPc_t, NREP_t)$	
Bound test F-statistic	15.00874***
Significance	1%
Lower I(0) Bound	4.13
Upper I(1) Bound	5.00

*** indicates the significance at 1% level

Source: Eviews 10 software outputs

4.4 Short and long-run ARDL estimation

(Table 6) presents the short- and long-term ARDL estimates for the effect of the national renewable energy program, the gross domestic product per capita, and the oil price, on the implementation of renewable energy. As well as, this Table summarizes some diagnostic tests for residuals, including serial correlation and normality.

Table 6. Long and short-run estimates. Selected Model: ARDL (1, 2, 2)

Long-run analysis				
Variables	Coefficient	Standard Error	T-Statistic	p-Values
Constant	-1050.839***	217.5280	-4.830822	0.0000
OILP	-4.357466***	0.929622	-4.687353	0.0001
GDPc	0.389457***	0.073930	5.267931	0.0000
<i>short-run analysis</i>				
Δ (GDPc)	0.527400***	0.151018	3.492292	0.0015
Δ (GDPc (-1))	-0.421464**	0.154358	-2.730439	0.0103
Δ (OILPRICE)	1.109462	0.872569	1.271488	0.2130
Δ (OILPRICE (-1))	5.835314***	1.059471	5.507765	0.0000
NREP	187.8511***	28.24782	6.650107	0.0000
ECT (-1)	-0.687233***	0.084692	-8.114480	0.0000
R2	0.739163			
Adjusted R2	0.700805			
F-statistic	37.55073***			0.0000
<i>Diagnostic tests</i>				
Serial correlation	0.078011			0.9251
Normality	0.150792			0.9273
Heteroscedasticity	1.403922			0.2339

***refers to the significance at1% level; **refers to the significance at5%; *refers to the significance at 10%

Source: Eviews 10 software outputs

The long-term results in (Table 6), reveal that the impact of oil prices on renewable energy deployment is negative. In addition, we find positive impact of Gross Domestic Product per capita on renewable energy generation, furthermore, these impacts are statistically significant.

The short-term outcomes show that GDPc has a negative and significant effect on renewable energy output. Furthermore, the effect of the political variable NREP and oil prices are positive and statistically significant. Notably, the impact of NREP on the implementation of renewable energy is considerably more pronounced when compared to the influence of economic factors (GDP per capita and oil prices).

As can be seen, oil prices have a positive effect on the implementation of renewable energy in the short term. With an increase of 1% in oil prices, the deployment of renewable energy increases by **5.835314%**. According to (STATISTA, 2021), hydrocarbons accounted for around 94% of Algeria's total merchandise exports which represents 40% of GDP in 2021. This demonstrates the heavy reliance of the Algerian economy on hydrocarbon revenues. When oil prices are high, the Algerian government may have an incentive to diversify its economy by investing in other sectors, such as renewable energy. This diversification can be beneficial in the short term to reduce overdependence on oil revenues and stimulate the deployment of renewable energy. In addition, the large budget surplus that the Algerian government generates from high oil prices provides an incentive to diversify its economy by providing sufficient funding for R&D initiatives and renewable energy projects. These results are consistent with (Dogan et al., 2021), (Zhao et al., 2021) (Lee and Huh, 2017), and (Özdurak, 2021), (Shah et al., 2018). Our findings are in direct opposition to those of Omri et al. (2015), Payne (2012), Sadorsky (2009), Mukhtarov et al. (2020)

In the long-term, an increase of 1% in oil prices impact negatively the implementation of renewable energy (**-4.357466%**). Must be remembered that Algeria is a country heavily dependent on oil revenues. In fact, when the oil price increases, the government's revenues also increase. This can increase economic dependence on the oil sector and limit incentives to diversify the energy mix by investing in renewable energy. Oil revenues can be used to fund other economic and social priorities, which can reduce the resources allocated to renewable energy. In addition, when oil prices are high, fossil fuels become more profitable in terms of electricity and heat production than renewable energy sources. Renewable energy projects may require larger initial investments and may be more sensitive to production costs. Furthermore, the existing energy infrastructure in Algeria is often focused on the exploitation of oil and gas resources. Adapting this infrastructure to support renewable energy may require significant investment and upgrading efforts. When oil prices increase, there may be a reluctance to invest in new renewable energy infrastructure, which limits its long-term implementation. Finally, when oil prices raise, the government may be more inclined to focus on exploiting and maximizing revenues from oil resources rather than actively promoting renewable energy. Policy priorities may be influenced by oil revenues, and investments in renewable energy may take a back seat.

The renewable energy deployment is favourably correlated in long-term with the Gross Domestic Product per capita. A 1% increase in GDP per capita enhance the level of implementation of renewable energy by **0.389457%**. in other words, when GDP per capita increases and persists, it

may indicate sustained economic growth and an increase in the country's fiscal capacity. This can encourage policymakers to diversify the economy and invest in sectors such as renewable energy to reduce dependence on fossil fuels and stimulate long-term sustainable growth. According to Embassy of the People's Democratic Republic of Algeria in Brussels, Algeria, as a signatory to the Paris Climate Agreement, may be required to comply with international commitments to reduce greenhouse gas emissions and transition to a low carbon economy. This may require an increase in the implementation of renewable energy over the long term, using GDP per capita as an indicator of the country's financial capacity to support this transition. Although this finding support several studies (Chang et al., 2009), (Dogan et al., 2021), (Bamati and Raoofi, 2020) and differs from that of (Tambari and Failler, 2020), (Li et al., 2023), (Matei, 2017).

Otherwise, in the short-term, GDP per capita has a negative impact, in this case, 1% increase in GDP per capita, decreases renewable energy investment by **-0.421464%**. An increase in GDP per capita can mean additional financial resources for the government. However, these resources can be directed to other priority areas, such as infrastructure, education, social services, health, etc. Although renewable energy has long-term cost-saving potential compared to fossil fuels, it can be expensive to implement initially. This is particularly true for Algeria, a country that already has an established energy infrastructure and is heavily dependent on fossil fuels. Therefore, there may be a preference for faster and cheaper energy solutions in the short term, such as expanding existing oil or gas infrastructure. This finding are in line with (Tambari and Failler, 2020)

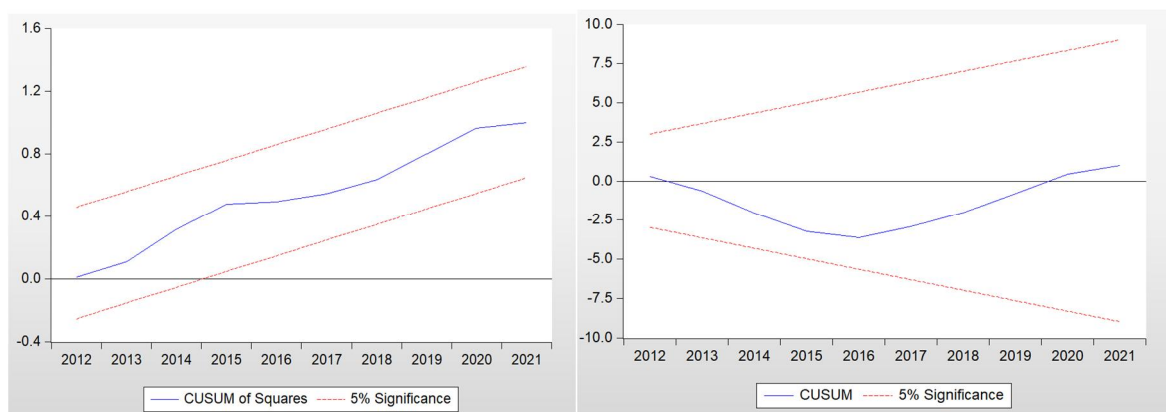
In the short term, there is a positive correlation between national renewable energy program and efficacy efficiency NREP and renewable energy deployment. A 1% increase in renewable energy programs results in an increase in renewable energy implementation of **187.8511%**. This coefficient is quite high, it shows us that Algeria focuses on political decisions more than economic conditions (oil price and GDP per capita) in the deployment of renewable energy. As a matter of fact, Algeria has committed to renewable energies in order to provide comprehensive, sustainable solutions to environmental challenges and the problems of preserving fossil energy resources, through the updated NREP, which aims to achieve a clean energy capacity of 22,000 MW by 2030, representing 27% of total installed electrical capacity and 37% of electricity production ("Ministry of Energy and Mining - Algeria," n.d.). In addition to increasing the share of renewable energies in the national energy mix, this program reduces dependence on fossil fuels for national power generation, which consumes a large proportion of gas production and reduces the amount of gas available for export, thus creating new opportunities for economic development and social well-being, as renewable

energy projects can generate jobs, income and added value at local level. However, a significant number of researchers have examined how policy choices affect renewable energy development, and the majority of them argue that policies have a significant impact on renewable energy markets. As an illustration, (Biresselioglu and Zengin Karabrahimoglu, 2012), (Uzar, 2020), (Smirnova et al., 2021), (Gallagher, 2013), (del Río and Mir- Artigues, 2014), (Fagiani et al. 2014) (Yoon and Sim, 2015).

4.5 Parameter stability

Model outcomes may be distorted by unstable parameters. Therefore, our goal is to test the estimated long-term parameters to analyze how they change over time. In order to verify the stability of the long-term parameters in the cointegrating equation, where renewable energy generation is the dependent variable, we employ the Pesaran and Pesaran (1997) test. This test necessitates the estimation of the error-correction model given by Eq. (1) by ordinary least squares and the residuals by the cumulative sum of the recursive residuals COSUM and the COSUMsq tests. The outcomes of the COSUM and COSUMsq stability tests are given in (Figure 7). The vertical axis, horizontal axis, and dotted red COSUM lines represent the year, COSUM statistics, and 5% critical limits for the statistics, respectively. The COSUM and COSUMsq test results demonstrate the stability of the ARDL parameters. In fact, both diagrams lie within the critical limits.

Fig.7. CUSUM and CUSUM of squares plot of recursive residual.



Source: Eviews 10 software outputs

4.6 Granger causality test

To investigate the causes and their direction and to differentiate between a long-run and a short-run relationship among variables (Granger, 1988), we applied vector error correction models VECM established to the previous equations (1)-(2)-(3)-(4).

After proving a long-term link between the controlled variables, the Granger causality test needs to be carried out. Table 7 gives the findings of the tests for Granger causality generated from the vector error correction models for the short- and long-runs, and summarizes findings on the direction of causality for each (for the short- and long-runs).

Table. 7 Outcomes of Granger causality tests

Dependent Variables	Independent variables					Direction of causality	
	Short-Run (SR)				Long-Run (LR)	SR	LR
	ΔREG	ΔGDP_c	$\Delta OILP$	$\Delta NREP$	ECT		
(1) ΔREG	---	3.572 (0.024)**	6.863 (0.001)***	3.598 (0.024)**	-0.687[- 8.114] ***	OILP → REG GDP _c →	OILP ↔REG
(2) ΔGDP_c	1.028 (0.393)	---	1.456 (0.244)	0.112 (0.952)	-0.271[- 4.300]	REG NREP → REG	GDP _c → REG
(3) $\Delta OILP$	0.651 (0.588)	0.700 (0.558)	---	0.569 (0.638)	-0.223[- 3.713]	OILP → NREP	OILP ↔ NREP
(4) $\Delta NREP$	0.611 (0.612)	2.414 (0.084)*	10.369 (0.000)***	---	-0.740[2.190] **	GDP _c → NREP	

*** 1% symbolizes the significance at 1% level. ** Symbolizes the significance at 5%. * Symbolizes the significance at 10%.

Source: Eviews 10 software outputs

According to Table 7, there is evidence of five unidirectional short-run Granger causality, the first one running from OILP to REG, confirms that fluctuating oil prices have an impact on renewable electricity generation. The second unidirectional link running from GDP_c to REG, this result confirm that when the GDP_c is higher the country has more financial resources to support the energy transition. Chang et al., (2015) explore the relationship between the use of renewable energy and economic growth in the G7 nations from 1990 to 2011. The findings show that there is a causal link between economic growth and renewable energy for the whole panel of G7 nations. Nevertheless, the individual results for each country show that Canada, Italy and the USA confirm the neutrality hypothesis; while there is a unidirectional causality among GDP and renewable energy for France

and the UK, and the opposite for Germany and Japan. The third unidirectional relationship going from NREP to REG. Our findings confirm that Algeria's national renewable energy program aims to reduce dependence on fossil fuels, diversify the energy mix and promote the development of renewable energies. After all, in short run, the outcomes show the existence of unidirectional link running from the economic conditions (OILP and GDPc) and policy decisions (NREP) to renewable electricity generation REG. These results confirm that the renewable energies transition depends on both, economic and policy factors in the short term. The last two unidirectional short-term relationships are running from economic conditions (OILP and GDPc) to policy decisions NREP, mean that OILP and GDPc are important factors that can help or slow down Algeria's national renewable energy program, high GDP and high OILP lead to a growing demand for energy, reinforcing the need to develop clean, sustainable energy sources.

However, in the long run, the findings involve two bidirectional relationships, the first among OILP and REG, confirm that the lower the oil price, the more energy producers tend to favor conventional energy sources and curb their investment in renewable energies, instead, the production of renewable electricity in Algeria has a negative impact on the price of oil, as it modifies the balance between supply and demand on the international market. The second link between OILP and NREP, show that energy policymakers set the fiscal and regulatory framework for the oil and gas sector, which influences hydrocarbon production, exports and prices, in return, the oil price affects the environmental goals and the energy transition strategies of energy policy makers, a high oil price means more incentives to develop renewable energy sources.

The third long run unidirectional link going from GDPc to REG confirm that the GDPc reflects the level of economic development and social welfare of the country. A high GDPc implies a high demand for energy, which increases the need to develop clean and sustainable sources of energy. A low GDPc indicates a situation of poverty and energy insecurity, which makes it difficult to access affordable, reliable, and modern energy services.

With regard to the long term, Table 7 shows that the estimated coefficients of the lagged error correction term in equation (1) and equation (4) are significant at the 1% and 5% level respectively, and have the expected negative sign. This implies, respectively, the existence of a long-term unidirectional causality between the economic variables (oil price and GDP per capita) and the implementation of renewable electricity. Thus, the existence of a bidirectional relationship between the oil price and the policy variable NREP, indeed, error corrections of -0.687 and -0.740 respectively

are the speed of adjustment, indicating that 68.7% of the deviations in the long-run relationships, for renewable electricity production in Eq. (1) and 74% of the deviations in the long-term relationships, for the national renewable energy program NREP in Eq. (4), are corrected in the current period to bring the system back to equilibrium.

There is no long run unidirectional causality among political decisions and renewable electricity implementation in Algeria, as they are often dictated by current considerations, such as fluctuating oil price.

5. CONCLUSION AND POLICY IMPLICATIONS

This paper intends to explore the dynamic relationship between renewable electricity generation, economic conditions (oil price, gross domestic product per capita), and political decisions (national renewable energy program) in Algeria over the period 1980-2021. In view of this objective, we examined an econometric model based on both, linear unit root tests (DF, ADF, PP) and non-linear unit root tests (ZA), as well as the cointegration approach ARDL bounds testing, and VECM Granger causality to investigate the existence and direction of a possible causal relationship between the series. By giving an increased understanding of all aspects of the causal relationship between the adoption of renewable electricity, the price of oil, the gross domestic product per capita, and the national renewable energy program in Algeria, this paper attempts to strengthen knowledge gained from previous studies in the field. The main reason is the lack of research regarding this relationship for Algeria. In fact, numerous causal connections between the series are discovered. Our findings indicate that Algeria's adoption of renewable energy depends on both political and economic factors.

The estimates of the ARDL model, in the short-run, indicate that renewable electricity generation is positively and significantly impacted by both, oil price and the national renewable energy program and negatively impacted by the gross domestic product per capita. As for the long run, renewable energy implementation is negatively impacted by the oil price, while positively impacted by the gross domestic product per capita and the policy instruments.

The outcomes of causality tests show, in both short and long terms, the existence of a unidirectional link running from gross domestic product per capita to renewable electricity generation. Moreover, the short-run findings reveal a unidirectional link going from economic conditions and policy decisions to renewable electricity production. Indeed, the presence of a unidirectional link going from economic conditions to policy decisions. Furthermore, the long run

results illustrate two bidirectional relationships, the first, among oil price and renewable electricity generation, the second, between oil price and the national renewable energy program.

This paper has several policy implications. Firstly, the oil price, which has been proved to influence renewable electricity generation, affects the competitiveness of renewable sources of electricity in relation to fossil fuels. For this reason, the Algerian government should adopt a long-term vision and commitment to the development of renewable energies, irrespective of oil price fluctuations. This will help the country to reduce its dependence on fossil fuels, diversify its energy mix.

Secondly, the Algerian government should consider the negative short run relationship between GDPc and renewable electricity generation, as higher income levels can increase the consumption and preference for conventional energy sources. At the same time, the government should also take into account the long-term favorable relationship between GDPc and the production of renewable power, since rising income levels might improve the demand for and affordability of clean energy sources. Therefore, policy makers should promote economic growth and diversification, especially in the non-hydrocarbon sectors, to reduce the dependence on fossil fuel revenues and create more opportunities for renewable energy development.

Thirdly, The Algerian government should pursue the implementation of the national renewable energy program (NREP) with determination and consistency, as it will help the country to achieve its renewable energy targets and objectives, as well as to contribute to the global efforts to combat climate change and promote clean energy transition. The NREP will also help the country to diversify its energy mix, reduce its dependence on fossil fuels, and create new opportunities for economic development and social welfare. Therefore, the policy makers should design and implement effective and consistent policies to support and stimulate renewable electricity deployment. For instance, simplifying and enhancing the tax system for renewable energy, establishing clear and ambitious renewable energy objectives, and providing transparent incentives and subsidies for renewable energy are essential steps.

5. Bibliography List :

Abada, Z., Bouharkat, M., (2018). Study of management strategy of energy resources in Algeria. Energy Reports 4, 1–7. <https://doi.org/10.1016/j.egyr.2017.09.004>

- Algeria Energy Information | Enerdata [WWW Document], 2023. URL <https://www.enerdata.net/estore/energy-market/algeria/> (accessed 5.24.23).
- Algeria Export Price: Annual: Crude Oil | Economic Indicators | CEIC [WWW Document], n.d. URL <https://www.ceicdata.com/en/algeria/export-price-of-hydrocarbon/export-price-annual-crude-oil> (accessed 5.20.23).
- Algeria Government Budget - 2022 Data - 2023 Forecast - 1990-2021 Historical - Chart [WWW Document], n.d. URL <https://tradingeconomics.com/algeria/government-budget> (accessed 5.20.23).
- Algeria: petroleum export value 1990-2021 | Statista [WWW Document], n.d. URL <https://www.statista.com/statistics/1180210/value-of-petroleum-exports-in-algeria/> (accessed 5.22.23).
- Algeria Powers Ahead with Huge Renewable Energy Plans [WWW Document], n.d. . International Energy Forum. URL <https://www.ief.org/news/algeria-powers-ahead-with-huge-renewable-energy-plans> (accessed 5.19.23).
- Apergis, N., Payne, J.E., (2015). Renewable Energy, Output, Carbon Dioxide Emissions, and Oil Prices: Evidence from South America. *Energy Sources, Part B: Economics, Planning, and Policy* 10, 281–287. <https://doi.org/10.1080/15567249.2013.853713>
- Apergis, N., Payne, J.E., (2014a). Renewable energy, output, CO2 emissions, and fossil fuel prices in Central America: Evidence from a nonlinear panel smooth transition vector error correction model. *Energy Economics* 42, 226–232. <https://doi.org/10.1016/j.eneco.2014.01.003>
- Apergis, N., Payne, J.E., (2014b). The causal dynamics between renewable energy, real GDP, emissions and oil prices: evidence from OECD countries. *Applied Economics* 46, 4519–4525. <https://doi.org/10.1080/00036846.2014.964834>
- Apergis, N., Tsoumas, C., (2011). Integration properties of disaggregated solar, geothermal and biomass energy consumption in the U.S. *Energy Policy* 39, 5474–5479. <https://doi.org/10.1016/j.enpol.2011.05.015>
- Bamati, N., Raoofi, A., (2020). Development level and the impact of technological factor on renewable energy production. *Renewable Energy* 151, 946–955. <https://doi.org/10.1016/j.renene.2019.11.098>
- Bélaïd, F., Youssef, M., (2017). Environmental degradation, renewable and non-renewable electricity consumption, and economic growth: Assessing the evidence from Algeria. *Energy Policy* 102, 277–287. <https://doi.org/10.1016/j.enpol.2016.12.012>
- Biresselioglu, M.E., Zengin Karaibrahimoglu, Y., (2012). The government orientation and use of renewable energy: Case of Europe. *Renewable Energy* 47, 29–37. <https://doi.org/10.1016/j.renene.2012.04.006>

- Bounds testing approaches to the analysis of level relationships - Pesaran - 2001 - Journal of Applied Econometrics - Wiley Online Library [WWW Document], n.d. URL <https://onlinelibrary.wiley.com/doi/abs/10.1002/jae.616> (accessed 5.21.23).
- Bouraiou, A., Necaibia, A., Boutasseta, N., Mekhilef, S., Dabou, R., Ziane, A., Sahouane, N., Attoui, I., Mostefaoui, M., Touaba, O., (2020). Status of renewable energy potential and utilization in Algeria. *Journal of Cleaner Production* 246, 119011. <https://doi.org/10.1016/j.jclepro.2019.119011>
- Brini, R., Amara, M., Jemmali, H., (2017). Renewable energy consumption, International trade, oil price and economic growth inter-linkages: The case of Tunisia. *Renewable and Sustainable Energy Reviews* 76, 620–627. <https://doi.org/10.1016/j.rser.2017.03.067>
- Chang, T., Gupta, R., Inglesi-Lotz, R., Simo-Kengne, B., Smithers, D., Trembling, A., (2015). Renewable energy and growth: Evidence from heterogeneous panel of G7 countries using Granger causality. *Renewable and Sustainable Energy Reviews* 52, 1405–1412. <https://doi.org/10.1016/j.rser.2015.08.022>
- Chang, T.-H., Huang, C.-M., Lee, M.-C., (2009). Threshold effect of the economic growth rate on the renewable energy development from a change in energy price: Evidence from OECD countries. *Energy Policy* 37, 5796–5802. <https://doi.org/10.1016/j.enpol.2009.08.049>
- del Río, P., Mir-Artigues, P., (2014). Combinations of support instruments for renewable electricity in Europe: A review. *Renewable and Sustainable Energy Reviews* 40, 287–295. <https://doi.org/10.1016/j.rser.2014.07.039>
- Dickey, D.A., Fuller, W.A., (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association* 74, 427–431. <https://doi.org/10.1080/01621459.1979.10482531>
- Dogan, E., Inglesi-Lotz, R., Altinoz, B., (2021). Examining the determinants of renewable energy deployment: Does the choice of indicator matter? *International Journal of Energy Research* 45, 8780–8793. <https://doi.org/10.1002/er.6413>
- Edenhofer, O., Pichs Madruga, R., Sokona, Y., IPCC (Eds.), (2011). Renewable energy sources and climate change mitigation: summary for policymakers and technical summary. International Panel of Climate Change, Genf.
- Eder, L.V., Provornaya, I.V., Filimonova, I.V., Kozhevin, V.D., Komarova, A.V., (2018). World energy market in the conditions of low oil prices, the role of renewable energy sources. *Energy Procedia*, 5th International Conference on Energy and Environment Research, ICEER 2018, 23-27 July 2018, Prague, Czech Republic 153, 112–117. <https://doi.org/10.1016/j.egypro.2018.10.068>
- Executive summary – Renewables 2022 – Analysis [WWW Document], n.d. . IEA. URL <https://www.iea.org/reports/renewables-2022/executive-summary> (accessed 5.20.23).
- Fagiani, R., Richstein, J.C., Hakvoort, R., De Vries, L., (2014). The dynamic impact of carbon reduction and renewable support policies on the electricity sector. *Utilities Policy* 28, 28–41. <https://doi.org/10.1016/j.jup.2013.11.004>

- Gallagher, K.S., (2013). Why & How Governments Support Renewable Energy. *Daedalus* 142, 59–77. https://doi.org/10.1162/DAED_a_00185
- Global Energy Transformation: A Roadmap to 2050 (2019 Edition), n.d.
- Granger, C.W.J., (1988). Some recent development in a concept of causality. *Journal of Econometrics* 39, 199–211. [https://doi.org/10.1016/0304-4076\(88\)90045-0](https://doi.org/10.1016/0304-4076(88)90045-0)
- Inglesi-Lotz, R., (2016). The impact of renewable energy consumption to economic growth: A panel data application. *Energy Economics, Energy Markets* 53, 58–63. <https://doi.org/10.1016/j.eneco.2015.01.003>
- Jiménez-Rodríguez, R., Sánchez, M., (2005). Oil price shocks and real GDP growth: empirical evidence for some OECD countries. *Applied Economics* 37, 201–228. <https://doi.org/10.1080/0003684042000281561>
- World Bank [WWW Document], n.d. . World Bank. URL <https://www.banquemondiale.org/fr/home> (accessed 5.18.23).
- Law and Policy Search - Climate Change Laws of the World [WWW Document], n.d. URL <https://climate-laws.org/> (accessed 5.20.23).
- Lee, C.-Y., Huh, S.-Y., (2017). Forecasting the diffusion of renewable electricity considering the impact of policy and oil prices: The case of South Korea. *Applied Energy* 197, 29–39. <https://doi.org/10.1016/j.apenergy.2017.03.124>
- Li, N., Jin, Y., Li, Y., Ma, X., (2023). How can visual communications aid in renewable energy development? *Renewable Energy* 208, 702–708. <https://doi.org/10.1016/j.renene.2023.03.108>
- Meredith, S., (2023). ‘Entering the clean power era’: Wind and solar generated a record amount of global power in 2022 [WWW Document]. CNBC. URL <https://www.cnbc.com/2023/04/12/wind-and-solar-generated-a-record-amount-of-global-power-in-2022.html> (accessed 5.19.23).
- Ministry of Energy and Mining - Algeria [WWW Document], n.d. URL <https://www.hotelsinvictoria.net/mem-algeriaorg/> (accessed 5.24.23).
- Mukhtarov, S., Mikayilov, J.I., Humbatova, S., Muradov, V., (2020). Do High Oil Prices Obstruct the Transition to Renewable Energy Consumption? *Sustainability* 12, 4689. <https://doi.org/10.3390/su12114689>
- Narayan, P.K., Smyth, R., (2005). Electricity consumption, employment and real income in Australia evidence from multivariate Granger causality tests. *Energy Policy* 33, 1109–1116. <https://doi.org/10.1016/j.enpol.2003.11.010>
- Ntanos, S., Skordoulis, M., Kyriakopoulos, G., Arabatzis, G., Chalikias, M., Galatsidas, S., Batzios, A., Katsarou, A., (2018). Renewable Energy and Economic Growth: Evidence from European Countries. *Sustainability* 10, 2626. <https://doi.org/10.3390/su10082626>

- Ohler, A., Fetters, I., (2014). The causal relationship between renewable electricity generation and GDP growth: A study of energy sources. *Energy Economics* 43, 125–139.
<https://doi.org/10.1016/j.eneco.2014.02.009>
- Omri, A., (2013). CO2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. *Energy Economics* 40, 657–664.
<https://doi.org/10.1016/j.eneco.2013.09.003>
- Omri, A., Daly, S., Nguyen, D.K., (2015). A robust analysis of the relationship between renewable energy consumption and its main drivers. *Applied Economics* 47, 2913–2923.
<https://doi.org/10.1080/00036846.2015.1011312>
- Özdurak, C., (2021). Nexus between crude oil prices, clean energy investments, technology companies and energy democracy. *GF* 3, 337–350. <https://doi.org/10.3934/GF.2021017>
- Pao, H.-T., Fu, H.-C., (2013). Renewable energy, non-renewable energy and economic growth in Brazil. *Renewable and Sustainable Energy Reviews* 25, 381–392.
<https://doi.org/10.1016/j.rser.2013.05.004>
- Payne, J.E., (2012). The Causal Dynamics Between US Renewable Energy Consumption, Output, Emissions, and Oil Prices. *Energy Sources, Part B: Economics, Planning, and Policy* 7, 323–330. <https://doi.org/10.1080/15567249.2011.595248>
- PHILLIPS, P.C.B., PERRON, P., (1988). Testing for a unit root in time series regression. *Biometrika* 75, 335–346. <https://doi.org/10.1093/biomet/75.2.335>
- Renewable Energy Target Setting [WWW Document], 2015. URL
<https://www.irena.org/publications/2015/Jun/Renewable-Energy-Target-Setting> (accessed 5.20.23).
- Sadorsky, P., (2009). Renewable energy consumption, CO2 emissions and oil prices in the G7 countries. *Energy Economics* 31, 456–462. <https://doi.org/10.1016/j.eneco.2008.12.010>
- Sahu, P.K., Solarin, S.A., Al-mulali, U., Ozturk, I., (2022). Investigating the asymmetry effects of crude oil price on renewable energy consumption in the United States. *Environ Sci Pollut Res* 29, 817–827. <https://doi.org/10.1007/s11356-021-15577-9>
- Shah, I.H., Hiles, C., Morley, B., (2018). How do oil prices, macroeconomic factors and policies affect the market for renewable energy? *Applied Energy* 215, 87–97.
<https://doi.org/10.1016/j.apenergy.2018.01.084>
- Smirnova, E., Kot, S., Kolpak, E., Shestak, V., (2021). Governmental support and renewable energy production: A cross-country review. *Energy* 230, 120903.
<https://doi.org/10.1016/j.energy.2021.120903>
- Stokes, L.C., (2013). The politics of renewable energy policies: The case of feed-in tariffs in Ontario, Canada. *Energy Policy* 56, 490–500. <https://doi.org/10.1016/j.enpol.2013.01.009>
- Strielkowski, W., Civín, L., Tarkhanova, E., Tvaronavičienė, M., Petrenko, Y., (2021). Renewable Energy in the Sustainable Development of Electrical Power Sector: A Review. *Energies* 14, 8240. <https://doi.org/10.3390/en14248240>

- Tambari, I., Failler, P., (2020). Determining If Oil Prices Significantly Affect Renewable Energy Investment in African Countries with Energy Security Concerns. *Energies* 13, 6740.
<https://doi.org/10.3390/en13246740>
- Tracking SDG7 The Energy Progress Report, 2022, n.d.
- Troster, V., Shahbaz, M., Uddin, G.S., (2018). Renewable energy, oil prices, and economic activity: A Granger-causality in quantiles analysis. *Energy Economics* 70, 440–452.
<https://doi.org/10.1016/j.eneco.2018.01.029>
- Uzar, U., (2020). Political economy of renewable energy: Does institutional quality make a difference in renewable energy consumption? *Renewable Energy* 155, 591–603.
<https://doi.org/10.1016/j.renene.2020.03.172>
- Wang, R., Hsu, S.-C., Zheng, S., Chen, J.-H., Li, X.I., (2020). Renewable energy microgrids: Economic evaluation and decision making for government policies to contribute to affordable and clean energy. *Applied Energy* 274, 115287.
<https://doi.org/10.1016/j.apenergy.2020.115287>
- Yang, X., He, L., Xia, Y., Chen, Y., (2019). Effect of government subsidies on renewable energy investments: The threshold effect. *Energy Policy* 132, 156–166.
<https://doi.org/10.1016/j.enpol.2019.05.039>
- Yoon, J.-H., Sim, K., (2015). Why is South Korea's renewable energy policy failing? A qualitative evaluation. *Energy Policy* 86, 369–379. <https://doi.org/10.1016/j.enpol.2015.07.020>
- Zeb, R., Salar, L., Awan, U., Zaman, K., Shahbaz, M., (2014). Causal links between renewable energy, environmental degradation and economic growth in selected SAARC countries: Progress towards green economy. *Renewable Energy* 71, 123–132.
<https://doi.org/10.1016/j.renene.2014.05.012>
- Zhao, J., Dong, K., Dong, X., Shahbaz, M., (2022). How renewable energy alleviate energy poverty? A global analysis. *Renewable Energy* 186, 299–311.
<https://doi.org/10.1016/j.renene.2022.01.005>
- Zhao, Y., Zhang, Y., Wei, W., (2021). Quantifying international oil price shocks on renewable energy development in China. *Applied Economics* 53, 329–344.
<https://doi.org/10.1080/00036846.2020.1808173>
- Zivot, E., Andrews, D.W.K., (2002). Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis. *Journal of Business & Economic Statistics* 20, 25–44.
<https://doi.org/10.1198/073500102753410372>