Renewable energy consumption and its contribution to Algeria's economic growth: Applying a model ARDL.

استهلاك الطاقات المتجددة ومساهمتها في النمو الإقتصادي الجزائري: تطبيق نموذج الانحدار الذاتي للفجوات الزمنية المبطئة.

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Abstract: In our paper, we aim to clarify the complementary relationship between renewable energy consumption and economic growth represented by real GDP in Algeria between 1980 and 2018, although there is a one-trend (Unidirectional) or two-trend (Bidirectional) relationship.

In the latter, we found that there is no complementary, one-trend, two-trend relationship between the consumption of renewable energy and economic growth, but the existence of short- and long-run integrative relations between the independent and dependent variables and the lack of causal relationship between them.

Keys words: **renewable energy, consumption, capital real, growth economy, ARDL.**

JEL classification codes: P18, E21, E22, O44, C61.

ملخص: نهدف في ورقتنا البحثية إلى توضيح العلاقة التكاملية بين استهلاك الطاقة المتجددة والنمو الاقتصادي الممثل بالناتج المحلي الإجمالي الحقيقي في الجزائر بين عامي 1980 و 2018، وتوضيح أيضا مدى وجود علاقة ذات اتجاه واحد (أحادي الاتجاه) أو ثنائية الاتجاه.

وتوصلنا إلى أنه لا توجد علاقة تكاملية ذات اتجاه واحد في اتجاهين بين استهلاك الطاقة المتجددة والنمو الاقتصادي، ولكن وجود علاقات تكاملية قصيرة الأجل وطويلة الأجل بين المتغيرة التابعة والمتغيرات المستقلة وعدم وجود علاقة سببية بينهما.

الكلمات المفتاحية: الطاقات المتجددة، الاستهلاك، رأس المال الحقيقي، النمو الاقتصادي، منهجية الانحدار الذاتي للفجوات الزمنية المبطئة.

تصنيف JEL: P18، E21، E22، O44، C61.

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1-Introduction

Most economists and experts agree that energy is the mainstay of the economy and the source of growth of any country. There is no sector immune to various energy sources, forcing countries to search for energy either by exploring or discovering it within its geographical area or importing it from abroad. What happened in those markets and waiting for any emergency either on price or other factors of stability, and gave these sources the status of their owners and the source of income over time split non-renewable fossil energy sources and emerged what is known as the renewable sources of many species, given the importance of the environment in particular and increase its importance after The enormous effects of fossil sources and the recent result of what is known as global warming. The call was urgent and urgent from international organizations that see empathy and know very well how it affects our planet, especially on human health and imposed several criteria to alleviate

this dilemma and carbon taxes to reduce greenhouse gas emissions, which led us to establish the need to link renewable and non-renewable energy to development and economic growth. Economists have differed through literary literature and current studies on the relationship between total energy consumption and economic growth. The difference still prevails in economic thought. Some believe that these two-trend **(Bidirectional)** variables, from energy consumption to GDP and from GDP to two-trend or one-trend **(Unidirectional)** from GDP to energy consumption or lack of relationship between variables according to current studies and the four hypotheses derived from those Studies and then the separation of recent studies total energy consumption to consumption and consumption of non-renewable energy renewable energies and their relationship to economic growth. From this point of view, we will begin by posing the following problem:

How is Algeria's renewable energy consumption related to economic growth?

Each study hypotheses at the beginning of the research to prove the validity or lack of validity in the latter are:

• Renewable energy consumption in Algeria has an impact on economic growth;
• Economic growth has an impact on renewable energy consumption in Algeria;
• There is a causal relationship between the formation of fixed capital and the consumption of renewable energies in Algeria.

The importance of the research in the new direction of the Algerian state in particular to raise the share of renewable energies in the energy mix to reduce the pressure on fossil sources and benefit from the advantage granted to Algeria with the enormous potential of renewable energy sources, especially solar energy;

We aim to highlight the impact of renewable energies on economic growth by providing energy, opening up new jobs, taking advantage of the huge savings from these sources, and then determining the relationship between renewable energy consumption and economic growth at the national level (Algerian). Renewable sources;

To describe, analyze and measure the relationship between renewable energy consumption and economic growth, we followed the descriptive method by mentioning the theoretical aspect of the previous studies and the analyzes methodology by analyzing the evolution of the variables of the study and then the standard method by forming a standard model of relationship and carrying out various tests using the ARDL methodology;

The third axis was devoted to the model of the study and the economic theory that was based on it. The fourth axis will deal with measuring the relationship between the consumption of renewable energy and growth Economic development in Algeria by applying the ARDL methodology.

2- Previous studies (time new romaine 14)

There are many studies that dealt with the relationship between energy in general and economic growth previously and then specialized studies

to include the relationship renewable energy and non - renewable (we find some studies focused on renewable energy alone and once together with non - renewable energies) and economic growth and some studies:

2-1- R. Sari et al., 2008: Estimation of the ARDL model on the variables of industrial production, employment, fossil energy, hydropower, solar, wind, natural gas, biomass energy and wood consumption in the case of the United States of America. Conducted this study from January 2001 to June 2005 and showed that the industrial production factor with labor has a negative and positive impact (at the same time) on the consumption of hydropower, biomass and wind (Ramazan sari, 2008).

2-2- The study of Menyah and Wolde-Rufael (2010): reveal the causal relationship between carbon dioxide emissions, renewable energy consumption, nuclear power, and the real GDP of the United States of America for the period 1960-2007. Experimental estimates indicate a one-way causal relationship from nuclear power consumption to CO2 emissions. These estimates have shown that nuclear power consumption can contribute to the reduction of CO2 emissions and, conversely, have found no causal relationship resulting from the consumption of renewable energies Carbon dioxide emissions have even found a causal relationship, one-trend from carbon dioxide emissions to renewable energy consumption, and the economic evidence for these studies appears to be (Menyah, 2010).

2-3- The study of MSB Aïssa et al. (2014): The study examined the relationship between the consumption of renewable energies and the trade and economic production of 11 African countries during the period 1980-2008. They used the panel cointegration method for variables of GDP, consumption of electricity produced from renewable energies, Exports and imports, fixed capital formation, labor, and found no causal relationship between these variables in the short-run (M. S. Ben Aïssa, 2014).

2-4- A. Omri et al. (2015): Test the relationship between nuclear energy consumption, GDP, renewable energy consumption of 17 developed and emerging countries. They used the method of des equations simultanées dynamiques during 1990-2011 and found a causal link between GDP and renewable energy consumption for Belgium, Bulgaria, Canada, France, Pakistan and the United States of America. However, they found that there is a one-trend causal relationship from GDP to renewable energy consumption (A. Omri, 2015).

2-5- Study of A.A. Rafindadi and I. Ozturk (2017): This study was conducted on the relationship between renewable energy consumption and economic development - the case of Germany. The method used was ARDL and VECM (Vector Error Correct Model) and the structural separator in the unit root test. The researchers used these techniques during the first half of 1970 to the fourth quintile of 2013 and relied on the following variables: GDP per capita, renewable energy consumption per capita, real per capita capital and labor force

per capita. They found long-term with the ARDL method that a 1% increase in renewable energy consumption would increase economic development by 0.2194%, also they had the same positive results with the VECM method, but with different coefficients. Also, the causal result was the same (positive), so they concluded a two-trend relationship between GDP and renewable energy consumption (Rafindadi, 2017).

2-6- study of F. Amri (2017): The study examined the causal relationship between carbon dioxide emissions, income, non renewable energy and renewable energy consumption in Algeria during the period from 1980 to 2011. The study examined the validity of the Kuznets environmental hypothesis using the ARDL method. Positive impact of non-renewable energy on CO2 emissions. On the contrary, the results reveal a small impact of renewable energy on improving the environment, so the Algerian authorities to expand the proportion of renewable energies in the energy mix and reduce the share of non-renewable energy consumption (Amri, 2017).

3- The study model

There are effects of renewable energies on economic growth and economic development when the integration of these energies in the energy mix according to the previous studies that we mentioned, this study was conducted as a case study between 1980 to 2018 taking into account the following elements of real capital, Employment, in the energy demand function, based on the demand theory of COBB-DOUGLASS, and the energy demand function is as follows:$Y_t = f(RE_t \times K_t \times L_t)$; Where the string is converted by entering the logarithms to be transmitted in linear form, the form is as follows (Rafindadi, 2017): $\ln Y_t = \beta_1 + \beta_2 \ln RE_t + \beta_3 \ln K_t + \beta_4 \ln L_t + \mu_t$

The model variables are defined as follows:

$Ln\ Y_t$: Represents the natural logarithm of real GDP;

ln RE_t: Represents the natural logarithm of real RE;

ln K_t: Represents the natural logarithm of real K;

ln L_t: Represents the natural logarithm of real L.

We first test the dormancy to see ,if the series is stable or unstable by determining the delay period (or delay). We test the dependent variables of GDP, real capital stock (K), labor (L) each variable separately and we test Independent variable renewable energy consumption (RE) during that period. In this study we took the time series from 1980 to 2018 in Algeria. We relied on two data extraction bodies, the World Bank, for the dependent variables (Gross Domestic Product (GDP), Real Capital Stock (K), Labor (L) and Variable Data (Renewable Energy Consumption (RE)) from the Renewable Energy Development Center the Algerian.

4- Evolution of the variables of the study

4-1- Evolution of the Gross Domestic Product in Algeria between 1980 and 2018: The GDP was characterized by increases in periods and others marked by

a decline due mainly to the rise and fall of oil prices to consider the Algerian economy highly profitable by relying on the oil supplier in its revenues and its contribution to the ratio The gross domestic product, by looking at Figure (2), we find that the largest rate achieved by Algeria in the crude output was in 2014 to reach the price of a barrel to about $ 149, in addition to the production of nearly one million and 200 thousand barrels per day, the treasury lost billions of dollars, where Algeria achieved that year An output of $ 213.81 billion The average output rate in the 1990s was exactly in 1995 at $ 41.76 billion, well below the peak, and all agree on a fall in output over the 1990s tensions or so-called "black decadence" and the ensuing instability. Starting in 2014, GDP started to decline as a result of the drop in the price of oil. This led the OPEC countries led by Algeria to reduce production in order to raise the price of oil until the oil markets recovered as a result of the strategy of reducing production in addition to other reasons, most importantly sanctions on Iran. In the first quarter of 2018, nearly 1.3% (according to the National Bureau of Statistics), thanks to the recovery of the price of a barrel of oil, where the price reached $ 70 per barrel following the policy of roofing production by the Organization of Petroleum Exporting Countries (OPEC) Increase the contribution of outside sectors Water, fuel, agriculture, construction, public works and industry were up by 2% compared to the first half of 2017, respectively: 4.7% for public works and construction, 4.2% for agriculture and fishing, 4.1% % For industry. Algeria, through the new growth model for the period 2016-2019, aims to raise the contribution of the non-hydrocarbon sectors in the GDP to 6.5% each year over the period 2020-2030, thus increasing per capita GDP by 2.3 once.

Table 1. Algeria's GDP growth between1980-2018 (current US $).

1987	**1986**	**1985**	**1984**	**1983**	**1982**	**1981**	**1980**
66.742	63.696	57.938	53.698	48.801	45.207	44.349	42.345
1995	**1994**	**1993**	**1992**	**1991**	**1990**	**1989**	**1988**
41.764	42.543	49.946	48.003	45.715	62.045	55.631	59.089
2003	**2002**	**2001**	**2000**	**1999**	**1998**	**1997**	**1996**
67.864	56.76	54.745	54.79	48.641	48.188	48.178	46.941
2011	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**
200.019	161.207	137.211	171.001	134.977	117.027	103.198	85.325
	2018	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**
	188.321	167.555	160.130	165.979	213.81	209.755	209.059

Source: World Bank, Statistics on Gross Domestic Product (current value of US $), view website Date: 06/03/2019, Location:https://data.albankaldawli.org/indicator/NY.GDP.MKTP.CD?locations=DZ.

4-2- Fixed capital evolution between 1980-2018: Gross fixed capital formation (formerly called fixed gross domestic investment) includes real estate improvements (fences, drainage channels, dams ...) and purchase of equipment, machinery and equipment, road and rail construction Schools, hospitals, private

housing, public, commercial and industrial buildings according to the 1993(www.knoema.fr, 2011). According to the annual data, fixed capital peaked during 2014 due to the large increase in oil prices at a rate of $ 97.40 billion - In the current value of the dollar where the exchange rate is used The market in the International Monetary Fund for currency transfers(www.ceicdata.com, 1992) - and reached its lowest level in 1997, reaching $ 10,814 billion due to the situation and the instability experienced by Algeria. The fixed capital ratio declined in 2015 and 2016 until it grew by 2017 at an increase rate of US $ 900 million compared to the previous year. The rate recovered in 2018, reaching US $ 82 billion, summarizing the development of fixed capital formation through the following table (albank aldawli, 1974).

Table2. Development of fixed capital formation in Algeria between the period1980-2018 (current US $).

1987	**1986**	**1985**	**1984**	**1983**	**1982**	**1981**	**1980**
19.814	21.948	18.795	17.980	16.768	15.570	14.597	14.306
1995	**1994**	**1993**	**1992**	**1991**	**1990**	**1989**	**1988**
12.169	12.082	13.489	12.997	11.823	16.734	15.087	15.503
2003	**2002**	**2001**	**2000**	**1999**	**1998**	**1997**	**1996**
16.347	13.947	12.504	11.329	11.863	12.407	11.058	11.679
2011	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**
63.346	58.491	52.465	49.988	35.532	27.110	23.086	20.493
	2018	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**
	70.098	69.306	68.933	70.138	80.005	71.702	64.388

Source:https://data.albankaldawli.org/indicator/NY.GDP.MKTP.CD?locations=DZ&view=char.

4-3- Evolution of the total labor force in Algeria between the period 1980-2018: The total labor force of the International Labor Organization consists of persons over the age of 15 who are economically active and include all persons who provide the labor force to produce goods and services within a specified period. They include both workers and the unemployed. While some national customs differ in the inclusion of different groups of the total labor force, such as the armed forces and seasonal or part-time workers, the labor force generally includes the armed forces, unemployed and job seekers for the first time but excludes housewives and others Carers and workers in the non-seasonal sector(www.tradingeconomics.com, 2011). The total labor force reached a peak in 2014 due to the opening of employment in all sectors of the public sector. This is due to the availability of wage funds as a result of the increase in the gross domestic product this year. This contributed to the growth of the total labor force and the lowest starting year. (2018). The state works to create jobs in the private sector where the labor environment is characterized by difficult access to credit, the complex regulatory environment and the time consumption of business creation. This hinders the private sector on the one hand and represents corruption and lack of sufficient skills. Large dome in front of

business Despite efforts to facilitate the establishment of institutions and the granting of building permits, Algeria still ranks late in the Doing Business report. Algeria ranked 163th out of 189 countries in 2016 in the ease of doing business (The European Training Foundation, 2019). We find the decrease in the number of employment in 2014 compared with 2013 as a result of the departure of a large number of employees because of reaching retirement age, the total workforce in 2018 about 11 million 864 thousand workers and the private sector is about 6.95 million workers, or 63% of the total workforce by And the public sector will absorb about 4.09 million workers, or 37% of the total labor force and most of the male workers, which amounted to 9,073 million, or 82.1%. As for the distribution of workers in sectors, the construction sector comes in the first quarter by 17.2 (1,9 million), then the public sector by 15.7% (1.73 million) (excluding the health sector), the trade sector 15.5% (1.71 m) Lyon), health and social activity 14.1% (1.56 million), manufacturing 12% (1.33 million) and agriculture by 10.4% (1.14 million) (Office National des Statistiques, 1964). Table (03) shows the most comprehensive development between the period 1980-2018 (WORLD BANK AND ONS, 1944, 1990).

Table3. Evolution of the total labor force in Algeria between the period 1980-2018 (million).

1987	**1986**	**1985**	**1984**	**1983**	**1982**	**1981**	**1980**
6.098	5.990	5.466	5.346	5.123	4.987	4.675	4.367
1995	**1994**	**1993**	**1992**	**1991**	**1990**	**1989**	**1988**
7.847	7.594	7.300	7.004	6.755	6.484	6.346	6.246
2003	**2002**	**2001**	**2000**	**1999**	**1998**	**1997**	**1996**
9.599	9.379	9.158	8.931	8.719	8.508	8.298	8.095
2011	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**
11.359	11.137	10.861	10.661	10.460	10.255	10.042	9.820
	2018	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**
	12.264	12.106	11.937	11.799	11.642	12.065	11.598

Source*:* World Bank, Algeria's total labor force data for the period 1980-2017, and the National Statistical Bureau of Statistics (ONS) Statistical Abstract of 2018.

4-4- Evolution of renewable energy consumption in Algeria between the period 1980-2018: The renewable sources of electricity generation are divided into several sections mentioned in the previous chapter and we will focus on some of these sources in the case of Algeria. This is because there are not all other sources or not exploited by decision makers for example But the sources of exploitation in Algeria are primarily the source of the sun to provide Algeria with enormous capabilities, and then the source of water to generate electricity Algeria has a coast of 1300 km, waterfalls and dams that will contribute significantly In generation electricity is exploited and there is a wind source. Despite the establishment of a wind farm in Adrar to generate electricity, it remains relatively small compared to the existing capabilities without forgetting

the source of geothermal energy. There are many bathrooms in Algeria. This means that there is underground energy to be used to generate thermal energy and electric power. And household restoration is an important source of energy at the local level. The total renewable energy production in Algeria (solar energy in particular) has been remarkable especially in recent years thanks to the interest of decision makers in the development of renewable energies, especially in remote areas isolated from the network and desert areas, in addition to establishing stations in several places mentioned in the previous chapter. Of the rate of generation of electricity from renewable sources, especially solar energy, Algeria intends under the program of renewable energies and energy efficiency to generate 12000 MW by 2030. There are several joint projects - domestic foreign – Algeria-Japan and Algeria-China and Algeria-Germany to generate solar energy. Renewable energy generation in early years was dominated by hydropower until early 2003, when the first solar power project was launched. Carlo-robia said: "The Algerian Sahara, where the sun is raining every year, is equivalent to one barrel of oil per square meter of solar energy. The future capacity on earth in Algeria is between 85 and 290 W / m². According to the distribution of electricity generation in Algeria, natural gas represents 94.5%, a small amount of hydroelectric power, 5%, solar energy and 0.5% wind, which is very small compared to available solar sources. Algeria has diversified and valued generation Renewable energies to achieve the share of renewable in primary energy supply by 5% in 2015 and increase the share to 10% by 2020(Khanfri khaider, 2018). The following table shows the evolution of renewable energy consumption in Algeria between 1980-2018 (WORLD BANK, CDER, IAEA, , 1974, 2011).

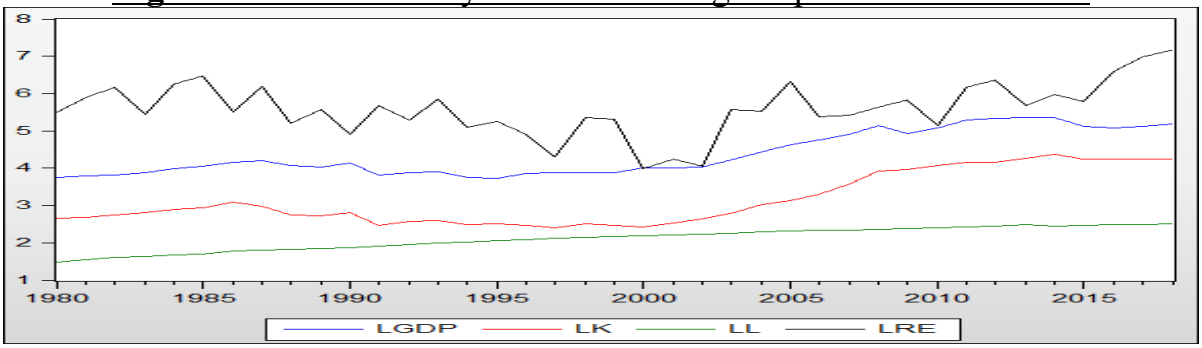
Table4. Evolution of renewable energy consumption (GW) in Algeria between 1980-2018.

1987	**1986**	**1985**	**1984**	**1983**	**1982**	**1981**	**1980**
491	247	639	516	233	474	362	248
1995	**1994**	**1993**	**1992**	**1991**	**1990**	**1989**	**1988**
191	164	349	197	290	134	263	181
2003	**2002**	**2001**	**2000**	**1999**	**1998**	**1997**	**1996**
265.2	57.4	69	54	201	213	74	134
2011	**2010**	**2009**	**2008**	**2007**	**2006**	**2005**	**2004**
481.3	172.9	342	282.7	226.1	217.6	555.3	251.1
	2018	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**
	1300	1088	726	326.5	391.3	291	582.6

Source: World Bank (www.albankaldawli.org), Renewable Energy Development Center (www.cder.dz), and International Renewable Energy Agency (www.iaea.org), for information on renewable energy consumption data in Algeria at: 16/03/2019.

We summarize these developments in the different variables of the study as follows.

Fig1. Evolution of study variables during the period 1980 - 2018.



Source: EVIEWS Outputs.

5- Results of the ARDL model tests to determine the relationship between renewable energy consumption and economic growth in Algeria:

Economists are likely to have three important steps to implement the ARDL methodology, the first being unit root test and then the joint integration test by testing bounds of the minimum and upper critical values test bounds) and the ARDL VECM error correction methodology, Pesaran and others have shown that if the F statistic exceeds the critical value, we reject the null hypothesis that there is no integration between the variables and accept the alternative hypothesis that assumes a long-run relationship among the series. If F-statistic is less than the minimum critical value, Term relationship and then the second step of estimating long-run and short-run parameters using the error correction model (ECM). For long-run convergence of dynamics, a condition must be provided that ECM_{t-1} is a negative and statistically significant sign. Once the variables are integrated over the long-run, the long-run causal relationship can be investigated as well as in the short-run. The existence of this long-run relationship requires the detection of the trend of the causal relationship, whether mono or binary, between the variables by applying the model of error correction and causal testing of Granger. In order to unit root test and there are several tests of unit root and all these tests are similar in terms of null hypothesis and alternative hypothesis except KPSS test (Kwiathowski-Phillips-Schmidt-Shin) and is contrary to those tests. All of these tests examine the integration relationship with respect to the long-run relationship.

5-1- lag order selection optimal of series: There are several criteria for measuring the optimal lag order selection: AIC (Akaike information criterion, 1973) and (SC)Schwarz standard (Schwarz information criterion in 1978), which are the most important criteria for determining the lag order: This criterion is more accurate and rigorous in choosing the lag order. Other criteria are: HQ (Hannan and Quinn, 1979), the Final Predication Error proposed by Akaike in 1969, and according to the results of the lag order selection test The optimal lag order in Table (05) is: 1(*) according to the most accurate SC standard as well as the coefficient See FPE and LR, and we find that all the appropriate tests or lag order selection optimal is: 1, all chose at the level of 5%.

Table5. Criteria for lag order selection to determine stability series.

Lag	Log L	LR	FPE	AIC	SC	HQ
0	-16.95254	NA	4.18e-05	1.269851	1.451246	1.330885
1	134.7910	257.5042*	1.13e-08*	-6.957029	-6.050055*	-6.651860
2	146.9450	17.67850	1.49e-08	-6.723937	-5.091383	-6.174632
3	158.1724	13.60905	2.26e-08	-6.434693	-4.076559	-5.641252
4	171.3517	12.77990	3.46e-08	-6.263739	-3.180027	-5.226164
5	201.7940	22.13987	2.35e-08	-7.139032	-3.329740	-5.857321
6	242.3183	19.64812	1.36e-08	-8.625350*	-4.090479	-7.099504*

*Indicates lag order selected by the criterion.

5-2- Stationary the series of model:

a- Augmented Dickey-Fuller unit root test: There are several tests related to string stationary testing, including ADF, the Dickey-Fuller (GLS), Phillips Perron, NG-Perron, and the Augmented Dickey-Fuller test. The ADF value is greater than the critical values at the levels of 1%, 5% and 10% in the case of the existence of the Intercept. In the case of the trend & intercept and if there is no trend & intercept (None) set by Mackinnon in 1996 to test one-sided p-values, we say that the GDP variable is unstable at the level I(0) and thus has unit root at the levels (1%, 5%, 10%). In the ADF test for the variable GDP We found that the value of ADF, which is -5.043577, is significant in the absence of intercept& trend, and less than the critical values tested at the levels of 1%, 5% and 10%. Therefore, we reject the null hypothesis and accept the alternative hypothesis which assumes stability Variable and therefore does not have a unit root and the variable GDP is stable at level I(1).The ADF test for variable K was found to be unstable at level I(0). The ADF value is greater than the critical values at the levels (1%, 5% and 10%) in the case of intercept and in the case of intercept & trend. In the three cases and therefore accept the null hypothesis that assumes the instability of the variable series K and therefore have a root unit and the K series is unstable at the level I(0), while the ADF test for the same change at the first difference I(1) The absence of intercept & trend (None) of the variable has a statistical significance at 5% and less than the critical values at each level (1%, 5%, 10%) and the value of - 4.208045below the critical values respectively: -2.628961, -1.950117, -1.611339 thus rejecting the null hypothesis and accepting the alternative hypothesis that assumes the stability of the K series at the first difference I(1) It has a root unit. The ADF test for variant L we found is unstable at level I(0) and its value is greater than the critical values at all levels 1%, 5%, 10% in the case of the intercept and in the case of intercept & trend and the state of absence of intercept & trend (None). In the first difference I(1) of variant L, we found an ADF value below the critical values at all levels and in all three cases (intercept, trend & intercept, none) We therefore reject the null hypothesis and accept the alternative hypothesis that assumes the stability of the L series at the first difference I(1) and therefore not unit root. For the series stability test with the ADF test we found that the ADF value is greater

than the critical values at 1%, 5% and 10% in the case of intercept and in the case of intercept & trend and in None, and thus accept the hypothesis of nothingness and reject the alternative hypothesis that assumes instability I(1) proves that it is stable and does not have a root unit at all levels 1%, 5% and 10% when there is None.

Table6. Augmented Dickey-Fuller unit root test results.

First Différence I(1)		LEVEL I(0)		Variables
Results	**Statistic ADF**	**Results**	**Statistic ADF**	
Stable	(not significatif) (I) -5.383 (not significatif) (T&I) -5.339 (significatif in 5 %)(N) *-5.043	**unstable**	(I) -3.314 (T&I) -1.329 (N) 1.829	**LGDP**
Stable	(not significatif) (I) -4.489 (not significatif) (T&I) -4.603 (significatif 5 %) (N)*-4.208 (in	**unstable**	(I) 0.356 (T&I) -1.060 (N) 2.039	**LK**
Stable	((significatif in5 %) (I) *-9.315 (significatif 5% (T&I)*-10.018 (in (significatif 5 %) (N) * -5.975 (in	**Unstable**	(I) -2.277 (T&I) -0.862 (N) 5.030	**LL**
Stable	(not significatif) (I) -9.419 (not significatif) (T&I) -9.551 ((significatif in5 %) (N) -9.503	**Unstable**	(I) -2.710 (T&I) -2.843 (N) 0.369	**LRE**

Source: EVIEWS Outputs.

From Table 06, all variables of the GDP, K, L and RE model are unstable at level I (0) and stable at the first difference when the Augmented Dickey-Fuller test is performed where the GDP and K variables are stable at the first difference I (1) There is no constant and only trend but the L series is stable at the first level in the three cases.

B- NG-Perron Unit root test: In addition to the Dickey-Fuller extender test, we test the root of another unit, the NG-Perron test. In order to determine the characteristics of the unit root of the variables, in the NG-Perron test of the GDP variable we found that the MZa, MZt, MSB and MPT NG-Perron test values at level I(0) were greater than all the critical values of the approach at 1% and 5% (MZa, MZt, MSB, MPT) expressed in the NG-Perron data is lower than the critical values at 5% and 10% in the case of NG-Perron. The trend and at all levels 1%, 5% and 10% in the case of intercept, and thus accept the null hypothesis and reject the alternative hypothesis and therefore has no root unit and stable series in first difference level I(1). N-Perron K series test at level (0) I

found that the MZa, MZt, MSB, and MPT values that express the NG-Perron statistic are greater than the critical values of the approach at all levels. We reject the alternative hypothesis and thus have a unit root. K series is unstable. When testing at the first difference I(1), we found that the NG-Perron values are less than the critical values at all levels 1%, 5% and 10% of the critical values at 5% and 10% in the case of intercept& trend and thus reject the null hypothesis and accept The alternative hypothesis is that the K series does not have a unit root and is therefore stable at the first difference I(1). The NG-Perron Variable L test at level I(0) found that the declared values of MZa, MZt, MSB, and MPT were greater than the critical values of the approach at all levels 1, 5% and 10%, thus accepting the null hypothesis and rejecting the alternative hypothesis 1 We found that the values expressed in the NG-Perron statistic are also lower than the critical values in levels 1, 5 and 10%. If there is a intercept and less than the critical values of the approach at 5% and 10% levels, in the case of intercept and trend we accept the alternative hypothesis and reject the null hypothesis and say to the variable L does not have unit root and therefore are considered stable in the first difference I(1). For the NG-Perron variable RE at level I(0), the MZa, MZt, MSB, and MPT values for the NG-Perron statistic are greater than the critical values at all levels 1, 5% and 10% (MZa, MZt) in case intercept & trend and say the series RE is not stable in level I(0). for NG-Perron Less than critical values at all levels 1%, 5% and 10% and other expressive values (MSB, MPT) are below critical values approaching 5% and 10% levels in case of intercept and less than critical values approach at 10% level if there is The trend and thus accept the alternative hypothesis and reject the null hypothesis and say the RE series does not have the root unit and is considered stable at the first difference I(1). Table (07) shows the results of the NG-Perron root test and shows that all local model variables K, L and RE are unstable at level I(0) and stable at the first difference I(1).

Table7. NG-Perron root unit test results for study variables.

MPT	MSB	MZt	MZa	variables
37.6181 30.6213	0.73850 0.40975	0.40441 -1.21835	0.54761 -2.97338	**ln GDP_t -:I -T&I**
22.7946 60.8177	0.56763 0.57170	0.02401 -0.79716	0.04229 -1.39437	**ln K_t - :I -T&I**
106.784 27.7162	1.25043 0.34250	1.36881 -0.80506	1.09467 -2.35054	**ln L_t - :I -T&I**
2.93174 8.13940	0.18863 0.19221	-2.18891 -2.34240	-11.6045 -12.1868	**ln RE_t - :I -T&I**
1.34514 4.97415	0.16502 0.16504	-3.02518 -3.02743	-18.3326 -18.3437	**Δln GDP_t -:I -T&I**
1.43590 5.27157	0.17088 0.16846	-2.92383 -2.94715	-17.1103 -17.4950	**Δln K_t -:I -T&I**

1.49104 6.33473	0.16956 0.18623	-2.91325 -2.68218	-17.1815 -14.4021	**$\Delta \ln L_t$ -:I** **-T&I**
1.53405 6.03483	0.17694 0.18186	-2.82585 -2.74796	-15.9709 -15.1105	**$\Delta \ln RE_t$ -:I** **-T&I**

Source: EVIEWS outputs.

The results of the NG-Perron test showed that the study variables were unstable at level I(0) and stable at the first difference I(1). The results were consistent with previous ADF test results.

5-3- Bound test: This test is different from other models. It does not require that the time series be integrated into the first class (it is possible to be integrated with class 0, ie at level I (0)). It has better characteristics for short-run series, Compared to other methods of detection of co-integration, and this test is due to Pesaran & Al (2001). This methodology defines the long-run and short-run complementary relationship between GDP and independent variables (K, L, RE), as well as the extent to which each independent variable affects the gross real domestic product (GDP).When bounds tests approach, we rely on F-statistic to determine the long-run integrative relationship. There are two hypotheses for the existence or absence of a long-run integrative relationship. The null hypothesis assumes that there is no long integrative relationship when the value F is below the upper critical limits. I1 Accept the null hypothesis and reject the hypothesis if we are larger than the upper critical limits I1 or greater than one or two of the upper critical bounds we reject the null hypothesis and accept the null hypothesis and thus have a long-run integrative relationship. For the minimum bounds I0 we apply the same hypotheses applied to upper bounds I1, The value of F between the minimum I0 and the upper bounds I1 was considered to be a doubt about the complementary relationship between long-run variables. In the test, we found the F statistic of 1.947593 less than the critical values of the minimum bounds at the levels of 1%, 2.5%, 5% and 10% (3.65, 3.15, 2.79, 2.37, respectively) And 10%, respectively, are: 4,66, 4,08, 3,67, and 3.20. Thus, there is a long-run complementary relationship between the dependent variable and the independent variables. Thus, independent variables - real capital, employment and renewable energy consumption - affect the economic growth represented by GDP. These test results are shown in Table (08).

Table8. Results of bounds tests.

value Statistic test	K3 =	
Statistic-F	1.947593	
Critical values bounds		
levels	I0	I1
10%	2.37	3.20
5%	2.79	3.67
2,5%	3.15	4.08
1%	3.65	4.66

Source: EVIEWS outputs.

5-4- Johansen's co-integration test: This test is based on the VAR model from which the VECM model is extracted in order to determine the number of integrative relations between the variables. Johansen's co-integration test focuses on finding two values: the trace statistic. The table for these values is called the impact test, Johansen and Max-Eigen and compare them with the critical values in which we compare the calculated value of the effect statistic at the level of 0.05 (5%). We find values of matrix p called Eigen-value. There are two hypotheses, one of which is the null hypothesis, Statistical value (calculated) is less than the critical (tabular) value of 5% and the alternative hypothesis. If the two statistics are greater than the tabular value at 0,05, we say that there is a long-run integrative relationship : None, at most1, at most2, at most3.In the test, we found that the value of TRACE (calculated), which is 66.44800, is greater than the critical value (tabular) at 5%: 63.87610 at the hypothesis: none. Therefore, we reject the null hypothesis and accept the alternative hypothesis. Hence, there is one complementary relationship between the dependent variable and the independent variables. The same hypothesis for Max-EIGEN (calculated) is 37.28394 greater than the critical value (the scale) at the level of 5%, which is 32.11832 at the premise of none, from which we accept the alternative hypotheses and reject the null hypothesis. Hence there is one complementary relationship between the dependent variable of GDP and variables Straight Of (K, L, RE) This is by testing Johansen relationships co-integration between the variables described the results of the table (09) where the table indicates the number of integration relationships in a 1 for the statistical impact of TRACE, as well as statistical Great Eigen-values MAX-EIGEN.

Table9. The results of the co-integration test for Johansen.

p prob** Signific atif	Critical value (%5)	max-Eigen	proba bility prob** *(sign	Critical value (%5)	Statistic Trace	Eigen-value	Hypot he-sis CE(s)
0.0107	32.11832	37.28394*	0.0299	63.87610	*66.44800	0.634933	None*
0.5438	25.82321	16.00976	0.5521	42.91525	29.16406	0.351242	At most1
0.8231	19.38704	7.982533	0.7261	25.87211	13.15430	0.194059	At most2
0.5719	12.51798	5.171770	0.5719	12.51798	5.171770	0.130448	At most3

Source: EVIEWS outputs.

* we reject the null hypothesis and accept the alternative hypothesis there is one complementary relationship between the dependent variable and the independent variables.

** MacKinnon-Haug-Michelis (1999) p-values.

5-5- VECM Test: This test is used to study the integrative relationship between short and long run variables. The error correction coefficient (ECT) is assumed to be negative and significative. The VECM equation is as follows:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i \Delta Y_{t-1} + \sum_{i=0}^{n} \delta_i \Delta X_{t-1} + \varphi_i Z_{t-1} + \mu_t$$

According to this test, the error correction coefficient is Z_{t-1} And equal ECT_{t-1} His equation is as follows:

$$ECT_{t-1} = Y_{t-1} - \beta_0 - \beta_1 X_{t-1}$$

In our study these correction coefficients equals: $ECT_{t-1} = GD_{t-1} - \beta_0 - \beta_1 K_{t-1} - \beta_2 L_{t-1} - \beta_3 RE_{t-1}$. Given the results of the VECM test shown in the table below (07), the error correction coefficient is negative and its value is -0.0913, and the error correction equation for the study model becomes:

$$GDP_t = -0.0913 ECT_{t-1} - 0.116\, GDP_{t-1} + 0.675\, K_{t-1} + 0.043\, L_{t-1} - 0.038\, RE_{t-1} + 0.0118$$

.

From the test results, we find the integration equation of the error correction parameter (long run model):

$$ect_{t-1} = 1.000\, GDP_{t-1} - 1.027\, K_{t-1} - 7.904\, L_{t-1} - 0.431\, RE_{t-1} + 122.496$$

Table10. VECM test results.

Cointegrating Eq:	CointEq1			
LGDP (-1)	1.00000			
LK (-1)	-1.027248			
	(0.08645)			
	[-11.8827]			
LL (-1)	-7.903961			
	(0.98261)			
	[-8.04382]			
LRE (-1)	-0.431200			
	(0.08440)			
	[-5.10925]			
@TREND(80)	0.234964			
	(0.03082)			
	[7.62354]			
C	122.4958			
Error Correction:	D(LGDP)	D(LK)	D(LL)	D(LRE)
CointEq1	-0.091343	0.064192	0.069541	2.015304

	(0.09790)	(0.11693)	(0.03601)	(0.34660)
	[-0.93307]	[0.54896]	[1.93118]	[5.81444]
D(LGDP(-1))	-0.116138	0.228527	0.030697	-0.753035
	(0.13418)	(0.16028)	(0.04936)	(0.47508)
	[-0.86552]	[1.42582]	[0.62194]	[-1.58507]
D(LK(-1))	0.675649	0.421158	0.053993	2.858550
	(0.16909)	(0.20197)	(0.06220)	(0.59867)
	[3.99580]	[2.08521]	[0.86808]	[4.77482]
D(LL(-1))	0.043344	0.341696	-0.042749	8.220785
	(0.64797)	(0.77399)	(0.23835)	(2.29417)
	[0.06689]	[0.44148]	[-0.17936]	[3.58333]
D(LRE(-1))	-0.038045	-0.023577	-0.000442	-0.204576
	(0.03255)	(0.03888)	(0.01197)	(0.11526)
	[-1.16870]	[-0.60634]	[-0.03694]	[-1.77496]
C	0.011848	0.008589	0.023475	-0.276477
	(0.02776)	(0.03316)	(0.01021)	(0.09830)
	[0.42675]	[0.25901]	[2.29863]	[-2.81260]
R-squared	0.507763	0.226724	0.281526	0.698365
Adj. R-squared	0.428370	0.102002	0.165644	0.649714
Sum sq. resids	0.291604	0.416052	0.039455	3.655402
S.E. equation	0.096988	0.115849	0.035676	0.343389
F-Statistic	6.395569	1.817837	2.429405	14.35466
Log likelihood	37.09987	30.52473	74.10411	-9.678558
Akaike AIC	-1.681074	-1.325661	-3.681303	0.847490
Schwarz SC	-1.419844	-1.064431	-3.420073	1.108720
Mean dependent	0.036375	0.043196	0.025713	0.034553
S.D. dependent	0.128280	0.122252	0.039057	0.580197

Source: EVIEWS outputs.

5-6- Granger's test of causality: This test is done to find the causal relationship between the variables of the model and determining whether this relationship is one-trend or two-trend or the absence of causal relationship between the variables based on two hypotheses, one of which is the null hypothesis that assumes prob value greater than 0.05 (The absence of a causal relationship between the two variables) and the alternative hypothesis whose value is less than 0.05 (a causal relationship between the two variables). Only the results of the test concluded that there is a one-trend causal relationship from the gross fixed capital formation (K) and gross domestic product (GDP) prob (0.0002) is less than 0.05 and therefore we reject the counting hypothesis We accept the alternative hypothesis. And the existence of a one-trend causal relationship from the total fixed capital formation (K) and renewable energy consumption (RE) according to the prob value, which is 0.0118 less than 0.05, from which we

reject the null hypothesis and accept the alternative hypothesis. There is no causal relationship between the other variables according to prob values and Table (08) shows the results of the Granger causality test.

Table11. Results of the Granger Causality Test.

Null Hypothesis:	Obs	F-Statistic	Prob.
LK does not Granger Cause LGDP	38	17.9881	0.0002
LGDP does not Granger Cause LK		0.03141	0.8603
LL does not Granger Cause LGDP	38	1.54828	0.2217
LGDP does not Granger Cause LL		0.00039	0.9843
LRE does not Granger Cause LGDP	38	0.05735	0.8121
LGDP does not Granger Cause LRE		3.44616	0.0718
LL does not Granger Cause LK	38	3.78001	0.0599
LK does not Granger Cause LL		0.03038	0.8626
LRE does not Granger Cause LK	38	0.35846	0.5532
LK does not Granger Cause LRE		7.06153	0.0118
LRE does not Granger Cause LL	38	1.42678	0.2403
LL does not Granger Cause LRE		0.71992	0.4019

Source: EVIEWS outputs.

6- CONCLUSION: According to previous studies, there is evidence of a one-trend relationship from the consumption of renewable energy to GDP only or from GDP to renewable energy consumption or a two-trend relationship between the two variables or lack of relationship between them. In our study of the relationship between renewable energy consumption and economic growth represented by gross domestic product (GDP) through the application of the ARDL methodology, which includes three steps, the first is to test the stability of the series of the model variables by applying two important tests: Augmented dickey fuller and NG-Perron test, The optimal lag order selection period by different criteria, and then the bounds tests to find the long-run integrative relationships between the dependent variable and the independent variables, and then the Johanson test to find the number of integrative relations between the variables and the last test VECM to see a short-run equilibrium relationship between the variables and the impact that we found the following results:

- Through the augmented dickey fuller ADF and NG-Perron tests, we demonstrated that the time series of the GDP, K, L, and RE variables are unstable at level I(0) and stable at the first difference I(1);
- We found that the optimal lag order selection is 1 according to the most accurate SC standard as well as the FPE standard and the LR standard.
- A long-run relationship between the GDP variable and the independent variables K, L and RE according to the bounds test where we found the value of F below the minimum critical limit I0. This satisfies the hypothesis of a long-run integrative relationship.

- There is a single integrative relationship between the model variables according to the Johanson test where we found the statistical value of statistic TRACE and the MAX-EIGEN value statistic greater than the critical value at the 5% level in the hypothesis none.
- A one-trend causal relationship from gross fixed capital formation to gross domestic product and a one-trend causal relationship from total fixed capital formation to renewable energy consumption according to the Granger causality test and no causal relationship between renewable energy consumption and gross domestic product This negates the hypothesis of the study of a causal relationship.
- A short-run equilibrium relationship between the GDP variable and the independent variables K, L and RE according to the VECM test model because of the value and significance of the error correction coefficient is negative and statistically significant.

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