The Role of the Policy support and the Government Institutionson the Renewable Energy Deployment in Algeria

دور سياسات الدعم والمؤسسات الحكومية في نشر الطاقة المتجددة في الجزائر

berberi mohamed amine[1]

professor; SFBPM Laboratory; University of Chlef, Alger **Sari Hassoun Salah Eddine**

PhD student; POLDEVA Laboratory, University of Tlemcen, Algeria

Mouzarine abdelmadjid

PhD student; MENA Laboratory, University of Tlemcen, Algeria

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Abstract

We develop (OLS) method to study the long-run coefficient between the contribution of renewable energy to total energy supply(renewable energy deployment variable), the institutional overall score (IV) or the government institution, the renewable energy policy (REP), per capita gross domestic product (GDP) and energy use (EU)in Algeria over the period 1995-2016. We found that the (REP), per capita (GDP) and (EU) have a negative and insignificant sign. However, the coefficient of (IV) was positive and insignificant.

[1] Correspondent author's E-mail; berberimoh@yahoo.fr

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الملخص:

قمنا باستخدام طريقة المربعات الصغرى لدراسة المعاملات في المدى الطويل ما بين نسبة استعمال الطاقة المتجددة في الانتاج الكلي للطاقة و مؤشر الحكومة، سياسة الطاقة المتجددة، الناتج المحلي الخام على عدد السكان و الاستعمال الطاقوي في الجزائر خلال الفترة 1995-2016. كنتيجة توصلنا اليها ان العلاقة ما بين سياسة الطاقة المتجددة و الناتج المحلي الخام على عدد السكان و الاستعمال الطاقوي كان تأثيره سلبي وغير معنوي، بينما أثر مؤشر الحكومة كان موجبا و غير معنوي

الكلمات المفتاحية: طريقة المربعات الصغرى، انتشار الطاقة المتجددة، مؤشر المنظمة الحكومية، سياسة الطاقة المتجددة، الجزائر

1. Introduction:

Algeria has applied several incentive programs to hasten the renewable energy deployment and to diversify its energy sector that is mainly based on fossil fuel exportation. The recent energy policy was to support the technology research and development and the introduction of several plans that can offer lower risks for private shareholders that want to associate and introduce the renewable sources in the economy and energy system.

The most common of renewable energy policies is the Feed-in Tariff and quantity-based quota obligations or renewable portfolio standards (RPS) who can offer guaranteed prices for fixed period for electricity produced from renewable energy sources (**T.Couture & Y. Gagnon, 2010)**, and these policies are also used to study the impact of renewable energy initiatives on different functions of innovations systems (**P. Del Rio & M. Bleda, 2012)**. In the same stream, the government institutions can also have a serious impact on the introduction of renewable energy in the energy system, especially when there are a strict law and long-term strategy about energy policy.

Moreover, a large literature exists on the role and effects of policies on the development of renewable energy sources, but, they're mainly based on qualitative and descriptive studies. In this topic, we shall develop a quantitative study that will base on the role of government institutions and energy policy factors on the renewable energy deployment in Algeria.

In this study, we shall develop the (OLS) method to study the long-run coefficient between the contribution of renewable energy to total energy supply, the institutional overall score (IV), the renewable energy policy (REP), per capita gross domestic product (GDP) and energy use (EU) over the period 1995-2016 in Algeria. This paper is divided into 5 sections, introduction, a brief literature review, data and method, results and discussion, and conclusion.

2. A brief literature review:

N. Kilinc-Ata (2016) analysed the assessments of renewable energy policies for 27 European countries and 50 states of US over the period of 1990-2008. The analysis was based on a ratio of renewable electricity capacity in total electricity supply from non-hydro renewable sources as dependent variables, followed by independent variables like the renewable energy policy instruments in use (FIT, quota, tender and tax), (GDP), energy security (energy import), thermal consumption, nuclear consumption, electricity consumption, gas price, coal price, electricity import and carbon dioxide (Co_2) emission. She employed the panel regression tests and model of fixed effect. The results showed that the most variables have a significant sign on determinants of (RE) deployment capacity. The renewable promotion policies are being enacted due to powerful lobbying activities in traditional industries and the fossil-based energy industry has been funding political campaigns in the world because politicians are mainly related with the current levels of wealth and quality of life. Fossil-based fuels have also been used as a strong geo-strategic force in the military industry, employment, capital markets and economy in general.

F. Polzin et al. (2015) investigated the community policy contribution on cleaner energy investments for OECD countries over the period of 2003 to 2011. The data were investments (additions in renewable energy capacity) which included 5840 solar investments, 9643 wind investments and 2889 biomass and waste investments and policy indicators (Policy and Measures) which include 957 distinct policy measures. The variables were aggregated newly installed capacity and proxy for the deployment of a technology, active instances of policies affecting the renewable energy sector, technological progress, (GDP), (Co_2) intensity, electricity consumption, interest rate and share prices. They employed panel data regression with random effects/pooled OLS, fixed effects, and panel-corrected standard error. They concluded that the fiscal and financial incentives were highlighted as an effective policy because it directly influences the renewable energy projects. The (FIT) policy concerning wind and solar sector exposed a highly significant positive coefficient. However, the effect varies across sectors. In the solar sector, the (FIT) has a stronger impact than in the wind sector. They showed also that the grants and subventions prove to be effective as short-term measures to alleviate financial constraints. The Market-based incentive which is mainly founded on the presence of greenhouse gas (GHG) emissions and its allowances was found to have a stronger impact on the capacity financed by institutional investors than (FIT).

T.F. Bolkesjø et al. (2014) tested the effect of renewable energy support on renewable energy deployment with fixed effect panel data model. The variables were renewable energy capacity, the share of return on the investment in renewable energy support scheme, incremental percentage requirement, binary tender, nuclear share, coal share, gas share, petroleum share and renewable share in the electricity, real (GDP) per capita, energy use per capita. The model was estimated over the period of 1990-2012 with using photovoltaic and wind technology, while over the period of 1990-2011 with using biomass technology. They found that the renewable portfolio standards (RPS) have a significant and positive result on the growth of bioenergy for power generation and the existence of tendering schemes have contributed to the expansion of onshore wind. The penetration of the different renewable energy technologies, as well as the energy supply mix as a whole, varies significantly in the different regions.

S.Jenner et al. (2013) employed two different dependent variables, the (RPS) Binary and incremental share indicator that represent the mandated increase in renewable generation. This study was done over the period of 1998-2010 for a panel data of 50 states in the USA. They used the method of maximum likelihood estimation and Tobit model. They found a statistically significant relationship between the contributions and the likelihood of a state to adopt (RPS). However, in the short-term, the conventional energy interest groups contributions have a negative influence on the possibility of (RPS) adoption whereas renewable energy interest groups contributions have a positive impact.

F.Zhang (2013) used OLS and GMM method to study the renewable energy policy for the case of 35 European countries covering the period from 1991 to 2010. The variables were annual wind capacity additions, total amount of wind electricity generation, (FIT) rate measured in euro cents/Kwh, (FIT) contract length, grid access and elasticity if investment with respect to (FIT) incentives. He concluded that the coefficient associated with (FIT) rates is positive but insignificant, implying that higher (FIT) rates do not necessarily lead to higher levels of wind installation. However, the countries with high remuneration levels may have a lack of the necessary institutional and regulatory environment to attract investment and will fail to scale-up investment due to these non-economic barriers.

A.C.Marques & J.A. Fuinhas (2012) examined the renewable energy policy and the IEA nine policy-related variables (education and outreach, financial, incentives/subsidies, policy processes, public investment, research and development (R&D), regulatory instruments, tradable permits and voluntary agreements). They employed the panel corrected standard error for 23 European countries over the period of 1990 - 2007. They found that the deployment of renewables has everything to be successful, both in the reducing the global warming, and mitigating the use of classical energy dependence. However, they suggested that the opportunity cost of supporting renewables has been too high, maybe it’s due the high cost of renewable energy technology and the implementation of new deployment policy. But, the negative effect of the use of renewable energy supplants the positive effect of creating income and increasing (GDP), which is generated locally by exploiting a natural resource. It is likely that the high costs of promoting renewable sources are being placed excessively upon the economy, namely by increasing tariffs for electricity, and this induces an economically counterproductive effect and a deceleration in economic activity since renewable sources increase production costs.

M.A. Delmas & M.J. Montes-Sancho (2011) studied the policy effectiveness for renewable energy and climate change plans. They used two models, the renewable portfolio standard (RPS) over the period of 1997-2006 and the mandatory green power option (MGPO) over the period of 2001 to 2006. They employed two-stage modelling technique that allows determining simultaneously the adoption of (RPS) or (MGPO) in the binary logit model. The variables used were disclosure, wind, solar and biomass resources, deregulation, democratic governor. They concluded that the wind resources was positive and significant to predict (RPS) and (MGPO) at the level of 1% and 10%, respectively, while the sign of solar resources was positive and significant for (RPS) and negative for (MGPO). However, the coefficient of biomass resources was negative for both policies.

N.Johnston et al. (2010) examined the effect of policy variables on renewable energy technology using number of patents as a proxy (public policy measures, electricity consumption, the cost of electricity production from renewable energy source, electricity price). They applied the fixed-effect panel model for the case of 25 OECD countries over the period 1978-2003 and they used the variables patent application in each of technological areas of renewable energy, policy application, research and development expenditures, electricity consumption and total EPO filings. They concluded that they need to add two further control variables to support the wind power model and wind-to-energy patent activity the electricity consumption and the electricity price.

S. Carley (2009) used the fixed effect vector decomposition (FEVD) model to study the application of energy policy (the adoption of the carbon mitigation and the renewable energy deployment) in 50 states of USA over the period 1998-2006. The variables were renewable portfolio standard (RPS) and share of renewable energy electrification in the electricity market. She found that the (RPS) operation is not considered as a good significant predictor for the proportion share of renewable energy generation out of the total generation mix. However, the other nations who will able to apply this (RPS) policy in their system will have surely an increase in their share of renewable energy and may reduce their price of electricity produced by renewable energy.

F.C.Menz & S. Vachon (2006) studied the policy efficiency on the promotion of wind power generation in the USA with using OLS method for 39 states between period of 1998 and 2003. They used five different policies instruments, renewable portfolios standard (RPS), fuel generation disclosure requirement (FGS), mandatory green power option (MGPO), public benefit funding (PBF), and retail choice (RET). They found that the public benefits funding was not a significant factor in wind energy development which is responsible for the granting and loaning funds for these types of financial incentives.

3. Data and Method :

The following table definite several variables used in this study:

Table 01: Variable definition

Variables	**Unites**	**Source of Data**
CREES: Contribution of Renewable Energy to Total Energy Supply	Percentage (%)	OECD database[13]

GDP: per capita Gross Domestic Product	Constant 2010 US $	World Bank[14]
IV: Institutional Overall Index	Score 0 to 100	Heritage database[15]
REP: Renewable Energy Policies and measures	Accumulated number of policies	IEA database[16]
EU: Energy Use	Kg of oil equivalent per $1,000 GDP (constant 2011 PPP)	World Bank

Source: Made by the authors

The Model:

$$CREES_t = c + a_1 IV_t + a_2 Eu_t + a_3 GDP_t + a_4 REP_t + \varepsilon_t$$

(CREES) Define the renewable energy deployment.

(C) Is the constant variable that represents all elements which are not included in the equation such as the political assessment indices, laws implication and expected profitability.

(IV) Represents the government institutions index and is composed of political, law and economic score. It can also be used to measure the level of corruption, the law application, and long-term strategy.

(REP) Characterize the accumulated number of renewable energy policies and measurements. We constructed this indicator by counting distinct of policies affecting the renewable energy sector such as policy support, economic instruments, and regulatory instruments.

(GDP) designs the economic growth and the income.

(EU) symbolizes the energy use that refers to use of primary energy before transformation to other end-use fuels.

We perform the long-run coefficient with the Ordinary Least Squares (OLS) estimation and made different statistical tests to see if the model is fit or if the coefficients are statically accepted.

4. Results and Discussion:

4.1. The goodness of Fit test:

We made different tests to see if the model is statistically accepted or not. We made the variance inflation factors (coefficient diagnostic) that study the multicollinearity between exogenous variable. We found in the model that all centred VIF of exogenous variables are less than 10, so we accept the null hypothesis and we can say that the regressors cannot inflate the variance and won't lead us to a misspecification of the model.

Then, we performed several residual diagnostics, so we started with Ljung-Box test and it indicate that the probability of Q-statistic is higher than 5%, so we cannot reject the null hypothesis, and we can say that the errors are white noise and the processes have not autocorrelation in the long-term. The Skewness for this model was 0.925, so this indicates that the size of the right-handed tail is larger than the left-handed tail. The Kurtosis coefficient was 3.334, demonstrating that the distribution has heavier tails and is called a leptokurtic distribution. The probability of Jarque-Berra test is higher than 5%, so we accept the null hypothesis, indicating that the errors are normally distributed. The probability of Breusch-Godfrey test is found to be greater than 5%, so we reject the alternative hypothesis, so there's no existence of autocorrelation in the error. The probability of heteroscedasticity test appears to be greater than 5%, so we cannot accept the alternative hypothesis, rather we accept the null hypothesis, so the variance of the error is constant and homoscedastic. Also, we made the stability diagnostics about CUSUM and CUSUM of square test and we found that there's no instability in the graph of CUSUM and the model is stable over the period of the study.

4.2. The model estimation:

From the OLS estimation, we found that the ($R^2 = 0.624$), meaning that 62.4% of the exogenous variables explain the endogenous variable and the probability of Fisher statistic found to be less than 5% (F = 7.054), so we cannot reject the alternative hypothesis, and we can say that the model is statistically accepted.

The coefficient of (IV) found to be positive and not statistically accepted, so an increase by 1 unit in (IV) will increase (CREES) by 2%, indicating that the government institutions can participate to increase the level of renewable energy and encourage the introduction of renewable energy in Algerian energy system. Consequently, the control mechanism, division of material resource, subventions and development support applied by the government will support the introduction of renewable energy. The same result was found in the studies of **S. Jenner et al. (2013).**

The term constant appears to be positive; indicating that the omitted variables that weren't included in the model can increase the renewable energy contribution such as technology advancement, profitability assessment, and other factors.

However, the (REP) was negative and insignificant, so a rise by 1 unit in (REP) will decrease (CREES) by 1.9%, demonstrating that the Algerian energy policy is inefficiency to surge the contribution share of renewable energy in the total energy supply, due to the high cost of renewable energy technology such as the large-scale solar photovoltaic installations, solar thermal and onshore wind. But, the energy policy can play a key role in the introduction of renewable capacity and they cannot compete with traditional energy technologies without having a support from such policies. This result is supported by studies of **N.Johnston et al. (2010) & A.C. Marques & J.A. Fuinhas (2012).**

In the same way, the (EU) was negative and significant, an upsurge by 1 unit in (EU) will reduce (CREES) by 0.8%, meaning that the energy use, especially the fossil fuel energy in Algeria affect negatively the renewable energy deployment. The same result has been found in the solar photovoltaic model of **T.F. Bolkesjø et al. (2014).**

In the same stream, the (GDP) was negative and insignificant, a rise by 1 unit in (GDP) will diminish (CREES) by 0.0012%, representing that the economic growth needs more energy to satisfy its demand and the socio-economic development. That demand is matched with more production, requiring more energy consumption. This result is in line with the main literature of **S. Carley (2009), T.F. Bolkesjø et al. (2014) & N. Kilinc-Ata (2016)**.

5- Conclusion:

This paper presents an empirical investigation about the role of government institutions and energy policy on the introduction of renewable energy in Algeria by using ordinary least square method. We found that the whole model was statistically accepted, but some of the exogenous variables were not statistically accepted. However, the coefficient and residual diagnostic provide a good result and we can interpret those variables. We provided the results between the endogenous variable in (CREES) and exogenous variables composed of (GDP, IV, REP, and EU).

.The analysis proves that the variable of government institutions are supporting the deployment of renewable energy, but, some public policy have not a positive impact on the introduction of renewable energy in the energy system of Algeria.

We showed also that the Algerian energy policy needs to shift some of its current policy and economic support, because the coefficient of renewable energy policy, per capita gross domestic product and energy use were affecting negatively the variable of contribution of renewable energy to total energy supply, indicating that the renewable energy situation in Algeria won't improve with the application of such energy policy (Feed-In Tariff policy, institutional creation and research & development). However, the sign of the government institutions was positive, indicating that with the introduction of renewable energy, the socio-economic situation will be stabilized and improved.

The main thing in this topic is that the Algerian energy policy needs to change its instruments supporting renewablesthat may increase the competition between different technologies to market creation policies. And the government should look after incentives and instruments, which support the promotion not only the cheapest and mature renewable energy technologies but also to create a market for renewables that will activate innovation effects and reduce the costs as well.

Annex:

Table 02: The renewable energy policies and measures in Algeria

Title	**Year**	**Policy Type**	**Policy Target**
Renewable Energy and Energy Efficiency	2015	Policy Support	Wind, Solar, Geothermal,

Development Plan 2015-2030			Bioenergy
Feed-in tariff for solar PV installations	2014	Economic Instruments	Solar Photovoltaic
Renewable Energy and Energy Efficiency Development Plan 2011-2030	2011	Policy Support	Solar Photovoltaic, Solar Thermal
Renewable energy National Fund	2009	Policy Support	Multiple RE Sources
Law 04-92 on the Diversification of Power Generation Costs (REFIT)	2004	Economic Instruments	Multiple RE Sources
Law 04-90 on Renewable Energy Promotion in the Framework of Sustainable Development	2004	Regulatory Instruments	Bioenergy, Biomass, Geothermal, Hydropower, Solar
Law 99-09 on the Management of Energy	1999	Policy Support	Multiple RE Sources

Source: International Energy Agency

Table 03: Variance Inflation Factors

Variable	**Coefficient Variance**	**Centred VIF**
IV	$3.15*10^{-5}$	2.482
REP	0.0004	1.099

EU	$8.25*10^{-6}$	2.209
GDP	$7.67*10^{-10}$	1.738

Source: Eviews 9.0

Table 04: Ljung-Box test

Lags	Q-Statistics	Probability
12	8.122	0.775

Source: Eviews 9.0

Table 05: Normality test

test	Coefficients	Probability
Skewness	0.925	…
Kurtosis	3.334	…
Jarque-Bera	3.245	0.197

Source: Eviews 9.0

Table 06: Breusch-Godfrey serial correlation LM test

Lags	F-statistics	Probability	$N*R^2$	Probability
1	$7.16*10^{-5}$	0.993	$9.85*10^{-5}$	0.992
2	0.051	0.950	0.149	0.928
3	0.416	0.743	1.802	0.614
4	0.293	0.877	1.822	0.768

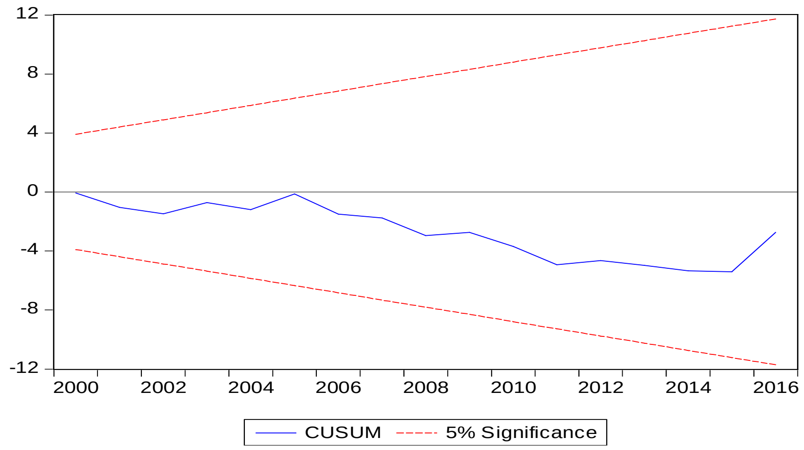
Source: Eviews 9.0

Table 07: Heteroscedasticity tests

Test	F-statistics	Prob	N*R²	Prob	Scaled explained SS	Prob
Breusch-Pagan-Godefrey	0.906	0.482	3.867	0.424	2.695	0.610
Harvey	0.444	0.775	2.081	0.720	1.619	0.805
Glejser	0.675	0.618	3.018	0.554	2.390	0.664

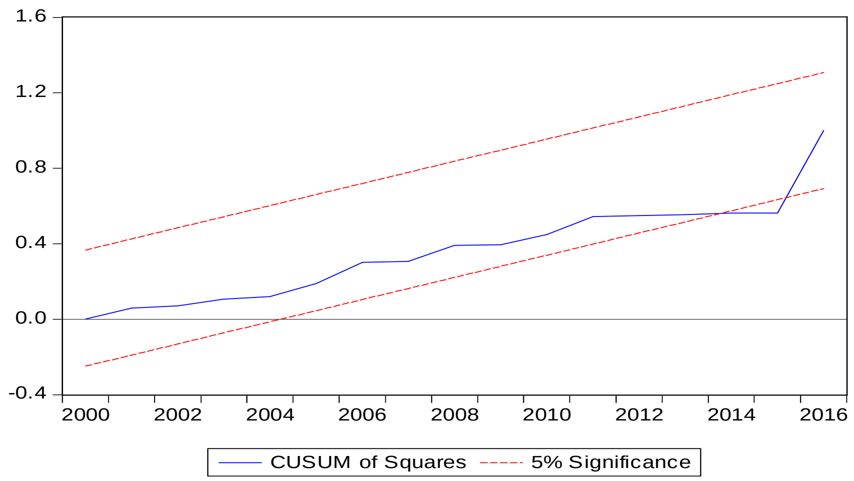
Source: Eviews 9.0

Graph 01: Cusum test



Source: Eviews 9.0

Graph 02: Cusum of squares test



Source: Eviews 9.0

Table 08: Model estimation with OLS method

Variable	Coefficient	t-Statistic	Prob
IV	0.002	0.418	0.680
C	0.850	1.613	0.125
REP	-0.019	-0.931	0.364
EU	-0.008**	-2.845	0.011
GDP	$-1.19*10^{-5}$	-0.430	0.672

Source: Eviews 9.0

*, **, ***, describe the level of significance at 10%, 5%, and 1%.

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