

Assessment of the Impact of Renewable Energy Exploitation on Social Sustainability in Algeria during 2005-2023

- Econometric Study Using VAR Model -

*HARIECHE Ibtiissam**

*Lab of Organizational Economics
and Sustainable Development
Jijel (Algeria)*

ibtissam.harieche@univ-jijel.dz

ZENAD Souheyla

*Lab of Organizational Economics
and Sustainable Development
Jijel (Algeria)*

Zsouheyla@yahoo.fr

Abstract

This study analyses the relationship between renewable energy exploitation and social sustainability, emphasizing the impact of renewable energy production capacity on Algeria's unemployment rate during the period 2005 to 2023. The Vector Autoregressive (VAR) model reveals a causal relationship between renewable energy production capacity and the unemployment rate. The analysis shows that random shocks to the unemployment rate have an immediate but diminishing effect over time, whereas the impact of renewable energy utilization on unemployment is delayed yet grows significantly in the long term. Variance decomposition analysis indicates that changes in the unemployment rate are predominantly influenced by its own dynamics.

Article info

Received

15/12/2024

Accepted

22/01/2025

Keyword:

- ✓ Renewable energy
- ✓ social sustainability
- ✓ VAR model

* Autour corresponding

1. Introduction

Sustainable development relies on the equitable distribution of resources and opportunities for both current and future generations. A key aspect of this concept is reducing disparities and fostering inclusivity through fair access to essential benefits. As global momentum shifts toward cleaner energy solutions, these innovations have emerged as pivotal tools for addressing unemployment, enhancing quality of life, and promoting social cohesion.

Non-conventional energy sources, far from being mere alternatives to traditional power systems, are foundational to enduring development. By mitigating environmental harm and supporting societal integration, they bridge inequalities and foster equitable resource allocation.

In emerging economies like Algeria, alternative energy plays a transformative role by creating employment opportunities and strengthening social cohesion, thereby contributing to socio-economic progress. This study investigates the impact of cleaner energy solutions on social development, focusing on their effects on unemployment and equity. It explores the hypothesis that advancements in renewable energy positively influence Algeria's socio-economic landscape, establishing a link between production capacity and employment trends.

By aiming to diversify its economy and reduce dependence on hydrocarbons, Algeria emphasizes enhancing investment and improving the business environment, aligning these efforts with sustainable development goals.

This study explores the central question: ***How does the exploitation of renewable energy affect social sustainability in Algeria?***

It hypothesizes that increasing renewable energy production has a positive influence on social sustainability by lowering unemployment rate and enhancing economic stability. The study argues that there is a causal relationship between renewable energy production capacity and the unemployment rate, which suggests that expanding renewable energy deployment can enhance social cohesion and drive sustainable growth.

1.1 Research Focus:

The study investigates the relationship between renewable energy utilization and social sustainability by examining its influence on unemployment rates. It evaluates the capacity of clean energy technologies to mitigate joblessness and analyses the dynamic interactions of variables using econometric models. Additionally, it seeks to propose actionable strategies for optimizing renewable energy deployment as a means to promote social equity and reduce economic disparities.

1.2 Study Approach:

The study adopts a descriptive-analytical approach to explore the key concepts of renewable energy and social sustainability. It also employs an econometric methodology, focusing on statistical data analysis to examine the relationship between renewable energy utilization and social sustainability.

2. The Relationship Between Renewable Energy Utilization and Social Sustainability

2.1 Definition of Social Sustainability

Social sustainability refers to creating a society that meets current needs while preserving future opportunities. It emphasizes the equitable distribution of resources, protection of individual rights, and the enhancement of well-being, ensuring that future generations can meet their needs. This concept focuses on fostering equitable and inclusive communities, where individuals have equal access to education, healthcare, and employment, while efforts are made to minimize social disparities (Dempsey, Bramely, Power, & Brown, 2011, pp. 291-293).

2.2 The Role of Renewable Energy in Advancing Social Sustainability

2.2.1. Promoting Social Equity and Enhancing Well-being

Social sustainability prioritizes equitable access to resources, aiming to address disparities in education, employment, and essential services. Clean energy projects empower rural communities by offering affordable electricity, improving health through reduced pollution, and fostering inclusivity. These initiatives strengthen resilience and quality of life, especially in underserved regions (Allen & Thomas, 2000, p. 65).

2.2.2. Reducing Inequalities and Supporting Social Justice

Renewable energy bridges regional disparities by bringing reliable electricity to remote areas, alleviating energy poverty, and fostering local development (Sovacool & Dworkin, 2015, p. 118). It also reduces dependence on fossil fuels, enhancing energy independence and economic stability while promoting fairness in resource distribution (Sachs, 2015, p. 115).

2.2.3. Creating Economic Opportunities and Developing Human Capital

The renewable energy sector generates substantial employment, spanning manufacturing, installation, and maintenance, particularly in emerging economies. Concurrently, investments in education and skills training in clean energy equip individuals to participate in future economic opportunities, addressing unemployment and fostering equitable growth (Goodland, 1995, p. 11).

2.2.4. Holistic Integration for Long-Term Sustainability

The synergistic relationship between renewable energy and social sustainability lays the foundation for just, inclusive development. This comprehensive approach ensures progress in public health, economic empowerment, and environmental stewardship, fostering a resilient and sustainable future.

2.2.5. Challenges to Social Sustainability in Sustainable Energy Utilization

Sustainable energy deployment, despite its recognized advantages, is accompanied by several social and structural challenges:

2.2.6. Structural and Financial Constraints:

The high upfront investments required for clean energy projects often hinder their stationarity at their levels, with probability values exceeding the 5% threshold, indicating the presence of unit roots. To address this, differencing was applied: the unemployment rate achieved stationarity after

the first difference, being integrated of order one I (1), while renewable energy production required a second difference to reach stationarity, making it integrated of order two I (2).

3.2.1. Optimal Lag Length

Determining the optimal lag length is a critical step in econometric modelling, as it ensures the accuracy and validity of analytical results. Lag length influences the ability of the Vector Autoregressive (VAR) model to capture the dynamic interdependencies between variables effectively.

For this study, the optimal lag length was identified using statistical criteria, including the Akaike Information Criterion (AIC), Schwarz Criterion (SC), Hannan-Quinn Criterion (HQ), Final Prediction Error (FPE), and the Likelihood Ratio (LR) test. These criteria determine the lag length that minimizes prediction errors and maximizes model reliability.

Table 1. Criteria for Determining Optimal Lag Lengths

Sample: 2005 2023 Included observations: 18						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-144.5360	NA	40386.74	16.28178	16.38071	16.29542
1	-120.6057	39.88391*	4437.393*	14.06730*	14.36409*	14.10822*

Source: Outputs generated by the author through the application of the software

As shown in Table (2), all criteria identified one lag period as optimal, providing a robust basis for model estimation. This selection ensures that the dynamics of unemployment and renewable energy production are adequately captured without overfitting or underfitting the model.

3.2.2. Estimating the Functional Relationship Between Unemployment Rate and Renewable Energy Production Capacity Using the VAR Model

The relationship between unemployment and renewable energy production capacity was estimated using a Vector Autoregressive (VAR) model with one lag period. The model includes the unemployment rate (UPLYMENT) as the dependent variable and renewable energy production capacity (REC) as the independent variable. The equations for VAR (1) are expressed as:

$$UPLYMENT = C_1 \times UPLYMENT(-1) + C_2 \times REC(-1) + C_3$$

$$REC = C_4 \times UPLYMENT(-1) + C_5 \times REC(-1) + C_6$$

The results of the Ordinary Least Squares (OLS) estimation yielded the following equation for the unemployment rate:

Table 2. Estimation Results of Model Parameters Using the Ordinary Least Squares Method

Included observations: 18				
Total system (balanced) observations 36				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.359179	0.151379	2.372714	0.0243
C(2)	0.004287	0.001552	2.762091	0.0097
C(3)	5.718996	1.672292	3.419854	0.0018
C(4)	-13.13664	9.739388	-1.348816	0.1875
C(5)	1.009523	0.099855	10.10991	0.0000
C(6)	168.2554	107.5915	1.563835	0.1283
Determinant residual covariance		2263.976		
Equation: UPLYMENT = C(1)*UPLYMENT(-1) + C(2)*REC(-1) + C(3)				
Observations: 18				
R-squared	0.581814	Mean dependent var	11.56711	
Adjusted R-squared	0.526056	S.D. dependent var	1.372554	

Source: Outputs generated by the author through the application of the software

Based on the results, the model illustrating the impact of renewable energy exploitation on the unemployment rate is as follows:

$$UPLYMENT = 0.359179 \times UPLYMENT(-1) + 0.004287 \times REC(-1) + 5.718996$$

○ **Statistical and Economic Analysis:**

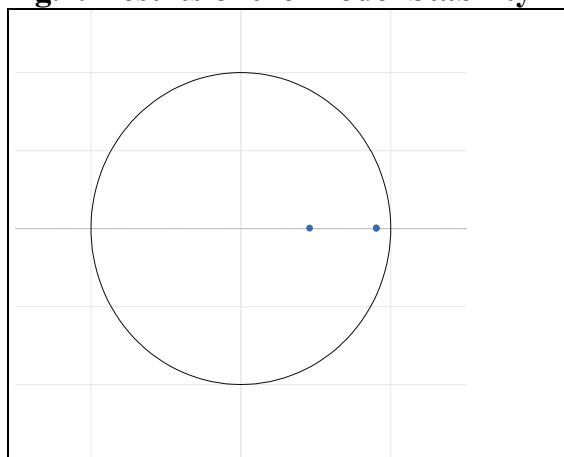
- ✓ Both coefficients for UPLYMENT (-1) and REC (-1) and the constant term are statistically significant at the 5% level.
- ✓ The elasticity of UPLYMENT (-1) (0.359179) indicates a direct relationship; a 1% increase in last year's unemployment rate results in a 0.359% rise in the current unemployment rate.
- ✓ The elasticity of REC (-1) (0.004287) also indicates a direct relationship, suggesting that a 1% increase in renewable energy production capacity from the previous year increases unemployment by 0.004%.

○ **Interpretation and Implications:**

- ✓ The positive association between REC and UPLYMENT appears counterintuitive. Renewable energy projects are traditionally expected to create jobs. However, structural factors such as delayed workforce adaptation or an initial increase in automation in green sectors could explain this outcome.
- ✓ The R-squared value of 0.5818 indicates that 58.18% of the variability in the unemployment rate is explained by the lagged values of unemployment and renewable energy production capacity. By situating these findings within Algeria's socio-economic context, the analysis highlights the complexities of labour market adjustments during the transition to renewable energy.

3.2.3. Model Stability Analysis

To ensure the reliability of the estimated VAR model, a stability analysis was conducted using the inverse roots test. This test evaluates whether the model satisfies stability conditions by examining the location of roots derived from the companion matrix.

Fig.1. Results of the Model Stability Test**Table 3. Results of the Model Stability**

Root	Modulus
0.906661	0.906661
0.462041	0.462041

Test

Source: Outputs generated by the author through the application of the software

The results confirm that all roots have absolute values smaller than one and are positioned inside the unit circle. This outcome indicates that the model is dynamically stable and capable of generating consistent forecasts over time without erratic behaviour.

3.2.4. Diagnostic Tests for the Estimated Model

To validate the reliability and robustness of the VAR (1) model, diagnostic tests were applied to the residual series to evaluate its statistical properties.

3.2.4.1. Autocorrelation Test for Residuals

Table 4. Results of the Autocorrelation Test for the Residuals Series

Sample: 2005 2023						
Included observations: 18						
Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	1.205306	4	0.8772	0.296360	(4, 24.0)	0.8774
2	0.888026	4	0.9263	0.216957	(4, 24.0)	0.9264
3	0.932548	4	0.9198	0.228038	(4, 24.0)	0.9200
4	4.649212	4	0.3252	1.226306	(4, 24.0)	0.3260

Source: Outputs generated by the author through the application of the software

The LM test evaluates whether residual errors are independent across observations. The results indicate a statistical probability greater than 0.05, leading to the acceptance of the null hypothesis. This suggests no significant autocorrelation in the residuals, ensuring the model's independence assumption holds.

3.2.5. Heteroscedasticity Test

Table 5. Results of the Heteroscedasticity Test for the Residuals Series

Sample: 2005 2023 Included observations: 18		
Joint test:		
Chi-sq	df	Prob.
17.03245	12	0.1484

Source: Outputs generated by the author through the application of the software

The Chi-sq test checks for constant variance in the residuals. With a p-value exceeding 0.05, the null hypothesis is accepted, indicating homoscedasticity. This confirms that residuals exhibit uniform variance, enhancing the model's reliability.

These results confirm the statistical soundness of the VAR (1) model, ensuring its robustness for further analysis.

3.2.6. Dynamic Analysis of the Estimated Model

3.2.7. Causality Test

The Granger causality test evaluates the directional influence between the production capacity of renewable energy (REC) and the unemployment rate (UPLYMENT). In this context, REC is treated as the independent variable, while UPLYMENT is the dependent variable.

Table 6. Results of the Causality Test

Sample: 2005 2023 Included observations: 18			
Dependent variable: UPLYMENT			
Excluded	Chi-sq	df	Prob.
REC	7.629149	1	0.0057
All	7.629149	1	0.0057

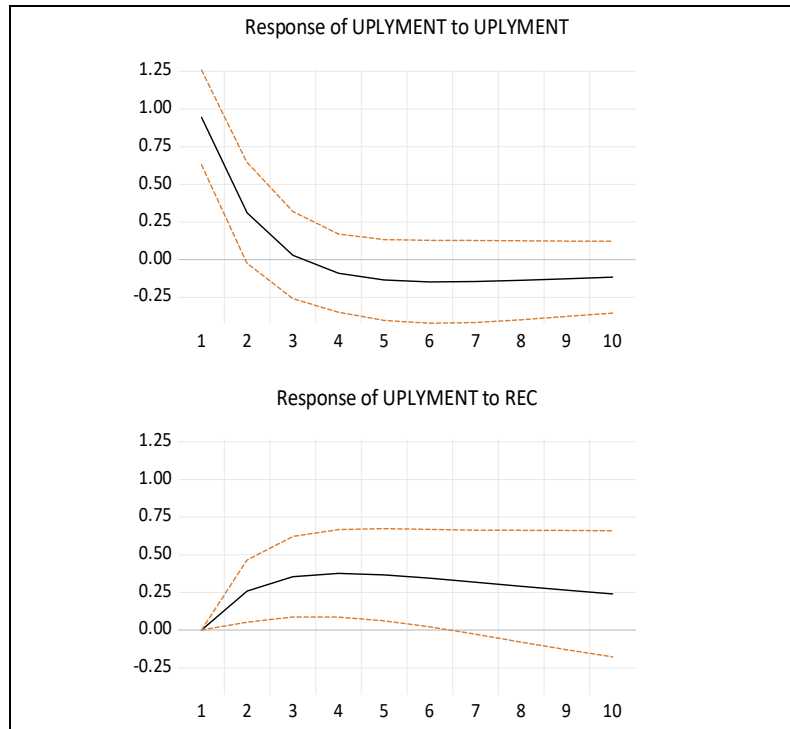
Source: Outputs generated by the author through the application of the software

With a p-value below 0.05, the null hypothesis of no causal relationship is rejected. This indicates a statistically significant causal link from REC to UPLYMENT, where changes in renewable energy production capacity contribute to variations in the unemployment rate.

3.2.8. Impulse Response Functions

Impulse response functions (IRFs) provide insights into the dynamic interplay between variables, capturing the immediate and subsequent effects of a one-standard-deviation shock. They assess how a disturbance in one variable influences its own values and those of others in the system over time, allowing for the differentiation between short- and long-term impacts.

Fig.2. Results of the Impulse Response Functions



Source: Outputs generated by the author through the application of the software

The analysis reveals that:

- **Unemployment rate shocks:** These represent unexpected changes that cause a temporary rise in the unemployment rate, showing positive effects in the short and medium terms. However, these effects diminish over time as the system stabilizes. The positive influence observed in the short and medium terms gradually fades by the second period, indicating a stabilizing mechanism within the system that mitigates the shock's impact over time.
- **Renewable energy shocks:** Initially, no immediate effect is observed in the first period. However, by the second period, a shock in renewable energy production leads to a 0.25 standard deviation increase in unemployment, persisting until the fourth period before gradually tapering off in the long term.

This suggests a lagged but temporary influence of renewable energy shocks on unemployment, with effects receding as the system stabilizes over time.

3.2.8.1. Variance Components

Variance decomposition in the VAR model identifies the contribution of each variable to overall variation within the system over time. It allocates the variance among variables based on their mutual influences.

Table 7. Results of the Variance Decomposition Analysis

Period	S.E.	UPLYMENT	REC
1	0.944915	100.0000	0.000000
2	1.027885	93.64901	6.350994
3	1.087714	83.70371	16.29629
4	1.154611	74.88996	25.11004
5	1.219103	68.40694	31.59306
6	1.275451	63.83383	36.16617
7	1.322485	60.58016	39.41984
8	1.360992	58.21381	41.78619
9	1.392291	56.45355	43.54645
10	1.417686	55.11839	44.88161
Cholesky Ordering: UPLYMENT REC			

Source: Outputs generated by the author through the application of the software

Initial results indicate that changes in the unemployment rate are entirely self-driven in the first period (100%), reflecting a strong immediate response. Over time, this influence diminishes to 55%, suggesting that while the direct impact lessens, a significant portion remains attributed to the variable itself.

In contrast, the contribution of renewable energy is non-existent in the first period but increases significantly from the second period onward. By the tenth period, renewable energy production accounts for 44.88% of the variance in the unemployment rate, emphasizing its growing long-term impact on labour dynamics.

3. CONCLUSION

For Algeria to achieve social sustainability, renewable energy is essential. With strategic investments, supportive policies, and skill development, it can significantly reduce unemployment rate, enhance stability, and drive long-term development.

Key findings from this study's use of the Vector Autoregressive (VAR) model were:

- Impulse Response Functions (IRFs):
 - Short term: An increase in renewable energy production leads to a slight rise in unemployment, reflecting an immediate labour market impact.
 - Medium and long term: The effect gradually diminishes, indicating a temporary positive relationship as the sector develops.
- Variance Decomposition:
 - Initial period: Unemployment rate changes are mostly explained by internal shocks.
 - Later periods: Renewable energy's contribution increases, suggesting its long-term positive impact with effective policies.

This study recommends the following actions:

1. Invest in Renewable Energy Infrastructure: Focus on clean energy to reduce unemployment and foster development.
2. Reduce Initial Costs: Provide financial incentives to accelerate economic returns and job creation.
3. Capacity Building: Equip the workforce with skills for the renewable energy sector.
4. Develop Social Sustainability Policies: Integrate green energy projects with broader social justice goals.

4. Bibliography list:

1. Books

Sovacool , B., & Dworkin, M. (2015). *Global Energy Justice*. Cambridge University Press.

Sachs, J. D. (2015). *The Age of Sustainable Development*. NEW YORK: Columbia University Press.

2. Journal Articles

Goodland, R. (1995). The Concept of Environmental Sustainability. *Annual Review of Ecology and Systematics*, 11.

Allen, T., & Thomas, A. (2000). Poverty and development into the 21st Century. Oxford University Press, 65.

Dempsey, N., Bramely , G., Power, S., & Brown , C. (2011). The social dimension of sustainable development: Defining urban social sustainability. *Sustainable Development*, 291-293.

Sovacool, B. K. (2016). Energy Research & Social Science. *Elsevier*, 97.