

The Role of Renewable Energy in Achieving Industrial Sustainability as a Strategic Objective of Sustainable Development in Algeria

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Abstract:

In contemporary assessments of national welfare, industrial advancement and the integration of modern technologies are considered key indicators of progress. As industrialization inherently relies on energy, the transition toward environmentally sustainable energy sources has become imperative to replace depleting non-renewable resources and to meet the objectives of sustainable development—most notably, environmental preservation and industrial sustainability.

Algeria, like many nations, is leveraging its renewable energy potential to promote sustainable industrial growth, particularly through the integration of clean energy sources into electricity production systems.

Keywords: Renewable energy; Sustainable development; Industrial sustainability; Environmental protection.

Jel Classification Codes: Q01, Q20, Q50.

1. INTRODUCTION:

In recent years, there has been an accelerating global imperative to transition towards cleaner and more sustainable energy sources. This transformation is driven by the increasing awareness of the detrimental effects of conventional fossil fuels on the environment and the urgent necessity to realize sustainable development goals (SDGs) that balance economic growth, social equity, and environmental stewardship.

Simultaneously, the development of modern societies is increasingly measured through multifaceted indicators, among which the growth and technological advancement of the industrial sector stand out. Industry remains a pivotal engine of economic expansion, attracting considerable

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attention from policymakers worldwide—including in Algeria—due to its capacity to enhance national income, increase production output, boost exports, and ultimately improve the standard of living at both individual and societal levels.

However, the recent surge in industrial activity, combined with its environmental ramifications—such as pollution and climate change—has necessitated a paradigm shift toward more sustainable models of industrial development. This includes not only enhancing productivity but also ensuring environmental protection and the conservation of natural resources for future generations.

1.1. Problem Statement:

Accordingly, this study seeks to address the following core research question: What role do renewable energy sources play in promoting sustainable industrial development in Algeria as a core component of its national sustainable development strategy?

To explore this central issue, the study poses several subsidiary questions:

- What is the strategic importance of renewable energy within the industrial sector?
- How does renewable energy interact with industrial dynamics?
- What are the driving factors behind Algeria's energy transition?
- How does renewable energy contribute to sustainable development and sustainable manufacturing in Algeria?

1.2. Hypotheses:

To address the research problem and questions, the study proposes the following hypotheses:

- Renewable energy serves as a critical substitute for depleting energy sources in the industrial sector.
- Efficient utilization of renewable energy and the rationalization of fossil fuel consumption significantly support the realization of sustainable development objectives.
- The attainment of holistic and inclusive sustainable development is contingent upon the establishment of sustainable manufacturing systems.

1.3. Objectives of the Study:

This study aims to:

- Explore the strategic importance of renewable energy and its integration into the industrial sector.

- Analyze the underlying motivations for Algeria's energy transition.
- Examine the implications of renewable energy adoption on national development.
- Assess the feasibility of substituting fossil fuels with renewable energy sources within the Algerian industrial context.

1.4. Methodology:

This study adopts a mixed-method approach, combining descriptive analysis to outline the relationship between renewable energy and the industrial sector—while also explaining the national motivations for pursuing an energy transition—with analytical methods aimed at investigating the potential impact of renewable energy adoption on various dimensions of sustainable development in Algeria.

1.5. Structure of the Study:

To comprehensively address the research questions and hypotheses, the study is structured into three main sections:

- The significance of renewable energy in industrial development.
- The driving forces behind Algeria's energy transition.
- The influence of renewable energy deployment on selected sustainable development goals in Algeria.

2. The Importance of Renewable Energy in Industry:

A resilient and technologically adaptive industrial sector fundamentally depends on the availability of consistent and efficient energy inputs. Industrial production processes are energy-intensive by nature; thus, no industrial activity can operate in the absence of adequate energy supply. Historically, the sector has relied almost exclusively on fossil fuels (Zemri, 2024, p 122). However, the adverse environmental externalities associated with their extraction and combustion—such as atmospheric pollution, global warming, and the emission of greenhouse gases—have necessitated a paradigm shift in global energy strategies.

The strategic value of renewable energy lies in its sustainability and inexhaustibility. It offers a viable alternative to fossil-based energy, capable of satisfying the rising energy demands of the industrial sector without depleting natural resources or exacerbating ecological degradation. As global industrial output continues to expand, the urgency to adopt low-carbon, high-efficiency energy sources becomes increasingly apparent. Beyond its renewability, the adoption of clean energy technologies

substantially mitigates emissions, reduces fossil fuel dependency, and contributes to lowering environmental costs while enhancing the overall energy performance of industrial systems(Abbasi et al., 2022, p 395).

Accordingly, recognizing and operationalizing the potential of renewable energy within industrial systems is imperative. In the contemporary economic landscape, sustainability constitutes a critical determinant of industrial competitiveness. The utilization of solar, wind, or other renewable sources to generate electricity for industrial use allows firms to decouple energy consumption from carbon emissions, thus improving cost-efficiency and production resilience. As a result, industrial actors are increasingly called upon to formulate integrated energy transition strategies aimed at embedding renewables into their core operational models.

2.1 Applications of Renewable Energy in Industry:

Renewable energy technologies present a wide range of industrial applications, particularly in electricity generation and thermal energy provision(Panwar et al., 2011, p 1521). These technologies enable the direct powering of manufacturing facilities while also facilitating the use of renewable thermal energy in various industrial processes. Solar photovoltaic systems, onshore and offshore wind turbines, as well as emerging renewable-based nuclear solutions, can all be harnessed to meet electricity demand across diverse industrial domains.

Electricity derived from renewable sources supports critical functions such as machinery operation, lighting, and digital infrastructure. Moreover, renewable heat—generated through solar thermal collectors, biomass systems, or geothermal technologies—can be deployed for process heating, steam generation, or water pre-heating, which are essential components in many industrial manufacturing chains.

Over recent decades, the integration of renewable energy into industrial systems has been significantly advanced by continuous technological innovation and supportive regulatory frameworks. These advancements, however, necessitate considerable capital investments in power generation capacity, transmission networks, and smart energy infrastructure to ensure reliability and scalability. Furthermore, the expansion of the renewable energy industry has catalyzed labor market transformations by creating a multitude of employment opportunities in the green economy, particularly in sectors related to equipment manufacturing, infrastructure deployment, systems maintenance, and energy management.

Today, renewable energy enterprises constitute some of the fastest-growing employers within the global energy ecosystem.

2.1.1. Generation of Electrical Energy:

Renewable energy is utilized to generate electricity for industrial applications through a variety of methods. One common approach involves the deployment of photovoltaic panels to convert solar radiation into electrical energy (Parida et al., 2011, p 1628). Another method relies on wind turbines that harness kinetic energy from wind currents to produce electricity. Additionally, thermal collectors can be employed to convert heat derived from solar radiation or geothermal sources into electrical power (Khaled, 2021, p 26). These renewable systems provide a reliable, sustainable, and environmentally sound alternative for meeting the substantial energy demands of industrial operations.

The generation of electrical energy from renewable sources constitutes an effective solution for supplying the electricity required to operate industrial machinery and systems, while simultaneously reducing environmental impact and promoting cost-efficiency in energy use.

2.1.2. Use of Renewable Heat in Industry:

The deployment of renewable thermal energy in industrial settings serves as a sustainable and energy-efficient means of fulfilling heating and process heat requirements. Sources such as solar thermal energy or residual heat generated from industrial processes can be used to heat water or air, which is subsequently applied in various stages of manufacturing.

Reducing reliance on conventional thermal energy derived from fossil fuels not only contributes to environmental protection and emissions reduction but also enhances the overall energy efficiency of industrial operations and lowers production costs over time.

2.2 Technical and Technological Challenges of Renewable Energy in Industry:

Despite the growing potential of renewable energy in industrial applications, its adoption is accompanied by several technical and technological constraints that necessitate innovative and adaptive engineering solutions. Key among these challenges are the development of advanced energy storage systems, the mitigation of variability in energy supply due to the intermittent nature of renewable resources, and the need to ensure the operational reliability and integration of renewable systems

within complex industrial infrastructures.

To meet these challenges, industries must invest in cutting-edge technologies that enhance sustainability and optimize energy utilization across processes.

2.2.1. Technical Challenges in the Application of Renewable Energy in Industry:

Technical constraints represent a critical barrier to the widespread implementation of renewable energy in industrial systems. These include the intermittency of renewable energy generation due to meteorological variability, the high capital costs associated with the deployment and maintenance of renewable energy infrastructure, and the need to improve the energy efficiency of industrial equipment and processes.

Addressing these technical issues requires robust system design, smart grid integration, and the development of hybrid energy systems that combine renewable with supplementary sources to ensure reliability and continuity in energy supply.

2.2.2. Technological Innovations in Renewable Energy:

Technological innovations in the renewable energy sector aim to advance the performance, scalability, and integration of clean energy systems in industrial contexts (Tsoutsos & Stamboulis, 2005, p 754). These innovations include the development of high-capacity and cost-efficient energy storage solutions, the application of artificial intelligence and predictive data analytics to optimize energy consumption patterns, and the creation of more effective and environmentally benign energy conversion technologies.

Such technological advancements are pivotal in enhancing the reliability, responsiveness, and economic feasibility of renewable energy systems, thereby reinforcing their role as a core component of industrial energy strategies.

2.3 Policies and Legislation:

Policies and legislative frameworks governing renewable energy adoption in industry constitute critical determinants of successful integration. The promotion of renewable energy utilization within the industrial sector is heavily reliant on the existence of supportive governmental strategies and localized legal instruments that incentivize and facilitate investment in clean energy infrastructure.

2.3.1. Stimulating Government Legislation and Policies:

The implementation of enabling regulatory frameworks and proactive

government policies plays a pivotal role in expanding the industrial deployment of renewable energy technologies. These policies may include fiscal incentives—such as tax exemptions, subsidies, and preferential tariffs—for industrial enterprises that adopt renewable energy systems. In parallel, governments can establish binding national targets and emissions reduction commitments, thereby compelling industrial actors to engage in energy transition efforts.

Furthermore, public policies can foster innovation by allocating funding and institutional support for research and development (R&D) activities in renewable technologies. In this context, legislative instruments function not only as regulatory tools but also as catalysts for sustainable industrial transformation, laying the foundation for a low-carbon economy.

2.3.2. International Cooperation and Strategic Partnerships:

International cooperation plays a strategic role in facilitating the transfer of knowledge, technology, and best practices in renewable energy deployment. Bilateral and multilateral partnerships enable the exchange of advanced technical expertise, particularly in the design, implementation, and management of renewable energy systems adapted to industrial contexts.

Collaborative initiatives contribute to strengthening national industrial competitiveness, enhancing innovation capacities, and unlocking access to global markets. Moreover, strategic alliances with multinational companies can accelerate technological transfer and scale up investment flows. Therefore, international cooperation serves as a critical enabler of sustainable industrial development driven by renewable energy adoption.

2.3.3. The Investment Role of the Private Sector:

The private sector holds a central position in financing and operationalizing renewable energy initiatives in industry. Private enterprises contribute capital investment, technical expertise, and innovative business models necessary for constructing, maintaining, and optimizing renewable energy facilities.

Through public-private partnerships (PPPs) and direct investments, private sector actors complement governmental efforts in expanding renewable energy infrastructure. Their involvement is instrumental in accelerating energy transitions, fostering industrial competitiveness, and promoting resilient and sustainable production systems anchored in clean

energy technologies.

2.4 The Role of Scientific Research and Technological Development in Utilizing Renewable Energy in Industry:

Scientific research and technological advancement are fundamental to the evolution of renewable energy systems within industrial domains. Investment in applied research and the development of cutting-edge technologies enables improvements in energy conversion efficiency, cost reduction, and system reliability.

Contemporary research contributes to solving technical challenges related to energy storage, grid integration, and process optimization. In addition, collaborative platforms between research institutions and industrial firms facilitate knowledge transfer, prototype development, and innovation diffusion. These synergies enhance the adaptive capacity of industries, positioning renewable energy as a driver of sustainable transformation, environmental performance, and energy security.

3. Motivations for the Energy Transition in Algeria:

Algeria's shift toward renewable energy is driven by a confluence of strategic, economic, and environmental considerations. These motivations reflect both domestic constraints and external pressures, necessitating a structural transformation in the national energy model.

3.1 Fluctuations in Oil Prices on Global Markets:

Oil price volatility has been a persistent feature of Algeria's macroeconomic environment since independence. The national economy, heavily dependent on hydrocarbon revenues, has experienced repeated fiscal shocks due to abrupt collapses in global oil markets. Notable instances include the 1986 crisis, which saw oil prices plummet to \$13 per barrel, followed by further contractions in 1999 (\$10 per barrel) and 2002 (\$19 per barrel). The 2008 global financial crisis resulted in a decline to \$36 per barrel, while the COVID-19 pandemic in 2020 caused an unprecedented drop to \$28 per barrel (Souhila, 2018, p. 292). This recurrent instability has underscored the vulnerability of oil-dependent economies and reinforced the urgency of diversifying energy sources.

3.2 The Issue of Depleting Oil Reserves:

The progressive depletion of Algeria's oil reserves constitutes a structural challenge to long-term energy security. Many of the country's oil fields are in a phase of decline, characterized by diminishing production yields and rising extraction costs. As the majority of Algeria's hydrocarbon output is derived from mature fields exhibiting natural decline rates, the

imperative to identify and invest in alternative energy sources becomes increasingly critical. Renewable energy presents a strategic option to offset resource exhaustion and ensure energy continuity.

3.3 Global Decline in Demand for Fuels:

A notable contraction in global fossil fuel demand has emerged in response to international climate policies, notably the imposition of carbon pricing mechanisms such as carbon taxes. These policies aim to disincentive fossil fuel consumption and promote cleaner energy alternatives. Consequently, many advanced economies have significantly reduced their oil imports while scaling up renewable energy investments. Germany, for instance, has positioned itself as a global leader in renewable energy adoption, setting an influential precedent in the global energy transition landscape.

3.4 Increase in Local Energy Demand:

Domestic energy consumption in Algeria has surged in recent years, placing significant pressure on the national energy supply chain and reducing the volume of hydrocarbons available for export. This trend, coupled with ongoing fossil fuel subsidies and relatively low domestic fuel prices, poses a growing concern for the national budget and external revenues. The upward trajectory in electricity demand is particularly noteworthy: in 2022, demand reached an all-time high of 666.16 MW, a dramatic increase from 224.16 MW in 2021(sonelgaz,2022).

This sharp rise is closely linked to the intensification of climate-induced heatwaves across the country, which have heightened reliance on electricity, particularly for cooling. With climate projections indicating continued temperature increases, the government faces mounting pressure to adopt alternative energy solutions that alleviate the burden on finite fossil resources.

Phased Model for Energy Transition (Adapted from the German Model)

To achieve a comprehensive and effective transition towards a fully renewable energy-based system, Algeria must adopt a phased approach. Drawing from the German experience, this transition can be structured across four sequential stages(Khaled, 2021, p 4):

- Stage 1: Introduction of renewable energy technologies following their development and cost decline, facilitated by sustained investment

in research and development (R&D), technological innovation, and increased market accessibility.

- Stage 2: Integration of electricity from renewable sources into the national energy grid, with the support of flexible fossil fuel reserves to ensure energy reliability and system stability.
- Stage 3: Deployment of long-term energy storage infrastructure to meet peak demand periods and enhance renewable energy penetration. This stage also involves establishing transmission systems to ensure efficient distribution of renewable electricity across regions.
- Stage 4: Full substitution of fossil fuels with renewable energy across all economic sectors, culminating in the establishment of a 100% renewable-based energy system. This final stage requires significant investment in supportive infrastructure for transportation, storage, and sectoral integration, laying the foundation for a resilient and sustainable industrial economy.

4. The Impact of Renewable Energy Utilization on Some Sustainable Development Goals in Algeria:

In alignment with global efforts to realize the dimensions of sustainable development, Algeria has launched a long-term strategic plan to invest in renewable energy, with a particular emphasis on solar energy. This is largely attributed to the country's vast solar potential, especially in the Sahara region, where annual sunshine durations exceed 2000 hours nationwide and reach up to 3900 hours in the high plateaus and desert zones(aapi,2022).

4.1 Renewable Energy and Economic Sustainability:

Amid increasing awareness of the necessity to transition to renewable energy, and the proliferation of technologies that support the emergence of new industrial segments—particularly solar energy—Algeria has begun leveraging this sector as a vector of economic transformation. The deployment of solar technologies necessitates manufacturing infrastructure for photovoltaic panels and related components such as solar heaters and mounting structures. This, in turn, stimulates employment creation, reduces unemployment, opens new opportunities for skilled and unskilled labor, and positively contributes to GDP growth(Zemrī, 2024, p. 93).

4.1.1. Reducing the Budget Deficit:

One of the major economic benefits of renewable energy lies in its potential to ease the fiscal burden associated with fossil fuel subsidies. The

Algerian state heavily subsidizes electricity and fuel prices, including covering nearly 60% of Sonelgaz's production costs. To address this issue, the government has begun revising its subsidy structure by gradually reducing fossil fuel support and redirecting resources toward clean energy development. In this context, Algeria has committed approximately \$120 billion to finance renewable energy and energy efficiency programs, with the objective of generating 22,000 megawatts of electricity from clean sources by 2030(BOUKRIKA, 2020, p 174). Additionally, Algeria incurs \$3 billion annually to import gasoline and diesel at €0.90 per liter, which it then provides domestically at €0.13 per liter—a disparity of €0.77 per liter that is absorbed by the public treasury(BOUAKRIF and QUERCHI, 2021, p 379).

4.1.2. Improving the Trade Balance:

The integration of renewable energy into the national energy mix facilitates a reduction in domestic fossil fuel consumption, thereby allowing for the reallocation of oil and gas toward export markets. Moreover, the potential to export surplus electricity generated from renewable sources enhances Algeria's trade position.

- Renewable energy will ensure the availability of non-depletable energy for both public and private development projects. Through the application of advanced technologies, solar energy will support the expansion of national development programs and meet increasing per capita electricity consumption, currently estimated at 24.7 kWh annually(MOUSSAWI, 2017, p 400). This strategy enhances energy security—one of the core objectives of Algeria's energy and development policies.
- **Preserving Fossil Fuel Reserves:** The strategic deployment of renewable energy for electricity generation could allow Algeria to preserve an estimated 300 billion cubic meters of natural gas by 2030—equivalent to eight times the national consumption of 2014(MOKHTARIA, 2018, p 168). Optimal utilization of renewable sources mitigates overexploitation of hydrocarbons, ensuring the availability of fossil resources for future generations while simultaneously contributing to emissions reductions and climate change mitigation.

4.2 Renewable Energy and Social Sustainability:

The social dimension of sustainable development is deeply influenced by the deployment of renewable energy, which offers numerous socio-economic benefits across various regions(Panagoda et al., 2023, p 71).

4.2.1. Achieving National Self-Sufficiency in Electrical Energy:

Algeria has adopted proactive policies aimed at enhancing energy sovereignty by incorporating modern renewable technologies into the electricity sector. As a result, renewable sources now account for approximately 27% of national electricity generation, including 19% from solar energy. These developments are crucial given the growing population and urban expansion, which have significantly increased residential electricity demand. In 2016, household electricity consumption reached 20,211 GWh—constituting 36.65% of the total national electricity use (55,144 GWh)(BOUAKRIF, 2021, p380).

4.2.2. Extension of Electricity to Remote Areas:

Solar energy offers a practical and cost-effective solution for supplying electricity to remote and isolated areas that are difficult to connect to the national grid. Algeria's revised energy strategy has prioritized the deployment of solar power stations in desert regions, thereby ensuring access to electricity in previously underserved communities.

4.2.3. Job Creation and Improving Living Standards:

Renewable energy infrastructure contributes to the socio-economic development of marginalized and low-income regions. The availability of electricity enhances living conditions, supports education and healthcare services, and facilitates local economic activity. The expansion of solar power plants near rural communities has directly generated employment opportunities. Algeria's renewable energy strategy is expected to create over 500,000 direct and indirect jobs. For instance, according to BLT (a solar energy firm), the construction of a \$100 million solar power plant can generate approximately 3,800 job opportunities(BOUAKRIF and QUERCHI, 2021, p381).

4.2.4. Fair Distribution of Energy:

Given Algeria's abundant renewable energy potential across all regions, energy equity becomes a realistic objective. Investments in solar energy projects, particularly in the southern provinces, have contributed to extending electricity access to desert communities previously excluded from energy infrastructure. This supports the realization of Sustainable

Development Goals related to social inclusion and equity. Additionally, solar energy can be employed in water desalination plants, contributing to water security—another fundamental pillar of sustainable development and social stability in arid regions.

4.3. Renewable Energy and Environmental Aspects:

In recent years, Algeria has experienced increasing environmental vulnerability, including rising average temperatures and decreasing precipitation levels—manifestations of broader climate change dynamics. Within this context, the deployment of renewable energy has a multifaceted environmental impact, contributing significantly to mitigation efforts and ecological preservation.

4.3.1. Reducing Greenhouse Gas Emissions:

Renewable energy is classified as clean energy because its generation does not emit greenhouse gases (GHGs) or other pollutants detrimental to atmospheric quality. Unlike fossil fuels, which release large quantities of CO₂, SO₂, renewable technologies—particularly solar and wind—offer a carbon-neutral alternative. The large-scale adoption of renewable energy therefore contributes directly to reducing Algeria's carbon footprint and aligning national practices with global climate mitigation commitments.

4.3.2. Reducing Harmful Solid and Liquid Waste:

Beyond emissions reductions, renewable energy systems contribute to minimizing industrial waste outputs. Unlike conventional power generation, which often produces hazardous by-products in solid and liquid forms—such as ash, sludge, and contaminated water—renewable technologies generate negligible waste. Their integration thus reduces the environmental burden of waste treatment and disposal, especially in the electricity production sector.

4.3.3. Preserving the Ecological System:

The ecological system, composed of interconnected living and non-living entities—including flora, fauna, humans, and microorganisms—relies on environmental equilibrium. Renewable energy investments have minimal ecological disruption compared to fossil fuel extraction and combustion, which are associated with land degradation, aquatic contamination, and biodiversity loss. The clean nature of renewable energy preserves the integrity of marine and terrestrial ecosystems, reducing the

risk of environmental imbalances and mitigating the drivers of global warming.

4.3.4. Rationalizing Energy Consumption to Reduce Environmental Impacts:

Algeria has integrated energy efficiency measures as part of its broader energy transition strategy. One key initiative includes the promotion of high-efficiency lighting technologies. The government has introduced and subsidized energy-saving bulbs that consume 20 watts—significantly less than traditional lighting—while providing superior luminosity and durability. With a unit cost of 800 DZD, the government subsidizes 70% of the retail price, bringing it below 250 DZD for consumers. These bulbs not only reduce household energy demand but also have a lifespan 15 times longer than conventional models, thus contributing to both environmental and economic sustainability(BOUKRIKA, 2020, p 170).

4.4 The Various Impacts of Investing in Renewable Energy on Industry:

Investing in renewable energy yields a broad spectrum of impacts on the industrial sector, spanning economic, technological, and environmental dimensions. These impacts enhance the sector's performance and sustainability.

4.4.1. Economic Impacts of Investing in Renewable Energy on Industry:

Key economic outcomes of renewable energy investments in the industrial sector include:

- Enhancing production efficiency and lowering operational costs, which increases industrial competitiveness in both domestic and international markets.
- Stimulating innovation and technological development by fostering the diffusion of renewable technologies and facilitating industrial upgrading.
- Creating new industrial segments and revitalizing existing ones through the localization of renewable energy technology manufacturing, assembly, and maintenance.

4.4.2. Environmental Impacts of Investing in Renewable Energy on Industry:

The environmental benefits of integrating renewable energy into industrial processes are substantial. These investments help reduce carbon dioxide emissions and other industrial pollutants, thereby mitigating the environmental footprint of manufacturing activities. Moreover, they support the conservation of non-renewable natural resources and contribute to

improving the environmental quality of life for communities situated near industrial zones. Renewable energy thus emerges as a tool for advancing both industrial productivity and environmental integrity.

5. CONCLUSION:

The industrial sector faces mounting sustainability challenges, most notably the dual imperative of meeting growing energy demands while reducing greenhouse gas emissions. Within this context, renewable energy emerges as a strategic and viable solution—capable not only of supporting energy-intensive industrial operations but also of fostering the transition toward sustainable manufacturing systems. Beyond its environmental value, renewable energy contributes to broader development goals by enhancing living standards, promoting equitable access to energy, and supporting inclusive socio-economic development.

This study has led to several key conclusions:

- Renewable energy constitutes a foundational pillar for industrial activity, as energy availability is essential to operate machinery and production lines. As a sustainable and inexhaustible source, renewable energy represents the future direction of industrial energy supply.
- The efficient deployment and integration of renewable energy into industrial processes yield tangible environmental benefits, contributing to the realization of sustainability targets while simultaneously creating employment opportunities and promoting social equity by reducing poverty and energy exclusion.
- Renewable energy use supports industrial development by ensuring access to clean, secure, and resilient energy sources that reduce dependency on fossil fuels.
- Transitioning to renewable energy enhances environmental sustainability, playing a crucial role in mitigating the adverse effects of climate change and reducing ecological degradation.
- Industrial competitiveness can be significantly strengthened through investment in research, technological innovation, and the seamless integration of renewable energy into the broader energy system.

5.1. Recommendations:

Despite the manifold benefits associated with renewable energy adoption, significant challenges persist—chief among them being the high

initial capital costs required for developing generation facilities and infrastructure for energy transmission and storage. To address these constraints and advance the national energy transition, the following recommendations are proposed:

- Strengthen collaboration between the public and private sectors to foster joint ventures, technological exchange, and innovation aimed at improving system efficiency and reducing investment and operational costs in the renewable energy sector.
- Expand funding for research and development (R&D) focused on enhancing system performance, developing Next-Generation energy solutions, and adapting existing technologies to local industrial contexts.
- Formulate and revise policy and regulatory frameworks that provide institutional incentives and strategic guidance for the widespread adoption of renewable energy across industrial sectors.
- Invest in human capital development by supporting training programs, academic curricula, and public awareness campaigns aimed at promoting a clean energy culture and positioning renewable energy as a central component of modern economic life.

5. Bibliography List:

- **Theses:**
 1. Zenad, Souhila, Strategy for Promoting the Efficiency of Alternative Energy Sources to Replace Oil Wealth According to Sustainability Criteria - A Case Study of Solar Energy in Algeria (Doctoral Thesis). Department of Economics, Faculty of Economic Sciences, Commercial Sciences, and Management Sciences, Setif 1 University, Algeria, 2018.
 2. Ladjal, Khaled. A Strategic Study of the Substitution of New and Renewable Energies in Algeria "The Case of Solar Energy in the Period 1995-2010" (Master's Thesis). Department of Economics, Faculty of Economic Sciences, Commercial Sciences, and Management Sciences, Algiers 3 University, Algeria, 2011.
- **Journal article :**
 1. Abbasi, K. R., Shahbaz, M., Zhang, J., Irfan, M., & Alvarado, R. (2022). Analyze the environmental sustainability factors of China: The role of fossil fuel energy and renewable energy. *Renewable Energy*, volume 187, p 390-402.
 2. BOUAKRIF Zohir, Z. S., QUERCHI Elaid. (2021). Energy Transition Toward the Necessity of Utilizing Renewable Energies to Achieve

The Role of Renewable Energy in Achieving Industrial Sustainability as a Strategic Objective of Sustainable Development in Algeria

Sustainable Development in Algeria. *Journal of Finance and Markets*, Volume 8 issue 01, p 368-386.

3. BOUKRIKA Rafika, Z. S. (2020). Green Economy as a Tool for Achieving Sustainable Development – The Case of Algeria". *Journal of Finance and Markets*, Volume 07 issue 03, p 164-183.
4. Khaled, S. (2021). Sustainable Transition of the Algerian Energy System: Developing a Stage Model. Algeria Office.
5. MOKHTARIA Din, Z. Z. (2018). The Role of the National Electricity Company and Renewable Energies in Activating the National Program for Sustainable Development. A Causal Study of Solar Power Electricity Production. *Journal of Finance and Markets*, volume 4 issue 2, p162-181.
6. MOUSSAWI Rafika, M. Z. (2017). The Role of Renewable Energies in Achieving Sustainable Development. *Journal of Finance and Markets*, volume 7 issue 3, p164-183.
7. Panagoda, L., Sandeepa, R., Perera, W., Sandunika, D., Siriwardhana, S., Alwis, M., & Dilka, S. (2023). Advancements in photovoltaic (Pv) technology for solar energy generation. *Journal of research technology & engineering*, volume 4 issue 30, p30-72.
8. Panwar, N. L., Kaushik, S. C., & Kothari, S. (2011). Role of renewable energy sources in environmental protection: A review. *Renewable and sustainable energy reviews*, volume 15 issue 3, p1513-1524.
9. Parida, B., Iniyar, S., & Goic, R. (2011). A review of solar photovoltaic technologies. *Renewable and sustainable energy reviews*, volume 15 issue 3, p1625-1636.
10. Tsoutsos, T. D., & Stamboulis, Y. A. (2005). The sustainable diffusion of renewable energy technologies as an example of an innovation-focused policy. *Technovation*, volume 25 issue 7, p753-761.
11. Zemri, B. E. (2024). Green Growth in Algeria: Balancing industry and environment for sustainable economic development. *Dirassat Journal Economic Issue*, volume 15 issue 1, p119-136.
12. Zemri, B. E. (2024). Forecasting the Role of Renewable Energy on Algeria's Economic Stability: ARIMAX Model. *International Journal of Business and Economic Studies*, volume 6 issue 2, p90-109.

- Internet websites:

1. Algerian Agency for Investment Promotion. (2022). Available potential in the field of renewable energies. <https://aapi.dz/ar/secteur-des-energies-nouvelles-et-energies-renouvelables-ar/#>. (Accessed on March 28, 2025, at 10:23 AM)

2. Sonelgaz. (2020). News: Electricity consumption peak 2022. <https://www.sonelgaz.dz/ar/5509/pic-conso-2022-ar>(Accessed on March 28, 2025, at 10:23 AM)