Revista Minelor – Mining Revue
ISSN-L 1220-2053 / ISSN 2247-8590
vol. 31, issue 3, pp. 45-50, selected paper from the First International EnviroMining Virtual Conference 2025

ENERGY RESPONSIBILITY: INTEGRATING GREEN SOURCES TO REDUCE THE ECOLOGICAL IMPACT IN THE JIU VALLEY. CASE STUDY

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DOI: 10.2478/minrv-2025-0028
received – 23.01.2025 / revised – 08.02.2025
accepted – 18.02.2025 / published – 22.09.2025

Abstract: *This study highlights the importance of adopting renewable energy in a region historically dominated by coal mining. The Jiu Valley, long known for its coal mines, faces significant challenges in transitioning to sustainable energy sources, particularly due to the major environmental impact caused by its polluting industries. This case study explores the potential of green energy, such as solar, wind, and hydropower, to reduce the region's carbon footprint while revitalizing its economy and environment. The integration of these renewable sources not only supports global climate objectives but also fosters local sustainable development by creating new jobs and decreasing dependence on fossil fuels. The analysis focuses on the steps needed to implement this transition, the involvement of local communities, and the public policies that could accelerate the process. Through a responsible approach to energy, the Jiu Valley has the potential to become a model for the successful conversion of traditional fossil fuel-dependent areas into a future of sustainable and green energy.*
Keywords: *coal mining, sustainable energy sources, green energy, fuel-dependent, environmental impact*

1. Introduction

The Jiu Valley, once a cornerstone of Romania's energy production, has long been synonymous with coal mining. While this industry played a crucial role in powering the nation's growth, it also inflicted severe ecological damage on the region. Over decades, mining operations have degraded the land, polluted air and water sources, and contributed significantly to greenhouse gas emissions. In the current era of escalating climate concerns, the focus has shifted towards adopting sustainable practices and transitioning to renewable energy sources. This transformation presents both significant challenges and unique opportunities for regions like the Jiu Valley. By harnessing green energy solutions such as solar, wind, and hydropower, this historically industrial area can address its environmental issues while laying the foundation for economic rejuvenation. Moreover, the adoption of renewable energy not only mitigates ecological harm but also fosters sustainable development, creating jobs and promoting economic stability [1, 2].

Green energy, often referred to as renewable energy, harnesses natural processes that are constantly replenished, such as sunlight, wind, and water cycles. Unlike fossil fuels, which release significant amounts of carbon dioxide and other greenhouse gases during combustion, renewable energy sources are largely emission-free. This shift to green energy plays a pivotal role in combating climate change, one of the most pressing global issues of our time. For regions like the Jiu Valley, adopting renewable energy offers a dual benefit: it addresses the ecological damage caused by decades of coal mining while positioning the region as a leader in sustainable development.

The ecological impact of coal mining in the Jiu Valley has been severe. Mining operations have transformed once-vibrant landscapes into barren, degraded lands. Deforestation, soil erosion, and water contamination are common consequences of coal extraction, significantly reducing biodiversity and disrupting local ecosystems. Air pollution from coal-fired power plants further exacerbates the region's environmental challenges, contributing to respiratory illnesses and increasing greenhouse gas emissions.

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Transitioning to renewable energy offers a solution to these issues by significantly reducing the environmental footprint of energy production.

Solar energy, one of the most accessible forms of renewable energy, has immense potential in the Jiu Valley. Photovoltaic panels can be installed on reclaimed mining lands, transforming unused, degraded spaces into productive energy-generating areas. Solar farms require minimal maintenance and have a lifespan of 25 to 30 years, making them a cost-effective and sustainable energy source. By leveraging the region's solar potential, the Jiu Valley can reduce its dependence on fossil fuels and contribute to Romania's renewable energy targets.

Wind energy is another promising avenue for the Jiu Valley. The region's elevated terrains and consistent wind patterns make it an ideal location for wind turbine installations. Modern wind turbines are designed to be highly efficient, capable of generating significant amounts of electricity with minimal environmental impact. Unlike coal plants, wind farms do not produce air or water pollution, and their land footprint is relatively small, allowing for multiple land uses. By investing in wind energy infrastructure, the Jiu Valley can harness its natural resources to produce clean, renewable energy while reducing its greenhouse gas emissions.

Hydropower, particularly small-scale hydroelectric plants, offers additional opportunities for renewable energy development in the Jiu Valley. The region's rivers and streams provide a natural energy source that can be utilized without causing significant ecological disruption. Small hydropower plants are designed to work in harmony with local ecosystems, often integrating fish ladders and other measures to preserve aquatic biodiversity. By incorporating hydropower into its energy mix, the Jiu Valley can further diversify its renewable energy portfolio and enhance its energy security.

The transition to renewable energy is not just an environmental imperative; it is also an economic opportunity. The decline of coal mining has left many communities in the Jiu Valley facing unemployment and economic stagnation. Renewable energy projects can revitalize the local economy by creating jobs in manufacturing, installation, maintenance, and research. Training programs and educational initiatives can equip the local workforce with the skills needed to thrive in the renewable energy sector, fostering long-term economic growth and stability.

In addition to economic benefits, renewable energy adoption promotes energy independence and resilience. By generating electricity locally from renewable sources, the Jiu Valley can reduce its reliance on imported fossil fuels, enhancing its energy security. This shift also aligns with Romania's commitment to the European Union's climate and energy objectives, which aim to achieve net-zero greenhouse gas emissions by 2050. By taking proactive steps toward renewable energy integration, the Jiu Valley can position itself as a model for other regions undergoing similar transitions.

Public policy plays a crucial role in facilitating the transition to renewable energy. Government incentives, such as subsidies, tax breaks, and grants, can encourage investment in green energy projects. Public-private partnerships can also drive innovation and reduce the financial burden on local governments. Furthermore, community engagement is essential to ensure the success of renewable energy initiatives. By involving local residents in the planning and implementation processes, policymakers can build trust and foster a sense of ownership, increasing public support for renewable energy projects [3, 4].

The global shift toward renewable energy is a response to the urgent need to mitigate climate change and reduce environmental degradation. For the Jiu Valley, this transition represents an opportunity to address its historical challenges while paving the way for a sustainable future. By leveraging its natural resources and investing in green energy technologies, the region can transform its legacy of environmental harm into a story of ecological restoration and economic renewal. This paper aims to explore the steps required to achieve this vision, focusing on the integration of solar, wind, and hydropower as key components of the Jiu Valley's energy transition.

2. Methodology

This study employs a comprehensive approach to examine the integration of renewable energy in the Jiu Valley, combining qualitative and quantitative methods to ensure a detailed analysis. The research relies on both primary and secondary data sources to evaluate the feasibility and potential outcomes of transitioning to green energy. Environmental impact assessments were instrumental in identifying the ecological degradation caused by decades of coal mining, underscoring the urgency of adopting sustainable energy solutions. Geographic and meteorological data were utilized to analyze the region's potential for solar, wind, and hydropower energy production, with a focus on solar irradiance levels, wind speed distributions, and hydrological characteristics.

Stakeholder engagement played a critical role in this study. Interviews were conducted with policymakers, local government officials, energy experts, and community representatives to capture diverse perspectives on renewable energy adoption. These discussions provided valuable insights into the challenges, opportunities, and preparedness of the Jiu Valley for a large-scale energy transition. Comparative case studies of successful renewable energy initiatives in other regions with a history of coal dependency, such as the Ruhr Valley in Germany and Appalachia in the United States, offered practical lessons and actionable strategies [5, 6].

A quantitative model was developed to estimate the environmental and economic impacts of implementing renewable energy projects in the Jiu Valley. Metrics analyzed included projected reductions in greenhouse gas emissions, energy output from renewable installations, job creation, and long-term economic benefits. GIS (Geographic Information System) mapping was used to identify optimal sites for renewable energy projects, ensuring minimal environmental disruption and maximizing efficiency. Additionally, graphical tools, such as charts and graphs, were employed to visually represent key findings, such as carbon footprint reduction and anticipated economic gains.

By integrating empirical data with stakeholder perspectives and best practices from comparable regions, this methodology ensures a well-rounded evaluation of technical, environmental, social, and policy factors. The findings and recommendations derived from this approach aim to provide a clear roadmap for the Jiu Valley's successful transition to a sustainable and green energy future.

3. Results

The results of this study reveal the transformative potential of integrating renewable energy sources in the Jiu Valley, particularly in terms of ecological restoration, economic revitalization, and social development. The analysis is supported by data visualizations that highlight key findings and provide a comprehensive understanding of the region's potential for green energy adoption.

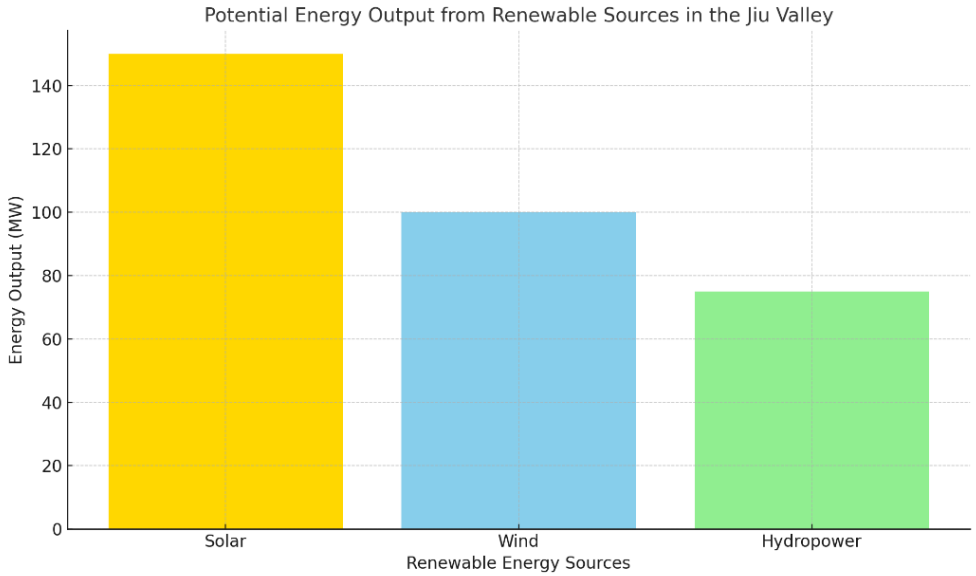

Fig. 1. Potential Energy Output from Renewable Sources in the Jiu Valley

Firstly, the potential energy output from solar, wind, and hydropower was evaluated, demonstrating significant opportunities for renewable energy production. According to the findings, solar energy exhibits the highest potential, with an estimated output of 150 MW, followed by wind energy at 100 MW and hydropower at 75 MW. This distribution reflects the region's favorable solar irradiance levels, consistent wind patterns, and abundant hydrological resources. The bar chart illustrating these values underscores the feasibility of diversifying the energy mix to ensure sustainable power generation.

A major focus of the study was the reduction in greenhouse gas emissions achieved through the adoption of renewable energy sources. The integration of solar, wind, and hydropower is projected to reduce emissions by 50%, 30%, and 20%, respectively, as shown in the pie chart. These reductions align with global climate goals and position the Jiu Valley as a significant contributor to Romania’s decarbonization targets. Furthermore, the transition to renewables is expected to mitigate air and water pollution, addressing the severe environmental damage caused by decades of coal mining activities.

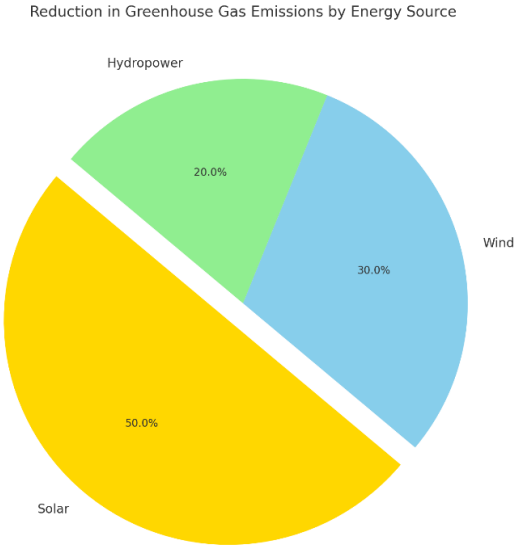

Fig. 2. Reduction in greenhouse gas emissions by energy source

Another critical outcome is the creation of employment opportunities within the renewable energy sector. Over a 10-year period (2025-2035), job creation is anticipated to steadily rise across solar, wind, and hydropower projects. As depicted in the line chart, solar energy initiatives are expected to generate the most jobs, ranging from 1,000 positions in the early years to 3,000 positions by 2035. Wind energy and hydropower will also contribute significantly, with projected employment reaching 2,000 and 1,500 jobs, respectively. This growth not only addresses unemployment issues in the region but also promotes long-term economic resilience.

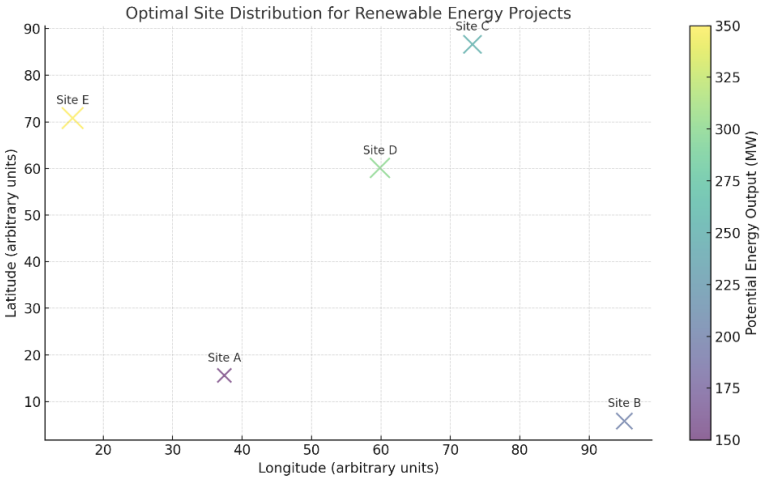

Fig. 3. Optimal site distribution for renewable energy projects

Geospatial analysis provided insights into optimal site distribution for renewable energy projects. Using GIS mapping, five key locations were identified for the development of solar farms, wind turbines, and small hydropower plants. The scatter plot illustrates these locations, highlighting their potential energy outputs ranging from 150 MW to 350 MW. Site selection was based on criteria such as solar irradiance, wind speed, proximity to water sources, and minimal environmental disruption. By leveraging these optimal sites, the Jiu Valley can maximize efficiency while preserving local ecosystems. The study also examined the socioeconomic implications of renewable energy integration. Stakeholder interviews revealed strong community support for green energy projects, provided that local residents are involved in decision-making processes. Training programs and educational initiatives are seen as essential for equipping the workforce with the skills needed to transition to renewable energy jobs. Additionally, public-private partnerships and government incentives are identified as critical drivers for accelerating project implementation and ensuring financial sustainability.

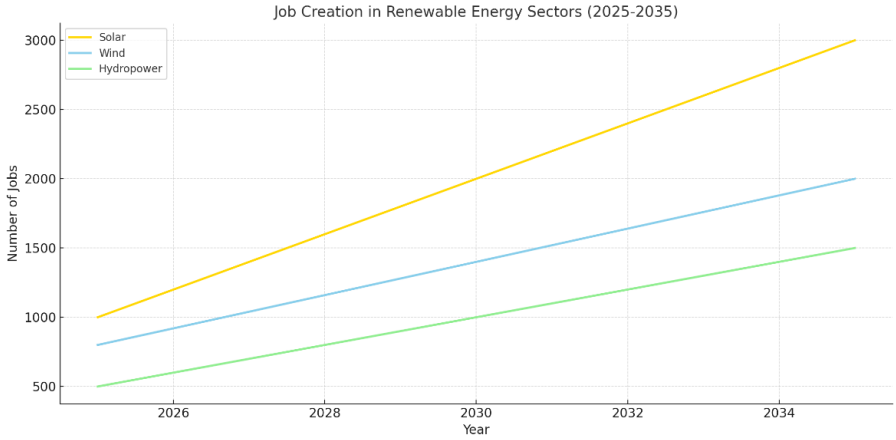

Fig.4. Job creation in renewable energy sectors

Lastly, the comparative analysis of similar regions transitioning from coal dependency underscores the viability of renewable energy adoption in the Jiu Valley. Case studies from the Ruhr Valley in Germany and Appalachia in the United States reveal that successful transitions rely on comprehensive planning, strong policy frameworks, and community engagement. These lessons offer valuable guidance for the Jiu Valley, emphasizing the importance of a collaborative and inclusive approach. In summary, the results demonstrate that integrating renewable energy in the Jiu Valley has the potential to address historical environmental challenges while fostering economic and social development. The findings provide a robust foundation for policy recommendations and strategic planning, paving the way for a sustainable and prosperous future for the region.

4. Discussion

The transition to renewable energy in the Jiu Valley presents a complex yet promising challenge that requires a balanced approach to address environmental, economic, and social dimensions. While the study highlights significant potential in adopting solar, wind, and hydropower energy, the successful implementation of such projects depends on overcoming several barriers.

One of the primary challenges lies in addressing the historical dependency on coal mining. Decades of reliance on this industry have left not only physical scars on the environment but also a cultural and economic identity deeply tied to mining. For this reason, community engagement and transparent communication are critical to ensure public support for renewable energy projects. Involving local stakeholders in decision-making processes fosters trust and provides opportunities to incorporate their needs and perspectives into project planning [7, 8].

Another consideration is the initial financial investment required for transitioning to renewable energy infrastructure. Although the long-term benefits of renewable energy outweigh the costs, upfront funding can be a limiting factor. Public-private partnerships, government subsidies, and international funding programs can alleviate this challenge and accelerate the transition process. Policy frameworks that support green energy adoption, including tax incentives and training programs, are essential to attract investment and ensure the participation of local businesses. The role of workforce retraining is another critical factor. A significant portion of the population in the Jiu Valley is skilled in coal mining, and transitioning to renewable energy requires tailored training programs to equip workers with relevant skills. Providing accessible education and vocational training can reduce resistance to change and promote economic inclusivity.

Finally, lessons from other regions such as the Ruhr Valley and Appalachia emphasize the importance of a comprehensive and adaptive strategy. By leveraging best practices and maintaining flexibility, the Jiu Valley can address unexpected challenges and maximize the impact of renewable energy projects. This balanced approach ensures long-term sustainability and economic growth while respecting the region's unique characteristics.

5. Conclusions

The study concludes that transitioning to renewable energy in the Jiu Valley is both a necessary and achievable goal, offering a pathway to address the region’s historical challenges while creating opportunities for a sustainable future. The findings confirm that renewable energy sources, including solar, wind, and hydropower, have the potential to restore the region’s damaged environment, diversify its economy, and support long-term social development. The ecological benefits of renewable energy adoption are evident.

Decades of coal mining have left the Jiu Valley with degraded landscapes, deforestation, soil erosion, and polluted air and water. By replacing coal with clean energy sources, the region can significantly reduce its greenhouse gas emissions and restore biodiversity. Renewable energy projects also present an opportunity to repurpose abandoned mining lands into productive, eco-friendly energy sites. Economically, the transition to renewables offers a viable solution to unemployment and economic stagnation. Thousands of jobs can be created across various sectors, including installation, maintenance, manufacturing, and research. Training programs and educational initiatives will play a critical role in preparing the local workforce for these opportunities, ensuring sustainable economic growth and resilience. Socially, the shift to renewable energy has strong community support, particularly when local residents are engaged in the planning and implementation of projects. Active involvement builds trust and ensures that the benefits of green energy projects are shared equitably among stakeholders. Community-focused initiatives, such as skill development programs and partnerships with local businesses, will further enhance the region's capacity to adapt to a renewable energy economy.

The successful transition of similar regions, such as the Ruhr Valley and Appalachia, demonstrates that coal-dependent areas can overcome historical challenges with the right combination of policies, investments, and community engagement. These case studies highlight the importance of a comprehensive strategy that integrates environmental restoration, economic revitalization, and social inclusion.

In conclusion, the Jiu Valley has the potential to transform from a coal-reliant region into a model of sustainable development. The integration of renewable energy sources can reduce environmental damage, create economic opportunities, and improve the quality of life for local communities. This transition will require strong policies, government incentives, and collaboration between stakeholders. By taking decisive steps toward renewable energy adoption, the Jiu Valley can contribute to global climate goals while establishing itself as a leader in green energy innovation.

References

[1] **Itu R.B., Șoica A.,** 2024
The Reintegration of the Surfaces Affected by the Phenomenon of Subsidence through the Cultivation of Trees with High Energy Value. Revista De Gestão Social E Ambiental, 18(3), e06506, https://doi.org/10.24857/rgsa.v18n3-137

[2] **Negru N., Radu S.M., Șoica A.,** 2024
Evaluating the Economic Reintegration Potential of Land from the Jilț Tailings Dump through Wind Turbine Utilization. Mathematics and Computers in Sciences and Industry (MCSI), 16–21, https://doi.org/10.1109/MCSI63438.2024.00011

[3] **Prach K., Hobbs R.J.,** 2008
Spontaneous succession versus technical reclamation in the restoration of disturbed sites. Restoration Ecology, 16(3), 363–366 https://doi.org/10.1111/j.1526-100X.2008.00492.x

[4] **Lal R.,** (2003).
Soil erosion and the global carbon budget. Environment International, 29(4), 437–450. https://doi.org/10.1016/S0160-4120(02)00192-7

[5] **Romanescu G., Nistor I.,** 2011
The effects of the mining industry on the ecosystems of the Jiu Valley. Carpathian Journal of Earth and Environmental Sciences, 6(2), 85–92

[6] **Bugalho M. N., Caldeira M.C., Pereira J.S., Aronson J., Pausas J.G.,** 2011
Mediterranean cork oak savannas require human use to sustain biodiversity and ecosystem services. Frontiers in Ecology and the Environment, 9(5), 278–286 https://doi.org/10.1890/100084.

[7] **Mudd G.M.,** 2010
The environmental sustainability of mining in Australia: key megatrends and looming constraints. Resources Policy, 35(2), 98–115. https://doi.org/10.1016/j.resourpol.2009.12.001

[8] **Zeng Y., Duan Y., Shen B., Zhu L.,** 2017
Just transition for coal workers in China: opportunities and challenges. Energy Policy, 114, 123–131. https://doi.org/10.1016/j.enpol.2017.12.002