International Journal of Environmental Sciences & Natural Resources
ISSN: 2572-1119

Juniper Publishers
key to the Researchers

Opinion
Volume 34 Issue 2 - October 2024
DOI: 10.19080/IJESNR.2024.34.556385

Int J Environ Sci Nat Res

Jamaica's Renewable Energy Transition: Pathways and Challenges to Achieving 50% Renewable Electricity by 2030

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Submission: October 09, 2024; **Published:** October 23, 2024

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Abstract

Jamaica has set an ambitious aim of generating 50% of its electricity from renewable sources by 2030, reflecting its commitment to sustainable energy and climate resilience. This paper examines the key drivers and challenges influencing Jamaica's energy transition, focusing on the unique circumstances encountered by Small Island Developing States (SIDS) like Jamaica. The analysis covers policy frameworks, economic factors, technological advancements, and international collaborations that shape Jamaica's progress toward its renewable energy targets. Despite significant obstacles, including reliance on imported fossil fuels, financial constraints, and climate vulnerabilities, Jamaica's efforts offer valuable lessons for other SIDS and developing nations. This paper underscores the potential of Jamaica's renewable energy transition to serve as a model for similar contexts, inspiring a global movement toward sustainable energy solutions.

Keywords: Renewable energy Jamaica 2030; SIDS energy policy; Caribbean renewable integration; Jamaica energy policy impact; sustainable SIDS energy

Introduction

Jamaica, nestled in the Caribbean, mirrors the energy challenges many Small Island Developing States (SIDS) confront. Historically, imported fossil fuels have significantly shaped Jamaica's energy landscape, influencing its security and economic stability. The country's susceptibility to natural disasters and climate change further exacerbates these challenges. However, in recent years, Jamaica has embarked on a transformative journey towards renewable energy sources that underscores its commitment and progress. This paper meticulously scrutinizes Jamaica's progress towards its ambitious renewable energy (RE) goal of 50% by 2030 [1] and the factors that shape this target. It also provides insights into the broader implications for energy transitions in similar contexts. The global significance of Jamaica's efforts as a potential model for other SIDS and developing nations is underscored, as it offers scalable solutions for countries grappling with similar geographical, economic, and environmental challenges [2]. Jamaica's journey serves as a beacon of hope and inspiration for the global community, demonstrating that a transition to renewable energy is possible and beneficial, even in the face of significant challenges.

Current energy landscape

Jamaica's energy sector has long been dominated by a reliance on imported fossil fuels, which has posed significant challenges to its energy security and economic resilience. The country has faced volatility in global oil prices, leading to substantial foreign exchange expenditures and economic instability [3]. This historical dependency on fossil fuels has underscored the need for a more resilient and self-sufficient energy system, prompting the country to explore alternative energy sources to mitigate these risks.

Recent developments reflect a gradual but notable shift towards renewable energy sources. Following reports by the Ministry of Science, Energy, and Technology (2021) [4], RE contributed approximately 13% of Jamaica's electricity generation in 2020. This increase is primarily attributed to wind and solar power growth, with wind accounting for 9% and solar contributing 3% to the electricity mix [5]. The rise in renewable energy adoption aligns with global trends and demonstrates Jamaica's pledge to diversify its energy sources and decrease dependence on conventional energy sources.

Despite the progress in renewable energy adoption, fossil fuels dominate Jamaica's energy landscape. As of 2020, fossil fuels amounted to approximately 87% of Jamaica's electricity generation [5]. This heavy reliance on fossil fuels, particularly oil, presents significant challenges to the nation's energy security and environmental objectives [3]. Reducing this dependency is crucial for advancing its sustainability goals and mitigating the ecological impact of its energy sector. Therefore, it is vital to review and analyze the historical and current growth of alternative energy sources, identify trends, and assess potential obstacles to achieving the 2030 target of 50% renewable energy in electricity generation, as set by the Prime Minister's Office [1,6]. Addressing these potential barriers is essential to ensure Jamaica stays on course to meet its renewable energy goals. Consequently, this commentary article aims to protect Jamaica's renewable energy growth over the next 26 years, identify key impediments, and offer policy recommendations to achieve the national renewable energy target by 2030.

Factors Influencing Jamaica's Renewable Energy Transition

Many factors influence Jamaica's rapid RE growth, including, but not limited to, (1) current RE policy, (2) economic dynamics, (3) climate change susceptibilities, (4) external, technical, and financial assistance, and (5) technological developments. Nonetheless, these are subject to changes in the long and short run. Consequently, rapid growth might depend on changes in one or more of these variables.

Implementing the National Energy Policy in 2009 and subsequent legislation, such as the Electricity Act of 2015, has established a supportive environment for renewable energy development [2]. These policies provide clear targets, incentives, and regulatory frameworks that facilitate the growth of renewable energy. Effective policy frameworks are not just guidelines but strategic tools driving investment and guiding the transition towards sustainable energy sources, providing reassurance about the country's strategic approach.

Economic factors significantly influence Jamaica's renewable energy transition. The volatility of oil prices and the declining costs of renewable technologies have made alternative energy solutions increasingly attractive [3]. Over the past decade, the cost of solar PV and wind technologies has decreased, making them more competitive with fossil fuel-based generation. These economic drivers support the expansion of renewable energy and contribute to Jamaica's efforts to diversify its energy mix.

Jamaica's vulnerability to climate change is a crucial motivator for its renewable energy transition. The country faces risks such as sea-level rise, increased hurricane intensity, and precipitation pattern changes, significantly affecting its energy sector [7]. Addressing these impacts through renewable energy adoption is part of a broader climate change adaptation and mitigation strategy. Renewable energy helps reduce carbon dioxide emissions and enhances the resilience to climate-related risks.

International support has been instrumental in advancing Jamaica's renewable energy goals. Collaborations with international organizations and development banks have provided essential technical and financial assistance for renewable energy projects [8]. These partnerships help overcome barriers to renewable energy deployment, including financial constraints and technical challenges. International support is crucial for facilitating the progress towards its renewable energy targets.

Technological advancements in renewable energy enhance the viability of projects in Jamaica. Innovations in solar PV efficiency, energy storage systems, and grid management technologies have improved the effectiveness and reliability of renewable energy sources [9]. Continued advancements in these technologies are essential for optimizing the integration of renewable energy into Jamaica's energy system.

Challenges in Achieving the 2030 Target

Several vital challenges must be addressed to achieve Jamaica's ambitious renewable energy goals. These include (1) integrating renewable sources into the existing grid, (2) building technical capacity, (3) overcoming financial barriers, and (4) managing land use conflicts.

Integrating renewable energy into Jamaica's electricity grid presents considerable challenges due to the intermittent nature of these sources and the need for considerable modifications to the country's isolated power grid [9]. Addressing these challenges involves investing in innovative grid technologies, energy storage systems, and infrastructure improvements. Concurrently, building local technical capacity through education and training programs is crucial for supporting the development and maintenance of renewable energy projects, ensuring long-term success in the energy transition [8].

Financial constraints remain a significant barrier to renewable energy adoption as limited access to finance and high upfront costs hinder project development [3]. Attracting private investment and securing affordable financing is critical for supporting large-scale renewable energy initiatives and achieving the 2030 target. Addressing these financial challenges is essential for advancing the renewable energy goals.

Land use conflicts challenge renewable energy projects, particularly solar PV and wind installations requiring substantial land areas. Balancing land use for renewable energy with other needs, such as agriculture and tourism—which contribute 30% of the archipelago's annual GDP is essential [2,10]. Consequently, developing strategies to address these conflicts is crucial for ensuring sustainable development and minimizing negative environmental impact.

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Method for Detecting Renewable Energy Trends for 2030-2050

The National Energy Policy, established in 2009, represents a critical component of the country's strategy to transition to renewable energy. The policy sets ambitious targets to proliferate the share of alternative energy in the electricity mix to 50% by 50% [5]. These targets reflect Jamaica's dedication to sustainable energy development and climate change mitigation. The policy outlines a strategic framework for achieving these goals, including measures to promote renewable energy technologies and enhance energy efficiency. For this achievement, gaining insight into the growth trend of energy generation is essential. Consequently, the study examines various mathematical models to project renewable energy adoption in Jamaica, including exponential growth, logistic growth, polynomial, and linear regression, as each model offers unique advantages and limitations for forecasting long-term trends in renewable energy adoption.

The exponential growth model assumes a constant growth rate, represented by equation 1:

$$y = a * e^{rt} \tag{1}$$

Where y is the renewable energy percentage, a is the initial value at t = 0, e is the natural logarithm base, approximately equal to 2.71828, r is the growth rate, and t is time. This model can accurately represent early-stage rapid growth but often overestimates long-term adoption due to its unbounded nature [11].

On the other hand, the logistic growth model accounts for an upper limit or carrying capacity, following equation 2:

$$y = \frac{K}{1 + Ae^{-rt}} \tag{2}$$

Here y represents the RE capacity, K is the carrying capacity, A is constant, r is the growth rate, and t is time. This model is often more realistic for long-term projections as it considers market saturation and resource limitations [12]. However, it requires an accurate carrying capacity estimation, which can be challenging in rapidly evolving markets.

The polynomial regression can capture non-linear trends and is represented by equation 3:

$$y = a_0 + a_1 x + a_2 x^2 + \ldots + a_n x^n \tag{3}$$

Where n is the gradation of the polynomial. While flexible, higher-degree polynomials can lead to overfitting and unrealistic long-term projections [13]. This model can capture the curvature in the data and provide a smoother trend line that fits the historical data well while allowing for reasonable future predictions. However, when applied, the model predicts a slight decrease in renewable energy percentage after 2040, with 23.61% in 2040, 23.01% in 2045, and 21.66% in 2050. Given the current trends in renewable energy adoption, it may be unrealistic. This highlights the limitation of using polynomial regression for long-term predictions in this context.

Conversely, the linear regression assumes a constant rate of change, following equation 4:

$$y = mx + b \tag{4}$$

In the equation, m is the slope, x represents the independent or explanatory variable, and b is the y-intercept. Despite its simplicity, linear regression can provide robust projections, especially for shorter time horizons or when trends are relatively stable [14].

For this case study of Jamaica's renewable energy adoption, the linear regression model is selected due to several factors, including data consistency, simplicity of the interpretation, strength, and adaptability. Regarding data consistency, the available data from 2000 to 2020 shows a relatively consistent linear trend, particularly in recent years. Moreover, linear regression offers easily interpretable results, crucial for policy-making and stakeholder communication [15]. When utilizing predictive assessment models, it is vital to consider the robustness of the model applied, and the linear models are less prone to overfitting than complex models, especially with limited historical data points [14] as in this case. Considering conservative estimates in the context of renewable energy planning, slightly underestimating future adoption (as linear models might do compared to exponential models) is often preferable to overestimation, which could lead to overinvestment or unrealistic policy targets [11]. For example, when the exponential growth model is applied, the projected value for 2045 is 121.45%, while 180.2% was obtained for 2050. Evidently, it exceeds 100%, which is unrealistic for energy percentages. This suggests that while the growth has been exponential, it will likely slow down and follow a logistic curve model as it approaches 100%. Nonetheless, while more complex models like the exponential growth model might capture nuanced trends, the linear regression model balances simplicity, interpretability, and reliability, given the available data and the study's objectives.

Results and Discussion

The trend for 2010 to 2050 reveals a clear trajectory towards increased renewable energy adoption in Jamaica (Figure 1). Research by Loy et al. [9] demonstrates that Jamaica has the technical potential to achieve 100% renewable electricity by 2050, leveraging a combination of solar PV, wind, and biomass. Additionally, Richards et al. [16] highlight the potential for reaching 50% renewable electricity by 2030, provided that substantial policy and infrastructure improvements are accomplished. These studies underscore the feasibility of Jamaica's renewable energy goals, instilling confidence in the country's ability to achieve these targets with continued investment and policy support.

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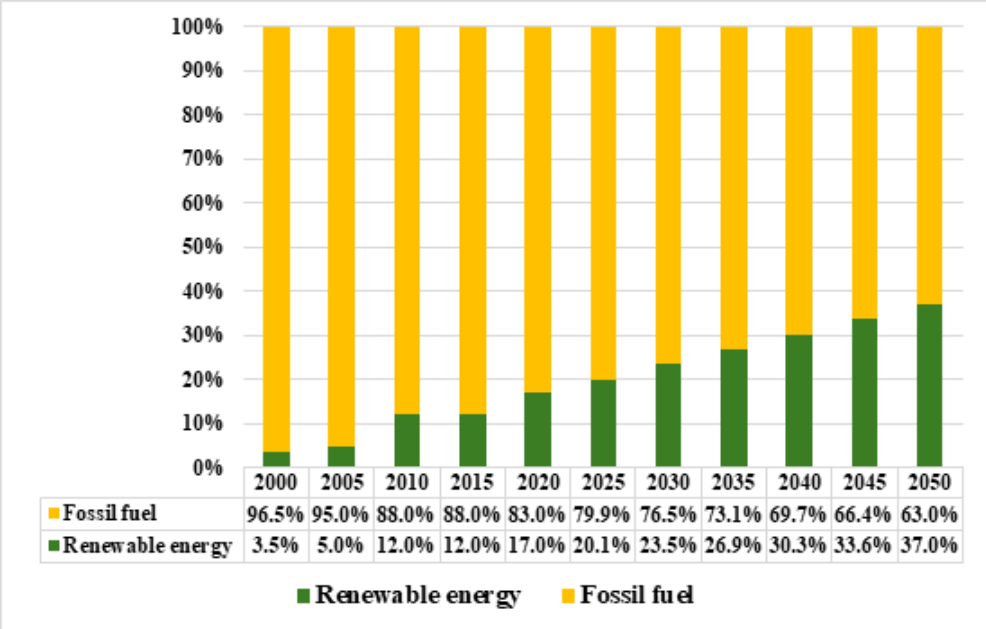
Nonetheless, the business-as-usual operation of the energy sector suggests that by 2050, Jamaica will not be able to achieve its goal of 50% renewable energy generation when all its renewable output is combined (Figure 2). The results show that by 2030, there will be 23.5% in cumulative RE generation, which will increase to 37% by 2050.



	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Fossil fuel	96.5%	95.0%	88.0%	88.0%	83.0%	79.9%	76.5%	73.1%	69.7%	66.4%	63.0%
Renewable energy	3.5%	5.0%	12.0%	12.0%	17.0%	20.1%	23.5%	26.9%	30.3%	33.6%	37.0%

Figure 1: The projected energy mix for Jamaica 2010-2050.

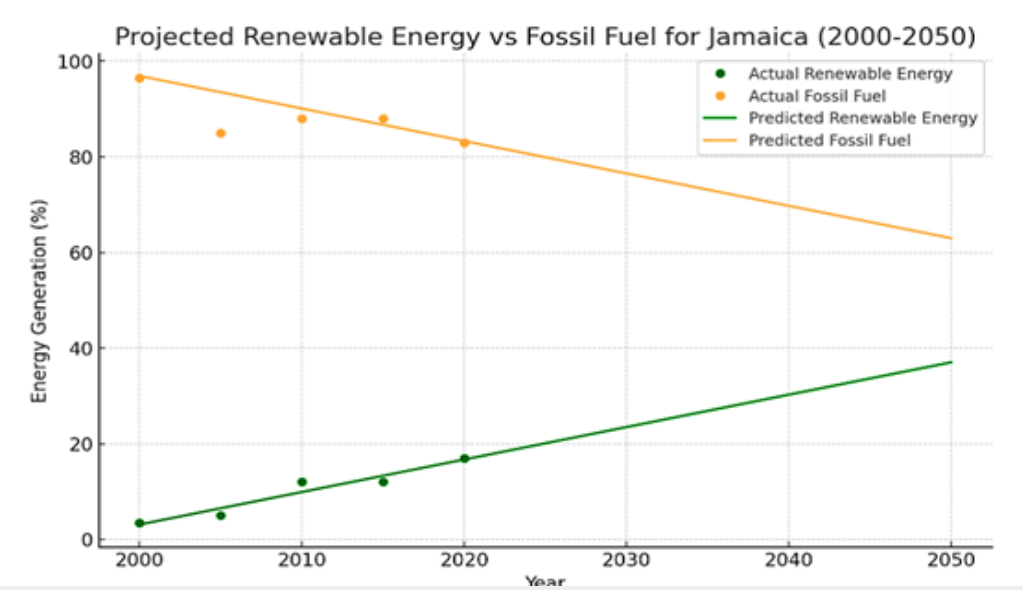


Figure 2: The trend line of Jamaica's energy output for 2050.

The projected trend in Jamaica's renewable energy generation, as illustrated in Figure 2, underscores the country's gradual but consistent shift towards sustainable energy sources. The data utilized for the generation of the regression are employed from various sources, including Country economy.com (2001), the International Renewable Energy Agency (2024), the United

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Nations Economic Commission for Latin America (UNECLAC) via Loy & Coviello (2005), and the World Bank (2019) [17-20]. This shift is influenced by various factors, including the robust policy framework established by the National Energy Policy of 2009 and subsequent legislation like the Electricity Act of 2015. These policies have provided the necessary incentives and regulatory frameworks to foster an environment conducive to renewable energy development. The adoption of renewable energy in Jamaica is also driven by economic factors, particularly the volatility of oil prices and the decreasing costs of renewable technologies. As renewable energy becomes more economically viable, its adoption will likely accelerate, contributing to a diversified energy mix that reduces the country's dependence on fossil fuels.

However, despite the positive outlook, Jamaica faces significant challenges in achieving its 2030 renewable energy targets. One of the primary challenges is incorporating alternative energy sources into the existing grid, which is complicated by the intermittent nature of renewables and the need for substantial upgrades to the isolated power grid. Addressing these issues will require investments in advanced grid technologies and energy storage systems, as well as the development of local technical capacity through education and training programs. Building this capacity is essential for theRE sector's sustainable growth and ensuring that the energy transition's technical aspects are effectively managed.

Financial constraints also pose a considerable challenge to the country renewable energy ambitions. The exorbitant upfront costs of renewable energy projects and limited access to financing have been significant barriers to the prevalent adoption of these technologies. Attracting private investment and securing affordable funding to support large-scale renewable energy initiatives are crucial to overcoming these barriers. By addressing these financial challenges, Jamaica may meet its renewable energy targets and sustain the momentum needed to transition successfully to a low-carbon energy system.

In addition to technical and financial challenges, land use conflicts represent another hurdle in achieving the 2030 renewable energy goals. Expanding renewable energy infrastructure, particularly for solar PV and wind projects, requires substantial land areas, which can result in conflicts with other land uses such as agriculture and tourism. These sectors are vital to Jamaica's economy, with tourism alone contributing 30% to the nation's GDP. Balancing the land requirements for renewable energy with these other economic activities is essential to ensure that the advance of the renewable energy sector does not come at the expense of other critical industries. Developing strategies to mitigate these conflicts will be vital in achieving a harmonious and sustainable energy transition.

Recommendations for Accelerating the Renewable Energy Transition

Numerous strategic actions are essential to accelerate Jamaica's transition to RE. Enhancing grid flexibility, diversifying renewable sources, and strengthening the policy framework are crucial. Fostering regional cooperation, promoting energy efficiency, and investing in capacity building and education support a more effective and sustainable energy transition.

Moreover, investing in smart grid technologies and energy storage schemes is critical to improving the integration of variable renewable energy sources [9]. This includes deploying battery storage systems, implementing demand response programs, and upgrading transmission and distribution infrastructure. Enhancing grid flexibility facilitates the effective integration of RE and improves grid stability.

While solar and wind energy have made substantial progress, researching alternative renewable sources such as biomass and ocean energy can provide a more balanced and robust energy mix [2]. Conducting feasibility studies and pilot projects for emerging technologies can help identify new opportunities for renewable energy development and enhance Jamaica's energy diversification.

Also, refining and implementing policies that support renewable energy development is crucial, which includes streamlining permitting processes, establishing guidelines for grid integration, and developing innovative financing mechanisms [3]. Carbon pricing, enhanced RE incentives, and targeted technology-specific goals can drive progress toward Jamaica's RE targets.

Furthermore, enhancing energy cooperation with neighboring Caribbean countries can improve energy security and facilitate the integration of renewable energy sources [7]. Regional initiatives such as power interconnections, shared best practices, and collaborative research can support Jamaica's RE transition and promote regional integration.

Going further, implementing energy efficiency measures can reduce overall energy demand and support a smoother transition to renewables [8]. Strategies include enforcing building energy codes, promoting energy-efficient appliances, and conducting energy audits. Energy efficiency initiatives can complement renewable energy efforts and contribute to sustainability goals.

Likewise, Investing in education and training programs is critical for developing local knowledge of RE technologies and project management [2]. Collaborations with universities, technical institutions, and industry stakeholders can develop a skilled workforce to support the renewable energy sector. Capacity-building efforts will enhance Jamaica's ability to develop, implement, and maintain RE projects.

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Conclusion

Jamaica's journey towards achieving 50% renewable energy by 2030 reflects the country's dedication to energy transformation despite facing significant challenges as a Small Island Developing State (SIDS). The trend analysis revealed a positive trajectory in adopting renewable energy technologies, particularly solar and wind energy, which have grown substantially over the past decade. This upward trend is a direct result of Jamaica's robust policy frameworks, strategic investments, and international partnerships, which have fostered an enabling environment for RE development.

The impact of these trends on Jamaica's current renewable energy policy is profound. The observed progress has reinforced the government's commitment to its renewable energy targets, leading to the introduction of more ambitious policies aimed at accelerating the transition. This includes enhanced incentives for renewable energy investments, grid infrastructure development to accommodate higher renewable penetration, and increased focus on energy efficiency measures.

However, the trend analysis also highlighted areas requiring attention, such as further diversification of the renewable energy mix and expanding capacity-building initiatives to support local expertise. Addressing these areas is crucial in maintaining momentum and ensuring the transition is inclusive and sustainable.

In conclusion, while Jamaica's progress towards its 2030 renewable energy targets is commendable, continued efforts are essential. The findings from the trend analysis underscore the importance of sustained innovation, capacity building, and policy support in navigating the complexities of the global energy transition. The country's experience is a valuable model for other SIDS and developing nations, demonstrating the critical role of tailored approaches in achieving sustainable energy futures.

Acknowledgment

The authors of this paper are grateful to Mr. Ron Israel of Climate Scorecard, who inspired this article.

Data Availability Statement

Data sharing is granted upon request.

Author Contribution

D.R. wrote the first draft of the manuscript. After that, H.Y. reviewed and edited the work. All authors have read and agreed to the published version of the manuscript.

References

1. Richards D, Yabar H (2022) Potential of renewable energy in Jamaica's power sector: Feasibility analysis of biogas production for electricity generation. Sustainability 14(11): 6457.
2. Ince D, Vredenburg H, Liu X (2016) Drivers and inhibitors of renewable energy: A qualitative and quantitative study of the Caribbean. Energy Policy 98: 700-712.
3. Surroop D, Raghoo P (2018) Renewable energy will improve the energy situation in African island states. Renewable and Sustainable Energy Reviews 88: 176-183.
4. Ministry of Science, Energy and Technology (2021) Jamaica Energy Statistics 2020.
5. Jamaica Public Service Company (2021) Annual Report 2020.
6. Jamaica Information Service, Office of the Prime Minister (2018) Jamaica to Increase Renewables Target to 50%—PM Holness.
7. Robinson SA, Dornan M (2017) International financing for climate change adaptation in small island developing states. Regional Environmental Change 17(4): 1103-1115.
8. Ochs A, Konold M, Auth K, Musolino E, Killeen P (2015) Caribbean Sustainable Energy Roadmap and Strategy (C-SERMS): Baseline Report and Assessment. Worldwatch Institute.
9. Loy D, Shenderovich V, Betak J (2021) 100% Renewable Electricity Worldwide Is Feasible and Cost-Effective than the Existing System: Jamaica Case Study. Energies 14(9): 2508.
10. World Bank (2021) Poverty & Equity and Macroeconomics, Trade & Investment Global Practices.
11. Inman M (2020) How to forecast energy futures. Nature Energy 5(1): 12-14.
12. Tsai SB, Chien MF, Xue Y, Li L, Jiang X, et al. (2017) Using the fuzzy DEMATEL to determine environmental performance: A case of printed circuit board industry in Taiwan. PloS one 12(1): e0170270.
13. Wang B, Wang Q, Wei YM, Li ZP (2018) Role of renewable energy in China's energy security and climate change mitigation: An index decomposition analysis. Renewable and Sustainable Energy Reviews 90: 187-194.
14. Aghahosseini A, Bogdanov D, Breyer C (2020) Towards sustainable development in the MENA region: Analysing the feasibility of a 100% renewable electricity system in 2030. Energy Strategy Reviews 28: 100466.
15. Kök AG, Shang K, Yücel Ş (2020) Investments in renewable and conventional energy: The role of operational flexibility. Manufacturing & Service Operations Management 22(5): 925-941.
16. Richards D, Yabar H, Mizunoya T, Koon RK, Tran GH, et al. (2024) Sustainable solar energy deployment: A multi-criteria decision-making approach for site suitability and greenhouse gas emission reduction.
17. Country economy (2001) Jamaica - Electricity Generation.
18. International Renewable Energy Agency (2024) ENERGY PROFILE, Jamaica.
19. World Bank (2019) Improving Energy Efficiency and Security in Jamaica.
20. Loy D, Coviello M (2005) Renewable energies potential in Jamaica.

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