International Journal of Computer Engineering in Research Trends
Multidisciplinary, Open Access, Peer-Reviewed and fully refereed
Review Paper Volume-10, Issue-2 ,2023 Regular Edition E-ISSN: 2349-7084

A Review on the Innovation of Renewable Energy System

Avril Anne S. Bernal[1*], Joemark D. Ablian[2]

[1*]*Senior High School, Polytechnic College of Botolan, Philippines*
[2] *Institute of Education, Polytechnic College of Botolan, Philippines*

**Corresponding Author: joemark.ablian@gmail.com*

Available online at: https://www.ijcert.org/

Received: 12/12/2022, Revised: 18/01/2023, Accepted: 18/02/2023, Published: 26/02/2023

Abstract:

Background/Objectives: Renewable energy comes from sources including the sun, wind, hydropower, geothermal, and biomass that replenish themselves naturally and sustainably. These energy sources provide a clean, limitless substitute for traditional fossil fuels, which have negatived environmental effects and a limited supply. An extensive literature evaluation of studies on innovations in renewable energy was the paper's main goal. The researcher's objectives were to locate pertinent papers, examine their conclusions, and offer suggestions for further study and practical applications. Determine the scope of study on renewable energy innovation, assess and synthesize the results of the studies, and offer suggestions for future research and practical applications.

Methods: This literature review examines existing research on the innovation of renewable energy systems. The inclusion and exclusion criteria were based on the scope, quality, and relevance of the studies.

Findings: The transition to renewable energy is necessary to achieve a sustainable and resilient power system that emits fewer greenhouse gases and reduces pollution. While challenges exist in integrating renewable energy into existing power systems, innovative solutions and sustainable practices can help overcome these challenges. Achieving renewable energy goals requires updating regulations, securing funding, upgrading infrastructure, and engaging with stakeholders to ensure a socially and economically sustainable transition. Future research areas to accelerate the transition to renewable energy and ensure its sustainability include exploring innovative financing mechanisms, enhancing energy storage technologies, advancing renewable energy policy, improving renewable energy forecasting, and evaluating the environmental impact of renewable energy. Such research could help overcome barriers to widespread adoption and promote the integration of renewable energy into existing power systems while minimizing the environmental impact of renewable energy production and use.

Keywords: energy, renewable energy system, literature review

1. Introduction

Renewable energy innovation has been a rapidly growing area of research in recent years. Accordant to a literature review by International Energy Agency (IEA) published in 2020 until 2023, the percentage of renewable power in the global power fuse has been gradually increasing, reaching 26% in 2019. The IEA attributes this growth to several factors, including technological advancements, policy support, and declining costs of renewable energy technologies [1], [2], [3].

One cornerstone in renewable energy innovation is the development of advanced technologies for solar, wind, and bioenergy. A 2018 study by the National Renewable

Energy Laboratory (NREL) found that enhancement in materials and manufacturing processes had significantly improved the adaptability and work of solar panels and wind turbines [4]. Additionally, researchers have been working to develop new technologies for bioenergy, such as algae-based biofuels and waste-to-energy systems. Another study by the European Union's Collaborative Research Centre in 2019 found the potential for floating offshore wind farms. This can be deployed in deeper waters and potentially produce more power. [5].

Furthermore, the decreasing cost of renewable energy technologies has been a major driver of their growth. A 2012 review of the Renewable Energy Policy Network for the 21st Century (REN21) found that the cost of solar and wind power had decreased significantly over the previous decade, making them competitive with traditional fossil fuels [6].

Another 2017 study by Lawrence Berkeley National Laboratory found that the value of solar energy has declined by 99% since the 1970s [7]. Solar and wind energy costs have continued to decline over the past few years, making them even more affordable and available to a wider spectrum of users.

Innovation is also important for all industries worldwide. Global consumption of greenhouse gases is also on-board change is worsening. What the planet receives, nature returns. In the minds of these masterminds' typhoons and floods face a terrifying challenge. Using charcoal and gas for daily energy production is one of the biggest contributors to ozone depletion. Solutions that stop or slow down the climate change impact are linked to renewable raw resources. The expansion of renewable energy often occupies a dominant place on the global agenda. It aids in mitigating the most severe consequences of global warming. With the advent of renewable energy sources such as solar and wind, they do not contribute to global warming by pouring out carbon dioxide and supplementary greenhouse gases [8]. There are clear signs that shortages of cobalt and lithium could threaten clean energy development by mid-century without rapid advances in technologies for exploration and reuse [9]. It's prodigious to perceive that 85% of the world's 1.4 billion people living in rural areas and have no access to electricity. According to Kaygusuz [10], The quantity of rural populations dependent on conventional biomass use is projected to grow from 2.7 billion to 2.8 billion in 2030. The dominance of coal, oil, and gas extraction as fossil fuels, and rising population growth. A global challenge arises from the expeditious increase in carbon dioxide (CO2) emissions resulting from decades of increasing energy demand.

The goal is long-term progress provide specifics regarding the latter's national policies, procedures, and extensions in the nations of the legion [11]. The SDGs are more important than the Millennium Development Goals and put a lot of pressure on scientists. A harmonious global awareness and modeling of numerous social, economic, and environmental factors are needed to combat climate change, for renewable energy, nutrition, health, and water storage [12], in consonance with Owusu, Asumadu-Sarkodie, & Ameyo [13], one gate to decreasing the justifications of climate change is expanding renewable energy sources. According to Alvarez-Herranza, Balsalobre-Lorente, Shahbaz, & Cantos [14], innovation policy on the development of per capita consumption and consumption of renewable energy sources in 17 OECD member countries. The expansion of renewable energy in four Nordic nations, from innovation to renewable energy. Innovation in technology leads. According to Irandoust [15], it is one of the strongest connections between growth and renewable energy. As China's RETI activities are made more clear, political sanctions become more effective. Reduce technology and develop metrics that can more scientifically measure RETI levels. Bai, Feng, Wang, & Gong [16] recommend that policymakers, based on a two-factor model, adopt an action strategy to balance innovation and execution in agreement with a portfolio of policies, which is more inclined to lead to environmental innovation than a particular policy. [17]. The data needed for innovation might lead to a deep analysis closely related to disaggregating changes in wind energy expenditure into wind energy renewable share, renewable energy share, energy intensity, economic activity, and demographic factors [18]. Good wind speeds are only available during the 5-6 months of the year when insolation is present [19], and A shunt active power filter that compensates for current asymmetries, load current harmonics, and reactive power requirements of the load [20]. This article demonstrates that to satisfy those who want to stop using charcoal to generate electricity, renewable energy needs to be developed or innovated. This study's objective is to: explore the potential for expanding previously conducted research, define variables, and demonstrate research, determine whether we are developing renewable energy resources in the same manner, and collect and summarize research concepts.

The overall intent of this literature review is to explore the current state of innovation in the renewable energy sector and identify key trends and research areas from 2012 to 2023. The study seeks to give a broad overview of the developments in solar, wind, and bioenergy technologies as well as the effects of falling costs on the expansion of renewable energy. Additionally, this review examines the role of political support and other factors that have contributed to increasing the interest in renewable energy in the global electricity mix. This research endeavour strives to provide a current and complete overview of the literature on renewable energy innovation and will be a useful tool for academics, decision-makers, and business professionals who are interested in the topic.

1.1 Objective of the Study

The goal of the research is to perform a comprehensive literature search of the study on renewable energy innovation with the specific objectives of determining the studies (1), analyzing the findings of the studies (2), and

providing the recommendation, implication, and future scope of the study (3).

2. Methods

The function of literature research is to build an argument, not a library [21]. A literature review surveys the authors of books, erudite articles, and extra data related to a distinct topic, field of study, or theory and presents a depiction, cursory assessment, and analytical assessment of that work in the context of the research question. Literary criticism consists only of the essence of the fundamental sources, whereas in the social sciences, literary criticism usually has a bureaucratic pattern that blends both depiction and synthesis, recurrently within a specific conceptual league. Advise readers about research and literature reviews. This is usually done, and we are aware of where there are gaps in previous exploration on the topic. Shows how to meet the need for additional investigation [22].

An analysis of the literature and research that has already been done on a subject is the goal of a literature review. It summarizes the information found in the sources used to research the subject, highlights the key points, and presents a critical assessment of the sources in relation to the research question. The literature review helps to identify gaps in previous research and suggests areas for further investigation. The goal is to place each study in the larger context of the field and to describe the relationship between the study and other relevant works. The literature review serves to provide guidance to readers about the research and literature on the topic, and it helps to track the intellectual progress and evolution of the field. It is an important tool in constructing arguments and building a comprehensive understanding of the topic under investigation.

3. Results and Discussion

This section of the cogitation focuses on the conclusions sapped from the findings of the foregoing research. In addition to a summary of results and summary of results. Discussion interpreted for future recommendations.

3.1 Objectives of the Studies

Table 1 shows a comprehensive approach to evaluating renewable energy projects that would involve analyzing the resource availability and potential energy generation, evaluating the technical and economic feasibility, and incorporating energy storage and demand-side management strategies to improve flexibility.

Table 1: Objective of the Studies

Authors and Years	Objectives
Alizadeh, Soltanisehat, Lund, Zamanisabzi, 2019	Provide a more comprehensive approach for evaluating renewable energy projects.
Li, Wang, Li, Wang, Zhao, Chen, 2019	Various strategies and methods improve the flexibility of the system.
Fan, Sun, Lane, Gu, 2019	Optimize the activity of energy systems with immense penetration of renewable energy sources.
Xiao, Pei, Deng, Ma, Zhang, Kong, 2020	Enabling more capable and decent integration of renewable energy toward the power grid.
Gungah, Emodi, Dioha, 2018	Identify the challenges and opportunities for the implementation of renewable energy.
Khan, Chenggang, Hussain, Kui, 2021	Investigate how these factors affect the energy mix and environmental performance of BRI countries and make recommendations.
Guen, Mosca, Perera, Coccolo, Mohajeri, Scartezzini, 2017	Become less reliant on fossil fuels, emit fewer climate gases, and improve our energy independence.
Abdelwahab, Moussaid, Moutaouakkil, Medromi, 2018	Improve renewable energy diffusion in astute and green communities by authorizing energy capability amplification.
Strielkowski, Civín, Tarkhanova, Tvaronavičienė, Petrenko, 2021	Achieving a more sustainable and resilient power system.
Hassanein, Ahmed, Osama abed el-Raouf, Ashmawy, Mosaad, 2020	Improve the work of a self-contained hybrid renewable energy system powering a brand-new nation.

Renewable energy projects are becoming increasingly important as the world strives to become more sustainable and reduce its reliance on fossil fuels. Evaluating these projects can be a complex task that requires a comprehensive approach. In this discussion, we will explore different strategies and methods that can be used to evaluate renewable energy projects, as well as the challenges and opportunities for implementing renewable energy in different contexts. One important strategy for evaluating renewable energy projects is to optimize the activity of energy systems with immense penetration of renewable energy sources. This can be achieved by developing energy storage systems that can store excess energy generated by renewable sources and release it during times of low generation. Another strategy is to enable more capable and decent integration of renewable energy towards the power grid, which involves upgrading the grid infrastructure to accommodate more renewable energy sources. In addition to these strategies, it is also important to identify the challenges and opportunities for implementing renewable energy. This entails being aware of the environmental and technological issues that must be taken into account, as well as the political, social, and economic

variables that may have an effect on the implementation of renewable energy. For example, in BRI countries, there may be unique challenges and opportunities related to the energy mix and environmental performance that need to be addressed. To achieve a more sustainable and resilient power system, it is important to become less reliant on fossil fuels and emit fewer climate gases. This can be accomplished by improving the diffusion of renewable energy in astute and green communities, as well as by authorizing energy capability amplification. Improving the work of self-contained hybrid renewable energy systems can help power brand-new nations and reduce their dependence on non-renewable energy sources.

A thorough evaluation process that considers a variety of aspects, including technical, economic, social, and environmental issues, is necessary when evaluating renewable energy projects. By adopting strategies such as optimizing energy systems and enabling greater integration of renewable energy, and identifying and addressing challenges and opportunities, we can achieve a more sustainable and resilient power system that relies less on fossil fuels and emits fewer climate gases. The potential of renewable energy is analyzed considering country plans and global sectoral assumptions, taking into account resource availability [33]. Demand-side management strategies help in developing clean and reliable microgrids by providing balancing services and reducing operational costs, increasing the stability and sustainability of the microgrid systems [34]. Planners will handle uncertainty in hybrid energy project inputs through sensitivity analysis, Monte Carlo simulation, and scenario analysis [35]. To summarize it, those study present the factors and way that renewable energy possible development and what kind of strategy to use in creating clean power energy.

3.2 Main Results of the Studies

Research on the synthesis of renewable energy sources toward power systems and its arrow on system enforcement is the subject of Table 2.

Table 2: **Main Results of the Studies**

Authors and Years	Findings and Results
Alizadeh, Soltanisehat, Lund, Zamanisabzi, 2019	The model prioritized solar, wind, and biomass as the best options for future investments.
Li, Wang, Li, Wang, Zhao, Chen, 2019	For thermal and electrical decoupling measures, accessories such as HST, EB, and BESS have various effects that increase the working flexibility of the system.
Fan, Sun, Lane, Gu, 2019	The rescheduling algorithm is found to be more effective than the PFC algorithm.
Xiao, Pei, Deng, Ma, Zhang, Kong, 2020	Show excellent feasibility for practical risk assessment and mitigation and can be enforced to integrated energy systems.
Gungah, Emodi, Dioha, 2018	Poverty can be decreased, and socioeconomic development can be facilitated by the development and utilization of renewable energy sources.
Khan, Chenggang, Hussain, Kui, 2021	Found that commerce also renewable energy playS a significant part in reducing CO2 emissions and increasing renewable energy consumption in BRI countries.
Guen, Mosca, Perera, Coccolo, Mohajeri, Scartezzini, 2017	Large-scale solar PV integration is not economically viable, and a long-term energy repository could possibly offset mismatched demand generation patterns.
Abdelwahab, Moussaid, Moutaouakkil, Medromi, 2018	The proposed solution for optimizing the use of locally produced renewable energy through intelligent redistribution.
Strielkowski, Civín, Tarkhanova, Tvaronavičienė, Petrenko, 2021	The use of renewable energy has increased significantly and has many benefits, but it also has some negative impacts.
Hassanein, Ahmed, Osama abed el-Raouf, Ashmawy, Mosaad, 2020	The recommended controller outperformed the static and fine-tuned PI controller in terms of performance.

Prioritizing solar, wind, and biomass as the best options for future investments, he emphasizes the importance of ancillary equipment and rescheduling his algorithms to improve system stability. The study also demonstrates the potential of renewable energy integration to boost socioeconomic development and reduce poverty but recognizes the challenges of large-scale PV integration and energy storage. In this study, we propose a solution for optimizing regional renewable energy through smart redistribution and present the proposed controller, which showed superior performance compared to conventional controllers. All this study highlights the importance of system optimization and control strategies for sustainable and efficient energy systems. Additionally, the shift to a more sustainable energy system is crucial for protecting the environment and ensuring a better future for future generations [36]. Furthermore, the optimization of energy consumption leads to reduced power costs and CO2 emissions, making energy efficiency and the deployment of green energy a compelling and challenging aspect of sustainability that is increasingly gaining attention [37]. Lastly, successful implementation of policies requires reducing unit electricity costs, making energy carriers and services affordable, and implementing regulations to improve energy efficiency and reduce environmental impact for the benefit of the public [38].

3.3 Recommendations of the Studies

Table 3 demonstrates the need for the government to switch to renewable energy. An integrated scheduling model to enhance the integration of solar and wind energy, create a separate ministry for renewable energy, phase out subsidies, impose solar energy requirements for housing, enact new taxation regulations, and spend money on research and development.

Table 3: **Recommendation of the Studies**

Authors and Years	Recommendations
Alizadeh, Soltanisehat, Lund, Zamanisabzi, 2019	Prioritize solar and wind energy as the most suitable sources for replacing fossil fuels.
Li, Wang, Zhao, Chen, 2019	Investigate the union of Vehicle-to-Grid into integrated power systems.
Fan, Sun, Lane, Gu, 2019	Use the proposed generation rescheduling algorithm, which uses weighting factors to prioritize the importance of branches.
Xiao, Pei, Deng, Ma, Zhang, Kong, 2020	Implement the proposed flexible DC framework and risk assessment method and also consider using it for integrated energy systems.
Gungah, Emodi, Dioha, 2018	Establish a separate ministry for renewable energy, phase out subsidies, fund education and innovation, mandate solar energy in housing units, seek funding from development agencies, and explore green bonds for funding.
Khan, Chenggang, Hussain, Kui, 2021	Adopt new and selective taxation policies, invest in R&D, raise traditional energy prices, and implement carbon emission strategies as potential solutions.
Guen, Mosca, Perera, Coccolo, Mohajeri, Scartezzini, 2017	Suggests that by renovating buildings to Minergie standards and implementing a hybrid renewable energy system with wind and solar energy.
Abdelwahab, Moussaid, Moutaouakkil, Medromi, 2018	Sustainability in the use of renewable energy should be further developed and implemented in new developments.
Strielkowski, Civín, Tarkhanova, Tvaronavičienė, Petrenko, 2021	Focus on finding solutions to mitigate the pessimistic impacts and defiance of integrating renewable energy to attain renewable energy systems.
Hassanein, Ahmed, Osama abed el-Raouf, Ashmawy, Mosaad, 2020	Include further improvements in response time, voltage regulation, and efficiency, as well as implementation and testing in similar off-grid communities.

Due to their sustainability and affordability, renewable energy sources like solar and wind are gaining popularity as fossil fuel replacements. However, the integration of renewable energy into existing power systems poses a significant challenge, requiring the adoption of innovative solutions such as vehicle-to-grid integration, generation rescheduling algorithms, and flexible DC frameworks. One of the key solutions proposed in the discussion is the implementation of a proposed generation rescheduling algorithm that uses weighting factors to prioritize the importance of branches. This approach is particularly useful for prioritizing renewable energy sources over traditional fossil fuels in power generation, enabling the efficient use of renewable energy sources such as wind and solar energy. Another solution suggested is the adoption of vehicle-to-grid integration, which enables electric vehicles to act as mobile energy storage units. This strategy lessens reliance on conventional power sources, as well as energy waste and the sustainability of using renewable energy sources. It suggests creating a separate ministry for renewable energy, eliminating subsidies gradually, and supporting research and development to encourage the use of renewable energy sources. The implementation of selective taxation policies, investing in R&D, and raising traditional energy prices are also potential solutions to promote the adoption of renewable energy sources. The importance of sustainability in the use of renewable energy sources, recommending further development and implementation of sustainability measures in new developments. To address the challenges of integrating renewable energy sources into existing power systems, the discussion suggests focusing on finding solutions to mitigate the pessimistic impacts and defiance. The need for further improvements in response time, voltage regulation, and efficiency and the implementation and testing of similar off-grid communities. The adoption of innovative solutions, the promotion of sustainability, and the continued development of renewable energy sources are critical to achieving renewable energy systems that can replace fossil fuels effectively. Moreover, although all studies concur on the future prospects of renewable energy in electricity, there is still some skepticism regarding its application in high energy-intensive areas [39]. Transitioning to fully renewable energy has numerous benefits, including reduced pollution, improved health and energy security, sustainable economic growth, job creation, and increased local level democracy [40]. Achieving renewable energy goals requires overcoming legal, financial, and technical challenges and increasing awareness, including updating regulations, streamlining technology transfer, securing funding, upgrading infrastructure, and promoting education [41].

4. Conclusion and Future Scope

Based on the given data, the world stands at a crossroads. Transitioning to renewable energy is a crucial step towards achieving a sustainable and resilient power system that is less reliant on fossil fuels and emits fewer greenhouse gases. The fundamental source of climate change, which poses a serious threat to the planet's biosphere, diversification, and human well-being, is well-known to be the combustion of fossil fuels. The world's energy demand is increasing day by day, and it is essential to meet this demand while reducing the environmental impacts of energy production. The fact that renewable energy sources like solar, wind, hydropower, and geothermal do not create greenhouse gases and are naturally replenished is one of their main advantages. These sources of energy are abundant, and their utilization can significantly reduce the need for fossil fuels. The transition to renewable energy also has other significant benefits, such as reducing air pollution, improving public health, and increasing energy security.

However, transitioning to renewable energy is not a simple task. It requires a comprehensive approach that considers technical, economic, social, and environmental aspects. Renewable energy projects must be evaluated to ensure that they are feasible, cost-effective, and socially acceptable. Governments, policymakers, and stakeholders must work together to optimize energy systems and enable greater integration of renewable energy. One of the most significant challenges in integrating renewable energy into existing power systems is the issue of intermittency. Solar and wind energy are dependent on weather conditions and can fluctuate widely in their power output. This poses a challenge to grid operators, who must maintain a stable supply of electricity for consumers. Innovative solutions such as energy storage, demand-side management, and smart grid technologies can help address this challenge. The adoption of sustainable practices is another essential factor in promoting the transition to renewable energy. The continued development of renewable energy sources requires selective taxation policies, investment in R&D, and the raising of traditional energy prices. These measures can incentivize the adoption of renewable energy sources and reduce the dependence on fossil fuels. Achieving renewable energy goals requires overcoming legal, financial, and technical challenges. Governments must update regulations, streamline technology transfer, secure funding, upgrade infrastructure, and promote education to increase awareness and facilitate the adoption of renewable energy sources. It is also essential to engage with communities, businesses, and other stakeholders to ensure that the transition to renewable energy is socially and economically sustainable.

To sum up, transitioning to renewable energy is critical for achieving a sustainable and resilient power system that is less reliant on fossil fuels and emits fewer greenhouse gases. The benefits of transitioning to renewable energy are far-reaching, including reduced pollution, improved health, sustainable economic growth, job creation, and increased local level democracy. While challenges remain in integrating renewable energy into existing power systems, innovative solutions and sustainable practices can help to overcome these challenges and achieve a sustainable energy future. Future research that can help to further accelerate the transition to renewable energy and ensure its long-term sustainability in some of these areas include: Developing innovative financing mechanisms: One of the biggest barriers to the widespread adoption of renewable energy is financing. Researchers can explore innovative financing mechanisms that can help to overcome this barrier, such as green bonds, crowd-funding, and public-private partnerships. Enhancing energy storage technologies: Energy storage is critical for the integration of renewable energy into existing power systems. Researchers can focus on improving the efficiency and affordability of existing energy storage technologies, as well as developing new technologies, such as hydrogen fuel cells and supercapacitors.

Advancing renewable energy policy: Policymakers play a critical role in promoting the adoption of renewable energy. Future research can focus on evaluating and developing effective policies that can help to accelerate the transition to renewable energy, such as feed-in tariffs, tax incentives, and renewable portfolio standards. Improving renewable energy forecasting: Accurate forecasting of renewable energy generation is critical for the efficient integration of renewable energy into the grid. Future research can focus on developing better forecasting models that can help to optimize energy generation and reduce costs. Evaluating the environmental impact of renewable energy: While renewable energy is generally considered to be environmentally friendly, there are still environmental impacts associated with its production and use. Future research can focus on evaluating and minimizing the environmental impact of renewable energy, such as reducing the use of rare earth metals in wind turbines and developing more sustainable manufacturing processes. Lastly, future research can play a critical role in accelerating the transition to renewable energy and ensuring its long-term sustainability. By focusing on these key areas, researchers can help to overcome the remaining barriers to renewable energy

adoption and unlock the full potential of clean, renewable energy.

References

[1] International Energy Agency. (2020). *Renewable Energy: Market and Industry Trends.* Retrieved from https://www.iea.org/reports/global-energy-review-2020/renewables

[2] International Energy Agency. (2023). *Renewable Energy Medium-Term Market Report 2023.* Retrieved from https://www.iea.org/reports/renewable-energy-market-update-may-2022

[3] International Renewable Energy Agency. (2021). *Renewable Power Generation Costs in 2019.* Retrieved from https://www.irena.org/reports/2021/May/Renewable-Power-Generation-Costs-in-2019

[4] National Renewable Energy Laboratory (NREL). (2018). *Advances in materials and manufacturing for solar and wind technologies.* Retrieved from https://www.nrel.gov/docs/fy18osti/70654.pdf

[5] European Commission Joint Research Centre. (2019). *Bioenergy: Developing new technologies.* Retrieved from https://ec.europa.eu/jrc/en/publication/bioenergy-developing-new-technologies

[6] Renewable Energy Policy Network for the 21st Century. (2012). *Renewables 2012 Global Status Report.* Retrieved from https://www.ren21.net/wp-content/uploads/2019/07/REN12-GSR_2012_Full_Report.pdf

[7] Lawrence Berkeley National Laboratory. (2017). *Tracking the Sun IX: The Decline in Solar Prices.* Retrieved from Lawrence Berkeley National Laboratory. (2017). Tracking thttps://emp.lbl.gov/sites/all/files/lbnl-1004234.pdf

[8] Nunez, C. (2019, January 22). CAUSES AND EFFECTS OF CLIMATE CHANGE. *Environment*. Retrieved from https://www.nationalgeographic.com/environment/article/global-warming-overview

[9] Klimenko, V., Ratner, S., & Tereshin, A. (2020, April 9). Constraints imposed by key-material resources on renewable energy development. *Renewable and Sustainable Energy Reviews*. doi:10.1016/j.rser.2021.111011

[10] Kaygusuz, K. (2012, February). Energy for sustainable development: A case of developing countries. *Renewable and Sustainable Energy Reviews, 16*(2), 1116-1126. doi:10.1016/j.rser.2011.11.013

[11] Asumadu-Sarkodie, S., & Owusu, P. (2016). Feasibility of biomass heating system in Middle East Technical University, Northern Cyprus campus. . *Cogent Engineering , 3* . doi:doi:10.1080/23311916.2015.1134304

[12] Hák, T., Janoušková, S., & Moldan, B. (2016). Sustainable development goals: A need for relevant indicators. *Ecological Indicators, 60*, 565–573. doi:10.1016/j.ecolind.2015.08.003

[13] Owusu, P., Asumadu-Sarkodie, S., & Ameyo, P. (2016). A review of Ghana's water resource management and the future prospect. *Cogent Engineering*. doi:doi:10.1080/23311916.2016.1164275

[14] Alvarez-Herranza, A., Balsalobre-Lorente, D., Shahbaz, M., & Cantos, J. (2017, June). Energy innovation and renewable energy consumption in the correction of air pollution levels. *Energy Policy, 105*, 386-397. doi:10.1016/j.enpol.2017.03.009

[15] Irandoust, M. (2016). The renewable energy-growth nexus with carbon emissions and technological innovation: Evidence from the Nordic countries. *Ecological Indicators, 69*, 118-125. doi:10.1016/j.ecolind.2016.03.051

[16] Bai, C., Feng, C., Wang, Y., & Gong, Y. (2020, August). Understanding spatial-temporal evolution of renewable energy technology innovation in China: Evidence from convergence analysis. *Energy Policy, 143*. doi:10.1016/j.enpol.2020.111570

[17] Kittner, N., Lill, F., & Kammen, D. (2017). Energy storage deployment and innovation for the clean energy transition. *Nature Energy*. doi::10.1038/nenergy.2017.125

[18] Sadorsky, P. (2020, July 2). Wind energy for sustainable development: Driving factors and future outlook. *Journal of Cleaner Production*. doi:10.1016/j.jclepro.2020.125779

[19] Irfan , M., Zhao, Z., & Ahma, M. (2019, February 25). Solar Energy Development in Pakistan: Barriers and Policy Recommendations. *Irfan, Muhammad; Zhao, Zhen-Yu; Ahmad, Munir; Mukeshimana, Marie (2019). Solar Energy DevelopmSustainability*. doi:10.3390/su11041206

[20] Patil, M., & Vadirajacharya, K. (2019, January). PERFORMANCE IMPROVEMENT OF RENEWABLE ENERGY SOURCES INVERTER FOR INTERFACE WITH SMART GRID. *INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR.ORG), 6*(1), 157-163. doi:10.1729/Journal.19309

[21] Rudestam, K., & Newton, R. (1992). *Surviving your dissertation: A comprehensive guide to content and process.*

[22] Fink, & Arlene. (2014). Conducting Research Literature Reviews: From the Internet to Paper.

[23] Alizadeh, R., Soltanisehat, L., Lund, P., & Zamanisabzi, H. (2019, May 21). Improving renewable energy policy planning and decision-making through a hybrid MCDM method. *Energy Policy*. doi:10.1016/j.enpol.2019.111174

[24] Li, Y., Wang, C., Li, G., Wang, J., Zhao, D., & Chen, C. (2019, September 14). Improving operational flexibility of integrated energy system with uncertain renewable generations considering thermal inertia of buildings. doi:10.1016/j.enconman.2020.112526

[25] Fan, M., Sun, K., Lane, D., & Gu, W. (2019, February). A Novel Generation Rescheduling Algorithm to Improve Power System Reliability With High Renewable Energy Penetration. *IEEE Transactions on Power Systems for Publication*. doi:10.1109/TPWRS.2018.2810642

[26] Xiao, H., Pei, W., Deng, W., Ma, T., Zhang, S., & Kong, L. (2020, September 1). Enhancing risk control ability of distribution network for improved renewable energy integration through flexible DC interconnection. *Applied Energy*. doi:10.1016/j.apenergy.2020.116387

[27] Gungah, A., Emodi, N., & Dioha, M. (2018, April 6). Improving Nigeria's renewable energy policy design: A case study approach. *Energy Policy*. doi:10.1016/j.enpol.2019.03.059

[28] Khan, A., Chenggang, Y., Hussain, J., & Kui, Z. (2020, Septemper 17). Impact of technological innovation, financial development and foreign direct investment on renewable energy, non-renewable energy and the environment in belt & Road Initiative countries. *Renewable Energy*. doi:10.1016/j.renene.2021.02.075

[29] Guen, M., Mosca, L., Perera, A., Coccolo, S., Mohajeri, N., & Scartezzini, J. (2017, June 27). Improving the energy sustainability of a Swiss village through building renovation and renewable energy integration. *Energy and Buildings*. doi:10.1016/j.enbuild.2017.10.057

[30] Abdelwahab, H., Moussaid, L., Moutaouakkil, F., & Medromi, H. (2018, July 30). Energy Efficiency: Improving the renewable energy penetration in a smart and green community. *Procedia Computer Science*. doi:10.1016/j.procs.2018.07.199

[31] Strielkowski , W., Civín, L., Tarkhanova, E., Tvaronavičienė, M., & Petrenko, Y. (2021, October 28). Renewable Energy in the Sustainable Development of Electrical Power Sector: A Review. *Energies*. doi:10.3390/en14248240

[32] Hassanein, W. S., Ahmed, M. M., M, O., & Ashmawy, M. G. (2020). Performance Improvement of Off-Grid Hybrid Renewable Energy System Using Dynamic Voltage Restorer. *Alexandria Engineering*, 1567-1581. doi:10.1016/j.aej.2020.03.037

[33] Gielen, D., Boshell, F., Saygin, D., Bazilian, M., Wagner, N., & Gorini, R. (2019). *The role of renewable energy in the global energy transformation.* Energy Strategy Reviews. Retrieved from https://doi.org/10.1016/j.esr.2019.01.006

[34] Usman, R., Mirzania, P., Alnaser, S. , & Hart, P. (2022). *Systematic Review of Demand-Side Management Strategies in Power Systems of Developed and Developing Countries. Energies.* Energies. Retrieved from http://dx.doi.org/10.3390/en15217858

[35] Uwineza, L., Kim, H., & Kim, C. (2021). *Feasibility study of integrating the renewable energy system in Popova Island using the Monte Carlo model and HOMER.* Energy Strategy Reviews. Retrieved from https://doi.org/10.1016/j.esr.2020.100607

[36] Weidner, T., Martin, A., Ryberg, M., & Gosalbez, G. (2022). *Energy systems modeling and optimization for absolute environmental sustainability: current landscape and opportunities.* Computers & Chemical Engineering. Retrieved from https://doi.org/10.1016/j.compchemeng.2022.107883

[37] Sadollah, A., Nasir, M., & Geem, Z. (2020). Sustainability and Optimization: From Conceptual Fundamentals to Applications. Retrieved from https://doi.org/10.3390/su12052027

[38] Kabeyi, M., & Olanrewaju, O. (2022). Sustainable Energy Transition for Renewable and Low Carbon Grid Electricity Generation and Supply. *Sec. Sustainable Energy Systems*. Retrieved from https://doi.org/10.3389/fenrg.2021.743114

[39] Bhattarai, U., Maraseni, T., & Apan, A. (2022). Assay of renewable energy transition: A systematic literature review. *Science of The Total Environment*. Retrieved from https://doi.org/10.1016/j.scitotenv.2022.155159

[40] Future Policy. (2023). Accelerate the Transition to 100% Renewable Energies. *World Future Country*. Retrieved from https://www.futurepolicy.org/policy-area/renewable-energies/

[41] Cholewa, Mammadov, & Nowaczek. (2022). The obstacles and challenges of transition towards a renewable and sustainable energy system in Azerbaijan and Poland. *Mineral Economic*. Retrieved from https://link.springer.com/article/10.1007/s13563-021-00288-x

Authors Profile

1. **Avril Anne S. Bernal** – A student from Science, Technology, Engineering, and Mathematics strand in the senior high school department at Polytechnic College of Botolan

2. **Joemark D. Ablian –** A College Instructor of Mathematics at Polytechnic College of Botolan, Botolan, Zambales, Philippines. A Graduate of Master of Arts in

Education, major in Mathematics at PRMSU, Iba, Zambales. A member of the Philippine Association of Researchers and Statistical Software Users (PARSSU), and Mathematics Teachers Association of the Philippines – Tertiary Level (MTAP-TL). Currently the College Statistician, Research Associate, and Assistant Research Coordinator of Polytechnic College of Botolan.

