Reproducibility of Academic Journals in the Green Energy Sector

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**Abstract.** This paper provides a comprehensive overview of the critical role of reproducibility in scientific articles relevant to the clean & renewable energy (“green energy”) sector. It emphasizes the imperative need for transparent and reproducible research in the context of combating climate change and transitioning to clean and renewable energy sources. The literature review delves into various dimensions of reproducibility, beginning with its significance in scientific research for green energy and its implications for innovation, public knowledge, and government policy. The text offers concrete examples of reproducible research in solar energy, wind power, energy storage, and sustainable materials. It also addresses methodologies, challenges, and shortcomings in ensuring reproducibility, such as reluctance in data sharing and algorithm sensitivity. Furthermore, the review discusses the integration of vulnerable consumers into renewable energy communities and how it aligns with reproducibility goals. It concludes by stressing the importance of promoting transparency, open collaboration, and standardized reporting to create a more scientifically rigorous, technologically reliable, and practically sustainable green energy future. The text encourages researchers to embrace a culture of openness and reproducibility while also suggesting the development of standardized tools and frameworks for more efficient & convenient reproducibility across renewable energy domains.

1 Introduction

The global pursuit of sustainable and environmentally friendly energy solutions has led to a transformative shift in the energy sector. As the detrimental consequences of climate change become increasingly evident, it's critical that human civilization transition wholesale away from fossil fuels and towards clean and renewable energy sources. Towards that end, the green energy sector has emerged as a pivotal domain for scientific research, technological innovation, and policy development. Central to this transformation is the concept of reproducibility in research—a critical element in ensuring the credibility, reliability, and scalability of green energy solutions.

Anytime a new technology or methodology is introduced it is met with skepticism. Environmentally friendly energy is no exception to this. The effectiveness and practicality of environmentally friendly energy is often debated on threads on Twitter & Facebook as well as on the floors of legislatures. While a plethora of research has been done on this topic, it is often out of the public eye. When it is introduced into the public space it is imperative that the presented science can readily be reproduced. Too often criticisms are leveled at research such as it is not an accurate representation of the facts, is a deliberate obfuscation of the truth, or even is entirely fake. This easy dismissal of research betrays a breakdown of trust between the scientific and lay communities or even among scientists themselves, all of which could easily be lessened if not avoided were that research readily reproducible. This would help renewable energy garner the further support that it needs to progress and accomplish what the world needs it to.

To affect such an improvement, reproducibility standards would need to be introduced to ensure that research was *consistently* reproducible. Among other things, comprehensive documentation that included research elements such as methodologies, data, and code would be a major element of the standard. Dauntingly, such changes would pose a significant logistical challenge as it would require a large shift in the current standards that inform the practical systems and conventions now guiding research and its peer-review process and dissemination.

The adoption of green energy technologies, such as solar photovoltaic panels, wind turbines, and novel energy storage systems, has grown exponentially in recent years. These technologies hold the promise of significantly reducing greenhouse gas emissions, mitigating climate change, and fostering energy independence. However, the successful implementation of green energy solutions hinges on the ability to produce consistent and replicable research outcomes. This need for reproducibility extends to various aspects of the green energy sector, including materials development, system design, and energy policymaking.

This literature review aims to explore the critical role of reproducible research in advancing the green energy sector. By critically examining the existing body of knowledge, this study will elaborate on how reproducibility is addressed, measured, and implemented across various subfields within green energy research. Additionally, this study will identify key challenges, gaps, and opportunities in the literature related to reproducibility, with the goal of providing insights into how the green energy sector can achieve greater sustainability and impact.

This study will examine reproducibility within the green energy sector by discussing in detail the importance of reproducibility in scientific research and its implications for advancing renewable energy technologies. Following that, this study will explore specific examples of reproducible research in areas such as solar energy, wind power, energy storage, and sustainable materials. Penultimately, this study will analyze the methodologies and practices employed to ensure reproducibility in these studies and highlight the challenges that researchers encounter. Finally, this study will synthesize the key findings, identify knowledge gaps, and suggest directions for future research in the quest to create a more sustainable and scientifically reproducible green energy sector.

Through this comprehensive examination of reproducibility in the context of green energy research, this study aims to contribute to the ongoing discourse regarding how to accelerate the transition to a cleaner and more sustainable energy future. By fostering transparency, rigor, and collaboration in the green energy research community, this study can play a valuable role in realizing the full potential of renewable energy technologies and addressing the global challenges posed by climate change.

1.1 Problem Statement

The efficacy of science in influencing policy, public knowledge, and education depends on faith in the quality of the science in keeping with the scientific method and on preventing biases and special interests from putting a “thumb on the scale”, i.e., influencing or misrepresenting the results to support a certain conceptualization of, or perspective towards, the issue. As Climate change is pushed to the forefront of public discussion due to extreme weather conditions, renewable energy is often looked at as a major facet of the greater solution. As the public discourse continues it is imperative that accurate academic research is present in the discussion. To that end the peer review system has long been used to ensure that outcomes are honest and reproduceable. As outside parties continue to fund research it is important to hold those parties accountable to the scientific method. Often peer reviews can be subject to issues of practicality and time/resource constraints as well as peer reviewers giving the researchers the benefit of the doubt. The question of reproducibility is raised as an ever-relevant standard. This paper will be looking at several peer-reviewed articles in the renewable energy space and will investigate the reproducibility of their findings. This study expects to find statistics or conceptual information reflecting the current state of the peer-review process of statistical journals covering the renewable energy sector.

2 Literature Review

The transition to sustainable green energy represents a vital response to climate change and resource depletion. Ensuring the credibility of scientific research in this field is paramount, as it underpins innovations and policy decisions. However, the trustworthiness of this research hinges on its reproducibility – the ability to replicate findings independently. This comprehensive literature review delves into the multifaceted dimensions of reproducibility within the green energy sector. In order, this study will commence by discussing the significance of reproducibility in scientific research and its implications for advancing renewable energy technologies before exploring specific examples of reproducible research in areas such as solar energy, wind power, energy storage, and sustainable materials. Lastly, this study will scrutinize the methodologies and challenges researchers encounter in ensuring reproducibility, synthesize the key findings, identify knowledge gaps, and suggest directions for future research.

2.1 Importance of Reproducibility in Scientific Research for Green Energy

The credibility of research findings in the green energy sector is essential for garnering the trust of stakeholders, most notably investors, policymakers, and the public. Reproducibility ensures that research outcomes are robust and dependable, cultivating confidence in the sector's innovations. Green energy technologies are characterized by their dynamism and rapid evolution. Reproducibility is pivotal for building upon previous research, fostering innovation and advancing renewable energy solutions. Research such as DeepSI (Gerges et al., 2023) exemplifies the commitment to reproducibility by utilizing Bayesian deep learning for solar irradiance prediction. It sets high standards for rigor and transparency in solar energy research (Devitt et al., 2020). Akhadov's study (2023) showcases the significance of mathematical modeling in ensuring the reproducibility and reliability of thermal energy production. It underscores the importance of rigorous, reproducible site assessments when selecting suitable areas for solar power installations. Researchers like Sørensen and Shen (2017) emphasize the importance of reproducibility in wind power research through numerical simulations and standardized test cases. Transparent research practices establish a foundation for reliable, reproducible research in wind energy. In energy storage, reproducibility is crucial for ensuring battery safety and reliability. Whittingham (2012) stresses the need for transparent research practices, data sharing, and standardized reporting to support reproducibility in energy storage research.

2.2 Sustainable Materials and Reproducibility

In sustainable materials research, such as perovskite solar cell materials, reproducibility is essential for advancing solar cell efficiency. Law et al. (2019) emphasizes comprehensive documentation and transparency to ensure the replicability of results. Research on sustainable building materials (Pomponi et al., 2019) underscores the importance of reproducibility in assessing environmental and energy performance. Transparent reporting and research methodologies enable result replication and drive sustainable building practices.

2.3 Empowering Vulnerable Consumers in Renewable Energy Communities

Hanke and Lowitzsch (2020) emphasize the critical role of involving vulnerable consumers in Renewable Energy Communities (RECs) to address energy poverty and promote a socially equitable transition to renewable energy sources. Their study defines vulnerable energy consumers and explores barriers, incentives, and communication strategies for their participation in RECs. The involvement of vulnerable consumers in RECs, as advocated by Hanke and Lowitzsch (2020), aligns with the overarching goals of reproducibility, innovation, and sustainability within the green energy sector. It underscores the importance of fostering participation and addressing energy poverty, thereby ensuring that the benefits of a green energy transition are equitably distributed.

2.4 Methodologies and Challenges in Ensuring Reproducibility

The research community acknowledges that reproducibility hinges on the comprehensive documentation of research methodologies used in the analysis; namely, data, mathematical techniques, domain expertise, and code. Transparent sharing of data and open-source tools is crucial for replicating research findings. Some of the challenges in ensuring reproducibility in green energy research include reluctance to share data, availability of code, and issues with algorithm sensitivity. Researchers are addressing these issues to shift research culture towards prioritizing replication attempts and transparent reporting.

2.5 Gaps and Source Comparison

While significant progress has been made in recognizing the importance of reproducibility in green energy research and in promoting the inclusion of vulnerable consumers in RECs, there are still notable gaps and controversies. The reluctance to share code and data remains a significant challenge (Hutson, 2018), with only a minority of researchers openly sharing their work (Balal et al., 2023). The sensitivity of AI algorithms to random factors poses a complex issue (Hutson, 2018), which parallels the sensitivity of machine learning models in solar energy predictions (Balal et al., 2023). These challenges necessitate comprehensive solutions.

Multiple sources highlight the critical role of reproducibility in green energy research (Devitt et al., 2020; Gerges et al., 2023; Whittingham, 2012; Akhadov, 2023), emphasizing its influence on trust, innovation, and sustainable development. They underscore the need for transparency and comprehensive documentation. Additionally, Hanke and Lo21o09oi9witzsch (2020) showcase the importance of integrating vulnerable consumers into renewable energy communities to address energy poverty and achieve a sustainable energy transition. This inclusive perspective further aligns with the overarching goals of advancing renewable energy technologies and ensuring a sustainable and reproducible green energy future.

2.6 Synthesis and Future Directions

In synthesis, reproducibility stands as a non-negotiable element of scientific research within the green energy sector. It safeguards the credibility of research findings, propels innovation, and accelerates the transition to sustainable energy sources. The path forward involves promoting transparency, open collaboration, and standardized reporting. The development of open-source tools, repositories for sharing algorithms and data, and frameworks for reproducible research across renewable energy domains are vital steps toward a more reliable and reproducible green energy future.

The future of research in the green energy sector necessitates addressing the gaps in data and code sharing, algorithm sensitivity, and the need for comprehensive replication frameworks. Researchers must embrace a culture of open collaboration, prioritize transparency, and encourage replication attempts to fortify the sector's sustainability and credibility further. Future studies should focus on developing standardized tools, repositories, and frameworks to facilitate reproducibility across all domains of renewable energy research. Furthermore, efforts should continue to empower vulnerable consumers to participate actively in renewable energy communities, ensuring an inclusive and equitable green energy transition.

3 Methods

This section will be for methods identified and utilized.

3.1 Subsection

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3.2 Subsection

An example is given at the end of this information sheet. For citations in the text please use square brackets and consecutive numbers: [1], [2], [3], etc. Use APA format in the reference section. You can choose to either have it alphabetical order or order of which it is shown in the paper.

4 Results

The correct BibTeX entries for the Lecture Notes in Computer Science volumes can be found at the following website shortly after the publication of the book: <http://www.informatik.uni-trier.de/~ley/db/journals/lncs.html>

5 Discussion

The Lecture Notes in Computer Science volumes are sent to ISI for inclusion in their Science Citation Index Expanded.

6 Conclusion

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Acknowledgments. The heading should be treated as a 3rd level heading and should not be assigned a number.

Notes. we are aware that our problem statement and the state of our paper are not aligned presently. We are presently redirecting our approach in the efforts of fully reproducing a study and expanding upon it.

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Appendix.