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Exploring the Nexus of Climate Change, Energy Justice, and Sustainability

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ABSTRACT

This study provided a definitive analysis of the interconnections between climate change, energy justice, and sustainability using a systematic literature review (SLR). It employed a VOSviewer analysis using data from the Scopus (ScienceDirect) database to analyse a co-occurrence of 2,108 keywords. The analysis included only those with a minimum of five occurrences, up to a maximum of 88, to ensure the highest level of accuracy and precision. The study used the Association Strength Method to emphasize co-occurrence keywords and generate visual networks based on title and abstract. A total of 89 items were divided into five clusters, with a total link strength of 801. Smaller clusters were excluded, ensuring each cluster contained at least ten items. The VOSviewer analysis identified five key clusters: climate change and sustainability (red), energy justice and policy (yellow), just transition and regional aspects (blue), health, inequality, and policy (green), and environmental degradation and democracy (purple). The findings reveal a significant interconnection between climate change, energy justice, and sustainability. While progress toward green energy is linked to rising threats posed by climate change, challenges remain. This research highlights the complex interplay of these issues and offers insights for future policy and research directions.

Introduction

The global challenge of climate change presents profound implications for energy systems, requiring urgent attention and action. In light of the environmental consequences of fossil fuel dependence, the concept of energy justice has emerged as a pivotal framework for addressing the imbalances that arise from traditional energy systems. It has led to the emergence of a new cross-cutting social science research agenda.[1] *Energy justice* is a theoretical framework that aims to create equality in the energy system and to guarantee that all individuals are able to access energy resources on an equal basis, regardless of their race, nationality, income, or location.[2] It is pivotal to consider not only the environmental impacts that are derived from the energy sector but also the social and economic

[1] Kirsten Jenkins et al., "Energy Justice: A Conceptual Review," *Energy Research & Social Science* 11 (January 2016): 174–82, https://doi.org/10.1016/j.erss.2015.10.004.
[2] Natascha van Bommel and Johanna I. Höffken, "Energy Justice within, between and beyond European Community Energy Initiatives: A Review," *Energy Research & Social Science* 79 (September 2021): 102157, https://doi.org/10.1016/j.erss.2021.102157.

inequalities that are frequently intensified by these processes. In parallel, sustainability has become a central goal in global efforts to transition towards renewable energy sources, which aim to mitigate climate change while promoting equitable and long-lasting development.

Even with an increasing awareness of the importance of these issues, there is a gap in the literature with regard to the interconnection between climate change, energy justice, and sustainability. While each of these areas has been extensively studied in isolation, there needs to be more existing literature with regard to comprehensive analyses that integrate all three dimensions, which impedes the formulation of effective policy and practice. This study looks at how climate change, energy justice, and sustainability affect the prospects of building a fairer, more sustainable future. The study comes at a time when international efforts, including those in the Paris Agreement, are being made to enable a just transition to a low-carbon economy. In considering the relationships among these topics, the research aims to generate knowledge that can help address the policy dilemmas at this critical juncture in history in a more equitable manner.

The purpose of the current study is to evaluate the relationship that exists between climate change, energy justice, and sustainability, as well as their manifestations in policies and practices across different contexts. The research also considers the relationship among the dimensions stated whenever there is an initiative or policy that aims to help the world achieve net-zero carbon emissions. In order to accomplish all these goals, the research study adopts a Systematic Literature Review (SLR) methodology. This methodology is chosen because it seeks to allow for a detailed and logical examination of the body of knowledge available on a particular research topic, which enables the identification of the main subjects, developments, and shortcomings in the available literature. This study adopts the SLR methodology because it makes it possible to understand how climate change, energy justice, and sustainability are interrelated.

The structure of this article includes 1) *methodology*, which outlines the rationale and steps for using the SLR approach; 2) *results*, which are presented and the findings of the method are analyzed; 3) *discussion section*, which explores the interplay between the clusters identified in the results, providing a deeper understanding of the nexus between climate change, energy justice and sustainability, and 4) *concluding section* which presents a synthesis of the main findings of the study and suggests avenues for future research in this crucial area. It is anticipated to significantly contribute to the existing body of knowledge on the topics. By integrating these three dimensions, the study provides an understanding of opportunities and challenges of this issue. The findings are expected to have a meaningful impact on future research, policy development, and practical implementations in related fields, ultimately contributing to pursuing a more just and sustainable world.

Methodology

Systematic Literature Review (SLR)

A SLR is used as the primary methodology in this research. The process is conducted as follows: (i) selecting academic databases for searching and identifying relevant literature, (ii) developing a

systematic review protocol to answer the research questions, and (iii) synthesizing the findings.[3] This method is particularly suited for development and social research, which emphasizes qualitative data collection by structuring relevant literature within a specific context and time frame. Several necessary steps are involved in conducting an SLR: (1) formulating the research problem, (2) reviewing and validating the systematic protocol, (3) generating key search terms, (4) searching the literature, (5) screening based on inclusion/exclusion criteria, (6) assessing the quality of the relevant literature, (7) extracting data, and (8) synthesizing the findings.[4]

Data Collection Process

We collected data from the *ScienceDirect* database, which is well-known for its academic research articles and journals, particularly in the fields of social sciences, environmental studies, and development studies—the focus areas of this paper. Previous studies on this topic have used various terms, including (i) "country emission," (ii) "inequality," (iii) "economic outcomes," and (iv) "environmental outcomes." We examined these four concepts to uncover their intersections and identify patterns emerging from their combined analysis. To achieve this, we developed specific keywords using a Boolean search string and systematically recorded the data obtained from the search process. The search terms and records are presented in Table 1. Given the focus on the relationship between global emissions and inequality from a development perspective, we included keywords such as "global north" and "global south" to capture the dynamics of emissions and their impact on various regions. For the second concept, we included keywords like "emission disparity" and "emission factors" to address the differences in emission levels among countries specifically. Lastly, for outcomes, we utilized keywords such as "impact," "risk," "climate change," and "environmental justice" for environmental outcomes, as well as "economic inequality" and "energy justice" for economic outcomes. To ensure the relevance and focus of the selected articles, we applied specific inclusion and exclusion criteria. The process involved (i) restricting the publication years to 2021 onwards, (ii) refining the records based on the social science subject area, including only open access and open archive articles, (iii) selecting articles published in English, and (iv) excluding reviews, books, and conference proceedings. Following this protocol, 622 articles were identified, as shown in Table 1.

Data analysis

We analyzed the data using VOSViewer 16.0.20, employing bibliometric methods to generate valuable insights. The analysis began with data mapping. We imported bibliographic information from reference manager files, specifically utilizing citation export files in the Research Information System (RIS) format obtained from the ScienceDirect database. The analysis focused on the co-occurrence of keywords, with the selected keywords verified based on their frequency of occurrence, ranging from a minimum of 5 to a maximum of 88 out of 2,108 detected keywords. The Association Strength method

[3] Madeleine Bottrill et al., "What Are the Impacts of Nature Conservation Interventions on Human Well-Being: A Systematic Map Protocol," *Environmental Evidence* 3, no. 1 (August 5, 2014), https://doi.org/10.1186/2047-2382-3-16.
[4] Yu Xiao and Maria Watson, "Guidance on Conducting a Systematic Literature Review," Journal of Planning Education and Research 39, no. 1 (August 28, 2017): 93–112, https://doi.org/10.1177/0739456x17723971.

was applied to identify similarities and form clusters, emphasizing co-occurrence to visualize networks and relationships among keywords extracted from titles and abstracts. This process resulted in 89 items, categorized into 5 clusters, with a total link strength of 801. To enhance the precision and significance of the analysis, smaller and less relevant clusters were excluded by setting a minimum cluster size of 10 items. This approach effectively revealed the intricate connections among keywords, resulting in five major clusters. The qualitative meta-analysis aims to uncover the nexus and interconnections between global emissions, economic inequality, and environmental outcomes.

Table 1.
Keyword Search Terms (ScienceDirect) - Cutoff Date: August 16, 2024
A series of English search terms will be employed to filter and refine the data:

Database	Concept	Keywords	Boolean search keywords	Records	Inclusion/ Exclusion criteria
ScienceDirect	Country emission	carbon emission, greenhouse gas emission, fossil fuels	("global carbon emissions" OR "greenhouse gas emissions") AND (Fossil fuels) AND (global north) AND (global south) AND ("factors" OR "causes" OR "economic development" OR "energy consumption")	233	Selected year: (2021-2024), research articles, social sciences, open access and open archive.
	Inequality	emission disparity, emission factors	("Why do countries emit differently?" OR "differences in carbon emissions" OR "factors affecting country emissions" OR "emission disparities" OR "economic impact on emissions") AND (causes OR factors OR analysis)	16	(2021-2024), research articles, social sciences, open access, and open archives.
	economic development and outcomes	development agenda, international development	("development agenda" OR "economic development" OR "international development") AND ("emissions disparity" OR "emission differences" OR "risk") AND ("implications for inequality" OR "economic inequality" OR "energy justice")	275	(2021-2024), social sciences, research articles.
	Environmental outcomes	impact, risk, climate change, environmental justice	("environmental impact OR environmental consequences OR environmental effects OR environmental risk OR climate change") AND ("carbon emissions") AND (“SIDS” OR “developing countries”) AND (environmental justice")"	98	(2021-2024), research articles, social sciences, open access, and open archives.

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Results

The VOSviewer analysis identified five distinct clusters related to climate change, energy justice, and associated topics. These clusters are as follows: (i) the red cluster, representing climate change and sustainability; (ii) the yellow cluster, focusing on energy justice and policy; (iii) the blue cluster, emphasizing just transition and regional aspects; (iv) the green cluster, connecting health, inequality, and policy; and (v) the purple cluster, relating to environmental degradation and democracy. The relationships and details of each cluster will be explored in this section.

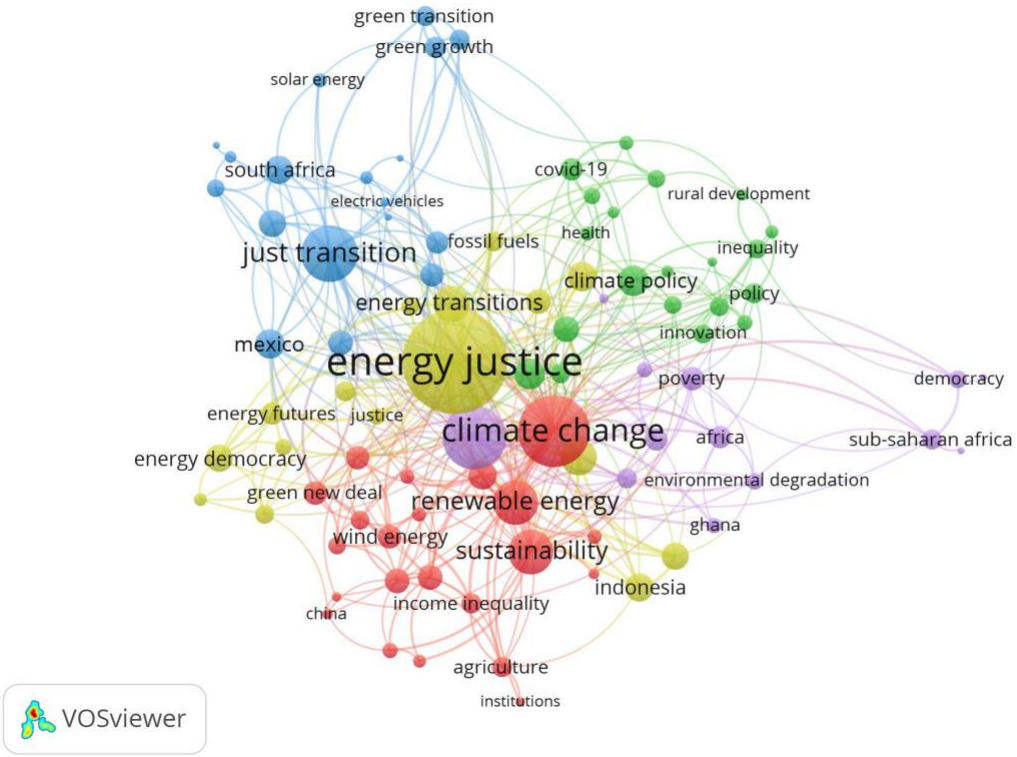

Fig. 1. Co-occurrence of global emission, inequality, economic and environmental outcomes.
Source: Developed by the author using VOSviewer.

Climate change and sustainability

The growing body of literature on climate change has profoundly impacted global development, policy, and practices. Climate change has been the global issue of the twenty-first century, with a significant effect on billions of lives, particularly those in the Global South.[5] Extensive research on climate change has demonstrated that carbon emissions from fossil fuels constitute a significant contributor to climate

[5] Larry A. Swatuk and Corrine Cash, *Water, Energy, Food and People Across the Global South: 'The Nexus' in an Era of Climate Change* (Springer, 2017).

change.[6] Until the mid-20th century, Europe and the United States were the dominant contributors to global emissions, accounting for over 90% in 1900 and more than 85% by 1950. However, there has been a notable shift in the distribution of emissions in recent decades, with a considerable increase observed in Asia, particularly in China. Currently, the United States and Europe account for less than one-third of global emissions.[7] The advent of non-Western hemisphere dominance in the total share of global emissions can be attributed to several factors, including the manufacturing and industry sector, as well as the process of domestic electrification, which is mainly dependent on the burning of coal and fossil fuels.[8] China, for instance, was responsible for 31.7% of global CO_2 emissions, equivalent to 10,648.54 metric tonnes from combustible fuels in 2021. Most of these emissions originated from fossil fuel combustion, including coal, oil, and natural gas. Notably, coal combustion alone contributed to 79% of China's CO_2 emissions from fuel combustion.[9]

[6] Yassine Kirat, Tina Prodromou, and Sandy Suardi, "Unveiling the Nexus: Climate Change, Green Innovation, and the Pendulum of Energy Consumption and Carbon Emissions," *Energy Economics*, July 2024, 107727, https://doi.org/10.1016/j.eneco.2024.107727.

[7] Hannah Ritchie and Max Roser, "CO_2 Emissions," *Our World in Data*, n.d., accessed August 18, 2024.

[8] Wirjawan, Gita. "The Paradox of Sustainability: A Critique of the Modern World's Approach to Sustainable Development." Shorenstein Asia-Pacific Research Center working paper, Stanford University, Stanford, CA, March 2024.

[9] "China - Countries & Regions," IEA, accessed August 18, 2024, https://www.iea.org/countries/china/emissions#what-are-the-main-sources-of-co2-emissions-in-china.

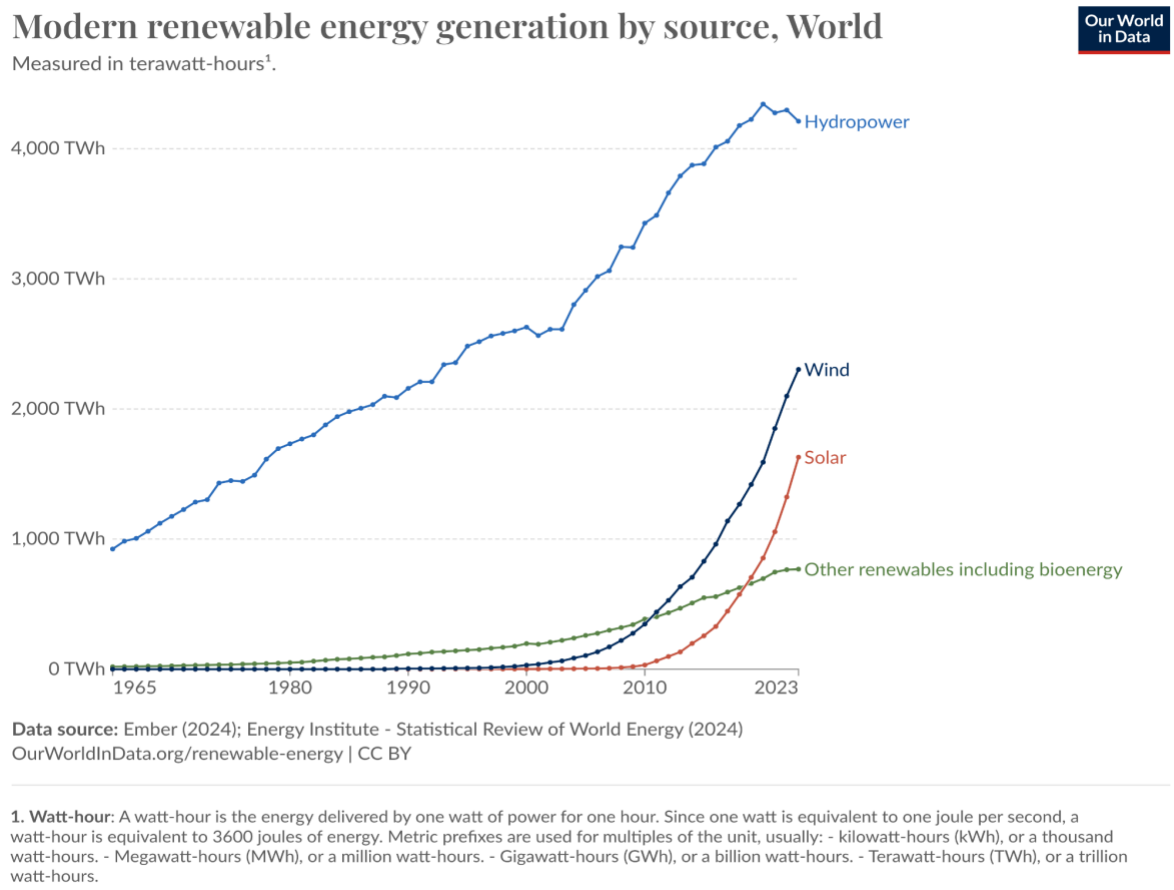

Fig. 2. Modern renewable energy generation by source in TWh (Terawatt-hours)
Data Source: Our World in Data, accessed August 18, 2024.

To reduce CO_2 emissions and air pollution, it is imperative that the global community expeditiously transitions to low-carbon energy sources, including renewables and nuclear[10]. Renewables are derived from the energy mix, including wind, solar, and other renewables, such as biofuels and hydropower. The transition to a power system that is entirely reliant on sustainable energy sources, such as solar, wind, hydroelectric, and geothermal power, represents a significant shift from the traditional reliance on fossil fuels for electricity generation at the regional and national levels.[11] As illustrated in Figure 2, hydropower has emerged as the dominant source, demonstrating a consistent growth trajectory and reaching over 3,500 terawatt hours (TWh) by 2023. However, recent observations indicate some fluctuations in this trend. The growth of wind energy began in the early 2000s and accelerated after 2010, reaching a total of over 2,000 TWh by 2023. Solar power, which initially exhibited a gradual growth trajectory, experienced an exponential surge around 2010, reaching a cumulative output

[10] Hannah Ritchie, Max Roser, and Pablo Rosado, "Renewable Energy," *Our World in Data*, n.d., accessed August 18, 2024.
[11] Sanjeevikumar Padmanaban, Sharmeela Chenniappan, and Sivaraman Palanisamy, *Power Systems Operation with 100% Renewable Energy Sources* (Elsevier, 2023).

exceeding 1,000 TWh by 2023. The growth of other renewables, including biofuels, has been more gradual, with a consistent but less prominent contribution.

Nevertheless, the lack of access to modern energy services represents a significant impediment to sustainable development, affecting millions of people, mainly in the South, where disparities in energy persist.[12] The substantial expectations regarding environmental and economic progress in both developed and developing nations are subjected to critical examination, focusing on the coal-powered electricity sector that has historically driven global electrification. For instance, there is a sustainability paradox in electrification for developing economies like Indonesia, where the primary source of electricity is coal. Consequently, transitioning to renewables is challenging due to the high costs associated with renewable energy compared to the relatively low cost of coal[7].

Energy justice and policy

Energy justice has been the subject of considerable debate and analysis in recent decades, with ongoing developments in this field of inquiry. The concept of energy justice is predicated on the fundamental tenet that all individuals should be guaranteed equitable access to safe, reliable, and affordable energy sources.[13] This concept encompasses the assurance that no group is subjected to an undue burden of costs or adverse impacts associated with the development, operation, and maintenance of energy systems.[14] The four core tenets of energy justice are as follows: (1) *distributional*, whereby instances of injustice are identified; (2) *recognitional*, whereby the affected parties are acknowledged, despite often being ignored; (3) *procedural*, concerning the processes that exist to both reveal and reduce injustice; and (4) *restorative*, outlining how injustice can be repaired and returned to its previous state.[15] the objective of these tenets is to reduce disparities in energy access and the distribution of energy-related burdens. These disparities frequently manifest in marginalized communities, which are disproportionately affected by pollution, health risks, and the economic costs associated with traditional energy systems, such as fossil fuel-based power generation.[16] The transition to a more equitable energy system necessitates the addressing of these inequalities through the implementation of measures ensuring the fair benefit and consequences associated with energy.

[12] Jinjun Zhang, "Energy Access Challenge and the Role of Fossil Fuels in Meeting Electricity Demand: Promoting Renewable Energy Capacity for Sustainable Development," *Geoscience Frontiers* 15, no. 5 (September 2024): 101873, https://doi.org/10.1016/j.gsf.2024.101873.

[13] Kirsten E.H. Jenkins et al., "Synthesizing Value Sensitive Design, Responsible Research and Innovation, and Energy Justice: A Conceptual Review," *Energy Research & Social Science* 69 (November 2020): 101727, https://doi.org/10.1016/j.erss.2020.101727.

[14] Benjamin K. Sovacool et al., "Pluralizing Energy Justice: Incorporating Feminist, Anti-Racist, Indigenous, and Postcolonial Perspectives," *Energy Research & Social Science* 97 (March 2023): 102996, https://doi.org/10.1016/j.erss.2023.102996.

[15] Mariah D. Caballero, Thushara Gunda, and Yolanda J. McDonald, "Energy Justice & Coastal Communities: The Case for Meaningful Marine Renewable Energy Development," *Renewable and Sustainable Energy Reviews* 184 (September 2023): 113491, https://doi.org/10.1016/j.rser.2023.113491.

[16] Noel Healy, Jennie C. Stephens, and Stephanie A. Malin, "Embodied Energy Injustices: Unveiling and Politicizing the Transboundary Harms of Fossil Fuel Extractivism and Fossil Fuel Supply Chains," *Energy Research & Social Science* 48 (February 2019): 219–34, https://doi.org/10.1016/j.erss.2018.09.016.

Disparity in energy resulted from a failing international climate regime and historical factors. International efforts (e.g., the Paris Agreement; the UNFCCC) to incentivize the decarbonization of the economy have largely been ineffective, with many wealthy nations failing to meet their pledges to reduce greenhouse gas emissions due to conflicts with their national interests and economic priorities.[17,18] Additionally, the disparities in economic growth, resource availability, and vulnerability to climate risks across different regions contribute to the varying levels of support for international mitigation policies. Less developed nations without fossil fuel resources tend to advocate for stricter measures, while wealthier, oil-dependent countries are more likely to resist global emissions reduction targets.[15] From a historical perspective, the United States has emitted the most CO_2, accounting for nearly a quarter of global emissions since 1751, with around 400 billion tonnes released. This is over 1.5 times more than China, the second-largest emitter. The European Union countries, which often collaborate on climate targets, also have a significant historical footprint, contributing nearly one-fifth of total emissions. In contrast, despite being significant emitters today, countries like India and Brazil have relatively small historical contributions. Africa's regional contribution has been minimal, especially considering its population size, due to historically and currently low per capita emissions.[6]

Economic and technological obstacles also pose significant challenges to achieving energy justice, particularly in developing countries. Indonesia, for example, where the primary energy sources are coal and oil, accounting for 30% and 29% of the energy supply, respectively. Coal dominates Indonesia's domestic energy production, making up 67% of the total.[19] Transitioning to renewable sources would be difficult for most countries in Southeast Asia because there are conditions such as fuel considered relatively environmentally friendly, as seen in Singapore; (2) the plentiful availability of fossil fuels, as is the case in Brunei and Indonesia; (3) developing renewable energy power generation is considered costly; and (4) the insufficient purchasing power for renewable energy at both the wholesale and individual consumer level.[7] the renewable transition also requires setting up green infrastructure or technologies. Although many research reports have said that the swift implementation of clean technologies reduces the cost of energy rather than increasing it,[20] significant concerns about stranded assets, transition costs, energy security, and sustainability may slow down the transition or push the system in alternative directions.[21]

A crucial responsibility for governments is to ensure that clean energy technologies are more accessible to those who might find the initial costs challenging. Democratic governance plays a vital role in the transition toward equitable energy distribution. It requires participation from all stakeholders in the

[17] Robert Falkner, "The Paris Agreement and the New Logic of International Climate Politics," *International Affairs* 92, no. 5 (August 31, 2016): 1107–25, https://doi.org/10.1111/1468-2346.12708.
[18] David G. Victor et al., "Prove Paris Was More than Paper Promises," *Nature* 548, no. 7665 (August 2017): 25–27, https://doi.org/10.1038/548025a.
[19] "Indonesia - Countries & Regions," IEA, accessed August 19, 2024, https://www.iea.org/countries/indonesia/energy-mix.
[20] "Rapid Rollout of Clean Technologies Makes Energy Cheaper, Not More Costly - News," IEA, accessed August 19, 2024, https://www.iea.org/news/rapid-rollout-of-clean-technologies-makes-energy-cheaper-not-more-costly.
[21] Nur Firdaus and Akihisa Mori, "Stranded Assets and Sustainable Energy Transition: A Systematic and Critical Review of Incumbents' Response," *Energy for Sustainable Development* 73 (April 2023): 76–86, https://doi.org/10.1016/j.esd.2023.01.014.

decision-making process. By incorporating diverse perspectives and ensuring transparency, democratic governance can foster policies prioritizing social equity and environmental sustainability. In this context, energy justice must be integrated into policy frameworks at all levels of management. This includes implementing regulations that promote the development of renewable energy infrastructure, providing financial incentives for clean energy adoption, and ensuring that marginalized communities are included in the transition. Additionally, democratic governance requires holding energy producers and policymakers accountable for their decisions' environmental and social impacts.

Just transition and regional aspects

The *just transition* is a relatively newly emerged concept in the course and practice of sustainability. After the Paris Agreement, states were asked to submit their intended nationally determined contributions (NDCs) and implement their pledges until a specific target is achieved.[16] The NDCs differ across nations, and they follow a bottom-up approach in which states formulate policies based on their own resources and capacity.[22] All member states should ratify their NDCs and evaluate their progress in climate change actions in a particular assessment review meeting called Global Stocktake.[23] The GST assessment in 2023 identified that in mitigation efforts, new cost-effective ways to reduce emissions, including green industrialization, can also support other development objectives like poverty alleviation. It emphasizes the importance of just transition and equity by advocating for collective and participatory decision-making processes to mitigate the disruptive effects on jobs and communities during the shift away from fossil fuels.[24] Therefore, many countries are seeking renewable and sustainable alternatives to existing energy systems due to increasing energy demand, the need to reduce CO_2 emissions, declining fossil fuel reserves, and the impact of climate change.

Just transition is defined as a process that ensures the advantages of transitioning to a green economy are distributed equitably while also providing support to those who may experience economic losses during the transition.[25] The process of energy transition involves a gradual reduction in the use of fossil fuels and an increase in reliance on renewable energy sources, such as solar and wind, which have historically constituted only a minor share of the energy mix.[26] This transition necessitates adjustments in policy, technology, and the social sector, presenting numerous challenges. These challenges are especially significant in regions where fossil energy fueled the economy.

The particular references to South Africa and Mexico in the VOSviewer analysis illustrate the regional complexities inherent in implementing a just transition. South Africa was one of the countries that had a significant reliance on fossil fuels, and 88.2% of total energy was based on coal and oil in 2021.[27] The

[22] Emilson Caputo Delfino Silva, "Self-Enforcing Agreements under Unequal Nationally Determined Contributions," *SSRN Electronic Journal*, 2017, https://doi.org/10.2139/ssrn.2978774.
[23] David G. Victor et al., "Prove Paris Was More than Paper Promises," *Nature* 548, no. 7665 (August 2017): 25–27, https://doi.org/10.1038/548025a.
[24] "What Is the Global Stocktake?," Grantham Research Institute on climate change and the environment, November 29, 2023, https://www.lse.ac.uk/granthaminstitute/explainers/what-is-the-global-stocktake/.
[25] "What Is a Just Transition?," accessed August 21, 2024, https://www.ebrd.com/what-we-do/just-transition.
[26] Xinxin Wang and Kevin Lo, "Just Transition: A Conceptual Review," *Energy Research & Social Science* 82 (December 2021): 102291, https://doi.org/10.1016/j.erss.2021.102291.
[27] "South Africa - Countries & Regions," IEA, accessed August 21, 2024,

country later set up the Just Energy Transition Implementation Plan (JET IP) for 2023–2027, which aims to move away from coal-fired power and towards renewable energy sources, representing a significant step towards a just transition. This plan involves targeted investments and interventions to facilitate the transition, emphasizing the inclusion of all communities and workers affected by these changes. Additionally, it aims to create jobs, reduce inequality, and attract investment. However, the feasibility of achieving deep decarbonization in coal-dependent countries like South Africa is increasingly complicated by the challenge of ensuring that the processes and outcomes of the clean energy transition align with principles of fairness and equity.[28] However, South Africa's pursuit of a just transition faces several significant challenges, including techno-economic constraints that limit the feasibility of its ambitions and power struggles, along with corruption that undermines transition efforts.[27] Additionally, place-based policies contribute to distributive and recognition injustices, meaning that the benefits and recognition of the transition are not equally shared among all communities.[29] Opportunities for "presuming" (where individuals both produce and consume energy) are often limited to certain areas and social groups, reinforcing existing social hierarchies.[30] Moreover, the transnationalisation of renewable energy projects poses a threat to the just transition by potentially prioritizing international interests over local needs, further complicating efforts to ensure a fair and equitable energy transition for all.[31]

In Latin America, for instance, Mexico also has considerable reliance on fossil fuels, with oil and natural gas constituting 85% of its overall energy portfolio.[32] Despite this dependence, Mexico was one of the first countries to ratify the Paris Agreement by submitting its Nationally Determined Contributions (NDCs), and it has implemented significant policies aimed at transitioning to greener energy. The country's national climate change policy includes plans to deploy 13.5 GW of wind energy, 1 GW of biomass, 0.7 GW of geothermal, 1.75 GW of hydropower, and 10.4 GW of solar energy between 2018 and 2030. However, these planned green investments fall short of the scenarios proposed by IRENA (International Renewable Energy Agency) that align with the Paris Agreement.[33] However, the challenges of transitioning to greener energy sources in Mexico are diverse, primarily stemming from fossil-fuel regimes' economic and entrenched assets, insufficient investment in clean energy research, development, and innovation, and shifts in policy paradigms over time. These shifts, driven by evolving societal needs and socio-political interests, have often favored fossil fuel power generation.[34] While

https://www.iea.org/countries/south-africa/energy-mix.

[28] Pegah Mirzania et al., "Barriers to Powering Past Coal: Implications for a Just Energy Transition in South Africa," *Energy Research & Social Science* 101 (July 2023): 103122, https://doi.org/10.1016/j.erss.2023.103122.

[29] Minna Kaljonen et al., "Policy Mixes for Just Transitions: A Holistic Evaluation Framework," *Environmental Innovation and Societal Transitions* 52 (September 2024): 100885, https://doi.org/10.1016/j.eist.2024.100885.

[30] Julia M. Wittmayer et al., "Thinking, Doing, Organising: Prefiguring Just and Sustainable Energy Systems via Collective Prosumer Ecosystems in Europe," *Energy Research & Social Science* 86 (April 2022): 102425, https://doi.org/10.1016/j.erss.2021.102425.

[31] *Our Future: Make It Work : National Development Plan, 2030 : Executive Summary*, 2012.

[32] "Mexico - Countries & Regions," IEA, accessed August 22, 2024, https://www.iea.org/countries/mexico/energy-mix#where-does-mexico-get-its-energy.

[33] Santacruz Banacloche et al., "Assessment of the Sustainability of Mexico Green Investments in the Road to Paris," *Energy Policy* 141 (June 2020): 111458, https://doi.org/10.1016/j.enpol.2020.111458.

[34] Omar Castrejon-Campos, "Evolution of Clean Energy Technologies in Mexico: A Multi-Perspective

most COP member states have adopted international norms to combat climate change under the Paris Agreement, progress on the just transition process remains slow and fraught with challenges. The connection between just transition and regional factors continues to be a topic of extensive discussion in policies and practices aimed at shifting toward a greener energy paradigm.

Inequality, health, and rural development

The climate change and inequality issues have been disproportionately impacting the world's poorest populations, particularly those in developing countries. Climate change is one of several factors endangering the livelihoods of the rural poor, alongside economic transitions due to industrialization and urbanization, as well as governance challenges like unclear property rights and civil conflict. According to a World Bank report, climate change could add approximately 68 to 135 million people into poverty by 2030.[35] The focus on inequality within this context underscores the recognition that climate change and health crises do not affect all populations equally. The most vulnerable are typically those who are impoverished, reside in harsh or rural regions, have limited access to green energy and technology, and live in politically unstable states.

During the COVID-19 pandemic, the world's poorest and most marginalized communities were disproportionately impacted, exacerbating existing inequalities, particularly in health outcomes across various socio-economic groups.[36] The pandemic highlighted how vulnerable populations are more severely affected by both health crises and climate change, further deepening inequalities.[37] Health outcomes related to climate change and environmental degradation are linked to factors such as air pollution, food insecurity, and extreme weather events, all of which have direct and indirect effects on public health, such as hearing loss and dehydration, infectious diseases, water and food-related illness, and mental health issues.[38] Researchers employed a multidimensional poverty framework and an econometric model to evaluate the contribution of health vulnerability to health poverty. The findings revealed that 17.95% of farmers were living in poverty due to healthcare costs, with those from low-income backgrounds being particularly at risk of severe medical affordability poverty.[39]

Analysis," *Energy for Sustainable Development* 67 (April 2022): 29–53, https://doi.org/10.1016/j.esd.2022.01.003.

[35] "Linking Climate and Inequality," IMF, accessed August 23, 2024, https://www.imf.org/en/Publications/fandd/issues/2021/09/climate-change-and-inequality-guivarch-mejean-taconet.

[36] Lukas Kerschbaumer et al., "COVID-19 and Health Inequalities: The Impact of Social Determinants of Health on Individuals Affected by Poverty," *Health Policy and Technology* 13, no. 1 (March 2024): 100803, https://doi.org/10.1016/j.hlpt.2023.100803.

[37] Si Ying Tan et al., "Mitigating the Impacts of the COVID-19 Pandemic on Vulnerable Populations: Lessons for Improving Health and Social Equity," *Social Science & Medicine (1982)* 328 (July 2023): 116007, https://doi.org/10.1016/j.socscimed.2023.116007.

[38] Trung Thanh Nguyen et al., "Security Risks from Climate Change and Environmental Degradation: Implications for Sustainable Land Use Transformation in the Global South," *Current Opinion in Environmental Sustainability* 63 (August 2023): 101322, https://doi.org/10.1016/j.cosust.2023.101322.

[39] Muhammad Khalid Anser et al., "Beyond Climate Change: Examining the Role of Environmental Justice, Agricultural Mechanization, and Social Expenditures in Alleviating Rural Poverty," *Sustainable Futures* 6 (December 2023): 100130, https://doi.org/10.1016/j.sftr.2023.100130.

Focusing on rural development is also crucial, as rural areas are typically more vulnerable to climate change and socio-economic disparities. For instance, the intersection of poverty and climate change in Pakistan calls for a focus on environmental ethics and justice.[40] Climate change will likely worsen socioeconomic inequalities, widening the gap between the wealthy and low-income populations. Pakistan, with its limited resources and high poverty rate, is particularly vulnerable to the impacts of climate change.[41] Factors such as economic inequality, lack of quality education, and inadequate healthcare contribute to poverty and must be carefully considered. The country's sensitivity to climate change is evident from its history of floods, droughts, and other natural disasters. The research identifies obstacles in processes and structures that impede efforts to escape poverty and adapt to or mitigate the effects of these natural disasters.[3]

Environmental degradation and democracy

The relationship between democracy and environmental outcomes has been a contentious issue within the ecological politics literature.[42] Some scholars argue that democracy hinders environmental performance, while others contend the opposite, and still others propose that specific democratic models are more conducive to sustainability. It also indicates that democracies with more robust deliberative characteristics tend to adopt more environmental policies, though these are not necessarily stricter or more effective. In contrast, democracies with more robust social-liberal features are found to implement both more rigorous and more effective environmental policies.[43]

Research indicates a cointegrated relationship between urbanization, environmental degradation (CO_2 emissions), and political economy variables such as democracy and bureaucratic quality.[44] In the long run, both democracy and bureaucratic quality are effective in mitigating environmental degradation. Additionally, a positive bi-directional relationship exists between CO_2 emissions and factors such as affluence and population, as demonstrated by panel vector autoregressive models and impulse response functions.[45] However, a negative unidirectional relationship between CO_2 emissions and bureaucratic quality is observed. The findings further reveal that high-level democracy indicators moderate energy

[40] Patricia M. DeMarco, "Rachel Carson's Environmental Ethic – a Guide for Global Systems Decision Making," *Journal of Cleaner Production* 140 (January 2017): 127–33, https://doi.org/10.1016/j.jclepro.2015.03.058.
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[42] Alex O. Acheampong, Eric Evans Osei Opoku, and Janet Dzator, "Does Democracy Really Improve Environmental Quality? Empirical Contribution to the Environmental Politics Debate," *Energy Economics* 109 (May 2022): 105942, https://doi.org/10.1016/j.eneco.2022.105942.
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[44] Zahoor Ahmed et al., "Linking Urbanization, Human Capital, and the Ecological Footprint in G7 Countries: An Empirical Analysis," *Sustainable Cities and Society* 55 (April 2020): 102064, https://doi.org/10.1016/j.scs.2020.102064.
[45] Rida Waheed, Sahar Sarwar, and Chen Wei, "The Survey of Economic Growth, Energy Consumption and Carbon Emission," *Energy Reports* 5 (November 2019): 1103–15, https://doi.org/10.1016/j.egyr.2019.07.006.

consumption, leading to increased CO_2 emissions in regions like West and Central-Eastern Africa but not in Sub-Saharan Africa (SSA) and Southern Africa.

Moreover, corruption and democracy significantly negatively affect carbon emissions across most quantiles in SSA countries. While better control of corruption enhances democracy's positive impact on forest protection, the influence of renewable energy utilization, trade globalization, and business freedom tends to weaken this effect. The study also highlights that parliamentary and majoritarian democracies are more likely to safeguard forests compared to presidential or proportional democracies.

In the context of advanced-economy states, policymakers in BRICS countries should focus on implementing pro-growth economic policies in conjunction with improved democratic practices, promoting renewable energy resources, and enhancing living standards to achieve higher environmental quality.[46] The study suggests that prioritizing democracy could play a crucial role in carbon reduction.[47]

Discussions

The study investigates the interplay between climate change, energy justice, and sustainability, focusing on reducing carbon emissions through a just transition to renewable energy systems. The relationship between climate change and sustainability is evidenced by the significant rise in global carbon emissions, which began to surge in the early 1900s. Europe and the United States were the primary contributors to these emissions during that period, largely due to their economic advancement through industrialization. However, the trend has shifted over time, with Asian countries like China and India becoming major contributors to global emissions due to industrial expansion.

Consequently, there is an urgent need to transition to greener and renewable energy sources, particularly by shifting from fossil fuel-based power to a mix of renewable energy sources. Operating a power system entirely on renewable energy represents a major shift from traditional fossil fuel-based electricity generation. However, the transition faces several challenges, including resistance from incumbents due to the risk of stranded assets, the high costs of transition, and the relatively lower cost and abundant availability of fossil fuels in many countries compared to renewables.

Our study also highlights significant disparities in energy justice, particularly affecting marginalized communities that disproportionately experience pollution, health risks, and economic burdens associated with traditional fossil fuel-based energy systems. These disparities are also evident in regional differences in per capita electricity consumption. For example, with its small population, Qatar has the highest per capita energy consumption, approximately 225 MWh, in 2023 due to abundant oil resources. Conversely, Indonesia, despite its substantial coal reserves, particularly in Kalimantan, has a relatively low per capita energy consumption of about 1.04 MWh in 2021. The study further identifies that regional disparities are exacerbated by the failure of the international climate regime to meet

[46] Smarnika Ghosh et al., "Unveiling the Spillover Effects of Democracy and Renewable Energy Consumption on the Environmental Quality of BRICS Countries: A New Insight from Different Quantile Regression Approaches," *Renewable Energy Focus* 46 (September 2023): 222–35, https://doi.org/10.1016/j.ref.2023.06.004.
[47] Tasnim Sultana et al., "Democracy, Green Energy, Trade, and Environmental Progress in South Asia: Advanced Quantile Regression Perspective," *Heliyon* 9, no. 10 (October 2023): e20488, https://doi.org/10.1016/j.heliyon.2023.e20488.

emission reduction commitments. While some countries have made strides towards transitioning to greener energy, policy and implementation challenges persist, slowing progress.

In the context of a just transition, various countries, particularly COP member states, have been working to ratify and implement their Nationally Determined Contributions (NDCs) as part of their commitments under the Paris Agreement. Countries like South Africa and Mexico are adapting their policies, technologies, and resources to gradually shift towards green energy, including renewable sources like hydropower, wind, and solar PV, despite continued reliance on fossil fuels. This trajectory is critical for achieving emission reductions while promoting economic growth and cost-effectiveness. However, the *just transition* process faces considerable obstacles and needs to be uniformly experienced across all communities. In many cases, communities directly affected by energy policies encounter limitations in energy access and disparities in per capita emissions. Countries heavily dependent on fossil fuels are often resistant to transition efforts due to concerns about the impact on their energy sources, economies, and export revenues. Additionally, opportunities for "prosuming"—where individuals produce and consume energy—are often restricted to specific regions and social groups, reinforcing existing social hierarchies. The transnationalisation of renewable energy projects further complicates the *just transition* by potentially prioritizing international interests over local needs, making it challenging to achieve a fair and equitable energy transition for all.

This research also highlights the intersection of inequality, health, and rural development in transitioning to modern renewable energy and the risks posed by climate change. Complemented by inequality and governance challenges, climate change threatens the livelihoods of the rural poor, particularly in regions still reliant on traditional energy sources. Inequality in this context, particularly related to climate change and health crises, disproportionately disadvantages specific populations. The COVID-19 pandemic, for example, demonstrated how the world's poorest and most marginalized communities were disproportionately affected, especially in terms of access to energy, income, and health services. These issues were most prevalent in developing countries, where climate change is expected to exacerbate existing socioeconomic inequalities, further widening the gap between rich and poor and leading to increased poverty rates.

The importance of democracy and good governance in environmental management, including forest protection, is also highlighted in the result. Different models of democracy yield varying outcomes in terms of sustainability. Democracies with vital deliberative elements tend to adopt more environmental policies, although these policies are not always more stringent or effective. On the other hand, democracies with strong social-liberal characteristics are found to implement both stricter and more effective environmental policies. It leads to the formulation of policies that more adequately address pressing issues related to inequality, health, and rural development. A robust democracy also enhances policy implementation, ensuring justice and security, particularly for vulnerable, impoverished populations.

Conclusion

This research explores contemporary works on climate change, energy justice, and sustainability and analyses how they relate to transition pathways and economic and environmental implications, specifically in regions dependent on traditional energy. The outcomes support the position that climate

change and sustainability are arguably two sides of the same coin, for when the latter implicitly speaks about attempts to disentangle oneself from cheap energy, the former is much more explicit in the threats to come. Other issues like just transition and inequality are also notable causes of energy non-justice, especially in energy transitioning or developing countries dependent on fossil fuels. The study also discusses the democracy/environment relationship, observing how different forms of democracies have different sustainability outcomes.

However, several obstacles remain within this nexus that make it difficult to move toward sustainability in practice. Some of these challenges include opposition from incumbent industries due to the threat of lost investments, the costliness of transition, the cheaper and more accessible fossil fuel sources than renewables, and the ineffectiveness of climate change treaties in enforcing emission reductions. This transition is also taking a long time, especially in rural and third-world regions, which worsens energy limitations, heightens disparity, and spurs higher poverty levels. Furthermore, adherence to policy standards has also needed to be faster by this change, which has hindered development. Thus, although there are some achievements, such factors still present significant obstacles to attaining sustainability.

This study may be limited in terms of articles addressing policy implementation in the transition process, particularly those involving policies, transparent processes, public support, and the availability of modern energy transmission systems. This limitation is also perceived from the restricted keyword coverage used during the search process and the reliance solely on the Scopus (*ScienceDirect)* database due to accessibility challenges. The paper also includes only a limited number of articles discussing the use of renewable energy sources such as hydropower, solar PV, and wind.

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