

Exploring Energy Justice on Solar Mini-Grid Implementation in Rural Island Communities in Ghana

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Abstract

Energy justice has gained significant attention in the energy-related social sciences and humanities. In the Global South, there have been several works in the energy justice scholarship, but few on exploring energy justice through the implementation of mini-grids in rural communities. In light of this, the study assessed how the implementation of mini-grids in rural island communities in Ghana fared from an energy justice perspective. Empirical data was collected from three island communities in the South-Eastern part of Ghana along the Volta Lake, namely Kudorkope, Atigagome and Wayokope within three months. The analysis drew from 52 interviews (28 from the field and 24 interviews from renewable energy experts) and secondary data. The findings revealed that the implementation of solar mini-grids in the rural island communities in Ghana had energy justice concerns. These include a lack of access to quality information on the project, unfairness in the consultation and decision-making process, erratic electricity supply which disrupted their daily activities particularly economic activities and issues of marginalisation. The study recommends top-level stakeholders in the renewable energy sector to ensure a fair distribution of the costs and benefits of energy transition efforts. This would mitigate the disproportionate impacts of climate change on rural communities and reduce the gap in energy access between rural and urban communities.

Keywords: Energy Justice, Solar Mini-grids, Distributional Justice, Procedural Justice, Recognition Justice, Ghana, Rural Electrification

Introduction

Energy supply is essential for socioeconomic and human development in any country or jurisdiction (Zalengera, 2020), which connects the economic, social and environmental components of sustainable development (Bhattacharyya, 2018; Weinand et al., 2023). Modern energy services like solar mini-grids offer a clean and steady approach towards achieving SDGs (Boamah, 2020; Mugambiwa & Rapholo, 2023). In this context, improving modern energy access is Sub-Saharan Africa's top energy priority in order to help the region's nations fulfil their aspirations for social and economic growth (Khomenko et al., 2021). Access to modern energy is required for the supply of clean water, sanitation and healthcare as well as for the reliable and efficient operation of lighting, heating, cooking, mechanical power, transportation and telecommunications (International Energy Agency, 2020). Though it may not be the only essential condition for Africa to meet its development

and poverty reduction targets, the availability of modern energy will surely be the main driver of economic growth (Twinomuhangi et al., 2022).

The advantages and burdens of energy consumption are imbalanced not only across and among nations but also within communities (Jones, 2021). Numerous experts advocate for equitable and fair access to modern energy services for all parts of society as well as inclusive approaches to energy system development (Malakar et al., 2019; McCauley et al., 2019). Transitioning to a low-carbon economy enables us to reassess how to provide universal energy access as increased renewable energy consumption promotes economic development and poverty reduction (Bhattacharya et al., 2016). The low-carbon transition, however, is dependent on the political economy of energy and demonstrates the underlying disparities in current energy systems (Khennas, 2012; Newell & Mulvaney, 2013). Questions of justice apply to both low-carbon and energy access plans (Goldthau & Sovacool, 2012).

Energy justice can be a suitable framework for promoting green economy transitions in solving energy issues (Jenkins et al., 2018). Over the past decade, the concept of "energy justice" has gained significant traction in the energy-related social sciences and humanities, given the very unequal distribution of the benefits and impacts of energy systems in our world (McCauley et al., 2013; Sovacool & Dworkin, 2014). The concept examines critically where (in) justice can be identified in energy systems and how it might be attained, especially in the light of the speed at which low-carbon transitions are happening (McCauley et al., 2013; Jenkins et al., 2016).

Scholars interested in the energy justice debate are primarily concerned with the sociopolitical and economic imbalances in energy systems (Jones, 2021). Conventional approaches to addressing energy justice concentrate on particular regions or segments of society that are negatively impacted by the energy system as well as the necessary corrective measures to provide equitable energy results for everyone (Bouzarovski & Simcock, 2017; Lacey-Barnacle et al., 2020; McCauley et al., 2019). In the Global South, there have been several works in the energy justice scholarship (Abe & Azubike, 2024; Baker et al., 2021; Jones, 2021; Kruger & McCauley, 2020; Mang-Benza et al., 2023; Siciliano et al., 2018) including community renewable energy (Ambole et al., 2021; Domegni & Azouma, 2022; Ehanmo, 2024; Kumar & Taylor, 2021; Nsude et al., 2024; Van der Horst et al., 2021) but few on exploring energy justice through the implementation of mini-grids in rural communities (Cole, 2024; Mottram, 2022). In light of this, the study will assess how the implementation of mini-grids in rural island communities in Ghana fared from an energy justice perspective, as no work has been done in Ghana yet. The research questions of the study are as follows.

To what extent has energy justice been practised in the implementation of solar mini-grids in the rural island communities?

- a. What are the procedural (In) justices?
- b. What are the distributional (In) justices?

- c. What are the recognition (In) justices?

Rationale of the Study

Despite the growing interest in solar mini-grids for energy access in developing countries like Ghana, there have been no detailed investigations into how these projects match with energy justice concept in Ghana. The research aims to shed light on how the application of the energy justice framework can enhance the socio-economic benefits of mini-grids for marginalised and underserved communities in Ghana, ultimately contributing to poverty reduction, livelihood improvement, and social inclusion under the Sustainable Development Goals.

Investigating the use of energy justice for solar mini-grids in Ghana would be done by engaging stakeholders, such as government agencies, non-governmental organisations, developers and local communities to enable data collection, knowledge sharing and solution co-creation. These collaborations not only improve the rigour and relevance of the research but also increase its potential for real-world impact and scalability.

Findings can help Ghanaian policymakers make decisions about energy access and rural electrification. Emphasising the significance of including energy justice issues in solar mini-grid projects can influence the design, implementation and regulation of energy policies and programmes in the country, creating more inclusive and sustainable development results.

Literature Review

Energy justice can be a suitable framework for promoting green economy transitions in solving energy issues (Jenkins et al., 2018). In recent times, energy justice has progressed from a novel and beneficial idea to a decision-making framework (Heffron, 2023). According to Heffron & McCauley (2017), energy justice can circumvent the issues with environmental and climate justice scholarship and provide a more stable and long-lasting basis for its central meaning. Notably, it highlights the three fundamental principles of distributional justice, procedural justice and recognition justice (Fuller & McCauley, 2016; Jenkins et al., 2016; McCauley et al., 2016).

Energy researchers can utilise energy justice as a framework to examine how values are embedded in energy systems, which will assist energy planners in making more informed energy decisions (Sovacool & Dworkin, 2015). The discipline of energy justice has developed frameworks to help identify energy injustices and inform energy decision-making. Two strategies have gained traction: 1) Sovacool et al (2013) developed an eight-principle idea of energy justice as an analytical and decision-making instrument. They later added two, making it ten (Sovacool et al., 2019). These were *Availability, Affordability, Due Process, Transparency and accountability, Sustainability, Intragenerational equity, Intergenerational equity, Responsibility, Resistance* and *Respect*. 2) McCauley et al (2013) proposed the

triumvirate tenets concept of energy justice, which is based on the environmental justice framework in terms of distribution, recognition and procedural (Jenkins et al., 2016; Sovacool & Dworkin, 2014). The framework developed by Sovacool and colleagues lacked clear incorporation of justice as recognition; hence, the study adopted the triumvirate tenets of energy justice by McCauley et al (2013). According to the triumvirate tenets of energy justice, to identify energy injustices, one must first determine the distribution of the problem, then determine who it affects and thirdly, determine repair plans and procedures (Jenkins et al., 2016).

Distributional justice is associated with the outcomes of decision-making (costs and benefits), particularly their distribution, duties and potential hazards (Jafino et al., 2021). Outcomes can be physical (e.g., infrastructure), public goods (e.g., clean air), or adverse consequences. Distributional justice examines the allocation of results among entities as well as the mechanism of distribution (Sovacool & Dworkin, 2015). In the context of environmentally friendly technology initiatives, examples of (in) justice include the setting of infrastructure, suppliers of energy, access to energy services, incentives, investment costs, ownership, profits, accountability for action, possibilities for development and how much people pay for energy (Jenkins et al., 2016). It analyses when arguments concerning the general desirability of technologies become linked with local difficulties (Owens & Driffill, 2008). This serves as a call for the equitable distribution of advantages and effects on all members of society, regardless of income, colour etc. (Jafino et al., 2021).

Recognition justice determines which parts of society have been disregarded or misrepresented (Ciplet, 2021). Individuals must be fairly represented, free of physical threats and granted absolute and equal civil rights (Saif et al., 2022). A lack of acknowledgement can manifest in numerous types of cultural and political dominance, insults, humiliation, and devaluation. It can manifest not only as a failure to recognise but also as a demeaning misreading of people's opinions (Saif et al., 2022). By understanding where inequities occur, energy justice forces us to consider who we should focus on when we think about energy victims (Jones, 2021). This process is known as post-distributional or recognition-based justice (Heffron & McCauley, 2017). It is commonly referred to as post-distributional in the context that the investigation of distributional disparities includes a thorough examination of where injustice develops and its influence on various segments of society (Suboticki et al., 2023). Thus, acknowledgement of recognition justice involves calls to accept diverse perspectives based on social, cultural, ethnic, racial and gender disparities (Lenzi et al., 2023).

Procedural justice is concerned with access to decision-making processes that oversee distribution which includes a need for equitable procedures that engage all stakeholders in an inclusive way (Jafino et al., 2021). This includes access to information, the ability to participate, the acknowledgement of unfair practices and the absence of bias on the side of project promoters and decision-makers (Arya, 2023; Francis, 2021). It is underpinned by access to and influence from multifaceted legal systems (Burke & Leben, 2024). It can also

be influenced by softer non-regulatory factors like practices, norms, attitudes and behaviours (Kordzadeh & Ghasemaghaei, 2022). In the context of communities, major criteria utilised to evaluate the process include local knowledge mobilisation, information disclosure and institutional representation (Jenkins et al., 2016). According to Sovacool & Dworkin (2015), procedural fairness is achieved when the decision maker is not biased and there is meaningful stakeholder input. As a result, institutional stakeholder representation (Jenkins et al., 2016) and the ability to be heard (Francis, 2021) are critically important. These factors influence social and community acceptance as well as public trust (Burke & Leben, 2024).

Methodology

Study Area

About 2.9 million out of the 14.1% population without access to grid power reside on lakeside and island communities which were created by the construction of the Akosombo Dam in the Volta River and was built in 1965 (SNV, 2021). With a total surface area of 3275 square miles, it was found that the dam is the largest man-made lake in the world and the largest hydroelectric dam in Ghana (Philips, 2015). The Volta River Authority (VRA) is responsible for managing the dam and the generation of electricity for transmission (VRA, 2021). Targeting these communities with conventional grid extensions is physically and economically unviable considering the costs of such investments (SNV, 2021). This is mainly because of the lack of bridges or roads and the high cost of laying underwater cables to the closest grid facilities (FAAPA, 2015). None of the 200 island communities that were created by the construction of the Akosombo hydroelectric dam had power until 2015 when the World Bank Group funded the provision of 5-pilot mini-grids (Nuru, 2021a). The 5-pilot mini-grids developed were estimated to have cost \$230 million, whilst the operating cost of each solar mini-grid plant was around \$6400 per year (World Bank, 2018). This was funded under the Ghana Energy Development and Access Project (SNV, 2021). With a combined capacity of roughly 200kW, these solar projects were anticipated to supply about 3,500 people in the Sene East, Krachi West, Krachi East and Ada Districts who live in the five island settlements of Kudorkope, Aglakope, Atigagome, Wayokope, and Pediatorkope with energy at all times (SNV, 2021).

The case selection was influenced by the project's uniqueness as being the first solar mini-grid project for island communities. Out of the five island communities, three of them were used as case study areas. The three communities were Kudorkope, Wayokope and Atigagome. These island communities were chosen based on their strategic locations: Kudorkope is in the northern belt, Atigagome and Wayokope are further south which provide a fair representation of the five communities. In addition, the three communities share socio-cultural, economic and geographical features with the other two communities, namely Aglakope and Pediatorkope. Kudorkope is found in the Krachi East District in the

Oti Region. Wayokope and Atigagome are found in the Sene East District in the Bono East Region as shown in Figure 1.1

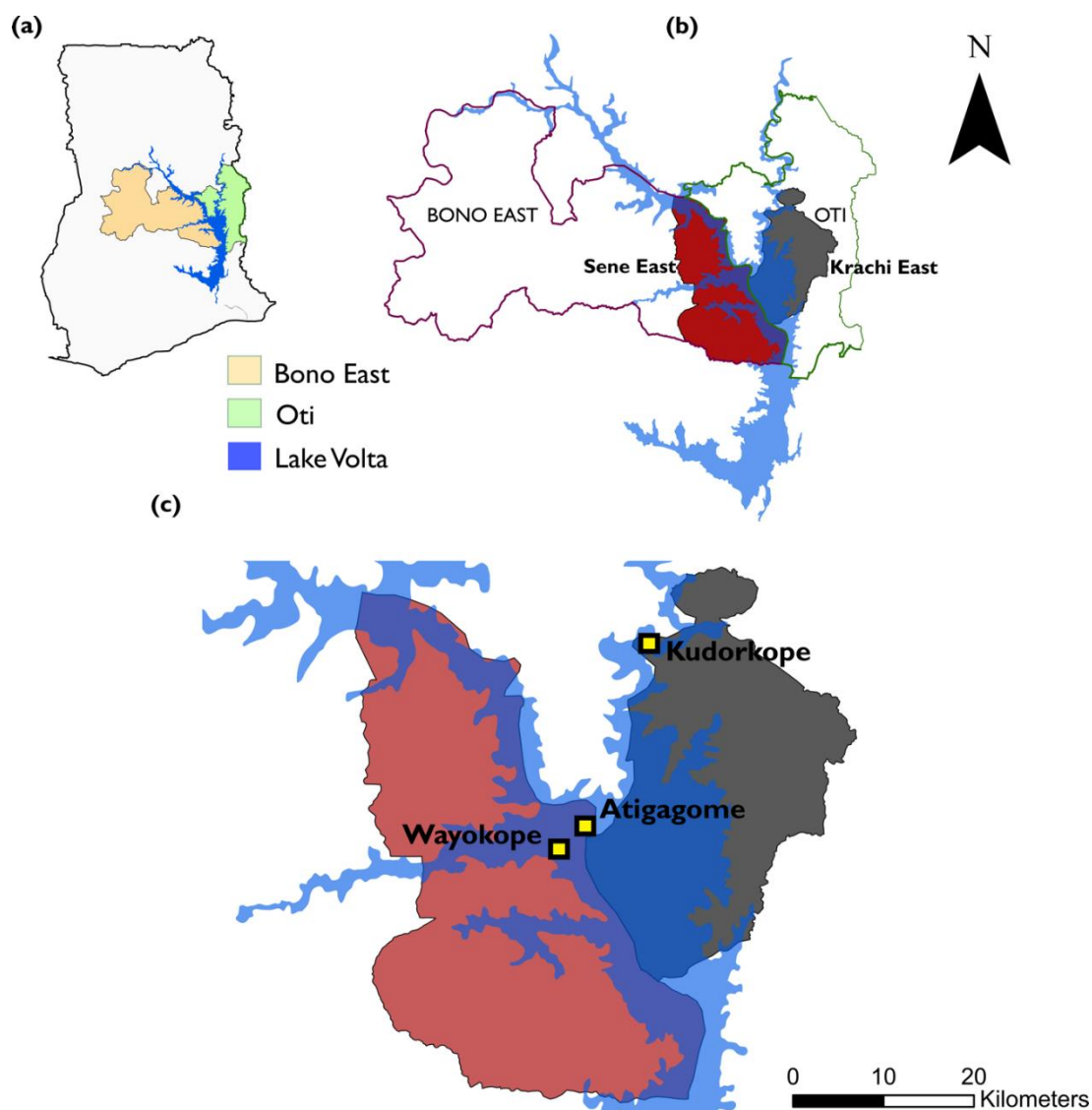


Figure 1.1 Case Study Areas (Source: Author)

Technical Specification of Solar Mini-grids

The standalone mini-grid systems in the rural island communities use solar panels to power a 48 V battery bank via a charge controller (Adu Poku et al., 2023; Bukari et al., 2022). This energy is converted to alternating current using an inverter and distributed to the community as a three-phase power supply. Each system features a diesel generator as a backup power source that may deliver electricity directly to the towns (Adu Poku et al., 2023). Table 1.1 summarises the technical specifications for all systems.

Table 1.1. Mini-grid power generation capacities (Source: Adu Poku et al., 2023)

Community	PV capacity (kW)	Genset (kVA)	Battery (Ah)
Wayokope	31	20	2124
Atigagome	41	20	2124
Kudorkope	54	33	4248

Note: kW= Kilowatts, kVA = kilo-volt-amperes¹, Ah = Ampere hours²

A take-and-pay end-user pricing model is adopted by beneficiaries, whereby they pay a set monthly amount determined by the type of power they use, which can be either residential or non-residential (Bukari et al., 2022; Nuru et al., 2021b). As per the tiered subscription model, users are allotted a daily energy budget known as the Estimated Daily Allowance (EDA). If this amount is exceeded, the smart meters promptly cut off the power supply till the next day (Adu Poku et al., 2023; Hellmuth et al., 2019). When the system produces excess power, which is signalled by smart meters, residents can use free additional electricity (Adu-Poku et al., 2023; Hellmuth et al., 2019). The tariff range for the mini-grid business model is displayed in Table 1.2.

Table 1.2. Tariff band, power consumption and price allocation (Source: Hellmuth et al., 2019)

Tariff Band	EDA (Wh/Day)	Power (W)	Monthly Expenditure (GHS)	Mini-grid unit cost (GHS/kWh)	National grid unit cost (GHS/kWh)
<i>Residential</i>					
T0.1-R	275	500	4.30	0.52	1.08
T1.1-R	550	500	7.00	0.42	0.95
T2.1-R	1100	500	12.40	0.38	1.91
T3.1-R	1650	1000	17.80	0.36	1.73
T4.2-R	2200	1000	33.70	0.51	1.64
T5.3-R	2750	1500	44.70	0.54	1.58
<i>Non-residential</i>					
T2.1-R	1100	500			
T3.1-R	1650	1000			
T4.2-R	2200	1500			
Street lighting	5 h/day	34			

Note: Wh/Day =Watt per hour in a day, GHS= Ghanaian currency, kWh = Kilowatt per hour

Methods of Data Collection

A qualitative research method was adopted because of the need for an intensive conversation to gather detailed data to examine the outcomes in terms of the energy justice concept. Examining energy systems through the lens of the energy justice concept

requires careful analysis to assure the validity and methodological rigour of the themes and conclusions that emerge (Jenkins et al., 2021; Velasco-Herrejon & Bauwens, 2020), hence the choice of qualitative approach. To better understand the experiences and social realities of individuals and groups, qualitative research enables in-depth interviews with respondents in addition to observation (Liamputtong, 2020). In addition to assisting in the exploration or description of the data in a real-life setting, the comprehensive qualitative approach generated by case studies also aids in the explanation of the intricacies of real-life circumstances that may not be captured by survey or experimental research (Creswell, 2007).

It is worth noting that a rigorous qualitative methodological approach requires triangulation to increase research reliability and validity (Bans-Akutey & Tiimub, 2021; Lincoln & Guba, 1985; Johnson & Onwuegbuzie, 2004). Triangulation employs many ways in the research to extract the necessary information while critically assessing findings (Casey & Murphy, 2009), thereby establishing validity and reliability (Bans-Akutey & Tiimub, 2021). It is recommended that a research strategy consider the triangulation of two or more methods (Liamputtong, 2019; Lincoln & Guba, 1985). In this regard, the study used two data collection methods in qualitative research. In-depth interviews were the main methodology the research relied on. Additionally, data was collected from a range of secondary sources, including reports and academic journals. In-depth interviews were appropriate for the research to enable the understanding of the lived experiences and perspectives of local stakeholders of the solar mini-grids in Ghana (community members) and the perspectives of top-level stakeholders in the renewable energy sector in Ghana and Africa. Secondary data also provided a comprehensive overview of the field of the renewable energy sector which had been documented in reports and academic journals. This helped to establish validity and reliability.

Fieldwork

The fieldwork was embarked on for a duration of three months in the three selected island communities along the Volta Lake, namely Kudorkope, Atigagome and Wayokope. A month was spent on each island. In-depth interviews were conducted across three island communities using the same semi-structured interview questions. Transcription was done manually and verbatim from data from the field. The reason for manual transcription was that a first-hand translation was done in the field. This was possible with the help of a translator as the predominant local dialect of the rural indigenes was not English and the researcher couldn't speak the local dialect. This means the audio recording had two languages and as such, transcribing the interviews manually was the easiest approach. For validation purposes, the translated responses in English recorded in the field were translated back to the participants by the translator after the interview session for them to confirm as a true representation of what had been recorded. The popularity of respondent validation has been attributed to Lincoln & Guba (1985). The authors described respondent

validation (also known as member checking) as “the most critical strategy for building credibility” and checking data and findings with participants (Lincoln & Guba, 1985, p.314). Pyett (2003) confirms that good qualitative researchers understand that there is no avoidance of the tiresome process of returning to the data to check whether they are accurate after collecting them.

10 people were interviewed in Kudorkope, 9 in Atigagome and 9 in Wayokope. In total, 28 people across the three island communities were interviewed. The participants in the community comprised Opinion Leaders and Heads of Households (both men and women). The number of participants was determined as a result of saturation. The saturation point is reached when sufficient data have been gathered to allow for research replication (Saunders et al., 2018; Walker, 2012).

Renewable Experts Interviews

In-depth semi-structured interviews were conducted with top-level stakeholders within the renewable energy sector. The interviews were conducted for six months via MS Teams audio calls and recordings were done concurrently using MS Teams with their permission for transcription purposes. A follow-up session was conducted mainly to clarify the transcripts. This helped the respondents to validate the interview transcripts with the researcher which is a critical component of rigorous research as explained in the fieldwork session above. The participants were recruited from international, national and regional levels in the renewable energy sector. These interviews included some representatives from international organisations, government national organisations, district national organisations, academics/ consultants, civil society organisations and developers of the solar mini-grid, as shown in Table 1.3. Interviewing these divergent stakeholders represents a fair representation of views and experiences which is very important in the qualitative data approach for analysing the data thematically (Miles et al., 2014). The total number of interviewees was 24 which was also determined due to saturation as explained above.

Table 1.3 Representation of Interviewees within the Renewable Energy Sector

Organisation Type	Number of Interviewees	Representation in analysis
International Organisation	5	INT (1), INT (2), INT (3), INT (4), INT (5)
National Government Organisation	4	NGO (1), NGO (2), NGO (3), NGO (4)
District Government Organisation	3	DGO (1), DGO (2), DGO (3)
Civil Society Organisation	3	CSO (1), CSO (2), CSO (3)
Project Manager of solar mini-grid project	3	PM (1), PM (2), PM (3)
Developer of solar mini-grid	2	DP (1), DP (2)
Academic	4	AC (1), AC (2), AC (3), AC (4)

In total, there were 28 interviews from the field and 24 interviews from renewable energy experts which constituted 52 interviews.

Data Analysis

The study's research design followed a retroduction approach through thematic analysis and coding to aid in the research findings. NVivo software was used to aid in the analysis of the data gathered. The data from the field was analysed across the three cases known as a cross-case analysis by Miles et al (2014). The three cases are the three communities known as Kudorkope, Atigagome and Wayokope. Cross-case analysis has the benefit of improving generalisability which reassures the researcher that the processes and events in a single well-described situation are not entirely peculiar (Miles et al., 2014). The analysis stage was carried out using Braun & Clarke's (2021) qualitative analysis approach which adopted a six-phase process in the thematic analysis. These were familiarisation with the data, generating initial codes, initial themes, defining and naming themes and producing the report.

Ethical Consideration

It is extremely important to observe all the research ethical principles before embarking on empirical data collection. Acknowledging research ethics protects the researchers and participants, aids in minimising the risk of harm, increases the sum of good, assures trust and ensures integrity (Israel & Hay, 2006). To ensure conformity with these ethical norms, research must be approved by an Ethics Committee which ensures that the research is properly designed and that no participants, researchers, or institutions/organisations are injured or affected (Bryman, 2015). In this regard, this study was approved by the relevant Ethics Boards at the researcher's institution. This approval confirmed that the research project examined all ethical issues at all stages. Both the information sheet and consent form were distributed to all participants during the project's recruitment phase. The participant information sheet thoroughly explained the research to participants in the field and top-level stakeholders via email. For confidentiality, participants' names and addresses were not collected.

Results and Discussion

Five major themes were generated from the analysis concerning the three core tenets of the energy justice framework as presented in Table 1.4.

Table 1.4. Themes based on the three tenets of the Energy Justice framework

Themes	Energy Justice Concept
Access to Information	Procedural
Consultation and Decision-making process	Procedural
Electricity Usage and Sufficiency	Distributional

Overall outcomes	Distributional
Recognising Marginalised Group	Recognition

Procedural [in] justices

Analysis of Access to Information

Four key components comprise procedural justice: (1) information accessibility; (2) meaningful participation in decision-making; (3) decision-makers' impartiality; and (4) access to legal processes for seeking remedy (Sovacool & Dworkin, 2014; Walker, 2012). Gross (2007) confirms that the most crucial aspect of achieving a just procedural process is access to information. In this research, questions were asked about the medium of how the information was shared, the specific information shared and its correlation to the implementation of the community energy project witnessed to assess the quality of information.

With the interviews in the three communities, most of the respondents confirmed that representatives from the project management team of the mini-grids were sent by the project developer to the island communities to survey the various households. The team asked the community members about their previous energy source, informed them about the solar mini-grid implementation and further asked about their energy usage after being connected to the solar mini-grid. This confirmed that community members were informed of the implementation of the solar mini-grid, but the capacity, functionalities and technicalities of the solar mini-grid were not made privy to them. McCauley et al (2013) confirm that procedural justice should provide the mechanisms to provide full information disclosure by the government and industry. The level of trust between the community members and stakeholders in project advancement is essential (Ishola et al., 2024), primarily if information is managed accurately and transparently at every level of the project (González et al., 2016). Some Interviewees within the renewable energy sector also confirmed these assertions. Project developers must not hide any information regarding any decentralised energy project (INT (3), NGO (2), NGO (4), AC (2), AC (4)). How the energy system operates, its functionalities and maintenance are important for effective cooperation and sustainability of the project (INT (3), NGO (3), AC (2), AC (4), CSO (1), CSO (3)).

The analysis shows how important it is for project developers to be transparent in relaying information to their energy beneficiaries. When the trust is broken, the beneficiaries would be discontented and conflict can arise between them and the project developers, which can ultimately affect the implementation of the project.

Consultation and Decision-Making Process

The processes of procedural justice should be encouraged by all communities in energy decision-making processes (Jenkins et al., 2014). Perceptions of fairness during a public

involvement procedure run by a natural resource agency were investigated by Van Der Schoor et al (2016). They discovered that justice principles such as representation, voice, consideration, logic and desired outcomes were used by people to assess fairness. According to Sovacool & Dworkin (2015), procedural justice pertains to the processes of decision-making, including who is involved, how those decisions are contested and the impartiality of those processes. Meetings must be open to the public, decision-makers must acknowledge the valid contributions of local citizens and public input must have some influence on final choices for these processes to be deemed just (Liu et al., 2019). It has been suggested that increasing perceived procedural fairness can be achieved by public participation in decision-making (Gross, 2007; McComas et al., 2008).

The rural islanders in all three communities felt they were not allowed to express their concerns as some views were incorporated into the implementation process, but not all and they felt they were not represented. Those that were incorporated were mainly about their views and consent on the location for the solar mini-grids implementation. This constitutes unfairness in the consultation and decision-making process. In Kudorkope village, some of the opinion leaders interviewed had a strong resentment. They did not feel represented as they wanted to be connected to the grid power, but got a solar mini-grid instead. They argued their community is an island community, but there is an access route via land to the community. The question that emerged was "*why were they not connected to grid power but connected to the solar mini-grid*". The answer was because the MP told them that the grid power would delay and the mini-grid was the fastest way to connect to electricity. The same question was asked of the District Government Organisation interviewees within the community. They answered that solar mini-grids are the best option for them, and they don't think they should be connected to the national grid (DSO (1), DSO (2)). They further said they provide the same capacity and can equally use their domestic gadgets as compared to people connected to the national grid (DSO (1), DSO (2)).

This is evident that the local authorities were not transparent to the community members in disclosing the information with regards to the main reason why they chose this energy source for them. Business and Human Rights Resource Centre (2016) asserted that there has been much reporting on the lack of formal consultation processes and informed consent has resulted in several procedural inequities and local opposition. It is important to note that procedural justice is essential to building trust because it promotes involvement, cooperation, and the supply of sufficient information, all of which lead to the growth of reliable relationships (Hazrati, 2023). The concerns raised and words of discontentment from the opinion leaders in Kudorkope confirmed how unfair they felt in terms of their voices not being acknowledged. Individuals are more likely to believe that decisions are made in a fair, transparent and open manner when they have greater involvement in the process (Siegrist & Keller, 2012; Walker & Baxter, 2017). Conversely, public acceptance of energy initiatives is positively correlated with perceived procedural fairness (Siegrist & Keller, 2012; Walker & Baxter, 2017).

Distributional [in] justices

Electricity usage and sufficiency

In the previous section under the procedural [in] justice, most of the respondents stressed on the fact that they informed the project team of their energy needs when they inquired of them. Distributional fairness is concerned with not only infrastructure siting but also access to energy services (Jenkins et al., 2016). In this context, energy justice is concerned with both physical access to heating and electricity, as well as the scope of an individual's liberties (Jenkins et al., 2016). The concept of sufficiency is critical in determining energy justice. According to Israr et al (2017), everyone has the right to the amount of energy needed to achieve a minimum level of well-being. This is concerning allocating resources so that each person has enough energy to live a decent life. Energy sufficiency is defined by Barnes et al (2011) as the moment at which individuals utilise the absolute least amount of energy required to maintain life. The availability of electrical equipment and a sufficient supply of energy have a significant impact on people's quality of life (Jones, 2021).

In this section, the research seeks to find out about the specific energy needs of the community members that were relayed to the project team and to find out whether their energy needs have been met or not after the implementation of the solar mini-grids. In general, most of their basic energy needs for their daily activities mostly were to power their lighting bulbs, charge their phones and televisions. This corroborates with findings from Nuru et al (2021a), which was also done in the Oti Region along the Volta Lake namely Atigagome, Kudorkope and Pediatorkope among the 5-pilot communities with the solar mini-grids. The findings top three most used electrical appliances with the solar mini-grids are electrical bulbs, phones and televisions. In terms of whether their needs were met or not, the Kudorkope community was not pleased with the erratic power supply and they felt their usage was not maximised enough. Atigaome village people had the same response. This response corroborated with research findings by Nyarko et al (2023) and Bukari (2021) on the island communities, confirming rural indigenes complained about fluctuations in the power supply. On the other hand, in Wayokope, the rural indigenes were satisfied with the power supply.

Overall Outcomes

Distributional justice is not only concerned with access and consumption (Walker & Day, 2012; Day et al., 2016) but also concerned with the outcomes of decision-making (i.e., the costs and benefits); notably, their distribution, the allocation of responsibilities and potential risks (Jafino et al., 2021). The distributional justice concerns a range of economic benefits (creation of jobs), social benefits (education) and energy benefits (access to energy) (Yenneti & Day, 2016). Solar mini-grids enable locally accessible resources that have some economic, health and social co-benefits (Duran & Sahinyazan, 2021; Nuru et al., 2021b). The outcomes achieved after an intervention such as the implementation of the

solar mini-grids are very important to the community and local stakeholders. The situation before the intervention can be compared to the aftermath of the intervention of which the results can serve as a baseline for further implementation. In all three communities, there were both positive and negative outcomes after the intervention.

Regarding the positive outcomes, there were environmental, educational, health and security benefits. With regards to environmental and health benefits, the rural islanders acknowledged that there was less pollution as they were not using polluting fuels to power their lanterns. Solar mini-grids reduced the reliance on fossil fuels, which is safe for the environment and the communities (AC (2), INT (4), INT (5), NGO (3)). Educationally, parents interviewed in the island communities expressed their joy with the success rate of their children's results, as they were able to study at night without disruption from polluting fuels. An interesting finding in the field from the rural island communities in terms of security was the reduction in snake and scorpion attacks due to the street lighting system powered from the solar mini-grids. Some renewable energy experts interviewed confirmed the same findings and acknowledged that they witnessed the sense of relief of rural islanders after solar mini-grid implementation, as they are able to see clearly at night without any attacks (IN (2), INT (3), CSO (1), CSO (2)).

Concerning the negative outcomes, the irregular power supply resulted in the majority of economic activities in the rural island communities becoming slow, thus affecting their livelihood. Negative impacts arising from the inadequacy of rural energy projects in Africa hinder the goal of achieving sustainable development (Falk et al., 2021; Pueyo & DeMartino, 2018).

Recognition [In] Justices

Recognition justice is based on concepts such as cultural domination and disregard for people and their concerns, which focuses on the use of stereotyping and derogatory words (Jenkins et al., 2016; Tarekegne, 2020). Recognising energy justice aims to address the root causes of inequality and deprivation (Jones, 2021). Research findings revealed that distributional justice proves to be the most visible tenet and recognition justice the least observable (Calver & Simcock, 2021; Hurlbert & Rayner, 2018; Tarasova, 2024; Velasco-Herrejon & Bauwens, 2020). A few studies have examined how environmental change is linked to concerns of class, race, gender, sexuality and nationality (Reames, 2016; Monyei et al., 2018). The questions of "whose knowledge counts" in determining needs and objectives, as well as who gains and loses in energy systems are crucial in understanding the dynamics of exclusion and devaluation that occur through epistemic practices (Pandey & Sharma, 2021). The call for recognition-based justice in energy systems becomes a means of recognising the vulnerabilities generated by the devaluation, disrespect and misrepresentation of the origins and viewpoints of marginalised people (Thomas et al., 2020).

In all three communities, evidence from the interviews suggests that there were no significant differences in responses among the various categories of interviewees. This concludes that the community members, regardless of their gender or position in the community were treated in the same manner by the authorities as they were all being marginalised. An example was when the opinion leaders in Kudorkope contended with the government about not wanting to be connected to the solar mini-grid but preferred to be connected to the national grid, as they felt the mini-grid was inferior to the national grid as stated earlier in the procedural [in] justice section. Follow-up questions were asked in the interviews to explore issues of importance asking, *"Of all the things we discussed, which one is the most important to you?"* and *"Is there anything you would like to talk about the solar mini-grid?"* Most respondents reiterated the answers they had mentioned earlier about their discontent with the functioning of the solar mini-grids. This shows clearly how their expectations have not been met and how they feel disregarded in that sense. Monyei et al (2016) confirmed that increasing rural marginalisation in Sub-Saharan Africa has coincided with an increase in energy-poor dwellings in rural off-grid communities. According to Jones (2021), social justice has a long history of ignoring marginalised communities which have been overlooked in industrial, urbanisation and environmental policies and procedures.

Conclusion

The study contributed to the literature by examining the decentralised solar mini-grid electrification and its community beneficiaries in the selected rural island communities in Ghana in the light of the energy justice framework. In the context of this research, procedural justice refers to the participation of community members in the consultation and decision-making process for implementing solar mini-grids. On the field, the rural islanders expressed their disappointment due to lack of representation in the consultation and decision-making process which has led to procedural injustice. The distributional justice ensures electricity access, sufficient use of electricity and related outcomes. Most respondents confirmed the insufficiency in the electric usage due to erratic power supply. With regards to the outcomes, there were both positive and negative outcomes. These resulted in an issue of distributional justice. Lastly, recognition justice involves the acknowledgement of the views of diverse members in communities without discrimination. The communities felt they were not acknowledged and their views did not matter to the authority which has led to recognition injustice. The study concluded that the implementation of solar mini-grids in the rural island communities in Ghana had energy justice concerns. It is worth noting that recognition justice is a minor element in the empirical data from the research sites. The reason is that issues of procedural justice and distributional justice lead to issues of recognition justice. This has been confirmed by these three authors (Walker, 2012), Hurlbert & Rayner (2018) and Velasco-Herrejon & Bauwens (2020). The authors asserted that the three tenets of energy justice are not only interrelated

but also nested into one another: distributional justice is underpinned by procedural justice, while these two are intertwined within issues associated with recognition justice. This confirms that energy justice cannot be achieved unless all three tenets have been satisfied.

Recommendations

Energy justice in the Global South tackles the underlying disparities that underpin energy poverty and social injustice and actively seeks to remove these barriers. By prioritising the needs of vulnerable populations in Ghana and ensuring a fair distribution of the costs and benefits of energy transition efforts, there would be mitigation of the disproportionate impacts of climate change on rural communities. Community participation should be inclusive regardless of gender or cultural background. Before the implementation of decentralised renewable energy projects, communities need to be included in the decision-making and consultation process. This means that the information must be clear and disseminated properly. Without this, communities cannot meaningfully participate. Some of the decisions they can be involved in include tariff setting, maintenance schedules and expansion plans. In addition, developers and the project team must train and educate community members on how the solar mini-grids work. This is very important to conserve energy, which would eventually enhance the sustainability of the solar mini-grid plant.

Recommendation for Future Research

The study was conducted in a single national context, limiting comparative insights across other Global South countries. In light of this, comparative research across other countries in the Global South would assist in identifying best practices and scalable solutions for promoting energy justice and lowering rural-urban energy inequities.

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