Energy Research & Social Science 121 (2025) 103938

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Connecting power to people: Integrating community renewable energy and multi-level governance towards low-carbon energy transition in Nigeria

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ARTICLE INFO

Keywords:
Community renewable energy
Energy policy
Energy transitions
Multi-level governance
Sub-Saharan Africa
Sustainable development

ABSTRACT

Despite extensive investments and deregulation efforts, the issue of carbon lock-in persists in the Nigerian context and across much of sub-Saharan Africa (SSA). Recognising the value of citizen involvement in shaping energy transformation, this research advocates for the adoption of community renewable energy (CRE) in Nigeria. Drawing inspiration from paradigmatic CRE models in Germany and Denmark, the study explores the evolving landscape of low-carbon energy transitions in developing economies through the Nigerian case. Currently, Nigeria's low-carbon transition remains constrained by inadequate policies and top-down energy strategies, motivating the need for a more inclusive and decentralised approach. To address these challenges, this paper proposes a policy framework grounded in multi-level governance (MLG) theory. The conceptual framework delineates the roles and responsibilities of federal, state, and local governments, highlighting the scope for introducing renewable energy desk officers at the local level. Crucially, this research contributes to the limited body of CRE literature within Nigeria and similar sub-Saharan African contexts. The output provides concrete recommendations for renewable energy policy development in SSA nations with diverse political landscapes, in addition to supporting the future research agenda on CRE. Accordingly, the proposition of community renewable multi-level governance (CRE-MLG) reflects the rationale that citizen-centric energy practices can strengthen sustainability pathways in challenging contexts such as Nigeria. In contributing towards the burgeoning literature on energy transitions, this study advocates for an integrated governance approach and the bottom-up adoption of CRE practices to help drive sustainable development.[1]

1. Introduction

As Nigeria's energy demand continues to grow, integrating national renewable energy (RE) objectives with local energy planning presents an increasingly critical opportunity for overcoming fossil fuel lock-in [1,2]. Diversifying the electricity mix and improving energy efficiency, while accounting to citizens' opinions and preferences is crucial for supporting sustainable development in Nigeria [1,2]. Despite decades of significant investment and financial support, including a €165 million grant from the European Union (EU) for RE projects [3] and over $1 billion in funding from other sources [4,5], Nigeria's peak energy capacity remained limited to around 5000 MW in 2021 [6–8]. Faced with this shortfall, there is a growing imperative to seek alternative and innovative solutions [9], which can help bridge the gap for meeting a power requirement of at least 33,000 MW [10]. In view of this deficit and historical failures [11], off-grid RE led by individuals and private entities holds significant potential for accelerating electrification in Nigeria.

In the context of sub-Saharan Africa (SSA), one factor contributing to the lack of recognition of individuals in as financial players is poverty and low savings rates [9]. Nevertheless, Dalberg [12], a nonprofit research organization, argues that energy insecurity in Nigeria led citizens to spend ~$12 billion annually on hydrocarbon-powered portable generators, as further corroborated by Bloomberg [13]. Besides harming public health, reliance on these generators exacerbates global greenhouse gas (GHG) emissions. Nigeria has at least 22 million and up to 60 million such generators [14], which is eight times the capacity of the national grid. Given the substantial level of spending on generators and

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[1] CRE, Community renewable energy; CRE-MLG, Community renewable energy multi-level governance; DRE, Decentralised renewable energy; EU, European Union; FiT, Feed-in Tariff; FG, Federal Government; GHG, greenhouse gas; FG, Federal Government; LG, Local Government; MLG; Multi-level governance; OECD, Organization for Economic Cooperation and Development; RE, Renewable energy; REDOs, Renewable energy desk officers; RESs, Renewable energy sources; SG, State Government; SSA, sub-Saharan Africa.

https://doi.org/10.1016/j.erss.2025.103938
Received 22 October 2023; Received in revised form 14 January 2025; Accepted 17 January 2025
Available online 29 January 2025

inadequate supply of power [15], market dynamics in Nigeria may enable a tangible shift to a cleaner energy system through low-carbon substitutions [16].

Despite significant investments and efforts to deregulate Nigeria's energy sector, the country remains trapped in a state of carbon lock-in. To address this challenge, the adoption of community renewable energy (CRE) offers an alternative strategy to strengthen decarbonisation prospects. Notably, a recent study by Delina [17] confirms the increasing importance of citizen engagement in energy transformation, emphasizing citizens as the *sine qua non* of ensuring energy availability. At its core, CRE is a decentralised, non-governmental approach involving the voluntary commitments of communities, citizens, and residents to promote the generation and utilization of renewable energy sources (RESs) and technologies [18].

As reviewed in Section 4, Germany and Denmark provide exemplars of countries where CRE is thriving, and insights can be drawn. In 2012, ~47-50 % of decentralised RE capacity installed in Germany belonged to citizens and communities [19]. Similarly, the Danish energy transition is a widely studied example of a successful shift from fossil fuels to RE with strong community participation, serving as a paradigmatic model for bourgeoning CRE initiatives globally [20]. Both Germany and Denmark attribute the growth of CRE to successful policies implemented since the 1990s, aimed at promoting and engaging citizens in decision-making and RE system management [21].

Although the financial stability of citizens typically reflects a critical success factor of CRE, Menyeh [9] argues that current spending on hydrocarbon-powered generators could provide sufficient capacity for replicating the success of European countries in SSA. Despite the apparent potential for consumers to adopt low-carbon technologies, inadequate policies impede the feasibility of this pathway in Nigeria [22]. To date, energy policies and implementation strategies have adopted a top-down, heavily centralised approach, which has resulted in structural gaps in the roles of mid-level governments and local governments actors.

In response, this study aims to develop a policy framework for supporting the adoption of CRE in Nigeria through a multi-level governance (MLG) approach. To support this aim, the initial research objective involves identifying critical patterns and gaps in the literature by analyzing how CRE scholars have engaged with social, economic, and environmental components underlying the sustainability triangle. The second research objective focuses on drawing insights from CRE-related developments in Germany and Denmark to better understand opportunities for replicating success in Nigeria. Recognizing the context-specific nature of CRE and need for adaptive mechanisms, the final research objective centres on explicating the value proposition of community renewable energy multi-level governance (CRE-MLG) by identifying and delineating the potential roles and responsibilities of state and non-state actors in Nigeria. Leveraging insights from the Nigerian case, the proposed framework supports the wider goal of sustainable development by promoting active citizen participation and community empowerment towards realizing a low-carbon energy future.

Following this introduction, Section 2 provides an overview of multi-level governance to contextualize the tenets of this analysis. Next, Section 3 reports the research methodology, which is followed by a review of CRE-related literature in Section 4. Section 5 introduces the Nigerian case study, while Section 6 expands the theoretical lens by distinguishing between two types of MLG. Section 7 visualizes the proposed framework and discusses the value proposition of CRE-MLG. Finally, Section 8 concludes by outlining implications for policy makers and future research opportunities.

2. Multi-level governance

Governance encompasses the multifaceted processes of formulating, implementing, and legitimizing public policies [23]. It involves cooperation between public and private institutions to guide and manage society, organizations, and networks [24]. Initially, "governance" typically denoted the complicated and uncertain conditions that constitute governing [25]. Governance entails achieving consensus, obtaining permission, or ensuring compliance to implement policies, projects, or strategies in arenas with diverse interests, distinguishing it from a top-down, government approach [24,26]. In this context, low-carbon governance involves a multi-level process involving state actors, non-state actors from various industries, and local community stakeholders.

2.1. Theoretical background to multi-level governance

Multi-level governance (MLG), introduced by Gary Marks in 1993 [27], seeks to decentralize and liberalize governance and authority. Marks [28] initially defined MLG as an ongoing negotiation system among governments at various geographical levels, including supranational, national, regional, and local tiers, shaped by institutional developments and decision-making reallocation. In recent years, MLG has gained importance in reshaping energy governance [24,29,30]. To achieve RE targets effectively, climate and energy governance should engage all governance levels, from national to municipal [29].

Given the pivotal role of finance in driving CRE implementation, collaboration between private and public sector actors is crucial. While citizens can pool resources for CRE efforts, deliberate state-led strategies for incentivising CRE could significantly accelerate RE penetration rates in SSA. Thus, MLG involves interconnected governance processes with state (public) and non-state (private) actors, adapting to context-specific modes of engagement and collaboration [31]. Another governance perspective emphasizes coordination and alignment towards a shared purpose and meaning, involving public and private actors and resources [32]. This view suggests that communities, central to CRE initiatives, form integral components of the governance structure beyond the formal institutional levels [28].

Initially, scholars applied MLG to European and global politics to describe federalist organizations with power dispersed among levels and institutions [33]. These systems coordinate policies across various government levels through consensus-building, compromise, competitive pressure, or hierarchical control [34,35]. However, as the global economy continues to evolve, mechanisms for developing, implementing, and monitoring public policies have become more complex, leading to different definitions of MLG [36].

According to Stilwell and Troy [37], MLG refers to challenges that arise when coordinating policies and plans across multiple levels of government and with other sectoral policies. Following Ringel (2017), challenges may include issues of authority, resources, and institutional constraints where tiers of government (top or bottom) must interact with various (state/non-state) actors to address public policy concerns. Previously, researchers described the European view of MLG as systems of continuous negotiation among nested governments at multiple territorial tiers [39,40]. Nonetheless, studies have also failed to fully consider that authorities are horizontally distributed across sectors and spheres of influence [37–39] [40], including non-state actors which form the core of the governance concept [41].

2.2. Alternative perspectives on multi-level governance

The concept of MLG serves as a mechanism to coordinate government efforts for more efficient policy implementation [42]. However, an alternative perspective on MLG [23] proposes viewing it as a policy-dimensional framework, which is adaptable to local contexts and beneficial to countries. This perspective focuses on hierarchical levels of governance and explores attributes beyond geographical and bureaucratic boundaries, offering valuable insights for the formulation and implementation of Nigeria's CRE policies. Within the context of a diverse nation like Nigeria, characterized by its demographic heterogeneity, MLG emerges as a potent instrument for facilitating participatory decision-making processes in low-energy transition plans

[21,23,40]. Such plans necessitate active engagement from both state and non-state actors, as well as residents, who articulate their interests, exercise their legal rights, and collectively address differences through collaborative methods [43].

MLG empowers regional and local governments with the autonomy to mobilise resources independently of central government intervention [32]. However, it is important to highlight that MLG serves as a framework for researching political processes across multiple levels of government and scales within countries, rather than being a specific method [32,44]. Understanding the increasing engagement of non-state actors in governance processes [24] is crucial for grasping how MLG emphasizes "negotiated" and "non-hierarchical" linkages and interdependence among institutions and actors across various geographical borders [45]. It follows that MLG is highly relevant to empirically comprehending the modern state and the evolving dynamics of governance [42].

3. Research methodology

In line with recent contributions to the energy transitions literature, this employs a *narrative* literature review [46–49], and undertakes country case studies to develop a conceptual framework for implementing CRE in Nigeria. Prior to reviewing CRE-based studies, mapping the Nigerian context, and elucidating insights on MLG [27], Section 2 frames the conceptual contribution by summarising the theoretical foundations of MLG and key developments associated with this line of thinking [23,36,37], as depicted in Fig. 1.

Following an initial scoping of the literature, which revealed a modest number of case studies on CRE, and in line with the aim to develop a conceptual framework, this study leverages insights from a multi-stage narrative literature review (see Section 4). Whereas a systematic literature review (SLR) [50] [51–55] is a rigorous and replicable research method for synthesizing insights from a large evidence base (e.g. following the guidelines of PRISMA[2]), a narrative approach is better aligned to supporting exploratory research and qualitative insights [56], and for purposes of developing a future research agenda [57].

While a narrative approach involves synthesizing evidence familiar to an author on a corresponding research area [56], this study incorporates a structured approach by implementing specific search criteria to support its objectives. However, as opposed to following an iterative process by adjusting search strings or rigorously cross-checking results from several databases [56], this study relied exclusively on strategic filtering methods vis-à-vis subject matter, citation ranking, and journal impact factor, alongside collective evaluation between the research team to identify pertinent results.

The initial search commenced in September 2022 as part of a wider research project which involved field work in Nigeria. Following parallel analyses of qualitative and quantitative data retrieved via interviews with CRE stakeholders and surveys with local communities, the literature search concluded in September 2023, thereby facilitating an iterative research process and enabling triangulation of results within the wider project.

The first step involved retrieving academic studies[3] by searching for 'community renewable energy' in Scopus and Google Scholar, which was supplemented via subsequent rounds of snowballing [58,59]. Saturation was reached once clear patterns between research engagement levels with the sustainability triangle (i.e. social, economic, and environmental pillars) could be observed and a range of research perspectives had been captured, which yielded a small to moderate sample ($N = 35$). This starting point helped demarcate various aspects of CRE such as terminologies and definitions, organizational structures, competing ideas, nuances and research perspectives.

The subsequent procedure focuses on a more targeted search with the following keywords support the first research objective: 'community renewable energy' AND 'Germany' OR 'German'; and 'community renewable energy' AND 'Denmark' OR 'Danish'. Both Germany and Denmark have played a pioneering role in advancing CRE, and each context has been well researched. This research stage served as an opportuning to extract critical lessons regarding the potential drivers and barriers shaping prospects for CRE in Nigeria. Saturation was reached once 15 academic papers had been retrieved on each country context, since this volume of literature proved adequate for representing the most active research groups or highly cited studies. The quality of the small sample was further validated by carrying out a supplementary check via snowballing, which demonstrated high levels of interconnectivity between the retrieved evidence base.

Following critical engagement with the European perspective, Section 5 unpacks the context-specific nuances underlying the Nigerian case, recognizing the imperative to consider the distinct characteristics, expectations, and specific needs of citizens and local communities in the design and implementation of CRE initiatives [60,61]. In shifting attention to the Nigerian energy landscape, this stage drew on a combination of peer-reviewed articles and materials from the grey literature to understand policy developments and barriers to implementing CRE. The final research stage involved expounding on the two types of multi-level governance (MLG) and citing examples from the German and Danish context to consolidate the conceptual framework, as reflected via the integrated research procedure illustrated Fig. 1.

4. Literature review on community renewable energy

A 'community' can take various definitions, such as a group of people living in a particular location during a specific period [62], or a social grouping of any size of individuals who reside near one another geographically, such as a neighborhood, municipality, district, or urban area, where members can interact face-to-face [63]. Notably, Walker [64] constructed a 6-point vocabulary for the concept of community: actor, scale, place, network, process, and identity. Accordingly, the term community encompasses a broader conceptualization than simply a physical location, relating to shared politics, culture, interests, and social connections [65].

Scholars also differentiate between "communities of interest" and "communities of locality" when discussing community in energy systems. "Community of interest" refers to a group of individuals who share a common objective but are not necessarily situated in the same geographic area while "communities of localities" pertain groups of people who share a common geographic location [66,67]. Furthermore, Walker & Devine-wright [66] offer a community model that includes the two essential elements of CRE, outcome and process dimensions. The former reaps the social and monetary rewards i.e., who is the project for. While the process dimension includes questions such as who creates the project and actively involved participants i.e., who manages the project [18,67].

However, there is a lack of consensus regarding the definition of CRE, which often hinders the development of an effective policy design and obscures the differences between different forms of citizen ownership [28,29,31–33]. Depending on the researcher or environment, CRE, is usually contextual in nature with blurred boundaries depending on the country [68]. Given its many variations and terminological ambiguity, clearly demarcating the characteristics of CRE remains a research task.

This review of the literature juxtaposes the following collection of associated synonyms under the umbrella term CRE: sustainable energy communities (SEC), renewable energy communities (REC), community-based energies (CBE), citizens' ownership, citizens' energy, low-carbon communities, and sustainable communities, energy communities, community renewable initiatives, community energy projects, community renewable energy projects (CREPs), renewable energy community

[2] Preferred Reporting Items for Systematic reviews and Meta-Analyses [192]

[3] Grey literature sources were excluded from the narrative literature review.

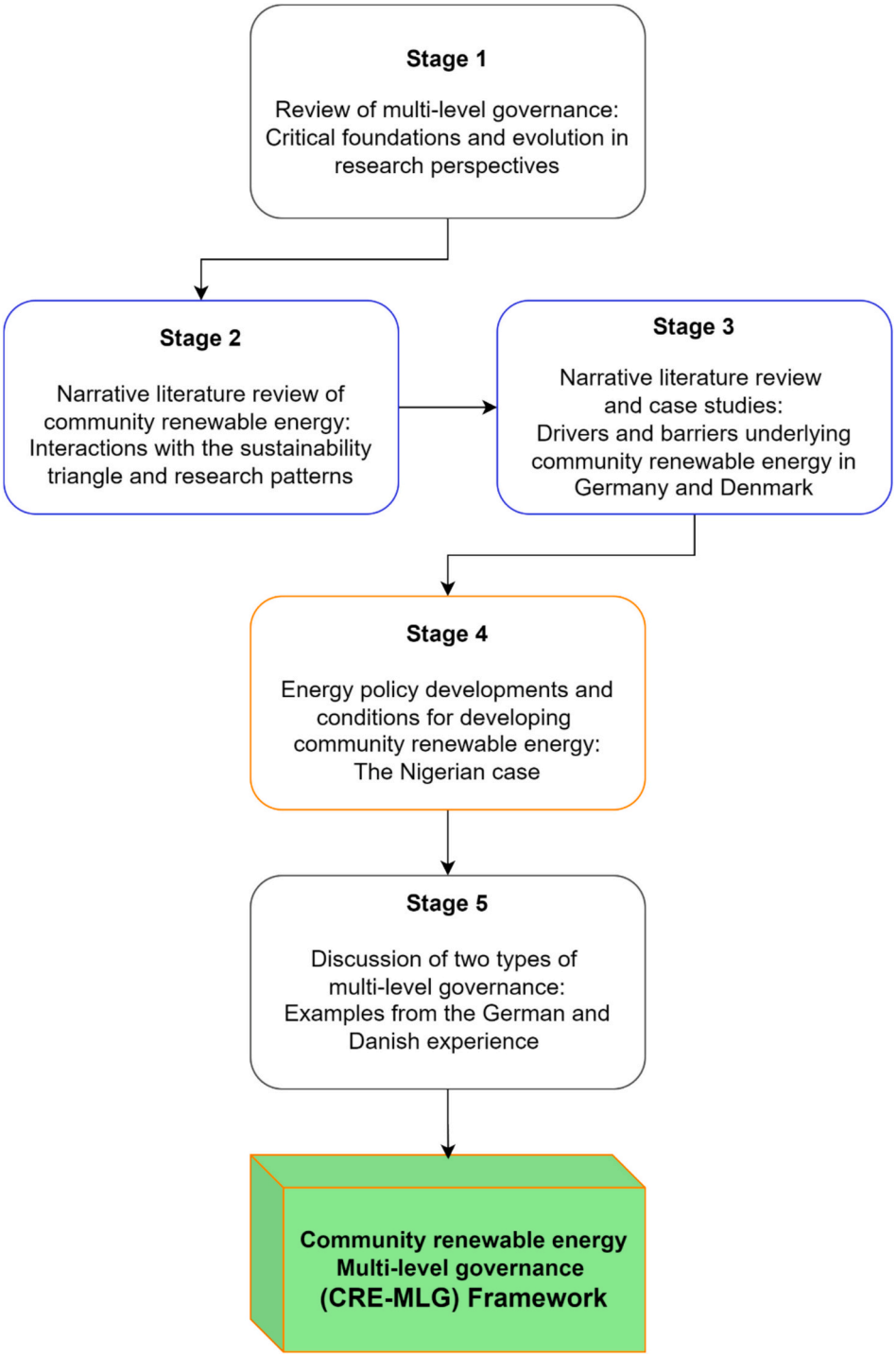

Fig. 1. Research procedure integrating narrative literature review and case studies.

(REC), energy cooperatives, local energy community and community energy [19,69–75]. Due to the lack of unanimity over CRE's definition, local context-specific approaches illustrate a range of CRE-related directions that may emerge [76]. For example, multiple studies undertaken in the UK [65,66,77] have documented business and legal models, motivations, objectives, actors and social connections in the field of CRE.

Existing definitions have a common feature, whereby CRE aims to redistribute benefits and decision-making authority to local communities through the collective administration of individuals to enhance their sense of ownership, involvement, and energy security. Three common threads that highlight the emerging interconnectedness of social, economic, and environmental variables within the realm of CRE. Specifically, the social dimension, which encompasses community participation and engagement, is a key and consistent aspect of all CRE definitions (see Table 1), whereas the environmental dimension stresses the mitigation of environmental impact, energy-efficient behaviors, and a reduction of carbon emissions. Additionally, the economic dimension of CRE focuses on the creation of financial gains, job opportunities, and the enhancement of community value.

According to Purvis et al. [78], these three characteristics form the cornerstone of sustainability. Most CRE scholars highlight at least two

Table 1
Scholarly engagement with CRE within the sustainability triangle.

Source(s)	Social	Environmental	Economic
Sovacool [80]	X	X	X
Walker et al. [64,66]	X	X	X
Martiskainen [81]	X	X	X
Rogers et al. [82]	X	–	X
Seyfan et al. [77]	X	X	X
Kalkbrenner et al. [72]	X	X	–
Hicks et al. [83]	X	–	X
Schoor et al. [84]	X	X	–
Greenius et al. [63]	X	–	X
Mey [85]	X	–	X
Romero-Rubio et al. [75]	X	X	X
Middlemiss et al. [73]	X	X	–
Oteman et al. [18]	X	–	X
Oteman et al. [21]	X	X	X
Chaichana et al. [86]	X	–	X
Süsser et al. [87]	X	–	X
Sciullo et al. [88,89]	X	X	–
Ebers Broughel et al. [89]	X	–	X
Marquardt [90]	X	X	–
Curran [91]	X	X	–
Dobravec et al. [29]	X	X	–
Delina [17]	X	–	X
Magnoni et al. [92]	X	–	X
Toke [93]	X	X	–
Yildiz [19]	X	–	X
Luangchosiri [94]	X	–	X
Menyeh [9]	X	–	X
Fernandez [95]	X	X	–
Becker et al. [96]	X	–	X
Lakshmi et al. [62]	X	–	X
Musall et al. [74]	X	–	X
Ringel [38]	X	X	X
Ohlhorst [97]	X	X	X
Salm et al. [98]	X	X	–
Mean frequency (%)	100	52.9	70.5

X denotes inclusion of CRE pillar.
– denotes exclusion of CRE pillar.

variables in the sustainability triangle as pillars in defining CRE [79], as illustrated in Table 1. As an emerging sustainable model, CRE is an opportunity for citizens of SSA to join other members of the global community in confronting the environmental and social consequences of climate change, while also combating energy poverty and creating economic opportunities.

Most of the literature and case studies on CRE apply a European lens [77,81,87,99–103], failing to consider the unique cultural and local factors that shape the development and execution of energy initiatives in non-Western countries. Consequently, studies with a citizen-centric focus [72,95,101,104] have failed to capture non-European perspectives of participatory processes in the energy transition. Additionally, researchers who have explored energy cooperatives [105,106] are yet to engage with case studies in the developing world. Arguably, Cloke et al.'s [107] paper provides the closest assessment of CRE in the context of developing economies in general, nonetheless, SSA was not the primary focus of their research. Although Lakshmi & Tilley [62] and Menyeh [9] discuss CRE and SSA, they prioritize a profit- version of decentralized renewable energy (DRE), as opposed to the pro-social CRE variant, although CRE is presented as a subtype of DRE [106].

The study of Ambole et al. [108] engages with the context of SSA, concluding that CRE can play a role in boosting energy access in Africa. However, the research lacks ideas for policy and governance frameworks that could facilitate their development and implementation [108]. Other scholars underline the potential of RESs for meeting Africa's energy demand but fail to propose policy frameworks required for their implementation. For example, Ibrahim et al. [109] and Ambole et al., [110] discuss the failure of policy execution in respect to (implementing) subsidies and tariffs. Boamah [111] present country-specific factors critical for DRE, whereas other studies [112–114] discuss mini and micro-grids markets as investment options, but none provide a clear solution relating to the governance framework for accomplishment. Despite Musonye et al.'s [115] recognition that prospective DRE solutions have effective implementation methodologies, their work did not elaborate on specific mechanisms. Additionally, Nkoana [116] acknowledge the need for a participatory governance framework, without providing details on how to create one.

Modern energy production is centralized, primarily fossil-fuel-based, and dispersed widely. By contrast, the philosophy of CRE is grounded in decentralized, community-owned, small-scale RE facilities [94]. Therefore, for a community to be sustainable, it requires fossil fuel-to-RE transitions [117]. CRE promises such transitions through social transformational potential, enabling a democratic environment and participative bottom-up CRE projects [118]. At present, most countries are still in the process of determining the feasibility and suitability of implementing CRE in their specific geographic and socio-economic contexts [20]. Nevertheless, three fundamental components characterize the meaning behind CRE: it is a type of DRE system; it adopts any RE source; and its focus is on collaborative (communal) effort and citizen participation.

4.1. *Ownership models and financing mechanisms*

4.1.1. *Ownership models for community renewable energy*

Ownership models are critical to the success and sustainability of CRE, especially in developing economies such as Nigeria, where local socioeconomic, cultural and institutional contexts must be accounted for. Key examples include the community-owned model, cooperative model, public-private partnerships (PPPs) and third-party ownership.

The **community-owned model** involves direct community ownership and management of RE projects. It empowers local stakeholders and ensures that benefits, such as profits and energy savings, are retained within the community. This structure fosters a sense of agency, social cohesion, and accountability, aligning with the principles of decentralization and inclusivity that underpin CRE initiatives [66,119].

Under a **cooperative model**, community members collectively own and operate renewable energy projects. Cooperatives have gained prominence in countries such as Germany and Denmark, where they have successfully scaled renewable energy transition by mobilising investments and building local trust [120,121]. By pooling resources and decision-making power, this model exemplifies grassroots participation and democratic governance.

PPPs represent collaborative efforts between government entities and private sector players, combining public oversight and funding with private sector efficiency, technical expertise, and financial resources. These partnerships help bridge resource gaps and are particularly effective in scaling projects in resource-constrained regions like Nigeria [99,122].

Third-party ownership sees external organisations own and operate CRE projects, while communities receive energy services. Although this minimizes financial risks for communities, it often limits their involvement in governance. Strong contractual agreements, however, can ensure equitable benefit-sharing and accountability [83,123].

4.1.2. *Financing mechanisms for community renewable energy*

Alongside ownership models, innovative financing mechanisms can help address the capital-intensive nature of CRE projects while ensuring long-term sustainability and inclusivity. Prominent mechanisms include crowdfunding, grants and subsidies, revolving funds, green bonds and international climate finance, and Pay-As-You-Go (PAYG) models.

Crowdfunding democratizes investment by enabling individuals to contribute small amounts to RE projects. In rural Nigeria, leveraging local thrift systems—prevalent community-based savings mechanisms—can enhance resource mobilization for CRE. This approach fosters grassroots engagement, expands participation, and builds a sense of local ownership [19,123].

Government grants and subsidies provide essential catalytic funding, particularly for initial capital requirements. These incentives lower financial barriers, helping communities overcome economic constraints and unlocking broader socioeconomic benefits, such as improved health and education outcomes [119,122]. Subsidies also reduce dependence on unsustainable fossil fuel alternatives.

Revolving funds offer a sustainable capital flow mechanism by providing low-interest loans for RE projects, with repayments reinvested into the fund to finance future projects. This self-sustaining financing model, often managed by community organisations or cooperatives, ensures financial accountability and promotes long-term viability [99,124,125].

Institutional mechanisms such as **green bonds and international climate finance** are increasingly relevant for CRE initiatives. Green bonds provide large-scale, long-term financing linked to environmental goals, while climate funds (e.g., the Green Climate Fund) offer grants or concessional loans to promote RE transitions. These tools not only address financing gaps but also align CRE projects with global climate targets [126,127].

Finally, **PAYG models** facilitate incremental payments for energy services, often via mobile platforms. In their seminal work, [128] refer to "Fee-for-Service" as an example of a PAYG model in the context of supporting solar systems for rural households in South Africa. Such schemes are particularly effective in underserved regions where communities face limited upfront capital capacity but can afford small, regular payments. PAYG models help expand inclusivity and affordability, enabling communities to access clean energy without significant financial strain [66].

4.2. Community renewable energy in Germany and Denmark

As CRE spreads geographically and contributes towards reducing energy consumption, community-driven RE efforts are expanding rapidly within Germany and Denmark, while the UK is another CRE frontrunner [18,75]. In other industrialized nations, new public engagement initiatives, like RE advocacy and awareness campaigns are informing citizens about their role in advancing energy transitions [17].

Germany and Denmark have successfully employed CRE to support their sustainable energy objectives [47]. Both nations serve as paradigms, with Germany being a model for RE-powered industrialization while Denmark is renowned for its decentralized CRE ownership model, which originated with wind energy cooperatives in the late 1970s [20,129,130]. Since the 1990s, both countries have promoted CRE operations through regulations and efforts to expand RE project ownership [21]. Notably, Germany has actively promoted RE since 1991, when it enacted a renewable power feed-in-law making its energy economy and public RE delivery structure highly interventionist [18,131].

This section aims to extract lessons and common factors from the German and Danish cases to help identify the tenets for establishing CRE-MLG in Nigeria. The CRE-MLG approach entails pioneering a domestic and pragmatic transition towards a low-carbon society which necessitates the active involvement and collaboration of citizens and local communities. Accordingly, by reviewing how each country implemented policies and supported incentives to promote CRE (see Table 2), researchers can support progress in the Nigerian context. While CRE has proved integral to Germany's and Denmark's RE strategy, as reflected via a range of studies within the academic literature (see Supplementary Note 1 and 2), a mix of drivers and barriers underlying the implementation of CRE are identifiable (see Table 3), which can support the learning curve in Nigeria.

4.2.1. Germany

Citizen engagement has been the driving factor behind the growth and spread of RE in Germany [106], as reflected in findings in the literature (See SN1). Most German CRE projects are cooperatives popularly known as *Energiegenossenschaften*. About 970 such projects

Table 2
Comparison between key characteristics underlying the energy transition in Germany and Denmark.

Characteristics/ features	Germany	Sources
RE Policy targets	• 40-45 % of power from RE by 2025 and 80 % by 2050	[132,133]
Government strategy/ policies/legal framework	• Energy Transition- *Erneuerbare Energien Gesetz* (EEG 2000) *"Energiewende"*.	[106,132,133]
Motivation	• 1970s oil crisis; Chernobyl 1986 environmental crisis, anti-nuclear energy movement • Economic/financial incentives (employment creation); community image; environment	[73,97,134,135]
Actors	• State: Federal, State (Laender), Local governments • Non-State: RE cooperatives & associations	[71,97,98,106]
Major regulatory body	• Ministry of Economy and Technology	
Role of local government	• *Burgerenergie* is a democratically run enterprise and government participation at all levels	[71,106]
Governance structure	• Decentralized bottom-up model at subnational levels.	[18,72,106]
Ownership schemes & structures	• Citizens' energy cooperatives and associations (*Bürgerenergie)* • Citizens' collaboration between local governments (LG) and local actors • Collective ownership widespread • Varying cooperatives *(Energiegenossenschaften)*	[18,98,132,133,136]
Financial incentives	• The most subsidies worldwide • Feed-in-Tariffs Act *Stromeinspeisegesetz StrEG* (1990) operational • Deployment support (RE Sources Act EEG) • A form of PPP between banking institutions (e.g., *Okostromgruppe Freiburg; GmBHFesa GmBH*) and State/ Federal Administration • Local/regional subsidies and low interest loans • Fossil fuels and other environmentally detrimental actions are taxed	[18,19,75,80,98,106,137,138]
Dominant community-level renewable energy technology (RET)	• Solar (photovoltaic)	[106]

(*continued on next page*)

Table 2 (*continued*)

Characteristics/ features	Germany	Sources
Progress level	• Most installed solar PV globally in 2013 (36GW), surpassing 70GW in 2023 (Q1) • Target 215GW by 2030 • Approx. 50 % of solar PV is community owned	[19,106]
Community and citizens engagement	• Citizens control approximately half of RE capacity and instrumental in the energy revolution. • Citizens own most shares of CRE *Bürgerenergie.*	[98,106]
Characteristics/ features	Denmark	Sources
RE Policy targets	• Wind turbines generated 26 % of the nation's electricity by 2011 • 30 % RE by 2025 • 100 % RE by 2050	[80,92]
Government strategy/ policy/ legal framework	• Electricity Supply Act • National Renewable Energy Action Plan • Draft-National Energy and Climate Plan • Energy Strategy 2050, • National Recovery and Resilience Plan • Green Transition, Renewable Energy Act (2009) • Innovative democratic process • Denmark RE Policy Handbook, (2022)	[20,68,139]
Motivation	• Energy net exporter • 1/3 world market for wind turbines	[80]
Actors	• State: Federal, State and local government; The green majority in parliament. • Non-State: RE NGOs, *Organisationen for Vedvarende Energi (OVE)*; The Danish Wind Turbine Association; OOA Lobby organization-advancing RE information discussion and dissemination	[20,139,140]
Major regulatory body	• Department of Energy and Climate	
Role of local government	• Part 1(3), Promotion of RE Act (2009) includes roles for municipalities. • Centralized 'coercion' in a legislative sense on involvement of local authority. • Establishment of federation of energy offices (SEK) in 1977 • CRE mobilized by partnership with local government authorities. • Local governments are required in their role as planning and approving authority to deliver share of national RE targets • Sub-municipality plans called strategic energy plans; stepdown from national RE plans.	[20,93,139–141]
Governance structure	• Bottom-up decentralized approach • Local and regional cooperation with central government • Communities in charge of meeting ambitious RE national targets with local government support *(Kommuner)* • Delegated authority from Copenhagen to local municipalities	[18,141,142]
Ownership schemes & structures	• Citizen-led bottom-up initiatives • Collective ownership widespread • Agriculture cooperatives in wind energy policy • Traditional cooperatives *(interessentskab)* led to the homogeneity of organization form for community wind projects	[20,75,85,143]
Financial incentives	• Energy efficiency, long-term taxes on energy fuels, electricity, and carbon • Tax-free subsidies, investment grants and low-interest • FITs (1993) operational	[20,92,139]
Dominant community-level renewable energy technology (RET)	• Wind turbines	[20]
Progress level	• In 2017, Denmark had 4910 wind turbines, total installed capacity-5229 MW • About 20 % (1082 MW) owned locally by citizen cooperatives.	[68,85,142,144]
Community and citizens engagement	• Most wind turbine owners are local community investors.	[67,92]

exist, corresponding to the largest shareholders of Germany's 36 GW installed solar and the most installed capacity globally [18,72,145]. The state-led *Energiewende* strategy promotes community activities that support energy policy [18]. The country's energy transformation relies on cogeneration and community engagement [72]. Table 3 highlights a particular political lesson Nigeria can learn from Germany as both countries have a federal structure. Due to distinct geographic, economic, and demographic frameworks, Germany's *Laender* (federal states) – like Nigerian states – may not necessarily share the national government's aims or policies [97]. As noted by Kalkbrenner and Roosen [18], the frequency and configuration of CRE may vary according to unique regional characteristics, while Sun and Baker [23] note MLG is flexible to local settings. This explains why *Bürgerenergie* – as a democratically managed enterprise – prioritises community RET choice and most importantly government participation [106], offers an additional less

Table 3
Drivers and barriers of community renewable energy in Germany and Denmark.

Drivers	Germany	Denmark
Government policies and incentives	• The Act (EEG) allows for citizen participation in the form of community or citizen-owned energy cooperatives • Germany's *Energiewende* spurred CRE development • Community groups can develop and implement their projects using RE auction systems • Feed-in Tariffs: This financial structure assures a fixed price for RE [98,145]	• Community groups plan and implement projects using the Feed-in Tarriff policy, Community Energy Development (CED) programme, and green certificate system • CRE in Denmark relies largely on state facilitation and subsidies • The institutionalization of CRE by providing financial and regulatory incentives for its operations [20,93]
Local Support and Participation	• Local authorities and communities support have been key to the development of CRE [96]	• Long tradition of public participation, decision making and ownership of CRE has driven CRE's development [80,93]
Increasing public interest and awareness of RE	• Community RE involvement mobilizes project support [146]	• Communication and training for RE awareness [92]
Economic benefits	• Energy savings, job creation, and local economic development [71,106]	• Energy self-sufficient and net exporter reflecting in balance of payments [141]
Social benefits	• Community empowerment, enhanced social cohesion, and improved environmental quality [71]	• Ensures broad participation of diverse actors [147]
Barriers	**Germany**	**Denmark**
Administrative procedures	• Complex and lengthy [71]	• Administrative bottle necks exist [141]
Legal and Regulatory	• Lack of clear objectives, lack of standards and processes [148]	• Lengthy planning process [68]
Financial constraints	• High initial investment costs and limited access to funding [98]	• High initial investment costs and lack of access to finance [80]
Limited technical expertise	• Smaller communities' difficulties grasping CRE technical and operational aspects [106,149]	• Technical expertise not widespread in all municipalities [92]
Limited public awareness/ acceptance	• Low community participation and RE benefits understanding • Local community and stakeholder opposition can hinder their development [98]	• Local communities and other stakeholders may oppose CRE projects preventing their implementation [80]

for the Nigerian case.

4.2.2. Denmark

Denmark has the most decentralised RE use in Europe, with municipal administrations (*Kommuner)* possessing vast financial resources and autonomy in RE policymaking. Accordingly, multiple studies on the Danish case have been conducted by energy scholars, drawing on a range of research methods (see SN2). The institutional framework of Denmark includes local cooperatives which is a key part of governance and enabler for community action in RE programmes [18,93]. The nation boasts the highest level of energy independence and sustainability in the Organization for Economic Cooperation and Development (OECD), achieving self-sufficiency in energy production and consumption [80]. Following the 1973 oil crisis, Denmark shifted from a centralized fossil-fuel-based power network to one dominated by wind turbines and combined heat and power (CHP) units within two decades and has since maintained its leadership in wind energy [80]. Denmark's energy transformation has received significant funding through community involvement [127], with the government now aiming for a 100 % RE grid by 2050 (see Table 2). Despite limited resources, municipal administrations (*Kommuner*) have energy policy autonomy and receive legislative and financial support from the national energy framework, especially in RE [18,20].

4.2.3. Insights from Germany and Denmark

While Germany's emphasis on citizen engagement has undoubtedly propelled its RE growth, questions arise regarding the inclusivity and equity of this approach [71,106]. Despite the proliferation of energy cooperatives, there are concerns about the accessibility of these initiatives to marginalized communities and the extent to which they truly empower citizens in decision-making processes [98]. Similarly, Denmark's decentralized governance model appears promising, but deeper analysis reveals potential pitfalls, such as disparities in local government capacities and resources, which may exacerbate inequalities in RE access and adoption [80]. Potential CRE-newcomers such as Nigeria must critically assess these models to ensure new initiatives are not only effective in promoting RE but also socially just and equitable.

Furthermore, while policy mechanisms such as Germany's Feed-in Tariff (FIT) and Denmark's cooperative ownership model have been instrumental in driving CRE progress, their applicability and effectiveness in the Nigerian context requires careful consideration. Questions arise regarding the scalability and sustainability of FIT schemes in a developing economy like Nigeria, where regulatory uncertainties and financial constraints may hinder private sector investments in RE. Similarly, while cooperative ownership models have demonstrated success in Denmark, challenges may arise in replicating this model in Nigeria's diverse socio-economic landscape, where issues of governance, trust, and transparency pose significant barriers [150,151].

While CRE initiatives in Germany and Denmark offer important lessons for Nigeria's energy transition, context-specific dynamics dictate the need to adapt existing models to address the complex socio-economic and institutional realities within the Nigerian context. Combining ownership models and financing mechanisms provides a critical pathway towards effectively scaling CRE initiatives and combatting energy poverty in Nigeria. Therefore, while Germany and Denmark offer important lessons for Nigeria's energy transition, context-specific dynamics dictate the need to adapt existing models to address the complex socio-economic and institutional realities within the Nigerian context.

Community-owned and cooperative models, underpinned by government grants, revolving funds, and climate finance mechanisms, provide a foundation for fostering local participation and ownership. Collaborating with private sector investors through PPPs and leveraging tools like PAYG systems further ensures financial inclusivity and scalability. Moreover, Nigeria's decentralized energy governance framework must integrate these models with robust regulatory support and capacity-building initiatives.

By aligning local and national priorities through green bonds and climate funds, CRE projects can contribute to Nigeria's Nationally Determined Contributions (NDCs), addressing both energy poverty and climate goals. Ultimately, ownership and financing models are more than operational strategies—they are vehicles for ensuring the social, economic, and environmental sustainability of CRE initiatives. By adopting a tailored, hybrid approach that reflects Nigeria's unique socioeconomic realities (see Section 5), the country can advance towards equitable energy access and inclusive energy transitions.

5. Energy policy issues and challenges in Nigeria

Despite global advancements, an estimated 573 million people in

SSA lack access to electricity, equivalent to around 41 % of the population [152] [9]. Nigeria, the sixth most populous nation in the world, with an estimated 219 million citizens [153], is energy deficient, unable to meet the need of its rising population and facing a significant energy crisis despite its abundant RE potential [2,109,154,155]. Although Nigeria relies heavily on fossil fuels to support its energy infrastructure, there is a significant shortfall in satisfying the increasing energy demands of a growing population [2]. Foremost, the national electrification rate in the country stands at approximately 55 %, with rural electrification at around 39 % [156]. The persistent growth of Nigeria's annual CO2 emissions further compounds this predicament (see Appendix 1, Fig. A1–A3).

In rural communities, access to energy is even more limited, with the average household consuming only 100 kWh of electricity, which is significantly less than 4500 kWh, 1934 kWh, and 1379 kWh consumed in South Africa, Brazil, and China respectively [157]. This shortage forces families and businesses to rely on portable hydrocarbon-powered generators to supplement energy needs [155,158]. CRE adoption in Nigeria is overdue given rising energy demands and substantial citizen investments in hydrocarbon-powered generators. Introducing CRE can create a cleaner, more reliable energy market while raising awareness about RE's role in sustainability, rural development, lower health costs, energy independence, and economic growth [157]. Specifically, the northern region, with the highest lack of access to electricity, stands to benefit significantly from CRE adoption, as depicted in Fig. 2.

5.1. Energy policy developments in Nigeria

Diversifying Nigeria's energy supply with renewables is imperative amid global concerns about climate change, the environment, and sustainable development [160,161]. In response, Nigeria has implemented energy policies, programs, and legislation to enhance accessibility, however, progress to date has fallen short of realizing economic ambitions. In this study, energy policy pertains to government strategies for boosting energy production, decreasing emissions, and improved efficiency [162]. Table A1 provides an overview of Nigeria's energy policies and Acts for both renewable and non-renewable sources to further contextualise the focus of this analysis.

Despite degrees of policy changes, institutional restructuring, persistent challenges in Nigeria's energy landscape (see Appendix, Table A1), the country still falls short of its energy sufficiency and RE targets. The Revised Renewable Energy Master Plan (REMP) 2012 aimed for 23 % RE by 2025, but by 2023, only 4 % was achieved. As of December 2022, RE targets remain unmet. Similarly, RESIP's goal of nationwide electricity access had limited success. While the Electricity Act of 2023 represents a significant step forward in Nigeria's energy legislation, it falls short of the objectives outlined in the CRE-MLG framework due to certain limitations.

Section 2(2) of the Act grants authority to states, companies, and individuals for electricity generation, transmission, and distribution, but excludes roles for local government authorities, citizens, and communities. Additionally, the Act lacks provisions for energy storage, which are crucial for maximizing the potential of RE within the energy mix. Despite its passage, the law faces challenges, as most governors have yet

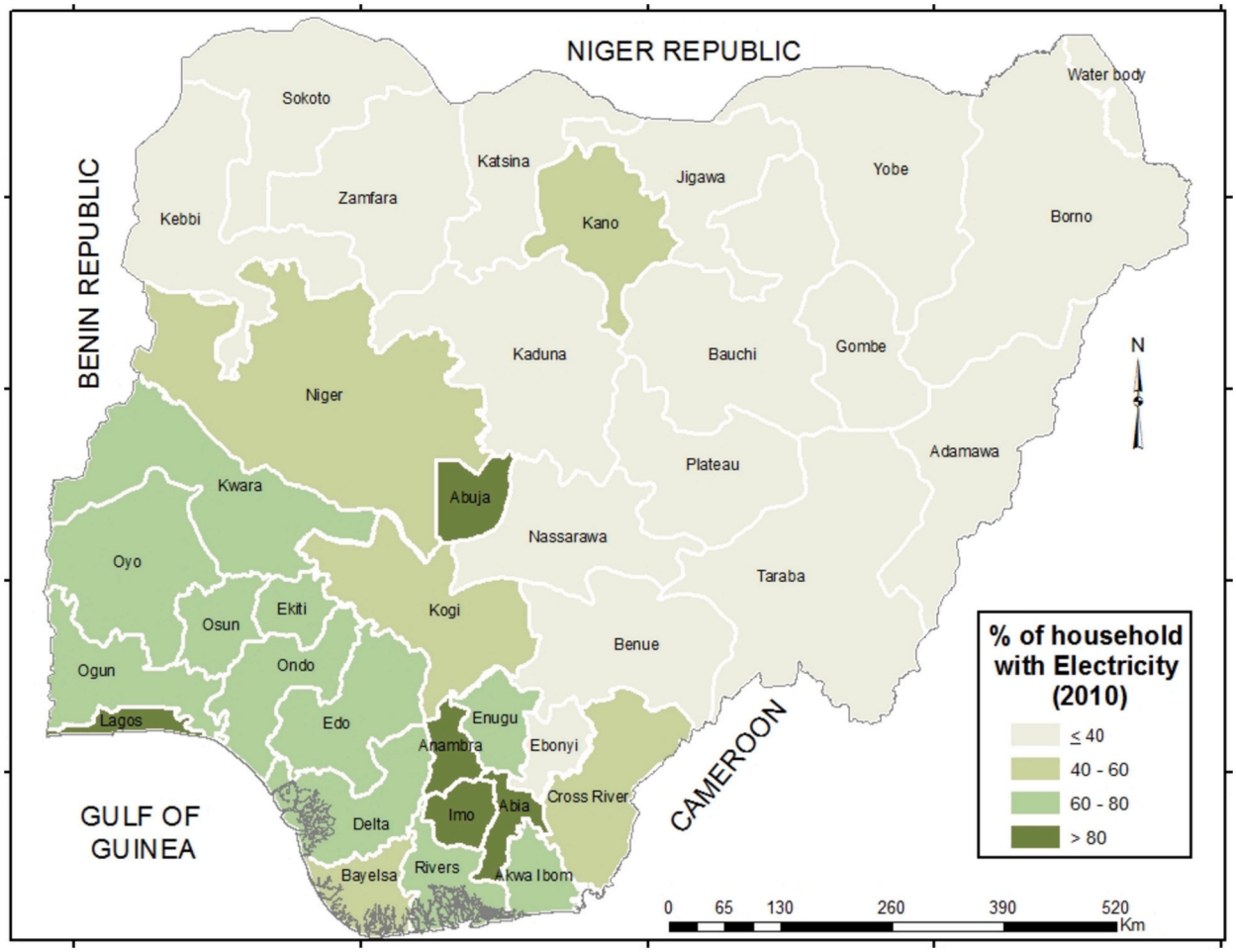

Fig. 2. Spatial distribution of households with electricity in Nigeria. Source: [159].

to adopt it, and the Nigerian Electricity Regulatory Commission (NERC) has approved a substantial 300 % increase in electricity tariffs, exacerbating the already unreliable power supply [163]. With 46 grid collapses between 2017 and 2023, Nigeria continues to grapple with frequent power failures, leading to widespread reliance on small carbon powered backup generators which provide 40 % of the total electricity [164].

Although, various policy revisions aiming at RE goals over the years, none of these revisions present a comprehensive strategy for CRE across all local communities in Nigeria, including the recent Nigerian Electricity Act 2023 [165]. This Act empowers state governments but overlooks citizens and local governments (see Table A1). The absence of roles assigned to local governments hinders aspirations for developing and accelerating decentralized RE. Consequently, there is pressing need to prioritize citizen engagement and social acceptance through supportive frameworks targeting a low-carbon and inclusive energy future [166]. This resonates with Petersen's [141] observation regarding an implementation gap between national policy and local practice as a barrier to meeting RE targets. In sum, the Nigerian Electricity Act of 2023 falls short of taking a transformative approach towards decarbonisation, as it primarily focuses on modernizing and expanding traditional energy infrastructure without prioritizing citizen engagement in its policies.

5.2. Implications of community renewable energy in Nigeria

5.2.1. Climate change dimension

Current estimates suggest the Paris Agreement's 2 °C target will fall short without global investments of around $1 trillion in RE [152]. RE adoption is imperative for securing rapid shifts in energy efficiency and electrification to reduce GHG emissions [87,167,168]. Nigeria faces challenges like fossil fuel reliance, carbon lock-in, and limited government support for RE. Despite the urgent need for a low-carbon shift, not all countries fully endorse or meaningful support the RE transition [87,100,169]. Counteracting a low-carbon trajectory, Nigeria subsidizes imported refined hydrocarbon fuels [154]. Implementing initiatives like CRE could redirect subsidy funds towards vital areas like healthcare, education, and transportation.

5.2.2. Government budget constraints and socioeconomic impact

Given the substantial investments by governments and multinational entities in global energy transition, there is a growing call for the involvement of individuals and civil society actors [127]. In the UK context, Mirzania et al. [170] argue that strategic support for enhancing networking and collaborative efforts through citizen participation could bolster CRE initiatives during the energy transition, thereby mitigating investment risks and market constraints. Furthermore, the adoption of CRE with government backing in rural areas holds the potential for substantial socioeconomic advantages, including improved education, healthcare, access to safe drinking water, empowerment of women and youth, and poverty reduction [171].

5.2.3. Seasonal variations and energy security dimension

Declining dam water levels contribute towards energy instability coupled to grid dependence highlighting the need for a more decentralised energy system in Nigeria [157]. To address these challenges, Ikejemba et al. [172] propose CRE solutions for decentralizing energy production. Furthermore, Bauwens [169] highlights energy security threats in SSA stemming from limited fossil fuels, price volatility, and energy poverty. Similarly, Süsser and Kannen [87] emphasize the growing recognition of RE for low-carbon, sustainable, and secure nations, in alignment to the Paris Agreement.

6. Two types of multi-level governance

Hooghe and Marks [28] proposed two classic ideal models of MLG: Type I and Type II (see Table 4). Type I is common in federal systems where the central government shares power with multiple levels of government, resulting in a flexible and adaptable administration with limited interactions among jurisdictional levels [173,174]. Type II MLG is more versatile, spanning multiple levels with overlapping jurisdictions, involving government agencies, state-owned enterprises, industry groups, and non-governmental organisations (NGOs) to address specific tasks or policies. Accordingly, Type I is characterized by state-centric politics, while Type II features task-specific jurisdictions, flexibility, and adaptability to transient needs [25], whereby the operational character of institutions is brought to life by actors at various government levels [175].

Table 4
Type I and Type II Multi-level governance.

Type I	Type II
• General Purpose jurisdiction • Non-intersecting memberships • Jurisdictions organized on a limited number of levels • System-wide architecture	• Task-specific jurisdictions • Intersecting memberships • No limit to the number of jurisdictional levels • Flexible design

Source: Adapted from [28].

6.1. Type I multi-level governance: jurisdictional governance

Type I MLG limits authority dissemination to a few non-overlapping jurisdictional borders across a limited number of levels, emphasizing stability and government levels rather than specific programs [176]. In contrast, Type II MLG views governance as a complex and fluid system with overlapping governments, organized around tasks and adaptable to changing governance needs [174], as conveyed in Table 4.

Gargano [43] characterizes Type I MLG as a general-purpose jurisdiction across international, national, regional, and local levels, divided into units with distinct authorities and policy requirements. It typically includes executive, elected legislature, and judiciary structures, with municipalities serving as stable entities overseeing various aspects of governance. These structures align with the formal, federalist qualities of Type I MLG, which feature hierarchical jurisdictions to some extent [177].

Type I MLG operates with well-organized, layered roles across multifunctional organizations and networks at defined levels. Type I MLG emphasizes finite levels of collaboration or cooperation, which Zürn [178] refers to as cooperative federalism in modern states. Conversely, Type II MLG exhibits more flexible institutional frameworks allowing for membership overlap between levels [24]. While Type I serves as the formal implementation framework, the mechanisms of Type II MLG can either support or hinder policy implementation [177].

6.2. Type II multi-level governance: distributed public governance

Type II MLG delegates implementation responsibilities to government bodies with non-overlapping geographical jurisdictions, emphasizing task-specific, single-purpose entities across various governmental levels and independent of ministerial agencies [177]. This approach transcends hierarchical tiers and offers a more fluid analysis across geographical and jurisdictional boundaries [23]. CRE projects align with this approach, as local planners follow national and regional policies [27].

Gargano [43] further distinguishes Type II MLG as task-oriented and adaptable to changing functional needs. It involves specialized public services such as law enforcement, fire protection, social services, and transportation, each with its internalized jurisdiction. This category involves various public and private actors coexisting in the same space and addressing coordination challenges collectively at the relevant level. Type II MLG is associated with economic efficiency, adaptability, innovation, community engagement, and shared decision-making [43].

In Nigeria's governance framework, both Type I (jurisdictional governance) and Type II MLG (distributed public governance) hold relevance. Jurisdictional governance, characterized by vertical power distribution, poses challenges in addressing local energy policy needs due to centralisation. In contrast, distributed public governance, focusing on horizontal coordination and involving various stakeholders, offers opportunities for collaboration and inclusive policy development. Nigeria can benefit from integrating both approaches, leveraging the federal government's role while strengthening collaboration across government levels and with non-state actors to enhance policy outcomes and sustainable development.

6.3. *The multi-level governance approach in Germany and Denmark*

The analysis of Germany and Denmark's RE strategies through the MLG framework reveals distinct approaches to CRE development. Germany's model aligns with Type I MLG, featuring top-down policy formulation at the national level, complemented by decentralised governance structures empowering local communities to drive CRE initiatives. Denmark, on the other hand, embodies Type II MLG, characterized by task-specific jurisdictions and collaborative efforts among diverse stakeholders to address specific policy objectives. Both countries showcase how MLG principles shape CRE outcomes, emphasizing the importance of coordination, collaboration, and decentralisation in achieving sustainable energy transitions.

The aim of using the two western cases is limited to drawing empirical examples of citizens' mobilization, engagement, and participation in the RE transition. However, CRE in the western context does not necessarily fight energy poverty. In a SSA country like Nigeria, subsistence energy has the potential to alleviate energy poverty in a straightforward manner. By transitioning from carbon-powered generators to clean and sustainable energy sources, small and medium enterprises (SMEs), which drive local economies, can significantly reduce their operational costs, thereby enhancing their ability to thrive.

7. Conceptual framework

The success and public acceptance of RE initiatives, including community-based projects like CRE, depend significantly on the implementation strategy [74]. This underscores the need to customise policies

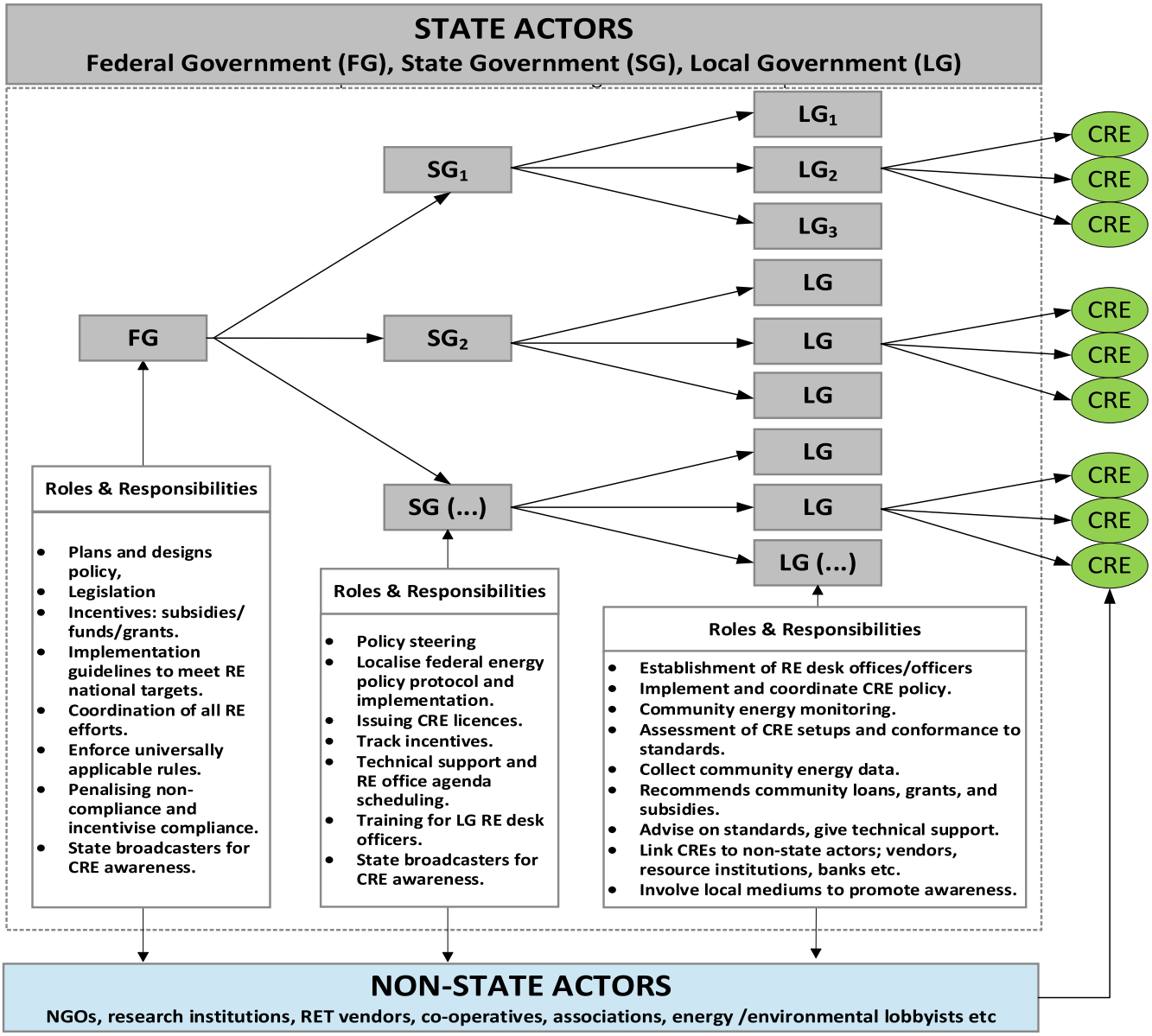

Fig. 3. The community renewable energy multi-level governance framework.

to fit the local context. MLG can play a pivotal role in shaping a context-specific CRE policy framework for Nigeria. Such a framework would align with the nation's unique political, social, and cultural dynamics, addressing shortcomings in previous government-led approaches. In response, the proposed CRE-MLG framework (see Fig. 3) provides a viable alternative for supporting Nigeria's potential transition to a low-carbon economy. By engaging local citizens in energy production and adopting a community-based approach, CRE-MLG aims to foster sustainable and reliable energy solutions through a decentralized approach.

CRE-MLG, as conceptualised in Fig. 3, could prove instrumental to supporting a clean and equitable energy future in Nigeria. Past energy policies, as documented in Section 5 have fallen short of achieving stated targets, while failing to combat energy poverty. This shortcoming stems from the federal government's exclusion of local governments and communities from energy policy formulation and coordination. To date, a focus on centralized energy policies and regulations has yielded limited results. Moving forward, local governments would prove better suited to implementing CRE initiatives, since they are more engaged with the communities they serve. Shifting the focus to MLG can foster a more democratic and legitimate public policy development process, help decentralize state power, and encourage a more pluralistic administration by involving local governments, non-state actors, and community stakeholders. This approach holds promise for CRE advancement in Nigeria, considering the country's diversity and vast size.

The CRE-MLG framework offers a solution by engaging state (mid-level) governments, local governments, and communities as pivotal players in CRE development, alongside the federal government. In Nigeria, the existing 776 local governments are particularly well-positioned to interact with communities, underscoring the significance of collaboration among national, regional (36 states), and local stakeholders. Each government level has distinct jurisdictional roles and responsibilities, necessitating synergies between state and non-state actors for effective implementation. As depicted in Fig. 3, promoting CRE is predicated on harnessing potential synergies between top-down and bottom-up processes.

7.1. Roles of key actors supporting CRE-MLG

Given the importance of energy as a national resource in a SSA nations such as Nigeria [179], under the CRE-MLG framework, it is crucial for state actors at all three tiers to collaborate with non-state actors. Currently, critical institutions in Nigeria's energy industry are centralized and concentrated at the federal level. In Table 2, it is noteworthy that in the Danish case, part 1 (3) of the promotion of RE Act (2009), clearly stipulates and includes roles of actors in municipalities in the national transition plan [139]. Therefore, the framework aims to address this by decentralizing roles and responsibilities to lower levels of government to promote RE penetration in the country.

Implementing CRE-MLG is the responsibility of key actors at both vertical (state) and horizontal (non-state) levels. Fig. 3 highlights the three state actors representing the federal, state, and local governments vertically, while non-state actors are horizontally juxtaposed to the framework at each level of authority including the local community who are host to where RE initiatives are domiciled. These non-state actors provide technical support and input to governments and act as private sector partners in crystallizing the CRE-MLG approach. While the federal government is the highest coordinating entity at the top, the state governments (mid-level) government follows and then local government (bottom level) which is closest government to the community (non-state) actors, who host to the CRE project.

7.2. State actors

7.2.1. Federal government

The Federal government (FG) plans and designs CRE policy framework, legislates, support with funds/grants, and creates CRE implementation guidelines to meet national RE targets. Following the tenets of the CRE-MLG framework, the federal government is primarily tasked with coordinating all RE efforts and enforcing universally applicable rules by penalising non-compliance, while incentivizing compliance. The FG also has the responsibility of using its broadcast institutions for CRE public awareness campaigns.

7.2.2. State government

The state government (SG), composed of the 36 states of Nigeria, carries out governance at the meso-level (mid-level). The proposed framework suggests scaling down federal energy policy guidelines and implementation protocol to fit local contexts, thus accounting for diverging cultural and social characteristics across states. The main responsibility of the SG includes policy steering, issuing CRE licenses, maintaining a record of funding, coordination and agenda setting for RE offices and technical support/ training for local government renewable energy desk officers (REDOs). As a pivotal link in the CRE-MLG chain, REDOs correspond to focal officials in local government (LG) offices responsible for implementing and coordinating national CRE policy objectives.

Similar to the FG, SGs have the ability to use their broadcast institutions for CRE public awareness campaigns. The new Electricity Act of 2023 [165] grants SGs authority over power generation, transmission, and distribution within their respective states. Notably, section 63(1) of the Act acknowledges the unique needs and objectives of each Nigerian state, encouraging the enactment of state-level legislation related to the electricity industry. This provision allows SGs to tailor laws and policies to suit their specific requirements, promoting a decentralised approach to the development of the electricity sector in Nigeria. Furthermore, the Act acknowledges the SGs' authority to issue licenses for activities related to electricity markets within their states. Coincidentally, this is the juncture at which the new electricity Act ceases, restricting the involvement and accountability of the pivotal and most proximate tier of government to the populace and consumers of this energy, namely, the local government.

7.2.3. Local government

The local government (LG) is more accountable for understanding and implementing national RE policy since it can more easily engage at the community level [81], thereby strengthening prospects for 'connecting power to people'. The LG sits at the lowest level in the vertical element of the CRE-MLG framework yet carries the most weight in terms of its roles and responsibilities. It is crucial to highlight that none of Nigeria's 774 local government areas (LGAs) currently has an agency or a staff devoted to energy programmes, projects, or challenges. This stands in contraction to other Type I governance institutions such as health and education, which have departments and staff domiciled in all LGAs in the country.

The proposed staffing of each REDO office in the 774 LGAs should range from a minimum of three to a maximum of ten employees, contingent on the geographical expanse of the LGA. Personnel would be drawn from a mix of government energy agencies (Type II governance), situated exclusively at the central headquarters in the country's capital. The integration of REDOs supports a critical gap for implementing and monitoring of energy activities at community level. This is one of the shortcomings that has hindered the country from meeting its national RE objectives.

In contrast, the Danish case presents an example where there is a strong connection between national RE targets, community acceptance, participation, and local policy implementation [92,141]. In 1977, the Danes established the federation of local energy offices (SEK) with staff in all municipalities (local authorities) to help ensure collaboration and participation of residents in meeting national goals [140]. With step down training from SGs, REDOs assess CRE setups, architectures, and conformance according to standards and collect accurate energy data in the community. This SG level connects federal RE policy to local

communities where CRE operates establishing a bottom-up channel. It also can approve federal community loans, grants, and subsidies.

LGs are responsible to advice communities on sustainability standards, give technical support, and connect them to non-state enterprises including RE manufacturers, vendors, resource institutions and banks [137]. LGs also have the responsibility of using local mediums, outreaches, associations, traditional/religious leaders for CRE public awareness campaigns.

7.3. Non-state actors

The framework presented in Fig. 3 incorporates various non-state (private) actors within its horizontal governance structure and their involvement is crucial across all tiers of government [118]. These actors play a significant role contributing towards national level where policies are formulated, as well as the local level where government programs are implemented and executed in collaboration with each level of government, either independently or in a complementary manner. While the objectives of non-state (private) may extend beyond profit-making, encompassing endeavors such as addressing climate change concerns, ensuring energy security for vulnerable populations, and protecting the environment, their identities encompass a wide range of entities. These actors include private developers, RET vendors, international and national consultants, civil society organizations/non-governmental organizations, financial institutions, political and environmental advocacy groups, research institutions, prosumers (producer-consumers), academia, training companies, voluntary associations, pressure groups, professional organisations, among others.

7.3.1. Community-level actors

Given the absence of a singular trajectory towards achieving a low-carbon transition within any particular nation, the conventional elucidation of identifying appropriate stakeholders in CRE is contingent upon the interests of constituents and policymakers. It is crucial for actors responsible for determining the parameters of CRE to make well-informed and deliberate choices, as these decisions have ramifications on the scalability, management, funding, establishment, and regulation of CRE initiatives, thereby significantly impacting the parties affected by the outcomes [83].

The effective implementation of CRE necessitates the active involvement of the community actors in the processes of planning, decision-making, and administration through establishing and legalisation of unstructured energy associations and cooperatives. This is to ensure the successful operation of a CRE project within a community, the CRE-MLG framework proposes engaging and collaborating with key community actors, leaders including residents and local institutions as key stakeholders. By incorporating their perspectives, obtaining their acceptance, leveraging on their indigenous knowledge, securing their endorsement and encouraging their participation, these actors assume the role of project stewards, fostering a sense of ownership and commitment towards the project within their community.

7.4. The value proposition of CRE-MLG

Decentralization in Nigeria has been applied across various sectors, including education, healthcare, and more recently, water supply. For instance, the FG has delegated education responsibilities to SGs and primary education duties to LGs. This decentralization means that SGs are now in charge of formulating education policies, managing schools and providing teachers. Another notable example is the delegation of service provision responsibilities, such as water, sanitation, and healthcare, to LG agencies.

A successful model that can be adopted and modified in Nigeria is the Universal Basic Education Commission (UBEC) for primary education at local government level. UBEC is backed by the Universal Basic Education Act (2004) which mandates the provision of basic education in Nigeria. It was established to oversee the programme's implementation at the state and local levels. This coordination occurs through the State Universal Basic Education Boards (SUBEB) in each state and the Local Government Education Authorities (LGEAs) [180,181]. With the CRE-MLG framework, REDOs at the LG level would function as the primary contact points for 'bottom-up' RE development and coordination within communities. They would engage with community stakeholders and residents, oversee off-grid associations or cooperatives, provide information on accessing quality RETs, facilitate access to government subsidies and ensure the dissemination of government's national sustainability goals.

The Afrocentric CRE model differs from European frameworks by focusing on decentralized, subsistence-level energy provision for households and small enterprises, emphasizing community involvement. Financing for this model through the supervision of REDOs, would rely on a combination of government subsidies, international aid, microfinancing, and private-public partnerships, with additional support from grants and climate funds. The community plays an active role as "prosumers," participating in decision-making, governance, and management to ensure sustainability. While not profit-focused, cost-recovery mechanisms such as affordable tariffs would ensure long-term viability by covering operational expenses. Ultimately, the Afrocentric CRE model prioritizes social and economic benefits for the community, fostering local resilience and energy autonomy.

Considering the spending of Nigerian citizens on hydrocarbon-powered generators [12], through harnessing local resources and community involvement, CRE can provide reliable and clean energy for domestic use, small-scale businesses, and community facilities. Collaboration between government, private sector, and civil society stakeholders is crucial to support and scale up CRE initiatives, facilitating Nigeria's transition towards a resilient and low-carbon energy system. However, the CRE-MLG framework offers a solution to accelerate Nigeria's transition to a low-carbon economy and support the fulfilment of our Nationally Determined Contributions (NDCs) to the global economy.

8. Conclusion

To date, few studies have examined the socio-political dynamics of CRE projects and how they address energy inequalities in developing countries like Nigeria [182]. Despite the growing prevalence of CRE initiatives, research on their effects and contributing factors is mostly concentrated in Europe and North America, with scarce attention given to the implementation of programs in developing nations in SSA [183].

This study marks a novel contribution to the socio-technical transitions literature in the global south by integrating CRE and MLG into a conceptual framework, with a specific focus on the potential for developing CRE initiatives in Nigeria. The entry point to the analysis involved analyzing the characteristics, constraints, mobilization strategies, and state facilitation of CRE in Germany and Denmark to identify potential success factors for adopting in the Nigerian context. Using the CRE-MLG framework, the study assesses the viability of CRE efforts in Nigerian communities to address energy poverty. The findings of this study may inform the development of a policy framework that promotes CRE activities and enables REDOs at the local government level to effectively oversee and monitor policy targets and access to energy infrastructure. Additionally, the CRE-MLG framework offers a solution to accelerate Nigeria's transition to a low-carbon economy and support the fulfilment of our Nationally Determined Contributions (NDC) to the global economy.

The novelty of this study lies in its integration of two key concepts: CRE and MLG. This approach recognizes the importance of community involvement and decentralized decision-making in RE development, while also acknowledging the complex interplay of governance structures at multiple levels. By combining these perspectives, the framework offers a holistic understanding of how CRE initiatives can be effectively

implemented within the context of diverse and tiered governance systems. Scholarly innovation is evident in the framework's emphasis on critical learning points derived from empirical research and theoretical insights. Through rigorous analysis of two case studies, existing literature, and policy documents, key lessons emerge regarding the role of stakeholders, the effectiveness of governance mechanisms, and the challenges and opportunities inherent in CRE implementation. These critical learning points are identified through review of literature and synthesis of evidence and highlighting best practices.

A more critical assessment of the transferability of these learning points to the Nigerian context is essential. While the CRE-MLG framework offers valuable insights into effective RE governance, its applicability to Nigeria may be limited by contextual factors such as political dynamics, institutional capacity, and socio-economic conditions. Critical scrutiny is needed to evaluate the feasibility and adaptability of CRE-MLG principles within Nigeria's unique governance landscape. This assessment should consider the alignment of the framework with existing policies and practices, the potential for stakeholder buy-in and participation and the scalability of CRE initiatives across diverse communities. Additionally, attention must be paid to potential barriers and challenges, such as regulatory constraints, funding limitations, and socio-cultural norms, which may impede the implementation of CRE-MLG strategies in Nigeria. Overall, a nuanced and context-specific analysis is necessary to assess the potential impact and feasibility of adopting the CRE-MLG framework in the Nigerian context.

8.1. Implications for policy makers

Without the Danish government's systematic and deliberate public policy intervention in the market, its wind power technology would not be the global success it is today [68,139]. Therefore, CRE through this MLG-CRE framework would not spread without institutional support, such as a supportive energy policy by the Nigerian government or political class [82,92]. Without focused government policy, the implementation of CRE in Nigeria may occur in a disparate, uncoordinated, and unsystematic manner. And implementation success rates are directly proportional to local acceptance levels [19]. Decentralisation creates institutional space for local (community) actors, which is essential to institutional progress [18]. However, the Nigerian government lack supportive policy schemes for CRE, so policymakers may want to maximize the potential of community investment in CRE by designing effective policies with multiplier effect on local communities in Nigeria, such as combating energy poverty, reducing the country's carbon footprint, improving quality of life, and promoting economic growth [98].

Echoing Ohunakin's [184] call to develop favorable policies and strong "political will" at all levels of government (federal, state, and local) in Nigeria to accelerate RE development. For CRE-MLG to take root in Nigeria, appropriate policies must a) effectively unbundle and distribute the intricate and overloaded monopoly of energy administration held solely by the FG. This entails delegating well-defined roles and responsibilities to the other two tiers of government, as depicted in Fig. 3, fostering an interdependent yet collaborative structure b) consider citizens as a source of funding for the energy transformation, c) prioritize public engagement as the key to a successful energy transformation, especially given the substantial impact on energy use by citizens, and d) enhance the local energy industry administration through offices of REDOs so that residents and local stakeholders can engage in RE initiatives.

8.2. Limitation of research

A limitation of this study lies in the use of a narrative review for the literature, which can introduce selection bias in choosing sources and references, potentially leading to gaps in coverage. Unlike systematic reviews, which follow a structured and transparent methodology, narrative reviews may unintentionally prioritise certain perspectives or omit relevant studies. To address this, future research should consider adopting a systematic review or meta-analysis to provide a more comprehensive and objective synthesis of the literature on CRE in SSA, which is currently lacking in the field.

8.3. Further research agenda

The liberalization of the energy sector has been an ongoing policy initiative in many SSA countries. In this context, the CRE-MLG framework has been proposed as a useful tool to guide energy sector reforms in the region. However, there is a need for further research to explore the implementation of this framework, particularly in terms of defining stakeholder groups and customizing CRE structures for local environments in SSA. This would involve adapting the CRE-MLG framework to suit the specific institutional, legal, and socio-economic contexts of individual countries in the region. Such customisation would be essential to ensure that the framework is effective in achieving its intended objectives in different settings.

Another critical area of further research could focus on the identification and classification of stakeholder groups in the energy sector in SSA countries. This would involve a thorough analysis of the various state and non-state actors involved in the sector, including government entities, private companies, civil society groups, and individual consumers. Such an analysis would provide a clearer understanding of the interests and priorities of these groups and could inform the development of tailored policy interventions.

Unlike Germany and Denmark, which have experienced RE expansion facilitated by their stable political history, Nigeria's history of political volatility has hindered similar progress. This, in turn, has impeded various essential factors for the advancement of CRE research within the country, such as inadequate funding, making it challenging to conduct in-depth studies and gather data (especially due to the scarcity of energy utilization statistics in rural Nigeria). Nigeria also suffers from a lack of infrastructure and technical capacity as there is a dearth of qualified technicians and researchers to study CRE. This makes community-scale RET development and design of RE systems that meet local energy needs difficult. Again, from the policy documents highlighted so far, Nigeria lacks clear regulations for CRE initiatives. This causes ambiguity and makes it hard for the researcher to get clear information on CRE research.

Future research should involve adapting the CRE-MLG framework to suit the specific institutional, legal, and socio-economic contexts of individual countries in the region and a review of various LG/citizens ownership models. Such customisation would be essential to ensure that the framework is effective in achieving its intended objectives in different settings. Overall, further research in these areas could inform the development of evidence-based policy interventions to promote sustainable and inclusive energy access and economic growth in Nigeria.

CRediT authorship contribution statement

Kim Kaze: Methodology, Data curation, Conceptualization, Writing – original draft. **Nazmiye Balta-Ozkan:** Supervision, Project administration, Funding acquisition, Writing – review & editing. **Elisabeth Shrimpton:** Supervision, Project administration, Funding acquisition, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Appendix

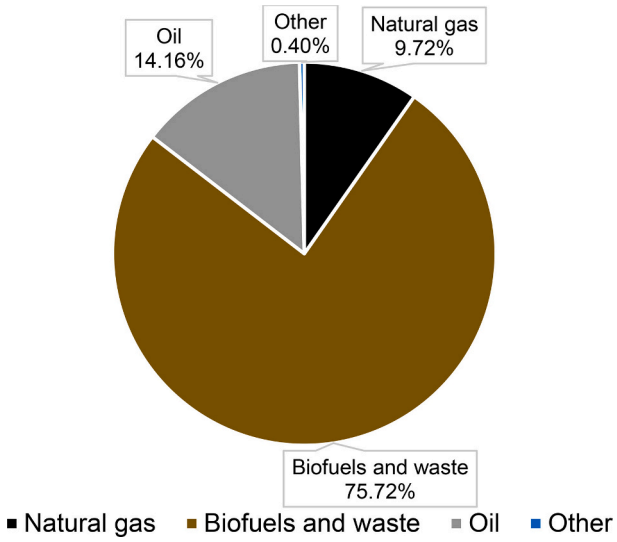

Fig. A1. Distribution of energy sources in Nigeria in 2020.

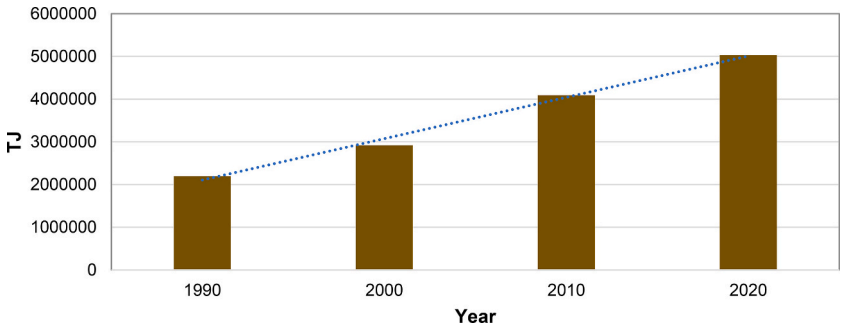

Fig. A2. Energy supply from biofuels and waste, 1990–2020.

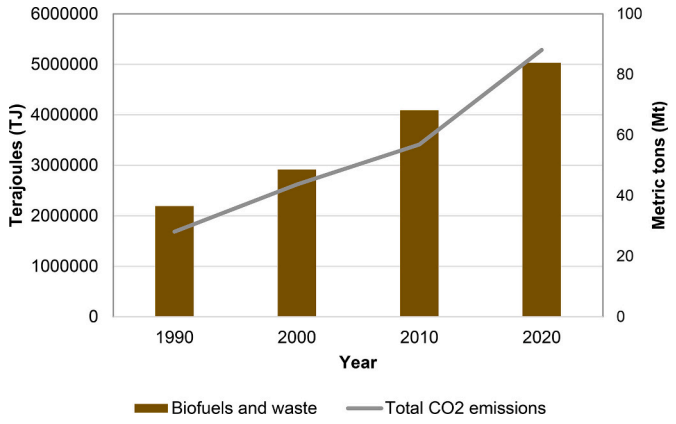

Fig. A3. Trends in Nigerian energy consumption and CO^2 emissions, 1990–2020 [185].

Table A1
Summary of Nigeria's energy policies to date.

Policy	Start year	Key details and characterization	Source(s)
National Electric Power Implementation Policy (NEPIP)	2001	• Unbundled the powerful state-owned NEPA into electricity-generating Independent Power Producers (IPPs) to boost market competitiveness, phase out subsidies and sell excess electricity to Distribution Companies (DISCOs) for full market liberalization • No focus on renewable energy	[4,186]

(continued on next page)

Table A1 (*continued*)

Policy	Start year	Key details and characterization	Source(s)
National Energy Policy (NEP) 2003, (Reviewed 2006, 2013)	2003	• Addressed energy production, supply and consumption. Promoting rapid solar energy integration into Nigeria's power system and efficient use of other RES to diversify energy sources and ensure energy security	[155,186]
National Economic Empowerment and Development Strategy (NEEDS)	2004	• Supported a higher RE balance • Proposed a RE agency and National Power Sector Reform Act-sponsored technology	[186]
National Power Sector Reform Act -NPSRA	2005	• Liberalized Nigeria's power sector in response to the 2001 NEPIP's new legislative and regulatory framework. • Unbundled and Privatized the electricity sector • Restricts licensee rights to the federal government to manage the deregulated energy market • Facilitated the establishment of National electric regulation commission (NERC) and the Rural Electrification Agency (REA)	[155,186,187]
Renewable Electricity Policy Guidelines (REPG)	2006	• Expanded RE generation targets (5 % of total power generation by 2025 and 5 TWh) • Defined RE development usage and policy aims, Prioritizing RE production and distribution • Proposed cost-effective RE trust fund management	[186]
Renewable Electricity Action Programme (REAP)	2006	• Cleared the playing field for RE providers, multi-sector alliances, demonstration projects and supply chain activities • Investigated RE programme support	[186]
Nigerian Biofuel Policy and Incentives (NBPI)	2007	• Integrate agricultural activities with oil and gas activities • Aimed to grow and promote the domestic fuel ethanol sector by using agricultural goods, gradually reduce the nation's reliance on imported gasoline, reduce environmental pollution and develop financially viable businesses and sustainable jobs	[186] [155]
Multi-Year Tariff Order (MYTO) 2008 & 2012	2008	• The NERC created MYTO 1 in 2008 to cost-reflective pricing. Then MYTO II (2012-2017) • MYTO determines reasonable prices for licenced energy producers to provide distribution and retailing enterprises under the EPSRA (2005) Act • No focus on renewable energy	[188]
Renewable Energy Master Plan (REMP) 2005, (Revised) 2012	2012	• Based on an increasing convergence of goals, concepts and aims of NEEDS, National Energy Policy, National Policy on Integrated Rural Development, Millennium Development Goals (MDGs) and international treaties to alleviate poverty and reverse global environmental change • Promoted building grid, and off-grid RE integration, underlining the importance of solar energy • Expected growth of RE generation from 13 % in 2015 to 23 % in 2025 and 36 % by 2030 • REMP expects 10 % of Nigeria's electricity to be renewable by 2025	[186] [155]
National Renewable Energy and Energy Efficiency Policy	2015	• Prioritized hydropower, biomass, solar, wind, geothermal, wave, tidal, co-generation, and energy efficiency • Meant to be driven by community-funded RE systems. Established the National Energy Efficiency Action Plans 2015–2030 (NEEAP)/National Renewable Energy Action Plans (NREAP)	[155]
Rural Electrification Strategy and Implementation Plan (RESIP)	2017	• Supported the REA to increase energy availability quickly and cheaply • Demanding widespread adoption of grid and off-grid alternatives and access-based incentives • Outlined the Nigerian rural electrification enabling framework.	154], [157]
The Nigeria Electrification Project	2018	• Nigeria's most ambitious energy project yet with an estimated $1.215 billion portfolio investment • Breakdown: African Development Bank (AfDB)—$150 million (loan), Africa Growing Together Fund (AGTF)—$50 million, World Bank—$350 million, Government of Nigeria—$5 million (counterpart funding), Others (Private Sector)—$660 million (commercial financing) • Policy goals: (i) 60 % rural power by 2020 and RE as rural development accelerator. Low-cost equipment and operators. (ii) the government intends to improve energy access to rural and underserved areas and deliver at least 10,000 MW (off-grid and on-grid) of operational capacity by 2020	[189]
Climate Change Bill	2021	• Incorporated RE strategies for Nigeria's net-zero aim for 2050–2070 and five-year carbon budgets under a National Climate Change Action Plan • The Federal Ministry of Environment sets the carbon budgets and the National Council on Climate Change implements them	[190,191]
Nigeria Electricity Act	2023	• The Act repeals and replaces the Electricity and Power Sector Reform Act of 2005 and aims to establish a decentralized legal and institutional framework for Nigeria's power sector, covering electricity generation, transmission, distribution, and supply, as well as fostering the integration of RE into the country's energy mix • Aims to facilitate an environment conducive to investment in the Nigerian Electricity Supply Industry (NESI)	[165]

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.erss.2025.103938.

Data availability

No data was used for the research described in the article.

References

[1] P. Fenton, S. Gustafsson, J. Ivner, J. Palm, Stakeholder participation in municipal energy and climate planning – experiences from Sweden, Local Environ. 21 (3) (Mar. 2016) 272–289, https://doi.org/10.1080/13549839.2014.946400.

[2] N.V. Emodi, C.C. Emodi, G.P. Murthy, A.S.A. Emodi, Energy policy for low carbon development in Nigeria: A LEAP model application, Renew. Sust. Energ. Rev. 68 (August 2015) (2017) 247–261, https://doi.org/10.1016/j.rser.2016.09.118.

[3] Vanguard, EU unveils solar tree, contributes 165m euros for renewable energy…, Vanguard Newspaper. Accessed: Jan. 10 (2023) [Online]. Available: https://www.vanguardngr.com/2019/05/eu-unveils-solar-tree-contributes-165m-euros-for-renewable-energy-in-nigeria/.

[4] Aye Israel, Odude Funmilayo, Odekina Immaculate, Iheonye Ini, The renewable energy law review: Nigeria, Accessed: Dec. 24. [Online]. Available: https://thelawreviews.co.uk/title/the-renewable-energy-law-review/nigeria#footnote-054, 2022.

[5] NEP, Nigeria Electrification Project (Nep) Project Report Summary, 2018.

[6] O. Adanikin, "INVESTIGATION: Jonathan, Buhari spent N1.164 trillion on power in 8 years, yet Nigeria remains in darkness," Oct. 14, 2019. Accessed: May 28, 2022. [Online]. Available: https://www.premiumtimesng.com/investigationspecial-reports/357448-investigation-jonathan-buhari-spent-n1-164-trillion-on-power-in-8-years-yet-nigeria-remains-in-darkness.html.

[7] O. Akinyi, "Nigeria's Generator Addiction Is An Opportunity in Disguise – emerge85," emerge85. Accessed: May 28 [Online]. Available, https://emerge85.io/Insights/nigerias-generator-addiction-is-an-opportunity-in-disguise/, 2022.

[8] O.M. Ikeanyibe, Nigeria's post-privatisation energy sector is a mess: here are some solutions, Accessed: May 28. [Online]. Available: https://theconversation.com/nigerias-post-privatisation-energy-sector-is-a-mess-here-are-some-solutions-155067, 2022.

[9] B. O. Menyeh, "Financing electricity access in Africa : A choice experiment study of household investor preferences for renewable energy investments in Ghana," vol. 146, no. May, 2021.

[10] H. Livinus, Nigeria needs 33,000MW for stable power supply – DisCos, Punch Newspaper (2023). Accessed: Aug. 07, 2023. [Online]. Available: https://punchng.com/nigeria-needs-33000mw-for-stable-power-supply-discos/.

[11] F. Adeniyi, "Overcoming the market constraints to on-grid renewable energy investments in Nigeria," Oxford, United Kingdom, Oct. 2019. doi: 10.26889/9781784671495.

[12] Dalberg, "Putting an end to Nigeria's generator crisis: the path forward," Access to Energy Insitute, no. June, p. 35, 2019, [Online]. Available: https://a2ei.org/.

[13] A. Osae-Brown and R. Olurounbi, "Nigeria runs on generators and nine hours of power a day-Bloomberg." Accessed: Mar. 02, 2023. [Online]. Available: https://www.bloomberg. com/news/articles/2019-09-23/nigeria-runs-on-generators-and-nine-hours-of-power-a-day?leadSource=uverify%20wall.

[14] T. Adeleru-Balogun, Nigeria's ever-present hum (of generators), Accessed: Mar. 02 (2023) [Online]. Available: https://www.dailymaverick.co.za/article/2019-10-17-nigerias-ever-present-hum-of-generators/.

[15] B. Adoluju, "Nigerians Spend Huge Importing Electric Generators Bad for the Environment-Africa's premier report on the oil, gas and energy landscape.," https://africaoilgasreport.com/2021/05/power-deficit/nigerians-spend-huge-importing-electric-generators-bad-for-the-environment/.Accessed:Mar.03,2023. [Online]. Available: https://africaoilgasreport.com/2021/05/power-deficit/nigerians-spend-huge-importing-electric-generators-bad-for-the-environment/.

[16] M. Suzuki, J. Jewell, A. Cherp, Have climate policies accelerated energy transitions? Historical evolution of electricity mix in the G7 and the EU compared to net-zero targets, Energy Res. Soc. Sci. 106 (2023), https://doi.org/10.1016/j.erss.2023.103281.

[17] L.L. Delina, Climate mobilizations and democracy: the promise of scaling community energy transitions in a deliberative system, J. Environ. Policy Plan. 22 (1) (2020) 30–42, https://doi.org/10.1080/1523908X.2018.1525287.

[18] M. Oteman, M. Wiering, J.K. Helderman, The institutional space of community initiatives for renewable energy: a comparative case study of the Netherlands, Germany and Denmark, Energy Sustain. Soc. 4 (1) (2014) 1–17, https://doi.org/10.1186/2192-0567-4-11.

[19] Ö. Yildiz, Financing renewable energy infrastructures via financial citizen participation - the case of Germany, Renew. Energy 68 (2014) (2014) 677–685, https://doi.org/10.1016/j.renene.2014.02.038.

[20] F. Mey and M. Diesendorf, "Who owns an energy transition? Strategic action fields and community wind energy in Denmark," *Energy Res Soc Sci*, vol. 35, no. October 2017, pp. 108–117, 2018, doi:https://doi.org/10.1016/j.erss.2017.10.044.

[21] M. Markantoni, Low carbon governance: mobilizing community energy through top-down support? Environ. Policy Gov. 26 (3) (2016) 155–169, https://doi.org/10.1002/eet.1722.

[22] N.V. Emodi, K.J. Boo, Sustainable energy development in Nigeria: current status and policy options, Renew. Sust. Energ. Rev. 51 (2015) 356–381, https://doi.org/10.1016/j.rser.2015.06.016.

[23] B. Sun, M. Baker, Multilevel governance framework for low-carbon development in urban China: a case study of Hongqiao Business District, Shanghai, Cities 119, no. July (2021) 103405, https://doi.org/10.1016/j.cities.2021.103405.

[24] J. Kunchornrat, A. Phdungsilp, Multi-level governance of low-carbon energy systems in Thailand, Energies (Basel) 5 (3) (2012) 531–544, https://doi.org/10.3390/en5030531.

[25] A.S. Hermanson, Energy security in a multi-level governance perspective, Mar. Policy 98 (September) (2018) 301–308, https://doi.org/10.1016/j.marpol.2018.09.025.

[26] P. Murray, Uses and abuses of the concept of integration, The SAGE Handbook of European Studies (2009) 227–244, https://doi.org/10.4135/9780857021045.n13.

[27] A. Smith, Emerging in between: the multi-level governance of renewable energy in the English regions, Energy Policy 35 (12) (2007) 6266–6280, https://doi.org/10.1016/j. enpol.2007.07.023.

[28] L. Hooghe, G. Marks, Unraveling the central state, but how? Types of multi-level governance, Am. Polit. Sci. Rev. 97 (2) (2003) 233–243, https://doi.org/10.1017/S0003055403000649.

[29] V. Dobravec, N. Matak, C. Sakulin, G. Krajačić, Multilevel governance energy planning and policy: a view on local energy initiatives, Energy Sustain. Soc. 11 (1) (2021) 1–17, https://doi.org/10.1186/s13705-020-00277-y.

[30] J. Marquardt, Central-local relations and renewable energy policy implementation in a developing country, Environ. Policy Gov. 27 (3) (2017) 229–243, https://doi.org/10.1002/eet.1756.

[31] A. Smith, "governance in the English regions Multi-level governance : Towards an analysis of renewable energy governance in the English regions," vol. 44, no. 153, pp. 0–22, 2006.

[32] B.G. Peters, P. Science, Multi-Level Governance : A Faustian Bargain ?, 2000.

[33] P. Cairney, "Understanding public policy: Theories and issues (2nd ed.) Chapter 8 Multi-level Governance and Multi-centric Policymaking," in *Cairney, P. (2019). Understanding public policy: Theories and issues*, 2nd ed., University Press., 2019, ch. 8, pp. 1–4.

[34] M. Benz, B.S. Frey, Corporate governance: what can we learn from public governance? Acad. Manag. Rev. 32 (1) (2007) 92–104, https://doi.org/10.5465/AMR.2007.23463860.

[35] L. Hooghe, G. Marks, Unraveling the central state, but how? Types of multi-level governance, Am. Polit. Sci. Rev. 97 (2) (2003) 233–243, https://doi.org/10.1017/S0003055403000649.

[36] K. A. Daniell and A. Kay, "Multi-level Governance: An Introduction," *Multi-level Gover- nance: Conceptual challenges and case studies from Australia*, no. February 2018, pp. 3–32, 2017, doi: 10.22459/mg.11.2017.01.

[37] F. Stilwell, P. Troy, Multilevel governance and urban development in Australia, Urban Stud. 37 (5–6) (2000) 909–930, https://doi.org/10.1080/00420980050011154.

[38] M. Ringel, Energy efficiency policy governance in a multi-level administration structure — evidence from Germany, Energ. Effic. 10 (3) (2017) 753–776, https://doi.org/10.1007/s12053-016-9484-1.

[39] I. Bache, M. Flinders, Multi-level governance and the study of the British state, Public Policy Admin. 19 (1) (2004) 31–51, https://doi.org/10.1177/095207670401900103.

[40] L. Hofbauer, W. Mcdowall, and S. Pye, "Challenges and opportunities for energy system modelling to foster multi-level governance of energy transitions," vol. 161, no. February, 2022.

[41] J. Peel, L. Godden, R.J. Keenan, Climate change law in an era of multi-level governance, Transnat. Environ. Law 1 (2) (2012) 245–280, https://doi.org/10.1017/S2047102512000052.

[42] C. Coopenergy, "A Guide to Multi-level Governance For Local and Regional Public Authorities A Guide to Multi-level Governance," no. December, 2015.

[43] G. Gargano, The bottom-up development model as a governance instrument for the rural areas. The cases of four local action groups (lags) in the United Kingdom and in Italy, Sustainability (Switzerland) 13 (16) (2021), https://doi.org/10.3390/su13169123.

[44] A. Giraudy and S. Niedzwiecki, "Multi-level governance and subnational research: similarities, differences, and knowledge accumulation in the study of territorial politics," Region. Fed. Stud., vol. 0, no. 0, pp. 1–19, 2021, doi:https://doi.org/10.1080/13597566.2021.1941900.

[45] D. Feltenius, Multi-level governance as 'post-constitutional' politics: subnational actors and the Swedish constitution, Local Gov. Stud. 41 (2) (2015) 301–319, https://doi.org/10.1080/03003930.2014.919267.

[46] E. Holden, K. Linnerud, and B. J. Rygg, "A review of dominant sustainable energy narratives," Jul. 01, 2021, Elsevier Ltd. doi:https://doi.org/10.1016/j.rser.2021.110955.

[47] M. D. Scovell, "Explaining hydrogen energy technology acceptance: A critical review," Mar. 01, 2022, Elsevier Ltd. doi:https://doi.org/10.1016/j.ijhydene.2022.01.099.

[48] J.A. Gordon, N. Balta-Ozkan, S.A. Nabavi, Homes of the future: unpacking public perceptions to power the domestic hydrogen transition, Renew. Sust. Energ. Rev. 164 (2022), https://doi.org/10.1016/j.rser.2022.112481.

[49] J. Szenderák, D. Fróna, and M. Rákos, "Consumer Acceptance of Plant-Based Meat Substitutes: A Narrative Review," May 01, 2022, MDPI doi:https://doi.org/10.3390/foods11091274.

[50] William J. Sutherland and Claire F. R. Wordley, "A fresh approach to evidence synthesis," *Nature*, vol. 558, Jun. 2018, Accessed: Apr. 29, 2024. [Online]. Available: https://www. nature.com/articles/d41586-018-05472-8.

[51] P. Devine-Wright and A. Peacock, "Putting energy infrastructure into place: A systematic review," Jun. 01, 2024, Elsevier Ltd. doi:https://doi.org/10.1016/j.rser.2023.114272.

[52] V. Apfel, et al., Therapeutic assessment of targeting ASNS combined with l -Asparaginase treatment in solid tumors and investigation of resistance mechanisms, ACS Pharmacol. Transl. Sci. 4 (1) (2021) 327–337, https://doi.org/10.1021/acsptsci. 0c00196.

[53] K. E. H. Jenkins, B. K. Sovacool, N. Mouter, N. Hacking, M. K. Burns, and D. McCauley, "The methodologies, geographies, and technologies of energy justice: A systematic and comprehensive review," Apr. 01, 2021, IOP Publishing Ltd. doi: https://doi.org/10.1088/1748-9326/abd78c.

[54] N. V. Emodi, H. Lovell, C. Levitt, and E. Franklin, "A systematic literature review of societal acceptance and stakeholders' perception of hydrogen technologies," Sep. 01, 2021, Elsevier Ltd. doi:https://doi.org/10.1016/j.ijhydene.2021.06.212.

[55] K. E. H. Jenkins, B. K. Sovacool, N. Mouter, N. Hacking, M. K. Burns, and D. McCauley, "The methodologies, geographies, and technologies of energy justice: A systematic and comprehensive review," Apr. 01, 2021, IOP Publishing Ltd. doi: https://doi.org/10.1088/1748-9326/abd78c.

[56] B. K. Sovacool, J. Axsen, and S. Sorrell, "Promoting novelty, rigor, and style in energy social science: Towards codes of practice for appropriate methods and research design," Nov. 01, 2018, Elsevier Ltd. doi:https://doi.org/10.1016/j.erss.2018.07.007.

[57] R. Ferrari, Writing narrative style literature reviews, Medical Writing 24 (4) (2015) 230–235, https://doi.org/10.1179/2047480615z.000000000329.

[58] F. Robertson Munro and P. Cairney, "A systematic review of energy systems: The role of policymaking in sustainable transitions," Mar. 01, 2020, Elsevier Ltd. doi: https://doi.org/10.1016/j.rser.2019.109598.

[59] C. Wohlin, M. Kalinowski, K. Romero Felizardo, E. Mendes, Successful combination of database search and snowballing for identification of primary studies in systematic literature studies, Inf. Softw. Technol. 147 (2022), https://doi.org/10.1016/j.infsof.2022. 106908.

[60] T.G. Reames, A community-based approach to low-income residential energy efficiency participation barriers, Local Environ. 21 (12) (2016) 1449–1466, https://doi.org/10.1080/13549839.2015.1136995.

[61] P. Rolffs, D. Ockwell, R. Byrne, Beyond technology and finance: pay-as-you-go sustainable energy access and theories of social change, Environ. Plan. A 47 (12) (2015) 2609–2627, https://doi.org/10.1177/0308518X15615368.

[62] G. Lakshmi and S. Tilley, "The 'power' of community renewable energy enterprises: The case of Sustainable Hockerton Ltd.," *Energy Policy*, vol. 129, no. April 2018, pp. 787–795, 2019, doi:https://doi.org/10.1016/j.enpol.2019.02.063.

[63] L. Greenius, E. Jagniecki, K. Thompson, Moving towards sustainable community renewable energy : a strategic approach for communities statement of contribution, Sustain. Dev. (2010).

[64] G. Walker, The role for 'community' in carbon governance, Wiley Interdiscip. Rev. Clim. Chang. 2 (5) (2011) 777–782, https://doi.org/10.1002/wcc.137.

[65] G. Seyfang, S. Hielscher, T. Hargreaves, M. Martiskainen, A. Smith, A grassroots sustainable energy niche? Reflections on community energy in the UK, Environ. Innov. Soc. Trans. 13 (2014) 21–44, https://doi.org/10.1016/j.eist.2014.04.004.

[66] G. Walker, P. Devine-Wright, Community renewable energy: what should it mean? Energy Policy 36 (2) (2008) 497–500, https://doi.org/10.1016/j.enpol.2007.10.019.

[67] F.D. Musall, O. Kuik, Local acceptance of renewable energy-a case study from Southeast Germany, Energy Policy 39 (6) (2011) 3252–3260, https://doi.org/10.1016/j. enpol.2011.03.017.

[68] L. Gorroño-Albizu, K. Sperling, and S. Djørup, "The past, present and uncertain future of community energy in Denmark: Critically reviewing and conceptualising citizen owner- ship," *Energy Res Soc Sci*, vol. 57, no. November 2018, p. 101231, 2019, doi:10.1016/j. erss.2019.101231.

[69] G. Dóci, B. Gotchev, When energy policy meets community: rethinking risk percep- tions of renewable energy in Germany and the Netherlands, Energy Res. Soc. Sci. 22 (2016) 26–35, https://doi.org/10.1016/j.erss.2016.08.019.

[70] V. Azarova, J. Cohen, C. Friedl, J. Reichl, Designing local renewable energy communities to increase social acceptance: evidence from a choice experiment in Austria, Germany, Italy, and Switzerland, Energy Policy 132 (January) (2019) 1176–1183, https://doi.org/10.1016/j.enpol.2019.06.067.

[71] V. Brummer, "Community energy – benefits and barriers: A comparative literature review of Community Energy in the UK, Germany and the USA, the benefits it provides for society and the barriers it faces," *Renewable and Sustainable Energy Reviews*, vol. 94, no. November 2017, pp. 187–196, 2018, doi:https://doi.org/10.1016/j.rser.2018.06.013.

[72] B.J. Kalkbrenner, J. Roosen, Citizens' willingness to participate in local renewable energy projects: the role of community and trust in Germany, Energy Res. Soc. Sci. 13 (2016) (2016) 60–70, https://doi.org/10.1016/j.erss.2015.12.006.

[73] L. Middlemiss, B.D. Parrish, Building capacity for low-carbon communities: the role of grassroots initiatives, Energy Policy 38 (12) (2010) 7559–7566, https://doi.org/10.1016/j.enpol.2009.07.003.

[74] F.D. Musall, O. Kuik, Local acceptance of renewable energy-a case study from Southeast Germany, Energy Policy 39 (6) (2011) 3252–3260, https://doi.org/10.1016/j.enpol.2011.03.017.

[75] C. Romero-Rubio, J.R. de Andrés Díaz, Sustainable energy communities: a study contrasting Spain and Germany, Energy Policy 85 (2015) 397–409, https://doi.org/10.1016/J.ENPOL.2015.06.012.

[76] S. Becker, C. Kunze, Transcending community energy: collective and politically motivated projects in renewable energy (CPE) across Europe, People, Place and Policy Online 8 (3) (2014) 180–191, https://doi.org/10.3351/ppp.0008.0003.0004.

[77] G. Seyfang, J.J. Park, A. Smith, A thousand flowers blooming? An examination of community energy in the UK, Energy Policy 61 (2013) 977–989, https://doi.org/10.1016/j. enpol.2013.06.030.

[78] B. Purvis, Y. Mao, D. Robinson, Three pillars of sustainability: in search of conceptual origins, Sustain. Sci. 14 (3) (2019) 681–695, https://doi.org/10.1007/s11625-018-0627-5.

[79] R. Hansmann, H.A. Mieg, P. Frischknecht, Principal sustainability components: empirical analysis of synergies between the three pillars of sustainability, Int J Sust Dev World 19 (5) (2012) 451–459, https://doi.org/10.1080/13504509.2012.696220.

[80] B.K. Sovacool, Energy policymaking in Denmark: implications for global energy security and sustainability, Energy Policy 61 (2013) 829–839, https://doi.org/10.1016/j.enpol.2013. 06.106.

[81] M. Martiskainen, "Developing Community Energy Projects: experiences from Finland and the UK," p. 315, 2014.

[82] J.C. Rogers, E.A. Simmons, I. Convery, A. Weatherall, Public perceptions of opportunities for community-based renewable energy projects, Energy Policy 36 (11) (2008) 4217–4226, https://doi.org/10.1016/j.enpol.2008.07.028.

[83] J. Hicks and N. Ison, "An exploration of the boundaries of 'community' in community renewable energy projects: Navigating between motivations and context," *Energy Policy*, vol. 113, no. October 2017, pp. 523–534, 2018, doi:https://doi.org/10.1016/j.enpol.2017.10.031.

[84] T. Van Der Schoor, B. Scholtens, Power to the people: local community initiatives and the transition to sustainable energy, Renew. Sust. Energ. Rev. 43 (2015) 666–675, https://doi.org/10.1016/j.rser.2014.10.089.

[85] F. Mey, "the Role of Institutional Factors in Community Renewable Energy Development : a Three Country Comparison," no. August, p. 3007, 2015.

[86] C. Chaichana, W. Wongsapai, D. Damrongsak, K.N. Ishihara, N. Luangchosiri, Promoting community renewable energy as a tool for sustainable development in rural areas of Thailand, Energy Procedia 141 (2017) 114–118, https://doi.org/10.1016/j. egypro.2017.11.022.

[87] D. Süsser, A. Kannen, 'Renewables? Yes, please!': Perceptions and assessment of community transition induced by renewable-energy projects in north Frisia, Sustain. Sci. 12 (4) (2017) 563–578, https://doi.org/10.1007/s11625-017-0433-5.

[88] A. Sciullo, et al., Exploring Institutional and Socio-Economic Settings for the Development of Energy Communities in Europe, 2022, https://doi.org/10.3390/en15041597.

[89] A. Ebers Broughel and N. Hampl, "Community financing of renewable energy projects in Austria and Switzerland: Profiles of potential investors," *Energy Policy*, vol. 123, no. December 2017, pp. 722–736, 2018, doi:https://doi.org/10.1016/j.enpol.2018.08.054.

[90] J. Marquardt, A struggle of multi-level governance: promoting renewable energy in Indonesia, Energy Procedia 58 (2014) 87–94, https://doi.org/10.1016/j.egypro.2014.10. 413.

[91] G. Curran, Is renewable energy still green? Shaping Australia's renewable energy enterprise in an age of ecological modernisation, Env. Polit. 28 (5) (2019) 950–969, https://doi.org/10.1080/09644016.2018.1510215.

[92] S. Magnoni, A.M. Bassi, Creating synergies from renewable energy investments, a community success story from Lolland, Denmark, Energies (Basel) 2 (4) (2009) 1151–1169, https://doi.org/10.3390/en20401151.

[93] D. Toke, Wind power in UK and Denmark: can rational choice help explain different outcomes? Env. Polit. 11 (4) (2002) 83–100, https://doi.org/10.1080/714000647.

[94] N. Luangchosiri, T. Ogawa, H. Okumura, K.N. Ishihara, Success factors for the implementation of community renewable energy in Thailand, Energies (Basel) 14 (14) (2021), https://doi.org/10.3390/en14144203.

[95] R. Fernandez, Community renewable energy projects: the future of the sustainable energy transition? Int. Spect. 56 (3) (2021) 87–104, https://doi.org/10.1080/03932729.2021.1959755.

[96] S. Becker, C. Kunze, M. Vancea, Community energy and social entrepreneurship: addressing purpose, organisation and embeddedness of renewable energy projects, J. Clean. Prod. 147 (2017) 25–36, https://doi.org/10.1016/j.jclepro.2017.01.048.

[97] D. Ohlhorst, Germany's energy transition policy between national targets and decentra- lized responsibilities, J. Integr. Environ. Sci. 12 (4) (2015) 303–322, https://doi.org/10.1080/1943815X.2015.1125373.

[98] S. Salm, S.L. Hille, R. Wüstenhagen, What are retail investors' risk-return preferences towards renewable energy projects? A choice experiment in Germany, Energy Policy 97 (2016) 310–320, https://doi.org/10.1016/j.enpol.2016.07.042.

[99] T. Bauwens, B. Gotchev, L. Holstenkamp, What drives the development of community energy in Europe? The case of wind power cooperatives, Energy Res. Soc. Sci. 13 (2016) 136–147, https://doi.org/10.1016/j.erss.2015.12.016.

[100] D. Gielen, F. Boshell, D. Saygin, M.D. Bazilian, N. Wagner, R. Gorini, The role of renewable energy in the global energy transformation, Energ. Strat. Rev. 24 (January) (2019) 38–50, https://doi.org/10.1016/j.esr.2019.01.006.

[101] C. Nolden, J. Barnes, and J. Nicholls, "Community energy business model evolution: A review of solar photovoltaic developments in England," *Renewable and Sustainable Energy Reviews*, vol. 122, no. May 2019, p. 109722, 2020, doi: https://doi.org/10.1016/j.rser.2020. 109722.

[102] M. Schäfer, N. Kebir, K. Neumann, Research needs for meeting the challenge of decentralized energy supply in developing countries, Energy Sustain. Dev. 15 (3) (2011) 324–329, https://doi.org/10.1016/j.esd.2011.07.001.

[103] C. Sebi, A.L. Vernay, Community renewable energy in France: the state of development and the way forward, Energy Policy 147 (2020), https://doi.org/10.1016/j.enpol. 2020.111874.

[104] T. Van Der Schoor, B. Scholtens, Power to the people: local community initiatives and the transition to sustainable energy, Renew. Sust. Energ. Rev. 43 (2015) 666–675, https://doi.org/10.1016/j.rser.2014.10.089.

[105] G. Dóci, E. Vasileiadou, 'Let's do it ourselves' individual motivations for investing in renewables at community level, Renew. Sust. Energ. Rev. 49 (2015) 41–50, https://doi.org/10.1016/j.rser.2015.04.051.

[106] J. Rommel, J. Radtke, G. von Jorck, F. Mey, Ö. Yildiz, Community renewable energy at a crossroads: a think piece on degrowth, technology, and the democratization of the German energy system, J. Clean. Prod. 197 (2018) 1746–1753, https://doi.org/10.1016/J.JCLEPRO.2016.11.114.

[107] J. Cloke, A. Mohr, E. Brown, Imagining renewable energy: towards a social energy systems approach to community renewable energy projects in the global south, Energy Res. Soc. Sci. 31 (June) (2017) 263–272, https://doi.org/10.1016/j.erss.2017.06.023.

[108] A. Ambole, K. Koranteng, P. Njoroge, D.L. Luhangala, A review of energy communities in sub-saharan africa as a transition pathway to energy democracy, Sustainability (Switzerland) 13 (4) (2021) 1–19, https://doi.org/10.3390/su13042128.

[109] I.D. Ibrahim, et al., A review on Africa energy supply through renewable energy production: Nigeria, Cameroon, Ghana and South Africa as a case study, Energ.

Strat. Rev. 38, no. October (2021) 100740, https://doi.org/10.1016/j.esr.2021.100740.
[110] A. Ambole, et al., Mediating household energy transitions through co-design in urban Kenya, Uganda and South Africa, Energy Res. Soc. Sci. 55 (May) (2019) 208–217, https://doi.org/10.1016/j.erss.2019.05.009.
[111] F. Boamah, Desirable or debatable? Putting Africa's decentralised solar energy futures in context, Energy Res. Soc. Sci. (2020), https://doi.org/10.1016/j.erss.2019.101390.
[112] C. Muhoza, O.W. Johnson, Exploring household energy transitions in rural Zambia from the user perspective, Energy Policy 121 (May) (2018) 25–34, https://doi.org/10.1016/j.enpol.2018.06.005.
[113] J.M. Eder, C.F. Mutsaerts, P. Sriwannawit, Mini-grids and renewable energy in rural Africa: how diffusion theory explains adoption of electricity in Uganda, Energy Res. Soc. Sci. 5 (2015) 45–54, https://doi.org/10.1016/j.erss.2014.12.014.
[114] C. Kirubi, A. Jacobson, D.M. Kammen, A. Mills, Community-based electric Micro-grids can contribute to rural development: evidence from Kenya, World Dev. 37 (7) (2009) 1208–1221, https://doi.org/10.1016/j.worlddev.2008.11.005.
[115] X. S. Musonye, B. Davíðsdóttir, R. Kristjánsson, E. I. Ásgeirsson, and H. Stefánsson, "Integrated energy systems' modeling studies for sub-Saharan Africa: A scoping review," *Renewable and Sustainable Energy Reviews*, vol. 128, no. May, 2020, doi:https://doi.org/10.1016/j.rser. 2020.109915.
[116] E.M. Nkoana, Community acceptance challenges of renewable energy transition: a tale of two solar parks in Limpopo, South Africa, J. Energy South. Africa 29 (1) (2018) 34–40, https://doi.org/10.17159/2413-3051/2018/v29i1a2540.
[117] K. Klaniecki, I. A. Duse, L. M. Lutz, J. Leventon, and D. J. Abson, "Applying the energy cultures framework to understand energy systems in the context of rural sustainability transformation," *Energy Policy*, vol. 137, no. June 2019, p. 111092, 2020, doi:10.10 16/j.enpol.2019.111092.
[118] I. Capellán-Pérez, Á. Campos-Celador, J. Terés-Zubiaga, Renewable energy cooperatives as an instrument towards the energy transition in Spain, Energy Policy 123 (August) (2018) 215–229, https://doi.org/10.1016/j.enpol.2018.08.064.
[119] Z. Alam, Y. Watanabe, S. Hanif, T. Sato, T. Fujimoto, Community-based business on small hydropower (SHP) in rural Japan: a case study on a community owned SHP model of Ohito agricultural cooperative, Energies (Basel) 14 (11) (2021), https://doi.org/10.3390/en14113349.
[120] T. Bauwens, et al., Conceptualizing community in energy systems: a systematic review of 183 definitions, Renew. Sust. Energ. Rev. 156 (April) (2021) 2022, https://doi.org/10.1016/j.rser.2021.111999.
[121] K.S. Mboho, W. Akpan, D. Ukene, E.A. Ekoriko, Rural communities and Cooperative societies: a community-based alternative for sustainable socio economic development in Nigeria, Afr. J. Econ. Sustain. Develop. 7 (3) (2024) 57–70, https://doi.org/10.52589/ajesd-rshwm3cl.
[122] M. Njogu, P. Kimathi, and I. DaSilva, "Community-Developer Business Model Promoting Social Energy Enterprises (Case study of Mutunguru 7.8MW Community Driven Small Hydro Power Project)," in 2017 IEEE AFRICON, IEEE, 2017. doi:https://doi.org/10.1109/AFRCON.2017.8095643.
[123] G. Seyfang, J.J. Park, A. Smith, A thousand flowers blooming? An examination of community energy in the UK, Energy Policy 61 (2013) 977–989, https://doi.org/10.1016/J.ENPOL.2013.06.030.
[124] B. Ryszawska, M. Rozwadowska, R. Ulatowska, M. Pierzchała, P. Szymański, The power of co-creation in the energy transition—dart model in citizen energy communities projects, Energies (Basel) 14 (17) (2021), https://doi.org/10.3390/en14175266.
[125] A. Teladia and H. Van Der Windt, "A new framework for analysing local participation in community energy initiatives," in *IOP Conference Series: Earth and Environmental Science*, Institute of Physics, 2022, p. 36DUMMY. doi:https://doi.org/10.1088/1755-1315/1085/1/ 012034.
[126] IEA, IRENA, The World Bank, and World Health Organization, "Tracking SDG 7: The Energy Progress Report 2020," The World Bank, p. 176, 2020.
[127] T. Bauwens, Analyzing the determinants of the size of investments by community renewable energy members: findings and policy implications from Flanders, Energy Policy 129 (March) (2019) 841–852, https://doi.org/10.1016/j.enpol.2019.02.067.
[128] C.L. Azimoh, P. Klintenberg, F. Wallin, B. Karlsson, Illuminated but not electrified: an assessment of the impact of solar home system on rural households in South Africa, Appl. Energy 155 (2015) 354–364, https://doi.org/10.1016/j.apenergy.2015.05.120.
[129] K. Johansen, Blowing in the wind: a brief history of wind energy and wind power technologies in Denmark, Energy Policy 152 (2021), https://doi.org/10.1016/j.enpol. 2021.112139.
[130] L. Gorroño-Albizu, Ownership models for renewable smart energy systems: insights from Denmark and Sweden regarding onshore wind farms and district heating systems, Aalborg Univ. (2021), https://doi.org/10.54337/aau450851321.
[131] A.T. Gullberg, D. Ohlhorst, M. Schreurs, Towards a low carbon energy future - renewable energy cooperation between Germany and Norway, Renew. Energy 68 (2014) 216–222, https://doi.org/10.1016/j.renene.2014.02.001.
[132] F. Mey, M. Diesendorf, I. MacGill, Can local government play a greater role for community renewable energy? A case study from Australia, Energy Res. Soc. Sci. 21 (2016) 33–43, https://doi.org/10.1016/j.erss.2016.06.019.
[133] A. Schreuer and D. Weismeier-Sammer, *Energy cooperatives and local ownership in the field of renewable energy technologies: A literature review*, no. October. 2010. [Online]. Available: https://epub.wu.ac.at/2897/1/Literature_Overview_energy_cooperatives_final_(2).pdf.
[134] R. Rechsteiner, German Energy Transition (Energiewende) and What Politicians Can Learn for Environmental and Climate Policy vol. 23, no. 2, Springer, Berlin Heidelberg, 2021, https://doi.org/10.1007/s10098-020-01939-3.
[135] G. Walker, What are the barriers and incentives for community-owned means of energy production and use? Energy Policy 36 (12) (2008) 4401–4405, https://doi.org/10.1016/j. enpol.2008.09.032.
[136] M. Mendonça, S. Lacey, F. Hvelplund, Stability, participation and transparency in renewable energy policy: lessons from Denmark and the United States, Polic. Soc. 27 (4) (2009) 379–398, https://doi.org/10.1016/j.polsoc.2009.01.007.
[137] L.W. Li, J. Birmele, H. Schaich, W. Konold, Transitioning to community-owned renewable energy: lessons from Germany, Procedia Environ. Sci. 17 (2013) 719–728, https://doi.org/10.1016/J.PROENV.2013.02.089.
[138] V. Brummer, Community energy – benefits and barriers: a comparative literature review of community energy in the UK, Germany and the USA, the benefits it provides for society and the barriers it faces, Renew. Sust. Energ. Rev. 94 (June) (2018) 187–196, https://doi.org/10.1016/j.rser.2018.06.013.
[139] F. Hvelplund, Innovative democracy, political economy, and the transition to renewable energy. A full-scale experiment in Denmark 1976-2013, Environ. Res. Eng. Manag. 66 (4) (2014), https://doi.org/10.5755/j01.erem.66.4.6158.
[140] H. J. Kooij *et al.*, "Between grassroots and treetops: Community power and institutional dependence in the renewable energy sector in Denmark, Sweden and the Netherlands," *Energy Res Soc Sci*, vol. 37, no. September 2017, pp. 52–64, 2018, doi:https://doi.org/10.1016/j.erss. 2017.09.019.
[141] J. P. Petersen, "The application of municipal renewable energy policies at community level in Denmark: A taxonomy of implementation challenges," *Sustain Cities Soc*, vol. 38, no. December 2017, pp. 205–218, 2018, doi:https://doi.org/10.1016/j.scs.2017.12.029.
[142] A. Lagendijk, H.-J. Kooij, S. Veenman, M. Oteman, Noisy monsters or beacons of transition: the framing and social (un)acceptance of Dutch community renewable energy initiatives, Energy Policy 159 (2021) 112580, https://doi.org/10.1016/J.ENPOL.2021. 112580.
[143] F.D. Musall, O. Kuik, Local acceptance of renewable energy-a case study from Southeast Germany, Energy Policy 39 (6) (2011) 3252–3260, https://doi.org/10.1016/j. enpol.2011.03.017.
[144] H. J. Kooij *et al.*, "Between grassroots and treetops: Community power and institutional dependence in the renewable energy sector in Denmark, Sweden and the Netherlands," *Energy Res Soc Sci*, vol. 37, no. September 2017, pp. 52–64, 2018, doi:https://doi.org/10.1016/j.erss. 2017.09.019.
[145] C. Fraune, Gender matters: women, renewable energy, and citizen participation in Germany, Energy Res. Soc. Sci. 7 (2015) 55–65, https://doi.org/10.1016/j.erss.2015.02.005.
[146] C. Fraune, Gender matters: women, renewable energy, and citizen participation in Germany, Energy Res. Soc. Sci. 7 (2015) 55–65, https://doi.org/10.1016/j.erss.2015.02.005.
[147] B. Möller, Spatial analyses of emerging and fading wind energy landscapes in Denmark, Land Use Policy 27 (2) (2010) 233–241, https://doi.org/10.1016/j.landusepol.2009.06. 001.
[148] S. Becker, C. Kunze, M. Vancea, Community energy and social entrepreneurship: addressing purpose, organisation and embeddedness of renewable energy projects, J. Clean. Prod. 147 (2017) 25–36, https://doi.org/10.1016/j.jclepro.2017.01.048.
[149] J. Rommel, J. Radtke, G. von Jorck, F. Mey, Ö. Yildiz, Community renewable energy at a crossroads: a think piece on degrowth, technology, and the democratization of the German energy system, J. Clean. Prod. 197 (2018) 1746–1753, https://doi.org/10.1016/j. jclepro.2016.11.114.
[150] T. Obamuyi and F. Oladapo, "The Nigerian economy in the face of socio-political challenges," Int. J. Fin. Bank. Stud. *(2147-4486)*, vol. 5, no. 3, pp. 32–41, Apr. 2016, doi: 10.20525/ijfbs.v5i3.128.
[151] Agu and & Eneiga, Governance and anti-corruption measures in Nigeria: strategies for enhancing transparency, accountability and public trust, Int. J. Econ. Public Policy | IJEPP 8 (1) (2024), https://doi.org/10.5281/zenodo.12576796.
[152] IEA, Net zero by 2050: a roadmap for the global energy sector, Int. Energy Agency (2021) 224.
[153] United Nations, "World Population Prospects 2022," 2022. Accessed: Dec. 06, 2022. [Online]. Available: https://www.un.org/development/desa/pd/sites/www.un.org. development.desa.pd/files/wpp2022_summary_of_results.pdf.
[154] A. Nwozor, S. Oshewolo, G. Owoeye, O. Okidu, Nigeria's quest for alternative clean energy development: a cobweb of opportunities, pitfalls and multiple dilemmas, Energy Policy 149 (2021) 112070, https://doi.org/10.1016/j.enpol.2020.112070.
[155] A.S. Aliyu, J.O. Dada, I.K. Adam, Current status and future prospects of renewable energy in Nigeria, Renew. Sust. Energ. Rev. 48 (2015) 336–346, https://doi.org/10.1016/j.rser.2015.03.098.
[156] C. Nweke-Eze, "The Nigerian Electrification Project–An example of a successful rural electrification design?" Accessed: Sep. 22, 2023. [Online]. Available: https://www.rifs-potsdam.de/en/blog/2022/01/nigerian-electrification-project-example-successful-rural-electrification-design#:~:text=Nigeria%20has%20one%20of%20the,electrification% 20rate%20of%20only%2039%25.
[157] O. I. Okoro and U. B. Akuru, "Renewable energy investment in Nigeria : A review of the Renewable Energy Renewable energy investment in Nigeria : A review of the Renewable Energy Master Plan," no. August, 2014.
[158] N. V. Emodi, C. C. Emodi, G. P. Murthy, and A. S. A. Emodi, "Energy policy for low carbon development in Nigeria: A LEAP model application," *Renewable and Sustainable Energy Reviews*, vol. 68, no. August 2016, pp. 247–261, 2017, doi:https://doi.org/10.1016/j.rser.2016.09.118.

[159] Rural Electrification Agency, "Average electrification rate across the country — Rural Electrification Agency," Rural Electrification Agency.
[160] B. K. Sovacool *et al.*, "Sociotechnical agendas: Reviewing future directions for energy and climate research," Dec. 01, 2020, Elsevier Ltd. doi:https://doi.org/10.1016/j.erss.2020.101617.
[161] M. A. Nyasapoh, M. D. Elorm, and N. S. A. Derkyi, "The role of renewable energies in sustainable development of Ghana," Jul. 01, 2022, Elsevier B.V. doi:https://doi.org/10.1016/j.sciaf.2022.e01199.
[162] Decc, "The Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK," 2012.
[163] Vanguard, "FG hikes electricity tariff from N68_KwH to N225- vanguard news," Vanguard Newspaper. Accessed: Apr. 24, 2024. [Online]. Available: https://www.vanguardngr.com/ 2024/04/nerc-hikes-electricity-tariff-from-n68-to-n225-kwh/#:~:text=The%20Nigerian%20 Electricity%20Regulatory%20Commission,A%20consumers%20in%20the%20country.
[164] Punch, "Electricity woes persist as states fail to adopt new legislation," Punch News- paper. Accessed: Apr. 24, 2024. [Online]. Available: https://punchng.com/electricity-woes-persist-as-states-fail-to-adopt-new-legislation-2/.
[165] NEA, "Nigeria Electricity-Act-2023," 2023.
[166] R. Wüstenhagen, M. Wolsink, M.J. Bürer, Social acceptance of renewable energy innovation: an introduction to the concept, Energy Policy 35 (5) (2007) 2683–2691, https://doi.org/10.1016/j.enpol.2006.12.001.
[167] S. Pai, J. Emmerling, L. Drouet, H. Zerriffi, J. Jewell, Meeting well-below 2°C target would increase energy sector jobs globally, One Earth 4 (7) (2021) 1026–1036, https://doi.org/10.1016/j.oneear.2021.06.005.
[168] T. Bauwens, P. Devine-Wright, Positive energies? An empirical study of community energy participation and attitudes to renewable energy, Energy Policy 118 (March) (2018) 612–625, https://doi.org/10.1016/j.enpol.2018.03.062.
[169] T. Bauwens, Polycentric governance approaches for a low-carbon transition: the roles of community-based energy initiatives in enhancing the resilience of future energy systems, Green Energy Technol. 0 (9783319337524) (2017) 119–145, https://doi.org/10.1007/978-3-319-33753-1_6.
[170] P. Mirzania, A. Ford, D. Andrews, G. Ofori, G. Maidment, The impact of policy changes: the opportunities of community renewable energy projects in the UK and the barriers they face, Energy Policy 129 (February) (2019) 1282–1296, https://doi.org/10.1016/j.enpol.2019.02.066.
[171] R. Madriz-Vargas, A. Bruce, and M. Watt, "The future of Community Renewable Energy for electricity access in rural Central America," *Energy Res Soc Sci*, vol. 35, no. February 2017, pp. 118–131, 2018, doi:https://doi.org/10.1016/j.erss.2017.10.015.
[172] E.C.X. Ikejemba, P.B. Mpuan, P.C. Schuur, J. Van Hillegersberg, The empirical reality & sustainable management failures of renewable energy projects in sub-Saharan Africa (part 1 of 2), Renew. Energy 102 (2017) 234–240, https://doi.org/10.1016/j.renene. 2016.10.037.
[173] D. Liu, H. Xu, The politics of curtailment: multi-level governance and solar photovoltaic power generation in China, Env. Polit. 27 (5) (2018) 852–871, https://doi.org/10.1080/09644016.2018.1480920.
[174] D. McTavish, Politics and political strategies in multi-level systems, Crit. Perspect. Int. Public Sector Manag. 4 (May) (2015) 271–293, https://doi.org/10.1108/S2045-794420150000004011.
[175] S. Hampton, Policy implementation as practice? Using social practice theory to examine multi-level governance efforts to decarbonise transport in the United Kingdom, Energy Res. Soc. Sci. 38 (February) (2018) 41–52, https://doi.org/10.1016/j.erss.2018.01.020.
[176] I. Bache, "Multi-Level Governance in the European Union," *The Oxford Handbook of* Governance, no. May, p. 2022, 2012, https://doi.org/10.1093/oxfordhb/9780199560530.013.0044.
[177] K. F. F. Heidtmann and T. J. Selck, "Local level failure? Non-compliance of EU environmental policy within EU multi-level governance," Region. Fed. Stud., vol. 0, no. 0, pp. 1–20, 2021, doi:https://doi.org/10.1080/13597566.2021.1998006.
[178] M. Zürn, Unravelling multi-level governance systems, Br. J. Polit. Int. Rel. 22 (4) (2020) 784–791, https://doi.org/10.1177/1369148120937449.
[179] A. Genus, M. Iskandarova, Transforming the energy system? Technology and organisational legitimacy and the institutionalisation of community renewable energy, Renew. Sust. Energ. Rev. 125, no. February (2020) 109795, https://doi.org/10.1016/j.rser.2020.109795.
[180] O. Akinniyi, "Examining Universal Basic Education System in Nigeria," 2015. [Online]. Available: www.iiardpub.org.
[181] A. Festus Obun, O. V. Joseph, and E. M. Akan, "A Qualitative Analysis of Universal Basic Education Policy Implementation Strategies in Nigeria: Effective Management for Goals Realization," 2018. [Online]. Available: www.rsisinternational.org.
[182] H. S. Fathoni, A. B. Setyowati, and J. Prest, "Is community renewable energy always just? Examining energy injustices and inequalities in rural Indonesia," *Energy Res Soc Sci*, vol. 71, no. May 2020, p. 101825, 2021, doi:https://doi.org/10.1016/j.erss.2020.101825.
[183] S. Guerreiro, I. Botetzagias, Empowering communities–the role of intermediary organisations in community renewable energy projects in Indonesia, Local Environ. 23 (2) (2018) 158–177, https://doi.org/10.1080/13549839.2017.1394830.
[184] O. S. Ohunakin, M. S. Adaramola, O. M. Oyewola, and R. O. Fagbenle, "Solar energy applications and development in Nigeria: Drivers and barriers," Apr. 01, 2014, Elsevier Ltd. doi:https://doi.org/10.1016/j.rser.2014.01.014.
[185] International Energy Agency (IEA), "Nigeria- Countries and Regions- IEA," International Energy Agency.
[186] N. V. Emodi and N. E. Ebele, "Policies Enhancing Renewable Energy Development and Implications for Nigeria," vol. 4, no. 1, pp. 7–16, 2016, doi: 10.12691/rse-4-1-2.
[187] O.S. Ohunakin, S.J. Ojolo, O.O. Ajayi, Small Hydropower (SHP) Development in Nigeria: An Assessment, Elsevier Ltd., 2011, https://doi.org/10.1016/j.rser.2011.01.003.
[188] Global Data, "Nigeria Renewable Energy Policy Handbook, 2022 Update." Accessed: Jan. 11, 2023. [Online]. Available: https://www.globaldata.com/store/report/nigeria-renewable-energy-government-regulation-policy-analysis/.
[189] Nigeria Electrification Project, "THE NIGERIA ELECTRIFICATION PROJECT; World Bank," May 2018.
[190] R. E. Strategy, "Rural electrification strategy and implementation plan (resip)," no. November, pp. 1–28, 2017.
[191] Nigeria climate change Bill, CLIMATE CHANGE BILL, 2021," Jul. 2021.
[192] M.J. Page, et al., The PRISMA 2020 statement: an updated guideline for reporting systematic reviews, Syst. Rev. 10 (1) (2021), https://doi.org/10.1186/s13643-021-01626-4.