



Original research article

# Determinants of institutional change towards a sustainable energy transition in Ghana: A political economy analysis of solar photovoltaics<sup>☆</sup>

Callistus Agbaam<sup>a,\*</sup>, Ana Maria Perez Arredondo<sup>a,b</sup>, Kennedy Alatinga<sup>c</sup>, Katja Bender<sup>a,\*</sup>

<sup>a</sup> International Centre for Sustainable Development (IZNE), Bonn Rhein-Sieg University of Applied Sciences, Sankt Augustin, Germany

<sup>b</sup> Center for Development Research (ZEF), University of Bonn, Bonn, Germany

<sup>c</sup> Faculty of Planning and Land Management, SD Dumbo University of Business and Integrated Development Studies, Wa, Ghana

## ABSTRACT

The transition to sustainable energy systems does not only entail changes to existing technologies or infrastructure. It also involves significant changes in a country's institutional frameworks that are rarely examined. Anchored in institutional analysis, this paper analyses the political economy factors influencing institutional change towards a sustainable energy transition in Ghana, with a particular focus on solar photovoltaics (PVs). The findings indicate that even though progress has been slow moving and incremental, the process of institutional change is cumulative and constitutes a fundamental third-order change. Institutional legacies within the energy sector present strong but not prohibitive barriers to renewable energy adoption. Initially, the relatively homogenous nature of preferences among key actors facilitated the introduction of solar PV. However, conflicting interests among policymakers, who simultaneously support solar PVs and fossil-fuel agendas emerged during a later phase and undermined progress. The declining cost of solar PV systems over time has, nonetheless, provided new momentum for change. Environmental conditions or shocks exogenous to the reform domain have had mixed effects on Solar PV adoption. While Ghana's numerous power crisis exposed the inadequacies of hydro and thermal sources and created an opportunity for solar PVs, the discovery of oil and gas resources in 2007 significantly slowed change. Although international concerns about climate change and sustainable development have provided some momentum for policy change, perceived injustices in international relations between countries in the Global South and those in the Global North tend to slow the transition process down.

## 1. Introduction<sup>1</sup>

Recent developments in the global energy landscape underscore the urgent need to accelerate efforts towards achieving decarbonization and sustainability in energy use [1]. The heavy reliance on fossil-based energy systems presents significant threats to the environment, further worsening the current climate crisis [2]. Thus, in many countries, energy systems are currently undergoing profound changes with a focus on transitioning to low-carbon systems, especially those reliant on renewable energy sources such as solar and wind [3].

However, the transition to sustainable energy systems does not only entail changes to existing technologies or infrastructure, but it also involves significant changes in institutional frameworks such as policy guidelines, legislations and regulations that govern these systems [4,5].

Hence, sustainable energy transitions inherently entail processes of policy or institutional change (ibid). Yet, the dynamics of policy change or the resulting institutional trajectories from such processes may differ based on the specific type of renewable energy technology under consideration and influenced by a range of factors that may be highly context dependent [6,7].

Against this backdrop, this paper analyzes the determinants of institutional change towards a sustainable energy transition in Ghana with a focus on solar photovoltaics (PVs), following the analytical approach suggested by Bender et al. [8] drawing on Aoki [9,10], Dequech [11] and others. As evident in the extant literature, reforms or institutional responses governing renewable energy sources, including solar PVs in Ghana, dates back to the 1980s [12–14]. Tracing these developments over time, the process of institutional change has been

<sup>☆</sup> This research was supported by funding from the German Federal Ministry of Education and Research (BMBF), as part of the funding program “CLIENT II – International Partnerships for Sustainable Innovation”. Funding reference number: 03SF0567A-G. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The responsibility for the content of this publication lies with the authors.

\* Corresponding authors at: International Centre for Sustainable Development (IZNE), Bonn Rhein-Sieg University of Applied Sciences, Grantham-Allee 20, 53757 Sankt Augustin, Bonn, Germany.

E-mail addresses: [cagbaam@gmail.com](mailto:cagbaam@gmail.com) (C. Agbaam), [ana.perez@uni-bonn.de](mailto:ana.perez@uni-bonn.de) (A.M.P. Arredondo), [kalatinga@ubids.edu.gh](mailto:kalatinga@ubids.edu.gh) (K. Alatinga), [katja.bender@h-brs.de](mailto:katja.bender@h-brs.de) (K. Bender).

<sup>1</sup> We express our sincere gratitude to two anonymous referees for their constructive feedback and insightful comments. Our appreciation also extends to all interview partners in Ghana for their valuable time and commitment in supporting our research.

slowly moving in the energy sector. Until today, non-hydro renewable energy sources make up only 2.3 % of the total generation capacity [15]. Therefore, understanding the factors influencing these developments, and their long-term impact on the political feasibility or otherwise of supporting the diffusion of sustainable energy systems in Ghana remains highly relevant. Furthermore, although Ghana is endowed with various renewable energy resources, this paper focuses primarily on solar energy for two key reasons. First, solar energy remains the largest non-hydro renewable energy contributor to Ghana's energy mix [15]. Second, this paper forms part of a broader research project aimed at demonstrating the potential contribution of solar PVs in enhancing access to quality healthcare services in Ghana.<sup>2</sup>

This paper extends the existing literature on sustainable energy transitions in a number of ways. Firstly, it contributes to an enhanced understanding of the political economy factors that drive the evolution of various institutional frameworks or policy reforms governing clean energy transitions especially in a developing country context. As clearly highlighted in the comprehensive literature review by [16], although studies that seek to analyze the political economy of sustainable energy transitions are recently increasing, most contributions tend to focus on industrialized and high-income countries relative to low- and middle-income countries. Notable exceptions include for example [12,17–20]. However, given that clean energy transitions are increasing a global phenomenon, an expansive focus on low- and middle-income countries remains critical to the transition discourse.

Secondly, although energy transitions entail a process of institutional change, studies that attempt to analyze the political economy of sustainable energy transitions or reform dynamics using insights from an institutional change perspective remain relatively scarce. Notable exceptions include for example [4–6,21,22]. Lockwood [6] emphasizes the role of the institutional context in shaping policy feedback processes and divergent policy pathways in the UK and Germany. Becker et al. [5] also highlight the importance of path dependencies and illustrate the interplay between agency and structure in explaining the process of institutional change governing Hamburg's energy sector. Milchram et al. [4] develop a conceptual approach to address the role of values and normative principles in influencing institutional change. Rennkamp [21] explores how unequal power relations hinders institutional change in the context of decarbonization and climate change policy in South Africa, whereas Schoning and Zubaka [22] highlight how external influences and policy alignments provide an opportunity for institutional change towards renewables in the Ukrainian energy sector. By drawing on the analytical framework suggested by Bender et al. [8], this paper complements the existing approaches by offering a framework for classifying reform processes and explaining these processes by framing sustainable energy transitions as an outcome of collection action and distinguishing between endogenous and exogenous sources of institutional change. More specifically the paper explores the interplay between the initial institutional status quo, preferences of actors involved, information distribution and environmental conditions (reform context). This allows for a comprehensive understanding of reform dynamics by taking into consideration the multiple factors that influence institutional change.

Lastly, in the context of Ghana, although studies on renewable energy transition are burgeoning, a large chunk of the literature is focused on a review of existing renewable energy policies [23–25], analyzing Ghana's renewable energy potential [26], assessing the impact of renewable energy technologies on energy poverty and access [27–29], and exploring their link to the sustainable development goals in general [30,31]. As a matter of fact, studies that explicitly seek to provide a political economy analysis of sustainable energy transitions are still very limited. Acheampong and Tyce [32] present a political economy

analysis of perspectives and challenges of 'greening' the aluminium industry, an example of a heavy carbon-intensive industry. Sefa-Nyarko [33] examines how global politics and domestic aspirations intersect, complicating energy transitions from a justice and equity perspective. Pedersen [34] focuses exclusively on the role of donors and domestic political priorities in the deployment of renewable energy while Bawakyillenuo [35] analyzes the binding constraints to renewable energy investments in Ghana. This paper complements all these studies by examining the role of multiple factors from an institutional economics perspective.

The remainder of this paper is structured as follows: Section 2 presents the conceptual and analytical framework guiding the study. Section 3 describes the empirical methodology employed. Section 4 presents the empirical findings by first characterizing the dynamics of the reform process and thereafter explaining the factors that facilitate or hinder institutional change for solar PVs in the energy sector. Section 5 discusses the main findings and presents a conclusion.

## 2. Classifying and explaining reform dynamics: conceptual and analytical framework

### 2.1. Classifying the reform process

Generally, reforms involve processes of change that result from political decision-making [36,p. 20]. To enhance a comprehensive understanding of these processes of change or the reform trajectories, this paper draws on a classification scheme distinguishing between three key dimensions of change: (i) *Temporal baseline*, (ii) *Mode of change*, and (iii) *Scope of change* [8,pp.,2–3].

*Temporal baseline* also referred to as the initial status quo provides an indication as to when the reform subject first appeared on the agenda of political decision making. Given that this paper is concerned about institutional change towards solar PVs, the temporal baseline would signal the exact year that these first appeared on the political agenda.

The *mode of change* depicts the different stages involved in the reform process as well as the interdependencies between them. Following Howlett and Cashore [37], the mode of change is classified as either incremental (involving several steps) or non-incremental (involving only one major step). Furthermore, in line with Hinrichs and Kangas [38] incremental processes of change can be classified as cumulative when successive steps build on past steps or non-cumulative when subsequent steps diverge or reverse past steps.

Lastly, the *scope of change* describes the extent to which the contents of reforms deviate from the initial status quo [8,p. 2]. Drawing on Hall [39], three orders of change can be distinguished: first-order, second-order and third-order change. First-order change entails nominal deviation from status quo, for example minor adjustments to reform instruments, whereas second-order change entails fairly moderate deviations from the status quo such as a change in reform instruments. Third-order change involves major deviations from the status quo such as a change in goals [39, pp. 281–287]. Additionally, a different approach to capture the scope of change is presented by Streeck and Thelen [40,p.,20–26]. According to the authors, "Displacement" occurs when existing rules are replaced by new ones, while "layering" refers to the addition of new rules on top of existing rule components. When external conditions change the impact of rules though the rules themselves remain the same, it is called "drift". "Conversion" happens when institutions are redirected towards new goals or implemented in new ways although the rules component remain unchanged. Finally, Streeck and Thelen [40] also identify "exhaustion," a process that leads to the gradual breakdown and collapse of institutions.

### 2.2. Explaining reform dynamics and the determinants of institutional change

To explain the factors influencing the process of institutional change

<sup>2</sup> More information about the project 'Energy Supply for Healthcare Facilities in Ghana (EnerSHelF)' is available on the project's website: <https://enershelf.de/>.

for solar PVs, this paper draws on the actor-oriented analytical framework proposed by Bender et al. [8] in their analysis of long-term institutional change. Grounded within a game theoretical perspective, the analytical model frames the process of institutional change as a collective action problem where change is essentially an outcome of strategic interactions among different players involved in the game. The framework explores the interplay between conditions within a reform domain, including the initial institutional status quo, preferences of actors involved, information distribution and environmental conditions, i.e. the overall reform context, and how these factors provide the impetus for institutional change (see Fig. 1).

First, *existing institutions* also referred to as the *initial institutional status quo* define the current ‘rules of the game’ that govern the reform domain. These institutional arrangements “summarize the historical legacies influencing individual payoff structures of agents in the reform domain, define the shared behavioral and decision-making rules assigning authority at the initial status quo and represent the common knowledge.” [8, p. 3]. In the context of this paper, existing institutions may include for example, existing power regeneration sources, distribution infrastructure, as well as purchase and service delivery models. Given that they define the rules of engagement, when existing institutions become entrenched and induce path dependency, they complicate or obstruct the chances of reform by creating policy lock-ins and favoring incumbents [41,42].

The reform domain describes the specific policy area being considered and involves all agents with a marked interest in the reform process. *Preferences of agents* refer to their subjective evaluation of the reform agenda relative to maintaining the status quo. The preferences of agents consequently influence whether they support or oppose reforms. All things equal, when the preferences of agents are homogenous, it reduces the risk of cooperation problems and therefore increases the likelihood of change if the dominant coalition supports the reform. However, the likelihood of change becomes less likely when the dominant coalition is opposed to the reform.

Furthermore, *the type of uncertainty and the information structures* may also impede or facilitate the process of change. Although in their analytical framework Bender et al. [8] focus on explaining the effect of different types of uncertainty, in the context of this paper we focus on the degree of information available, particularly, on the distribution of information (information asymmetries). Given that the interest of all players may not be homogenous, information imbalances may lead to cooperation problems: If an agent has more information than other agents (private information) and interests between agents differ, the better-informed party has a strategic advantage to pursue its own interest. Thus, institutional change may become less likely if the agents with informational advantage are opposed to the reform, and more likely when such agents support the proposed reform.

*Environmental conditions* describe the *reform context*. They reflect the wider context within which the reform domain is embedded. Examples include the domestic socio-economic conditions of a country or the broader national and international institutional environment. Since the reform domain is embedded within the reform context, events or changes in the reform context may influence agents and how they interact with one another in the reform domain. Consequently, such exogenous changes may indirectly trigger institutional change by influencing either preferences of agents or the information structure in the reform domain [8, p. 4].

### 3. Methodology

The empirical analysis presented in this paper is based on a

combination of both primary and secondary data.<sup>3</sup> Primary data was collected using semi-structured interviews with relevant national-level stakeholders in Ghana's energy sector including government institutions (i.e., Ministry of Energy, Ghana Energy commission, Public Utilities Regulatory Council, Bui Power Authority) and NGOs/Civil society organizations (i.e., Association of Ghana Solar Industries, Africa Center for Energy Policy, the Renewable Energy Association of Ghana and the Kumasi Institute of Technology, Energy and Environment). We also interviewed individuals from donor institutions such as the World Bank, GIZ, UNDP, USAID, as well as independent experts and researchers working within the energy landscape in Ghana. All interviewees were purposively selected based on their expertise and long-standing engagement in Ghana's energy sector. Informed consent was obtained from all interviewees prior to the commencement of interviews. Anonymity was preserved throughout the research process by assigning codes to interview transcripts, with no personally identifying information retained. In all, about 17 national-level interviews were conducted between January 2021 and October 2022. Due to the global covid-19 pandemic, a majority of these interviews were conducted online via Webex and Microsoft Teams. The interviews were recorded, transcribed verbatim and analyzed using Atlas.ti. 22 based on a pre-defined coding scheme. This scheme was developed in alignment with the analytical framework discussed above to capture the factors that facilitate or hinder the process of institutional change, such as agent's preferences, information structure, historical legacies, domestic conditions and international institutional environment. Quotations from the interviews have been included to support the empirical arguments presented in Section 4.3. Additionally, secondary data including legal documents (e.g., laws, regulations, memorandums), policy and strategy documents, programme reports, newspaper articles and academic literature were also collected and analyzed qualitatively to provide a comprehensive understanding of the phenomena under study. Given that the analytical focus of this paper is to first of all present a detailed historical analysis of the reform process governing solar PVs from 1986 to 2022, a process tracing approach was employed. This method enabled the authors to explore various institutional responses over time, focusing on the mechanisms that generated them [43].

## 4. Results: the dynamics of institutional change for solar PVs in Ghana (1986–2022)

### 4.1. Country overview

Located on the west coast of Africa, Ghana is a lower-middle income country with a GDP per capita income of 2260.3 current US dollars in 2023 [44]. The annual real GDP growth rate averaged 6.9 % between 2017 and 2019 and decelerated to 0.5 % in 2020 due to the ravaging impact of the global Covid-19 pandemic and marginally improved at 2.9 % as at the close of 2023 [44]. Ghana is one of the few countries in the sub-region with a relatively stable and predictable political environment. Since 1992, the country has remained a competitive democracy and held nine successive peaceful elections, followed by a smooth transition of government. Over the last 25 years, poverty in Ghana has decreased significantly, although in recent years, the poverty rate appears to have stagnated. Inequality is also high with an estimated Gini coefficient of 43.5 as at 2016 [44].

Ghana has a relatively high electricity access rate of 88.85 %, although variations in electricity access exist across regions [15]. As of 2023, the total installed generation capacity for power plants in the country was 5639 MW. Of this, thermal generation accounted for 69.6 %, hydroelectric power contributed 28.1 % and non-hydro renewable

<sup>3</sup> Ethical clearance was granted by the Ghana Health Service Ethics Review Committee on 30 January 2020, under reference number GHS-ERC006/12/19. It was renewed and extended on 15 March 2021.

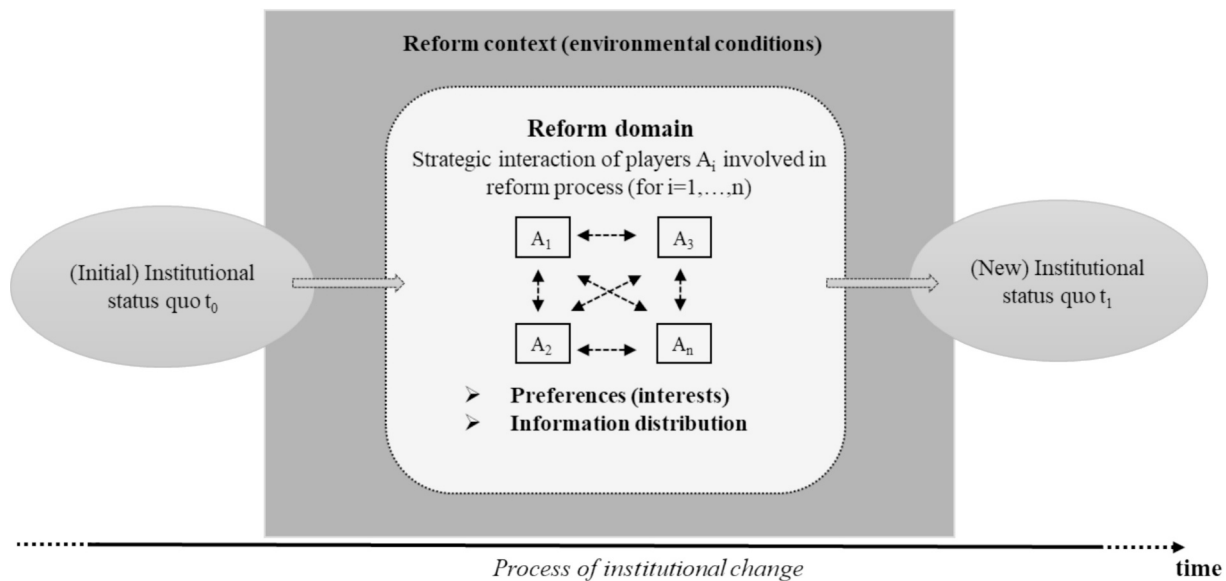


Fig. 1. The process of institutional change.  
Source: Adapted from [8]

energy constituted only 2.3 % of the total generation capacity [15]. In Ghana, both public and private companies participate in power generation. However, the state plays a significant role in the energy sector, with public entities like the Volta River Authority (VRA) and Bui Power Authority overseeing hydro electricity generation. While VRA is primarily focused on hydro power it is also partly involved in thermal power generation alongside private independent power producers. The Ghana Grid Company (GRIDCO) is responsible for transmitting power across the country, while the Electricity Company of Ghana (ECG) and the Northern Electricity Distribution Company (NEDCO) are in charge of power distribution. The Ministry of Energy oversees policy formulation in the energy sector, with the Ghana Energy Commission and the Public Utilities Regulatory Commission serving as key regulatory bodies within the sector.

#### 4.2. Classification of reform dynamics for solar PVs

To classify and assess the reform dynamics for solar PVs in Ghana's energy sector, this section applies the typology outlined in the previous section. A detailed timeline of events, illustrating the different phases of these reforms, is provided in the appendix.

##### 4.2.1. Temporal baseline

Although solar PVs were introduced in Ghana in the late 1960s by religious missions and NGOs, their formal recognition on the national policy agenda began in 1986, with the operationalization of the National Energy Board (NEB) which had been established in 1983. Amid a severe energy crisis in the early to mid-1980s, the NEB was tasked with conducting research and development activities to assess the viability of renewable energy technologies, including solar PVs, as a complimentary source for rural electrification in Ghana [14]. This period therefore marked the beginning of national policy discussions on solar PVs in Ghana.

##### 4.2.2. Mode of change

The reform process targeting renewable energy sources, particularly solar PVs can be categorized into three distinct phases: phase one (1986–2000), phase two (2001–2010) and phase three (2011–2022). Each phase highlights key developments and institutional responses aimed at promoting the diffusion of solar PVs in Ghana. As outlined below, the reform trajectory has been predominantly incremental and

cumulative, with a few instances of “back and forth” progress.

**4.2.2.1. Phase one (1986–2000) Demonstration, research and development.** The first phase of the reform process centered on research, development, and demonstration projects across parts of Ghana. Functional in 1986, the National Energy Board was tasked with the responsibility of planning the efficient use of the nation's energy resources and developing viable renewable energy technologies [14]. In line with its mandate and following the recommendations of a joint UNDP/World Bank energy assessment, the NEB issued a report in 1986 entitled “Issues, Strategies and Programmes in the Energy Sector under the Economic Recovery Programme” highlighting the urgent need for renewable energy development in Ghana [12,45]. Until its dissolution in 1991, the NEB developed and implemented several research and demonstration projects focusing on renewable energy technologies such as solar and wind [14,46]. Also, in 1989, the Ministry of Energy, launched the National Electrification Scheme with the goal of enhancing universal electricity access in Ghana by 2020. As part of this programme, many off-grid solar PV projects were initiated, targeting predominantly rural and remote communities [13].

In 1995, the Government of Ghana developed the “Vision 2020” agenda, a long-term policy framework that encouraged investment into research and development activities for solar energy [47]. Around the same time, to build on earlier progress, the then Ministry of Mines and Energy launched the Energy Sector Development Programme (ESDP) (1996–2000), highlighting the need for energy security and diversification, including solar power [14]. As part of ESDP, the Renewable Energy Development Programme (REDP) was developed as a sub-programme. In 1996, the REDP initiated a National Solar Energy Programme (NASEP) aimed at assessing and demonstrating the socio-economic and technical viability of solar technologies [14]. With support from donors and development partners, several notable off-grid solar demonstration projects were implemented during this period, including the Wechiau solar project, the Spanish off-grid solar project, the UNDP/GEF project, and the DANIDA/Ministry of Health solar project (Ibid).

Following a protracted power crisis in 1998/99, the government of Ghana announced a decision to reduce import duties on solar panels from 27 % to 5 % [14,p. 38]. Although this measure was aimed at opening the market for solar PVs and encouraging their use as an alternative energy source, it was largely ineffective due to

implementation challenges and the absence of clear policy directions [48].

#### 4.2.2.2. Phase two (2001–2010) Scale up and attempts to institutionalize.

In phase two, solar PVs remained central to the policy agenda for rural electrification. Many of the donor funded projects started under phase one, such as the Spanish/GoG and UNDP/GEF solar projects continued into the early years of phase two although new projects were also initiated. This phase was also characterized by several unique developments. In 2001, a new center-right government emerged after elections in the previous year and launched the policy framework titled “Energy for Poverty Alleviation and Economic Growth: Policy Framework, Programs and Projects”, aimed at diversifying the energy sector and promoting investments in renewable energy sources including solar [48]. In line with an agenda to promote sustainable rural electrification using solar PVs, in 2003, the government of Ghana requested support from the Japanese government to conduct a study on the viability of renewable energy for rural electrification in Northern Ghana. The study conducted between 2004 and 2006 proposed a master plan for the scale up of solar PV systems across the country, leading to the implementation of 20 rural electrification pilot projects later between 2008 and 2011 using the community solar business model [49].

Additionally, in 2003 and 2006, with World Bank support, Ghana developed its poverty reduction strategies (GPRS I & II) to guide inclusive socio-economic development. Both policy documents promoted private sector participation in the energy sector and encouraged diversification through renewable sources especially for rural electrification [50,51]. In 2006, with support from Denmark, Ghana developed the Strategic National Energy Plan (SNEP) 2006–2020, aimed at establishing a sustainable energy market in the country. For the first time, the government officially attempted to institutionalize renewable sources in the national energy mix by setting a contribution target of 10 % to be achieved by 2020 [47]. The plan also aimed to achieve 30 % rural electrification using renewables and encouraged public and private investments in large scale renewable energy projects since the government on its own was unable to fully meet the funding requirements for such projects (Ibid).

In pursuit of its electricity access agenda, in 2007, with support from the World Bank, the African Development Bank and the Swiss government, Ghana's government launched the Ghana Energy Development and Access Project (GEDAP). Among others, this project aimed at expanding solar PV deployment in rural communities using local financial institutions and the development of PV-based mini-grids [52]. To encourage adoption, the government introduced flexible end-user financing schemes, import duty waivers on generation equipment and VAT exemptions on solar products (Ibid). The push for renewable energy, including solar PVs, was further reinforced in the 2009 Ghana Shared Growth Development Agenda, the 2010 National Energy Policy and the Energy Sector Strategy and Development plan, all of which echoed the goal to achieve a 10 % renewable energy contribution to the national energy mix by 2020 [53].

#### 4.2.2.3. Phase three (2011–2022) Legislation and Institutionalization of policy measures.

After several years of experimenting and demonstrating the socio-economic viability of solar PVs in Ghana, the third phase of the reform process focused on institutionalization through legislation, operational changes and measures to incentivize large-scale deployments.

Although previous policies, such as the 2010 National Energy Policy and the Energy Sector Strategy and Development plan, all emphasized the importance of renewable sources for energy security in Ghana, there was broad recognition that specific legislation was needed to drive its implementation and regulation [12]. In response, the government passed the Renewable Energy Act (Act 832) in 2011 to create a legal framework that would encourage private sector investment in

renewable energy development [53]. Key provisions under the new law included a feed-in-tariff scheme, renewable energy purchase obligations, net metering, a licensing regime for commercial projects and the establishment of a renewable energy fund (Ibid). Despite challenges in implementation, some of these measures achieved notable success. For example, in 2012, the licensing guidelines for commercial service providers were developed, and in 2013, the first feed-in-tariffs for renewable energy sources, including solar PVs, were published but later revised and gazetted in 2014. A draft renewable energy purchase obligation was also prepared in 2013 and a net metering code developed in 2015 although it was later suspended [28]. Altogether, these measures spurred the development of several utility scale projects such as the 2.5 MW VRA solar PV project in Navrongo in 2014, and the 0.72 kWp solar PV park at the Noguchi Memorial Medical Research Center in 2015 (Ibid).

To accelerate Ghana's renewable energy goals, the National Solar Rooftop Programme was launched by the Ghana Energy Commission in 2016. The initiative aimed to facilitate the deployment of about 200,000 solar PV systems across public, residential and commercial buildings in the country [54]. Designed as a capital subsidy programme, beneficiaries of the programme either received a cash payment to cover the cost of solar panels or were supplied with solar panels after they had purchased all other components of the system in accordance with the Energy commission's requirements (Ibid). The primary objective was to help beneficiaries overcome the initial cost barriers associated with the purchase of solar PV systems in Ghana.

Also, to encourage local participation in Ghana's electricity sector, a local content and local participation law was enacted in 2017 [55]. In 2018, with support from USAID, the Government of Ghana developed the Integrated Power Sector Master Plan which also advocated for the inclusion of renewable energy sources such as solar PVs in the country's energy mix [56]. To address short-term planning issues, the Renewable Energy Master Plan was developed in 2019 with the objective to create a long-term framework for promoting renewable energy including solar PVs and mitigate climate change impacts [53]. However, in 2020, following new developments in the global renewable landscape, the Renewable Energy Act of 2011 was amended by the Renewable Energy (Amendment) Act, (Act 1045), replacing the feed-in-tariff regime with a competitive procurement scheme and mandating fossil fuel producers to invest in non-utility scale renewable energy to compensate for their emissions. The new law also introduced a net metering scheme to encourage self-generation of renewable energy primarily for reducing power costs and climate change mitigation [57].

Following the establishment of a supportive institutional framework, Ghana witnessed significant development of utility scale solar power projects, including the 20 MW BXC project, 6.5 MW VRA project in Lawra, 20 MW Meinenergy project and the 10 MW Bui solar power project [58]. However, in 2017, an executive fiat by the Minister of Energy directed the suspension of issuance of new provisional licenses for utility scale grid-connected solar PV and wind power projects. This decision was based on the non-operationalization of a significant number of previously issued licenses, as well as concerns over excess installed generation capacity resulting from numerous power purchase agreements signed by the Electricity Company of Ghana. [59]. In 2020, the government expanded the suspension to include embedded generation and other off-grid, large-scale Commercial and Industrial (C&I) solar installations. This decision was driven by concerns from distribution entities over the growing shift of bulk customers to off-grid solutions, which was reducing their expected revenue streams [60]. Nonetheless, in April 2023, the government of Ghana lifted the moratorium but tasked the Energy commission to develop clear guidelines for distributed renewable energy generation for all licensed entities in the sector [60].

In 2022, following calls for a clear energy transition strategy, the Ministry of Energy developed the National Energy Transition Framework (2022–2070). This long-term plan aims to achieve Ghana's

decarbonization goals by increasing the contribution of renewables in the national energy mix while balancing the need for socio-economic development through natural resources exploitation [61]. The projections outlined in Ghana's National Energy Transition Framework (2024) indicate the government of Ghana's strategic emphasis on nuclear energy, aiming for it to constitute over 50 % of the national energy mix by 2070, while non-hydro renewable energy sources are projected to account for approximately 20 %. The government's emphasis on nuclear energy seems to suggest that Ghana's primary motivation is to secure reliable and consistent base-load power supply to support its longstanding goals of energy security and industrialization. However, the projection for non-hydro renewable energy sources, such as solar and wind, to constitute 20 % of the energy mix by 2070 also suggests a more measured integration, possibly due to the associated challenges and significant investment requirements that such resources entail.

#### 4.2.3. Scope of change

Whereas the first and second phases represent second order change - integration of solar PV as a new additional energy source - the third phase indicates the shift to a third order change. Initially, from 1986 to 2000, the focus was on research, development and demonstration projects for solar PVs. In phase two (2001–2010), efforts expanded to scaling up deployments and attempts to integrate Solar PVs into the national energy mix. By phase three (2011–2020), the focus not only shifted from rural electrification to large scale commercial and utility projects, with new legislative measures facilitating the shift, but also assigning a stronger strategic role to renewables in the entire energy mix. Institutional change during this period involved adding new rules alongside existing ones, reflecting a layering approach.

Summing up, the solar PV reform process in Ghana mirrors a second-order change during phase 1 and 2 evolving to a third-order change in phase 3, characterized by incremental and cumulative policy measures layered on existing ones. Table 1 summarizes the main characteristics.

### 4.3. Explaining the factors influencing reform dynamics for solar PVs

#### 4.3.1. Endogenous factors (within reform domain)

4.3.1.1. *Pre-existing institutions (historical legacies)*. In the mid-1980s, Ghana's primary power source was hydroelectricity from the Akosombo and Kpong hydroelectric dams [62]. Before these dams, small-scale electricity from diesel-powered generators served some major cities and towns (Ibid). Consequently, the institutional structures and infrastructure of the power sector were largely centered on hydroelectricity and thermal energy.

From the start, solar PV reforms were small-scale and not aimed at displacing the existing hydro-electric regime, thus reducing the likelihood of conflicts in the reform domain. However, over time, the historical legacies governing the power sector did present barriers to change. For example, in the early 1990s, despite on-going solar demonstration projects in off-grid communities, the government prioritized grid electrification under the National Electrification Scheme [14]. Even with the RESPRO project, some communities in Northern Ghana that were marked for off-grid solar electrification or had such systems already installed were later connected to the grid. Consequently, this reduced the attention on off-grid solar in such communities

**Table 1**  
Characterization of the reform dynamics for solar PVs in Ghana (1896–2022).

Characterization	Solar PVs
Temporal baseline	1986
Mode of change	Incremental; largely cumulative
Scope of change (I)	2nd - 3rd order change
Scope of change (II)	Layering

Source: Authors.

[63]. More so, in the early 1990s, amid the hydroelectric power crisis, the government re-focused its efforts on thermal power generation with the construction of the Takoradi thermal plants, reinforcing existing path dependencies [62].

Also, despite the 2011 Renewable Energy Act, the institutional legacies of hydro and thermal energy, delayed development of grid codes for renewable energy integration until 2015. A net metering scheme initially piloted in 2015 was suspended due to technical, operational, and financial concerns from the Electricity Company of Ghana [28]. Furthermore, during the 2012–2016 power crisis, the government, in need of a quick fix, prioritized thermal power, signing multiple “take or pay” power purchase agreements with independent producers, leading to excess generation capacity [29]. Consequently, a ministerial directive suspended new licenses for utility scale solar PV and wind projects, despite policy targets to increase non-hydro renewable energy in the national energy mix by 10 %.

During the interviews, a stakeholder remarked that:

(...) with the current situation that we find ourselves in, driving up solar and integrating it in a large scale into our energy mix will be a little bit difficult until probably we overcome all these excess capacity challenges. (*National Level Interview No. 17*)

Hence, it may be concluded that the institutional architecture of the energy sector built on the dominance of hydroelectricity and thermal generation has induced path dependencies, hindering the adoption of renewables such as solar PVs in the energy sector. As previously mentioned, although Ghana's installed generation capacity is 5639 MW, the actual dependable capacity is often lower due to practical challenges such as inconsistent fuel supply, hydrological variability, infrastructural deficits, and financial constraints [60]. Since the existing infrastructure and financial models in the energy sector are primarily designed for conventional power sources like hydro and thermal, failing to address these underlying issues further complicates and restricts the integration of additional power sources, including renewable energy.

4.3.1.2. *Preferences of key stakeholders*. The solar PV reform domain includes key stakeholders such as policy makers, sector regulators, power generation and distribution companies, non-governmental and civil society organizations, professional associations and donor agencies. As it will be shown, while most stakeholders support Solar PVs, some conflict of interest, particularly from policy makers and state entities such as the Ghana National Petroleum Corporation (GNPC) can be observed.

In the early stages of the reform process, Ghana's development partners, including bilateral and multilateral agencies, played an instrumental role in promoting renewable energy and positioning solar PVs on the policy agenda. They provided funding for demonstration projects, research, technical assistance, and policy design support to enable renewable energy diffusion. For example, in the 1990s, donor agencies like the World Bank, CIDA, DANIDA, GTZ, JICA and the Spanish government funded solar demonstration projects [14]. The Strategic National Energy Plan (2006–2020) was developed with Danish support, while the 2019 Renewable Energy Master Plan was also developed through the support of the UNDP and the Chinese government. Other donors, such as the African Development Bank, USAID and the Swiss government have also contributed significantly to the process of change. During the interviews, an independent expert observed that:

They [donors] been extremely instrumental, they have been around all along from the early 1990s, (...) I remember that the renewable energy development program that started in 2000 was funded by the Danish (...). The Spanish have also done some projects with the Ministry of Energy (...). GIZ is supporting the net metering, they have set up an energy resource center with AGI to provide advisory services to members who would like to switch to renewables or solar.

The World Bank has played a role. I mean, the big bilateral and multilateral agencies have all played quite a bit of a role here. (*National Level Interview No. 6*)

In addition to donors, civil society groups such as the Africa Center for Energy Policy and Institute of Energy Security, and industry associations such as the Association of Ghana Solar Industries and the Renewable Energy Association of Ghana have supported Solar PV reforms through advocacy and coalitions-building. No major conflicts have arisen from state-owned power generation companies such as the Volta River Authority and the BUI Power Authority, as both entities have integrated solar into their generation mix. Also, the thermal independent power producers have not directly opposed solar PVs, possibly due to the “take or pay” nature of their contracts with the government, which guarantees payment regardless of electricity production from their thermal plants.

Lastly, policy makers from the Ministry of Energy and regulatory institutions such as the Energy Commission and PURC generally align with other stakeholders supporting Solar PVs. However, the focus of domestic policy makers on energy security and the need to power the country's industrialization drive using fossil fuel resources creates a conflict of interest. This reliance on fossil fuels for cost-effective base load generation contrasts with their renewable energy objectives. A representative of a civil society organization in the energy sector noted that:

(...) the Minister [of Energy] has been here speaking and trying to engage the minds of the public that the future is renewable, but their actions are not. You have GNPC [Ghana National Petroleum Corporation] that thinks that from a policy perspective they have to build their own capacity to produce Ghana's oil when no one needs it. When other companies are becoming renewable energy companies, integrating and (...) pushing for net zero, they (GNPC) want to be aggressive at fossil fuels, because that's where they see the future of their company. So that inconsistency clearly doesn't make Ghana appear strategic nor align with how transition conversations are happening globally. (*National Level Interview No. 10*)

Also, in a national television interview on the issue of Ghana's energy transition, a former deputy Minister of Energy, Dr. Mohammed Amin Adam explained that:

(...) Ghana will transition at our own pace, we want to produce oil and gas, we want to continue to do that because we need the resources, we need the revenue to develop our country, we need the value addition and therefore, we cannot abandon it now. (*TV3 News, April, 2022*)

Evidently, while the government seeks to integrate modern renewables as solar power into the energy mix, it also prioritizes exploiting the country's fossil fuel resources for socio-economic development. The argument that perceived trade-offs between economic development and energy security, on the one hand, and the renewable energy transition, on the other, act as a major barrier to change is also emphasized in [33]. Policymakers strongly assert that economic and energy needs can only be met by relying on fossil fuels, and that all available natural resources should be harnessed for economic development [6,33].

However, more recently the declining cost of solar energy generation provides a new momentum for change. Initially, high cost limited solar deployment to rural electrification. With technological advancements and the falling prices of solar panels especially, solar energy has become increasingly attractive for both off-grid and grid-connected use, prompting the need for policy measures to boost its adoption. During the interviews, an official from the Ministry of Energy pointed out that:

(...) at the time when some of us joined the solar industry, it was trading per kilowatt hour around \$17.00 and then this dropped so

rapidly, you know especially in the last five years solar got to grid parity and now it is even cheaper compared to what you get from conventional power sources. Solar is trading around 3 to 5 cents per kilowatt hour (...) and you would hardly get that from sources like natural gas (...). Solar has become so cheap, technology has matured, know-how exists, so it's very easy to deploy it. (*National Level Interview No. 9*)

During the passing of the Renewable Energy (Amendment) Bill, 2020 in parliament, the then Deputy Minister of Energy cited the declining cost of electricity from solar PVs as a key reason for replacing the feed-in-tariff regime with a competitive procurement scheme for renewable energy. He opined that:

The current pace of reduction the price of renewable systems and the resultant cost of electricity from renewable energy sources has rendered the feed-in-tariff regime a burden on consumers who have to pay for expensive solar photovoltaic power based on feed-in-tariff, while solar photovoltaic could be secured at a cheaper cost through competitive bidding. It has therefore become imperative that the existing Renewable Energy Act 2011 (Act 832) be amended to enable consumers of electricity in Ghana to benefit from the reduced cost of electricity generation from renewable energy sources through competitive procurement instead of the feed-in-tariff scheme [64].

Summing up, even though most agents are rather supportive of solar PV – except for the influential GNPC<sup>4</sup> – the need to power Ghana's industrialization in a cost-effective way constituted a barrier towards change in addition to prevailing path-dependencies. Nevertheless, the declining cost of solar PV systems and the increasing affordability of solar-generated electricity created a new momentum for change during the third phase.

**4.3.1.3. Information structures.** Since the 1980s, renewable energy reforms, including those for Solar PVs, have involved broad stakeholder consultations. In the first phase of the reform process, such consultations were mainly between the Ministry of Energy and donor institutions, with limited involvement of NGOs particularly those who were engaged in the implementation of various demonstration projects. However, in later phases, consultations expanded to include new government agencies within energy space, civil society, industry associations and the private sector. For instance, the National Solar Rooftop Programme involved extensive consultations led by the Energy Commission, engaging private companies, industry associations, local financial institutions and development partners to help raise awareness and discuss implementation modalities (Appiah, 2016). During the interviews, several key industry stakeholders confirmed their engagement with the Ministry of Energy and the Ghana Energy commission at various stages of policy and programme development:

(...) yes, there is engagement. I mean, in most cases, even before a law is passed, you are required to engage around it except that in recent times it is not as fluid as it used to be (...). (*National Level Interview No. 10*)

(...) Yes, [we] have been engaged in quite a number of projects that are tailored towards promoting renewable energy, particularly solar. In some instances, we are brought in at the point when it is being designed. But in most instances (...) they come for stakeholder engagement at the inception phase of the project allowing us to contribute or add on to it (...) and factor in different angles. (*National Level Interview No. 15*)

<sup>4</sup> It is crucial to acknowledge that even in the case of the GNPC, its complex history and the broader political economy dynamics shaping its institutional design and overall petroleum governance in Ghana reinforces its vested interest in fossil fuel production [65].

The engagement of key stakeholders in various stages of the reform process likely reduced information asymmetries among agents involved thereby creating a conducive sense of involvement and awareness. However, the extent to which these engagements translate into actual policy change or not cannot be corroborated by the available evidence.

#### 4.3.2. Exogenous factors (environmental conditions)

**4.3.2.1. Domestic socio-economic conditions.** The reform context shapes social interactions and can drive change by influencing stakeholders' preferences. In Ghana's energy sector, two important events - protracted power crisis and the discovery of oil and gas - have significantly influenced the reform trajectory for Solar PVs and new renewables in general in opposing directions.

Since the early 1980, Ghana has faced several power crises often resulting in load shedding or power rationing. These crises caused by factors such as prolonged drought affecting hydroelectric dams, global oil price hikes and shortages in the supply of natural gas, have played a crucial role in placing renewables including solar PVs on the political agenda. For example, solar PV demonstration projects from the late 1980s were largely in response to earlier power crisis. Also reform initiatives such as the import duty waivers for solar panels in 1998/99, and other economic incentives for renewable energy technologies often followed major power crisis in Ghana. Additionally, legislative actions such as the Renewable Energy Act of 2011 and programs like the National Solar Rooftop Programme in 2016 were also in response to institutional shortcomings highlighted during these crises. Overall, Ghana's numerous power crisis have significantly facilitated policy change towards the deployment of solar PVs. As one of the interviewees summarized:

I think the real impetus was provided by the power crisis that we experienced. We hear people talking about Solar PVs a lot when we have crisis. So, I think those were the real drivers. (*National Level Interview No. 6*)

However, in contrast to the effect of the power crisis, the discovery of oil and gas in 2007 created an incentive for Ghanaian policy makers to recalibrate the energy sector, undertaking institutional and regulatory reforms favoring thermal power generation. This shift slowed progress for renewable energy despite earlier goals of a 10 % contribution from non-hydro renewables including solar PVs by 2020. Implementation delays pushed this target to 2030 in the 2019 Renewable Energy Masterplan. Increased attention on developing the local petroleum and gas sector, with investments in new power plants such as the Sunon Asogli, CENIT energy, Kpone thermal power and the Atuabo Gas processing plant increased the contribution of thermal energy to 69 % of installed capacity by 2020, while renewables including solar accounted for only 1 % [58].

**4.3.2.2. International institutional environment.** In addition to domestic socio-economic conditions, international environmental concerns and commitments have also influenced Ghana's push towards a sustainable energy transition. Ghana signed the Kyoto protocol in 2003 committing itself to greenhouse gas emission reductions and joined the UN Sustainable Energy for All (SEforALL) initiative in 2012, developing its national action plan to include a focus on off-grid renewable energy for rural communities [53]. In 2015, Ghana adopted the sustainable development goals agenda which entailed a commitment to promoting affordable and clean energy for all. The country also signed and ratified the Paris Agreement on Climate Change in 2016. All these commitments implicitly reinforced the need to maintain clean energy sources such as solar PVs on the national policy agenda. This position was repeatedly expressed by many experts during the interviews:

I think for government of Ghana the main thing is for it to meet its international commitments to the Paris agreement and its NDCs [Nationally Determined Contributions], etc. (...) so that seems to be a major driver (...). (*National Level Interview No. 13*)

(...)Yes, a lot of the renewable energy drive is solely by the international space (...) I mean the Paris climate agenda and all of that. (*National Level Interview No. 11*)

(...) You know you cannot be part of some of these protocols and be seen not to be doing anything about it, so the targets and all these renewable energy diversifications that we are looking at are also contributing towards meeting the commitments that we have made under several of these climate protocols. (*National Level Interview No. 6*)

Overall, the international institutional environment, particularly, prevailing ideas around climate change and sustainable development have contributed in shaping policymakers' attitudes and actions towards renewable energy, driving crucial reforms and facilitating policy and institutional change.

However, as Sefa-Nyarko [33] demonstrates, the apparent support of international institutional arrangements must be interpreted more cautiously by considering perceived injustices in international relations. Although international donors appear unanimous in advocating for a shift towards renewable energy, their support is viewed with reservations by Ghanaian policymakers and civil-society groups, who highlight several injustices. Western governments, for instance, are perceived as having "double standards" in urging energy transitions in Ghana and other parts of the Global South while failing to meet the same standards themselves, despite countries in the Global North bearing most of the responsibility for the global climate crisis. In addition, Western governments are seen as renegeing on their commitments to provide capital and technology—or offering them only to serve their own economic interests [33, pp. 6–9]. Consequently, as long as these inequalities persist and governments in the Global North do not lead by example, this sentiment continues to hinder the pace of transition.

## 5. Conclusion

This paper analyzed the political economy of transitioning towards renewable energy, specifically solar PV, in Ghana by examining the dynamics and influencing factors of institutional change accompanying this transition.

Even though solar energy has been part of the national policy agenda since the 1980s, the share of renewable energy sources in the entire energy mix was only 2.1 % in 2022. Yet, despite the slow moving and incremental progress, the dynamics of institutional change are cumulative and can be grouped into three phases, starting with demonstration and research projects (1986–2000), followed by scaling up and attempts to institutionalize solar PV (2000–2010), and since then resulting in the legislation and regulation of solar PV (2010–2022). Thus, the entire process of institutional change for solar PV in the energy sector represents or can be characterized as a fundamental third-order change.

Looking at the factors shaping these reform dynamics, the analysis identified factors that both support and hinder change, thereby inducing counteracting dynamics. To start with, the institutional legacy of the energy sector is dominated by hydro and thermal energy-induced path dependencies presenting strong but not prohibitive barriers to renewable energy adoption. Within this given context, the analysis revealed that the initially surprisingly homogenous nature of preferences among key stakeholders—such as, donors, NGOs/CSOs and industry associations—initially reduced the likelihood of conflicts and cooperation problems, facilitating policy change and the introduction of solar PV. Broad stakeholder consultations by the Ministry of Energy and the Ghana Energy commission have helped provide relevant information to

stakeholders in the reform domain, stimulating change. However, conflicting interests among policymakers, who simultaneously support solar PVs and fossil-fuel agendas, the latter being supported by the influential Ghana National Petroleum Corporation (GNPC) emerged during the second phase and undermined progress. More recently, the declining solar PV prices and increasing affordability provided new momentum for change and have bolstered policy shifts during the third phase.

Environmental conditions have had mixed effects on Solar PV adoption. While Ghana's numerous power crisis have exposed the inadequacies of hydro and thermal sources and created an opportunity for solar PVs to feature on the policy agenda, the discovery of oil and gas resources in 2007 shifted policy makers' focus towards petroleum development, and slowing change. International concerns about climate change and sustainable development have also provided some momentum for policy change at least in terms of keeping renewable energies continuously on the policy agenda. However, perceived injustices in international relations between countries in the Global South and those in the Global North tend to slow the transition process down.

By addressing the case of long-term institutional change in Ghana the paper adds to the small but growing number of political economy analyses of energy transitions in low- or middle-income countries. Based on a conceptual framework that enables a classification of long-term processes of institutional change and considers multiple factors influencing institutional change it is possible to show that reform dynamics result from an interplay of factors inherent to the reform domain in question and to exogenous factors. "Context matters" as is exemplified by the role of the institutional status-quo as well as the impact of environmental conditions such as - for the case of Ghana - situations of power crisis, natural resource endowments or the broader international institutional context. Also, reform dynamics may accelerate or decelerate over time due to counteracting influences. More research is required, though, to better understand these changing reforms dynamics over time.

This paper has been concerned with the political economy of the

diffusion of PV solar energy in Ghana. However, the expansion of solar energy technologies, while promoting renewable energy use, is contributing to the growing problem of electronic waste (e-waste). If not properly managed, this e-waste could undermine the sustainability benefits of solar systems [66]. As has been shown for the case of Kenya, for example, investors in solar systems often do not fully account for e-waste generation in their investment decisions, posing long-term environmental challenges [67]. Even though Ghana is one of the few African countries with formal e-waste legislation,<sup>5</sup> its implementation remains inconsistent, partly due to difficulties in integrating the country's large informal sector into the formal waste management system [68,69]. It seems crucial that future research also addresses the political economy of implementing e-waste regulations and policies in Ghana and other countries in the Global South.

#### CRediT authorship contribution statement

**Callistus Agbaam:** Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization, Writing – review & editing, Writing – original draft. **Ana Maria Perez Arredondo:** Validation, Methodology, Conceptualization, Writing – review & editing. **Kennedy Alatinga:** Validation, Methodology, Conceptualization, Writing – review & editing. **Katja Bender:** Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization, 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. Supplementary data

### Appendix 1

Timeline of Reform process for Solar PVs in Ghana (1986–2022).

Year	Policy initiative/event
<b>Phase I</b>	
1986	National Energy Board (PNDC Law 62) becomes functional and tasked among others with the responsibility of planning the development of renewable energy.
1989	Ministry of Energy implements the National Electrification Scheme providing off-grid solar to rural communities.
1995	Ghana Vision 2020 policy document launched with calls for investment into R&D for solar energy.
1996	National Solar Energy Programme (NASEP) launched to demonstrate the social and economic viability of Solar energy in Ghana.
1998/99	Government of Ghana announces Solar PV import duty waiver/ reduction.
<b>Phase II</b>	
2003	Government of Ghana/JICA conducts study on the viability of renewable energy resources for rural electrification in Northern Ghana.
2003/ 2006	Government of Ghana develops poverty reduction papers (GPRS I & II), encourages private sector participation and renewable energy diversification.
2006	Strategic National Energy Plan (SNEP) 2006–2020 developed and set a 10 % target for Renewables in the national energy mix.
2007	Ghana Energy Development and Access Project (GEDAP) launched. Supports deployment of solar PVs to rural communities.
2010	National Energy Policy launched. Re-echoes 10 % contribution target for Renewables in the national energy mix.
<b>Phase III</b>	
2011	Renewable Energy Act (Act 832) enacted to provide a legal framework for the development of renewables including solar energy.
2012	Ghana signs up to Sustainable Energy for All initiative.
2014	2 MW VRA solar project & ARB Apex-Solar PV Electrification Project implemented.
2015	0.72 kWp solar PV park at the Noguchi Memorial Medical Research Center developed.
2016	National Solar Rooftop Programme launched.

(continued on next page)

<sup>5</sup> In 2016, Ghana introduced the Hazardous and Electronic Waste Control and Management Act (Act 917) and accompanying regulations (LI 2250) to control e-waste disposal. An eco-levy on all imported electrical and electronic equipment, including solar panels, was added in 2018.

## Appendix 1 (continued)

Year	Policy initiative/event
2017	Local content and local participation law was passed. Moratorium placed on issuances of new embedded generation licenses for utility scale grid-connected solar PV and wind power projects due to excess generation capacity issues.
2018	Integrated Power Sector Master Plan developed with support from USAID. Makes economic case for inclusion of renewables in energy mix
2019	Renewable Energy Master Plan developed to provide clear targets and boost deployment of renewables.
2020	Renewable Energy Act of 2011 amended and a new law the Renewable Energy (Amendment) Act, (Act 1045) duly passed.
2022	National Energy Transition Framework (2022–2070) developed to provide a long-term plan for achieving the country's decarbonization goals.

## Data availability

The participants of this study did not give written consent for their data to be shared publicly, so due to the sensitive nature of the research supporting data is not available.

## References

- [1] IRENA, World Energy Transition Outlook 2022. Available online at: <https://www.irena.org/Digital-Report/World-Energy-Transitions-Outlook-2022#:~:text=In%202022%2C%20the%20need%20for,highly%20dependent%20on%20fossil%20fuels,2022> (accessed on 26.02.2025).
- [2] IEA, World Energy Outlook 2022. Available online at: <https://www.iea.org/report-s/world-energy-outlook-2022,2022> (accessed on 26.02.2025).
- [3] Arent, D., Arndt, C., Miller, M., Tarp, F., Zinaman, O. Introduction and synthesis, in: Arent, D., Arndt, C., Miller, M., Tarp, F., Zinaman, O. (Eds.), *The political economy of clean energy transitions*. Oxford: Oxford University Press, 2017, pp. 3–15.
- [4] C. Milchram, C. Märker, H. Schlör, Understanding the role of values in institutional change: the case of the energy transition, *Energy Sustain. Soc.* 9 (2019) 46, <https://doi.org/10.1186/s13705-019-0235-y>.
- [5] S. Becker, R. Beveridge, A. Röhling, Energy transitions and institutional change: between structure and agency, in: L. Gailing, T. Moss (Eds.), *Conceptualizing Germany's energy transition*, Palgrave Pivot, London, 2016, pp. 21–42, [https://doi.org/10.1057/978-1-137-50593-4\\_3](https://doi.org/10.1057/978-1-137-50593-4_3).
- [6] M. Lockwood, Policy feedback and institutional context in energy transitions, *Policy. Sci.* 55 (2022) 487–507, <https://doi.org/10.1007/s11077-022-09467-1>.
- [7] M. Aklin, J. Urpelainen, *Renewables: the politics of a global energy transition*, MIT Press, Cambridge, MA, 2022.
- [8] K. Bender, B. Rohregger, B. Kinuthia, G. Ikua, E. Schüring, K. Alatinga, C. Adamba, N. Pouw, Different pathways of social protection reforms: an analysis of long-term institutional change in Kenya, *World Dev.* 131 (2021), <https://doi.org/10.1016/j.worlddev.2020.105210>.
- [9] M. Aoki, Endogenizing institutions and institutional changes, *J. Inst. Econ.* 3 (01) (2007) 1–31.
- [10] M. Aoki, *Toward a comparative institutional analysis*, The MIT Press, Cambridge, Massachusetts, 2001.
- [11] D. Dequech, Uncertainty: a typology and refinements of existing concepts, *J. Econ. Issues* 45 (3) (2011) 621–640.
- [12] R.A. Atuguba, F.X.D. Toukuu, Ghana's renewable energy agenda. Legislative drafting in search of policy paralysis, *Energy Res. Soc. Sci.* 64 (2020) 101453.
- [13] G.Y. Obeng, H. Evers, Solar PV rural electrification and energy-poverty: a review and conceptual framework with reference to Ghana, ZEF Working Paper Series No. 36 (2009).
- [14] I. Edjekumhene, S.B. Atakora, R. Atta-Konadu, A. Brew-Hammond, *Implementation of Renewable Energy Technologies- Opportunities and Barriers*, Ghana Country Case Study, UNEP Collaborating Centre on Energy and Environment, Denmark, 2001.
- [15] Ghana Energy Commission (GEC), *Energy Outlook for 2024*. Energy commission, Accra, 2024.
- [16] C. Agbaam, A. Perez Arredondo, K. Alatinga, K. Bender, The political economy of sustainable energy transitions: a literature review and a research agenda, *IZNE Working Paper Series No. 23/3* (2023), <https://doi.org/10.18418/978-3-96043-109-1>.
- [17] D. Alemzero, T. Acheampong, S. Huaping, Prospects of wind energy deployment in Africa: technical and economic analysis, *Renew. Energy* 179 (2021) 652–666, <https://doi.org/10.1016/j.renene.2021.07.02>.
- [18] K. Hochstetler, *Political economies of energy transition. Wind and solar power in Brazil and South Africa*, Cambridge University Press, Cambridge, 2020.
- [19] M. Jakob, C. Flachsland, J. Steckel, J. Urpelainen, Actors, objectives, context: a framework of the political economy of energy and climate policy applied to India, Indonesia, and Vietnam, *Energy Res. Soc. Sci.* 70 (2020), <https://doi.org/10.1016/j.erss.2020.101775>.
- [20] R.H. Pedersen, J. Poncian, The political economy of energy transitions in Africa: coalitions, politics and power in Tanzania, *Energy Res. Soc. Sci.* 117 (2024), <https://doi.org/10.1016/j.erss.2024.103712>.
- [21] B. Rennkamp, Power, coalitions and institutional change in south African climate policy, *Clim. Pol.* 19 (6) (2018) 756–770.
- [22] Schoning, S V. Zubaka, Energy transition in Ukraine: Renewable Energy in the context of Institutional Change, 2018, <https://emecon.eu/index.php/emecon/article/view/56/42> (accessed 27 February 2025).
- [23] C. Kuamoah, Renewable energy deployment in Ghana. *The hype, hope and reality*, *Insight on Africa* 12 (1) (2020) 45–64.
- [24] M.A. Oduro, S. Gyamfi, S. Asumadu-Sarkodie, F. Kemausuor, Evaluating the success of renewable energy and energy efficiency policies in Ghana: matching the policy objectives against policy instruments and outcomes, in: M. Al Quebesi, A. El-Kharouf, H. Serhad Soyhan (Eds.), *Renewable energy-resources, challenges and applications*, IntechOpen, 2020, <https://doi.org/10.5772/intechopen.88278>.
- [25] M. Sakah, F.A. Diawuo, R. Katzenbach, S. Gyamfi, Towards a sustainable electrification in Ghana: a review of renewable energy deployment policies, *Renew. Sust. Eng. Rev.* 79 (2017) 544–557, <https://doi.org/10.1016/j.rser.2017.05.090>.
- [26] S. Asumadu-Sarkodie, P.A. Owusu, The potential and economic viability of solar photovoltaic power in Ghana, *Energy Sources Part A Recover. Util. Environ. Eff.* 38 (5) (2016) 709–716, <https://doi.org/10.1080/15567036.2015.1122682>.
- [27] D.M. Sackey, D. Owusu-Manu, A. Acakpovi, F.K. Appiah, D.J. Edwards, R. M. Hosseini, Exploring the state of solar photovoltaic decentralization in Ghana: trends and success factors, *Earth Environ. Sci.* 1042 (2022) 012013, <https://doi.org/10.1088/1755-1315/1042/1/012013>.
- [28] B. Aboagye, S. Gyamfi, E.A. Ofosu, S. Djordjevic, Status of renewable energy resources for electricity supply in Ghana, *Sci. Afr.* 11 (2021) e00660, <https://doi.org/10.1016/j.sciaf.2020.e00660>.
- [29] I. Ackah, E. Banye, D. Bukari, E. Kyem, S. Suleman, Ghana's transition to renewable energy Mini-grids: an assessment of ownership, management and performance dynamics, *Int. J. Strat. Energy Environ. Plan.* 2 (3) (2020) 24–59, <https://doi.org/10.1201/9781003082408-10>.
- [30] M. Acheampong, Q. Yu, F. Cansu Ertem, L. Deba Enomah Ebude, S. Tanim, M. Eduful, M. Vaziri, E. Ananga, Is Ghana ready to attain sustainable development goal (SDG) number 7—a comprehensive assessment of its renewable energy potential and pitfalls, *Energies* 12 (3) (2019) 408, <https://doi.org/10.3390/en12030408>.
- [31] N.A. Obeng-Darko, Policy trends on renewable energy for decentralised electrification as a catalyst for achieving goal seven of the sustainable development goals in sub-Saharan Africa, The Case of Ghana, *Renew. Energy Law Policy Rev.* 8 (4) (2018) 12–24.
- [32] T. Acheampong, M. Tyce, Navigating the energy transition and industrial decarbonisation: Ghana's latest bid to develop an integrated bauxite-to-aluminium industry, *Energy Research & Social, Science* 107 (2024), <https://doi.org/10.1016/j.erss.2023.103337>.
- [33] C. Sefa-Nyarko, Ghana's National Energy Transition Framework: domestic aspirations and mistrust in international relations complicate 'justice and equity', *Energy Res. Soc. Sci.* 110 (2024), <https://doi.org/10.1016/j.erss.2024.103465>.
- [34] R.H. Pedersen, Towards a political economy of renewable energy in Ghana: a review. *MIASA working paper no. 2022 (4)*, University of Ghana, Accra, 2022.
- [35] Bawakyillenuo, S. Political economy analysis (PEA) of the binding constraints to renewable energy investment in Ghana (report for the green growth diagnostics for Africa project). ISSER and IDS, 2017.
- [36] I. Pavletic, Political competition, economic reform and growth: theory and evidence from transition countries, VDF Hochschulverlag AG an der ETH Zürich, Switzerland, 2010.
- [37] M. Howlett, B. Cashore, The dependent variable problem in the study of policy change: understanding policy change as a methodological problem, *J. Comp. Anal.* 11 (1) (2009) 33–46.
- [38] K. Hinrichs, O. Kangas, When is a change big enough to be a system shift? Small system-shifting changes in Finnish and German pension policies, *Soc. Policy Adm.* 37 (6) (2003) 573–591.
- [39] P. Hall, Policy paradigms, social learning, and the state: the case of economic policymaking in Britain, *Comp. Polit.* 25 (4) (1993) 275–296.
- [40] Streeck, W., Thelen, K. Introduction: Institutional change in advanced political economies, in: Streeck, W., Thelen, K. (Eds.), *Beyond continuity: institutional change in advanced political economies*. Oxford University Press, Oxford, 2005, pp. 1–39.
- [41] P. Pierson, Increasing returns, path dependence, and the study of politics, *Am. Polit. Sci. Rev.* 94 (2) (2000) 251–267.
- [42] I. Greener, Theorising path-dependency: how does history come to matter in organisations? *Manag. Decis.* 40 (6) (2002) 614–619.
- [43] R.H. Bates, A. Greif, M. Levi, J. Rosenthal, B.R. Weingast, *Analytic narratives*, Princeton University Press, Princeton, NJ, 1998.

- [44] World Bank. 2025. Data: Ghana. <https://data.worldbank.org/country/ghana> (accessed on 25 February 2025).
- [45] Ghana Energy Commission (GEC), Strategic National Energy Plan 2006–2020, Energy Commission, Accra, 2006.
- [46] F.O. Akuffo, Strengthening national energy policy and operations management capabilities, UNDP project GHA/89/003, 1992.
- [47] Government of Ghana, Ghana vision 2020 (the first step 1996-2000), presidential report on coordinated programme of economic and social development policies (policies for the preparation of 1996–2000 development plan). Accra, 1995.
- [48] J. Amankwah-Amoah, D. Sarpong, Historical pathways to a green economy: the evolution and scaling-up of solar PV in Ghana, 1980–2010, *Technol. Forecast. Soc. Chang.* 102 (2016) 90–101.
- [49] JICA, Human Resource Development for Disseminating PV Systems in the Republic of Ghana Final Report, JICA, Accra, 2011.
- [50] Government of Ghana, Ghana renewable energy master plan, Energy Commission, Accra, 2019.
- [51] F. Kemausuor, G. Obeng, G. Yaw, A. Brew-Hammond, A. Duker, A review of trends, policies and plans for increasing energy access in Ghana, *Renew. Sust. Energ. Rev.* 9 (2011) 5143–5554, <https://doi.org/10.1016/j.rser.2011.07.041>.
- [52] World Bank, Ghana Energy Development and Access Project (GEDAP), Project Appraisal Document, World Bank, Washington D.C, 2007.
- [53] Government of Ghana, Ghana Renewable Energy Master Plan, Energy Commission, Accra, 2019.
- [54] Appiah, F.K., National Rooftop Solar Programme. Presentation at 2<sup>nd</sup> Ghana Renewable Energy Fair, 2016, Accra International Conference Center, Accra, 2016.
- [55] Government of Ghana, Local Content and Local Participation (Electricity Supply Industry (ESI)) Regulations (L.I. 2354), Energy Commission, Accra, 2017.
- [56] Government of Ghana, Ghana Integrated Power System Master Plan, Energy Commission, Accra, 2018.
- [57] Government of Ghana, Renewable Energy Amendment Act, Act 1045, 2020.
- [58] Ghana Energy Commission (GEC), Energy Outlook for 2021. Energy commission, Accra, 2021.
- [59] Ghana Energy Commission (GEC), Public Notice: Suspension of Issuance of Provisional Wholesale Electricity Supply Licences. Energy Commission: Accra, Ghana, 2017, <http://www.energycom.gov.gh/public-notices/93-suspension-of-issuance-of-provisional-wholesale-electricity-supply-licences> (accessed 15 December 2022).
- [60] ACEP, From generation to distribution: investigating Ghana's power sector's value chain and its implications for reliable, affordable, and clean energy supply, ACEP and Oxfam, Accra, 2022.
- [61] Ministry of Energy, Ghana's National Energy Transition Framework (2022–2070), Ministry of Energy, Accra, 2024.
- [62] M.A. Opam, J.K. Turkson, Power sector restructuring in Ghana: reforms to promote competition and private sector participation, in: J.K. Turkson (Ed.), *Power sector reform in subSaharan Africa*, Palgrave Macmillan, London, 2000.
- [63] S. Bawakyillenuo, Policy and institutional failures: photovoltaic solar household system (PV/SHS) dissemination in Ghana, *Energy Environ.* 20 (6) (2009) 927–947.
- [64] Parliament of Ghana, The Renewable Energy (Amendment) Bill, 2020 Read the Third Time and Passed, <https://www.parliament.gh/news?CO=98>, 2020 (accessed 23 August 2021).
- [65] C. Sefa-Nyarko, The liminality of institutional design of petroleum governance in Ghana: political will, political settlements and contentions as defining factors, *Energy Res. Soc. Sci.* 92 (2022), <https://doi.org/10.1016/j.erss.2022.102799>.
- [66] U.E. Hansen, I. Nygaard, M. Dal Maso, The dark side of the sun: solar e-waste and environmental upgrading in the off-grid solar PV value chain, *Ind. Innov.* 28 (1) (2020) 58–78, <https://doi.org/10.1080/13662716.2020.1753019>.
- [67] U.E. Hansen, T. Reinauer, P. Kamau, H.N. Wamalwa, Managing e-waste from off-grid solar systems in Kenya: do investors have a role to play? *Energy Sustain. Dev.* 69 (2022) 31–40, <https://doi.org/10.1016/j.esd.2022.05.010>.
- [68] F.A.K. Bimpong, M.O. Asibey, D.K.B. Inkoom, Ghana's recently introduced e-waste regulatory policy: a hope for a better e-waste sector? *Waste Manag. Res.* 42 (11) (2024) 1031–1041, <https://doi.org/10.1177/0734242X231204457>.
- [69] E. Ndzibah, G. Pinilla-De La Cruz, A. Shamsuzzoha, Collaboration towards value creation for end-of-life solar photovoltaic panel in Ghana, *J. Clean. Prod.* 333 (2022), <https://doi.org/10.1016/j.jclepro.2021.129969>.