Institutional Quality: A hurdle or a catalyst to eliminating energy poverty in sub-Saharan Africa?

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Abstract

Energy poverty is considered a significant challenge in sub-Saharan Africa (SSA), impeding economic growth and social development. This study examines the role of institutional quality in addressing energy poverty across 45 SSA countries from 2002 to 2022, focusing on two critical indicators: access to clean cooking technologies and fuels and access to electricity. This study explores six institutional quality indicators: Control of Corruption, Regulatory Quality, Government Effectiveness, Rule of Law, Voice and Accountability, and Political Stability. At the aggregate level, institutional quality enhances clean cooking and electricity access, though effects vary by income group. In low-income countries, political stability and rule of law support electricity expansion, while in lower-middle-income countries, institutions promote clean cooking. In upper-middle-income countries, results are weaker. Overall, institutional quality matters for reducing energy poverty, but its impacts differ across contexts, highlighting the need for tailored governance reforms.

Keywords: Energy poverty, energy access, institutional quality, sub-Saharan Africa

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1. Introduction

Energy poverty is recognised as one of the most pressing challenges of the 21st century, affecting both developed and developing countries (Filho et al., 2024). However, experiences of energy poverty are not equal across these two groups. Energy poverty is often framed as an affordability issue in developed countries, whereas in developing countries, the main concern is insufficient basic clean energy access (Kez et al., 2024). Yet, energy poverty is much broader than just affordability and access. Reddy et al. (2000) provide a comprehensive definition, stating that energy poverty is an "absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe, and environmentally benign energy services to support economic and human development". As a result of its multidimensionality, the issue has drawn significant political, social, and academic attention to its causes and consequences.

The United Nations Sustainable Development Goal (SDG) 7, recognises its significance, by aiming for "access to affordable, reliable, sustainable, and modern energy for all" by 2030. Access to energy services is also crucial to fostering economic growth, human development, and meeting basic social needs (Gaye, 2008). Energy poverty impacts numerous development outcomes, including productivity, health, education, employment, life expectancy, and income inequality (Sarkodie & Adams, 2020; Adom et al., 2021; Filho et al., 2024). Addressing energy poverty is thus vital for achieving SDG 7 and supporting progress toward all other SDGs. However, notwithstanding its recognised importance, modern energy access in developing countries remains a "privilege rather than a right for many" (Acheampong et al., 2023). Hence, despite being prioritised on policy agendas, significant energy access challenges persist across Africa (Filho et al., 2024).

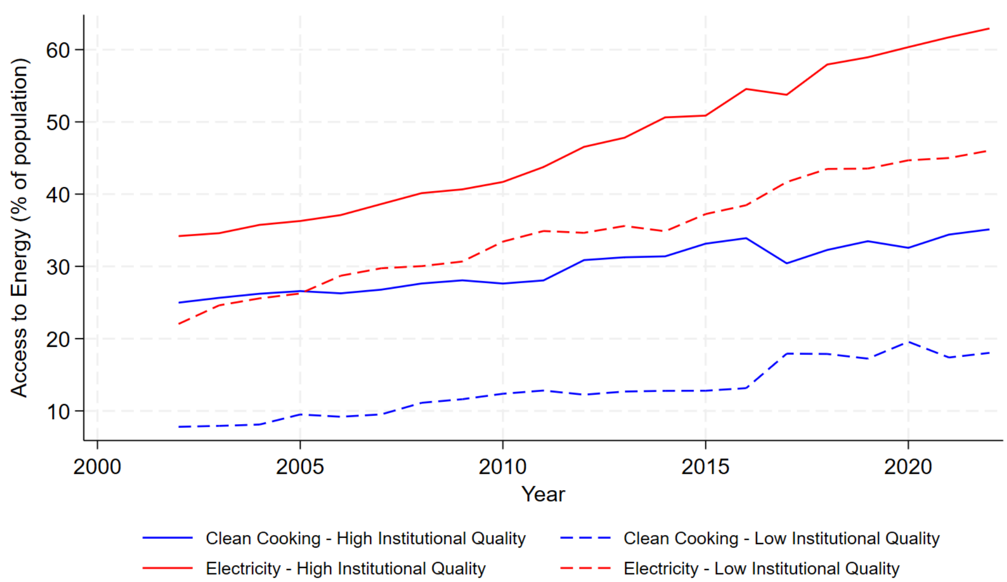
Globally, 760 million people lack access to electricity, and 2.3 billion people lack clean cooking facilities (International Energy Agency [IEA], 2023). Yet, most of those without these essential services are concentrated in sub-Saharan Africa (SSA), where 80% of the global population does not have electricity access, and 29 countries have clean cooking access rates below 20% (IEA, 2023). Consequently, SSA remains central to energy poverty discussions and an important region for studying this issue.

Africa's significant economic growth has yet to be translated into improved development for its people, who still lack access to essential services (Adom et al., 2021). The continent possesses abundant renewable energy resources and essential minerals critical to the global shift toward renewable energy. Still, its development remains hindered by an inefficient energy distribution system and unequal energy access (Filho et al., 2024). So, what is behind this misallocation of resources and policy failures? Filho et al. (2024) point to governance challenges—such as corruption and weak policy implementation—instead of technology, funding, or policy frameworks as Africa's primary drivers of energy poverty.

The literature emphasises institutional quality as a key factor in effectively addressing and reducing energy poverty (Bousnina & Gabsi, 2023; Nguyen & Su, 2022; Shittu et al., 2024a; Shittu et al., 2024b). Strong institutions, through better planning and efficiency, are essential for public good provision, attracting investment, creating policies to optimise resource mobilisation and allocation, and stimulating innovation and cost efficiency in energy technologies (Ahlborg et al., 2015; Aluko et al., 2023; Shittu et al., 2024a).

Identifying the determinants of energy access, particularly in SSA, cannot be overstated. Thus, this study contributes to the literature by examining the impact of institutional quality on both clean cooking and electricity access across 45 SSA countries from 2002 to 2022. Figure 1 shows the evolution of access to clean cooking and electricity in countries with high and low institutional quality from 2000 to 2022. Access to electricity is consistently higher than access to clean cooking, with the gap widening over time. In both cases, countries with higher institutional quality have higher access rates.

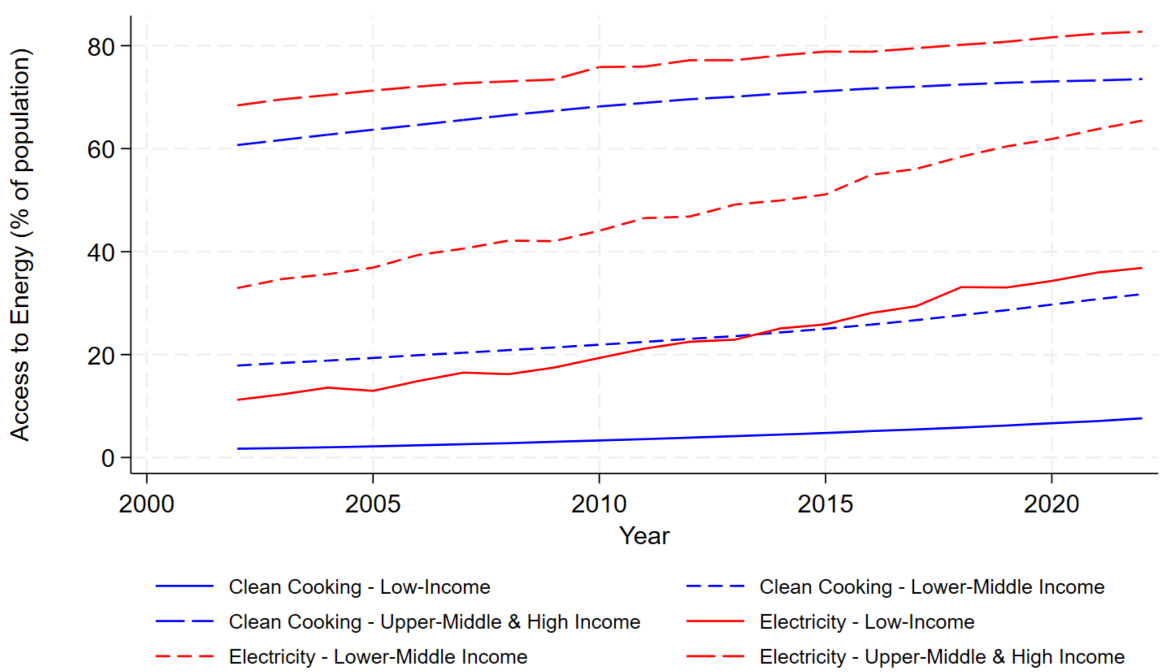
***Figure 1*. Trends in access to clean cooking and electricity by institutional quality level, 2000–2022.**



Countries with an index score below 0.5 are classified as low institutional quality, while those with a score of 0.5 or higher are classified as high institutional quality.

While not a novel topic, it is critical to recognise that energy poverty is not experienced uniformly across countries. Various factors influence the problem, and this study offers a unique perspective by examining the role of institutional quality across different income groups in the region. Figure 2 illustrates the clear disparities in energy access levels across these groups. Secondly, unlike much of the existing literature, which predominantly focuses on financial or demographic determinants and treats institutional quality as secondary or as a mediator of economic factors, this study highlights institutional quality as a central driver in addressing energy poverty. Lastly, this research contributes to the energy poverty conversation by analysing the relationship between institutional quality and energy access through a political science lens, which underscores how governance structures and institutional capacity shape the enabling environment for energy transitions.

***Figure 2*. Trends in access to clean cooking and electricity across low-, lower-middle-, and upper-middle/high-income countries, 2000-2022 (see Appendix Table A1 for income classifications).**



Energy poverty is mostly quantified through two key indicators: access to clean cooking technologies and fuels and access to electricity, which are crucial for improving quality of life and promoting sustainable development in the region. Six measures are employed to capture the multifaceted nature of institutional quality: Control of Corruption, Regulatory Quality, Government Effectiveness, Rule of Law, Voice and Accountability, and Political Stability and Absence of Violence. These indicators are analysed both individually and as a composite index. Following the World Bank's usage advisory, we emphasise that the Worldwide Governance Indicators (WGI) are designed for broad cross-country comparisons and to capture trends over time, rather than to provide precise country-level assessments. Accordingly, our analysis focuses on identifying regional associations between institutional quality and energy poverty in SSA, rather than on evaluating specific country reforms.

To address endogeneity, heteroskedasticity, autocorrelation and cross-sectional dependence, we use an Instrumental Variable Generalized Method of Moments (IV-GMM) procedure with Driscoll-Kraay standard errors (Baum et al., 2007; Aluko et al., 2023). The findings offer valuable insights into the relationship between the various aspects of institutional quality and energy poverty.

The article is structured as follows: the next section explores the political landscape of energy poverty, followed by a comprehensive literature review in Section 2. Section 3 outlines the theoretical framework, methodology, and data. Section 4 presents the empirical results and discussion. Finally, Section 5 concludes the study.

1.1. The Politics of Energy Poverty

Energy poverty, characterised by limited access to energy, is deeply influenced by political and institutional dynamics. North (1991) describes institutions as "the rules of the game in a society", which are the human-made constraints that shape political, economic, and social interactions. Institutions, encompassing formal rules and informal norms, play a critical role in fostering governance structures, economic growth, and social cohesion (North, 1990). Economic institutions shape the incentives and constraints faced by economic actors and reflect collective social decisions made with their expected impacts in mind, ultimately influencing broader economic results (Acemoglu et al., 2005).

Conflicts over economic institutions are frequently resolved in favour of groups with greater political power, shaped by formal political structures and resource-driven informal influence (Acemoglu et al., 2005). Political agendas often dictate which regions or communities benefit from investments in energy infrastructure (Asongu & Odhiambo, 2022). Additionally, entrenched corruption, weak governance, and regulatory inefficiencies hinder efforts to alleviate energy poverty, with public funds and international aid frequently failing to reach their intended beneficiaries (Acheampong et al., 2023; Bousnina & Gabsi, 2023; Filho et al., 2024). These political barriers perpetuate a cycle where marginalised populations remain trapped in energy poverty, limiting their economic opportunities and deepening social inequities.

The global push for renewable energy and sustainable development has added another layer of complexity to the politics of energy access (Asongu & Odhiambo, 2022). Governments face the dual challenge of transitioning to cleaner energy systems while ensuring energy access for all. However, energy transitions are not politically neutral; vested interests in fossil fuels and other traditional energy systems can obstruct reforms to expand access (Asongu & Odhiambo, 2022). Furthermore, international energy policies and agreements often place additional pressure on developing countries to decarbonise, which can divert resources from initiatives addressing immediate energy access challenges.

Policy design is often straightforward, but implementation and enforcement face challenges due to practical constraints, resistance, or resource limitations. Ultimately, tackling the politics of energy poverty demands technical and financial resources and a strong political commitment to achieving energy justice (Acheampong et al., 2023; Asongu & Odhiambo, 2022; Filho et al., 2024).

2. Literature review

For over a decade, researchers have sought to understand why SSA lags in energy access (Onyeji et al., 2012; Prasad, 2011). This study is novel in that it considers the individual impacts of six institutional factors—Control of Corruption, Regulatory Quality, Government Effectiveness, Rule of Law, Voice and Accountability, and Political Stability and Absence of Violence—alongside an aggregated institutional quality index, on both electricity and clean cooking fuel access across nearly all SSA countries (45 out of 48). Moreover, institutional quality is analysed as the primary explanatory variable rather than merely as a control, diverging from the approach commonly seen in the existing literature.

Onyeji et al. (2012) use cross-sectional data and an Ordinary Least Squares (OLS) regression to explore electricity access determinants in 60 emerging countries across Latin America, East Asia, South Asia, SSA, North Africa, and the Middle East. They categorise determinants into three groups: funding availability, population characteristics, and institutional quality, measured using the World Bank's Corruption Perceptions Index, Regulatory Quality Index, and Government Effectiveness Index. Their findings show that more than 90% of the variation in electricity access across these countries can be explained by poverty rates, domestic savings, corruption, and population dynamics. However, these factors impact SSA differently, with government effectiveness more strongly linked to electricity access in SSA than in other regions. Onyeji et al. (2012) conclude that strong political commitment and leadership are essential for expanding electricity access to SSA's rural poor.

Correspondingly, Ahlborg et al. (2015) aim to understand what explains the differences in per capita household electricity consumption across 44 African countries, examining the effects of institutional quality and democratic status from 1996 to 2009 using pooled data. They argue that household electricity consumption is a better measure than access rates—as it captures both access and reliability of supply—noting that the IEA's data on access to electricity can be inconsistent due to varying definitions and self-reporting. However, Aluko et al. (2023) point out that energy use measures fail to capture population-wide accessibility and the extent of progress needed to expand electricity infrastructure. To measure democracy, Ahlborg et al. (2015) use the Polity score from Freedom House, while institutional quality is proxied by the World Bank's indicators for the rule of law and control of corruption. The findings reveal a positive relationship between democratic institutions, institutional quality, and per capita household electricity consumption. Specifically, the average rule of law and control of corruption indicators, the rule of law, and democracy show a positive and significant impact. However, control of corruption does not have a considerable effect. The authors conclude that energy sector reforms and household electrification initiatives should prioritise addressing institutional constraints rather than focusing solely on financial resources.

Acheampong et al. (2023) investigate the relationship between globalisation, governance, and access to clean cooking fuels and technologies across 43 SSA countries from 2000 to 2017, using two econometric approaches: instrumental variable generalised method of moments (IV-GMM) and Driscoll-Kraay. While both methods agree on the direction of the relationship, they differ in the significance of the variables. Using the available six World Governance Indicators (WGI), they construct a composite index and find that globalisation and governance factors—such as control of corruption, government effectiveness, political stability, and the rule of law—drive the adoption of clean cooking technologies, with stronger governance enhancing the impact of globalisation.

Similarly, Aluko et al. (2023) use IV-GMM and apply principal component analysis (PCA) to create a composite index of the six WGI. However, they aim to analyse the degree to which governance influences the effect of foreign direct investment (FDI) on electricity access in 36 African countries from 2000 to 2017. Their findings indicate that FDI inflows generally enhance electricity access, while improved governance directly boosts access. However, their interaction reveals that FDI's impact is more significant in countries with weaker governance and diminishes in well-governed nations, likely due to nearing electricity access saturation in these contexts.

Bousnina and Gabsi (2023) examine the impact of public expenditure on energy poverty—measured by access to clean cooking fuels and technologies—in 20 SSA countries from 2006 to 2020 while accounting for institutional quality. They consider institutional quality through indicators like control of corruption, government effectiveness, democratic accountability, rule of law, and regulatory quality, which they average into a composite measure. Using a panel data threshold model with fixed effects and a difference GMM procedure (the latter employed for robustness), the study finds that government expenditure below 19.26% of GDP negatively affects access to clean cooking, whereas spending above this threshold significantly reduces energy poverty. Additionally, Bousnina and Gabsi (2023) find that institutional quality enhances access and amplifies the positive impact of public expenditure while mitigating its negative effects. The authors suggest that continuous improvements in institutional quality are essential for SSA economies to expand access to clean cooking. However, they specify a dynamic model, and the difference in GMM procedure does not correctly account for the endogeneity that results from it (Blundell & Bond, 1998).

Shittu et al. (2024a) consider the determinants of the clean cooking gap (the difference between the share of the population with access to clean cooking fuels and technologies and those without) for 65 developing countries from 2005 to 2022. They consider the determinants to be policies targeting economic management, social inclusion and equity, structural issues, public sector management and institutions. Variables under these categories were sourced from the World Bank's World Development Indicators, and cluster averages were computed to derive composite measures for each category. To investigate these relationships, the authors employ SYS-GMM and a dynamic panel threshold model. Their findings reveal that policies targeting economic management, social inclusion, and structural issues significantly reduce the clean cooking gap. However, they also find that a strict business regulatory environment and public sector management and institutions exacerbate the gap. Shittu et al. (2024a) argue that while strong institutions are essential for advancing clean cooking adoption, excessive rigidity can have unintended adverse effects. Thus, there is a need to balance regulatory strength with flexibility to ensure policies effectively promote clean cooking solutions.

3. Methodology and data

3.1. Theoretical Framework

This paper focuses on the importance of institutional quality in ensuring access to energy. The literature highlights the key institutional attributes essential for delivering public services like energy access, including efficient bureaucratic systems, skilled civil servants, regulatory quality, the rule of law enforcement, and the absence of corruption (Ahlborg et al., 2015; Aluko et al., 2023; Shittu et al., 2024a). In the African context, governance challenges such as ineffective policy implementation and corruption have been identified as the primary obstacles to attaining goals like SDG 7 (Filho et al., 2024).

To represent energy poverty, we focus on two widely used indicators: the share of the population with access to clean cooking technologies and fuels and the share with access to electricity (Acheampong et al., 2023; Bousnina & Gabsi, 2023; González Bautista et al., 2024). González Bautista et al. (2024) argue that assessing energy poverty objectively necessitates using more than one indicator. Garrone et al. (2019) explain that the electricity access indicator captures both infrastructural and non-infrastructural solutions, primarily reflecting the supply side of electricity provision. In agreeance are Aluko et al. (2023), highlighting the relevance of this variable, particularly in studies focused on Africa (which has the lowest electricity access rates globally) as it accounts for all communities, regardless of socioeconomic status. For clean cooking access, Bousnina and Gabsi (2023) underscore its importance in SSA, which, as of 2020, had the world's largest population lacking clean cooking solutions, with 82% relying on polluting methods. It is important to note that increasing these two measures means reducing energy poverty.

The explanatory variables include institutional quality, measured using the six Worldwide Governance Indicators (WGI) from the World Bank: control of corruption, regulatory quality, government effectiveness, rule of law, political stability and absence of violence/terrorism, and voice and accountability. These indicators are widely recognised in the literature as robust proxies for institutional mechanisms due to the WGI dataset's comprehensive nature and superior global coverage compared to alternative governance datasets (Aluko et al., 2023; Garrone et al., 2019). The WGI dataset aggregates governance-related data from over 30 global organisations, with regular updates, capturing diverse perspectives from numerous survey respondents and experts worldwide. Each indicator is scored on a scale from –2.5 (lowest) to 2.5 (highest). Definitions for all six indicators can be found in Table A2 in the Appendix. That being said, it is important to acknowledge their limitations. As highlighted in the World Bank's usage advisory, the WGI are intended for identifying broad patterns and trends rather than evaluating country-specific reforms, and they include margins of error reflecting the inherent imprecision of governance measurement. We therefore treat these indicators as proxies for institutional quality at the regional and income-group level, rather than as precise measures of country-level governance performance.

This study evaluates the individual impact of six institutional quality indicators on energy poverty measures and constructs a composite index to represent overall institutional quality. A positive relationship is expected for most indicators: control of corruption improves public spending efficiency and service delivery, regulatory quality attracts private sector investment in energy projects, and government effectiveness enhances infrastructure implementation and maintenance (Bousnina & Gabsi, 2023). Similarly, rule of law fosters entrepreneurship and economic stability, creating positive cycles for electrification (Filho et al., 2024), while political stability reduces risks of infrastructure damage from conflicts, enabling broader access (Ahlborg et al., 2015). The relationship between voice and accountability and energy access is expected to be positive but potentially weaker, as short political cycles may undermine long-term infrastructure investments, though democratic accountability still incentivises leaders to provide public goods in line with voter demands (Ahlborg et al., 2015). Building on the reviewed literature on institutional quality, this study hypothesises that a higher value for the institutional quality composite index corresponds to greater energy access, and thus lower levels of energy poverty.

Access to energy primarily reflects the supply side, requiring control variables to capture determinants of electricity demand and barriers to electricity infrastructure development (Garrone et al., 2019). Control variables include GDP per capita (GDP) and urbanisation (URB), common in the overarching literature (Aluko et al., 2023; Bousnina & Gabsi, 2023; González Bautista et al., 2024; Shittu et al., 2024a; Shittu et al., 2024b). GDP, a proxy for economic growth, is expected to have a positive relationship with energy access as rising incomes enhance job opportunities, purchasing power, and demand for energy, supporting the "energy ladder" theory that higher incomes lead to a shift from traditional to cleaner fuels (Acheampong et al., 2023; Aluko et al., 2023). Urbanisation's effect on energy poverty is mixed in the literature, though Acheampong et al. (2023) suggest that in most SSA countries, urban areas have better access to electricity and amenities. As migration to cities increases, governments are pressured to provide services like electricity, which aids clean cooking fuel adoption, and urban migrants, often benefiting from higher-paying jobs, can afford modern energy solutions (Acheampong et al., 2023).

3.2. Dataset

This study utilises a balanced annual panel data from 45 SSA countries from 2002 to 2022. The full list of countries is provided in Appendix Table A1, grouped by income according to the World Bank's 2022 fiscal year classification. We recognise that categorising countries by income is not an exogenous process and that reclassification over time can complicate panel analysis. To ensure consistency, we adopt the 2022 classification, which corresponds with the final year of our sample.

This choice maintains stability across the study period and prevents distortions from shifting group assignments.

Data for institutional quality indicators were sourced from the World Bank's Worldwide Governance Indicators (WGI) database. All other variables were obtained from the World Bank's World Development Indicators (WDI) database. Table 1 details the variables considered, with their definitions provided in Table A2 in the Appendix.

Table 1: Variables and Sources

Name	Variable	Units of measurement	Source
EP1	Access to clean cooking technologies and fuels	% of total population	(WDI, 2025)
EP2	Access to electricity	% of total population	(WDI, 2025)
CONT	Control of Corruption	Estimate of indicator	(WGI, 2025)
REGQ	Regulatory Quality	Estimate of indicator	(WGI, 2025)
GEFF	Government Effectiveness	Estimate of indicator	(WGI, 2025)
LAW	Rule of Law	Estimate of indicator	(WGI, 2025)
VOICE	Voice and Accountability	Estimate of indicator	(WGI, 2025)
STAB	Political Stability and Absence of Violence/Terrorism	Estimate of indicator	(WGI, 2025)
INST	A composite Institutional Quality index derived from Principal Component Analysis of the individual institutional aspects	Index	Authors' calculation
GDP	GDP per capita	PPP (constant 2021 international $)	(WDI, 2025)
URB	Urban population	% of total population	(WDI, 2025)

Note: All variables are used in their natural logarithmic form, except the normalised institutional quality proxies and composite index.

The sample was determined by data availability, and the aim was to include as many SSA countries as possible. Although the initial target was all 48 SSA countries, three were excluded due to significant data gaps: Eritrea lacked GDP per capita data; Liberia had electricity access data only from 2007 onward; and South Sudan lacked GDP per capita data and sufficient electricity access data. This left a final sample of 45 SSA countries with complete data for the percentage of the population with access to clean cooking technologies and fuels (EP1), percentage of the population with access to electricity (EP2), GDP per capita (GDP), urbanisation (URB), and governance indicators, including control of corruption (CONT), regulatory quality (REGQ), government effectiveness (GEFF), rule of law (LAW), voice and accountability (VOICE), and political stability (STAB).

We construct a composite institutional quality variable (INST) from the six governance indicators using Principal Component Analysis (PCA). This method was also used by Acheampong et al. (2023) and Aluko et al. (2023) in their studies considering the relationship between energy poverty and institutional quality. Alternatively, some studies create an overall measure by averaging selected institutional quality indicators (Ahlborg et al., 2015; Bousnina & Gabsi, 2023). However, Bittencourt (2012) motivates the use of PCA due to its ability to reduce omitted variable bias and model uncertainty while improving explanatory power.

In line with previous studies by Acheampong et al. (2023) and Aluko et al. (2023), we analyse both the composite institutional quality measure (INST) and its sub-components (CONT, REGQ, GEFF, LAW, VOICE, STAB) separately. Siddiqui and Ahmed (2013) highlight the importance of individual analyses for institutional quality indicators, as including multiple correlated indicators in a single regression model increases the risk of multicollinearity. To ensure consistency and facilitate interpretation, we normalise the INST and all sub-component variables to a scale ranging from 0 to 1, where higher values reflect better institutional quality (Aluko et al., 2023).

3.3. Econometric methodology

To assess the impact of institutional quality on access to clean cooking and electricity in SSA, we adopt a baseline specification following Bousnina and Gabsi (2023):

$$EP_{it} = \beta_0 + \beta_1 \mathrm{EP}_{\mathrm{it-1}} + \beta_2 \mathrm{INST}_{\mathrm{it}} + \beta_3 \mathrm{X}_{\mathrm{it}} + \varepsilon_{\mathrm{it}} \qquad (1)$$

Where i denotes the country and t denotes the year. EP_{it} is the energy poverty proxy, either access to clean cooking fuels and technologies (EP1) or access to electricity (EP2). $\mathrm{EP}_{\mathrm{it-1}}$ is the lagged dependent variable, capturing persistence in energy access. $\mathrm{INST}_{\mathrm{it}}$ is the vector of institutional variables, either the composite index ($\mathrm{INST}_{\mathrm{it}}$) or its sub-components (CONT, REGQ, GEFF, LAW, VOICE, STAB). X_{it} denotes a vector of control variables, which include indicators of economic growth (GDP) and urbanisation (URB). β_0 is the intercept and $\varepsilon_{\mathrm{it}}$ is the error term. β_1 measures the persistence of energy access, β_2 captures the impact of institutional quality on access, and β_3 reflects the impact of the control variables, ceteris paribus. Where appropriate, variables are transformed into their natural logarithms (ln).

Energy poverty—defined here as access to electricity and clean cooking fuels and technologies—remains particularly persistent or "sticky" due to several challenges. High capital costs and maintenance issues hinder the development of essential infrastructure, while limited household incomes may restrict access to modern energy solutions (Acheampong et al., 2023; Aluko et al., 2023). Weak policy frameworks and institutional constraints further delay or misdirect investments, often leaving rural communities underserved (Aluko et al., 2023). Moreover, technological and behavioural inertia can slow the transition away from traditional energy sources, reinforcing the cycle of energy poverty (Aluko et al., 2023; Filho et al., 2024). Given this persistence, lagging the dependent variable effectively captures the long-term nature of energy access challenges, with results in Appendix Tables A10 to A19 consistently confirming its significance.

As outlined in Section 2, existing literature has employed various panel econometric methodologies to explore the relationship between institutional quality and energy access. These include pooled models, fixed-effects models, and the Generalized Method of Moments (GMM) procedure. Among these, panel data methods are preferable over pooled models as they account for country-specific heterogeneity, which if ignored can cause bias and inconsistencies in parameters (Baltagi, 2013). Fixed-effects models, while effective at controlling for unobserved heterogeneity, are used for static panel models and, consequently, do not address the endogeneity resulting from dynamic models (Acheampong et al., 2023; Ullah et al., 2018).

Dynamic models, such as GMM, provide a solution to these issues. Incorporating lagged dependent variables addresses persistence in energy access, as supported by studies like Garrone et al. (2019), Bousnina and Gabsi (2023), and Shittu et al. (2024a). While Difference GMM (DIF-GMM) manages endogeneity, Blundell and Bond (1998) demonstrate that System GMM (SYS-GMM) is more efficient when the lagged dependent variable strongly correlates with the dependent variable. The SYS-GMM estimator combines instruments from Arellano and Bover's (1995) difference model with lagged differences of the relevant instruments, enhancing consistency and efficiency.

Studies examining the determinants of energy access often favour SYS-GMM due to the persistence of access (Byaro & Mmbaga, 2022; González Bautista et al., 2024; Shittu et al., 2024a). However, the literature also supports the use of the Instrumental Variable Generalized Method of Moments (IV-GMM) approach (Acheampong et al., 2023; Aluko et al., 2023), as it effectively addresses endogeneity, autocorrelation, and heteroskedasticity (Baum et al., 2007). In line with Aluko et al. (2023), we treat the institutional quality proxies as endogenous, with its first and second lags serving as instruments, due to the inherent challenges in identifying suitable and valid external instruments. The rationale is that past values of institutional quality are strongly correlated with its current level, thereby satisfying the relevance condition, while being plausibly uncorrelated with contemporaneous shocks to energy poverty, which helps satisfy the exclusion restriction. This approach also helps mitigate bias from simultaneity and measurement error in the WGI indicators.

We further complement these estimates with fixed-effects regressions using robust standard errors to test the stability of results. Furthermore, we ensure that our standard errors are robust to cross-sectional dependence by using Driscoll-Kraay standard errors (Aluko et al., 2023; Baum et al., 2007).

Table 2 summarises the descriptive statistics. On average, the 45 SSA countries in the sample have an access rate to clean cooking fuels of approximately 22% and an electricity access rate of 41.4%. Additionally, institutional indicators generally exhibit moderate scores, with most averaging around 0.5. Notably, control of corruption and government effectiveness have the lowest average scores, suggesting these may be the most challenging institutional aspects for these countries. GDP per capita has a relatively large standard deviation, indicating significant variation across the countries in the sample, which is confirmed by the minimum and maximum values. The average urbanisation rate across the region is 40.7%, indicating that most people live in rural areas.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Access to clean cooking	945	21.995	27.904	.1	100
Access to electricity	945	41.354	26.049	1.3	100
Control of corruption	945	.343	.185	0	1
Government effectiveness	945	.466	.175	0	1
Political stability	945	.612	.205	0	1
Regulatory quality	945	.498	.164	0	1
Rule of law	945	.525	.181	0	1
Voice & accountability	945	.518	.229	0	1
Institutional quality	945	.525	.191	0	1
GDP per capita	945	5777.314	6534.583	749.644	39994.617
Urbanisation	945	40.685	16.82	8.682	90.735

Note: All variables are presented in levels, however the institutional quality indicators have been normalised to be between 0 and 1.

Appendix Table A3 shows the pairwise correlations of the selected variables, with positive and significant correlations between all variables. These correlations align with the hypothesised relationships outlined in Section 3.1; however, further analysis is needed to confirm these relationships. Appendix Figure A1 graphically depict the correlations presented in Table A3, showing moderate to strong relationships across all graphs.

Before estimating Eq. (1), we conduct diagnostic tests for potential econometric issues. As reported in Appendix Table A4, the Variance Inflation Factor (VIF) values are all well below the conventional threshold of 10, suggesting no evidence of problematic multicollinearity among the explanatory variables.

Next, we test for cross-sectional dependence. For dynamic panels, Pesaran's (2004) test is often preferred, as it remains valid under fixed-effects or random-effects estimation, even when parameter estimates may be biased (De Hoyos & Sarafidis, 2006). Nonetheless, this study employs three tests: Pesaran (2004), Friedman (1937), and Frees (1995, 2004), which are considered appropriate given the sample structure, where the number of time periods (T = 21) is smaller than the number of countries (N = 45) (De Hoyos & Sarafidis, 2006).

Given that "the average absolute value of the off-diagonal elements of the cross-sectional correlation matrix of the residuals" is significantly larger than the 0 expected under no cross-sectional dependence and that the three tests yield conflicting results—Pesaran's and Friedman's tests support cross-sectional independence, while Frees' test concludes dependence—the latter should be used to make inference (De Hoyos & Sarafidis, 2006). Appendix Table A5 reports the Frees (1995, 2004) test results, where all CSD statistics exceed the critical value at a 1% significance level. This uniformly rejects the null hypothesis of cross-sectional independence across all conventional levels for the seven regressions under each energy poverty proxy. Consequently, cross-sectional dependence is confirmed, indicating that shocks in one country are likely to influence others due to the region's shared characteristics and strong economic integration (Aluko et al., 2023).

We test for heterogeneity using the test proposed by Pesaran and Yamagata (2008). The test rejects the null hypothesis of homegenous slope coefficients at the 1% significance level, as indicated in Appendix Table A6. Thus, country-specific factors must be taken into account (Bousnina & Gabsi, 2023).

The Wooldridge (2002) test for serial correlation in panel data in Appendix Table A7 reveals the presence of first-order serial correlation in both groups of the Access to Clean Cooking and Access to Electricity models. Additionally, the modified Wald test for groupwise heteroskedasticity in fixed-effects regression, as per Greene (2000), indicates strong evidence of heteroskedasticity in all models in Appendix Table A8.

Given the presence of cross-sectional dependence in the data series, this study employs two unit root tests designed to address this issue: Pesaran's (2003) CADF test and Pesaran's (2007) CIPS test. The results are presented in Appendix Table A9. We see here that upon first differencing, most of the variables become stationary at the 1% significance level, while urbanisation remains non-stationary[6].

For the Access to Clean Cooking models, the results indicate that time effects are not valid, as we fail to reject the null hypothesis of no period effects (p = 1.000). In contrast, we reject the null hypothesis of no country effects (p = 0.000), confirming the significance of country-specific effects. For the Access to Electricity models, the tests reveal that both time and country effects are significant. The null hypothesis of no period effects is rejected (p = 0.007-0.008). Similarly, the null hypothesis of no country effects is rejected (p = 0.000).

The Hausman test results for the static versions of the Access to Clean Cooking and Access to Electricity models indicate that we reject the null hypothesis of exogeneity at a 5% level. This suggests that at least one of the right-hand-side variables has an endogenous effect on the dependent variable.

4. Empirical results

4.1 Model 1: Access to clean cooking technologies and fuels (% of population)

Table 4 presents the primary results addressing our core research question: the effect of institutional quality and its dimensions on energy access (in this case clean cooking access) in SSA. Readers can find the full set of results in Appendix Tables A10-A14. We first estimate a fixed effects model on the aggregate sample to compare with the aggregate IV-GMM results as a robustness check. From this we see that the same institutional quality variables remain statistically significant, with the direction of the relationship staying the same, although the size of the coefficients differ. This confirms that the main results are not driven solely by the IV-GMM instrumentation and that the relationships are robust across estimation methods.

On aggregate, control of corruption, rule of law, government effectiveness and overall institutional quality play a significant, and positive, role in determining clean cooking access outcomes in the region. This aligns with findings from Acheampong et al. (2023), who emphasise the importance of governance structures, such as these, as a determinant of clean cooking technologies

[6] Although urban population (% of total population) is commonly used in the literature as a proxy for urbanisation, the series exhibits very little within-country variation over time, leading to challenges with unit root tests and limited explanatory power. Nevertheless, it is included to provide a basic proxy for demographic trends.

and fuels uptake by creating a supportive regulatory and business environment that safeguards investors, lenders, and stakeholders involved in these iniatives.

Next, we divide the sample into income groups based on the World Bank's classification (see Table A1 in the Appendix). The four groups are Low Income, Lower-Middle Income, Upper-Middle Income, and High Income. Given that only six countries in our sample fall into the Upper-Middle category and Seychelles is the only High-Income country, we combine these two groups.

The Low-Income group does not show any significant institutional quality determinants of clean cooking access. The World Bank (WDI, 2025) distinguishes between polluting fuels ("unprocessed biomass, charcoal, coal, and kerosene") and clean fuels ("gaseous fuels, electricity, and other modern options such as alcohol"). We suspect the "energy ladder" theory is at play here – as household income rises, families can afford clean cooking fuels (Acheampong et al., 2023). In low-income countries, where GDP per capita remains very low, institutional improvements may not substantially influence clean cooking access, particularly if access is often determined at the household level rather than directly through government action. In contrast, for the lower-middle income group, all six institutional quality indicators, as well as the composite measure of overall institutional quality, are positive and significant. In this context, institutional conditions appear to play a crucial role: a one-unit improvement in overall institutional quality is associated with a 28% increase in access to clean cooking, ceteris paribus.

For the upper-middle and high-income group, the results show that rule of law is positively and significantly associated with clean cooking access, while regulatory quality and government effectiveness are negatively and significantly associated. This aligns with Acheampong et al. (2023) and Shittu et al. (2024b), who attribute such findings to the unintended consequences of stricter governance. For example, stringent regulations (such as land-use or safety standards) may hinder scaling efforts, while stronger property rights can restrict access to key resources and technologies. In addition, lengthy bureaucratic procedures for permits and licenses raise costs and delay implementation, and strict transparency measures, although promoting accountability, often increase compliance burdens that disproportionately affect smaller firms and startups (Shittu et al., 2024b). Another possible explanation is offered by Peng (2003), who argues that "the pace of dismantling old institutions does not necessarily align with the construction of new ones, resulting in a period of incremental evolution fraught with uncertainties". Nevertheless, caution is warranted in interpreting these results: as shown in Appendix Table A14, the number of observations in this group is markedly smaller. With only seven countries and 19 years of data (after accounting for the instrumentation lag), we face an N<T imbalance, which violates the conditions for reliable GMM estimation.

Table 4: Primary regression results for access to clean cooking (EP1)

	Control of Corruption	Political Stability	Regulatory Quality	Rule of Law	Voice & Accountability	Government Effectiveness	Institutional Quality
Fixed Effects with Driscoll-Kraay standard errors							
Aggregate	0.104*	0.0264	0.00777	0.140***	0.0210	0.0728**	0.120***
	(0.0526)	(0.0219)	(0.0374)	(0.0380)	(0.0481)	(0.0265)	(0.0374)
Two-step IV-GMM with Driscoll-Kraay standard errors							
Aggregate	0.0609*	0.0296	0.00439	0.134***	0.0430	0.0886***	0.127***
	(0.0318)	(0.0203)	(0.0356)	(0.0426)	(0.0362)	(0.0218)	(0.0390)
Low-Income	0.0511	0.0202	0.0208	-0.00609	-0.0330	0.0611	0.0180
	(0.116)	(0.0207)	(0.0930)	(0.0822)	(0.0466)	(0.0571)	(0.0741)
Lower-Middle Income	0.0999***	0.130***	0.0507*	0.223***	0.235***	0.135***	0.280***
	(0.0275)	(0.0418)	(0.0277)	(0.0458)	(0.0269)	(0.0380)	(0.0369)
Upper-Middle & High Income	0.00153	0.0112	-0.0214***	0.0424***	0.00924	-0.0123*	0.0160
	(0.00533)	(0.00858)	(0.00545)	(0.00773)	(0.0131)	(0.00660)	(0.0170)

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. The full set of results can be found in Appendix Tables A10-A14.

The Hansen J-statistics reported in Appendix Tables A11–A14 are used to assess the validity of the instruments in the IV-GMM estimations (Aluko et al., 2023). In all cases, the J-statistics exceed the 5% significance level, indicating that the instruments are valid, which supports the reliability of the IV-GMM estimates.

4.2 Model 2: Access to electricity (% of population)

Table 5 presents the primary results addressing for the effect of institutional quality and its dimensions on electricity access in SSA. Appendix Tables A15-A19 present the full set of results. We first estimate a fixed effects model on the aggregate sample to compare with the aggregate IV-GMM results as a robustness check. From this we see that most of the institutional quality variables remain statistically significant, with the direction of the relationship staying the same, although the size of the coefficients differ. The only exceptions are control of corruption and political stability, with the fixed effects showing a positive relationship while the IV-GMM shows a negative one, although neither are significant at any conventional level. This confirms that the main results are not driven solely by the IV-GMM instrumentation and that the relationships are robust across estimation methods.

On aggregate, regulatory quality and rule of law are significant determinants of electricity access in the region, both showing positive relationships. This implies that stronger regulatory quality and rule of law are associated with higher levels of electricity access, consistent with the literature (Aluko et al., 2023). Effective regulatory quality ensures that governments design policies supportive of private sector development, which is crucial given the capital-intensive nature of electricity infrastructure and the reliance of many countries on the continent on external financing (Aluko et al., 2023). Similarly, while weak rule of law deters private investment by increasing costs and delays, strong rule of law (through coherent policies and regulations) enhances transparency, inclusiveness, efficiency, and responsiveness, thereby attracting greater private sector participation, particularly in mini-grids (Stritzke et al., 2021).

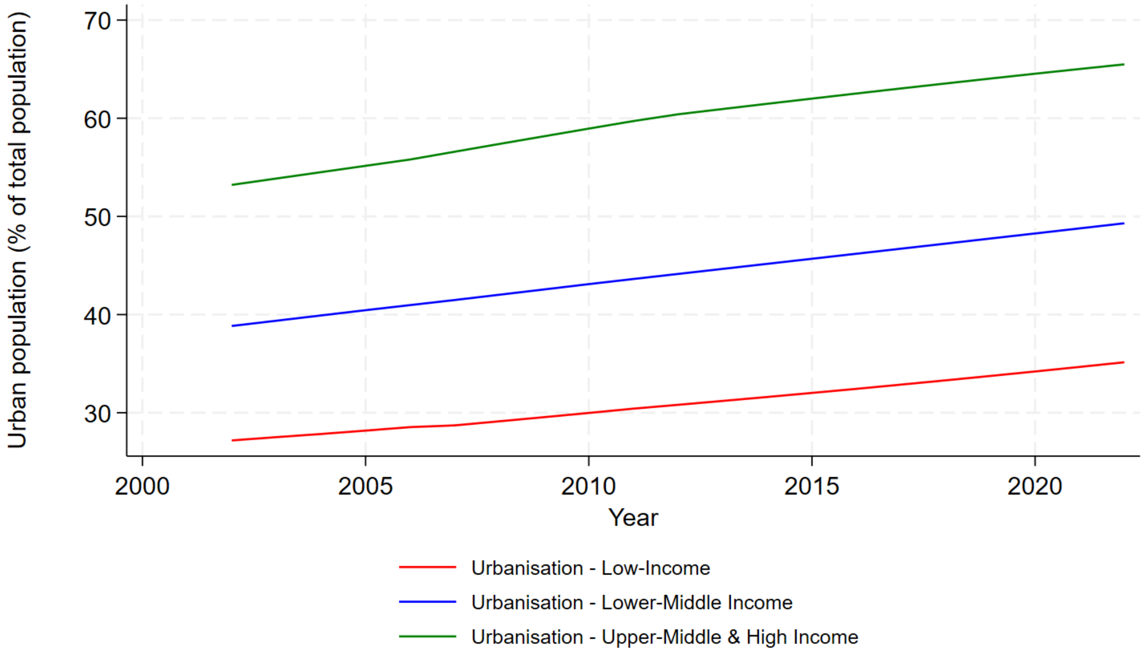
Similar to Table 4, we divide the sample into income groups based on the World Bank's classification (see Table A1 in the Appendix). The four groups are Low Income, Lower-Middle Income, Upper-Middle Income, and High Income, with the latter two grouped together.

For low-income countries, political stability, rule of law, and overall institutional quality are critical in determining electricity access, consistent with findings in the literature (Ahlborg et al., 2015; Onyeji et al., 2012; Zogo et al., 2024). All three show positive associations, as expected, and together they create an enabling environment that mobilises resources and supports electricity expansion in contexts where state capacity and financial constraints are particularly severe.

Access to electricity in lower-middle-income countries is significantly influenced by political stability, voice and accountability, government effectiveness, and overall institutional quality, although the associations are negative. This can be explained by Peng's (2003) observation that outdated institutions are often dismantled more quickly than new ones are established, creating transitional periods of uncertainty and slow progress despite positive long-term trajectories. Moreover, rapid urbanisation, as illustrated in Figure 3, intensifies energy demand that can outpace infrastructure development, posing challenges for national governments even when institutional frameworks improve (Ali, 2021).

In the upper-middle-income group, control of corruption emerges as the only significant determinant of electricity access, although only at the 10% level, and it shows a negative relationship. Again, caution is warranted in interpreting these results, as the number of observations in this group is markedly smaller (Appendix Table A19), which may limit the reliability of the IV-GMM estimates.

***Figure 3*. Trends in urbanisation across low-, lower-middle-, and upper-middle/high-income countries, 2000-2022 (see Appendix Table A1 for income classifications).**



The Hansen J-statistics reported in Appendix Tables A16–A19 further assess instrument validity. Across all specifications, the p-values exceed 0.05, so we fail to reject the null hypothesis of valid instruments. This suggests no evidence of instrument invalidity, and the chosen instruments are therefore considered appropriate (Aluko et al., 2023).

Table 5: Primary regression results for access to electricity (EP2)

	Control of Corruption	Political Stability	Regulatory Quality	Rule of Law	Voice & Accountability	Government Effectiveness	Institutional Quality
Fixed Effects with Driscoll-Kraay standard errors							
Aggregate	0.00289	0.00430	0.197*	0.163*	-0.0220	-0.0332	0.0841
	(0.0770)	(0.0294)	(0.0965)	(0.0841)	(0.0440)	(0.128)	(0.0800)
Two-step IV-GMM with Driscoll-Kraay standard errors							
Aggregate	-0.0360	-0.000256	0.173*	0.187**	-0.0235	-0.154	0.0744
	(0.0797)	(0.0305)	(0.0939)	(0.0850)	(0.0437)	(0.138)	(0.0835)
Low-Income	0.123	0.0961**	0.227	0.554***	0.0957	-0.240	0.307*
	(0.225)	(0.0406)	(0.235)	(0.171)	(0.0770)	(0.292)	(0.182)
Lower-Middle Income	-0.0453	-0.124**	0.00862	0.0452	-0.195***	-0.194***	-0.121**
	(0.0435)	(0.0554)	(0.0876)	(0.0874)	(0.0651)	(0.0678)	(0.0519)
Upper-Middle & High Income	-0.0400*	0.0173	0.0171	-0.0393	-0.0136	0.0177	-0.0255
	(0.0214)	(0.0405)	(0.0281)	(0.0463)	(0.0233)	(0.0436)	(0.0449)

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. The full set of results can be found in Appendix Tables A15-A19.

5. Discussion and Conclusion

In the pursuit of achieving the Sustainable Development Goals, understanding the drivers and implications of energy poverty is crucial. This is particularly true for SSA, where access to modern energy services remains low. The literature consistently identifies institutional quality and governance challenges as key reasons for SSA lagging behind the rest of the world in expanding energy access (Ahlborg et al., 2015; Aluko et al., 2023; Filho et al., 2024; Onyeji et al., 2012).

This study examined the role of institutional quality in shaping energy access and addressing energy poverty in SSA. We proxy energy poverty with two key dimensions: access to clean cooking technologies and fuels and access to electricity. Analysing data from 45 SSA countries over the period 2002–2022, the study evaluates the effects of corruption control, governance effectiveness, regulatory quality, rule of law, voice and accountability, political stability, and a composite index of these six indicators. To address endogeneity, autocorrelation, heteroskedasticity, and cross-sectional dependence, a dynamic Instrumental Variable Generalized Method of Moments (IV-GMM) estimator with Driscoll-Kraay standard errors is employed.

Our analysis provides new evidence on the role of institutional quality in shaping energy access in SSA. Across both dimensions of energy poverty, the results demonstrate that governance matters, though the channels and significance vary by income group.

At the aggregate level, we find that control of corruption, rule of law, government effectiveness, and overall institutional quality are significant and positively associated with access to clean cooking. Similarly, regulatory quality and rule of law emerge as significant determinants of electricity access, with stronger performance in these aspects linked to greater electrification. These findings align with the broader literature, underscoring the role of sound institutions in creating the enabling environments required for private investment and effective policy implementation in the energy sector (Aluko et al., 2023; Stritzke et al., 2021).

The disaggregated results reveal important heterogeneity. For low-income countries, institutional quality does not play a significant role in improving clean cooking access, consistent with energy ladder dynamics (Acheampong et al., 2023), but political stability, rule of law, and overall institutional quality are crucial for expanding electricity access. In lower-middle-income countries, institutional indicators strongly and positively influence clean cooking outcomes but are negatively associated with electricity access. We interpret these unexpected signs not as contradictions but as reflections of transitional dynamics: rapid urbanisation can drive energy demand beyond infrastructure capacity, and institutional reforms may temporarily constrain electricity expansion (Ali, 2021; Peng, 2003). For upper-middle- and high-income countries, we find mixed effects: rule of law is positively associated with clean cooking, while regulatory quality and government effectiveness show negative effects, possibly reflecting unintended consequences of stricter governance (Acheampong et al., 2023; Shittu et al., 2024b). Meanwhile, control of corruption shows a weak, negative relationship with electricity access. Given the small number of countries in the upper-middle- and high-income group, however, these outcomes are more volatile and should be interpreted as context-specific rather than generalisable patterns.

Overall, the results suggest that institutional quality is not uniformly beneficial across all contexts and outcomes. Instead, its effects are shaped by income level and transitional dynamics, pointing to the need for context-specific governance strategies to accelerate progress toward universal energy access.

While our estimates point to statistically significant associations between institutional quality and energy access, the economic effects are modest. A one-unit improvement in governance indicators translates into small but measurable gains in electricity and clean cooking access, supporting the notion that governance reforms alone cannot rapidly eliminate energy poverty in SSA. Rather, they form part of a wider set of conditions—including investment, infrastructure, and affordability—that shape long-term progress. These results underline the persistence of energy poverty as a structural challenge and suggest that institutional improvements should be understood as enabling, rather than decisive, drivers of change. There are several potential avenues for future research on the energy poverty-institutional quality nexus. First, investigating the distinction between national and local energy policies and their respective impacts on energy poverty would provide valuable insights, particularly as decentralised policy frameworks gain prominence. While this study lacks the data to address this distinction, future work could benefit from improved data availability in this area.

Second, developing an index specific to energy regulations and comparing regulatory quality across countries' energy sectors could shed light on sector-specific institutional dynamics. Such an index would enable a more precise analysis of the relationship between regulatory quality and energy poverty outcomes.

It is important to recognise the limitations of the WGI in this context. As highlighted by the World Bank, these indicators carry margins of error that reflect the unavoidable imprecision of measuring governance. Our findings should therefore be understood as indicative of broader regional dynamics, not as definitive country-specific evaluations. While this does not diminish the relevance of our results for understanding cross-country patterns, it does underscore the need for caution in interpreting them as evidence of precise institutional performance in individual countries. Future research could complement this approach with more granular, country-level governance data to deepen our understanding of the institutional pathways shaping energy access.

Finally, keeping with the recommendation made by Filho et al. (2024), future studies could expand the scope of energy poverty by incorporating an affordability dimension. In Africa, energy poverty is heavily influenced by affordability, as high energy costs prevent poor, rural communities from utilising accessible modern energy despite government efforts to build infrastructure (Filho et al., 2024). Moreover, we believe there is scope for a sustainability dimension as well, offering a more comprehensive understanding of energy poverty's multidimensional nature.

We do not claim that achieving SDG 7 in SSA countries depends solely on institutional quality improvements, but rather, we conclude that our findings highlight the complexity of providing energy access. Success is likely driven by a combination of factors, including institutional quality, foreign direct investment, globalisation, economic growth, government spending, etc. (Acheampong et al., 2023; Ahlborg et al., 2015; Aluko et al., 2023; Bousnina & Gabsi, 2023). Given the complexity of this topic, it necessitates the examination of additional factors, along with the use of diverse data and research approaches (Ahlborg et al., 2015).

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Appendix

Table A1: Sub-Saharan African sample countries included in the analysis

Low-Income				Lower-Middle Income				Upper-Middle Income		High Income	
Nr.	Country	Nr.	Country	Nr.	Country	Nr.	Country	Nr.	Country	Nr.	Country
1.	Burkina Faso	11.	Malawi	21.	Angola	31.	Lesotho	39.	Botswana	45.	Seychelles
2.	Burundi	12.	Mali	22.	Benin	32.	Mauritania	40.	Equatorial Guinea		
3.	Central African Republic	13.	Mozambique	23.	Cabo Verde	33.	Nigeria	41.	Gabon		
4.	Chad	14.	Niger	24.	Cameroon	34.	Sao Tome and Principe	42.	Mauritius		
5.	Congo, Dem. Rep.	15.	Rwanda	25.	Comoros	35.	Senegal	43.	Namibia		
6.	Ethiopia	16.	Sierra Leone	26.	Congo, Rep.	36.	Tanzania	44.	South Africa		
7.	Gambia, The	17.	Somalia	27.	Cote d'Ivoire	37.	Zambia				
8.	Guinea	18.	Sudan	28.	Eswatini	38.	Zimbabwe				
9.	Guinea-Bissau	19.	Togo	29.	Ghana						
10.	Madagascar	20.	Uganda	30.	Kenya						

Note: The names of the SSA countries align with their listings in the World Bank's World Development Indicators and Worldwide Governance Indicators. Income groups are classified according to the World Bank's 2022 fiscal year classification since this is the last year in our sample.

Table A2: Variables included in the analysis and their definitions

Name	Variable	Definition	Source
EP1	Access to clean cooking technologies and fuels (% of total population)	"The proportion of total population primarily using clean cooking fuels and technologies for cooking. Under WHO guidelines, kerosene is excluded from clean cooking fuels."	(WDI, 2025)
EP2	Access to electricity (% of total population)	"The percentage of population with access to electricity. Electrification data are collected from industry, national surveys and international sources."	(WDI, 2025)
CONT	Control of Corruption (Estimate of indicator)	"Captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests."	(WGI, 2025)
REGQ	Regulatory Quality (Estimate of indicator)	"Captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development."	(WGI, 2025)
GEFF	Government Effectiveness (Estimate of indicator)	"Captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies."	(WGI, 2025)
LAW	Rule of Law (Estimate of indicator)	"Captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence."	(WGI, 2025)
VOICE	Voice and Accountability (Estimate of indicator)	"Captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media."	(WGI, 2025)
STAB	Political Stability and Absence of Violence/Terrorism (Estimate of indicator)	"Measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism."	(WGI, 2025)

Name	Variable	Definition	Source
INST	A composite Institutional Quality index derived from Principal Component Analysis of the individual institutional factors		Authors' calculation
GDP	GDP per capita, PPP (constant 2021 international $)	"PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP at purchaser's prices is the sum of gross value added by all resident producers in the country plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2021 international dollars."	(WDI, 2025)
URB	Urban population (% of total population)	"Urban population refers to people living in urban areas as defined by national statistical offices. The data are collected and smoothed by United Nations Population Division."	(WDI, 2025)

Note: These definitions were retrieved from the World Bank's World Development Indicators (WDI) and Worldwide Governance Indicators (WGI).

Table A3: Pairwise correlations

Variables	Access to clean cooking (EP1)	Access to electricity (EP2)	Control of corruption (CONT)	Government effectiveness (GEFF)	Political stability (STAB)	Regulatory quality (REGQ)	Rule of law (LAW)	Voice & accountability (VOICE)	Institutional quality (INST)	GDP per capita (GDP)	Urbanisation (URB)
EP1	1.000										
EP2	0.678***	1.000									
CONT	0.394***	0.339***	1.000								
GEFF	0.474***	0.363***	0.862***	1.000							
STAB	0.410***	0.351***	0.707***	0.696***	1.000						
REGQ	0.373***	0.286***	0.812***	0.904***	0.660***	1.000					
LAW	0.428***	0.342***	0.879***	0.916***	0.775***	0.897***	1.000				
VOICE	0.274***	0.276***	0.754***	0.739***	0.675***	0.761***	0.809***	1.000			
INST	0.432***	0.358***	0.922***	0.942***	0.822***	0.927***	0.970***	0.867***	1.000		
GDP	0.774***	0.733***	0.416***	0.539***	0.530***	0.451***	0.470***	0.301***	0.496***	1.000	
URB	0.533***	0.676***	0.136***	0.136***	0.314***	0.096***	0.101***	0.204***	0.176***	0.645***	1.000

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index.

Figure A1. **Correlation graphs to visualise the relationships between the energy poverty proxies and the regressors.**

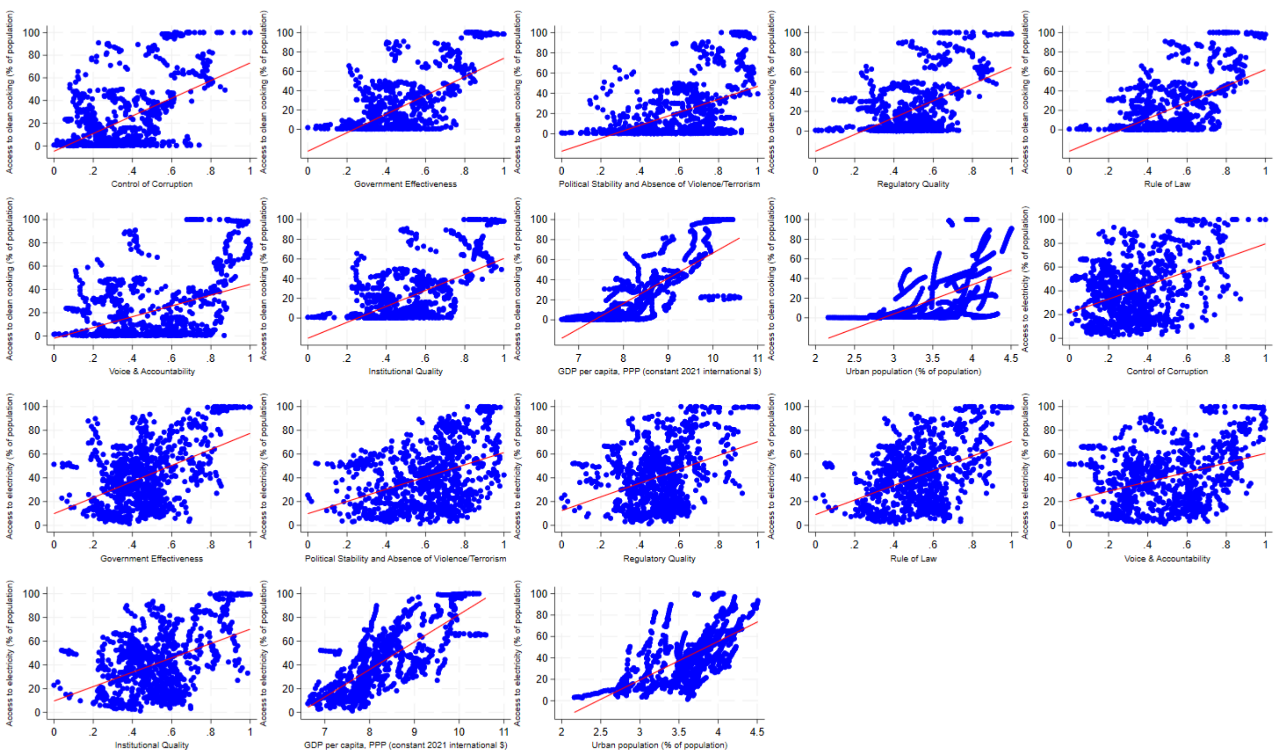

Table A4: Multicollinearity test results

Variables	VIF						
GDP per capita	2.11	2.65	2.15	2.32	2.39	1.80	2.31
Urbanisation	1.77	1.92	1.71	1.86	1.88	1.71	1.79
Control of corruption	1.25						
Government effectiveness		1.58					
Political stability			1.39				
Regulatory quality				1.37			
Rule of law					1.41		
Voice & accountability						1.10	
Institutional quality							1.39
Mean VIF	1.71	2.05	1.75	1.85	1.89	1.54	1.83

Note: All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Variance Inflation Factors remained consistent no matter the energy poverty proxy.

Table A5: Frees' cross-sectional independence test results

	Access to clean cooking (EP1)	Access to electricity (EP2)
Variable	CSD Statistic	CSD Statistic
Control of corruption	18.274	12.153
Government effectiveness	18.317	12.597
Political stability	18.746	12.228
Regulatory quality	19.419	12.474
Rule of law	16.545	12.549
Voice & accountability	19.014	12.309
Institutional quality	19.073	12.457

Note: All variables were used in their natural logarithmic form, except the institutional quality proxies and composite index. The critical value for $\alpha = 0.01$ is 0.2338.

Table A6: **Slope heterogeneity test results**

	Access to clean cooking (EP1)			Access to electricity (EP2)		
Variable	Delta	Delta adj	P-value	Delta	Delta adj	P-value
Control of corruption	38.992	44.671	0.000	26.334	30.169	0.000
Government effectiveness	39.109	44.805	0.000	27.287	31.261	0.000
Political stability	40.116	45.959	0.000	27.823	31.876	0.000
Regulatory quality	39.951	45.769	0.000	26.595	30.468	0.000
Rule of law	39.004	44.685	0.000	27.245	31.214	0.000
Voice & accountability	40.361	46.239	0.000	26.815	30.721	0.000
Institutional quality	39.958	45.778	0.000	27.365	31.351	0.000

Note: All variables were used in their natural logarithmic form, except the institutional quality proxies and composite index.

Table A7: First-order serial correlation test results

	Access to clean cooking (EP1)		Access to electricity (EP2)	
Variable	F-statistic	P-value	F-statistic	P-value
Control of corruption	129.440	0.0000	12.687	0.0009
Government effectiveness	131.398	0.0000	12.734	0.0009
Political stability	131.703	0.0000	12.794	0.0009
Regulatory quality	130.084	0.0000	12.887	0.0008
Rule of law	130.110	0.0000	12.695	0.0008
Voice & accountability	129.339	0.0000	12.799	0.0009
Institutional quality	129.483	0.0000	12.636	0.0009

Note: All variables were used in their natural logarithmic form, except the institutional quality proxies and composite index.

Table A8: **Heteroskedasticity test results**

	Access to clean cooking (EP1)		Access to electricity (EP2)	
Variable	χ^2-statistic	P-value	χ^2-statistic	P-value
Control of corruption	290 000	0.0000	24 800.27	0.0009
Government effectiveness	160 000	0.0000	13 994.69	0.0009
Political stability	310 000	0.0000	25 364.51	0.0009
Regulatory quality	330 000	0.0000	25 076.96	0.0008
Rule of law	68 078.17	0.0000	20 803.78	0.0008
Voice & accountability	560 000	0.0000	18 481.08	0.0009
Institutional quality	170 000	0.0000	17 510.36	0.0009

Note: All variables were used in their natural logarithmic form, except the institutional quality proxies and composite index.

Table A9: Panel unit root tests results

Variables	Levels		
	CADF Statistic	P-value	CIPS Statistic
Access to clean cooking	-1.566	0.910	-2.040
Access to electricity	-2.166***	0.002	-3.060***
Control of corruption	-1.577	0.897	-1.875
Government effectiveness	-2.186***	0.002	-2.472***
Political stability	-2.186***	0.002	-2.512***
Regulatory quality	-1.477	0.975	-2.007
Rule of law	-1.935	0.113	-2.211**
Voice & accountability	-1.834	0.305	-2.049
Institutional quality	-1.838	0.294	-1.896
GDP per capita	-1.777	0.454	-1.510
Urbanisation	-1.483	0.972	-1.405
	First Differences		
	CADF Statistic	P-value	CIPS Statistic
Access to clean cooking	-1.856	0.204	-2.798***
Access to electricity	-3.693***	0.000	-5.390***
Control of corruption	-3.267***	0.000	-4.269***
Government effectiveness	-3.435***	0.000	-5.120***
Political stability	-3.144***	0.000	-4.593***
Regulatory quality	-3.197***	0.000	-4.963***
Rule of law	-2.906***	0.000	-4.525***
Voice & accountability	-2.725***	0.000	-4.037***
Institutional quality	-2.793***	0.000	-4.212***
GDP per capita	-2.648***	0.000	-3.423***
Urbanisation	-0.910	1.000	-0.683
	Second Differences		
	CADF Statistic	P-value	CIPS Statistic
Access to clean cooking	-3.761***	0.000	-5.628***
Access to electricity	-5.088***	0.000	-6.036***
Control of corruption	-4.683***	0.000	-5.654***
Government effectiveness	-4.833***	0.000	-5.837***
Political stability	-4.615***	0.000	-5.593***
Regulatory quality	-4.123***	0.000	-5.516***
Rule of law	-4.391***	0.000	-5.898***
Voice & accountability	-4.261***	0.000	-5.436***
Institutional quality	-4.121***	0.000	-5.580***
GDP per capita	-3.999***	0.000	-5.437***
Urbanisation	-1.670	0.654	-2.339**

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index.

Table A10: Aggregate Fixed Effects results for access to clean cooking (EP1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag of EP1 (t-1)	0.989***	0.991***	0.992***	0.987***	0.992***	0.991***	0.990***
	(0.0117)	(0.0109)	(0.0111)	(0.0107)	(0.0110)	(0.0109)	(0.0108)
Control of	0.104*						
Corruption	(0.0526)						
Political		0.0264					
Stability		(0.0219)					
Regulatory			0.00777				
Quality			(0.0374)				
Rule of				0.140***			
Law				(0.0380)			
Voice &					0.0210		
Accountability					(0.0481)		
Government						0.0728**	
Effectiveness						(0.0265)	
Institutional							0.120***
Quality							(0.0374)
Control variables:							
GDP per capita	0.0366*	0.0479*	0.0489*	0.0391	0.0483*	0.0425	0.0366
	(0.0192)	(0.0259)	(0.0276)	(0.0242)	(0.0272)	(0.0264)	(0.0243)
Urbanisation	-0.0443	-0.0605	-0.0671	-0.0427	-0.0666	-0.0521	-0.0398
	(0.0441)	(0.0434)	(0.0489)	(0.0421)	(0.0453)	(0.0451)	(0.0416)
Constant	-0.107	-0.126	-0.0988	-0.167	-0.102	-0.129	-0.150
	(0.182)	(0.166)	(0.174)	(0.176)	(0.170)	(0.168)	(0.172)
Observations	900	900	900	900	900	900	900
F-statistic	17699.80	19588.30	21362.31	17824.23	19767.37	16238.17	17890.90
P-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Within R-squared	0.9832	0.9831	0.9831	0.9832	0.9831	0.9831	0.9832

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence.

Table A11: Aggregate Two-Step IV-GMM results for access to clean cooking (EP1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag of EP1	0.995***	1.002***	0.999***	1.007***	0.996***	1.001***	0.997***
(t-1)	(0.00519)	(0.00655)	(0.00789)	(0.00588)	(0.00763)	(0.00872)	(0.00644)
Control of	0.0609*						
Corruption	(0.0318)						
Government		0.0886***					
Effectiveness		(0.0218)					
Political			0.0296				
Stability			(0.0203)				
Regulatory				0.00439			
Quality				(0.0356)			
Rule of					0.134***		
Law					(0.0426)		
Voice &						0.0430	
Accountability						(0.0362)	
Institutional							0.127***
Quality							(0.0390)
Control variables							
GDP per	0.0206	0.0241	0.0153	0.0273	0.0197	0.0254	0.0180
capita	(0.0142)	(0.0146)	(0.0134)	(0.0189)	(0.0135)	(0.0194)	(0.0126)
Urbanisation	-0.0335	-0.0616*	-0.0413	-0.103**	-0.0418	-0.0684	-0.0385
	(0.0304)	(0.0372)	(0.0417)	(0.0432)	(0.0410)	(0.0508)	(0.0360)
Observations	855	855	855	855	855	855	855
Countries	45	45	45	45	45	45	45
R-squared	0.9842	0.9843	0.9842	0.9842	0.9844	0.9842	0.9843
Adjusted R-squared	0.9833	0.9833	0.9833	0.9832	0.9834	0.9833	0.9833
F	2.56e+04	2.99e+04	2.29e+04	3.60e+04	2.65e+04	2.40e+04	2.85e+04
Bandwidth	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Hansen J	0.4697	0.6236	4.3971	4.1488	0.1578	0.6526	0.0942
Hansen J p-value	0.7907	0.7321	0.1110	0.1256	0.9241	0.7216	0.9540

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. Bandwidth refers to the number of autocorrelation lags that the Driscoll–Kraay standard errors correct for.

Table A12: Low Income Two-Step IV-GMM results for access to clean cooking (EP1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag of EP1	0.996***	1.009***	1.003***	1.012***	1.004***	1.003***	1.003***
(t-1)	(0.00912)	(0.0109)	(0.0126)	(0.00889)	(0.0143)	(0.0138)	(0.0103)
Control of	0.0511						
Corruption	(0.116)						
Government		0.0611					
Effectiveness		(0.0571)					
Political			0.0202				
Stability			(0.0207)				
Regulatory				0.0208			
Quality				(0.0930)			
Rule of					-0.00609		
Law					(0.0822)		
Voice &						-0.0330	
Accountability						(0.0466)	
Institutional							0.0180
Quality							(0.0741)
Control variables							
GDP per	0.0457	0.0401	0.0223	0.0786	0.0401	0.0323	0.0408
capita	(0.0421)	(0.0532)	(0.0490)	(0.0504)	(0.0491)	(0.0477)	(0.0476)
Urbanisation	-0.0552	-0.0904	-0.0623	-0.155**	-0.0778	-0.0736	-0.0811
	(0.0584)	(0.0885)	(0.0796)	(0.0773)	(0.0774)	(0.0838)	(0.0764)
Observations	380	380	380	380	380	380	380
Countries	20	20	20	20	20	20	20
R-squared	0.9773	0.9773	0.9773	0.9771	0.9773	0.9774	0.9773
Adjusted R-squared	0.9758	0.9758	0.9758	0.9756	0.9758	0.9758	0.9758
F	3656.3382	1.50e+04	4683.3267	1.98e+04	5542.6557	4090.2063	8008.2947
Bandwidth	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Hansen J	0.3859	1.4438	4.8411	2.0678	1.4062	1.5316	1.0927
Hansen J p-value	0.8245	0.4858	0.0889	0.3556	0.4950	0.4650	0.5791

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. Bandwidth refers to the number of autocorrelation lags that the Driscoll–Kraay standard errors correct for.

Table A13: Lower-Middle Income Two-Step IV-GMM results for access to clean cooking (EP1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag of EP1	0.995***	0.998***	0.991***	0.996***	0.995***	1.004***	0.997***
(t-1)	(0.00635)	(0.00717)	(0.00701)	(0.00653)	(0.00642)	(0.00673)	(0.00704)
Control of	0.0999***						
Corruption	(0.0275)						
Government		0.135***					
Effectiveness		(0.0380)					
Political			0.130***				
Stability			(0.0418)				
Regulatory				0.0507*			
Quality				(0.0277)			
Rule of					0.223***		
Law					(0.0458)		
Voice &						0.235***	
Accountability						(0.0269)	
Institutional							0.280***
Quality							(0.0369)
Control variables							
GDP per	0.00984	-0.00778	-0.00699	0.00798	-0.00603	-0.0198	-0.0221
capita	(0.0145)	(0.0139)	(0.0194)	(0.0147)	(0.0188)	(0.0202)	(0.0205)
Urbanisation	-0.0476**	-0.0215	0.0308	-0.0377**	-0.0416**	-0.0444*	-0.0191
	(0.0217)	(0.0244)	(0.0353)	(0.0169)	(0.0196)	(0.0241)	(0.0257)
Observations	342	342	342	342	342	342	342
Countries	18	18	18	18	18	18	18
R-squared	0.9937	0.9937	0.9938	0.9936	0.9941	0.9941	0.9940
Adjusted R-squared	0.9933	0.9933	0.9934	0.9931	0.9937	0.9937	0.9936
F	2.88e+04	1.29e+04	3.20e+04	1.94e+04	7.27e+04	3.03e+04	2.14e+04
Bandwidth	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Hansen J	1.3933	0.5974	4.4185	2.3435	2.0373	2.5931	2.2496
Hansen J p-value	0.4983	0.7418	0.1098	0.3098	0.3611	0.2735	0.3247

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. Bandwidth refers to the number of autocorrelation lags that the Driscoll–Kraay standard errors correct for.

Table A14: Upper-Middle- & High-Income Two-Step IV-GMM results for access to clean cooking (EP1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag of EP1	0.921***	0.916***	0.923***	0.908***	0.924***	0.925***	0.928***
(t-1)	(0.00358)	(0.00234)	(0.00547)	(0.00671)	(0.00532)	(0.00350)	(0.00616)
Control of	0.00153						
Corruption	(0.00533)						
Government		-0.0123*					
Effectiveness		(0.00660)					
Political			0.0112				
Stability			(0.00858)				
Regulatory				-0.0214***			
Quality				(0.00545)			
Rule of					0.0424***		
Law					(0.00773)		
Voice &						0.00924	
Accountability						(0.0131)	
Institutional							0.0160
Quality							(0.0170)
Control variables							
GDP per	0.0198***	0.0229***	0.0235***	0.0237***	0.0160***	0.0206***	0.0186***
Capita	(0.00409)	(0.00373)	(0.00445)	(0.00491)	(0.00335)	(0.00461)	(0.00537)
Urbanisation	-0.00760*	-0.00789*	-0.0101	-0.00256	-0.00824	-0.0106**	-0.0111**
	(0.00458)	(0.00406)	(0.00636)	(0.00616)	(0.00608)	(0.00435)	(0.00542)
Observations	133	133	133	133	133	133	133
Countries	7	7	7	7	7	7	7
R-squared	0.9950	0.9950	0.9950	0.9951	0.9953	0.9950	0.9950
Adjusted R-squared	0.9945	0.9946	0.9945	0.9946	0.9949	0.9945	0.9945
F	8.52e+04	8.03e+04	6.20e+04	3.09e+04	5.39e+04	6.13e+04	1.17e+05
Bandwidth	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Hansen J	0.3796	4.6861	2.6391	3.6226	2.6790	3.0229	1.4078
Hansen J p-value	0.8271	0.0960	0.2673	0.1634	0.2620	0.2206	0.4947

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. Bandwidth refers to the number of autocorrelation lags that the Driscoll–Kraay standard errors correct for.

Table A15: Aggregate Fixed Effects results for access to electricity (EP2)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag of EP2	0.748***	0.748***	0.748***	0.748***	0.747***	0.747***	0.748***
(t-1)	(0.0519)	(0.0513)	(0.0518)	(0.0516)	(0.0514)	(0.0528)	(0.0515)
Control of	0.00289						
Corruption	(0.0770)						
Political		0.00430					
Stability		(0.0294)					
Regulatory			0.197*				
Quality			(0.0965)				
Rule of				0.163*			
Law				(0.0841)			
Voice &					-0.0220		
Accountability					(0.0440)		
Government						-0.0332	
Effectiveness						(0.128)	
Institutional							0.0841
Quality							(0.0800)
Control variables							
GDP per	0.132***	0.132***	0.106***	0.113***	0.135***	0.137***	0.121***
Capita	(0.0367)	(0.0378)	(0.0279)	(0.0331)	(0.0402)	(0.0392)	(0.0331)
Urbanisation	0.556***	0.557***	0.596***	0.576***	0.554***	0.551***	0.571***
	(0.154)	(0.159)	(0.170)	(0.165)	(0.159)	(0.152)	(0.159)
Constant	-2.185***	-2.190***	-2.215***	-2.186***	-2.188***	-2.188***	-2.191***
	(0.613)	(0.610)	(0.614)	(0.600)	(0.610)	(0.608)	(0.607)
Observations	900	900	900	900	900	900	900
F-statistic	757.11	635.80	662.90	822.29	685.35	660.84	818.85
P-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Within R-squared	0.8532	0.8532	0.8538	0.8537	0.8533	0.8533	0.8533

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence.

Table A16: Aggregate Two-Step IV-GMM results for access to electricity (EP2)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag of EP2	0.725***	0.730***	0.717***	0.752***	0.691***	0.742***	0.737***
(t-1)	(0.0550)	(0.0554)	(0.0448)	(0.0479)	(0.0493)	(0.0546)	(0.0521)
Control of	-0.0360						
Corruption	(0.0797)						
Government		-0.154					
Effectiveness		(0.138)					
Political			-0.000256				
Stability			(0.0305)				
Regulatory				0.173*			
Quality				(0.0939)			
Rule of					0.187**		
Law					(0.0850)		
Voice &						-0.0235	
Accountability						(0.0437)	
Institutional							0.0744
Quality							(0.0835)
Control variables							
GDP per	0.129***	0.126***	0.140***	0.102***	0.119***	0.111***	0.116***
Capita	(0.0331)	(0.0325)	(0.0376)	(0.0245)	(0.0341)	(0.0338)	(0.0281)
Urbanisation	0.655***	0.657***	0.668***	0.629***	0.760***	0.672***	0.657***
	(0.146)	(0.144)	(0.132)	(0.137)	(0.148)	(0.150)	(0.149)
Observations	855	855	855	855	855	855	855
Countries	45	45	45	45	45	45	45
R-squared	0.8329	0.8328	0.8329	0.8333	0.8330	0.8328	0.8330
Adjusted R-squared	0.8227	0.8227	0.8227	0.8232	0.8228	0.8226	0.8228
F	832.5758	714.1782	811.2710	665.7978	768.4419	729.3078	834.3928
Bandwidth	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Hansen J	1.1874	2.2064	0.4290	0.9350	1.8648	3.0915	1.2119
Hansen J p-value	0.5523	0.3318	0.8069	0.6266	0.3936	0.2132	0.5455

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. Bandwidth refers to the number of autocorrelation lags that the Driscoll–Kraay standard errors correct for.

Table A17: Low-Income Two-Step IV-GMM results for access to electricity (EP2)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag of EP2	0.696***	0.695***	0.654***	0.719***	0.634***	0.697***	0.697***
(t-1)	(0.0620)	(0.0681)	(0.0643)	(0.0610)	(0.0644)	(0.0674)	(0.0602)
Control of	0.123						
Corruption	(0.225)						
Government		-0.240					
Effectiveness		(0.292)					
Political			0.0961**				
Stability			(0.0406)				
Regulatory				0.227			
Quality				(0.235)			
Rule of					0.554***		
Law					(0.171)		
Voice &						0.0957	
Accountability						(0.0770)	
Institutional							0.307*
Quality							(0.182)
Control variables							
GDP per	0.162***	0.193***	0.201***	0.150***	0.109**	0.153**	0.131***
Capita	(0.0481)	(0.0667)	(0.0702)	(0.0416)	(0.0544)	(0.0634)	(0.0456)
Urbanisation	0.878***	0.767***	0.981***	0.803***	1.179***	0.918***	0.934***
	(0.207)	(0.218)	(0.222)	(0.218)	(0.248)	(0.235)	(0.220)
Observations	380	380	380	380	380	380	380
Countries	20	20	20	20	20	20	20
R-squared	0.8109	0.8095	0.8107	0.8109	0.8126	0.8105	0.8116
Adjusted R-squared	0.7981	0.7966	0.7980	0.7981	0.8000	0.7977	0.7989
F	327.5961	437.6343	415.4450	424.6243	329.0217	530.4187	384.8356
Bandwidth	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Hansen J	0.5996	2.0578	0.7660	1.5284	1.7566	2.4624	0.9675
Hansen J p-value	0.7410	0.3574	0.6818	0.4657	0.4155	0.2919	0.6165

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. Bandwidth refers to the number of autocorrelation lags that the Driscoll–Kraay standard errors correct for.

Table A18: Lower-Middle Income Two-Step IV-GMM results for access to electricity (EP2)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag of EP2	0.764***	0.750***	0.761***	0.782***	0.757***	0.735***	0.763***
(t-1)	(0.0424)	(0.0431)	(0.0461)	(0.0406)	(0.0454)	(0.0463)	(0.0447)
Control of	-0.0453						
Corruption	(0.0435)						
Government		-0.194***					
Effectiveness		(0.0678)					
Political			-0.124**				
Stability			(0.0554)				
Regulatory				0.00862			
Quality				(0.0876)			
Rule of					0.0452		
Law					(0.0874)		
Voice &						-0.195***	
Accountability						(0.0651)	
Institutional							-0.121**
Quality							(0.0519)
Control variables							
GDP per	0.0851*	0.123***	0.0822**	0.0897*	0.0797**	0.0980**	0.109***
Capita	(0.0438)	(0.0368)	(0.0397)	(0.0477)	(0.0375)	(0.0444)	(0.0419)
Urbanisation	0.588***	0.582***	0.596***	0.507***	0.632***	0.713***	0.578***
	(0.143)	(0.155)	(0.148)	(0.136)	(0.147)	(0.151)	(0.154)
Observations	342	342	342	342	342	342	342
Countries	18	18	18	18	18	18	18
R-squared	0.8931	0.8939	0.8936	0.8928	0.8929	0.8940	0.8933
Adjusted R-squared	0.8858	0.8866	0.8862	0.8854	0.8856	0.8868	0.8860
F	1066.5166	1657.1983	1341.9337	1365.7638	2222.8157	1395.6465	1204.0436
Bandwidth	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Hansen J	1.8503	0.1919	2.4939	1.4637	0.6842	2.2134	2.0589
Hansen J p-value	0.3965	0.9085	0.2874	0.4810	0.7103	0.3307	0.3572

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. Bandwidth refers to the number of autocorrelation lags that the Driscoll–Kraay standard errors correct for.

Table A19: Upper-Middle- & High-Income Two-Step IV-GMM results for access to electricity (EP2)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lag of EP2	0.891***	0.904***	0.898***	0.896***	0.899***	0.928***	0.914***
(t-1)	(0.0292)	(0.0289)	(0.0330)	(0.0340)	(0.0297)	(0.0269)	(0.0293)
Control of	-0.0400*						
Corruption	(0.0214)						
Government		0.0177					
Effectiveness		(0.0436)					
Political			0.0173				
Stability			(0.0405)				
Regulatory				0.0171			
Quality				(0.0281)			
Rule of					-0.0393		
Law					(0.0463)		
Voice &						-0.0136	
Accountability						(0.0233)	
Institutional							-0.0255
Quality							(0.0449)
Control variables							
GDP per	0.0154**	0.00629	0.00596	0.00535	0.00718	0.00131	0.00762
capita	(0.00742)	(0.00515)	(0.00538)	(0.00559)	(0.00651)	(0.00470)	(0.00707)
Urbanisation	0.0802**	0.0710**	0.0762*	0.0828*	0.0736**	0.0383	0.0559
	(0.0358)	(0.0346)	(0.0433)	(0.0423)	(0.0375)	(0.0330)	(0.0362)
Observations	133	133	133	133	133	133	133
Countries	7	7	7	7	7	7	7
R-squared	0.9550	0.9549	0.9550	0.9549	0.9551	0.9544	0.9547
Adjusted R-squared	0.9509	0.9509	0.9509	0.9508	0.9511	0.9503	0.9506
F	2441.6452	2201.9020	2482.8057	2508.4917	2804.5278	2653.4978	2776.1012
Bandwidth	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000
Hansen J	2.0435	1.7655	1.6125	3.3451	0.9308	2.7576	1.3391
Hansen J p-value	0.3600	0.4136	0.4465	0.1878	0.6279	0.2519	0.5119

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. All variables were used in their natural logarithmic form, except the normalised institutional quality proxies and composite index. Standard errors in parentheses. Driscoll-Kraay standard errors robust to heteroskedasticity, autocorrelation, and cross-sectional dependence. Bandwidth refers to the number of autocorrelation lags that the Driscoll–Kraay standard errors correct for.