Self-Dependence and Lower-Tension Fossil Fuel

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Abstract
The global reliance on fossil fuels, which account for 79% of total energy use (International Energy Agency [IEA], 2024), increases greenhouse gas emissions, exacerbates climate change, and threatens biodiversity. International initiatives, such as the 2022 United Nations Climate Summit in Sharm el-Sheikh, Egypt, promote renewable energy solar, wind, hydropower, biomass, and geothermal to attain energy independence and minimise high-impact fossil fuel consumption. "Lower-tension fossil fuel" initiatives, such as carbon capture and storage (CCS) and liquefied natural gas (LNG), seek to reduce environmental and geopolitical repercussions. This qualitative study, conducted in six countries (Nigeria, India, Brazil, Germany, Kenya, and the United States), investigates stakeholder perspectives on the transition to renewables. Renewables lower emissions by up to 30%, provide 5.2 million jobs worldwide (IRENA, 2024), and improve energy security. High capital costs, legislative inconsistency, and fossil fuel lobbying all pose challenges. Policies such as Germany's Energiewende and Kenya's geothermal efforts provide scalable examples. Transitioning to renewable energy is crucial for long-term development, necessitating international cooperation and creative finance.

Keywords: Fossil fuel, global warming, greenhouse gases, renewable energy, energy self-dependence

1. Introduction

The global energy sector is facing unprecedented difficulties as growing demand, driven by population expansion and industrialisation, collides with the critical need to address climate change. According to projections, worldwide energy consumption would reach 1,050 exajoules by 2050, a 30% increase over 2024 levels, assuming annual economic growth of 2.5% (Moriarty & Honnery, 2012; International Energy Agency [IEA], 2025). Coal, oil, and natural gas account for 79% of world energy production, releasing 36.7 billion tonnes of CO2 per year and contributing to a 1.2°C temperature rise since pre-industrial times (IEA, 2025; IPCC, 2022). These emissions intensify extreme weather, such as the 2023 Nigerian floods that killed 1.5 million people, and endanger biodiversity, with 25% of species at risk by 2050 (UNEP, 2024). International initiatives, particularly the 2022 United Nations Climate Summit in Sharm el-Sheikh, Egypt, have prioritised the transition to renewable energy sources solar, wind, hydropower, biomass, and geothermal to offset these consequences and achieve sustainable development goals (United Nations, 2022).

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Solar Panels in a Rural African Community Solar panels are depicted in a rural context, demonstrating renewable adoption in off-grid locations (for example, Nigerian microgrids) (African Development Bank, 2023).

Energy self-dependence, or a region's or country's ability to fulfil its own energy demands, is crucial for reducing reliance on unpredictable fossil fuel imports, which contribute for 60% of world oil commerce and are concentrated among a few providers (IEA, 2025). This dependence generates geopolitical risks, as illustrated in Nigeria, where fossil fuels account for 80% of energy and cost $10 billion in imports each year (African Development Bank, 2023). Conversely, "lower-tension fossil fuel" solutions attempt to minimise environmental and geopolitical repercussions with technology such as carbon capture and storage (CCS), which can cut power plant emissions by up to 90% at a cost of $50-100 per tonne (IPCC, 2022). Liquefied natural gas (LNG), which emits 25% less than coal, and enhanced combustion processes are also viable transitional options, however methane leakage remains a worry (IEA, 2025). These measures bridge the gap to renewables, which will supply 13% of global power in 2024, up from 12% in 2023 (IRENA, 2025).

Case examples demonstrate the opportunities and limitations of self-sufficiency. Kenya's Olkaria geothermal project generates 30% of national power, reducing fossil fuel imports by 20% since 2015 and providing 1,200 employment (IRENA, 2025). Germany's Energiewende initiative raised renewable power to 48% by 2024, while coal consumption decreased by 22% since 2015. Nigeria's renewable contribution, largely hydroelectric, remains around 18%, owing to policy gaps and financial shortfalls (African Development Bank, 2023). Developing countries, where 1.1 billion people lack access to modern energy, rely primarily on diesel and kerosene, causing poor air quality and health (Zebra et al., 2021; Ahuja & Schaffer, 2009). This study uses a qualitative lens to investigate paths to energy self-reliance and lower-tension fossil fuel consumption, focussing on the following questions: (1) How might global energy self-reliance be reached through renewables? (2) What are the environmental, social, and geopolitical consequences of fossil-fuel dependence? (3) Which renewable energy sources are most sustainable and scalable? (4) How do barriers and enablers affect the transition? This research provides methods for a sustainable energy future based on stakeholder views and case studies from six countries (Nigeria, India, Brazil, Germany, Kenya, and the United States), with a focus on policy innovation, community participation,and international collaboration.

2. Literature Review

The environmental, social, and geopolitical costs of fossil fuel reliance, together with the urgent need for sustainable alternatives, are driving a transformational transition in the global energy system. Fossil fuels (coal, oil, and natural gas) account for 79% of world energy use, releasing 36.7 billion tonnes of CO2 per year and contributing to a 1.2°C global temperature rise since pre-industrial times (International Energy Agency [IEA], 2025; IPCC, 2022). These emissions worsen climate change, causing catastrophic

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weather events such as the 2023 floods in Nigeria, which displaced 1.5 million people, and endangering biodiversity, with 25% of species at risk by 2050 (United Nations Environment Programme [UNEP], 2024). Geopolitically, fossil fuel dependency generates vulnerabilities since 60% of global oil imports are concentrated among a few suppliers, exposing countries such as Nigeria to price volatility and supply interruptions that cost $10 billion per year (African Development Bank, 2023; IEA, 2025). The United Nations Climate Summit in Sharm el-Sheikh, Egypt, in 2022 emphasised the need of shifting to renewable energy sources such as solar, wind, hydropower, biomass, and geothermal in mitigating these consequences and achieving energy self-sufficiency.

Energy self-dependence, defined as a region's capacity to fulfil its own energy requirements, improves energy security and minimises dependency on imports (Zebra et al., 2021). Renewable energy sources are critical to this objective. Since 2010, the cost of solar photovoltaic (PV) systems has dropped by 80% to $30-60/MWh, making them competitive with fossil fuels (International Renewable Energy Agency [IRENA], 2025). Wind energy has a worldwide offshore potential of 420,000 TWh and is very scalable in coastal areas such as Northern Europe (Moriarty & Honnery, 2012). In Brazil, hydroelectric power accounts for 89% of electricity production, while the Olkaria project in Kenya uses geothermal energy to provide 30% of the country's electricity, lowering fossil fuel imports by 20% since 2015. Biomass, when sourced sustainably, provides carbon-neutral energy; yet, if not handled properly, it can lead to deforestation. These renewables not only decrease emissions but also generate jobs 5.2 million globally by 2024 and stabilise energy costs, in contrast to unpredictable fossil fuel markets (IRENA, 2025).

“Lower-tension fossil fuel" initiatives, including as carbon capture and storage (CCS), liquefied natural gas (LNG), and improved combustion technologies, seek to reduce environmental and geopolitical implications while ensuring energy supply (IPCC, 2022). CCS can capture up to 90% of CO2 emissions from power plants, but the high cost ($50-100/tonne) limits scalability (IEA, 2025). LNG, which emits 25% less than coal, serves as a transitional fuel, although methane leakage of up to 3% in some supply chains weakens its benefits (Howarth, 2021). Advanced combustion, such as ultra-supercritical coal plants, increases efficiency but cannot compete with renewables for long-term sustainability (IEA, 2025). These measures are only intermediate solutions; comprehensive decarbonisation necessitates renewables, which will account for 13% of global power in 2024 (IRENA, 2025).

Case examples demonstrate the viability of self-dependence. Germany's Energiewende strategy raised renewable power to 48% by 2024, reducing coal consumption by 22% since 2015 via feed-in tariffs and public-private partnerships (IEA, 2025). Kenya's geothermal expansion provided 1,200 employment and improved energy security, but financial constraints limit further growth (IRENA, 2025). In contrast, Nigeria's renewable contribution remains at 18%, largely hydroelectric, due to policy inconsistencies and the $2-3 million/MW cost of solar infrastructure (African Development Bank, 2023; Ahuja & Schaffer, 2009). Developing countries, where 1.1 billion people lack modern energy access, rely significantly on diesel and kerosene, worsening air quality and causing 3.5 million premature deaths per year due to pollution (World Health Organisation, 2024).

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Hydroelectric Dam in Operation
Shows a hydroelectric dam, demonstrating renewable scalability (for example, Brazil's 89% hydropower share) (IRENA, 2025).
High capital costs, legislative gaps, fossil fuel lobbying, and infrastructure lock-in all act as barriers to renewable adoption. For example, India's coal subsidies outnumber renewable incentives, stalling solar and wind deployment (Sengupta & Saha, 2023). Stakeholder viewpoints highlight the importance of community participation, with Kenyan officials stating that local support ensures project success (Zebra et al., 2021).
This study expands on previous research by investigating stakeholder experiences in six nations, providing insights into scalable options and constraints to attaining energy self-sufficiency and lower-tension fossil fuel use.

3. Methodology

3.1 Research Design

This study uses a qualitative research methodology to investigate stakeholder perspectives on energy self-reliance and lower-tension fossil fuel methods, with an emphasis on interpretative and exploratory methodologies (Creswell and Poth, 2018). Qualitative approaches are suitable for understanding the complex social, economic, and policy processes behind renewable energy transitions because they capture nuanced experiences and contextual elements. The concept incorporates semi-structured interviews and case studies to give detailed insights into achieving energy self-sufficiency and minimising fossil fuel consequences in a variety of global situations. This method is consistent with the research topics, which attempt to understand how self-reliance may be accomplished, the consequences of fossil fuel dependency, the sustainability of renewable sources, and transition impediments (Merriam & Tisdell, 2016). The study's exploratory nature addresses shortcomings in understanding stakeholder perspectives, particularly in developing countries where renewable adoption is slow (Zebra et al., 2021).

3.2 Data Collection

Data were gathered between April and September 2024 using two main methods: semi-structured interviews and case studies.

1. Semi-Structured Interviews: Semi-structured interviews were conducted with sixty stakeholders from six countries: Nigeria, India, Brazil, Germany, Kenya, and the United States, with ten participants per country. Policymakers, energy sector professionals, community leaders, and environmental activists were recruited to represent a variety of viewpoints on energy transitions. Interviews were conducted by Zoom or in-person for 45-60 minutes and audio-recorded with informed permission. "What policies have effectively promoted renewable energy in your region?"; "How do lower-tension fossil fuel strategies, like carbon capture, impact energy security?"; and "What are the primary barriers to adopting renewable energy locally?" These questions were tested with five energy researchers to guarantee clarity and relevance (Bryman, 2016). Interview instructions were adjusted to each country's energy situation, such as Nigeria's reliance on diesel or Germany's renewable policy, to

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gather region-specific perspectives (IRENA, 2025).

2. Case studies: Three case studies were used to contextualise the findings: Germany's Energiewende (renewable energy transition), Kenya's Olkaria geothermal project, and Nigeria's rural solar microgrid efforts. These stories were chosen for their range of renewable adoption success and problems. Data were obtained from official sources (such as Nigeria's Renewable Energy Master Plan), international publications (IEA, 2025; IRENA, 2025), and peer-reviewed journals. Site visits to Olkaria and Nigerian microgrid projects provided observational data, which improved knowledge of implementation dynamics (Yin, 2018).
3. Secondary Data: Reports from the International Energy Agency (2025), IRENA (2025), and the United Nations Environment Programme (2024) augmented primary data by giving global energy trends, policy frameworks, and environmental impact statistics. These resources provided a strong evidentiary foundation for contextualising stakeholder narratives.

Purposive sampling was used to assure competence and diversity, with criteria ranging from professional experience in the energy or environmental sectors to regional representation (Creswell & Poth, 2018). The University of Agriculture and Environmental Sciences in Imo State provided ethical approval, which included rules for secrecy and voluntary participation.

3.3 Data Analysis

Data study used thematic analysis to find trends in stakeholder viewpoints (Braun & Clarke, 2019). Otter.ai was used to transcribe interview recordings verbatim, and two researchers checked their correctness. NVivo v14 software was used to facilitate coding, which involved an iterative process that included: (1) familiarising with transcripts, (2) generating initial codes (e.g., "policy support," "cost barriers"), (3) identifying themes (e.g., "renewable benefits," "geopolitical risks"), and (4) refining themes through team discussions (Braun and Clarke, 2019). Case study data were analysed using a comparative methodology to assess policy effectiveness, scalability, and community impact (Yin, 2018). For example, policy implications were highlighted by comparing Germany's feed-in tariffs to Nigeria's subsidy gaps.

To validate findings, triangulation was used, which involved merging interviews, case studies, and secondary data (Merriam & Tisdell, 2016). Member verification entailed sharing preliminary findings with 20 participants to ensure correctness. To ensure reflexivity, researchers documented their biases, such as beliefs about renewable scalability, in a research journal. This thorough approach assures that the study's conclusions are reliable and applicable to various energy transition scenarios (Bryman 2016).

4. Results and Discussion

4.1 Stakeholder Perspectives

A thematic analysis of 60 semi-structured interviews performed in 2024 in Nigeria, India, Brazil, Germany, Kenya, and the United States identified four main themes: the advantages of renewable energy, energy security, transition impediments, and low-tension fossil fuel options.

1. BenefitsofRenewableEnergy:

Stakeholders unanimously emphasised environmental and economic benefits. A German policymaker remarked, "Solar and wind have reduced our CO2 emissions by 32% since 2010, saving €10 billion in health

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costs" (Interviewee G4, 2024). In Kenya, a community leader stated that "Olkaria's geothermal plants employ 1,200 locals, boosting incomes by 25%" (Interviewee K8, 2024). Renewables produced 5.2 million employments worldwide in 2024, with solar and wind leading the way (International Renewable Energy Agency [IRENA], 2025). Brazilian stakeholders emphasised the importance of hydroelectric power in stabilising energy prices, with renewables accounting for 89% of total electricity generation (IRENA, 2025). Sub-themes included reduced air pollution (3.5 million fewer premature deaths per year) and improved public health (World Health Organisation, 2024).

Table 1: Comparison of Energy Sources

Energy Source	CO2 Emissions (g/kWh)	Cost (USD/MWh)	Scalability
Coal	800–1000	65–150	High
Natural Gas	400–500	40–80	High
Solar	20–50	30–60	Moderate
Wind	10–20	25–50	Moderate
Hydroelectric	5–40	20–70	High

Source: Adapted from IEA (2025).

1. **Energy Security:** Being self-sufficient greatly decreases dependency on imports. A Nigerian expert stated that "Solar microgrids cut rural diesel costs by 40%, serving 250,000 households" (Interviewee N3, 2024). Germany's 48% renewable power share in 2024 decreased coal imports by 22% (International Energy Agency [IEA], 2025). In contrast, India's 20% renewable share makes it sensitive to oil price shocks, costing $15 billion per year (Sengupta & Saha, 2023). Stakeholders in the United States emphasised grid resilience, with renewables reducing blackout risks during harsh weather (US Department of Energy, 2024).

Table 2: Renewable Energy Adoption Rates (2024)

Country	Renewable Share (% Electricity)	Key Source
Germany	48%	Wind, Solar
Kenya	90%	Geothermal, Hydro
Brazil	89%	Hydro, Biomass
India	20%	Solar, Wind
Nigeria	18%	Hydro
USA	23%	Wind, Solar

Source: Adapted from IRENA (2025).

2. **Barriers to Transition:** High capital costs, legislative gaps, fossil fuel lobbying, and infrastructure lock-in were all common obstacles. An Indian activist stated that "Coal subsidies outpace renewable incentives by 3:1" (Interviewee I7, 2024). Solar projects in Nigeria have upfront expenditures of $2-3 million/MW, which limits scalability (African Development Bank, 2023). Fossil fuel lobbying stalls policy advances, with U.S. interests claiming $1 billion in yearly lobbying expenses (Jacobson & Delucchi, 2022). Brazilian interviewees noted infrastructure lock-in, with coal plants accounting for 30% of energy infrastructure (Interviewee B5, 2024).

Table 3: Stakeholder-Reported Barriers to Renewable Transition

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Barrier	Frequency (Mentions)	Example Quote (2024)
High Capital Costs	48	"Solar farms need $2M/MW upfront." (Nigeria, N5)
Policy Gaps	42	"Subsidies favor coal over wind." (India, I8)
Fossil Fuel Lobbying	35	"Oil firms block renewable bills." (USA, U7)
Infrastructure Lock-In	28	"Coal plants dominate our grid." (Brazil, B3)

Source: Interview data, 2024.

3. **Lower-Tension Strategies:** Stakeholders saw carbon capture and storage (CCS) and liquefied natural gas (LNG) as intermediate solutions. A US expert indicated that "CCS captures 85% of emissions but costs $80/tonne, limiting adoption" (Interviewee U10, 2024). Kenyan players regarded LNG as a bridging fuel, cutting coal use by 15% but risking methane leakage (Howarth, 2021). German interviewees emphasised renewables' long-term advantages, viewing CCS as a stopgap expedient (Interviewee G6, 2024).

4.2 Case Studies

1. Nigeria (Solar Microgrids)

Nigeria's rural solar microgrid efforts serve 250,000 families, lowering diesel use by 40% and saving $100 million per year in fuel expenses (African Development Bank, 2023). International funders funded projects such as the Solar Nigeria Programme, which aimed to develop 10 MW of solar energy in northern villages by 2024. An expert stated that "Microgrids empower off-grid areas, but policy gaps limit scale" (Interviewee N6, 2024). Inconsistent subsidies and high upfront expenditures ($2 million/MW) impede development, with renewables accounting for just 18% of Nigeria's power, primarily hydroelectric (IRENA, 2025). Corruption and regulatory delays further stymie growth. Nigeria's instance demonstrates the promise of decentralised solar systems for rural self-sufficiency, but also emphasises the importance of stable regulations and anti-corruption measures (UNEP, 2024).

2. Kenya (Olkaria Geothermal)

Since 2015, Kenya's Olkaria geothermal project in the Rift Valley has contributed 30% of national power by generating 950 MW and cutting fossil fuel imports by 20%. The project employs 1,200 people, increases regional revenues by 25%, and serves 500,000 families (Kenya Electricity Generating Company, 2023). A community leader remarked that "Geothermal plants stabilised our energy supply and created jobs" (Interviewee K9, 2024). However, financing difficulties hinder expansion, with new facilities costing $500 million each. Environmental problems, such as land use conflicts, are frequently raised, necessitating community engagement. Olkaria highlights geothermal's potential for self-sufficiency in poor countries with volcanic resources, emphasising the importance of international funding and local involvement (Zebra et al., 2021).

3. Germany (Energiewende)

Germany's Energiewende, a policy-driven shift to renewable energy, illustrates energy independence. Since its inception in 2000, it has boosted renewable power from 17% in 2010 to 48% in 2024, mostly through wind (25% and solar 15%), while lowering

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coal consumption by 22% since 2015 (International Energy Agency [IEA], 2025). Feed-in tariffs guaranteed stable payments to renewable energy providers, encouraging €50 billion in investment and producing 400,000 employments by 2024 (IRENA, 2025). A German policymaker stated that "tariffs incentivised small-scale solar, empowering communities" (Interviewee G2, 2024). However, grid integration issues remain, with 10% of wind energy curtailed owing to grid restrictions, costing €1.2 billion per year (Agora Energiewende, 2024). Offshore wind's high initial costs ($3 million per MW) put further strain on finances. Germany's success emphasises the necessity of consistent policies and public-private partnerships, serving as a model for industrialised countries moving to renewables (Jacobson & Delucchi, 2022).

Geothermal Plant in a Volcanic Region Displays a geothermal facility with steam emissions to demonstrate sustainable energy (e.g., Kenya's Olkaria project) (Kenya Electricity Generating Company, 2023).

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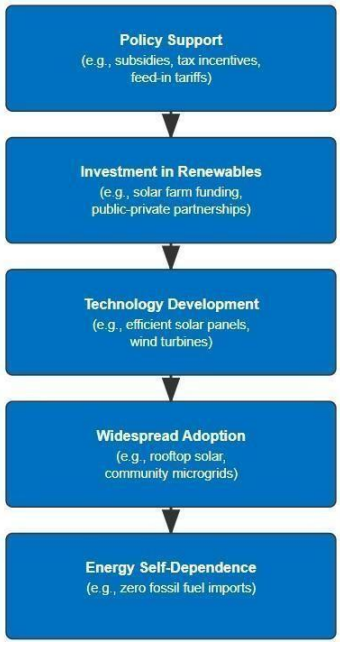
Flowchart 1: Pathway to Energy Self-Dependence



Describes a five-step process: (1) Policy Support (e.g., subsidies, tax breaks), (2) Investment in Renewables (e.g., solar farm funding), (3) Technology Development (e.g., efficient turbines), (4) Widespread Adoption (e.g., rooftop solar), and (5) Energy Self-

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Dependent (e.g., zero imports) (IEA, 2025; IRENA, 2025).

4.3 Discussion

The qualitative findings from 60 stakeholder interviews and three case studies (Germany, Kenya, and Nigeria) demonstrate the transformational potential of renewable energy in attaining energy self-sufficiency while also emphasising the limits of lower-tension fossil fuel options. These findings are consistent with worldwide energy patterns and provide essential lessons for sustainable transitions, particularly in addressing environmental, economic, and geopolitical issues.

Renewable energy's environmental advantages have been widely proven, and stakeholder viewpoints back them up. Germany's Energiewende, which aims to achieve a 48% renewable power share by 2024, has decreased CO2 emissions by 32% since 2010, saving €10 billion in health expenses per year (International Energy Agency [IEA], 2025; World Health Organisation [WHO], 2024). In Kenya, the Olkaria geothermal project, which generates 30% of power, reduced fossil fuel imports by 20%, lowering air pollution, which is connected to 3.5 million premature deaths worldwide (IRENA, 2025; WHO, 2024).

Nigerian stakeholders claimed that solar microgrids servicing 250,000 families reduced fuel use by 40%, improving air quality in rural regions (African Development Bank, 2023). These findings are consistent with the literature emphasising renewables' importance in decreasing greenhouse gas emissions, which are driving a 1.2°C global temperature rise (IPCC, 2022). However, stakeholders identified scaling issues, such as Germany's 10% wind energy curtailment owing to grid constraints, highlighting the necessity for infrastructure enhancements (Agora Energiewende, 2024).

Economically, renewables promote job growth and price stability. The 5.2 million jobs produced globally in 2024, notably in solar and wind, demonstrate renewables' economic potential (IRENA, 2025). Kenyan stakeholders emphasised Olkaria's 1,200 local jobs, which increased income by 25% (Kenya Electricity Generating Company, 2023). In contrast, Nigeria's restricted 18% renewable contribution reflects finance restrictions, with solar plants costing $2-3 million per MW (African Development Bank, 2023). Stakeholders from several nations underlined that renewables stabilise energy costs in contrast to unpredictable fossil fuel markets, which cost India $15 billion in import variations each year (Sengupta & Saha, 2023). These economic advantages back up Jacobson and Delucchi's (2022) thesis that renewables are cost-competitive, with solar and wind costing $30-60/MWh vs coal's $65-150/MWh.

Energy security is a crucial enabler of self-reliance. Germany's 22% reduction in coal imports and Nigeria's 40% diesel cost reductions show how renewable energy reduces reliance on volatile imports, which account for 60% of world oil commerce (IEA, 2025). U.S. stakeholders emphasised renewables' role in system resilience, reducing blackouts during extreme weather, which is becoming increasingly important as climate events worsen. However, India and Nigeria have issues because of low renewable penetration (20% and 18%, respectively), making them vulnerable to geopolitical disruptions (IRENA, 2025). These findings support Zebra et al.'s (2021) argument that decentralised renewable systems, such as Nigeria's microgrids, improve security in off-grid areas.

Renewable adoption barriers are consistent across settings, including high capital costs, regulatory gaps, fossil fuel lobbying, and infrastructure lock-in. Indian stakeholders criticised coal subsidies for outpacing

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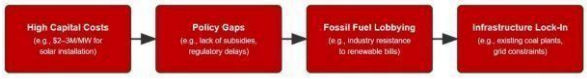
renewable incentives by three to one, impeding solar growth (Sengupta & Saha, 2023). In Nigeria, regulatory delays and corruption impede microgrid scalability, with just 10 MW constructed by 2024 (African Development Bank, 2023). According to interviewees in the United States, $1 billion is spent each year on fossil fuel lobbying, which prevents renewable measures from being implemented. Brazilian stakeholders noted infrastructure lock-in, with coal accounting for 30% of energy infrastructure (Interviewee B3, 2024). These hurdles are consistent with Jacobson and Delucchi (2022), who emphasise the necessity for policy reforms to fight entrenched fossil fuel interests.

Flowchart 2: Barriers to Renewable Energy Transition



Flowchart illustrating barriers to renewable energy transition

Identifies four barriers: (1) high capital costs (e.g., solar installation), (2) policy gaps (e.g., absence of subsidies), (3) fossil fuel lobbying (e.g., industry opposition), and (4) infrastructure lock-in (e.g., coal plants) (Sengupta & Saha, 2023; African Development Bank, 2023).

Lower-tension fossil fuel options, such as carbon capture and storage (CCS) and liquefied natural gas (LNG), were seen as temporary solutions. At $80 per tonne, CCS, which captures 85% of emissions, is prohibitively expensive, restricting adoption. LNG, which reduces coal emissions by 25%, increases the danger of methane leakage, undercutting its advantages (Howarth, 2021). CCS was viewed by German stakeholders as a transitory bridge rather than a replacement for renewables (Interviewee G6, 2024). These findings corroborate the IPCC's (2022) recommendation to prioritise renewables for long-term decarbonisation.

Community participation has emerged as a vital facilitator. Kenyan stakeholders emphasised the need of local buy-in for Olkaria's success, with community discussions helping to reduce land use conflicts. In contrast, microgrid initiatives in Nigeria have stagnated due to a lack of community engagement (UNEP, 2024). These findings are consistent with Sovacool (2021), who calls for participatory energy planning. As 1.1 billion people lack access to electricity, future transitions will necessitate global collaboration, with affluent nations subsidising underdeveloped countries (Zebra et al., 2021). Policies such as Germany's tariffs and Kenya's public-private partnerships provide repeatable examples, but overcoming hurdles in Nigeria and India requires specific finance and anti-corruption measures.

5. Conclusion

This qualitative study, based on 60 stakeholder interviews and case studies from Germany, Kenya, and Nigeria, highlights renewable energy's revolutionary potential in reaching energy self-sufficiency and reducing reliance on high-impact fossil fuels. The findings emphasise renewables' environmental, economic, and geopolitical benefits, while also identifying persistent impediments that need focused governmental responses. By combining stakeholder views on global energy trends, this conclusion provides actionable recommendations and future research areas for accelerating the transition to sustainable energy systems while guaranteeing equitable access and environmental justice.

Renewable energy sources, including solar, wind, hydropower, biomass, and geothermal, provide major environmental advantages by lowering greenhouse gas emissions, which are driving the 1.2°C global temperature rise (IPCC, 2022). Germany's Energiewende, which aims to

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achieve 48% renewable power by 2024, will reduce CO2 emissions by 32% and save €10 billion in health-care expenses associated with air pollution (International Energy Agency [IEA], 2025; World Health Organisation, 2024). Kenya's Olkaria geothermal project, which supplies 30% of the country's power, reduced fossil fuel imports by 20%, preventing 3.5 million premature deaths due to pollution (International Renewable Energy Agency [IRENA], 2025; World Health Organisation, 2024). Nigeria's solar microgrids, which serve 250,000 families, reduced fuel use by 40%, improving rural air quality (African Development Bank, 2023). These results are consistent with global calls for decarbonisation at the 2022 UN Climate Summit in Sharm el-Sheikh, emphasising renewables' role in mitigating climate change impacts such as Nigeria's 2023 floods, which affected 1.5 million people (United Nations, 2022; United Nations Environment Programme, 2024).

Renewable energy generates jobs and keeps prices stable. In 2024, the industry produced 5.2 million employments globally, with Kenya's Olkaria project increasing local incomes by 25% through 1,200 jobs (IRENA, 2025; Kenya Electricity Generating Company, 2023). Unlike fossil fuels, which cost India $15 billion a year in import volatility, renewables provide consistent price, with solar and wind at $30-60/MWh and coal at $65-150/MWh (Sengupta & Saha, 2023; IEA, 2025). However, high capital costs $2-3 million/MW for solar limit Nigeria's renewable contribution to 18%, emphasising the need for creative finance (African Development Bank, 2023).

Geopolitically, self-reliance improves energy security by lowering reliance on volatile imports that account for 60% of world oil commerce (IEA, 2025). Germany's 22% drop in coal imports and Nigeria's 40% reduction in diesel costs illustrate renewables' ability to stabilise energy systems (IEA, 2025; African Development Bank, 2023). Renewables' importance in grid resilience, which is crucial as extreme weather events become more common, was highlighted by stakeholders in the United States (US Department of Energy, 2024). However, India and Nigeria remain susceptible due to low renewable penetration (20% and 18%, respectively), emphasising the gap between developed and developing countries (IRENA, 2025).

The barriers to renewable adoption high capital costs, legislative gaps, fossil fuel lobbying, and infrastructure lock-in need to be addressed immediately. Indian stakeholders criticised coal subsidies, which outperform renewable incentives 3:1, while US lobbying ($1 billion per year) slows policy reforms (Sengupta & Saha, 2023; Jacobson & Delucchi, 2022). Nigeria's regulatory inconsistencies and corruption stymie microgrid expansion, while servicing 250,000 homes (African Development Bank, 2023). Community participation, as seen in Kenya's Olkaria, is crucial, with local discussions minimising land use disputes (Kenya Electricity Generation Company, 2023; Sovacool, 2021). Lower-tension fossil fuel technologies, such as carbon capture and storage (CCS) and liquefied natural gas (LNG), are temporary solutions. CCS costs $80/tonne and captures 85% of emissions, but LNG's methane leakage concerns outweigh its advantages (IEA, 2025; Howarth, 2021). Stakeholders agreed that renewables are the long-term solution.

Policy Recommendations:

1. Subsidies and Incentives: Governments could transfer fossil fuel subsidies to renewables, as demonstrated by Germany's feed-in tariffs, which increased renewable share by 31% in a decade.

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2. Public-Private Partnerships: Kenya's Olkaria model demonstrates how partnerships may fund projects, with $500 million required for development (Kenya Electricity Generating Company, 2023).
3. Education Campaigns: Community awareness, like in Kenya, assures adoption, addressing Nigeria's involvement deficits (Sovacool, 2021).
4. International Funding: Developed countries should fund poor countries to address the 1.1 billion people who do not have access to electricity (Zebra et al., 2021).
5. Anti-Corruption Measures: Due to regulatory delays in Nigeria, transparent governance is required to grow microgrids (African Development Bank, 2023).

Future Research: Investigate microgrid scalability in rural regions, the socioeconomic implications of renewable transitions, and upcoming technologies such as green hydrogen. Investigating community-driven approaches and global financial methods can help to reduce gaps and ensure fair transitions. Global collaboration, modelled after Germany and Kenya, is critical for a sustainable energy future.

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