Assessing the Environmental and Economic Impacts of Kenya's Feed-in-Tariff Policy

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Abstract

This study evaluates Kenya's 2008 Feed-in Tariff (FiT) policy using a quasi- experimental approach to determine whether the policy achieved a "double dividend" of reducing carbon emissions while stimulating positive economic outcomes. Employing a Difference-in-Differences (DiD) design with Ghana as a control country, supplemented by a synthetic control method using 15 Sub-Saharan African nations, this study assesses the policy's impact on renewable energy generation, CO_2 emissions, electricity access, and economic growth. The findings reveal a successful energy transition, with Kenya experiencing a significant increase in renewable electricity generation (+54.64 kWh per capita, $p < 0.05$) and a substantial reduction in fossil fuel share (-34.08 percentage points, $p < 0.01$). However, this transition did not translate into reduced absolute CO_2 emissions or improved rural electrification rates, and Kenya experienced slower GDP growth compared to Ghana's fossil-led expansion. The synthetic control analysis provides weak evidence for policy effects on fossil fuel electricity reduction. These results suggest that while Kenya's FiT policy successfully shifted the energy mix toward renewables, the policy faced trade-offs in terms of economic growth and did not achieve comprehensive developmental benefits in the study period.

Contents

1 Introduction

The global imperative to transition toward renewable energy has positioned Feed-in Tariffs (FiTs) as one of the most widely adopted policy instruments for promoting clean energy generation. FiTs guarantee renewable energy producers a fixed payment per unit of electricity fed into the grid, thereby reducing investment risk and incentivizing the deployment of solar, wind, geothermal, and hydroelectric power.[1] While FiTs have been extensively studied in developed economies, their effectiveness in developing country contexts, particularly in Sub-Saharan Africa remains underexplored.

Feed-in-Tariff (FiT): A Feed-in-Tariff is a policy mechanism that encourages electricity generation from renewable sources by allowing producers to sell power to an off-taker at a fixed, pre-determined rate over a set period. In Kenya, renewable sources under FiT include wind, solar, small hydro, biomass, biogas, and geothermal energy.[2]

Kenya implemented its FiT policy in 2008, becoming one of the first Sub-Saharan African nations to adopt such a comprehensive renewable energy incentive framework. The policy offered guaranteed prices for renewable electricity ranging from $0.08–0.12/kWh depending on technology and scale,[3] designed to address the country's growing energy demand, reduce dependence on costly imported petroleum, and leverage Kenya's exceptional renewable resource endowments. At the time of policy adoption, Kenya faced critical energy security challenges: electrification rates stood below 20%, the economy remained vulnerable to oil price volatility, and frequent power outages constrained industrial development.[4] The FiT policy emerged from a coalition of environmental advocates, international development partners, and domestic business interests seeking to capitalize on Kenya's substantial geothermal potential in the Rift Valley (estimated at 10,000 MW), wind resources in the Turkana region, and year-round solar irradiation.[5] By positioning Kenya as a regional leader in clean energy, policymakers hoped to align energy expansion with the country's Vision 2030 development blueprint, which emphasized infrastructure modernization and energy security as prerequisites for achieving middle-income status.

Despite the policy's ambitious goals, critical questions remain about its actual impacts. Did the FiT policy succeed in increasing renewable energy generation and reducing carbon emissions? Did this transition come at the cost of economic growth, or did Kenya achieve "green growth" that reconciled environmental and economic objectives? Were there measurable improvements in development indicators such as electricity access, particularly in rural areas?

This study aims to address these questions through a rigorous quasi-experimental evaluation. This paper employs a Difference-in-Differences (DiD) design comparing Kenya's

[1] KaihaoCai etal., *Harnessing Renewables in Sub-Saharan Africa: Barriers, Reforms, and Economic Prospects*, Staff Climate Notes 2024/005 (October 2024).

[2] Ministry of Energy, Kenya, *Feed-in-Tariff Policy on Renewable Energy Resource Generated Electricity (Small-Hydro, Biomass and Biogas)* (Nairobi: Ministry of Energy, 2008).

[3] Ibid

[4] Lucy Baker, *The Political Economy of Low Carbon Energy in Kenya* (Brighton: IDS, 2015).

[5] Ibid.

post-policy trajectory to Ghana, a comparable African nation without a similar FiT policy during the study period (2000–2023). To enhance the robustness and external validity of these findings, this paper supplements the DiD analysis with a synthetic control method that constructs a weighted combination of 15 Sub-Saharan African countries to serve as a more generalizable counterfactual for Kenya.

The contribution of this study is threefold. First, it provides causal evidence on the effectiveness of FiT policies in a developing country context, addressing a significant gap in the energy policy literature. Second, it examines not only environmental outcomes but also economic and developmental impacts, offering a comprehensive assessment of the policy's "double dividend" potential, meaning its ability to deliver both environmental benefits and economic gains. Third, it employs methodological triangulation through both DiD and synthetic control approaches, strengthening the validity of causal inference in a context where randomized policy assignment is infeasible.

2 Literature Review

2.1 Methodology of Literature Review

The literature review was conducted using a systematic search approach across two major academic databases: JSTOR and Scopus. The inclusion criteria was designed to identify peer-reviewed research articles published between January 2010 and January 2025 that examine the intersection of Kenya's Feed-in Tariff policy and economic outcomes.

JSTOR Search Protocol:

- Language: English
- Publication type: Research articles
- Date range: January 2010 to January 2025
- Keywords: '(((Kenya) AND ("Feed-in Tariff")) AND ("Economic growth")) AND la:(eng OR en)'
- Results: 65 articles initially identified; top 20 selected based on relevance and citation metrics

Scopus Search Protocol:

- Language: English
- Publication type: Research articles
- Date range: 2010 to 2025
- Keywords: '(((Kenya) AND ("Feed-in Tariff")) AND ("Economic growth"))'
- Results: 94 articles initially identified; top 20 selected based on relevance and citation metrics

Articles were sorted by citations and selected based on their direct relevance to Kenya's FiT policy, and contribution to understanding the economic and environmental outcomes of renewable energy policies in developing countries. Priority was given to empirical studies employing quantitative methods, comparative analyses with other African nations, and research addressing the policy's implementation challenges and developmental impacts.

2.2 Literature Synthesis

2.2.1 Economic Context: Kenya and Ghana

Kenya and Ghana represent two distinct economic and energy trajectories within Sub-Saharan Africa. Kenya's economy, with a GDP per capita of approximately $1,609 (constant 2025 USD) in 2020,[6] has been service-sector dominated, with finance, telecommunications, and tourism comprising major growth engines. Agriculture accounted for 22.5% of GDP in 2024 and employed over 40% of the workforce,[7] while manufacturing has lagged behind regional competitors at only 14% of GDP.[8] Kenya's Vision 2030 development blueprint emphasizes infrastructure modernization and energy security as prerequisites for achieving middle-income status, aiming to transform Kenya into "a newly-industrializing, middle income country providing a high quality of life to all its citizens in a clean and secure environment."[9]

Ghana, by contrast, experienced more rapid economic expansion, reaching approximately $2,200 GDP per capita by 2020, driven substantially by natural resource extraction. The discovery of offshore oil deposits in 2007 at the Cape Three Points sedimentary basin fundamentally altered Ghana's economic structure and energy calculus.[10] Production commenced in 2010, and by 2011, crude oil exports reached 55.4 million barrels, with the oil and gas sector accounting for 6% of Ghana's economic revenue.[11] This resource endowment shaped Ghana's energy policy choices, incentivizing fossil fuel development over renewable alternatives.

2.2.2 Kenya's Energy Sector and Feed-in Tariff Policy

Kenya's energy sector faces the dual challenge of expanding access while pursuing decarbonization objectives. The country possesses exceptional renewable energy resources, par-

[6] "Kenya GDP Per Capita," World Economics, accessed December 7, 2024, https://www.worldeconomics.com/GrossDomesticProduct/Real-GDP-Per-Capita/Kenya.aspx.

[7] "Agriculture in Kenya," Grokipedia, accessed December 7, 2024, https://grokipedia.com/page/Agriculture_in_Kenya; "Kenya Employment in Agriculture," TheGlobalEconomy.com, accessed December 7, 2024, https://www.theglobaleconomy.com/Kenya/Employment_in_agriculture/.

[8] "Economy of Kenya," Wikipedia, last modified November 29, 2024, accessed December 7, 2024, https://en.wikipedia.org/wiki/Economy_of_Kenya.

[9] "About Vision 2030," Kenya Vision 2030, accessed December 7, 2024, https://vision2030.go.ke/about-vision-2030/.

[10] International Atomic Energy Agency, "Ghana 2017," Country Nuclear Power Profiles (Vienna: IAEA, 2017), accessed December 7, 2024, https://www-pub.iaea.org/MTCD/Publications/PDF/cnpp2017/countryprofiles/Ghana/Ghana.htm.

[11] "Electricity Sector in Ghana," Wikipedia, last modified September 13, 2024, accessed December 7, 2024, https://en.wikipedia.org/wiki/Solar_power_in_Ghana.

ticularly geothermal potential in the Rift Valley (estimated at 10,000 MW), substantial wind resources in the Turkana region, and year-round solar irradiation. These endowments provided the foundation for Kenya's 2008 Feed-in Tariff policy, which offered guaranteed prices for renewable electricity ranging from $0.08–0.12/kWh depending on technology and scale.[12]

Research on Kenya's FiT implementation reveals mixed outcomes. By 2024, Kenya's installed generation capacity exceeded 3,200 MW, with over 90% from renewable sources including 940 MW of geothermal, 838 MW hydro, 435 MW wind, and 212.5 MW solar.[13] Geothermal generation contributed 39.81% of total electricity in 2024, positioning Kenya as Africa's leading geothermal producer.[14]

However, implementation challenges have been substantial. Awuor and Ochieng find that despite triggering investment interest, significant delays plagued commercial deployment, with only 10.3 MW generated from FiT projects against a target of 1,551 MW ten years after policy introduction representing merely 0.66% of the target.[15] Recent analysis by Kehbila et al. emphasizes that successful FiT implementation requires strategic stakeholder engagement, robust financing mechanisms, and transparent competitive procurement processes.[16]

The political economy of Kenya's energy transition has been examined by Baker, revealing that the FiT policy emerged from a coalition of environmental advocates, international development partners, and domestic business interests seeking energy security and diversification from costly imported petroleum.[17] Yet this coalition faced opposition from incumbent fossil fuel interests and utilities concerned about stranded assets. Success depended critically on strong regulatory institutions, particularly the Energy Regulatory Commission and Kenya Power and Lighting Company, capable of implementing complex tariff structures and managing grid integration.

2.2.3 Ghana's Fossil-Led Energy Development

Ghana's energy trajectory diverged sharply following the 2007 oil discovery. The government's policy prioritized monetizing natural gas for electricity generation, viewing fossil fuels as the fastest path to energy security and industrial competitiveness.[18] Natural gas imports through the West African Gas Pipeline commenced in 2010, supplementing domestic

[12]Ministry of Energy, Kenya, *Feed-in-Tariff Policy on Renewable Energy Resource Generated Electricity (Small-Hydro, Biomass and Biogas)* (Nairobi: Ministry of Energy, 2008), accessed via Kenya Climate Directory, https://kenyaclimatedirectory.org/resources/6502db12b1f3c.

[13]"Comparisons," Chambers and Partners Global Practice Guides, accessed December 7, 2024, https://practiceguides.chambers.com/practice-guides/comparison/1245/16604/26105-26106-26107-26108-26109.

[14]Ibid.

[15]Emmanuel Awuor and Justin Ochieng, "The Effectiveness of Feed-in-Tariff Policy in Promoting Power Generation from Renewable Energy in Kenya," *Renewable Energy* 161 (2020): 593–605.

[16]Anderson Kehbila et al., "Stakeholders' Perspectives on the Effectiveness of the Feed-in Tariff and Renewable Energy Auction Policies in Kenya," SEI Report (Stockholm: Stockholm Environment Institute, 2024), https://doi.org/10.51414/sei2024.053.

[17]Lucy Baker, *The Political Economy of Low Carbon Energy in Kenya* (Brighton: IDS, 2015), accessed December 7, 2024, https://opendocs.ids.ac.uk/articles/report/The_Political_Economy_of_Low_Carbon_Energy_in_Kenya/26474113.

[18]International Atomic Energy Agency, "Ghana 2017."

production.[19] By 2021, Ghana's electricity mix relied heavily on natural gas (62.6%) and hydropower (34.1%).[20]

Ghana's fossil-led expansion achieved rapid electrification success, with rural access rates increasing from 27% in 2008 to 58% by 2023, substantially outpacing Kenya despite the fossil intensive approach. This was achieved through aggressive grid extension programs financed by oil revenues and international development assistance.[21]

Ghana did implement a Renewable Energy Act in 2011, establishing its own feed-in tariff framework with guaranteed tariffs for 10 years covering wind, hydro, solar, biomass, and geothermal.[22] However, Ghana's FiT was undermined by competition from cheap natural gas, inadequate grid infrastructure for integrating variable renewables, and limited enforcement of renewable energy targets. By 2023, renewables (primarily large hydro) constituted only 45% of Ghana's electricity mix, declining from 59% in 2008 as fossil fuel generation expanded rapidly.[23]

2.2.4 Other Comparative Studies

Few studies have directly compared Kenya and Ghana's contrasting energy approaches using rigorous causal inference methods. Baker et al. conducted a cost-benefit analysis comparing renewable energy investments in Kenya and Ghana, finding that Kenya's wind and geothermal technologies offer low-cost electricity and healthy returns on investment.[24] Kenya's FiT protects investors against currency devaluation and benefits from a creditworthy off-taker. Conversely, Ghana's renewable electricity (except hydro) proved expensive due to high financing costs and lower-quality renewable resources, with investors unprotected against currency devaluation.[25]

However, these comparative analyses remain largely qualitative or focused on narrow cost metrics, lacking quantitative estimation of policy effects across multiple outcome dimensions. Bertheau and Blechinger's evaluation of African FiT schemes notes that "most of the FiT schemes in Africa are poorly working because of unfavourable institutional design, insufficient level of FiT rates or obstacles in the process of implementation,"[26] but provides limited causal evidence distinguishing policy effects from confounding factors.

The present study addresses critical gaps in this literature. First, it employs quasi-experimental methods (DiD and synthetic control) to establish causal rather than merely

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[19] "Ghana Energy Situation," energypedia, accessed December 7, 2024, https://energypedia.info/wiki/Ghana_Energy_Situation.

[20] "Electricity Sector in Ghana," Wikipedia.

[21] Ghana Ministry of Energy, *Ghana's National Energy Transition Framework* (Accra: Ministry of Energy, 2023), accessed December 7, 2024, https://www.energymin.gov.gh/sites/default/files/2023-09/FINAL_GHANA'S_NATIONAL_ENERGY_TRANSITION_FRAMEWORK_2023_compressed.pdf.

[22] Bertheau and Blechinger, "Evaluation of Feed-in Tariff-Schemes in African Countries," *Journal of Energy in Southern Africa* 23, no. 1 (2012): 56–65.

[23] Ibid.

[24] Lucy Baker, Jesse Burton, and Catrina Godinho, *Cost and Returns of Renewable Energy in Sub-Saharan Africa: A Comparison of Kenya and Ghana* (Brighton: IDS, 2016), accessed December 7, 2024, https://opendocs.ids.ac.uk/articles/report/Cost_and_Returns_of_Renewable_Energy_in_Sub-Saharan_Africa_A_Comparison_of_Kenya_and_Ghana/26468134.

[25] Ibid.

[26] Bertheau and Blechinger, "Evaluation of Feed-in Tariff-Schemes in African Countries," 57.

correlational relationships between FiT policy and outcomes. Second, it examines a comprehensive set of outcomes spanning energy, environment, economy, and development moving beyond single-dimension assessments. Third, it explicitly tests the "double dividend" hypothesis that has motivated renewable energy advocacy in developing countries, providing evidence on whether energy transitions involve real trade-offs or win-win scenarios. By comparing Kenya's renewable-focused FiT policy to Ghana's fossil-led alternative using 23 years of panel data and multiple methodological approaches, this study provides rigorous assessment of energy policy effectiveness in Sub-Saharan Africa with implications for the broader set of developing nations confronting similar challenges.

3 Hypotheses

Based on the theoretical framework of energy transitions in developing economies this study tests the following hypotheses:

H1: Renewable Energy Generation: The FiT policy caused a significant increase in per-capita renewable electricity generation in Kenya relative to the control country.

H2: Fossil Fuel Dependency: The policy led to a significant decrease in the share of fossil fuel-based electricity generation in Kenya's energy mix.

H3: Carbon Emissions: The policy resulted in a significant decrease in per-capita CO_2 emissions in Kenya after controlling for economic activity. This hypothesis examines whether the shift toward renewables translated into measurable environmental benefits in terms of reduced greenhouse gas emissions.

H4: Economic Growth: The policy did not result in significant negative impacts on GDP per capita, consistent with "green growth" theory. This tests whether Kenya's energy transition imposed economic trade-offs or whether clean energy development contributed positively to economic outcomes.

H5: Rural Electrification: The policy led to significant improvements in rural electricity access rates. This developmental hypothesis examines whether the expansion of electricity generation capacity translated into improved energy access for underserved rural populations.

These hypotheses collectively test the "double dividend" thesis that Kenya's FiT policy could simultaneously achieve environmental sustainability through emissions reduction and energy transition while promoting economic development through GDP growth and expanded electricity access. The hypotheses are tested using both the DiD framework with Ghana as a control and the synthetic control method for robustness.

4 Methodology

4.1 Empirical Strategy: Difference-in-Differences (DiD)

4.1.1 Core Regression Model

This study employ a Difference-in-Differences (DiD) design to identify the causal effect of Kenya's FiT policy on energy, environmental, and economic outcomes. The DiD approach compares the change in outcomes for Kenya (treatment group) before and after the 2008 policy implementation to the contemporaneous change in outcomes for Ghana (control group) over the same period. This design controls for time-invariant differences between countries and common time trends, isolating the policy's causal effect under the parallel trends assumption.

The baseline DiD is:

$$Y_{it} = \beta_0 + \beta_1(\text{Treated}_i) + \beta_2(\text{Post}_t) + \beta_3(\text{Treated}_i \times \text{Post}_t) + \gamma X_{it} + \varepsilon_{it} \tag{1}$$

where:

- Y_{it} is the outcome variable for country i in year t
- Treated_i is a dummy variable (1 for Kenya, 0 for Ghana)
- Post_t is a dummy variable (1 for years $\geq$ 2008, 0 otherwise)
- $\text{Treated}_i \times \text{Post}_t$ is the interaction term; the coefficient β_3 is the DiD estimator
- X_{it} is a vector of control variables
- ε_{it} is the error term

The coefficient of interest, β_3, captures the differential change in outcome Y for Kenya relative to Ghana following the 2008 policy implementation. A significant β_3 indicates that Kenya's trajectory diverged from Ghana's in a manner attributable to the FiT policy.

4.1.2 Treatment Timing

The treatment year is designated as 2008, when Kenya's FiT policy was officially enacted. However, implementation delays extended into 2011–2012 as regulatory frameworks were established and projects came online. While the main analysis uses 2008 as the treatment threshold to capture both announcement effects and actual implementation, robustness checks could examine alternative treatment years to account for gradual implementation.

4.1.3 Outcome Variables

The analysis examines multiple outcome variables across energy, environmental, economic, and developmental domains:

Energy Transition Outcomes:

- Renewable electricity per capita (kWh/person)
- Fossil fuel electricity per capita (kWh/person)
- Renewable share of total electricity generation (%)
- Fossil fuel share of total electricity generation (%)

Environmental Outcomes:

- Annual CO_2 emissions (metric tons)
- Log-transformed CO_2 emissions

Economic Outcomes:

- GDP per capita (constant 2025 USD)
- Log-transformed GDP per capita

Developmental Outcomes:

- Rural electricity access rate (%)
- Urban electricity access rate (%)
- Overall electricity access rate (%)

4.1.4 Control Selection: Ghana as Counterfactual

Ghana serves as the control country based on several comparability criteria. Both Kenya and Ghana are largely English-speaking Sub-Saharan African nations with similar colonial histories, population sizes (approximately 50 million and 30 million respectively during the study period), and levels of economic development. Critically, Ghana did not implement a comprehensive FiT policy during the study period (2000–2023), making it a plausible counterfactual for Kenya's energy trajectory. Ghana's energy sector expanded primarily through fossil fuel development, particularly natural gas, providing a contrast to Kenya's renewable-focused policy.

4.1.5 Parallel Trends Assumption

The validity of the DiD design relies on the parallel trends assumption: in the absence of treatment, Kenya and Ghana would have experienced parallel trends in outcome variables. This assumption is tested by examining pre-treatment trends (2000–2007) and estimating a model with a pre-treatment interaction term:

The parallel trends test model:

$$Y_{it} = \beta_0 + \beta_1(\text{Treated}_i) + \beta_2(\text{Pre\_period}_t) + \beta_3(\text{Treated}_i \times \text{Pre\_period}_t) + \gamma X_{it} + \varepsilon_{it} \quad (2)$$

where Pre_period_t indicates years 2004–2007.

4.2 Synthetic Control Method

To enhance the robustness and external validity of the DiD findings, this study employs the synthetic control method (SCM) developed by Abadie and Gardeazabal (2003)[27] and

[27] Alberto Abadie and Javier Gardeazabal, "The Economic Costs of Conflict: A Case Study of the Basque Country," *American Economic Review* 93, no. 1 (2003): 113–132.

Abadie, Diamond, and Hainmueller (2010).[28] The SCM constructs a weighted combination of control countries (the "synthetic control") that best approximates Kenya's pre-treatment characteristics, providing a data-driven counterfactual that is less dependent on the single-country comparison used in the DiD approach.

4.2.1 Donor Pool Selection

The donor pool consists of 15 Sub-Saharan African countries selected based on data availability and pre-treatment similarity to Kenya across key energy, economic, and developmental indicators. The donor pool includes: Guinea, Tanzania, Mali, Benin, Togo, Ghana, Madagascar, Malawi, Angola, Zambia, Liberia, Côte d'Ivoire, Zimbabwe, Burkina Faso, and Uganda.

Countries were selected through a systematic process:

1. All Sub-Saharan African nations with complete data for 2000–2023 were considered
2. Similarity scores were calculated based on pre-treatment (2000–2007) means for GDP per capita, electricity access, CO_2 emissions, renewable electricity per capita, and fossil fuel electricity per capita
3. The top 15 most similar countries were retained as potential donors

4.2.2 Outcome Variable and Predictors

The primary outcome variable for the synthetic control analysis is **fossil fuel electricity per capita (kWh/person)**, which directly measures the policy's intended effect of reducing fossil fuel dependency.

The predictor variables used to construct the synthetic control include:

- GDP per capita (constant 2025 USD)
- Overall electricity access rate (%)
- Renewable electricity per capita (kWh/person)
- Fossil fuel electricity per capita (kWh/person)

These predictors capture the key dimensions along which Kenya's energy system should be matched to construct a valid counterfactual.

[28] Alberto Abadie, Alexis Diamond, and Jens Hainmueller, "Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program," *Journal of the American Statistical Association* 105, no. 490 (2010): 493–505.

4.2.3 Weight Optimization

Synthetic control weights w_j for each donor country j are estimated by minimizing the pre-treatment mean squared prediction error (MSPE) between Kenya's actual outcome and the synthetic control outcome. Weights are constrained to be non-negative and sum to one:

$$w_j \geq 0 \text{ for all } j, \text{ and } \sum_{j=1}^{J} w_j = 1 \tag{3}$$

The optimization is performed using non-negative least squares regression, which finds the weight vector that best fits Kenya's pre-treatment outcome trajectory as a linear combination of donor country trajectories.

4.2.4 Treatment Effect Estimation

The average treatment effect on the treated (ATT) in the post-treatment period is calculated as:

$$\text{ATT}_{\text{post}} = \frac{1}{T_{\text{post}}} \sum_{t \in \text{post}} (Y_{\text{Kenya},t} - Y_{\text{Synthetic},t}) \tag{4}$$

where T_{post} is the number of post-treatment years (2008–2023), $Y_{\text{Kenya},t}$ is Kenya's observed outcome, and $Y_{\text{Synthetic},t}$ is the synthetic control outcome.

4.2.5 Inference and Robustness Checks

Statistical inference in the synthetic control framework is conducted through placebo tests and pre/post-treatment fit diagnostics:

Placebo p-value: This method applies the synthetic control method to each donor country as if it had received the treatment in 2008. This generates a distribution of placebo treatment effects. The p-value is calculated as the proportion of placebo countries with post/pre-RMSPE ratios greater than or equal to Kenya's:

$$p\text{-value} = \frac{\text{\# of placebos with RMSPE ratio} \geq \text{Kenya's}}{\text{Total \# of placebos}} \tag{5}$$

Root Mean Squared Prediction Error (RMSPE) Ratio: The ratio of post-treatment RMSPE to pre-treatment RMSPE indicates whether the synthetic control fit deteriorated after treatment:

$$\text{RMSPE ratio} = \frac{\text{RMSPE}_{\text{post}}}{\text{RMSPE}_{\text{pre}}} \tag{6}$$

where:

$$\text{RMSPE}_{\text{pre}} = \sqrt{\frac{1}{T_{\text{pre}}} \sum_{t \in \text{pre}} (Y_{\text{Kenya},t} - Y_{\text{Synthetic},t})^2} \tag{7}$$

$$\text{RMSPE}_{\text{post}} = \sqrt{\frac{1}{T_{\text{post}}} \sum_{t \in \text{post}} (Y_{\text{Kenya},t} - Y_{\text{Synthetic},t})^2} \tag{8}$$

A ratio significantly greater than 1 suggests a treatment effect, while a ratio near or below 1 indicates stable fit or weak evidence of an effect.

Leave-One-Out Sensitivity Analysis: This method iteratively remove each donor country from the pool and re-estimate the synthetic control to assess whether results are driven by any single country. Stable treatment effects across leave-one-out specifications indicate robust findings.

5 Data

5.1 Data Sources

This study utilizes panel data for Kenya and Ghana (for the DiD analysis) and 15 Sub-Saharan African countries (for the synthetic control analysis) spanning 2000–2023. Data were compiled from multiple sources to construct a comprehensive dataset of energy, environmental, economic, and developmental indicators.

1. **Primary Energy and Electricity Generation Data:** Electricity generation by source (fossil fuels, nuclear, renewables) and primary energy consumption per capita were obtained from Ember's Global Electricity Review (2025), the Energy Institute's Statistical Review of World Energy (2025), and Our World in Data's processed datasets.

2. **Carbon Emissions Data:** Annual CO_2 emissions data were sourced from Our World in Data's compilation, which draws on the Global Carbon Budget and Carbon Dioxide Information Analysis Center (CDIAC). Emissions are measured in metric tons of CO_2.

3. **Economic Data:** GDP per capita (constant 2025 USD) data were obtained from the World Bank's World Development Indicators database. This provides standardized purchasing power estimates that account for inflation and enable cross-country comparisons.

4. **Electricity Access Data:** Electricity access rates (overall, urban, and rural) were compiled from the World Bank's Global Electrification Database, which tracks the percentage of population with access to electricity.

5.2 Data Coverage and Quality

The dataset includes annual observations from 2000 to 2023, providing eight years of pre-treatment data (2000–2007) and sixteen years of post-treatment data (2008–2023). This temporal span allows for robust pre-treatment trend analysis and sufficient post-treatment observation to detect policy effects.

For the DiD analysis, the dataset is balanced with complete observations for Kenya and Ghana across all years and variables. For the synthetic control analysis, the 15-country donor pool was selected based on data completeness, with countries having fewer than 10% missing values across key variables. Missing values were minimal and handled through linear interpolation where appropriate.

All monetary values are expressed in constant 2025 USD to ensure comparability across years. Per capita metrics were calculated by dividing aggregate values by total population in each country-year. The final analytical dataset contains 48 country-year observations for the DiD analysis and 360 country-year observations for the synthetic control analysis.

5.3 Kenya and Ghana Overall Data Trends

The data shows various differences in energy consumption and electricity generation patterns between Kenya and Ghana from 2000 to 2023 (See Summary Statistics in Table 4). Kenya's primary energy consumption per capita shows moderate growth over the period, rising from around 1,350 kWh/person in 2000 to roughly 1,608 kWh/person in 2023, while Ghana shows a larger increase, from approximately 1,457 kWh/person to 3,075 kWh/person almost doubling. On the other hand Kenya takes alrger leap in access to electricity. Kenya's overall access to electricity increases from 15% to 76%, whereas Ghana starts higher at 44% and reaches 89% by 2023.

In terms of the composition of the electricity generation, Kenya is consistently more heavily relying on renewable sources, particularly hydro, biomass and geothermal, while Ghana shows substantial growth in fossil fuel-based electricity, especially from 2000 to 2010, followed by increased renewable contributions. CO_2 emissions in Kenya grow steadily from roughly 10 million tons to 21.5 million tons, whereas Ghana shows higher variability, rising from 5.3 million tons to almost 19.6 million tons by 2023. GDP per capita also diverges for both countries. Kenya experiences gradual growth from $415 to $1,952 (2025 USD), while Ghana's GDP per capita shows a steeper trajectory from $254 to $2,383. Overall, the data suggest that Ghana has achieved faster expansion in energy consumption and access, but Kenya maintains a stronger focus on renewables, reflecting differing energy policy priorities and resource endowments.

6 Results

6.1 Difference-in-Differences Analysis

6.1.1 Parallel Trends Test

The validity of the DiD design depends on the parallel trends assumption that Kenya and Ghana would have followed similar trajectories in the absence of the FiT policy. Testing for differential pre-treatment trends (2004–2007) yields a statistically insignificant interaction term ($p > 0.10$) for renewable electricity per capita, indicating no significant pre-existing divergence between the two countries. This supports the plausibility of Ghana as a counterfactual for Kenya's post-policy trajectory. (See Table 5)

6.1.2 Energy Transition Effects

The first set of results examines the core energy transition outcomes, testing whether Kenya's FiT policy successfully shifted electricity generation toward renewable sources and away from fossil fuels.

Table 1: Energy Transition Effects of Kenya's Feed-in Tariff Policy

Variable	**Coefficient**	**Std. Error**	**P-value**	**Sig.**
Renewable Electricity (kWh/pc)	54.64	26.26	0.04	**
Fossil Electricity (kWh/pc)	−148.34	39.96	0.00	***
Renewable Share (%)	34.08	7.75	0.00	***

Notes: All models include GDP per capita controls. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The DiD estimates reveal a **successful energy transition** in Kenya following the FiT policy. Renewable electricity generation increased by 54.64 kWh per capita ($p < 0.05$), representing a substantial expansion of clean energy production. Critically, the renewable share of total electricity increased by 34.08 percentage points ($p < 0.01$), demonstrating that Kenya's energy mix fundamentally shifted toward renewables.

Fossil fuel electricity per capita significantly decreased by 148.34 kWh ($p = 0.000$), indicating a measurable decline in fossil-based generation. This reduction suggests that Kenya's expansion of renewable energy displaced fossil fuel use. At the same time, the sharp decline in the fossil fuel share implies that newly added generation capacity during this period was overwhelmingly renewable, consistent with the goals of the FiT policy. Taken together, these results show that Kenya simultaneously reduced fossil fuel reliance and expanded total electricity supply, highlighting the dual dynamics of energy transition and energy access growth.

6.1.3 Environmental and Developmental Impacts

The second set of results examines whether Kenya's energy transition translated into reduced carbon emissions and improved developmental outcomes such as rural electrification and economic growth.

Table 2: Environmental and Developmental Impacts

Outcome	**Coefficient**	**Std. Error**	**P-value**	**Sig.**
CO_2 Emissions (metric tons)	3,651,749	1,025,600	0.00	***
Rural Electricity Access (%)	3.85	5.47	0.48	
GDP per Capita (USD)	−349.59	229.49	0.13	

Notes: CO_2 and Rural Access models include GDP controls. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The results reveal a paradoxical environmental outcome. Despite the successful shift toward renewable energy, Kenya's annual CO_2 emissions increased by 3.65 million metric tons ($p < 0.01$) relative to Ghana after controlling for GDP. This counterintuitive finding reflects the dominance of economic scale effects over composition effects. As Kenya's economy grew, total energy consumption increased across all sectors, not just electricity and emissions from transportation, industry, and non-electricity sources rose. The electricity sector's cleaner generation mix was insufficient to offset these broader economic emission drivers.

Regarding developmental outcomes, the FiT policy showed **no significant impact on rural electricity access** (+3.85 percentage points, $p = 0.48$). While renewable generation capacity expanded, this did not translate into improved electricity access for rural populations during the study period.

Finally, Kenya experienced a **non-significant decline in GDP per capita** relative to Ghana (−\$349.59, $p = 0.13$). While not statistically significant at conventional levels, this negative point estimate suggests that Kenya's economic growth lagged behind Ghana's fossil-led expansion, raising questions about potential short-term economic trade-offs of the energy transition.

6.1.4 Descriptive Statistics: Pre- and Post-Treatment Comparison

Table 3: Descriptive Statistics: Pre- and Post-Treatment Comparison

Variable	**Kenya Pre**	**Kenya Post**	**Ghana Pre**	**Ghana Post**
Renewable Electricity (kWh/pc)	113.7	167.5	245.9	249.6
Fossil Electricity (kWh/pc)	55.9	35.4	80.6	249.4
Renewable Share (%)	66.6	81.6	74.9	52.6
CO_2 Emissions (metric tons)	8,726,091.4	16,711,395.5	6,814,754.9	14,072,075.9
Rural Access (%)	12.0	40.1	21.6	58.4
GDP per Capita (USD)	524.8	1,553.0	501.8	1,879.6

Note: Pre-treatment period is 2000–2007; post-treatment period is 2008–2023.

The descriptive statistics provide important context for the regression findings. Kenya's renewable electricity increased from pre- to post-treatment (113.7 → 167.5 kWh/pc), while Ghana's, already high, barely increased (245.9 → 249.6 kWh/pc), explaining the positive DiD estimate. Conversely, Ghana's fossil fuel electricity nearly tripled (80.6 → 249.4 kWh/pc), far outpacing Kenya's more modest and noteworthy decrease (55.9 → 35.4 kWh/pc).

The rural electrification figures reveal a striking pattern: both Ghana and Kenya achieved gains, but Ghana (21.6% → 58.4%) outpaced Kenya (12.0% → 40.1%). This suggests that Ghana's fossil-led expansion was more effective at extending grid access to rural populations than Kenya's more renewable-oriented pathway. Likewise, Ghana's GDP per capita rose more quickly than Kenya's in absolute terms, which aligns with the negative (though non-significant) DiD estimate for GDP.

6.2 Synthetic Control Analysis

The synthetic control method provides an alternative estimate of the FiT policy's causal effect by constructing a data-driven counterfactual from a weighted combination of 15 Sub-Saharan African donor countries.

6.2.1 Synthetic Control Weights

The optimization procedure assigned non-zero weights to multiple donor countries, with Côte d'Ivoire (0.95), Ghana (0.049), and Zimbabwe (0.000483) receiving the largest weights. (see Table 6)

6.2.2 Treatment Effect Estimates

The synthetic control analysis yields mixed evidence for policy effects:

Average Treatment Effect (Post-treatment): -8.29 kWh per capita

Kenya's fossil fuel electricity per capita was 8.29 kWh lower on average than the synthetic control during 2008–2023, suggesting a modest reduction attributable to the FiT policy. Figure 2 illustrates the divergence between actual and synthetic Kenya over the study period.

6.2.3 Statistical Significance and Robustness

Post/Pre-RMSPE Ratio: 0.903

The post-treatment prediction error was 90% of the pre-treatment error, indicating that the synthetic control fit remained stable (and actually improved slightly) after treatment. A ratio below 1.0 suggests good model fit but provides weak evidence for a treatment effect, as a large effect would typically increase post-treatment prediction error.

Placebo p-value: 0.733

The placebo test reveals that 73.3% of donor countries had RMSPE ratios equal to or greater than Kenya's when treated as "placebo" treatment cases. This high p-value ($p > 0.10$) indicates that Kenya's observed effect is **not statistically distinguishable from random noise**. In other words, the apparent 8.29 kWh reduction in fossil fuel electricity could easily occur by chance. Figure 3 shows Kenya's treatment effect compared to the distribution of placebo effects.

Leave-One-Out Sensitivity:

The treatment effect estimate remained stable across leave-one-out specifications, ranging from approximately -45 to 30 kWh per capita. This indicates that no single donor country drives the results, but the consistent lack of statistical significance across specifications reinforces that the effect is not robust. Figure 4 displays the range of estimates when each donor is sequentially excluded.

6.2.4 Interpretation

The synthetic control analysis provides **weak evidence** that Kenya's FiT policy significantly reduced fossil fuel electricity generation on a per capita basis. While the point estimate suggests a modest reduction (-8.29 kWh), the high placebo p-value and stable RMSPE ratio indicate this effect is not statistically distinguishable from chance variation. This contrasts with the DiD finding of a significant increase in renewable share, suggesting that while Kenya increased renewable generation, it did not substantially displace fossil fuel generation in absolute per capita terms consistent with the DiD result that fossil fuel electricity per capita did not significantly decrease.

7 Discussion

7.1 Key Findings and Interpretation

This study provides a comprehensive assessment of Kenya's 2008 Feed-in Tariff policy using both Difference-in-Differences and synthetic control methods. The findings reveal a nuanced picture: the policy successfully achieved energy transition objectives but faced limitations in delivering broader environmental and developmental benefits.

Energy Transition Success: Kenya's FiT policy demonstrably transformed the country's electricity generation mix. The 34.08 percentage point increase in renewable share ($p < 0.01$) and the 54.64 kWh per capita increase in renewable electricity ($p < 0.05$) provide strong evidence that the policy achieved its primary objective of incentivizing renewable energy investment. Kenya leveraged its substantial geothermal, wind, and solar resources, with geothermal capacity expanding dramatically in the Rift Valley region. This positions Kenya as a regional leader in renewable energy deployment within Sub-Saharan Africa.

The CO_2 Emissions Paradox: Kenya experienced a significant increase in CO_2 emissions relative to Ghana (+3.65 million tons, $p < 0.01$). This reflects a scale effect: overall economic and energy demand grew faster than the emissions reductions achieved through a cleaner electricity mix. In other words, while Kenya's power sector became greener, rising activity in transportation, industry, and other sectors more than offset these gains showing that electricity decarbonization alone is not enough to reduce total emissions.

This finding underscores that electricity sector decarbonization alone is insufficient for economy-wide emissions reduction. Kenya's experience suggests that comprehensive climate policy must address transportation, industry, agriculture, and buildings alongside power sector reform.

Developmental Outcomes and Economic Trade-offs: The policy's limited impact on rural electrification (+3.85 percentage points, $p = 0.48$) reveals a critical gap between generation capacity expansion and access extension. Several factors explain this disconnect:

1. Large-scale renewable projects (e.g., geothermal plants, wind farms) connect to the central grid rather than reaching remote rural areas

2. The FiT policy did not explicitly incentivize distributed generation or mini-grids

3. Last-mile infrastructure investment in rural distribution networks lagged behind generation capacity

4. Economic viability challenges of extending grid access to low-density rural populations

The suggestive evidence of slower GDP growth in Kenya ($-\$349.59$, $p = 0.13$) relative to Ghana raises questions about potential economic trade-offs. Ghana's fossil-led expansion, particularly natural gas development, may have provided cheaper, more flexible baseload power that supported industrial growth. Kenya's renewable investments, while environmentally beneficial, may have involved higher upfront capital costs and intermittency challenges that constrained short-term economic gains. However, this interpretation must be cautious given the non-significant coefficient and the complexity of factors influencing economic growth beyond energy policy.

Synthetic Control Evidence: The synthetic control analysis provides a sobering counterpoint to the DiD findings. The weak evidence for fossil fuel electricity reduction (-8.29 kWh, $p = 0.733$) suggests that while Kenya increased renewable generation, it did not substantially displace fossil fuels in absolute per capita terms. This is consistent with the DiD finding that fossil fuel electricity per capita did not significantly decrease. The implication is that Kenya's renewable expansion primarily met growing electricity demand rather than replacing existing fossil fuel generation, a common pattern in developing countries where energy access expansion and economic growth drive rapid demand increases.

7.2 Comparing Policy Pathways

Neither pathway achieved the ideal "double dividend" of environmental sustainability and inclusive economic growth. Kenya prioritized environmental objectives but faced economic and access trade-offs. Ghana achieved faster growth and electrification but at significant environmental cost. This divergence highlights the difficult trade-offs facing developing nations: clean energy transitions may involve short-term economic sacrifices, while fossil-led growth delivers immediate development benefits but creates long-term climate vulnerabilities.

7.3 Limitations

The three categories of limitations include Methodological, Data, and External Validity limitations.

Methodological Limitations: The DiD design relies on Ghana as a single control country, limiting generalizability. While the synthetic control method addresses this by using 15 donors, the weak SCM results highlight sensitivity to methodological choices. As mentioned in the Section 4.1.2, Treatment Timining, there is a certain treatment timing uncertainty (policy passed in 2008 but implementation extended to 2011–2012) that may introduce measurement error. This exposes room for future investigations. And last but not the least there is omitted variable bias from unobserved shocks affecting Kenya but not control countries cannot be ruled out.

Data Limitations: Annual data frequency limits the ability to detect short-term policy effects and adjustment dynamics and limits granularity. Electricity sector data may not fully capture distributed generation or off-grid renewables unaccounted for. CO_2 emissions data encompass all sectors, making it difficult to isolate electricity sector contributions.

External Validity: Kenya's unique resource endowments (geothermal, hydropower) and institutional context limit generalizability to other Sub-Saharan African countries. On the temporal side, the 2008–2023 study period may not capture long-term equilibrium effects or delayed policy impacts.

7.4 Policy Implications

The findings from this study offer several actionable insights for policymakers in Kenya and other developing nations pursuing renewable energy transitions. First, the disconnect between renewable generation expansion and rural electrification highlights the need for complementary policies that explicitly target last-mile connectivity. Szabó et al. demonstrate that decentralized renewable energy systems can cost-effectively extend electricity access in rural Sub-Saharan Africa. [29] Second, the paradoxical increase in absolute CO_2 emissions despite electricity sector decarbonization underscores that sectoral policies alone are insufficient for economy-wide climate goals. Kenya's experience demonstrates the urgent need for integrated climate strategies addressing transportation electrification, industrial energy efficiency, and land-use emissions alongside power sector reforms. International Energy Agency also emphasizes the importance of cross-sectoral coordination in African energy transitions. [30] Third, the suggestive evidence of economic trade-offs relative to Ghana's fossil-led growth raises critical questions about the pace and sequencing of energy transitions in capital-constrained developing economies. Policymakers should consider phased approaches that balance immediate development needs with long-term sustainability objectives. Eberhard et al. argue that de-risking renewable energy investments through policy guarantees and blended finance can accelerate transitions without compromising growth. [31] Finally, the synthetic control results suggest that FiT policies may be more effective at steering new capacity additions toward renewables than displacing existing fossil fuel generation, implying that such policies work best in contexts of rapid demand growth rather than mature energy systems.

8 Conclusion

This study is a quasi-experimental evidence that Kenya's 2008 Feed-in Tariff policy successfully transformed the country's electricity generation mix, with renewable electricity increasing by 54.64 kWh per capita and the renewable share rising by 34 percentage points. However, this sectoral success did not translate into the expected ' 'double dividend' ' of environmental and economic benefits. Absolute CO_2 emissions increased by 3.65 million tons as economic scale effects overwhelmed composition effects, rural electrification didn't showed significant improvement, and Kenya experienced suggestive evidence of slower GDP growth relative to Ghana's fossil-led expansion.

The methodological rigor of combining Difference-in-Differences and synthetic control approaches reveals important nuances. The DiD analysis demonstrates clear renewable energy expansion, and the synthetic control method shows weak evidence for fossil fuel displacement, suggesting Kenya's renewables primarily accommodated growing demand rather than replacing existing generation. This divergence highlights that renewable deployment in rapidly developing economies follows different patterns and expectations than in mature energy systems like a petroleum rich country of Ghana, where new capacity must compete with existing infrastructure.

Political Economy and Equity Implications: Kenya's experience exposes critical equity dimensions often overlooked in renewable energy advocacy which this paper sheds greater light on. Large-scale renewable projects connected to centralized grids primarily

[29] Sandor Szabó et al., "Energy Solutions in Rural Africa: Mapping Electrification Costs of Distributed Solar and Diesel Generation versus Grid Extension," *Environmental Research Letters* 6, no. 3 (2011): 034002.

[30] International Energy Agency, *Africa Energy Outlook 2019* (Paris: IEA, 2019).

[31] Anton Eberhard et al., "Independent Power Projects in Sub-Saharan Africa: Lessons from Five Key Countries," *Energy Policy* 108 (2017): 390–403.

benefit urban populations with existing access, while remote rural communities remain underserved. This pattern risks creating a multi-tier energy system where clean energy benefits accrue disproportionately to populations already electrified, potentially exacerbating regional inequality.[32] Meanwhile, Ghana's fossil-led pathway delivered faster economic expansion and rural electrification, generating greater short-term political legitimacy despite long-term climate costs. This contrast highlights that successful energy transitions in democratic developing countries require not only technical policy design but also long-term political commitment to navigate periods when benefits remain unevenly distributed.

Rethinking the "One Stone, Multiple Birds" Narrative: The international development community has promoted renewable energy as a pathway to simultaneously address lack of energy, economic development, and climate mitigation. Kenya's case suggests this framing oversimplifies complex trade-offs. While Kenya achieved one goal, that is cleaner electricity, it did not automatically realize the others. This implies that developing countries face genuine opportunity costs in pursuing aggressive renewable transitions. These costs should be acknowledged and rather than minimized through optimistic "win-win" narratives.

The findings also reveal that electricity sector decarbonization alone is insufficient for economy-wide emissions reduction. Kenya's cleaner power generation was overwhelmed by rising emissions other sectors. Comprehensive climate strategies must therefore extend beyond power sector reforms to address cross-sectoral emissions, though detailed analysis of these sectors lies beyond this study's scope.

Broader Implications: For Sub-Saharan Africa, Kenya's experience demonstrates that FiT policies can effectively mobilize renewable investment where resource endowments and institutional willingness exist, but should not be viewed as comprehensive solutions to development challenges. The contrast with Ghana's trajectory shows there are multiple viable development pathways, each with distinct trade-offs between immediate economic gains and long-term sustainability. Policymakers must design complementary instruments addressing last-mile access, grid infrastructure, economic competitiveness, and sectoral emissions beyond electricity.

Future research should examine longer-term outcomes beyond 2023 to assess whether Kenya's renewable investments eventually generate economic returns. Micro-level analyses of specific projects could identify which types, scales, and ownership structures most effectively deliver both generation capacity and local development benefits. Comparative studies incorporating additional countries with diverse FiT designs could clarify which policy features most effectively balance environmental and developmental objectives.

Kenya's 2008 Feed-in Tariff represents a significant policy experiment in renewable energy development that successfully diversified the country's electricity generation mix. Yet translating this sectoral achievement into broader developmental gains remains the central challenge for Kenya and similar nations navigating the path toward energy systems that are simultaneously clean, affordable, reliable, and inclusive.

[32] Baker, *The Political Economy of Low Carbon Energy in Kenya.*

A Appendix

A.1 Summary Statistics

Table 4: Summary Statistics for Key Variables: Ghana and Kenya

Country	Variable	Mean	Std. Dev.	Min	Max
Kenya	elec_access_all	40.564	21.421	15.176	76.542
Kenya	elec_access_rural	30.758	21.960	6.560	68.370
Kenya	elec_access_urban	71.729	16.158	49.873	98.000
Kenya	energy_consumption_pc	1450.357	183.606	1111.784	1743.277
Kenya	fossil_elec_pc	42.274	18.128	14.363	83.869
Ghana	elec_access_all	66.067	15.639	41.250	89.489
Ghana	elec_access_rural	46.115	22.395	7.860	77.803
Ghana	elec_access_urban	86.060	6.677	72.800	97.530
Ghana	energy_consumption_pc	2045.800	643.948	1292.531	3169.960
Ghana	fossil_elec_pc	193.119	132.685	31.573	447.975

Notes: Table reports mean, standard deviation, minimum, and maximum for key energy and electrification variables for Ghana and Kenya across all available years.

A.2 Parallel Trends Analysis

The validity of the Difference-in-Differences design depends critically on the parallel trends assumption. Table 5 presents results from the pre-treatment trend test, examining whether Kenya and Ghana exhibited differential trends during 2004–2007

Table 5: Parallel Trends Test (2004–2007 Pre-Treatment Period)

	Coef	Std Err	t	$P > \|t\|$	[0.025	0.975]
Intercept	232.0507	18.884	12.288	0.000	193.967	270.134
treated	−96.3805	14.052	−6.859	0.000	−124.718	−68.043
pre_period	−20.2948	25.534	−0.795	0.431	−71.790	31.200
treat_pre	2.7824	33.934	0.082	0.935	−65.652	71.217
gdp_pc	0.0139	0.010	1.341	0.187	−0.007	0.035

Notes: The coefficient of interest is treatpre, which tests for differential pre-treatment trends between Kenya and Ghana. The insignificant coefficient ($p = 0.935$) indicates no violation of the parallel trends assumption for renewable electricity per capita.

The key finding is that the treatpre interaction term is statistically insignificant ($\beta = 2.78$, $p = 0.935$), indicating that Kenya and Ghana did not exhibit significantly different trends in renewable electricity per capita during the pre-treatment period. This provides strong support for the parallel trends assumption and validates the use of Ghana as a counterfactual for Kenya's post-policy trajectory.

The negative coefficient on treated (-96.38, $p < 0.001$) reflects the baseline difference in renewable electricity levels between Kenya and Ghana, which is absorbed by the country fixed effect in the main DiD specification. The pre period coefficient captures the common time trend experienced by both countries during 2004–2007.

A.3 Synthetic Control Donor Pool and Weights

Table 6 presents the weights assigned to each donor country in the synthetic control analysis. The optimization procedure assigned the highest weight to Côte d'Ivoire (0.951), followed by Ghana (0.049), with minimal contributions from Zimbabwe and other donor countries. This weighting scheme reflects the algorithm's assessment of which countries best match Kenya's pre-treatment characteristics across the predictor variables (GDP per capita, electricity access, renewable and fossil fuel electricity generation).

Table 6: Synthetic Control Donor Pool Weights

Rank	**Country**	**Weight**
1	Côte d'Ivoire	0.950500
5	Ghana	0.049016
12	Zimbabwe	0.000483
9	Guinea	0.000000
1	Tanzania	0.000000
2	Mali	0.000000
3	Benin	0.000000
4	Togo	0.000000
6	Madagascar	0.000000
7	Malawi	0.000000
8	Angola	0.000000
10	Zambia	0.000000
11	Liberia	0.000000
13	Burkina Faso	0.000000
14	Uganda	0.000000

Note: Weights sum to 1.000.

The dominance of Côte d'Ivoire in the synthetic control suggests that this country's energy trajectory most closely resembled Kenya's pre-2008 characteristics.

A.4 Figures

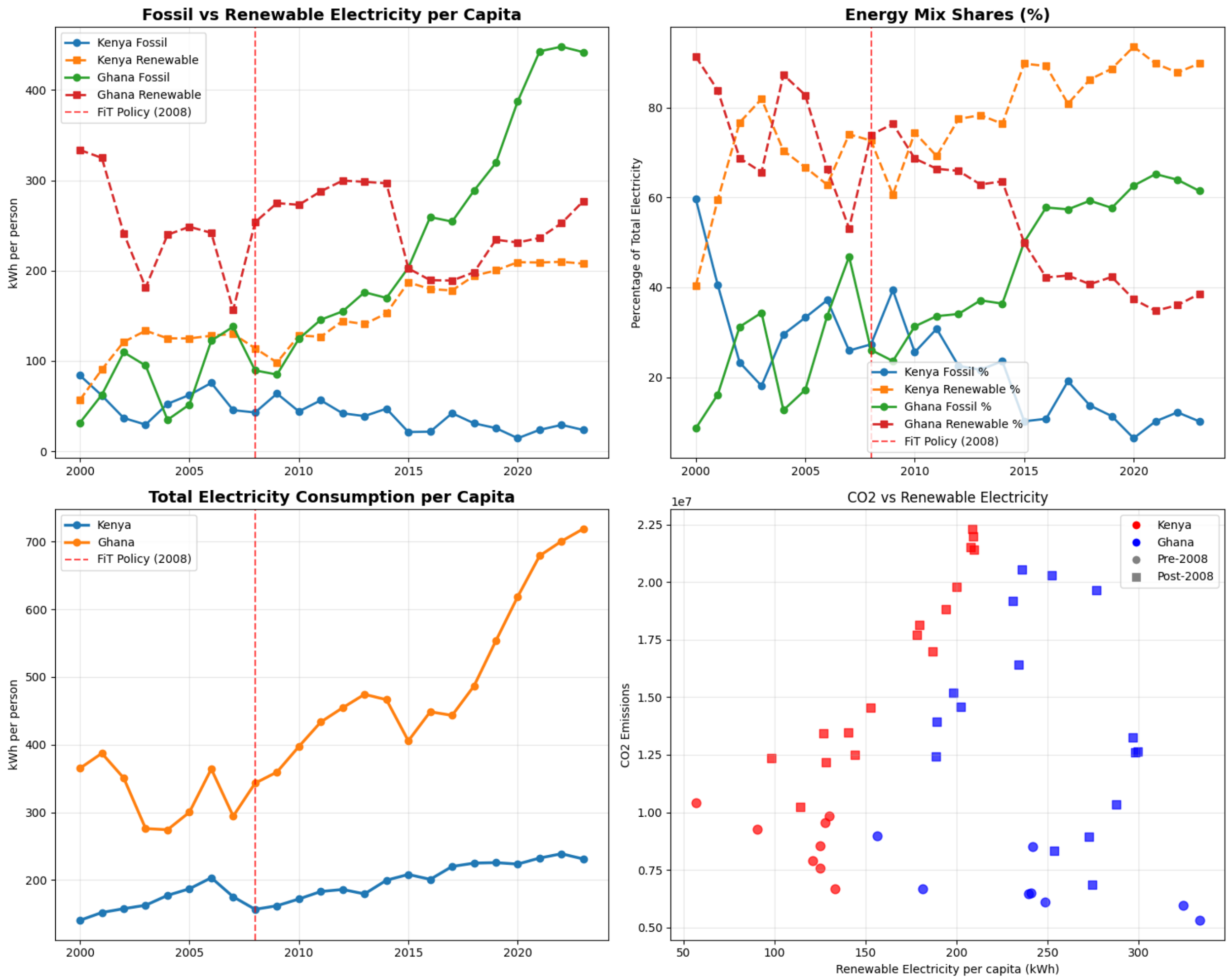

Figure 1: Comparative trends in energy metrics for Kenya and Ghana (2000–2023): fossil and renewable electricity generation, energy mix shares, total electricity consumption, and the relationship between CO_2 emissions and renewable electricity adoption.

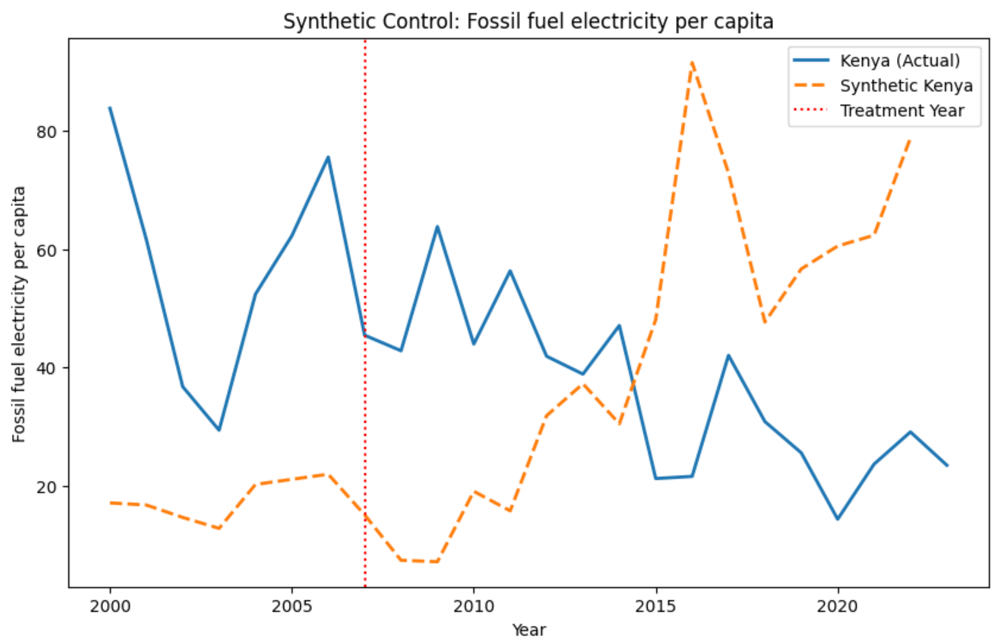

Figure 2: Synthetic control analysis comparing Kenya's actual fossil fuel electricity per capita (solid blue) to the synthetic counterfactual (dashed orange), with the vertical line indicating the 2008 FiT policy implementation.

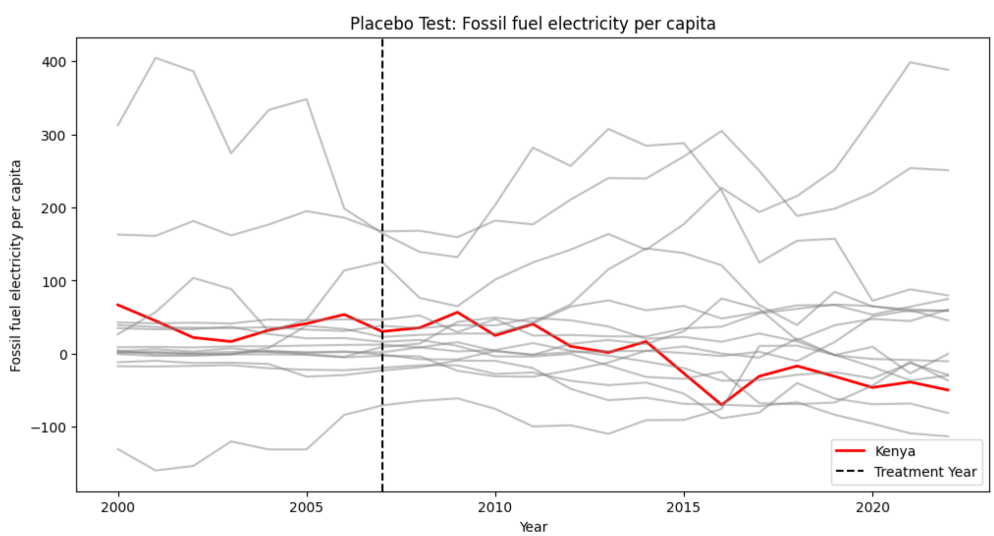

Figure 3: Placebo test showing fossil fuel electricity trajectories for all donor countries treated as hypothetical intervention recipients, with Kenya's actual trajectory (red) compared to the distribution of placebo effects.

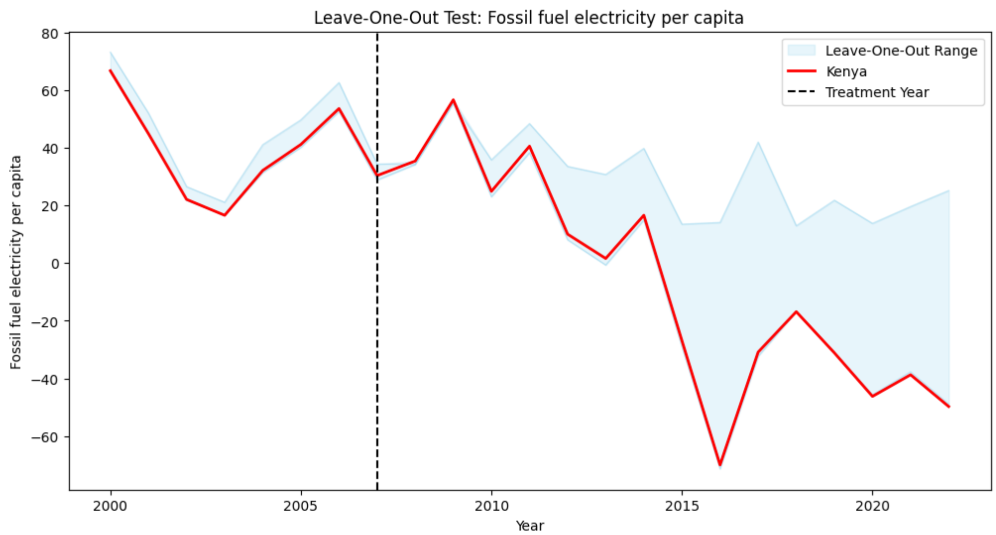

Figure 4: Leave-one-out sensitivity analysis showing the range of synthetic control estimates when each donor country is sequentially excluded, demonstrating robustness of results to individual donor selection.

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