IRJEMS International Research Journal of Economics and Management Studies
ISSN: 2583 – 5238 / Volume 5 Issue 6 June 2026 / Pg. No: 183-193
Paper Id: IRJEMS-V5I6P121, Doi: 10.56472/25835238/IRJEMS-V5I6P121

Original Article

Long and Short Span Dynamics of Electricity Usage on Kenya's Manufacturing Sector Growth

[1]Owuoth Habil Onyango, [2]Obange Nelson, [3]Ghabon Kuso Yasin
[1,2,3]*Department of Economics, Maseno University, Kisumu, Kenya.*

Received Date: 25 May 2026 Revised Date: 10 June 2026 Accepted Date: 16 June 2026 Published Date: 19 June 2026

Abstract: *The manufacturing sector is touted as a powerful tool in socioeconomic transformation. However, over the past three decades, Kenya has been experiencing stagnation in the sector's growth. This stagnation is about 10 per cent below the 15 per cent benchmark, raising concern about the sector's capacity for transformation in the country. Blamed for this stagnation are electricity consumption constraints, despite Kenya's efforts to improve grid supply. The literature suggests that constraints on electricity consumption impede manufacturing activities, yet Kenya receives limited empirical attention. Using a correlational design, this study examines the short- and long-run effects of electricity consumption on manufacturing sector growth in Kenya. The World Bank and the Kenya National Bureau of Statistics provided time-series data from 1965 to 2024, during which the sector stagnated. The Augmented Solow model underpinned this study with the Autoregressive Distributed Lag model and Error Correction Mechanism aiding parameter estimation. The findings reveal that electricity consumption has a positive and significant short-run and long-run effect on manufacturing sector growth in Kenya. Despite being positive, the effect is marginal, suggesting that Kenya's manufacturing sector struggles with electricity consumption constraints due to the high cost and unreliability of power supply. The study concluded that electricity quantity alone was insufficient to propel manufacturing growth unless accompanied by affordable tariffs and efficiency improvement—policy interventions to priorities reliability of electricity supply and affordability to enhance long-term sector growth in Kenya.*

Keywords: *Consumption, Electricity, Kenya, Manufacturing.*

I. INTRODUCTION

The manufacturing sector is touted as an engine of economic growth (966) and a powerful tool for socioeconomic transformation (Cantore et al., 2017; Wan et al., 2022; and Iheonu et al., 2025). Over the years, persistent stagnation in the sector's performance has been reported, posing a serious concern for economists and policymakers (UNIDO, 2025; Cilliers & Ngundu, 2025). This concern stems from the stagnating sector's inability to sustain the high growth, employment, and transformation so desired in contemporary economies. To demonstrate this, public policies at the global, regional, national, and devolved unit levels continue to emphasise economic transformation, with the manufacturing sector prominently featured as an enabler. This background makes the dynamics behind manufacturing sector stagnation worth investigating.

The manufacturing sector heavily depends on energy to produce output (Anyanwu & Kur, 2024). Alongside power, capital and labour are also important inputs to the sector (Jorgenson, 1984 and Stern & Kander, 2012). However, the sector is faced with several constraints in the developing world. At the top of the list has been power supply constraints, associated with high cost and unreliability (Aderemi & Sikwela, 2025; Cilliers & Ngundu, 2025; Ebhota & Tabakov, 2018). As a key factor, negative shocks to supply infrastructure reduce power consumption. This results in production disruptions that curtail output, sales, and employment in the sector (Elliott et al., 2021; Ndubuisi et al., 2025). In such an environment, new firms are reluctant to enter the market, and existing firms exit, reducing the performance of the manufacturing sector (Fried & Lagakos, 2023; Mensah, 2024). The foregoing indicates that shortfalls in energy supply to the sector are detrimental to its growth and to the economy as a whole (Ekong et al., 2021).

Despite the existence of multiple energy sources in the modern economy, Attigah et al. (2016) singled out electricity as the leading source for manufacturing activity. This justified heavy utilisation of electricity for mass industrial production. As a key input in manufacturing processes, the upward trend in debate about energy usage and its nexus with manufacturing sector performance (Sarkodie & Adom, 2018). Macharia et al. (2022) highlighted the importance of sufficient electricity for the continuity of manufacturing activities and the broader economy. To ensure power adequacy, power losses must be reduced or eliminated, and reliability must be maintained. These are heavily dependent on the equipment and technology deployed and on the frequency of surveillance for early detection of faults along the power production, transmission, and distribution chain. Raza et al. (2016), on the other hand, acknowledged the key role energy plays in manufacturing processes, which, according to them, consume significantly more energy than any other sector. The increase in income, economic growth, industrial growth, and urbanisation may lead to widespread utilisation of energy for the manufacture of goods and services and for national development programs (Zheng et al., 2021). High energy consumption is motivated by affordability and reliability. The more energy the manufacturing sector consumes, the more likely it is that mass production will serve the welfare of citizens and the growth of the sector.

These arguments led to the recognition of electricity consumption as an essential input in manufacturing. It enhances efficiency and productivity in all sectors, which, alongside urbanization and population growth, elevates the use of electric power (Korkmaz, 2022). The growth of manufacturing activities has been observed to be a catalyst for rapid growth. In their separate studies, Nnanzi et al. (2022) and Eke et al. (2018) found that electricity use drove industrial growth. As a consumer of about one-third of the power produced globally, Sankaran et al. (2019) and Bataille and Melton (2017) opined that it is nearly impossible to manufacture commodities without electricity. This suggests that insufficient electricity negatively affects manufacturing, as electricity is critical to its operations and to every other sector of the economy (Ekong et al., 2021). This implies that intermittent electricity supply leads to sector stagnation. It curtails production processes by forcing businesses to use costly alternative power sources, such as generators, which require additional purchase and maintenance costs. These stifle the performance of the manufacturing sector.

The debate on electricity utilisation and manufacturing sector progress nexus report either positive or negative results, a pointer towards an unending debate. Positive findings were captured by Abbasi et al. (2021) in Pakistan and Danmaraya and Hassan (2016) in seven low-income SSA countries. On their part, Asaleye et al. (2021) and Olawumi and Oriola (2020), both in Nigeria, and Abokyi et al. (2018) in Ghana, reported negative results. These negative results indicate constraints in power supply, associated with costs and reliability concerns. The literature on electricity use and manufacturing sector performance is limited in the developing world, including Kenya (Asaleye et al., 2021). The sector, however, is responsible for close to 52 per cent of the power utilised in Kenya (EPRA, 2024), making electricity one of the important inputs in the sector's production process. While manufacturing activities rely heavily on electricity, Raza et al. (2016) noted that electricity supply in Kenya has been less effective than in other lower-middle-income economies. This points to the fact that as more emphasis is placed on power supply, little effort is made to ensure supply stability. In such a situation, supply interruptions become frequent, impeding gains in electricity supply. A robust power supply infrastructure is required to guarantee the stability of the electricity supply. As observed by Sarkodie and Adom (2018), this low effectiveness, mainly due to weaknesses in the power supply infrastructure, discourages production in the manufacturing sector. These discussions motivated the choice of electricity consumption and its effect on manufacturing sector growth in Kenya.

II. LITERATURE REVIEW

Aderemi and Sikwela (2025) examined the relationship between power consumption and manufacturing output across 12 countries in the Economic Community of West African States (ECOWAS) region. Their research was premised on the Harrod-Domar model, using annual panel data from 2000 to 2023 for 12 countries sourced from the World Bank's World Development Indicators. Variables of interest were the percentage of manufacturing value added to GDP, the proportion of labour force to population, electricity utilization in kilowatt hours, the consumer price index, the supply of broad money as a percentage of GDP, and direct investment from abroad as a proportion of GDP. A panel dynamic ordinary least squares (DOLS) was specified, and the industrial sector was found to benefit significantly from electricity consumption.

Idogun (2025) conducted a study on power consumption and its influence on the manufacturing sector output in Nigeria. The author anchored this work on neoclassical theory, used secondary annual series from 1981 to 2022 and employed the Autoregressive Distributed Lag (ARDL) technique. Key data sources included the Central Bank of Nigeria's statistical bulletin, the country's National Bureau of Statistics, and the International Monetary Fund. These sources provided information on sector output, power price (peroxide by the consumer price index [CPI]), electricity, generation, exchange rate, carbon dioxide emissions, and sector credit. His analysis reported that power consumption had a statistically significant positive long-run influence on manufacturing sector output. In the short run, power consumption was significant and positive, but its first and second lags reported significantly negative elasticities. The author attributed this episode to the underdeveloped power sub-sector, evidenced by generation and distribution gaps and the high cost of power.

Anyanwu and Kur (2024) investigated the influence of energy consumption on the performance of the industrial sector in 32 countries in Sub-Saharan Africa over the period 2002 to 2019. Their panel data for the industrial sector included annual growth, per capita primary energy use, renewable energy utilisation as a percentage of total final energy consumed, carbon dioxide emissions as a proxy for fossil fuel use, net flows of foreign direct investment as a percentage of GDP, and the exchange rate, all derived from the World Development Indicators. Several estimation techniques of Fully Modified Ordinary Least Squares (FMOLS), Pooled Mean Group (PMG) and Generalized Linear Model (GLM) were employed to evaluate the long-term impacts. The authors reported a significant positive influence of consumption of primary energy, renewable energy and fossil fuels on industrial growth.

Zhang and Wang (2023) considered how China's industrial carbon emissions were affected by power usage, using a panel regression model. The information was gathered for 13 Chinese firms for the years 2007 to 2019. Emission of carbon dioxide from industrial activities was the explained variable, with degree of digitisation, and percentage of power consumed as key explanatory variables. The controls were industrial factors, scale, export status, import status, value added, waste treatment costs, and participation in global value chains. The authors found, using the Instrumental Variables Two-Stage Least Squares (IV-2SLS) approach, that increased electricity use significantly increased carbon dioxide emissions in the manufacturing sector. Manufacturing companies generated greater output and emitted more carbon dioxide when electricity consumption was higher.

Eke et al. (2023) explored electricity consumption and its contribution to manufacturing sector growth prospects in Nigeria. The authors used annual time series data generated over the period 1981 to 2019. Information was sourced from World Development Indicators and the Central Bank of Nigeria for the various study variables. These included the ratio of manufacturing output to GDP as the predicted variable, and capital, labour, technology, the number of paved roads, and the quantity of electricity supplied as predictor variables. Neoclassical theory was used to model this study, with estimation done using ordinary least squares (OLS). The estimated output indicated that electricity consumption had an insignificant negative effect on manufacturing output in Nigeria.

Inedu et al. (2022) examined electricity consumption and its effect on manufacturing sector growth in Nigeria. Their study covered 1986 to 2020, with data sourced from the World Bank and International Energy Agency for the manufacturing sector growth rate (proxied by manufacturing sector contribution to GDP) as the dependent variable and electricity consumption, electricity generation, private capital invested in electricity generation, government expenditure on power generation and electricity consumption bills as independent variables. The study was modelled on neoclassical theory and applied Autoregressive Distributed Lag Modelling. Their findings showed that electricity consumption significantly propelled manufacturing growth in both the short term and long term. Lagged manufacturing sector growth was insignificantly positive in the long run but became significantly positive in the short run.

Ototo (2022) investigated the role of energy use in Kenyan manufacturing processes. Manufacturing performance, trade openness, energy prices, non-renewable energy use, renewable power use, and capital formation were examined using annual data from 1980 to 2019. The Energy Regulation Commission (ERC), the World Bank, the National Bureau of Statistics (KNBS), and the government's banker (CBK) provided the dataset. The results of the OLS approach indicated that consuming renewable and non-renewable energy each negligibly improved Kenyan manufacturing performance.

Nnyanzi et al. (2022) examined how governance, trade liberalisation, and infrastructure modernisation affected the value added of manufacturing in Sub-Saharan Africa. Their study was aided by a panel dataset covering 30 SSA nations between 2003 and 2018. Manufacturing value added, transportation infrastructure, ICT, water and sanitation, electricity infrastructure, GDP per capita, real currency conversion rate, investment, and employment were the observations obtained from the African Development Bank database. The parameters were estimated using Panel Corrected Standard Errors (PCSE), based on the Cobb–Douglas aggregate production function. Their investigation revealed that access to electricity positively impacted manufacturing output in both urban and rural settings.

Asaleye et al. (2021) investigated how Nigeria's industrial sector performed over the long term in terms of energy use. They relied on a series spanning 1981 through 2019 for interest rates, exchange rates, capital utilization in the manufacturing sector, manufacturing sector output, and industrial sector power consumption. The statistical bulletin, the Electric Power Authority, the central bank, the Office of Statistics Industrial Surveys, and the government's Bureau of Statistics were among the sources of data. The study's parameters were estimated using canonical cointegrating regression (CCR), with results showing that power use and capital, respectively, reduced manufacturing output by close to 0.18 and 0.03 percentage points. The adverse effect of electricity usage in the sector was attributed to inefficiency in the electricity infrastructure and the high cost of electricity. The findings led to the recommendation for a legal framework to promote the efficiency of the electricity infrastructure.

Ekong et al. (2021) analyzed how energy consumption affects the performance of the industrial, agricultural, and service sectors in Nigeria. They used an annual series covering 1980 to 2019, derived from several sources, such as Nigeria's Central Bank, the country development reports compiled by the World Bank and statistical reviews of the world energy. The variables were agricultural output, industrial output, service sector output, petrol use, electricity utilization, diesel consumption, natural gas usage, currency supply and gross fixed capital formation. Modelling their work on the Solow framework, the authors used ARDL and Granger causality techniques to estimate parameters. Long-run results revealed an insignificant gain of the industrial sector from electricity consumption and a significant negative influence of capital. The short-run findings indicated that current electricity consumption was significantly positive, while current capital and lagged capital each had significant negative effects on the industrial sector, about 0.5% and 0.18%, respectively.

Hadi et al. (2021) conducted a study across 34 Indonesian provinces to highlight the Impact of power distribution and consumption on industry development. The research examined a panel data set spanning 2012 to 2019, derived from economic surveys, on the industrial sector's share of GDP, electricity distribution, energy consumption (represented by diesel), investment, and inflation. Fixed effects, GMM, and first differences or System GMM were used for estimation. The fixed-effects findings reported that diesel consumption was insignificantly positive. The GMM results reported energy consumption to have a negligible positive link. Results of the System GMM model showed that energy use significantly lowered industrial value.

On their part, Omotosho and Ogu (2021) examined the role power utilisation plays in the performance of Nigeria's manufacturing activities. Their research used yearly statistics gathered between 1980 and 2019 from the World Bank's database and the Nigerian Central Bank's bulletin of observations. The analysis variables were manufacturing value added in local currency, electricity consumption, private-sector credit to proxy for credit to the manufacturing sector, the currency exchange rate, and public spending on skills development and healthcare to represent the development of human capital. The authors adopted an ex post facto design, with the model estimated using the ARDL approach. The authors reported that electricity consumption had an insignificant positive impact on manufacturing in the long run. The authors suggested that policies to improve electricity availability be formulated in light of these findings.

Halkos et al. (2021) sought to investigate the Impact of economic progress, power intensity, and competitiveness index on business sector value added. The authors considered panel data for 117 countries from 1995 to 2017, grouped into industrialized (45) and emerging (72). Their study variables were the industrial value-added portion of GDP, GDP growth, energy intensity in the productive sector, and the UNIDO competitiveness index for industrial progress. Using Granger causality tests, the energy intensity of the manufacturing sector was detrimental, while competitive industrial performance raised value added to a high degree.

Onabote et al. (2021) evaluated the contribution of energy infrastructure to the Nigerian productive sector's capacity using an annual dataset from 1981 to 2016. The Central Bank's statistical bulletin, the World Development Indicators, the Statistical Office, and the Manufacturing Association provided information for analysis. The study variables were manufacturing contribution to GDP to proxy for the output of the manufacturing sector, foreign direct investment (FDI), electricity consumption to proxy for electricity infrastructure, gross fixed capital formation (GFCF) to proxy for manufacturing capital stock, and labor force engaged in the sector. The study was modelled on the endogenous theory, and parameter estimates were generated using the Vector Auto regression (VAR) model. According to their findings, Nigerian manufacturing rose by 7.92 per cent and 3.04 per cent, respectively, due to electricity use and labor input.

Ajibola et al. (2021) undertook a study on the Impact of electricity supply on the performance of SMEs in Ado-Odo Ota, Ogun state. The state was one of Nigeria's largest industrial hubs, which motivated the authors to focus on this space. Primary data were collected from 90 respondents across various SMEs using a closed-ended questionnaire. To aid the analysis, SMEs' turnover, electricity consumption, and the cost of alternative power supply were considered as the study variables. The authors conducted their analysis using the Ordinary Least Squares technique and found a positive relationship between electricity supply and SME performance. An increase in electricity supply by a unit is associated with a 3.984 per cent increase in SME performance in Sango-Ota, Nigeria.

Olawumi and Oriola (2020) investigated the relationship between energy use and industry output in Nigeria. Using secondary information covering 1981 to 2018 sourced from the Central Bank, the authors considered industrial output, petroleum consumption, gas consumption, coal consumption, and electricity supply as their study variables. Their study was modelled on an endogenous model developed by Romer (1986), with the FMOLS approach used to estimate the parameters. The results reported a positive and significant relationship between coal use and output; a significant negative nexus between power use and industrial output; an insignificant positive link between petroleum use and industrial output; and a negatively insignificant nexus between gas utilisation and industrial output. These findings led the authors to advocate for policies that support improvements in power supply stability, diversification of the energy mix, and the affordability of power for investors.

Oyeyimi and Onuoha (2020) examined the effect of electricity generation and consumption on industrial output in Nigeria. Their analysis covered the period from 1981 to 2017, using annual time-series data collected from the Central Bank of Nigeria and the World Development Indicators. The study variables were industrial output, power consumed by the industrial sector in megawatt-hours, electricity generated in megawatts, electricity price proxied by the Consumer Index Price, carbon emissions, and credit to the industrial sector. The authors considered the Schumpeterian theory of capitalist development for modelling their study, and used ARDL and pairwise Granger causality techniques. Their empirical analysis from the ARDL approach revealed that electricity consumption had an insignificant positive relationship with industrial output. The causality analysis reported unidirectional causality from industrial output to electricity consumption.

Omosebi et al. (2019) used disaggregated annual time-series data on energy consumption to examine their effects on industrial output in Nigeria. The authors sourced their observations spanning 1986 to 2018 from the Central Bank of the country and the International Energy Agency (IEA) website. Their dependent variable was the output of the industrial sector, with independent variables including consumption of petrol, gas, diesel, coal, kerosene, and electricity, and capital and labour as control variables. Fully modified ordinary least squares (FMOLS) was used to estimate the study parameters, which were anchored on the neoclassical growth theory. Their findings revealed a statistically significant increase in manufacturing output from petrol and diesel consumption. Significant negative results were reported for electricity, gas and kerosene use. Coal and labour had insignificant positive outcomes. The authors attributed the significant negative effects on electricity consumption to an insufficient and unpredictable power supply.

Sankaran et al. (2019) examined how manufacturing growth in 11 late-industrialised countries was affected by energy use. The analysis used a panel dataset from 1980 to 2016, sourced from the World Bank's Development Indicators and the International Energy Statistics. The observations considered by the authors were income per capita, the real exchange rate, exports, imports, utilisation of energy resources, and value added of the industry. The conservation, feedback and neutrality hypotheses underpinned the study, with estimation done using bounds testing and the Toda-Yamamoto test for causal relationships. Their long-run findings reported that power usage positively impacts the sector's value addition in Morocco, Tunisia, India, Sri Lanka, Bolivia, and Kenya. The short-run results showed that lagged manufacturing output had a positive impact on itself in Cameroon, India, and Kenya, but not in other countries; current and lagged electricity consumption had a positive impact in Sri Lanka, India, and Kenya, but a negative impact in Bangladesh and Bolivia.

In Ghana, Abokyi et al. (2018) used the Toda-Yamamoto technique and bounds test to examine the influence of electricity utilisation on industrial sector growth from 1971 to 2014. Industrial value-added as a proportion of GDP, per capita energy consumption, foreign trade, labor participation, and gross fixed capital accumulation were the variables extracted from WDIs. Their long-horizon findings reported that capital increased industrial growth by about 0.5 per cent, but power consumption and labour significantly reduced it by 0.8 and 1.7 per cent, respectively. Short-run dynamics revealed that power consumption had an insignificant adverse effect, capital was insignificant, and labour significantly retarded industrial progress. However, the causal analysis revealed a one-way causal relationship from energy use to industrial outcomes. Based on these findings, the authors recommended allocating more funds to electricity production to provide the industrial sector with more energy at reasonable costs.

III. RESEARCH MATERIALS

A) Research Methodology

This study, which used an ARDL auto regression, adopted a correlational design. Simon and Goes (2011) suggested that this study design enables researchers to quantify the Impact of explanatory variables on the explained variable, while controlling for other variables, rather than keeping them constant. By doing so, a correlational research design supports a multivariate regression, which enables the researcher to examine how variations in individual regressor(s) are related to the study's dependent variable. This design was appropriate for this study, as it examined the effects of installed electricity capacity, consumption, cost, and system losses on manufacturing sector growth in Kenya.

B) Data Types and Sources

Secondary time series data were identified for this study. These annual series were collected from 1965 to 2024, yielding 60 observations for each study variable. The dependent variable was manufacturing value added, and the independent variable was electricity consumption. Control variables were labor and capital. These data sets were derived from the Kenya National Bureau of Statistics and the World Bank Development Indicators.

C) Estimation Model

This empirical work was modelled on an augmented Solow growth framework. In its original form, the Solow growth model emphasized capital, the workforce, and technological advancement as drivers of long-run growth. Given that electricity was a critical intermediate input in manufacturing production, this study followed Keen et al. (2018) to augment the Solow model by incorporating electricity consumption as a productivity-enhancing factor. This augmented framework was consistent with the energy–growth nexus literature. The original Solow growth model can be represented as:

$$Y = \mathrm{A}\mathrm{K}^{\propto}\mathrm{L}^{\beta} \qquad 1.1$$

Incorporating the other variables and taking their natural logarithms yielded the models below, where 1.2 and 1.3 are the long-run and short-run models, respectively.

$$LNMVA_t = \Phi_0 + \sum_{k=1}^{v} \pi_{1k} LNMVA_{t-k} + \sum_{k=1}^{v1} \pi_{2k} LNECN_{t-k} + \sum_{k=1}^{v2} \pi_{3k} LNLAB_{t-k} + \sum_{k=1}^{v3} \pi_{4k} LNGCF_{t-k} + \varepsilon_t \quad 1.2$$

$$\Delta LNMVA_t = \mho_0 + \sum_{k=1}^{q} \Phi_{1k} \Delta LNMVA_{t-k} + \sum_{k=1}^{q1} \Phi_{2k} \Delta LNECN_{t-k} + \sum_{k=1}^{q2} \Phi_{3k} \Delta LNLAB_{t-k} + \sum_{k=1}^{q3} \Phi_{4k} \Delta LNGCF_{t-k} - \Pi ECM_{t-k} + \mu_t \quad 1.3$$

Where;

- $LNMVA_t$ denotes the logarithmic notation for manufacturing value added over period t
- $LNMVA_{t-k}$ represented the lagged natural log of manufacturing value added, lagged by k.
- $LNECN_{t-k}$ showed the natural logarithm of electricity consumption lagged by the k^{th} value.
- $LNLAB_{t-k}$ denoted the lagged natural logarithmic form for labour lagged to the k^{th} value.
- $LNGCF_{t-k}$ indicated the lagged natural log notation of capital lagged to the k^{th} value.

Φ_0 and $\mho_0$ are long-run and short-run constants
πs and Φs denote long-run and short-run elasticity's, respectively, associated with each estimated parameter.
Π is the estimate of ECM, which measures the duration taken by the system to fall back to equilibrium after a short-term disturbance.
ε - random disturbance.
vs and qs denote appropriate lag lengths

D) Descriptive Statistics

Table 1 below presents the statistical descriptions for each study variable. MVA, ECN, GCF, and LAB denote the manufacturing value added to GDP, electricity consumption, gross capital formation, and labour engaged in the manufacturing sector. Table 1 showed that manufacturing value added (MVA) averaged Ksh 402 billion, ranged from Ksh 57.1 billion to Ksh 874 billion, and had a median of Ksh 402 billion. Electricity consumption (ECN) by the manufacturing sector ranged from 165,695 kWh to 7,100,940 kWh, with an average of 2,570,769 kWh. Gross capital formation (GCF) averaged Ksh 778 billion, reached a maximum of Ksh. 1,910 billion and a minimum of Ksh. 95.6 billion over the study period. The labor force in the manufacturing sector averaged 230,917 persons, ranging from 63,946 to 389,233.

The descriptive statistics show that each of the study variables had a high value of standard deviation. The implication was that each variable exhibited a large degree of dispersion around the mean. This scenario supports log-transforming data to stabilise such large variance, as Hatem et al. (2022) recommend for moderately right-skewed observations. The skewness for MVA, ECN, and GCF was positive, while LAB reported negative skewness. The skewness values for these variables ranged from -0.1395 to 0.8254. This implied that the distributions of each of these variables around their respective means were generally acceptable and thus exhibited normal distributions. This was supported by Hair et al. (2022), who observed that skewness values between -1 and +1 point to a normal distribution.

Kurtosis for each of this study's variables were positive, indicating a more peaked distribution (Hair et al. 2022). Their values falling below 3 indicated thin tails and fewer outliers, suggesting a normal distribution. However, the Jarque-Bera statistics for ECN and GCF, which exceeded 3 and had p-values below 0.05, indicated that these values did not follow a normal distribution (Gujarati & Porter, 2009). Since the study anticipated that time series data, in most cases, violate the normality assumptions, it applied a logarithmic transformation to all data to reduce scale disparities among the study variables, stabilize their variances, and allow for elasticity interpretation. The logarithmic transformation was consistent with theoretical growth modelling rather than with normality assumptions.

Table 1: Descriptive Statistics for Study Variables

Variable	MVA	ECN	GCF	LAB
Mean	402	2,570,769	778	230,917.3
Median	40	2,254,750	592	243,465
Maximum	874	7,100,940	1,910	389,233
Minimum	57.1	165,695	95.6	63,946
Std. Dev.	230	1,979,553	526	93,711.44
Skewness	0.3216	0.6438	0.8254	-0.1395
Kurtosis	2.1469	2.2582	2.3866	2.1328
Jarque-Bera	2.8534	5.5206	7.7543	2.0750
Probability	0.2401	0.0633	0.0207	0.3543

E) Stationarity Analysis

This study undertook unit root testing using the Augmented Dickey-Fuller (ADF) test. The aim was to determine whether each study variable exhibited a unit root. The test was done with trend and intercept before differencing, and on the first-differenced observations. A maximum of ten lags, chosen automatically using Akaike information criterion (AIC), guided the test for stationarity. The results were reported in Table 2, and without differencing, LNMVA, LNECN, and LNGCF upheld the null hypothesis of a unit root at a 5 per cent significance level. This implied the observations were stationary at the level. However, the null hypothesis of a unit root was rejected for LNLAB only after first differencing. These ADF test results indicated that these variables were stationary at level I(0) and on first difference I(1). Manufacturing value added (LNMVA), electricity consumption (LNECN) and gross capital formation (LNGCF) were stable at their levels, implying integration of order zero, I(0). Labour (LNLAB) was unstable in its level form but became stable after a single difference, implying stationarity of order one (I(1). The orders of integration reported by the ADF process justified the use of the ARDL method to estimate the parameters for this empirical task. These results further supported the application of the Bounds test, which requires variables to be either I(0) or I(1), but not I(2).

Table 2: Augmented Dickey Fuller Test Results for Stationarity

Variable	Level	Order of Integration	First Difference	Order of Integration
LNMVA	-3.4725 (0.0521) *	I (0)		
LNECN	-3.4965 (0.0493) *	I (0)		
LNGCF	-4.3180 (0.0058) **	I (0)		
LNLAB	-1.8082 (0.6883)		-6.3793 (0.0000) **	I (1)

F) Bounds Testing

The bounds test procedure was undertaken as proposed by Pesaran et al. (2001) to determine the presence or absence of a cointegrating relationship between manufacturing-sector growth and electricity consumption in Kenya. Table 3 showed that the calculated F statistic from the bounds test was 6.7560, beyond the 3.61 upper bound I(1) critical value at a 5 per cent statistical level of significance. The revelation led to the rejection of the no cointegration hypothesis. According to Pesaran et al. (2001), if the value of the calculated F-statistic exceeds the I(1) critical value, the no cointegration claim should be rejected and a cointegrating equation is confirmed. In this analysis, the outcome of the bounds test confirmed a stable long-run equilibrium nexus between manufacturing sector growth and electricity consumption. The outcome justified the estimation of ARDL coefficients and the associated ECM model to capture immediate dynamics and speed of change towards the long-run equilibrium following a shock. This proof of the symmetrical relationship implied that electricity consumption and manufacturing sector growth move together over time, despite short-run fluctuations.

Table 3: Bounds Test Results

Test Statistic	Value	Level of Significance	I(0)	I(1)
F-statistic	6.756045	5%	2.45	3.61

G) Long Run Results

The long-run ARDL results were estimated and presented in Table 4 below.

Table 4: Long Run Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNECN	0.077984	0.029441	2.648801	0.0169
LNECN(-1)	0.031171	0.046205	0.674618	0.5090
LNECN(-2)	0.059116	0.051221	1.154142	0.2644
LNECN(-3)	0.125872	0.049686	2.533336	0.0214

H) Short Run Results

Short-run results for the error-correction mechanism, including the speed of adjustment, are presented in Table 5 below.

Table 5: Short Run Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Δ(LNECN)	0.077984	0.017042	4.575889	0.0003
Δ(LNECN(-1))	-0.184988	0.037440	-4.940884	0.0001
Δ(LNECN(-2))	-0.125872	0.036233	-3.473961	0.0029
ECT(-1)	-0.709175	0.088658	-7.998983	0.0000

I) Post Diagnostic Tests

It was necessary to run post-estimation tests to diagnose adherence to the regression assumptions. In practice, the validity and reliability of the parameter estimates are attained when post-diagnostic tests are passed. This gives the estimated parameters the ability to inform policy, forecasting and planning. For these reasons, Breusch-Godfrey LM for testing autocorrelation; Breusch-Pagan-Godfrey for heteroskedasticity test; normality testing by Jarque-Bera test for normality; and CUSUM testing for stability were conducted. The results shown in Table 6 below led the study to conclude that the model met the regression assumptions of normality, no serial correlation, and homoscedasticity.

Table 6: Post Estimation Tests Results

Test Name	Test Type	Test Statistic	P Value
Jarque Bera Test for Normality	Chi Square	**3.2726**	**0.1947**
Breusch-Godfrey Serial Correlation LM	F Test	1.119056	0.3524
Breusch-Pagan-Godfrey Test for Heteroskedasticity	F Test	0.457103	0.9753

J) Model Stability

The study used the cumulative sum (CUSUM) developed by Brown et al. (1975) to demonstrate the model stability. The results were captured in Figure 1 below. As shown in Figure 1, the CUSUM plots of residuals were within 5 per cent critical lines. Brown et al. (1975) suggested that if CUSUM plots did not extend beyond the region demarcated by the 5 per cent bound lines, the estimated parameters were deemed stable. In line with this suggestion, this analysis found that the parameters in the manufacturing sector growth model were stable. This means the manufacturing sector growth did not experience any structural disruptions over the period of this analysis. In econometrics, the implication was that the explanatory variables were truly exogenous because they were not positively correlated with the error term.

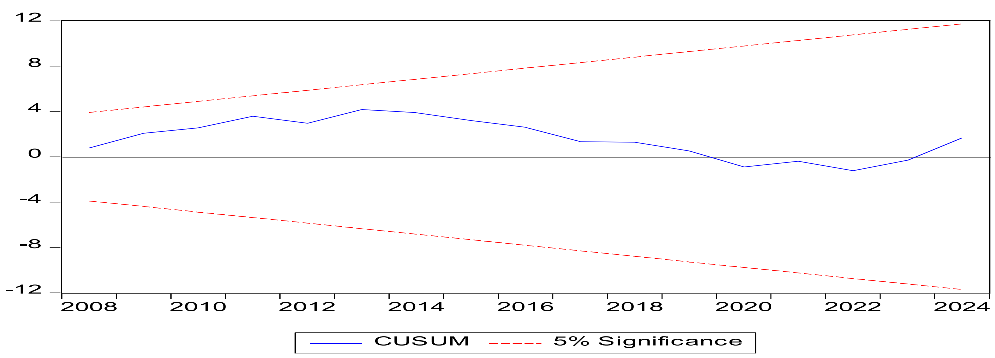

Figure 1. CUSUM Results for Residuals

Based on these results, this work concluded that each explanatory variable and random disturbance term was not interrelated. These deliberations imply that the estimation process passed all econometric tests and adhered to the ARDL assumptions. Having passed these tests, the author interpreted and discussed the statistical test results in line with economic theory and previous empirical results, with confidence that the analysis's output was free of incorrect inferences and recommendations.

III. RESULTS AND DISCUSSION

The findings directly addressed the study's specific objective, which was to examine the short- and long-run effects of electricity consumption on manufacturing sector growth in Kenya. This objective was based on the null hypothesis that electricity consumption did not have a statistically significant long-run and short-run effect on manufacturing sector growth in Kenya. The long- and short-run results were captured in Tables 4 and 5, respectively.

The long-run ARDL results indicated a positive contemporaneous effect (π = 0.0780, p-value 0.0169) and a positive three-year lag effect (π = 0.1259, p-value 0.0214). In the short run, the contemporaneous effect was also positive (Φ = 0.0780, p-value 0.0003). Given that these p-values were below 0.05, the null-hypothesis claim was rejected at the 5 per cent level. The study concluded that electricity consumption had a statistically significant positive effect on manufacturing sector growth in Kenya in both the short run and the long run. These results implied that a ten per cent increase in kilowatt hours of electricity usage pushed growth of the manufacturing sector in the immediate term and in the current year, and in the long term by about 0.8 per cent and 1.3 per cent after three years of consumption.

Despite their statistically significant push into the sector, its magnitude was marginal. The implication was that improving power supply for manufacturing activities without adequately accounting for affordability, reliability, adequacy, and efficiency of use results in suboptimal sector gains. This minimal push submits that Kenya's manufacturing sector was struggling with power consumption constraints, which seem to claw back gains made in enhancing the sector's access to electricity. Such constraints stem from inadequate and unreliable power supply, high electricity costs, and unsustainable energy use by the manufacturing sector in Kenya. According to KAM (2024), the Institute of Economic Affairs (2020), Wangui (2019), and Mutunga and Owino (2017), Kenya's manufacturing sector suffers from high electricity costs, an unreliable electricity supply, and unsustainable electricity use.

The favourable findings of the sector's progress met the a priori expectations. They further agreed with several other authors such as Ghouse (2025) in Pakistan, Idogun, (2025), and Inedu et al. (2022) in Nigeria who reported positive short and long run results; Aderemi and Sikwela (2025) in 15 ECOWAS member states; Anyanwu and Kur (2024) in 32 Sub Saharan Africa states; Quadri and Bukola (2022) in Nigeria; Nnyanzi et al. (2022) in 30 SSA nations; Onabote et al. (2021) in Nigerian context; Sankaran et al. (2019) for Morocco, Sri Lanka, Tunisia, Bolivia, India and Kenya; and Ekong et al. (2021) in Nigeria who reported positive short run elasticity.

In contrast, detrimental outcomes were reported by Asaleye et al. (2021), Olawumi and Oriola (2020), and Omosebi et al. (2019) in the Nigerian context, and by Abokyi et al. (2018) in Ghana's long-run results. The insignificant push was recorded by Hadi et al. (2021) in 34 Indonesian regions; Omotosho and Ogu (2021); Ekong et al. (2021) in Nigeria's long-span report; and Oyeyimi and Onuoha (2020) in Nigerian sectors. Finally, Eke et al. (2023) reported an insignificant drawback in the Nigerian case, and Azolibe and Okonkwo (2020) reported it for 17 SSA countries.

The elasticity of the first and second lagged power consumption were ($\pi = 0.0312$ and $\pi = 0.05912$) respectively, but not significant in the long span of time. They became negative ($\Phi = -0.1850$ and $\Phi = -0.1259$) and significant in the short time span. The short-duration negative and significant report indicates that power supply to the sector was probably costly, insufficient, and unpredictable. Similar short-run results were reported by Idogun (2025) in Nigeria for first and second lags due to the underdevelopment of power infrastructure.

IV. CONCLUSION

The long-run results suggested that electricity consumption had a statistically significant positive effect on manufacturing sector growth in the current year and a delayed effect after 3 years of consumption. Short-run results revealed a significant positive effect. These effects were minimal, suggesting consumption inefficiencies associated with unreliable power, high electricity costs, and unsustainable energy use.

The study's null hypothesis that electricity consumption had no statistically significant long- or short-run effect on manufacturing sector growth in Kenya was subsequently rejected. This followed sufficient evidence generated by the findings. Based on these findings, the study concluded that electricity consumption had a statistically significant positive effect on manufacturing sector growth in Kenya in the short and long run.

Conflicts of Interest

The authors declare that there is no conflict of interest concerning the publication of this paper.

Funding Statement

The author's own resources funded the research, as no external funding was obtained.

V. REFERENCES

[1] Abbasi, K. R., Hussain, K., Abbas, J., Adedoyin, F. F., Shaikh, P. A., Yousaf, H., & Muhammad, F. (2021). Analysing the role of the industrial sector's electricity consumption, prices, and GDP: A modified empirical evidence from Pakistan. *AIMS Energy*, 9(1), 29-49.
[2] Abokyi, E., Appiah-Konadu, P., Sikayena, I., & Oteng-Abayie, E. F. (2018). Consumption of electricity and industrial growth in the case of Ghana. *Journal of Energy*, 2018, 1–11.
[3] Aderemi, T., A. and Sikwela, M., M. (2025). Electricity consumption and industrial outputs in the economic community of West African states: Evidence from a Panel Dynamic Ordinary Least Squares and Granger Causality. *International Journal of Energy Economics and Policy*, 2025, 15(3), 1-7.
[4] Ajibola, A. A., Gbemi, M. S., Aderemi, T. A., and Yusuf, M. O. (2021). Impact of electricity supply on the performance of small and medium-scale enterprises (SMEs) in Nigeria: A Case Study.
[5] Anyanwu, C. O, & Kur, K. K. (2024). Impact of energy consumption on industrial sector performance. *SAGE Open*: 1–14. DOI: 10.1177/21582440241298856.
[6] Asaleye, A., J. et al (2021). Electricity consumption and manufacturing sector performance: evidence from Nigeria. *International Journal of Energy Economics and Policy*. 11(4), 195-201.
[7] Attigah, B., & Mayer-Tasch, L. (2016). Productive use of energy: The Impact of electricity access on economic development: A literature review.
[8] Azolibe, C. B. and Okonkwo, J. J. (2020). Infrastructure development and industrial sector productivity in Sub-Saharan Africa. *Journal of Economics and Development* Vol. 22. No. 1, 2020 pp. 91-109
[9] Bataille, C., & Melton, N. (2017). Energy efficiency and economic growth: A retrospective CGE analysis for Canada from 2002 to 2012. *Energy Economics*, 64, 118–130.
[10] Brown, R., L. Durbin, J., & Evans, J. M. (1975). Techniques for testing the consistency of regression relationships over time. *Journal of the Royal Statistical Society.* Vol. 37, No. 2
[11] Cantore, C., León-Ledesma, M., & McAdam, P. (2017). The role of the manufacturing sector in driving economic growth in developing countries. *Journal of Development Economics*, 123, 90-105.

[12] Cilliers, J. & Ngundu, M. (2025). Manufacturing thematic futures. Published online at futures.issafrica.org. Retrieved from https://futures.issafrica.org/thematic/07-manufacturing/ [Online Resource] Updated 16 September 2025.

[13] Danmaraya, I. A. & Hassan, S. (2016). Energy consumption and manufacturing industry performance: Evidence from low-income Sub-Saharan African countries. *International Energy Journal*, 16, 57–64.

[14] Ebhota, W. S., & Tabakov, P., Y. (2018). The role of small hydropower electrification schemes in socioeconomic development in Nigeria. *International Journal of Low-Carbon Technologies*, *13*(4), 311-319.

[15] Eke, F. A., Okoi, O. B., & Eke, I. C. (2018). Institutional quality, energy consumption mix and industrial sustainability in Nigeria. *African Journal of Applied and Theoretical Economics*, 4(1), 73–94.

[16] Eke, I. C., Eke, F. A., & Edom, A. E. (2023). Infrastructure and manufacturing sector performance in Nigeria. *International Journal of Research and Scientific Innovation* (IJRSI) ISSN No. 231-2705. DOI: 10.51244/IJRSI | Volume X Issue VII July 2023.

[17] Ekong, U. M., Isaac, U. E., & Isaac, S. E. (2021). Energy consumption and sectoral performance in Nigeria: New growth evidence from an ARDL model for consideration. *Asian Basic and Applied Research Journal*, 4(2), 103–119.

[18] Elliott, R. J., Nguyen-Tien, V., & Strobl, E. A. (2021). Power outages and firm performance: A hydro-IV approach for a single electricity grid. *Energy Economics*, *103*, 105571. https://doi.org/10.1016/j.eneco.2021.105571

[19] EPRA (2024) Energy & petroleum statistics report for the financial year ended 30 June 2024

[20] Fried, S., & Lagakos, D. (2023). Electricity and firm productivity: a general-equilibrium approach. Am. Econ. J. Macroecon. 15 (4), 67–103. https://doi.org/10.1257/mac.20210248.

[21] Ghouse, G (2025). Impact of energy prices, consumption, and government effectiveness on manufacturing output: Evidence from Pakistan. *International Journal of Advanced Social Studies ISSN: 3006-1776 (Print), 3006-1784 (Online)*

[22] Gujarati, D. N., & Porter, D. C. (2009). *Basic econometrics* (5th ed.). New York, NY: McGraw-Hill/Irwin.

[23] Hadi, Muhammad, H., et. al. (2021). The role of electricity and energy consumption in influencing industrial development across regions in Indonesia. *International Journal of Energy Economics and Policy* 11 (3), S. 403 - 408.

[24] Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modelling* (PLS-SEM) (3rd ed.). Thousand Oaks, CA: Sage.

[25] Halkos, G., de Alba, J. M., & Todorov, V. (2021). Analysing the manufacturing sector and selected development challenges: A panel data analysis.

[26] Hatem, G., Zeidan, J., Goossens, M., and Moreira, C. (2022) "Normality testing methods and the importance of skewness and kurtosis in statistical analysis," BAU Journal of Science and Technology: Vol. 3: Iss. 2, Article 7. DOI: https://doi.org/10.54729/KTPE9512

[27] Idogun, H., I. (2025). Electricity consumption and manufacturing sector output in Nigeria: An ARDL approach. *International Journal of Business Management and Economic Review* Vol. 8, No. 03; 2025 ISSN: 2581-4664

[28] Iheonu, C. O., Mbohwa, C., & Asongu, S. (2025). Industrial development in Africa: The role of energy price volatility, *Energy Sources, Part B: Economics, Planning, and Policy*, 20:1, 2484717, DOI: 10.1080/15567249.2025.2484717

[29] Inedu, H., Idoko, S A., & Abdul, M Y. (2025). Impact of Electricity Consumption on Manufacturing Sector Growth in Nigeria. International Journal of Scientific Development and Research (IJSDR) www.ijsdr.org

[30] Institute of Economic Affairs (2020). A Briefing on Public Finances: How Deep a Hole Are We In? International Energy Agency (2012). World Energy Outlook Report. https://www.iea.org/reports/world-energy-outlook-2012

[31] Jorgenson, D.W. (1984). The role of energy in productivity growth. Energy J. 5 (3), 11–26. https://doi.org/10.5547/ISSN0195-6574-EJ-Vol5-No3-2.

[32] Kaldor, N. (1966). *Causes of the Slow Rate of Economic Growth of the United Kingdom*. Cambridge University Press.

[33] KAM (2024). Manufacturing Priority Agenda (MPA) 2024. *Steering economic growth through the manufacturing sector for the common good.*

[34] Keen, S., Ayres, R. U., & Standish R., (2018). A note on the role of energy in production. Elsevier. http://creativecommons.org/about/downloads

[35] Korkmaz, O. (2022). Do oil, coal, and natural gas consumption and rents impact economic growth? An empirical analysis of the Russian Federation. *Resources Policy*, Vol 77, 102739

[36] Kouakou, D. C. M. (2026). Do power outages hurt registered firms' access to finance in developing countries? JEL codes: G20; H54; L94; O13; O16.

[37] Koyck, L. M. (1954). *Distributed Lags and Investment Analysis*, North-Holland, Amsterdam.

[38] Macharia, K., K. Gathiaka, J., K. & Ngui, D. (2022). Energy efficiency in the Kenyan manufacturing sector. *Journal of Sustainable Development*; Vol. 15, No. 3; 2022. ISSN 1913-9063 E-ISSN 1913-9071

[39] Mensah, J.T. (2024). Jobs! Electricity shortages and unemployment in Africa. J. Dev. Econ. 167, 103231. https://doi.org/10.1016/j.jdeveco.2023.103231.

[40] Mutunga, D., & Owino, E. (2017). Moderating role of firm size on the relationship between micro factors and financial performance of manufacturing firms in Kenya. *Journal of Finance and Accounting*, 1(1), 14 -27.

[41] Ndubuisi, G., Avenyo, E., V., & Asiama, R., (2025). Dancing on the grid: Electricity crises, energy vulnerability, and manufacturing jobs in South Africa, Energy Policy 202 (2025) 114534.

[42] Nnyanzi, J, B., Kavuma, S., Sseruyange, J., & Nanyiti, A. (2022). The manufacturing output effects of infrastructure development, liberalisation and governance: evidence from Sub-Saharan Africa. *Journal of Industrial and Business Economics* 49:369–400. https://doi.org/10.1007/s40812-022-00216-2

[43] Olawumi, R., O. & Oriola, A. (2020) Energy Consumption and Industrial Output Growth in Nigeria (1981-2018). *International Journal of Humanities & Social Studies,* ISSN 2321 – 9203.

[44] Omosebi, A., Aladejana, S. A., Ajetunmobi, K. T., & Asagunla, T. M. (2019). Disaggregated Energy Consumption and Industrial Output in Nigeria. *International Journal of Academic Research in Economics and Management Sciences*, *8*(4), 15–26.

[45] Omotosho, T. D., & Ogu, C. (2021). Electricity power consumption and manufacturing sector performance. *Indiana Journal of Humanities and Social Sciences, 2*(8), 1-10.

[46] Onabote, A., Ojamaliya, A., Oduntun, E., Oluwasegun, E., & Okafor, V. (2021). Foreign direct investment, energy infrastructure and manufacturing output in Nigeria. *International Journal of Energy Economics and Policy***,** 2021, 10 (3), 163-169.

[47] Ototo, E., G. (2022). Energy consumption and performance of the manufacturing sector in Kenya, *Unpublished Master's Dissertation, Kenyatta University, Kenya*.

[48] Oyeyimi, M., A. & Onuoha, F., C. (2020). Electricity consumption and industrial output in Nigeria. *International Journal of Arts and Social Sciences, Vol. 1, No 2*

[49] Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*, 289–326.

[50] Quadri, S. T. & Bukola, M. O. (2022). Impact of electricity consumption on manufacturing output in Nigeria from 1980 to 2021. *Research Gate.* https://doi.org/10.21203/rs.3.rs-2134279/v1

[51] Raza, S. A., Jawaid, S. T., & Siddiqui, M. H. (2016). Electricity consumption and economic growth in South Asia. *South Asia Economic Journal*, *17*(2), 200-215.

[52] Sankaran, A., Kumar, S., K A., & Das, M. (2019). Estimating the causal relationship between electricity consumption and industrial output: ARDL bounds and Toda-Yamamoto approaches for 10 late-industrialized countries. *Heliyon*. https://doi.org/10.1016/j.heliyon.2019.e01904

[53] Sarkodie, S. A., & Adom, P. K. (2018). Determinants of energy consumption in Kenya: a NIPALS approach. *Energy*, *159*, 696-705.

[54] Simon, M. K., & Goes, J. (2011). Correlational Research.

[55] Stern, D.I., Kander, A., 2012. The role of energy in the industrial revolution and modern economic growth. Energy J. 33 (3). https://doi.org/10.5547/01956574.33.3.5.

[56] UNIDO (2025). *Industrial Development Report 2026. The Future of Industrialization. Building Future-ready Industries for Sustainable Development*. Vienna.

[57] Wan, X., Kazmi, S. A. A., & Wong, C. Y. (2022). Manufacturing, exports, and sustainable growth: evidence from developing countries. *Sustainability*, 14(3), 1646.

[58] Wangui, M. (2019). Key challenges holding the manufacturing sector in Kenya, Kenya Tribune, 15 July 2019. www.kenyatribune.com

[59] Zhang, Q., & Wang, Q. (2023). Digitalization, electricity consumption and carbon emissions: Evidence from manufacturing industries in China. *International Journal of Environmental Research and Public Health*, 20, 3938. https://doi.org/10.3390/ijerph20053938

[60] Zheng, S., Wang, R., Mak, T. M., Hsu, S. C., & Tsang, D. C. (2021). How do energy service companies moderate the Impact of industrialization and urbanization on carbon emissions in China? *Science of the Total Environment*, *751*, 141610.