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Research Article

Electricity Consumption, Renewable Energy Share, and Industrial Production in the Philippines: Mediation Analysis from Aggregate and Sectoral Time-Series Data

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Abstract. This study examines the relationship of renewable energy and electricity consumption, towards Philippine industrial output from 2005 to 2024 (N = 20), while accounting for Brent oil price and joint GFCG and labor in manufacturing as production input. It investigates whether electricity consumption could act as a pathway between renewable energy share and manufacturing output. To capture these dynamics, the study employs ordinary least squares regression (OLS) with Newey-West heteroskedasticity and autocorrelation consistent standard errors, Johansen cointegration testing, Error Correction Model (ECM) alongside a 5,000-replication nonparametric bootstrap. The aggregate model indicates that production input is positively associated with manufacturing output, whereas renewable energy share, electricity consumption, and oil prices are statistically insignificant. The controlled bootstrap indirect effect of renewable energy share through electricity consumption yields is not statistically significant, as the 95% confidence intervals include zero. However, ECM identifies positive and statistically significant short-run associations between changes in renewable energy share, electricity consumption, and manufacturing output. The sectoral-specific estimation further reveals differences in the associations of energy variables and production inputs with output across manufacturing subsectors. Given the limited number of annual observations and the observational research design, the results are interpreted as statistical associations rather than definitive causal effects. These findings indicate that the relationships between variables vary across model specification, time horizons, and manufacturing industries. Future policy must look beyond uniform generation goals to prioritize targeted industrial grid modernization, energy storage deployment, and industry-specific support.

Keywords: *Electricity consumption; Industrial production; Ordinary least squares; Renewable energy share; Sectoral analysis.*

Energy is one of the fundamental inputs in order to achieve an efficient manufacturing process in industrial production. Reliable and affordable energy is essential for operating equipment, tools, machinery, and other manufacturing systems that make up product units. Persistent power shortages, rising electricity costs, and dependence on fossil fuels can increase production costs, disrupt operations, and weaken industrial competitiveness in the international market. This effect is especially visible in energy-intensive industries. Industrial electricity use indicates industrial activity, and cost variations can also affect energy prices and, in turn,

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production costs (Battung, 2022).

Industrial production and electricity consumption are closely related, with electricity serving as a major input to economic activity alongside capital and labor (Zhao et al., 2016; Wang et al., 2021; Aderemi & Sikwela, 2025). Moreover, the significance of electricity production and consumption for economic performance is apparent (Belmonte et al., 2025). Also, as Šimelytė & Dudzevi Śūtė (2017) state, renewable energy has positive effects on economic development, though its productive contribution varies with national and technological conditions. Therefore, renewable energy should be considered in relation to the electricity system that provides energy to productive activities as well as a direct determinant of industrial production.

However, while renewable energy can promote sustainable economic growth, its impact may vary depending on infrastructure, energy costs, technological preparedness, and the reliability of electricity supply (Papiez et al., 2019). Moreover, renewable energy affects energy prices, electricity availability, and supporting infrastructure rather than directly affecting industrial output. Meanwhile, the Philippines' industrial activities remain heavily dependent on a limited electricity system. As a result, the country faces ongoing challenges in infrastructure financing, grid reliability, and integrating renewable energy into the electricity supply. Unreliable electricity supply drives high prices and limits control over energy use, which affects economic contribution. (Elekwa et al., 2016; Abokyi, 2018).

In addition, the Philippine energy transition still suffers from infrastructure limitations, and implementation is uneven (Climate Analytics, 2022; Dressel & Saguin, 2025). So, even if the share of renewable energy in the generation mix increases a bit, it is difficult to predict that industrial output will be boosted. The outcome depends on how renewable energy affects the production system's electricity supply availability, reliability, and usage. However, the shift to renewable energy holds strong potential to improve the environmental compatibility of the electricity supply and diversify it.

Electricity consumption represents the amount of electrical energy used by productive activities; the renewable energy share captures shifts in the composition of electricity generation. Therefore, beyond direct production effects, renewable energy may also affect industrial production through its relationship with electricity consumption. Renewable energy can influence industrial and economic results through electricity-related channels, and infrastructure and financial circumstances can strengthen the link between electricity production and consumption (Anton & Nucu, 2020). This provides a theoretical and empirical basis for examining the relationship between the share of renewable energy in electricity consumption and industrial production.

Few studies have considered electricity consumption as a mediator between renewable energy and industrial production. Earlier work usually treated electricity consumption and renewable energy as two separate factors contributing to economic growth. Although industries differ in energy intensity, technology capital requirements, and exposure to price fluctuations, this study focuses on interactions among manufacturing sub-industries. Econometric issues, such as heteroskedasticity and the need for robust inference, are also often overlooked in research on energy production. These limitations serve to justify, in our opinion, that it would be very beneficial for multi-dimensional research to be carried out that would not only consider the relationship between industrial production and the share of renewable energy but also the effect of procedures specific to different sectors and time-series data on electricity consumption.

This study measures industrial production in the Philippines through the Production Volume Index (VoPI) based on the Philippine Statistics Authority's backcasted series. The contribution of Renewable Energy Share (RE) is measured through the total percentage of electricity generated by renewable energy, as provided by the Department of Energy data. Electricity consumption data are gathered from the Philippine Statistics Authority and the Department of Energy for the industry sector, measured in gigawatt-hours (GWh). The change in Oil Prices in this study is represented by the nominal Brent crude prices on an annual basis, in US dollars per barrel. The study covers annual data from 2005 to 2024, allowing the research to examine relationships among energy variables and industrial production over a period marked by a significantly increasing share of renewable energy and persistent structural challenges in the Philippine electricity sector.

Therefore, this study examines the relationship between the renewable energy share, electricity consumption, and

Philippine industrial production from 2005 to 2024. It uses OLS regression with Newey-West standard errors to examine the overall relationship, Baron-Kenny's method with Bootstrap repetitions to identify the mediating effect of electricity consumption, and the Johansen cointegration test and Error Correction Model (ECM) to analyze long-term and short-term dynamics. Using sector-specific regressions with Newey-West standard errors, the study also tests whether outcomes vary across eight manufacturing sub-sectors, examines evidence on the relationship between energy and industry in the Philippines, and offers insights for more sector-sensitive energy and industrial policies by combining aggregate, mediation, long-run, short-run, and sectoral analyses.

Methodology

Research Design

This study used a quantitative, non-experimental research design, employing annual secondary time-series and sector-specific econometric data to examine the statistical relationships between renewable energy share and Philippine industrial production, with electricity consumption as a potential mediating variable and oil prices and production inputs as control variables. The time-series approach allows the study to examine changes in the variables over time. In addition, aggregate and sectoral regression analysis was conducted to examine whether the observed relationships varied across industrial sectors. Given the nature of the observed data, the findings are interpreted as statistical associations rather than definitive causal effects.

Data Gathering Procedure

The study used annual secondary data for the Philippines covering 2005-2024, comprising 20 observations. The data for all observed variables were obtained from corresponding official statistical databases and institutional publications identified in the variable operationalization table. The selected study period was determined by the availability of annual observations for the variables included in the analysis. To construct a common time-series dataset, we organized and matched the collected datasets by calendar year.

The dataset was examined for completeness and consistency, and the necessary unit conversions and variable transformations were performed before estimation. Electricity consumption was expressed in thousands of GWh, while gross fixed capital formation and manufacturing labor were standardized and combined to construct the production input composite. The resulting dataset was used for the Aggregate regression, mediation, and sectoral analysis.

Table 1. *Data Operationalization and Sources*

Variable	Symbol	Definition / Operationalization	Unit	Source	Expected sign
Industrial Production Index	$VoPI_t$	Volume of Production Index for total manufacturing; harmonized to year 2018=100 as base.	Index (2018=100)	PSA OpenSTAT	Dependent variable
Renewable Energy Share	RE_t	Renewable energy share from solar, wind, hydro, geothermal, and biomass in total gross power generation.	% of total electricity generation	Department of Energy (DOE)	Positive (+)
Electricity Consumption	EC_t	Total annual electricity consumption of the manufacturing sector; mediating variable.	GWh	Department of Energy (DOE)	Positive (+)
Oil Price	Oil_t	Annual Brent crude oil price at current/nominal market prices	US $/barrel	U.S Energy Information Administration (EIA)	Negative (−)
Gross Fixed Capital Formation	$GFCF_t$	Gross Fixed Capital Formation representing real capital investment in manufacturing.	Million PHP	PSA National Accounts	Positive (+)
Manufacturing Labor	$Labor_t$	Employment in the manufacturing sector.	Thousands of persons	PSA Labor Force Survey	Positive (+)
Production-Input Index	$Prod_Input_t$	Arithmetic mean of the standardized z-scores of GFCF and manufacturing labor.	Standardized index	PSA National Accounts & LFS	Positive (+)

Production-Input Index

Production input composition was constructed by standardizing gross fixed capital formation (GFCF) and labor in manufacturing. Because GFCF and manufacturing labor are measured in different units, we first standardized each variable into a z-score. The resulting standardized scores were then averaged. Thus, Prod_Input is an arithmetic mean, not a sum, principal component, or separate raw-unit index.

$$\text{Prod_Input}_t = [z(\text{GFCF}_t) + z(\text{Labor}_t)] / 2 \quad (1)$$

VoPI Harmonization

Historical VoPI series for different base years (2000=100, 2006=100 and 2018=100) were harmonized to the 2018=100 base by overlap-period growth-rate chaining/backcasting, resulting in a continuous and comparable series for 2005–2024. Moreover, the Electricity Consumption was re-scaled from GWh to thousand GWh by dividing the original values of electricity consumption by 1,000 as follows:

$$EC_t = EC_t / 1{,}000 \quad (2)$$

Econometric Model Specification

A series of econometric procedures were adopted to model the aggregate VoPI, the three Baron-Kenny mediation associations, bootstrap estimation of the indirect effect, Johansen cointegration testing, Error Correction Model (ECM), and the sector-specific regression analysis. The regression-based model was estimated by Ordinary Least Squares (OLS) with Newey-West heteroskedasticity- and autocorrelation-consistent (HAC) standard errors used for statistical inference where applicable.

Aggregate VoPI Regression

$$\text{VoPI}_t = \beta_0 + \beta_1 RE_t + \beta_2 EC_t + \beta_3 Oil_t + \beta_4 \text{Prod_Input}_t + \varepsilon_t \quad (3)$$

In Equation (3), VoPI_t is the aggregate manufacturing Volume of Production Index in year t; RE_t is renewable energy share; EC_t is electricity consumption in GWh; Oil_t is the Brent crude oil price in US$ per barrel; Prod_Input_t is the standardized production-input index; β_0 is the intercept; β_1–β_4 are the corresponding regression coefficients; ε_t is the error term; and t denotes each year from 2005 to 2024.

Baron-Kenny Mediation Analysis

The mediation analysis examines whether electricity consumption provides a pathway through which renewable energy share is associated with industrial production. The three regression relationships are estimated while controlling for oil prices and the Production-Input Index.

Step 1: Total effect of renewable energy share on industrial production.

$$\text{VoPI}_t = c_0 + cRE_t + d_1 Oil_t + d_2 \text{Prod_Input}_t + \varepsilon_{1t} \quad (4)$$

Here, c is the total effect of RE on VoPI; c_0 is the intercept; d_1 and d_2 are the coefficients of Oil and Prod_Input; and ε_{1t} is the error term.

Step 2: Effect of renewable energy share on electricity consumption.

$$EC_t = a_0 + aRE_t + a_1 Oil_t + a_2 \text{Prod_Input}_t + \varepsilon_{2t} \quad (5)$$

Here, a is the effect of RE on EC; a_0 is the intercept; a_1 and a_2 are the coefficients of Oil and Prod_Input; and ε_{2t} is the error term.

Step 3: Effect of electricity consumption on industrial production controlling for renewable energy share.

$$VoPI_t = c'_0 + c'RE_t + bEC_t + b_1Oil_t + b_2Prod_Input_t + \varepsilon_{3t} \quad (6)$$

Here, c′ is the direct effect of RE on VoPI after EC is introduced; b is the effect of EC on VoPI controlling for RE; b_1 and b_2 are the coefficients of Oil and Prod_Input; c'_0 is the intercept; and ε_{3t} is the error term.

Bootstrap Mediation Model

$$IE=ab \quad (7)$$

In Equation 7, IE is the indirect effect of renewable energy share on the Volume of Production Index through electricity consumption; *a* is the estimated coefficient of renewable energy share in the model predicting electricity consumption; and *b* is the estimated coefficient of electricity consumption in the model predicting VoPI while controlling for renewable energy share, oil price, and the Production-Input Index. The indirect effect is evaluated using 5,000 bootstrap replications. The indirect effect is considered statistically significant when its 95% bootstrap confidence interval does not include zero.

Johansen Cointegration Model and Test

The Johansen cointegration procedure was used to determine whether a long-run relationship exists among renewable energy share, electricity consumption, manufacturing production, oil prices, and the Production-Input Index. The test used the trace statistic and maximum-eigenvalue statistic to determine the number of cointegrating relationships among the variables. The test starts with the assumption of no cointegrating relationship. (r=0) and proceeds to higher ranks. The results show three cointegrating relationships, as supported by both the trace and maximum-eigenvalue tests.

Error Correction Model (ECM) with Newey-West Standard Error

$$\Delta VoPI_t = \alpha_0 + \alpha_1\Delta RE_t + \alpha_2\Delta EC_t + \alpha_3\Delta Oil_t + \alpha_4\Delta Prod_Input_t + \lambda ECM_{t-1} + \nu_t \quad (8)$$

In Equation 8, Δ denotes the first difference and represents the short-run change in each variable; $\Delta VoPI_t$ is the short-run change in industrial production; ΔRE_t is the short-run change in renewable energy share; ΔEC_t is the short-run change in electricity consumption; ΔOil_t is the short-run change in oil price; and $\Delta Prod_Input_t$ is the short-run change in the Production-Input Index. ECM_{t-1} represents the lagged error-correction term derived from the long-run equilibrium relationship, while λ represents the speed of adjustment toward long-run equilibrium. α_0 is the intercept, α_1 through α_4 are the short-run coefficients, and ν_t is the error term.

Sector-Specific Regression Model

$$VoPI_{i,t} = \theta_{0,i} + \theta_{1,i}RE_t + \theta_{2,i}EC_t + \theta_{3,i}Oil_t + \theta_{4,i}Prod_Input_t + u_{i,t} \quad (9)$$

In Equation 9, $VoPI_{i,t}$ is the VoPI of manufacturing sector i in year t; RE_t is renewable energy share; EC_t is total electricity consumption in GWh; Oil_t is oil price; $Prod_Input_t$ is the production-input index; $\theta_{0,i}$ is the sector-specific intercept; $\theta_{1,i}$, $\theta_{2,i}$, $\theta_{3,i}$, and $\theta_{4,i}$ are the sector-specific coefficients; $u_{i,t}$ is the sector-specific error term; and i identifies the manufacturing subsector. The eight sectors are Food Products, Beverages, Tobacco, Wood and Bamboo, Paper Products, Recorded Media, Petroleum, and Nonmetallic Minerals. Newey-West heteroskedasticity-and autocorrelation-consistent (HAC) standard errors were used for inference in each sector-specific regression. Electricity consumption is not included as a predictor in the final sector-specific model, consistent with the sectoral analysis.

Time-Series Analysis and Diagnostic Procedures

Because the data are annual time series with N=20 observations, stationarity was assessed before interpreting the

regression relationships. The analysis used the Augmented Dickey–Fuller (ADF) test, with additional unit-root procedures reported where applicable. When the variables exhibit a long-run equilibrium relationship, the Johansen cointegration procedure is used to determine the cointegration rank, using the trace and maximum-eigenvalue statistics. An Error Correction Model (ECM) is then estimated to capture short-run changes and the speed of adjustment toward the long-run equilibrium.

The ECM relates changes in VoPI to changes in RE, EC, Oil, and Prod_Input together with the lagged residual from the long-run equilibrium relationship. A negative and statistically significant error-correction coefficient indicates adjustment toward long-run equilibrium. Newey-West heteroskedasticity- and autocorrelation-consistent (HAC) standard errors were used for inference in the ECM.

Post-estimation diagnostics include the Durbin–Watson and Breusch–Godfrey tests for autocorrelation or serial correlation, the Breusch–Pagan test for heteroskedasticity, the Ramsey RESET test for functional-form or specification error, the Jarque–Bera test for residual normality, and VIF diagnostics for multicollinearity. Newey–West HAC standard errors were used for inference in the regression models and sector-specific regressions to account for heteroskedasticity and autocorrelation concerns.

Data Analysis Procedure

The data were analyzed using R statistical software through the RStudio integrated development environment (RStudio August 2026 version). Descriptive statistics were first computed to summarize the characteristics and distribution of variables in the study. The Augmented Dickey-Fuller (ADF) test was then employed to examine the stationarity of the time-series variables at levels and first differences. The Johansen cointegration test was conducted to investigate long-run relationships among the variables, subject to their integration properties. This is supported by the results of cointegration, in which the Error-Correction Model (ECM) was employed to examine short-run dynamics and the adjustment toward long-run equilibrium.

To examine the potential mediating role of electricity consumption in the relationship between renewable energy share and industrial production, three regression models were estimated. The first model assessed the relationship between renewable energy share and electricity consumption, the second estimated the total relationship between renewable energy share and industrial production, and the third model examined the relationships of renewable energy share and electricity consumption with industrial production simultaneously while accounting for oil prices and the composite production input index in the three regression models. The indirect association was estimated by multiplying the regression coefficient linking renewable energy share to electricity consumption by the regression coefficient linking electricity consumption to industrial production, while controlling for oil prices and production inputs. Using bootstrap estimation with 5,000 replications to obtain confidence intervals for the indirect association. Newey-West heteroskedasticity and autocorrelation-consistent standard errors were used to obtain reliable statistical inferences in the presence of possible heteroskedasticity and serial correlation. A lag of one was specified to account for autocorrelation up to one year, and pre-whitening was not applied.

Lastly, separate regression models were estimated for the selected industrial sectors to examine whether the relationships among the study variables varied across sectors. Model diagnostics, including the Variance Inflation Factor, Breusch-Pagan test, Breusch-Godfrey test, Ramsey RESET test, Jarque-Bera test, and Durbin-Watson test, were performed to assess multicollinearity, heteroskedasticity, serial correlation, functional-form specification, and residual normality. Statistical significance was evaluated at the 5% level, with p-values below 0.05 considered statistically significant. All reported estimates and interpretations were based on the specified models and the observed annual data.

Ethical Considerations

The researchers employ secondary data from publicly available datasets at the aggregate level. Sources include reputable institutions such as the Philippine Statistics Authority (PSA), Department of Energy (DOE), and the U.S. Energy Information Administration (EIA). The study did not involve human participants; therefore, the researchers did not obtain any personally identifiable or confidential information. The researchers used the data exclusively for academic purposes. All datasets that were used were properly cited and referred to the respective institutions from which they originated. The terms and conditions of use imposed by the data providers were also duly adhered to. The data were handled properly, with no intentional manipulation or misrepresentation.

Results and Discussion

Diagnostic Tests and Time-Series Properties

Initial descriptive statistics confirmed the baseline characteristics for all study variables across the 20-year period (N = 20). As shown in Table 2, the renewable energy share averaged 26.52% (SD = 4.64%) and peaked at 36.03%. Electricity consumption averaged 22.65 thousand GWh, with a standard deviation of 5.07 thousand GWh. Industrial production is measured by the Volume of Production Index (VoPI), with a mean of 74.69 and a standard deviation of 17.26. Oil prices averaged 76.16, and the composite production input had a mean of 0.00 and a standard deviation of 0.98.

Table 2. *Descriptive Statistics of the Study Variables, 2005 - 2024*

Variable	*N*	Mean	*SD*	Minimum	Median	Maximum
RE	20	26.52	4.64	20.79	25.54	36.03
EC_GWh	20	22.65	5.07	15.71	21.97	31.07
VoPI	20	74.69	17.26	49.80	71.40	100.64
Oil	20	76.16	22.32	41.96	71.87	111.63
Prod_Input	20	0.00	0.98	-1.25	-0.17	1.45

Table 3. *Augmented Dickey-Fuller Unit-Root Test*

Variable	ADF Statistic at Level	*p*	ADF Statistic at First Difference	*p*	Integration
RE	-0.47	.976	-4.06	.021	I(1)
EC_GWh	-2.51	.379	-2.45	.401	Not conclusively I(1) by this test
VoPI	-2.98	.199	-3.29	.093	I(1) at 10%
Oil	-1.98	.579	-2.64	.331	Not conclusively I(1) by this test
Prod_Input	-2.11	.530	-2.47	.394	Not conclusively I(1) by this test

Before estimating the regression models, Augmented Dickey-Fuller (ADF) unit-root tests were conducted to assess the stationarity properties of variables (Table 3). At the 5% significance level, results indicate that renewable energy share (RE) was nonstationary at level but became stationary after first differencing, consistent with integration of order one I(1). Similarly, VoPI also failed to reject the unit-root null at levels and rejected it at the 10% significance level only at first differences. In contrast, electricity consumption (EC_GWh), oil prices (oil), and the composite production input (Prod_Input) did not reject the unit-root null at either level. The results did not establish that all the study variables are integrated of order one; therefore, the unit-root results alone do not establish the conditions needed to interpret the Johansen cointegration and ECM results as evidence of a valid long-run equilibrium. These findings warrant caution when interpreting the subsequent cointegration and error-correction analysis, given the limited number of annual observations.

Table 4. *Correlation Matrix and Variance Inflation Factors*

Variable	RE	EC	Oil	Prod_Input	VIF
RE	1.00	-0.91	0.11	-0.87	6.14
EC_GWh	-0.91	1.00	-0.09	0.96	21.51
Oil	0.11	-0.09	1.00	-0.13	1.05
Prod_Input	-0.87	0.96	-0.13	1.00	14.55

We examined correlation and Variance Inflation Factor (VIF) diagnostics before estimating the regression to assess the degree of association among the explanatory variables (Table 4). The table revealed a strong relationship between renewable energy share and electricity consumption (r = -0.91), and between renewable energy and the composite production input (r = 0.96). The VIF results also indicate elevated collinearity for renewable energy share (VIF = 6.14), electricity consumption (VIF = 21.51), and production input (VIF = 14.55), while oil exhibited a comparatively low VIF of 1.05. These findings suggest substantial overlap among the energy and production input variables, particularly among electricity consumption and the composite production input index. The individual regression coefficients for renewable energy share, electricity consumption, and production input should be interpreted cautiously, as multicollinearity may inflate their standard errors and reduce the precision of their estimated associations with industrial production.

Table 5 presents the results of the aggregate OLS method, used to examine the relationship between renewable energy share, electricity consumption, oil prices, and the composite product inputs with industrial production. Among the explanatory variables, production input was the only individual statistically significant regressor in

the reported OLS results, with a positive coefficient of 23.000 and a *p*-value of <.001. This indicates that, holding other variables constant, higher production input was associated with higher industrial production. Renewable energy share also had a positive coefficient of 1.18; however, the association was not statistically significant at the 5% level (p = .102). Electricity consumption exhibited a negative coefficient of -0.41 and a *p*-value of .726, while oil had a positive coefficient of 0.09 and a *p*-value of .134; neither had a statistically significant association at the 5% level.

Table 5. *Aggregate OLS Regression*

Variable	Coefficient	Standard Error	*t*-statistic	*p*
Constant	45.68	39.19	1.17	.262
RE	1.18	0.68	1.74	.102
EC_GWh	-0.41	1.16	-0.36	.726
Oil	0.09	0.06	1.58	.134
Prod_Input	23	4.93	4.79	<.001

Table 5.1. *Aggregate OLS Regression Model Fit*

Model Fit	Value
R^2	0.919
Adjusted R^2	0.897
F-statistic	42.49
F-test *p*-value	<0.001
Observation	20

Overall, the OLS *F*-test was F = 42.49, and the *p*-value was <.001, suggesting that the explanatory variables were jointly significant under the conventional OLS test. Model R^2 of 0.919 indicates that the included regressors accounted for 91.9% of the observed sample variation in industrial production, while adjusted R^2 of 0.897 accounts for the number of explanatory variables relative to the sample size. These measures of overall model fit did not establish causal relationships or resolve potential estimation concerns. As shown in Table 4 for correlation and VIF diagnostics, substantial multicollinearity among renewable energy share, electricity consumption, and the composite production input warrants caution when interpreting their individual coefficients and statistical significance, given the limited sample of 20 annual observations and the use of aggregate time-series data.

Baron and Kenny Mediation

To examine whether electricity consumption can serve as a mediating pathway between renewable energy share and industrial production, a mediation analysis was conducted using the Baron and Kenny regression framework and a nonparametric bootstrap with 5,000 replication procedures. The three regression models were estimated while accounting for oil and production input as control variables, and Newey-West standard errors were used for regression inference. The individual regression paths were examined to assess the associations among renewable energy share, electricity consumption, and industrial production, while a bootstrap procedure was used to evaluate the indirect effect, and its bootstrap confidence interval is reported in Table 7.

The Newey-West regression results indicated a negative and statistically significant relationship between renewable energy share and electricity consumption in Step 1: β = -0.34, p = .006. In Step 2, Renewable energy exhibited a positive association with industrial production; however, the coefficient was not statistically significant at 5% level (β = 1.32, p = .061). In step 3, the direct association between renewable energy and industrial production remained positive but statistically insignificant (β = 1.18, p = .111). Electricity consumption also exhibited a negative and statistically insignificant conditional association with industrial production after controlling for renewable energy share, oil, and composite production input (Step β = -0.41, p = .740). Overall, the regression paths provided no statistically significant evidence of a conditional association between electricity consumption and industrial production in the final mediation model.

Table 6. *Baron and Kenny Mediation Regression with Newey-West Standard Errors*

Variable	Step 1: EC	Step 2: VoPI	Step 3: VoPI
Constant	31.06 (3.12)	32.80 (21.27)	45.68 (40.51)
RE	-0.34 (0.11)	1.32 (0.66)	1.18 (0.70)
EC	—	—	-0.41 (1.23)
Oil	0.01 (0.001)	0.09 (0.06)	0.09 (0.06)
Prod_Input	3.61 (0.61)	22.14 (2.78)	23.64 (5.32)
R^2	0.95	0.92	0.92
Adjusted R^2	0.95	0.90	0.90
N	20	20	20

Table 6.1 *Bootstrap Mediation Analysis*

Pathway	β	SE	p
Step 1: RE	-0.34	0.11	.006
Step 2: RE	1.32	0.66	.061
Step 3: RE	1.18	0.70	.111
Step 3: EC	-0.41	1.23	.740
Step 3: Prod_Input	23.64	5.32	<.001

Table 7. *Estimated Mediation Effect of Electricity Consumption*

Mediation Path	Coefficient	Interpretation
Path *a*: RE → EC	-0.34	Negative
Path *b*: EC → VoPI	-0.41	Negative, not significant
Total effect (*c*): RE → VoPI	1.32	Positive
Direct effect (*c*'): RE → VoPI	1.18	Positive, not significant
Indirect effect ($a \times b$)	0.41	Positive
95% percentile CI	[-0.79, 1.62]	Includes zero
95% BCa CI	[-0.59, 1.91]	Includes zero

The indirect effect is estimated using a nonparametric bootstrap with 5,000 replications, where the confidence intervals are reported for the controlled indirect effect.

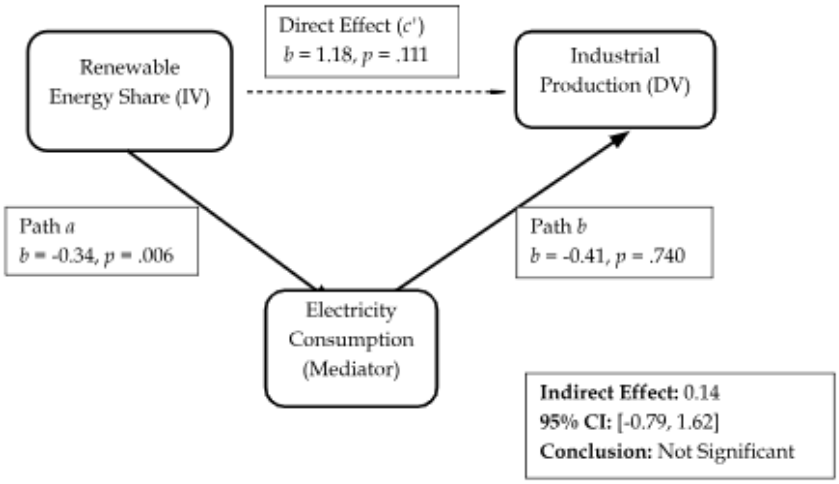


Figure 1. *Mediation Results*

The bootstrap analysis estimated a positive controlled indirect effect of 0.14 between renewable energy share and industrial production through electricity consumption. However, it was not statistically significant, as the 95% percentile confidence interval was -0.79 to 1.62. The 95% bias-corrected and accelerated (BCa) confidence interval of -0.59 to 1.91 contained zero. Thus, the bootstrap analysis suggests no statistically significant evidence that electricity consumption serves as a transmission mechanism linking renewable energy share to industrial production. Although the estimated indirect association was positive, the confidence intervals indicate considerable uncertainty surrounding its magnitude and direction. These findings suggest that the ongoing

transition to renewable energy in the Philippines does not yet translate smoothly into expanded industrial output through electricity consumption. Instead, the lack of mediation likely reflects current grid bottlenecks, adjustment costs, and transitional frictions within the power sector that prevent renewable integration from immediately boosting manufacturing volume.

Cointegration and Aggregate Error Correction Model Estimates

Table 8. *Johansen Trace Test for Long-Run Cointegration*

Hypothesis	Statistic	5% Critical Value	*p*-Decision	Cointegration Rank
$r = 0$	146.39	76.07	Reject H_0	At least 1
$r \leq 1$	86.01	53.12	Reject H_0	At least 2
$r \leq 2$	44.32	34.91	Reject H_0	At least 3
$r \leq 3$	17.22	19.96	Do not reject H_0	—
$r \leq 4$	5.59	9.24	Do not reject H_0	—

The Johansen trace test examined long-run cointegrating relationships among the study variables; the results are shown in Table 8. Based on the reported 5% critical values, the null hypothesis of no cointegration has at most one cointegrating relationship, and at most two cointegrating relationships were rejected. However, the null hypothesis of at most three cointegrating relationships was not rejected, indicating a cointegrating rank of three under the reported test specification. Providing evidence of cointegration according to the Johansen trace test. Nevertheless, interpret the findings cautiously because the ADF test did not conclusively establish that all variables were integrated of order one, and the analysis is based on only 20 available annual observations of the study variables.

Table 9. *Error Correction Model*

Variable	Coefficient	Newey-West *SE*	*t*-statistic	*p*
Constant	-5.41	0.97	-5.57	< .001
ΔRE	1.12	0.36	3.09	.009
ΔEC_GWh	7.59	1.13	6.73	<.001
ΔOil	0.01	0.03	0.36	.726
ΔProd_Input	12.97	2.63	4.94	< .001
ECM (-1)	-0.95	0.11	-9.00	< .001

Table 9.1. *Error Correction Model - Model Fit*

Model Fit	Value
R^2	0.95
Adjusted R^2	0.94
F-statistic	54.47
F-test p-value	<.001

The aggregate ECM in Table 9.1 Model Fit, reported $R^2 = 0.95$ and adjusted $R^2 = 0.94$, indicating that the included regressors accounted for approximately 95% of the observed sample variation in the dependent variable. The conventional OLS overall model reported an F-test of 54.47 and a *p*-value of <.001, indicating the model is statistically significant, and the five slope coefficients are jointly different from zero under the conventional OLS test. This test is distinct from the individual coefficient test, for which Newey-West heteroskedasticity- and autocorrelation-consistent standard errors were used.

Changes in electricity consumption were positively and statistically significantly associated with changes in industrial production ($\beta = 7.59$, $SE = 1.13$, $p < .001$), as seen in the short-run relationship. Similarly, changes in the composite production input index exhibited a positive and statistically significant association with industrial production ($\beta = 12.97$, $SE = 2.63$, $p = <.001$), and changes in renewable energy share also have a positive and statistically significant association with changes in industrial production ($\beta = 1.12$, $SE = 0.36$, $p = .009$). In contrast, changes in oil prices did not exhibit a statistically significant short-run association with industrial production ($\beta = 0.01$, $SE = 0.03$, $p = .726$). The lagged error-correction term yields $\beta = -0.95$, $SE = 0.11$, $p < .001$, reflecting a negative and statistically significant relationship. This result is consistent with adjustment toward the estimated long-run relationship under a valid error-correction specification. The coefficient implies an estimated adjustment of about 95% per year; however, this interpretation depends on the validity of the cointegration and ECM specification. Given the limited 20 annual observations and inconclusive order results reported in Table 3, the estimated long-

run adjustment should be interpreted cautiously. Overall, the ECM results indicate statistically significant short-run associations for renewable energy, electricity consumption, and production inputs towards industrial production, while no statistically significant short-run association was found between oil prices and industrial production.

Table 10. *Diagnostic Tests for the Error Correction Model*

Diagnostic	Statistic	*p*	Assessment
Durbin-Watson	1.39	.091	No statistically significant evidence of positive autocorrelation under the reported test
Breusch-Godfrey LM (1)	3.62	.055	Not significant at borderline of 5%
Breusch-Godfrey LM (2)	3.62	.163	No statistically significant evidence of autocorrelation at the tested order
Breusch-Pagan	3.89	.565	No statistically significant evidence of heteroskedasticity
Ramsey RESET	0.44	.655	No statistically significant evidence of the tested functional-form misspecification
Jarque-Bera	1.43	.488	No statistically significant departure from normality detected

Following the ECM estimation, a rigorous post-estimation diagnostic test was conducted to ensure model adequacy (Table 10). This step is vital to the study as it validates the reliability and trustworthiness of the estimated model. The Durbin-Watson test yielded a statistic of 1.39 and a *p*-value of .091, while the Breusch-Godfrey LM (1) test results produced a statistic of 3.62 and a *p*-value of .055, which was close to the significance threshold; neither test was statistically significant at the 5% level under the reported specifications. The Breusch-Godfrey LM (2) yields a statistic of 3.62 and a *p*-value of .163, which likewise did not provide statistically significant evidence of autocorrelation. The Breusch-Pagan test results confirmed the absence of heteroskedasticity, with a statistic of 3.89 and a *p*-value of .565. Similarly, the Ramsey RESET test (statistic = 0.44, $p = .655$) indicated no functional-form specification errors; lastly, the Jarque-Bera test (statistic = 1.43, $p = .488$) supported residual normality. Collectively, the diagnostic tests did not identify statistically significant violations of the examined assumption at the 5% level. However, these results should be interpreted cautiously, given the study's small sample size. Failure to reject the diagnostic null hypothesis does not establish that the model is free from all specification or estimation problems, nor does it independently establish the robustness of the model's substantive conclusions.

Sectoral Regression Results

Table 11. *Sectoral Effects of Renewable Energy Share on Manufacturing Production*

	Manufacturing Sector							
	Food Products	**Beverages**	**Tobacco**	**Wood & Bamboo**	**Paper Products**	**Record Media**	**Petroleum**	**Nonmetallic Minerals**
RE β (NWSE)	1.87 (0.59)	-0.80 (0.96)	32.68 (4.84)	1.08 (0.83)	2.77 (1.05)	-0.94 (6.57)	3.04 (2.12)	-0.94 (0.54)
p- value	.007	.417	<.001	.213	.018	.194	.173	.098
EC_GWh β (NWSE)	4.12 (0.85)	0.13 (1.18)	-26.17 (15.51)	-1.70 (1.76)	6.35 (1.61)	-22.64 (9.77)	-3.70 (4.02)	-0.30 (1.15)
p- value	<.001	.910	.112	.349	.001	.035	.372	.799
Oil β (NWSE)	0.02 (0.08)	-0.02 (0.06)	-2.71 (0.74)	0.18 (0.14)	0.04 (0.10)	-1.27 (0.63)	0.20 (0.12)	0.15 (0.06)
p- value	.850	.791	.002	.239	.722	.062	.111	.026
Prod_Input β (NWSE)	0.04 (4.19)	12.03 (4.74)	117.22 (55.70)	26.11 (9.62)	-5.20 (6.69)	89.37 (48.79)	21.78 (13.23)	12.43 (4.34)
p- value	.993	.023	.053	.016	.450	.087	.120	.012

To investigate industry-specific sensitivities, separate regressions were estimated across eight distinct manufacturing subsectors. Table 11 presents the sectoral effects of renewable energy share, electricity consumption, oil prices, and production inputs on manufacturing production using Newey-West standard errors. The findings indicate that the estimated relationship between renewable energy share and manufacturing production was not uniform across the selected eight sectors. The results confirm the positive and statistically significant effect of renewable energy share on food products ($\beta = 1.87$, $p = .007$), tobacco ($\beta = 32.68$, $p = <.001$), and paper products ($\beta = 2.77$, $p = .018$), while there is no statistically significant impact on the remaining five sectors at the 5% significance level. Electricity consumption shows positive, statistically significant effects on both food products ($\beta = 4.12$, $p = <.001$) and paper products ($\beta = 6.35$, $p = .001$), while showing negative effects on record media ($\beta = 4.12$, $p = <.001$) and statistically insignificant effects at the 5% level on the remaining five (5) sectors. Additionally, results in oil prices yield a negative and statistically significant association with tobacco production ($\beta = 2.71$, $p = .001$), whereas nonmetallic minerals exhibited a positive and statistically significant association ($\beta =$

0.15, p = .026) and no statistically significant effect at the 5% level in the remaining six (6) sectors. Lastly, the composite production input index shows a positive and statistically significant association with beverages (β = 12.03, p < .023), wood and bamboo (β = 26.11, p < .016), and nonmetallic minerals (β = 4.12, p < .001). No statistically significant association was found at the 5% level for food products, tobacco, paper products, recorded media, and petroleum. Overall, the sectoral estimates demonstrate that the relationship between renewable energy share, electricity consumption, oil prices, production inputs, and manufacturing production varies across the eight selected sectors, suggesting that the relationship between variables is sector-specific and highlighting the importance of considering sectoral differences when interpreting the aggregate findings rather than establishing causal effects.

Discussion

The study examined the relationship between electricity consumption and the renewable energy share in industrial production in the Philippines from 2005 to 2024, while accounting for oil prices and production inputs that, according to the study, combine GFCF and labor in manufacturing. The analysis was designed to determine not only whether renewable energy is associated with manufacturing production, but also whether electricity consumption serves as a pathway that provides a transmission mechanism through which changes in the energy mix may influence industrial output. In addition, this study considered the possibility that the relationship differs across manufacturing subsectors because industries vary in their energy requirements, production technologies, capital intensity, and exposure to changes in electricity conditions. Therefore, the findings are interpreted not as a single energy production relationship but as a set of aggregate, short-run, mediating, and sector-specific relationships that, together, provide evidence on how the Philippine manufacturing sector responds to changes in the energy-related variables.

The empirical findings reveal that descriptive statistics provide an initial context for interpreting the subsequent econometric results. Over the 20-year period, renewable energy accounted for an average of 26.52% of total electricity generation, while industrial electricity consumption averaged 22.65 thousand GWh and the Manufacturing Volume of Production Index averaged 74.69. These figures indicate considerable variation in both the energy mix and manufacturing activity during the study period of 2005-2024. However, because the analysis involves annual time-series data with a result of high correlation among electricity consumption and production inputs, indicating that energy use and productivity capacity have evolved closely together in the Philippines manufacturing sector, the use of descriptive statistics and static aggregate regression alone may not fully capture and analyze the relationships among the variables. Therefore, the analysis also uses cointegration and error-correction modeling to distinguish short-run dynamics from long-run relationships. The unit-root analysis showed that the variables were generally nonstationary in levels, although the evidence concerning their exact order of integration was mixed. This required the analysis to account for spurious regression and distinguish short-run movements from long-run relationships. The subsequent Johansen procedure identified three cointegrating relationships among the variables, supporting the use of the Error Correction Model to examine short-run dynamics rather than providing definitive evidence of an established long-run equilibrium mechanism.

The aggregate OLS results provide a baseline assessment of the relationship between renewable energy share, electricity consumption, oil prices, production inputs, and overall manufacturing production. The findings indicate that the composite production input index was the only explanatory variable within the static aggregate OLS specification that yields a statistically significant association with manufacturing production under the reported Newey-West inference. Among the explanatory variables of this study, the production input index was the only statistically significant predictor, indicating that greater productive capacity associated with capital and labor was strongly related to higher manufacturing output. In contrast, renewable energy share showed a positive but statistically insignificant association with manufacturing production, while electricity consumption had a negative and statistically insignificant coefficient, and oil prices likewise showed no statistically significant association with manufacturing production. These findings indicate that, at the aggregate level and within the static OLS specification, manufacturing production is strongly associated with production inputs rather than with the energy variables. This finding is similar to Faizi and Mohammad (2025), where production output in Indian manufacturing industries was most sensitive to capital, followed by labor, while energy had a comparatively smaller output elasticity, indicating that conventional productive inputs can play a stronger role in determining manufacturing output than energy inputs. Similarly, Aggarwal (2026) found that labor and electricity function as complementary inputs. However, the absence of statistically significant aggregate effects for renewable energy

share and electricity consumption should be interpreted alongside the subsequent dynamic and sector-specific analysis, which capture the short-run adjustments and differences across manufacturing industries.

The Error Correction Model findings provide central evidence on the short-run dynamics of Philippine manufacturing production. The results β= 1.12 and p= .009 indicate that changes in renewable energy share are positively and statistically significantly associated with changes in industrial production. Similarly, β= 7.59 and p<.001 indicate that changes in electricity consumption are positively and highly significantly associated with industrial production. The results of β= 12.97 and p= <.001 indicate that changes in the production input index are also positively associated with the output. These findings indicate that manufacturing activity responds not only to changes in the composition of the country's electricity supply but also to the actual availability and use of electricity and to the underlying capital and labor resources required for production. In contrast, β = 0.01 and p = .726 indicate that changes in global oil prices are not statistically significant, suggesting that annual changes in international crude oil prices did not have a distinguishable direct short-run association with manufacturing output in the estimated model. Thus, these findings suggest that the relationship between energy-related variables and manufacturing activity should be examined alongside electricity utilization and productive capacity, rather than as an isolated determinant of industrial output based on renewable energy share alone.

The empirical findings of this study reveal a positive short-run relationship between renewable energy share and industrial production, broadly consistent with studies indicating that renewable energy can contribute to industrial activity, although the magnitude and timing of the relationship vary across countries and time horizons. Hoang et al. (2020) found a positive long-run relationship between biomass energy consumption and U.S. industrial production, and showed that the relationship differed across renewable energy sources and became more pronounced during periods of crisis and economic turmoil. Similarly, Situma et al. (2025) reported that renewable energy had immediate positive effects on manufacturing output and productivity in Kenya, with additional effects emerging over subsequent periods. These findings align with the present study's positive short-run association between renewable energy share and industrial production and suggest that renewable energy can support industrial production when integrated into productive activities. However, the literature shows that the energy–production relationship is not always positive. This aligns with the study findings of Abokyi et al. (2018) and Asaleye et al. (2021), who found a negative relationship between electricity consumption and manufacturing output in Ghana and Nigeria, respectively. These differences imply that the productive effect of energy consumption depends on country-specific conditions, including grid structure and electricity-system reliability, industrial composition, and electricity use in production. Therefore, the study's findings in the Philippines suggest that the relationship between energy use and industrial output is context-dependent, rather than that an increase in renewable energy or electricity consumption automatically generates proportional growth in industrial output.

An important finding of the study concerns the proposed mediating role of electricity consumption. Although the Error Correction Model indicates that short-run changes in electricity consumption are positively associated with industrial production, the mediation analysis does not support the proposition that electricity consumption serves as the pathway through which renewable energy share affects industrial production. The results β = -0.34 and p = .006 for renewable energy share indicate a negative association with electricity consumption in the mediation specification, while the results β = -0.41 and p = .740 for electricity consumption in the production equation indicate it is statistically insignificant. Moreover, the estimated indirect effect is not statistically significant, as both the percentile bootstrap confidence interval and the bias-corrected and accelerated (BCa) confidence interval include zero. This finding suggests that, although electricity consumption and renewable energy share may each relate to manufacturing production, electricity consumption does not necessarily serve as the mechanism through which renewable energy share affects manufacturing output. Accordingly, the results did not establish that an increase in the share of renewable energy in electricity generation necessarily translates into increased electricity consumption in the manufacturing sector or higher manufacturing production through the proposed mediation pathway. The findings reflect a distinction between the composition of electricity generation and the amount of electricity ultimately utilized by industrial consumers. Renewable energy may also affect industrial productivity through other channels, including energy diversification, investment, technological adoption, enhanced energy security, and changes in electricity costs. However, these pathways were not directly examined in the present study and should therefore be regarded as plausible explanations rather than established causal mechanisms.

Furthermore, the long-run results indicate that, despite short-term fluctuations, the study variables are connected through an underlying equilibrium relationship. The Johansen cointegration test identifies three cointegrating vectors among renewable energy share, electricity consumption, industrial production, oil prices, and production inputs, indicating that these variables tend to move together over the long term. The estimated lagged error-correction coefficient was negative and statistically significant (β = -0.95, p-value < .001), justifying the use of the Error Correction Model to examine how short-run dynamic changes in the variables interact with the long-run equilibrium relationship. The error correction is negative and statistically significant, implying that deviations from the estimated long-run equilibrium are corrected rapidly; roughly 95% of the previous period's disequilibrium is eliminated in the subsequent period. Overall, although renewable energy share, electricity consumption, industrial production, and production inputs may vary in the short run, they remain linked through an underlying long-run equilibrium mechanism, suggesting a broader dynamic framework in which economic shocks are followed by swift reversion toward equilibrium.

Findings on the long-run relationship are consistent with existing empirical studies, demonstrating the interconnectedness of energy variables and industrial activity over the period. Sun and Anwar (2025) found evidence of cointegration among electricity consumption, manufacturing output, and entrepreneurship in Singapore, indicating a long-run equilibrium relationship between energy use and industrial activity. Similarly, Husaini and Lean (2015) reported that electricity consumption, manufacturing output, and electricity price were cointegrated in the Malaysian manufacturing sector, finding that electricity consumption and manufacturing output were positively related in both the short and long run. More recently, Situma et al. (2025) found evidence of long-run dynamics between renewable energy consumption and manufacturing performance in Kenya, while also reporting immediate positive effects of renewable energy on manufacturing output and productivity. These findings are consistent with the present study, which identified three cointegrating relationships among renewable energy share, electricity consumption, industrial production, oil prices, and production inputs. Evidence indicates that the connection between energy conditions and industrial output extends beyond short-term annual fluctuations, with energy consumption, energy supply composition, and productive activity remaining interconnected in the long run. The Johansen results in the present study are broadly comparable with this empirical literature, although the integration variables, sample size, and model specification vary across studies. Therefore, the comparison should be understood as contextual evidence of potentially interconnected energy systems, industrial dynamics, and prevailing economic conditions rather than confirmation of a uniform long-run relationship across countries.

The sector-specific regressions further show that the relationship between the study variables and manufacturing production varies across Philippine manufacturing industries. The analysis found statistically significant positive associations of renewable energy share with production in food products, tobacco, and paper products, whereas no statistically significant association was observed in the production of the remaining selected sectors, namely beverages, wood and bamboo, recorded media, petroleum, and nonmetallic minerals. Furthermore, electricity consumption is positively associated with production in food products and paper products but negatively associated with production in the recorded media sector. Oil prices were negatively associated with tobacco production and positively associated with nonmetallic minerals, while the production input index was possibly associated with beverages, wood and bamboo, and nonmetallic minerals manufacturing production. These differences at the 5% level suggest that manufacturing industries respond differently; variations in energy intensity, production methods, capital requirements, reliance on electricity, and firms' ability to adjust energy inputs possibly contribute to these different responses. Nevertheless, because the present study does not directly measure these sector-specific characteristics, they should be regarded as plausible explanations rather than causal determinants of the observed coefficients.

The sectoral-level findings are consistent with previous empirical research showing that the effects of study variables can vary across industries depending on production use. Das and Mahalik (2023) examined the relationship between renewable energy use and export performance across six manufacturing industries in India and found that renewable energy intensity positively affected export intensity in most industries, although the magnitude of the effect differed across industries. Emphasizing that such differences reflect the heterogeneous implications of the renewable energy transition for industry-level energy policy, particularly because industries differ in their reliance on non-renewable energy and their capacity to transition toward renewable sources. Similarly, Fizbein et al. (2020) documented heterogeneous effects of electricity use across industries and showed

that the production effects of electricity varied by industry characteristics and pre-existing energy intensity. Choi (2020) likewise found that the allocation of capital, labor, and energy resources is closely related to production output differences within manufacturing industries, indicating that t energy-market conditions alongside production inputs can influence industrial performance. Moreover, Berk and Yetkiner (2024) emphasized the role of energy, along with capital and labor, in explaining energy use in manufacturing, supporting the view that industrial energy relationships are shaped by the interaction of multiple production factors.

Conclusion

The empirical findings show that, in the aggregate OLS, the production input index was the only significant predictor, while renewable energy share, electricity consumption, and oil prices were insignificant. The Error Correction Model shows that renewable energy share, electricity consumption, and production inputs are positively associated with manufacturing production, with rapid correction of deviations from the long-run equilibrium. At the same time, the mediation results show that increased renewable energy generation does not significantly boost industrial production through electricity consumption, implying that the composition of the electricity supply and the actual use of electricity in production are distinct aspects of the energy-industry nexus. The sectoral results further reveal substantial heterogeneity; renewable energy share was positively significant with production in food products, tobacco, and paper products; electricity consumption was positively associated with food and paper products production but had a negative association with recorded media production; oil prices were negatively associated with tobacco and positively associated with nonmetallic minerals; lastly, production inputs have a positive association with beverages, wood and bamboo, and nonmetallic minerals. Overall, these findings imply that energy variables and productive inputs' contribution to industrial development depends not only on expanding renewable generation but also on the broader electricity system, firms' productive capacity, and industry-specific characteristics.

Although time-series econometric methods were used to account for non-stationarity, short-run dynamics, and long-run relationships, the relatively small number of annual observations constrains the strength of long-run inference and the ability to fully detect structural breaks, regime changes, or other changes in the Philippine energy and manufacturing system. The findings are specific to the Philippines and the 2005–2024 study period and therefore should not be assumed to apply directly to other countries, higher-frequency settings, or substantially different economic and energy-system contexts. Moreover, while the analysis uncovered significant statistical relationships in the short-run, sectoral, and error-correction models, not all relationships were statistically significant in the aggregate OLS and mediation analyses. The observed relationships should therefore be interpreted as statistical associations rather than definite causal effects. Based on the study's empirical findings, the following recommendations are proposed to enhance the contribution of renewable energy and electricity policy to Philippine industrial production.

Contributions of Authors

Author 1: Conceptualization, proposal writing, investigation, data gathering, data analysis, formal analysis, interpretation of results
Author 2: Data curation, data analysis, data gathering, formal analysis, validation, interpretation of results
Author 3: Proposal writing, data gathering, literature review, review and editing, interpretation of results
Author 4: Conceptualization, methodology, proposal writing, formal analysis, interpretation of results
Author 5: Proposal writing, data analysis, interpretation of results, visualization
Author 6: Proposal writing, data analysis, interpretation of results, visualization

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