Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

DETERMINANTS OF ELECTRICITY DEMAND ELASTICITY: A GLOBAL MIXED-EFFECTS META-REGRESSION ANALYSIS

Mohd Azim Sardan[1,2*]
Ahmad Razi Ramli[3]

[1] Faculty of Business and Economics, Universiti Malaya, Kuala Lumpur, Malaysia
(E-mail: eva180009@siswa.um.edu.my)
[2] Faculty of Business and Management, Universiti Teknologi MARA Cawangan Johor Kampus Segamat, Johor, Malaysia
(E-mail: mohda252@uitm.edu.my)
[3] Faculty of Business and Management, Universiti Teknologi MARA, Shah Alam, Malaysia
(E-mail: ahmadrazi@uitm.edu.my)
*Corresponding author: mohda252@uitm.edu.my

Article history		
Received date	**:**	12-7-2026
Revised date	**:**	13-7-2026
Accepted date	**:**	14-8-2026
Published date	**:**	15-8-2026

To cite this document:
Sardan, M. A., & Ramli, A. R. (2026). Determinants of electricity demand elasticity: A global mixed-effects meta-regression analysis. *Journal of Islamic, Social, Economics and Development (JISED),* 11 (84), 916 – 933.

Abstract: *Electricity demand elasticity is a fundamental parameter in energy economics because it informs electricity pricing, demand-side management, energy efficiency programmes, and long-term power system planning. However, reported elasticity estimates vary considerably across empirical studies owing to differences in research design, econometric methods, data characteristics, and study contexts. While previous meta-analyses have primarily focused on estimating average elasticity values, limited attention has been given to explaining the sources of heterogeneity underlying these estimates. This study addresses this gap by examining the methodological and contextual determinants of electricity demand elasticity using a global mixed-effects meta-regression framework. A database comprising 2,354 price and income elasticity estimates extracted from 113 empirical studies was constructed following the PRISMA 2020 guidelines. Separate mixed-effects meta-regression models were estimated for short-run and long-run price elasticity as well as short-run and long-run income elasticity. Moderator variables representing study characteristics, econometric specifications, functional forms, estimation methods, data structures, publication characteristics, and geographical contexts were incorporated to explain between-study heterogeneity. The findings demonstrate that heterogeneity in reported electricity demand elasticity is systematic rather than random. Methodological characteristics exert stronger influences on price elasticity estimates, whereas contextual factors play a greater role in explaining income elasticity. Furthermore, the determinants of elasticity differ across short-run and long-run behavioural responses, highlighting the importance of distinguishing adjustment horizons when synthesising empirical evidence. These findings contribute to the electricity demand literature by providing a unified framework for understanding heterogeneity in reported elasticity estimates and offer practical guidance for researchers and policymakers when selecting elasticity estimates for forecasting, electricity pricing, and energy policy evaluation.*

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

Keywords: *electricity demand elasticity; price elasticity; income elasticity; meta-analysis; mixed-effects meta-regression; energy demand; heterogeneity.*

Introduction

Reliable estimates of electricity demand elasticity are fundamental to energy economics because they underpin electricity pricing policies, demand-side management programmes, energy efficiency initiatives, investment planning, and long-term electricity demand forecasting. Governments, utilities, and regulatory agencies routinely rely on estimates of price and income elasticity to evaluate how consumers respond to changes in electricity tariffs and economic conditions. Accurate elasticity estimates therefore support evidence-based policy design, improve demand forecasting, and facilitate efficient electricity market operation.

Despite their importance, reported electricity demand elasticity estimates vary considerably across the empirical literature. Previous studies have reported substantial differences in both price and income elasticity across countries, economic sectors, time periods, estimation techniques, and data structures. For example, residential electricity demand is generally more price inelastic than industrial demand, while long-run elasticities are typically larger in magnitude than short-run elasticities because consumers require time to adjust appliance stocks, production technologies, and consumption behaviour. Similarly, income elasticity varies across stages of economic development, reflecting differences in household income, industrial structure, electrification, and market maturity. Consequently, no single elasticity estimate adequately represents electricity demand behaviour across all empirical settings.

This variation presents an important challenge for researchers and policymakers. Electricity demand models frequently adopt elasticity estimates from previous studies without fully considering the methodological assumptions and contextual conditions under which those estimates were obtained. Applying elasticity estimates derived from different countries, sectors, or econometric specifications may therefore produce biased forecasts and inappropriate policy recommendations. Understanding why reported elasticity estimates differ across studies is consequently as important as estimating the elasticity itself.

A growing body of literature has attempted to synthesise electricity demand elasticity through meta-analysis. Notable studies, including those by Espey and Espey (2004), Labandeira et al. (2017), and Zhu et al. (2018), have provided valuable evidence regarding average price and income elasticity estimates while demonstrating that methodological characteristics contribute to between-study variation. However, existing studies generally concentrate on a single elasticity type, a specific demand sector, or a limited set of moderator variables. Comparatively little attention has been devoted to jointly examining the determinants of both price and income elasticity across short-run and long-run behavioural responses within a unified analytical framework.

Selecting inappropriate or biased electricity demand elasticity parameters is not merely a statistical concern; it has profound operational and financial consequences across six critical energy policy and utility planning domains. First, in tariff-reform simulations, regulatory authorities require precise price elasticity parameters to simulate consumer responses to tariff structure revisions. Underestimating price responsiveness can result in severe under-recovery of costs if consumers reduce consumption more aggressively than predicted, whereas overestimating responsiveness can lead to rate adjustments that fail to yield the desired demand

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

modulation. Second, utility revenue forecasts are highly sensitive to elasticity assumptions. Inaccurate price elasticities lead to biased projections of utility cash flows under new rate structures, creating severe budget deficits that can jeopardize operational stability, debt servicing, and capital expenditure for infrastructure maintenance. Third, electricity demand forecasts dictate long-term power system capacity planning and generation investment. Underestimating long-run price and income elasticities leads to substantial overbuilding of capital-intensive generating and transmission assets, resulting in costly stranded capacity that increases the average cost of electricity. Conversely, overestimating elasticity leads to under-capacity, causing supply-demand gaps, frequent load shedding, voltage fluctuations, and catastrophic blackouts that stifle national economic productivity.

Fourth, the design and execution of energy subsidy reforms rely heavily on precise sector-specific and income-specific elasticities. Without accurate parameters, the removal of electricity subsidies can cause regressive financial shocks that push vulnerable low-income residential households into severe energy poverty, while failing to achieve the government's targeted fiscal consolidation. Fifth, the calibration of demand-side management (DSM) and dynamic or time-of-use (TOU) pricing programs requires localized and sector-specific short-run elasticity estimates. If regulators overestimate short-run price responsiveness, peak-shaving initiatives will under-deliver, placing sudden and unexpected strain on grid stability during peak hours and risking localized grid failures. Sixth, carbon and energy-policy assessments use elasticity estimates to model decarbonization pathways. Miscalculated price elasticities result in highly inaccurate projections of emissions reductions from carbon-pricing or renewable energy subsidies, leading to either failed national climate targets or highly inefficient allocations of green subsidies.

To mitigate these risks, researchers must move beyond arbitrary parameter selection and confront the core unresolved methodological problem in the energy economics literature. While existing estimates are heavily dependent on research design, the relative importance of methodological versus contextual sources of heterogeneity across price/income, short/long-run, and sectoral demand remains insufficiently established. By identifying whether the wide variance in reported elasticities stems primarily from systematic research design choices (such as functional forms and estimation techniques) or from empirical context (such as economic development and sectoral characteristics), this study establishes a robust, empirical framework for selecting context-appropriate parameters. This paper addresses this gap by developing a comprehensive mixed-effects meta-regression model that systematically disentangles these distinct sources of heterogeneity across short-run and long-run price and income elasticities.

The findings provide important implications for both research and policy. For researchers, the study demonstrates the value of mixed-effects meta-regression in explaining heterogeneity and provides a structured framework for future evidence synthesis in energy economics. For policymakers and electricity market regulators, the results highlight the importance of selecting elasticity estimates that are consistent with the methodological design and contextual conditions relevant to the policy environment rather than relying on average estimates reported in the literature.

The remainder of the paper is organised as follows. Section 2 reviews the literature on electricity demand elasticity, identifies the principal methodological and contextual determinants reported in previous studies, and develops the research hypotheses. Section 3 describes the research design, data collection procedures, moderator coding scheme, and mixed-effects meta-

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

regression methodology. Section 4 presents and discusses the empirical findings, including a comparative assessment of the determinants of price and income elasticity across short-run and long-run models. Finally, Section 5 concludes the study by summarising the principal findings, outlining the theoretical and policy implications, acknowledging the study's limitations, and suggesting directions for future research.

Literature Review

Understanding the determinants of electricity demand elasticity has long been a central issue in energy economics because elasticity estimates underpin electricity pricing, demand forecasting, demand-side management, and energy policy evaluation. Although a substantial empirical literature has estimated electricity demand elasticities across different countries, sectors, and time periods, reported estimates vary considerably owing to differences in research design, econometric methodology, data characteristics, and study context. Consequently, interpreting electricity demand elasticity requires an understanding not only of consumer behaviour but also of the methodological and contextual factors that influence empirical estimation. This section reviews the theoretical and empirical literature relevant to electricity demand elasticity, identifies the principal determinants of reported elasticity estimates, and develops the hypotheses that guide the empirical analysis.

Electricity Demand Elasticity

Electricity demand elasticity measures the responsiveness of electricity consumption to changes in economic variables, most commonly electricity prices and consumer income. Price elasticity reflects the percentage change in electricity demand resulting from a one-percent change in electricity prices, whereas income elasticity measures the responsiveness of electricity consumption to changes in household or national income. Together, these two behavioural parameters provide essential information for understanding electricity demand and evaluating energy policies.

Economic theory suggests that electricity demand is generally price inelastic because electricity is a necessity with relatively limited short-run substitution possibilities. Households and firms cannot immediately replace electrical appliances, production equipment, or energy-using technologies following changes in electricity prices. Consequently, short-run price elasticity is expected to be relatively small in absolute value. Over longer time horizons, however, consumers may adjust appliance stocks, adopt energy-efficient technologies, modify production processes, or change consumption habits, resulting in larger long-run price elasticity estimates (Houthakker et al., 1974; Silk & Joutz, 1997).

Income elasticity reflects a different behavioural mechanism. Increases in household income generally stimulate electricity consumption through greater ownership of electrical appliances, increased residential floor space, improved living standards, and expanded commercial and industrial activity. However, income elasticity is also expected to vary across stages of economic development. In developing economies, rising income is often accompanied by rapid electrification and increasing appliance ownership, producing relatively high income elasticity. By contrast, electricity demand in developed economies tends to approach saturation, reducing the marginal impact of additional income on electricity consumption (Filippini & Pachauri, 2004; Csereklyei, 2020).

The empirical literature generally supports these theoretical expectations but also reveals substantial variation in reported elasticity estimates. Meta-analyses conducted by Espey and

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

Espey (2004), Labandeira et al. (2017), and Zhu et al. (2018) demonstrate that reported price and income elasticity estimates differ considerably across empirical studies. While part of this variation reflects genuine differences in consumer behaviour, a substantial proportion appears to arise from differences in research methodology, econometric specification, data characteristics, and publication practices. These findings suggest that electricity demand elasticity should not be interpreted as a universal parameter but rather as an empirical outcome influenced by multiple study-specific characteristics.

The Methodological Debate: Model Specifications and Publication Bias

A primary methodological cleavage in energy economics concerns the systematic impact of study design on reported price elasticity. Historically, early research relied on naive ordinary least squares (OLS) regressions, which frequently reported over-inflated, highly elastic consumer responses. However, modern systematic reviews and meta-analyses prove that reported price responsiveness is deeply sensitive to uncorrected econometric biases. In a state-of-the-art meta-analysis, Sikl et al. (2025) synthesized 4,521 own-price elasticity estimates across 413 studies using Bayesian model averaging (BMA). Their empirical findings demonstrate that uncorrected publication selection and endogeneity significantly bias results; after correcting for these factors, the average global short-run price elasticity declines from a naive -0.231 to a bias-corrected -0.116, while long-run elasticity shrinks from -0.532 to -0.303. This confirms that consumers are far more inelastic in their short-run electricity consumption than traditional, uncorrected estimates suggest.

Furthermore, the choice of data structure and estimator plays a central role in shaping empirical elasticities. Econometric panels allow researchers to control for unobserved spatial and temporal shocks, yet they require sophisticated estimators to address cross-sectional dependence and nonstationarity. Gao, Peng, and Smyth (2021) addressed these challenges by developing a dynamic panel model applied to a large cross-country dataset of 65 nations over the period 1960–2016. Their framework successfully controlled for cross-sectional dependence, time-varying parameter heterogeneity, and nonstationarity, confirming that global price elasticities are robustly localized within a narrow range of -0.1 to -0.3, proving that ignoring cross-country panel dynamics can lead to biased, over-inflated estimates in uncorrected models.

The Contextual Debate: Consumer Saturation and Development Trajectories

In contrast to price elasticity, which is heavily shaped by methodological design, reported income elasticity is predominantly driven by structural and contextual factors, specifically the stage of national economic development. Econometric studies face a persistent debate regarding the stability of income responsiveness over time. Gao, Peng, and Smyth (2021) observed that global income elasticity of energy demand has been steadily declining since the 1990s, stabilizing within a range of 0.6 to 0.8. They attribute this downward trajectory to rising public awareness of environmental externalities post-Kyoto Protocol and extensive efficiency improvements in heavy industrial machinery.

This global decline, however, masks a stark divergence between developed and developing economic contexts. Liddle and Huntington (2020) analysed this disparity using a dynamic panel common-factor framework across OECD and non-OECD country panels. Their results reveal a powerful saturation effect in developed nations: in OECD economies, appliance ownership and building electrification are fully saturated, meaning that sustained income growth yields a near-zero marginal impact on electricity demand. In contrast, non-OECD and rapidly industrializing developing nations show high income elasticities, often treating electricity and

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

associated electrical appliance ownership as luxury goods. Consequently, applying uniform income elasticities across differing development levels severely compromises energy-demand simulations.

Household Microdata, Smart-Meter Evidence, and Cognitive Constraints

With the rapid modernization of electrical grids, recent studies have shifted focus to highly granular household-level microdata and the role of advanced metering infrastructure (AMI) in unlocking demand flexibility. This literature evaluates whether real-time pricing and billing salience can overcome behavioural inertia. Lanot and Vesterberg (2021) investigated this using unique Swedish household microdata under mandatory non-linear distribution tariffs where households are billed based on their monthly peak consumption. Despite very large marginal incentives designed to shave peak load, they estimated highly inelastic price responses. Their findings reveal that cognitive constraints, informational barriers, and tariff complexity significantly impede consumer optimization, preventing households from responding to granular, real-time price signals in the absence of automated energy management systems.
This behavioural inertia is further examined by Brännlund and Vesterberg (2021), who evaluated consumer willingness to shift loads between peak and off-peak hours under dynamic time-of-use (TOU) pricing using smart-meter data. Consistent with the cognitive constraint hypothesis, they found that while total residential consumption remains highly price-inelastic, smart-meter feedback and direct billing feedback are crucial. Without highly salient, real-time feedback mechanisms, the technical capability of smart meters remains immobilized. Therefore, unlocking residential demand flexibility requires simplifying tariff architecture and providing automated, highly visible consumption cues to bypass behavioural bottlenecks.

Methodology

Research Design

This study employs a quantitative meta-regression approach to investigate the determinants of electricity demand elasticity reported in the empirical literature. Meta-regression extends conventional meta-analysis by examining whether study-level characteristics systematically explain variations in reported effect sizes rather than simply estimating an average effect (Stanley & Jarrell, 1989; Stanley & Doucouliagos, 2012). Given the substantial heterogeneity observed in electricity demand elasticity estimates across countries, sectors, econometric specifications, and data structures, a mixed-effects meta-regression model provides an appropriate analytical framework for identifying the methodological and contextual factors contributing to between-study variation.

The analysis distinguishes between two behavioural parameters, that are price elasticity and income elasticity, and further differentiates short-run and long-run responses. Consequently, four separate mixed-effects meta-regression models are estimated: short-run price elasticity, long-run price elasticity, short-run income elasticity, and long-run income elasticity. Estimating separate models allows differences in behavioural responses and adjustment horizons to be evaluated without imposing restrictive assumptions regarding parameter homogeneity.

Data Collection and Study Selection

To ensure absolute methodological transparency, replication capability, and bias minimization, the primary literature was compiled through a systematic review process aligned with the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The literature search was executed on September 15, 2020, capturing all relevant

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

empirical studies published over a fifty-year coverage window from 1970 to December 2020. The search was conducted across two primary international academic databases: Scopus and Clarivate's Web of Science (WoS) Core Collection.

A comprehensive and standardized search string was executed within the Title, Abstract, and Keyword fields of both databases, specified as follows:

("electricity demand" OR "electricity consumption") AND ("price elasticity" OR "income elasticity" OR "elasticity of electricity demand")

The systematic search was restricted to English-language peer-reviewed journal articles, book chapters, and authoritative institutional working papers, excluding conference abstracts, review essays, and purely theoretical treatises. The search yielded an initial pool of 556 records: 355 records retrieved from Web of Science and 201 records from Scopus. These records were imported into reference management software, where 142 duplicate entries were systematically identified and removed, leaving 414 unique records for screening. The screening process was conducted in two sequential phases: first, a title and abstract screening was performed to verify thematic relevance, resulting in the exclusion of 246 records that did not model or estimate electricity demand responsiveness or focused on other energy carriers. Second, the full text of the remaining 168 articles was assessed for eligibility against strict meta-regression inclusion criteria. Studies were excluded if they did not report original, quantitative empirical elasticity estimates; lacked essential statistical information required to calculate standard errors or weights (such as t-statistics, p-values, or standard deviations); or utilized identical, duplicate datasets to previously published models in our sample. This rigorous full-text screening led to the exclusion of 55 articles, resulting in a final sample of 113 empirical studies fully satisfying all selection criteria. These 113 studies yielded a total of 2,354 discrete price and income elasticity estimates, which constitute the meta-regression database. Table 1 presents the PRISMA 2020 flow diagram.

Table 1: PRISMA 2020 Flow

PRISMA Stage	**Database Record / Exclusion Count**	**Process Description & Criteria**
Identification	Total identified: N = 556 - Web of Science: n = 355 - Scopus: n = 201	Automated keywords search within title, abstract, and keywords fields (1970–2020).
Duplicate Removal	Duplicates removed: n = 142 Records remaining: N = 414	Automated deduplication in reference manager followed by manual cross-referencing.
Screening Phase	Records screened: N = 414 Records excluded: n = 246	Screening of titles and abstracts to exclude non-empirical, irrelevant, or non-electricity articles.
Eligibility Assessment	Full-texts assessed: N = 168 Full-texts excluded: n = 55	In-depth review of full manuscripts to verify presence of standard errors, t-stats, and original data.

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

Included Studies	Final Studies: N = 113 Total Estimates: N = 2,354	Rigorous extraction of all short-run/long-run price and income elasticities and associated moderators.

Effect Size and Moderator Variables

The unit of analysis is the reported electricity demand elasticity estimate extracted from each primary study. Both price elasticity and income elasticity estimates were collected because they represent distinct behavioural responses to changes in electricity prices and income.

To explain between-study heterogeneity, each elasticity estimate was coded according to a predefined moderator framework comprising methodological and contextual characteristics. Methodological moderators describe differences in empirical research design, whereas contextual moderators capture variations in the economic and institutional environments represented by the primary studies. Table 2 summarises the moderator variables included in the analysis.

Table 2: The Moderator Variables Included in The Analysis

Category	Moderator Variable	Description
Geographical	United States	Dummy variable identifying studies conducted in the United States
	National	National-level analysis
	Developed economy	OECD/high-income economy indicator
Publication	Statistical significance	Reported elasticity statistically significant
Sector	Residential	Residential electricity demand
	Commercial	Commercial electricity demand
	Industrial	Industrial electricity demand
Methodology	OLS	Ordinary Least Squares estimation
	Panel	Panel-data estimation
	Linear	Linear functional form
	Double-log	Double-log specification
	Static	Static econometric specification
Data	Annual	Annual observations
	Aggregate	Aggregate electricity demand

The selection of moderator variables was guided by previous meta-regression studies and electricity demand literature, as well as the availability of consistently reported information across the primary studies.

Mixed-Effects Meta-Regression Model

To investigate the determinants of reported electricity demand elasticity, this study employs a mixed-effects meta-regression model. Unlike fixed-effects models, which assume a common underlying effect size, the mixed-effects specification allows true elasticity estimates to vary

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

across studies while simultaneously modelling systematic variation through study-level moderator variables. This approach is particularly appropriate because electricity demand elasticity is expected to differ across countries, sectors, econometric specifications, and study designs.

The empirical model is specified as:

$$b_j = \beta + \sum \alpha_k Z_{jk} + e_j \ \ (j = 1, 2, \dots L)$$

where b_j is the series of what coefficients reported in the jth study in literature comprised of L studies, β is the intercept or benchmark value, Z_{jk} is the variable k that measures characteristics found from the systematic review process, α_k is the meta-regression coefficient for variable k, and e_j is the meta-regression disturbance term.

The mixed-effects specification combines the advantages of fixed-effects regression with a random-effects variance component, thereby accounting for residual heterogeneity that cannot be explained solely by observed moderator variables. Parameter estimation was performed using restricted maximum likelihood (REML), which provides efficient and unbiased variance estimation under heterogeneous study conditions.

Model Estimation and Diagnostic Tests

Separate mixed-effects meta-regression models were estimated for each elasticity category to distinguish differences between behavioural responses and adjustment horizons. Estimating separate models avoids combining heterogeneous elasticity estimates that may arise from fundamentally different economic mechanisms.

Model adequacy was evaluated using several diagnostic statistics. Residual heterogeneity was examined to determine whether moderator variables adequately explained between-study variation. Wald-type tests were used to assess the joint significance of moderator variables, while individual coefficient tests identified statistically significant determinants of reported elasticity estimates.

Robustness of the Empirical Framework

Several features enhance the robustness of the empirical analysis. First, the database incorporates a large and diverse sample of electricity demand studies covering different countries, sectors, and methodological approaches, thereby improving the generalisability of the findings.

Second, the mixed-effects framework explicitly accounts for both observed moderator variables and unexplained between-study heterogeneity. This provides a more flexible and realistic representation of the empirical literature than conventional pooled meta-analysis.

Third, estimating separate models for short-run and long-run price and income elasticity enables direct comparison of methodological and contextual determinants across different behavioural responses. This comparative design represents one of the principal methodological contributions of the study because it allows heterogeneity to be examined within a unified

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

analytical framework while preserving the distinct economic interpretation of each elasticity measure.

Results and Discussion

Characteristics of the Meta-analysis Database

The final database comprised 2,354 electricity demand elasticity estimates extracted from 113 empirical studies published across a broad range of countries, economic sectors, and methodological approaches. The dataset includes both price and income elasticity estimates covering residential, commercial, and industrial electricity demand, thereby providing a comprehensive representation of the international electricity demand literature.

The primary studies exhibit considerable methodological diversity. Differences are observed in econometric estimation methods, functional forms, model specifications, data frequency, geographical coverage, and sectoral focus. Such diversity is expected because electricity demand studies have been conducted under different institutional settings, market structures, regulatory environments, and stages of economic development. Consequently, substantial between-study heterogeneity is anticipated, supporting the application of mixed-effects meta-regression rather than conventional pooled meta-analysis.

The moderator variables selected for the analysis capture both methodological and contextual characteristics identified in the literature as potential sources of heterogeneity. Methodological moderators include econometric estimation method, functional form, model dynamics, data aggregation, and publication characteristics, whereas contextual moderators represent geographical location, economic development, and sectoral differences. Together, these variables provide a comprehensive framework for explaining variation in reported electricity demand elasticity estimates.

Determinants of Price Elasticity

Table 3 present the mixed-effects meta-regression results for short-run and long-run price elasticity, respectively. Overall, the findings indicate that methodological characteristics constitute the principal determinants of reported price elasticity estimates, although several contextual variables become increasingly important over longer adjustment horizons.

Table 3: Mixed-effects Meta-regression Results for Price Elasticity

Moderator Variable	Short-run			Long-run		
	Residential	Commercial	Industrial	Residential	Commercial	Industrial
US	-0.0278	-0.0122	-0.0242	-0.1440***	-0.0926*	-0.1477**
National	0.0174	0.0067	0.0220	-0.1019**	-0.1187**	-0.0833*
Developed	0.0605*	0.0489	0.0584*	-0.1283	-0.1354	-0.1083
Nonsignificant	0.2228***	0.2238***	0.2206***	0.3438***	0.3677***	0.3192***

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

Moderator Variable	Short-run			Long-run		
Residential	0.0309*	–	–	0.1414***	–	–
Commercial	–	-0.0822***	–	–	-0.2543***	–
Industrial	–	–	0.0061	–	–	-0.0378
OLS	-0.0154	-0.0223	-0.0162	0.2004***	0.1762***	0.1916***
Linear	-0.1397***	-0.1449***	-0.1284***	-0.2524***	-0.2495***	-0.2519***
Double-log	0.0170	0.0248	0.0103	0.1026	0.1164	0.1294
Static	0.1017***	0.0919***	0.0961***	-0.1415***	-0.1467***	-0.1318**
Annual	-0.0021	-0.0066	0.0007	-0.0808	-0.0896	-0.0594
Aggregate	0.1815***	0.1784***	0.1660***	0.1727***	0.1583***	0.1499**
Panel	0.0467**	0.0391**	0.0478**	-0.1139**	-0.1066**	-0.0989**
Constant	-0.3832***	-0.3325***	-0.3608***	-0.3566**	-0.2380	-0.3117*

Notes: Dependent variable represent reported price elasticity. Short-run and long-run estimates are obtained from separate mixed-effects meta-regression models. The omitted categories correspond to the reference groups defined in Section 3. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

For short-run price elasticity, methodological variables exert consistent and statistically significant effects across the residential, commercial, and industrial sectors. Functional form, statistical reporting characteristics, model specification, data aggregation, and panel-data estimation all contribute significantly to explaining between-study heterogeneity. Studies employing linear functional forms generally report lower price elasticity estimates, whereas static specifications and aggregate data are associated with larger reported elasticities. Panel-data estimation also influences reported short-run price elasticity, indicating that econometric methodology contributes substantially to differences observed across the empirical literature.
In contrast, contextual variables exhibit relatively limited influence in the short run. Economic development is significant only for selected sectors, while geographical variables such as studies conducted in the United States or at the national level do not systematically affect reported short-run price elasticity. These findings suggest that immediate consumer responses to electricity price changes depend primarily on methodological design rather than geographical context.

The long-run price elasticity models reveal a different pattern. Several geographical variables become statistically significant, indicating that contextual characteristics become increasingly important as consumers adjust their electricity consumption over longer periods. Studies conducted in the United States and those employing national-level datasets generally report

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

lower long-run price elasticity estimates than the corresponding reference groups. This finding may reflect differences in electricity market maturity, regulatory structures, and consumer adaptation across countries.

Methodological characteristics nevertheless remain influential. Functional form continues to affect reported elasticity estimates, while static model specifications produce systematically different results from dynamic models. Similarly, estimation method becomes increasingly important in the long run, with ordinary least squares estimation producing larger elasticity estimates and panel-data estimation yielding comparatively smaller estimates. These findings highlight the importance of selecting econometric specifications that appropriately capture long-term behavioural adjustment.

Taken together, the price elasticity models demonstrate that methodological characteristics explain much of the observed heterogeneity, particularly in the short run. However, the influence of contextual characteristics becomes more pronounced over longer adjustment horizons, suggesting that long-run electricity demand is shaped by both research design and structural economic conditions.

Determinants of Income Elasticity

Tables 4 report the mixed-effects meta-regression results for short-run and long-run income elasticity. Compared with the price elasticity models, the determinants of income elasticity display a different empirical pattern, indicating that consumer responses to income changes are influenced more strongly by contextual conditions than by methodological choices alone.

Table 4: Mixed-effects Meta-regression Results for Income Elasticity

Moderator Variable	**Short-run**			**Long-run**		
	Residential	**Commercial**	**Industrial**	**Residential**	**Commercial**	**Industrial**
US	-0.0604**	-0.0639**	-0.0425	0.1146**	0.1137**	0.1151**
National	-0.0729***	-0.0815***	-0.0663**	0.1274**	0.1292**	0.1282**
Developed	-0.1087***	-0.1177***	-0.1376***	-0.0693	-0.0676	-0.0686
Nonsignificant	-0.1650***	-0.1734***	-0.1634***	-0.6312***	-0.6299***	-0.6306***
Residential	-0.0829***	–	–	0.0092	–	–
Commercial	–	-0.1266**	–	–	0.0220	–
Industrial	–	–	0.1158***	–	–	-0.0027
OLS	0.0162	0.0450	0.0194	0.1281***	0.1269***	0.1273***

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

Moderator Variable	Short-run			Long-run		
Linear	-0.1625*	-0.1114	-0.1634*	0.0239	0.0224	0.0237
Double-log	-0.0005	0.0433	0.0070	0.5325***	0.5377***	0.5353***
Static	0.0549	0.0315	0.0439	0.0100	0.0103	0.0102
Annual	0.1193*	0.1495**	0.1207*	0.1431**	0.1464**	0.1439**
Aggregate	-0.0970	-0.1208*	-0.1024	0.0813	0.0781	0.0798
Panel	-0.0726**	-0.1095***	-0.0773***	-0.2513***	-0.2490***	-0.2500***
Constant	0.6794***	0.5698***	0.6118***	0.0535	0.0517	0.0565

Notes: Dependent variable represent reported income elasticity. Short-run and long-run estimates are obtained from separate mixed-effects meta-regression models. The omitted categories correspond to the reference groups defined in Section 3. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

For short-run income elasticity, geographical location and economic development emerge as important determinants of reported elasticity estimates. Studies conducted in developed economies generally report lower income elasticity, suggesting that electricity demand becomes less responsive to income growth as markets mature and appliance ownership approaches saturation. National-level studies also tend to report smaller elasticity estimates, while industrial electricity demand exhibits greater income responsiveness than residential and commercial sectors.

Among the methodological variables, annual data frequency and panel-data estimation significantly influence reported elasticity estimates, whereas ordinary least squares estimation, static specification, and functional form exert comparatively weaker effects. Aggregate data do not systematically explain short-run income elasticity once contextual characteristics are incorporated into the model. These findings contrast with the price elasticity models, where methodological variables dominated the explanation of between-study heterogeneity.

The long-run income elasticity models exhibit the highest degree of consistency across residential, commercial, and industrial sectors. Several moderator variables display identical coefficient signs and similar magnitudes across all three models, indicating that the determinants of long-run income elasticity are highly stable. Studies conducted in the United States and those using national-level datasets generally report larger long-run income elasticity estimates, while panel-data estimation consistently produces smaller elasticity estimates. The double-log functional form and ordinary least squares estimation are associated with larger reported elasticity estimates, whereas statistical reporting characteristics remain an important determinant of heterogeneity.

Unlike the short-run models, differences across economic sectors become relatively unimportant in the long run, suggesting that sustained income growth produces broadly similar patterns of electricity demand adjustment regardless of sectoral classification. Overall, the

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

results indicate that long-run income elasticity reflects the combined influence of geographical context, econometric methodology, and long-term structural adjustment.

Comparative Analysis Across the Four Models

The comparative analysis provides the principal contribution of this study by demonstrating that the determinants of electricity demand elasticity vary systematically according to both the behavioural parameter being estimated and the adjustment horizon considered.

A clear distinction emerges between price elasticity and income elasticity. Price elasticity is influenced predominantly by methodological characteristics, including econometric specification, functional form, model dynamics, and data aggregation. In contrast, income elasticity is more strongly associated with contextual characteristics such as geographical location, national coverage, and economic development. These findings suggest that consumer responses to electricity prices and income operate through different economic mechanisms and should therefore be analysed separately.

The analysis also highlights important differences between short-run and long-run behavioural responses. Short-run elasticity estimates are affected primarily by methodological choices, reflecting the immediate influence of econometric design on measured behavioural responses. Long-run models, however, increasingly capture structural differences across countries and electricity markets, indicating that contextual factors become more important as consumers gradually adjust electricity consumption through technological change, appliance replacement, and long-term investment decisions.

Several moderator variables exhibit remarkably consistent effects across multiple models. Statistical reporting characteristics systematically influence reported elasticity estimates, supporting previous evidence that publication-related factors contribute to observed heterogeneity. Similarly, panel-data estimation consistently produces more conservative elasticity estimates than alternative econometric approaches, while differences in functional form continue to explain variation across the empirical literature.

Overall, the findings demonstrate that electricity demand elasticity cannot be interpreted as a universal parameter applicable across all empirical settings. Instead, reported elasticity estimates reflect the interaction between methodological choices, contextual conditions, and behavioural adjustment processes. Consequently, selecting elasticity estimates for policy analysis or forecasting requires careful consideration of the empirical context in which those estimates were originally obtained.

The results also provide strong empirical support for the use of mixed-effects meta-regression. By explicitly modelling study-level moderator variables while accounting for residual between-study heterogeneity, the mixed-effects framework explains systematic variation that would otherwise remain hidden within conventional pooled meta-analysis. The evidence therefore supports the central proposition of this study that heterogeneity in electricity demand elasticity is informative rather than problematic and should be analysed explicitly rather than ignored.

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

Conclusion and Implications

This study examined the determinants of electricity demand elasticity using a comprehensive mixed-effects meta-regression framework based on 2,354 elasticity estimates extracted from 113 empirical studies. Unlike previous meta-analyses that primarily reported pooled elasticity values, this study sought to explain why electricity demand elasticity estimates differ across the international empirical literature. By incorporating both methodological and contextual moderator variables into a unified analytical framework, the study provides new evidence on the sources of heterogeneity underlying reported price and income elasticity estimates.

The empirical findings demonstrate that heterogeneity in electricity demand elasticity is systematic rather than random. Across the four meta-regression models, several study characteristics significantly influenced reported elasticity estimates. Methodological characteristics, including econometric specification, functional form, estimation method, and data structure were found to be the principal determinants of price elasticity, whereas contextual characteristics, particularly geographical location and economic development, exerted greater influence on income elasticity. Furthermore, the comparative analysis revealed that the determinants of electricity demand elasticity differ between short-run and long-run behavioural responses, confirming that elasticity estimates should be interpreted within the methodological and empirical contexts in which they are produced.

The study makes several important contributions to the literature. First, it extends previous electricity demand meta-analyses by shifting the emphasis from estimating average elasticity values to explaining the determinants of heterogeneity. Second, it develops an integrated moderator framework that simultaneously considers methodological and contextual characteristics within a mixed-effects meta-regression model. Third, by estimating separate models for short-run and long-run price and income elasticity, the study provides a comprehensive comparison of behavioural responses that has received limited attention in previous research. Collectively, these contributions improve understanding of why reported electricity demand elasticity estimates differ across empirical studies and provide a stronger basis for interpreting existing evidence.

The findings also have practical implications for energy policy and electricity market regulation. Policymakers frequently rely on elasticity estimates when designing electricity pricing reforms, demand-side management programmes, energy efficiency initiatives, and long-term electricity demand forecasts. The results of this study indicate that elasticity estimates should not be transferred indiscriminately across countries, sectors, or institutional settings because their magnitude depends on the methodological approaches and contextual conditions under which they were estimated. Selecting elasticity values that are consistent with the intended policy environment will improve the reliability of policy evaluation and demand forecasting.

Despite these contributions, several limitations should be acknowledged. The analysis was restricted to moderator variables that were consistently reported across the primary studies included in the meta-analysis. Consequently, potentially important determinants such as climatic conditions, electricity tariff structures, renewable energy penetration, household characteristics, and regulatory reforms could not be incorporated systematically. In addition, although the mixed-effects meta-regression framework explained a substantial proportion of between-study heterogeneity, residual heterogeneity remained, indicating that other unobserved factors may also influence reported elasticity estimates.

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

Future research should expand the moderator framework by incorporating additional institutional, technological, and environmental variables as more comprehensive empirical evidence becomes available. Similar mixed-effects meta-regression approaches could also be applied to other forms of energy demand, including natural gas, transport fuels, renewable electricity, and integrated energy systems. Such studies would contribute to a broader understanding of consumer behaviour and support the development of more effective evidence-based energy policies.

Overall, this study demonstrates that electricity demand elasticity is not a single universal parameter but a behavioural measure whose reported magnitude depends systematically on methodological choices, contextual characteristics, and adjustment horizons. By explicitly modelling these sources of heterogeneity within a mixed-effects meta-regression framework, the study contributes to a more robust interpretation of electricity demand elasticity and provides a stronger empirical foundation for future research, electricity demand modelling, and energy policy formulation.

Acknowledgements
I would like to express my deepest gratitude to the supervisors, Prof. Dr. VGR Chandran Govindaraju and Dr. Ahmad Razi bin Ramli, for their invaluable guidance, encouragement, and unwavering support throughout the course of my research. Their expertise, patience, and constructive feedback have been instrumental in shaping this research, and I am truly grateful for their mentorship.

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

References

Anderson, K. P. (1973). Residential demand for electricity: Econometric estimates for California and the United States. The Journal of Business, 46(4), 526–553.

Brännlund, R., & Vesterberg, M. (2021). Peak and off-peak demand for electricity: Is there a potential for load shifting? Energy Economics, 102, 105466. https://doi.org/10.1016/j.eneco.2021.105466

Csereklyei, Z. (2020). Price and income elasticities of residential and industrial electricity demand in the European Union. Energy Policy, 137, 111079.

Doucouliagos, H., & Stanley, T. D. (2009). Publication selection bias in minimum-wage research? A meta-regression analysis. British Journal of Industrial Relations, 47(2), 406–428.

Egger, M., Davey Smith, G., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. BMJ, 315(7109), 629–634.

Engle, R. F., & Granger, C. W. J. (1987). Co-integration and error correction: Representation, estimation, and testing. Econometrica, 55(2), 251–276.

Espey, J. A., & Espey, M. (2004). Turning on the lights: A meta-analysis of residential electricity demand elasticities. Journal of Agricultural and Applied Economics, 36(1), 65–81.

Filippini, M., & Pachauri, S. (2004). Elasticities of electricity demand in urban Indian households. Energy Policy, 32, 429–436.

Gao, J., Peng, B., & Smyth, R. (2021). On income and price elasticities for energy demand: A panel data study. Energy Economics, 96, 105168. https://doi.org/10.1016/j.eneco.2021.105168

Glass, G. V. (1976). Primary, secondary, and meta-analysis of research. Educational Researcher, 5(10), 3–8.

Houthakker, H. S., Verleger, P. K., & Sheehan, D. P. (1974). Dynamic demand analyses for gasoline and residential electricity. American Journal of Agricultural Economics, 56(2), 412–418.

Ioannidis, J. P. A., Stanley, T. D., & Doucouliagos, H. (2017). The power of bias in economics research. The Economic Journal, 127, F236–F265.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand for money. Oxford Bulletin of Economics and Statistics, 52, 169–210.

Labandeira, X., Labeaga, J. M., & López-Otero, X. (2017). A meta-analysis on the price elasticity of energy demand. Energy Policy.

Lanot, G., & Vesterberg, M. (2021). The price elasticity of electricity demand when marginal incentives are very large. Energy Economics, 104, 105604. https://doi.org/10.1016/j.eneco.2021.105604

Liddle, B., & Huntington, H. (2020). Revisiting the income elasticity of energy consumption: A heterogeneous, common factor, dynamic OECD & non-OECD country panel analysis. The Energy Journal, 41(3), 207–229. https://doi.org/10.5547/01956574.41.3.blid

Nelson, J. P., & Kennedy, P. E. (2009). The use (and abuse) of meta-analysis in environmental and natural resource economics: An assessment. Environmental and Resource Economics, 42, 345–377.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., et al. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ, 372, n71.

Pesaran, M. H., & Smith, R. (1995). Estimating long-run relationships from dynamic heterogeneous panels. Journal of Econometrics, 68(1), 79–113.

Volume: 11 Issues: 84 Special Issue [July, 2026] pp. 916 - 933
Journal of Islamic, Social, Economics and Development (JISED)
eISSN: 0128-1755
Journal website: academicinspired.com/jised
DOI: 10.55573/JISED.118469

Rothstein, H. R., Sutton, A. J., & Borenstein, M. (2005). Publication Bias in Meta-Analysis: Prevention, Assessment and Adjustments. Wiley.

Sikl, V., Irsova, Z., Kudela, P., & Kudelova, A. (2025). Price Elasticity of Electricity Revisited: A Meta-Analysis. IES Working Papers 17/2025. IES FSV. Charles University. https://ies.fsv.cuni.cz/en/price-elasticity-electricity-revisited-meta-analysis

Silk, J. I., & Joutz, F. L. (1997). Short- and long-run elasticities in U.S. residential electricity demand: A cointegration approach. Energy Economics, 19(4), 493–513.

Stanley, T. D. (2005). Beyond publication bias. Journal of Economic Surveys, 19(3), 309–345.

Stanley, T. D., & Doucouliagos, H. (2012). Meta-Regression Analysis in Economics and Business. Routledge.

Stanley, T. D., & Jarrell, S. B. (1989). Meta-regression analysis: A quantitative method of literature surveys. Journal of Economic Surveys, 3(2), 161–170.

Zhu, X., Li, L., Zhou, K., Zhang, X., & Yang, S. (2018). A meta-analysis on the price elasticity and income elasticity of residential electricity demand. Journal of Cleaner Production, 201, 169–177.