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Received:

Nov 19, 2025

9:19 AM

GOVERNMENT OF PUERTO RICO
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PUERTO RICO ENERGY BUREAU

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| **IN RE: PUERTO RICO ELECTRIC POWER AUTHORITY RATE REVIEW** | **CASE NO.: NEPR-AP-2023-0003**<br><br>**SUBJECT**: **Informative Motion Regarding LUMA Exhibit 72** |

# INFORMATIVE MOTION REGARDING LUMA EXHIBIT 72

**TO THE HONORABLE PUERTO RICO ENERGY BUREAU, AND ITS HEARING EXAMINER, SCOTT HEMPLING:**

**COME NOW LUMA Energy, LLC** ("ManagementCo"), and **LUMA Energy ServCo, LLC** ("ServCo"), (jointly referred to as "LUMA"), and respectfully state and request the following:

1. On October 30, the Surrebuttal Testimony of Joseline N. Estrada Rivera ("LUMA Ex. 72") was filed.[1] Said testimony included LUMA's response testimonies filed by Dr. Ramón J. Cao García, Mr. E. Kyle Datta, Dr. Asa Hopkins, and Mr. Zachary Ming regarding LUMA's load forecasting methodology, rate design considerations, and the economic implications of proposed rate changes.

2. However, on October 27, 2025, the Solar and Energy Storage Association of Puerto Rico ("SESA") filed a *Motion to Resubmit Redlined Direct Testimony of E. Kyle Datta,* pursuant to the *Joint Motion on Agreements to Revise Testimonies on Solar Issues* ("Joint Motion"), filed by LUMA, SESA and Solar United Neighbors ("SUN"), on October 21, 2025, as corrected *nunc pro tunc* on October 23, 2025. The redline reflects testimony withdrawn pursuant to agreements

[1] See *Motion Submitting LUMA's Surrebuttal Testimonies (LUMA Ex. 70-72).*

between LUMA and SESA and SUN per the ruling by the Hearing Examiner regarding the scope of solar in this proceeding.

3. LUMA hereby informs that the version of LUMA Ex. 72 surrebuttal submitted on October 30th inadvertently included responses to testimony withdrawn by Mr. Datta in the redlined version of his testimony, filed October 27th.

4. Consistent with the referenced Joint Motion, LUMA respectfully resubmits Ms. Estrada's Surrebuttal Testimony.[2] The only changes made to Ms. Estrada's Surrebuttal Testimony were to remove references to Mr. Datta's stricken testimony and to remove Ms. Estrada's responses that were specific to that stricken testimony.[3]

5. For ease of reference, LUMA is also submitting a redlined version of Ms. Estrada's Surrebuttal Testimony herewith. *See* Annex 1.

**WHEREFORE**, LUMA respectfully requests that the Energy Bureau and its Hearing Examiner **take notice** of the above; and **deem** the resubmitted version of Ms. Estrada's Surrebuttal Testimony as final.

**RESPECTFULLY SUBMITTED.**

In San Juan, Puerto Rico, this 19th day of November, 2025.

**WE HEREBY CERTIFY** that this document was filed using the electronic filing system of this Energy Bureau and that electronic copies of this Motion will be notified to Hearing Examiner, Scott Hempling, shempling@scotthemplinglaw.com; and to the attorneys of the parties of record. To wit, to the ***Puerto Rico Electric Power Authority***, through: Mirelis Valle-Cancel, mvalle@gmlex.net; Juan González, jgonzalez@gmlex.net; Alexis G. Rivera Medina, arivera@gmlex.net; Juan Martínez, jmartinez@gmlex.net; and Natalia Zayas Godoy, nzayas@gmlex.net; and to ***Genera PR, LLC***, through: Jorge Fernández-Reboredo, jfr@sbgblaw.com; Giuliano Vilanova-Feliberti, gvilanova@vvlawpr.com; Maraliz Vázquez-Marrero, mvazquez@vvlawpr.com; ratecase@genera-pr.com; regulatory@genera-pr.com; and legal@genera-pr.com; ***Co-counsel for Oficina Independiente de Protección al Consumidor***,

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[2] LUMA is working with the Accion Support Team to upload the revised version of Ms. Estrada's Surrebuttal Testimony onto the Accion Evidentiary Platform.

[3] The testimony removed from Ms. Estrada's resubmitted testimony includes responses to Mr. Datta's stricken testimony on cost-shifting between NEM and non-NEM customers and whether NEM customers are adequately credited.

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*Annex 1 – Redline of Revised LUMA Ex. 72*

**LUMA Ex. 72**

**GOVERNMENT OF PUERTO RICO**

**PUERTO RICO PUBLIC SERVICE REGULATORY BOARD**
**PUERTO RICO ENERGY BUREAU**

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|---|---|
| **IN RE:**<br><br>PUERTO RICO ELECTRIC POWER AUTHORITY RATE REVIEW | **CASE NO.:** NEPR-AP-2023-0003 |

Surrebuttal Testimony of

Joseline N. Estrada Rivera
Director, Tariff & Budgets, Load Forecasting and Research, LUMA Energy ServCo, LLC

October 30, 2025

**Summary of Surrebuttal Testimony of**

**JOSELINE N. ESTRADA RIVERA**

**ON BEHALF OF**

**LUMA ENERGY LLC AND LUMA ENERGY SERVCO, LLC**

Ms. Joseline N. Estrada Rivera ("Ms. Estrada") is Director of Tariff & Budgets, Load Forecasting and Research at LUMA Energy ServCo, LLC. In her prepared Surrebuttal Testimony, Ms. Estrada presents LUMA's response to critiques by Dr. Ramón J. Cao García, Mr. E. Kyle Datta, Dr. Asa Hopkins, and Mr. Zachary Ming regarding LUMA's load forecasting methodology, rate design considerations, and the economic implications of proposed rate changes.

LUMA's forecasting methodology is built on econometric models that incorporate structural and behavioral changes in Puerto Rico's energy landscape. The core explanatory variables used in the regression models include Cooling Degree Days (CDD) to capture temperature sensitivity, monthly seasonal binary variables to account for intra-annual variation, Gross National Product (GNP) as the primary macroeconomic input, and population. While load modifiers such as energy efficiency (EE), electric vehicles (EVs), distributed generation (DG), and combined heat and power (CHP) systems are not included as explicit variables in the regression equations, their historical effects are embedded in the observed consumption data used to estimate the models. To avoid double counting, LUMA applies incremental adjustments for these modifiers in the forecast period, using FY2025 as the baseline for DG displacement and a similar approach for CHP in the industrial sector.

LUMA defends its exclusion of electricity price from the residential regression model based on both empirical evidence and practical forecasting considerations. Historical data show that electricity consumption in Puerto Rico is relatively price inelastic. In early 2023, Guidehouse and the LUMA LFR team explored the possibility of including electricity price as an explanatory variable in the forecast model. However, the analysis revealed counterintuitive correlations between historical consumption and average prices, suggesting that price was not a reliable predictor in Puerto Rico's context. Furthermore, many U.S. utilities, including those regulated by state commissions, do not include electricity price in their long-term load forecasting models. A 2016 study by Lawrence Berkeley National Laboratory found that only about half of load-serving entities explicitly modeled price elasticity. Utilities such as Portland General Electric, ISO New England, and DTE Electric have published methodologies that exclude price as a direct input, yet their forecasts are accepted by regulators and used for integrated resource planning. In this context, LUMA's decision to exclude electricity price is grounded in empirical testing, statistical rigor, and alignment with industry best practices. The model remains robust, transparent, and fit for purpose in supporting long-term planning and regulatory review.

An often-overlooked aspect of rate analysis is the composition of the electricity bill. Since 1996, the base rate has accounted for only 21% to 35% of the total bill, with the remainder driven by fuel and purchased power adjustments. These components are more volatile and influenced by external factors such as oil prices and generation availability. The base rate had not been updated since 1989 until a provisional increase was implemented in 2016. Despite this, economic indicators like GNP and disposable income did not show negative impacts, suggesting that base rate increases alone do not trigger economic crises. LUMA emphasizes that the Integrated Resource Plan (IRP), which includes lower-cost dispatchable resources, is expected to reduce long-term costs and help offset any base rate increases approved by the Energy Bureau.

Affordability concerns raised by Dr. Cao are addressed with updated 2024 data showing that average residential bills remain within the FOMB's 6% threshold under most scenarios. Low-income customers benefit from fixed-rate programs, and NEM participants are shielded from rate increases through a 1:1 retail credit. LUMA disputes the claim that electricity rate hikes will cause widespread grid defection, noting that full disconnection is economically impractical and that reliability, not price, is the primary driver of DER adoption. The company's CBES and ASAP programs aim to enhance reliability and manage DER integration.

LUMA challenges Dr. Cao's inflation projections, emphasizing electricity's small CPI weight and the dominant role of global supply chain and commodity price shocks in recent inflation trends. Historical data show that inflation remained low or negative in years when base rates increased, and recent inflation spikes were driven by external factors. LUMA argues that attributing inflation or economic decline primarily to electricity rates oversimplifies Puerto Rico's macroeconomic context.

The company also disputes the "death spiral" narrative, explaining that grid defection is limited and that most large customers remain connected for backup and flexibility. CHP adoption among industrial users is driven by reliability concerns, not cost avoidance. A 2023 Guidehouse analysis found that while 43 large customers displaced about 34 GWh/month through CHP, fewer than five fully disconnected from the grid. These customers continue to rely on centralized power for backup and operational flexibility. LUMA emphasizes that DER adoption is increasing, but the grid remains essential for most customers.

LUMA acknowledges past forecast errors, particularly in FY2023 and FY2024, and LUMA has since revised its residential and industrial models. The residential model now treats post-2020 consumption increases as a permanent structural change, driven by behavioral shifts and record-breaking heat. The industrial model was updated using a reconstitution approach that adds back historical self-generation to isolate underlying demand. These changes improve model accuracy and reflect evolving consumption patterns. The commercial model, by contrast, has demonstrated strong performance and remains unchanged.

The load forecasting improvement project, launched in 2023, is primarily aimed at the systematic evaluation of the factors driving significant variances across different customer classes. This effort focuses particularly on identifying and analyzing emerging variables that have begun to substantially impact electricity demand in recent years. The ultimate goal is to enhance the accuracy of forecasting models.

In response to Mr. Datta's testimony, LUMA defends its concerns about lost revenue ~~and cost shifting~~ under volumetric rate structures. NEM customers may underpay for grid services they still use, creating ~~cross-subsidization~~cross subsidization issues. While modern rate design tools like TOU rates can help, LUMA stresses the need to modernize tariffs to reflect cost causation and fairness. The company also highlights real marginal costs associated with DER integration, including voltage regulation, backflow protection, and transformer upgrades.

LUMA acknowledges the need for empirical data and is conducting a comprehensive load profile study to better quantify DER impacts. The company agrees with Dr. Hopkins that no additional adjustments are needed for non-programmatic EE, as these effects are already embedded in historical data. LUMA also defends its use of binary variables and exclusion of intercepts in regression models as standard econometric practice. The decision to use the 73rd percentile CDD scenario for residential forecasts is supported by recent heat trends and is better aligned with observed consumption.

The commercial model's low sensitivity to CDD and strong forecast performance justify maintaining its current specification. LUMA partially agrees with Mr. Ming's critique on load modifiers and is evaluating a revised residential model that excludes DG displacement from historical data. The company emphasizes that its forecasting approach is empirically grounded, transparent, and continuously refined. Overall, LUMA's testimony supports the validity of its models and the reasonableness of its assumptions in the context of Puerto Rico's evolving energy system.

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## I. INTRODUCTION

**Q. 1 Please state your name, business address, title, and employer.**

A. My name is Joseline N. Estrada Rivera. My business address is LUMA Energy, PO Box 363508, San Juan, Puerto Rico 00936-3508. I am the Director of Tariff & Budgets, Load Forecasting and Research for LUMA Energy ServCo, LLC ("LUMA ServCo").

**Q. 2 On whose behalf are you submitting this Surrebuttal Testimony?**

A. My surrebuttal testimony is provided on behalf of LUMA Energy, LLC and LUMA Energy ServCo, LLC (jointly referred to as "LUMA").

**Q. 3 What is the purpose of your surrebuttal testimony?**

A. To respond to several portions of the report of Dr. Ramón J. Cao García ("Cao Report") filed in this proceeding on September 8, 2025 by the Institute of Competitiveness and Economic Sustainability ("ICSE"); pre-filed testimony of Mr. E. Kyle Datta ("Datta Testimony") filed in this proceeding on September 8, 2025 on behalf of Solar & Energy Storage Association; the report of Dr. Asa Hopkins ("Hopkins Report"), consultant to the Puerto Rico Energy Bureau ("PREB"), dated October 2, 2025; and the report of Zachary Ming ("Ming Report"), consultant to PREB, dated October 6, 2025. The main purpose of my surrebuttal testimony is to respond to criticisms and mischaracterizations of my testimony, responses for information, and the load forecast used by LUMA. I will also respond to reports and statements made by others that I believe are inaccurate or provide incomplete information.

**Q. 4 Are there any exhibits attached to your testimony?**

A. Yes

**Q. 5 Please identify and enumerate those exhibits.**

A. I am sponsoring the following exhibits:

- LUMA Ex. 72.01 (Appendix 1 to my Surrebuttal Testimony)
- LUMA Ex. 72.02 (*An Analysis of the Economic Impact of Increasing the Price of Electricity in Puerto Rico*, prepared by Navigant Economics, August 19, 2016 )
- LUMA Ex. 72.03 (Improvement 5 CHP Report 2024-05-23)
- LUMA Ex. 72.04 (Improvement 5 Report - Solar PV 2024-04-29)
- LUMA Ex. 72.05 (Attachment 1 to LUMA's Response to SESA-of-LUMA-DIST-26).

**Q. 6 Did you consider any documents for your rebuttal testimony?**

A. Yes, I did.

**Q. 7 Which documents did you consider for your rebuttal testimony?**

A. In preparing this testimony, I reviewed the following documents:

- LUMA Ex. 4.0 (7.03.25) Direct Testimony Joseline N. Estrada-Rivera-Load Forecasting
- LUMA Ex. 4.03 (7.03.25) Load Forecast Modifiers FY 2025 (Excel)
- LUMA Exhibit 4.02 (7.03.25) Load Forecast 2025 Update
- PC Exhibit 58.03 – My response to PC-of-LUMA-LOAD_FOR-5

- My response to SESA-of LUMA-LOAD_FOR-3
- All documents referenced in Appendix 1, attached to this testimony as Ex. 72.01.

**Q. 8 Did you provide a response to a request for information regarding the calculations on Table 9 in your direct testimony?**

A. Yes.

**Q. 9 Please state and explain that response.**

A. In the previous estimate included in my testimony, load displacement due to Net Metering (NM) was applied uniformly across all rate classes. The methodology has been updated to more accurately reflect customer participation in the NM program. Net Metering (NM) load displacement was applied exclusively to the rate classes with customers actively enrolled in the program. Revised Table 9, inserted below, reflects this update. (Also refer to Ex. 72.05 derivation file SESA-of-LUMA-DIST-26_Attachment 1 with intact formulas for traceability.)

**Table 9. NEM Program Base Revenues Reduction (Revised)**

| FY | Base Load $ (only rates with enrolled customers) | Base load-NM (M$) (only rates with enrolled customers) | Base Load (GWh) | Base load-NM (GWh) (only rates with enrolled customers) | NM Displacement (GWh) |
|---|---|---|---|---|---|
| 2026 | 821.7 | 722.4 | 99.2 | 14,507.3 | 1,907.5 |
| 2027 | 823.5 | 705.3 | 118.2 | 14,165.1 | 2,294.0 |
| 2028 | 830.0 | 694.5 | 135.5 | 13,951.1 | 2,646.8 |

The reductions in load account for all displacements from the NM system, including both self-consumption and exported energy.

I was also asked to "explain why LUMA revenues, which only represent T&D costs, would be reduced by more than the reduction in NEM self-consumption [ KWh x the rate ($/Kwh) ] for the specific rate class." The reason why LUMA revenues would be reduced by more than the reduction due to NM displacement is because total revenues cover not only transmission and distribution expenses but also expenses associated to the Puerto Rico Energy Power Authority (PREPA), Genera, and Title III.

## II. SURREBUTTAL TO CAO REPORT

**Q. 10 On page 3 of the Cao Report, Dr. Cao stated that the equations used in his analysis did not take into account important recent developments in Puerto Rico, including the rapid growth of photovoltaic ("PV") electricity generation by resident consumers, post-COVID social trends, the adoption of combined heat and power systems ("CHP") by institutional consumers, the rise in temperatures, and other variables. Does LUMA have a response?**

A. Yes.

**Q. 11 Please state and explain LUMA's response.**

A. Dr. Cao's acknowledgment that his analysis did not incorporate several key developments in Puerto Rico, such as the rapid growth of distributed photovoltaic ("PV") generation, post-COVID behavioral shifts, increased adoption of combined heat and power ("CHP") systems, and rising temperatures, raises a significant methodological concern: the potential for Omitted Variable Bias ("OVB").

In econometric analysis, OVB arises when a model excludes variables that are both relevant to the outcome being studied and correlated with included explanatory variables.

This can lead to biased and inconsistent estimates, ultimately distorting the conclusions drawn from the analysis.

For example, failing to control seasonal temperature variation, as captured by Cooling Degree Days ("CDD"), can misrepresent electricity demand patterns. In Puerto Rico, electricity consumption, particularly for cooling, is highly sensitive to temperature fluctuations. If a model omits CDD, it may incorrectly attribute seasonal peaks in demand to other factors, such as economic activity or customer behavior, leading to flawed policy or planning conclusions.

LUMA emphasizes the importance of incorporating these evolving structural and behavioral factors into a forecast modelling of Puerto Rico's energy system. As explained later in this testimony, LUMA currently incorporates the historical impact of these variables into the development of its forecasting models for the residential and commercial customer classes. The models demonstrate strong statistical performance, with exogenous variables effectively explaining the trends in the endogenous variable (consumption). For the industrial class, this year we excluded from the historical data the load displaced by customers with CHP systems, in an effort to correct the deviation and improve the correlation with Gross National Product ("GNP").

The load forecast LUMA used to determine revenues incorporated the impact of weather and distributed generation sources, such as rooftop PV systems and CHP systems. Lines 85 to 176 of my direct testimony provide a detailed explanation of how both the distributed generation adjustments and the CDD variable were incorporated.

As a first step, LUMA developed a base load forecast using regression models, selecting CDD as an exogenous variable. CDD is a weather-related metric that estimates the energy required to maintain a comfortable indoor temperature. In other words, CDD reflects how hot it is and how much people are likely to use air conditioning, which is a major driver of electricity use in Puerto Rico. For further details, please refer to lines 160 to 176 of my direct testimony.

Then, the impact of distributed generation was applied to this base load. Additionally, a dummy variable was included in the residential model to capture the increase in residential consumption observed after the COVID-19 period. This variable represents lasting changes in how people use electricity at home, such as more time spent indoors or working remotely. This phenomenon is discussed in lines 179 to 196 of my direct testimony.

Including variables like CDD and a COVID-19-related adjustment makes LUMA's electricity demand forecast more accurate and reliable.

Additionally, households have increasingly transitioned to high-efficiency appliances, while others have integrated emerging end-use technologies such as electric vehicles, remote work infrastructure, and enhanced space cooling systems. These behavioral and technological shifts exert upward or downward trends on electricity consumption patterns. Although the model does not explicitly quantify the marginal impact of each individual driver, the inclusion of a structural dummy variable serves as a proxy to capture the aggregate effect of these exogenous changes. This adjustment improves the model's specification, enhances its alignment with observed consumption trends, and mitigates the risk of structural forecasting errors.

**Q. 12 On page 3 of the Cao Report, Dr. Cao argues that Appendix 1 to his report shows that that LUMA's "load forecasts are not valid" due to lack of information and methodological pitfalls. Does LUMA agree?**

A. No, LUMA respectfully disagrees with Dr. Cao's assertion.

**Q. 13 Please state and explain LUMA's response.**

A. LUMA applies an empirical methodology aligned with best practices used across many U.S. jurisdictions. Since 2023, as part of our forecast improvement project, LUMA, together with our consultant Guidehouse, has systematically evaluated each model to ensure that all relevant variables influencing demand are considered, leveraging the most advanced techniques in the industry.

As evidence for his assertion, Dr. Cao references "large forecasting errors resulting from LUMA's forecast equations" and "a serious lack of information and methodological pitfalls in these forecasting models." Dr. Cao provides no further evidence in his introduction supporting his assertion that LUMA's load forecasts are invalid. In the testimony that follows, LUMA will demonstrate that there is no evidence of a methodological pitfall.

**Q. 14 On page 12 of the Cao Report, Dr. Cao wrote that a "demand equation is essential to estimate how much is going to be the quantity demanded or consumed of a good or service when there are changes in the price of the merchandise, the income of the consumer, or the price of substitute or complementary goods or services." He argues that LUMA did not include "any information about estimated demand functions of electricity by customer categories," further arguing that if LUMA does not know the relevant demand equations then it cannot know what will happen to expected quantities of electricity to be consumed if requested increases in the fixed tariff rate are granted. Does LUMA have a response?**

A. Yes.

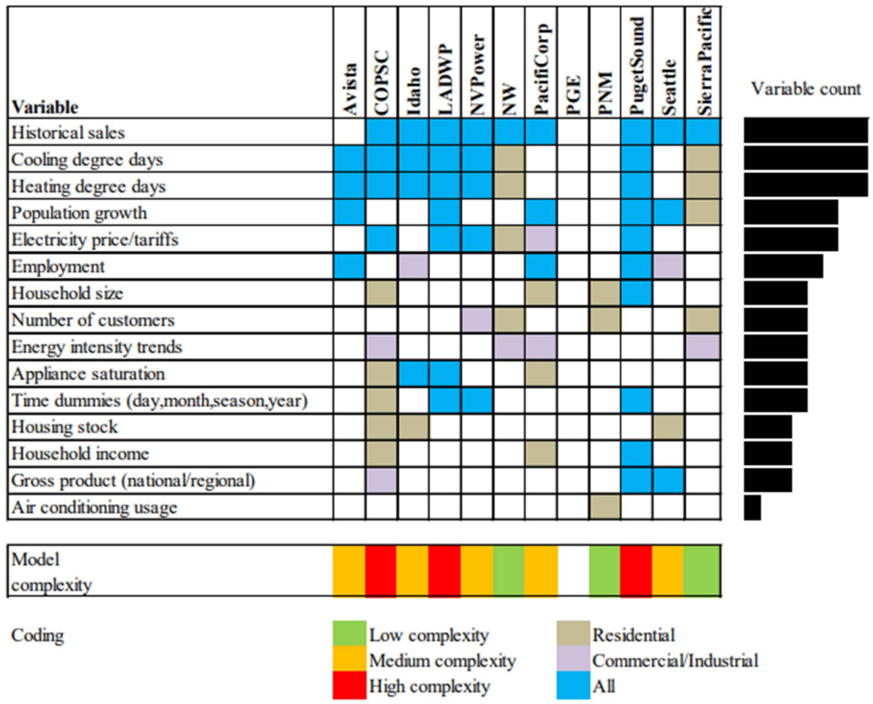
**Q. 15 Please state and explain LUMA's response.**

A. To start, other jurisdictions have accepted a similar approach to forecasts. Many mainland US utilities that use econometric methods to forecast customer energy consumption do not model electricity consumption directly as a function of its price, and these forecasts continue to be accepted by their regulators.

While Puerto Rico is indeed different from the mainland U.S. in many ways, this does not necessarily invalidate the use of similar forecasting methodologies. In fact, Puerto Rico's electricity market structure, characterized by a single transmission and distribution operator (LUMA) and a fully interconnected island-wide grid, supports the assumption of price inelasticity in the short run, as consumers have limited alternatives and remain highly dependent on grid-supplied electricity. While demand may become somewhat more elastic in the long run due to factors like increased adoption of distributed energy resources or changes in the current regulation related to the net metering program, structural constraints such as limited provider choice and continued grid reliance suggest that demand is likely to remain inelastic overall, even over longer time horizons. Unlike competitive markets where customers can switch providers or adopt alternative energy sources more freely, Puerto Rico's centralized service provision limits consumer responsiveness to price changes.

A 2016 study of IRP long-run load forecast performance documented what types of variables were included in the load forecasting methods of different utilities. *See* Carvallo, Juan Pablo; Larsen, Peter H.; Sanstad, Alan H. and Charles A. Goldman, *Load Forecasting in Electric Utility Integrated Resource Planning*, Ernest Orlando Lawrence Berkeley National Laboratory, October 2016 (Refer to Exhibit 72.01, at ¶ 1)https://eta-publications.lbl.gov/sites/default/files/lbnl-1006395.pdf. Figure 1 from that study, reproduced below, provides a visual summary from that paper identifying that: "About half of the LSEs [load serving entities] in our sample reported specific information about price elasticities…"

**Figure 1. LBNL Study of Model Variables**



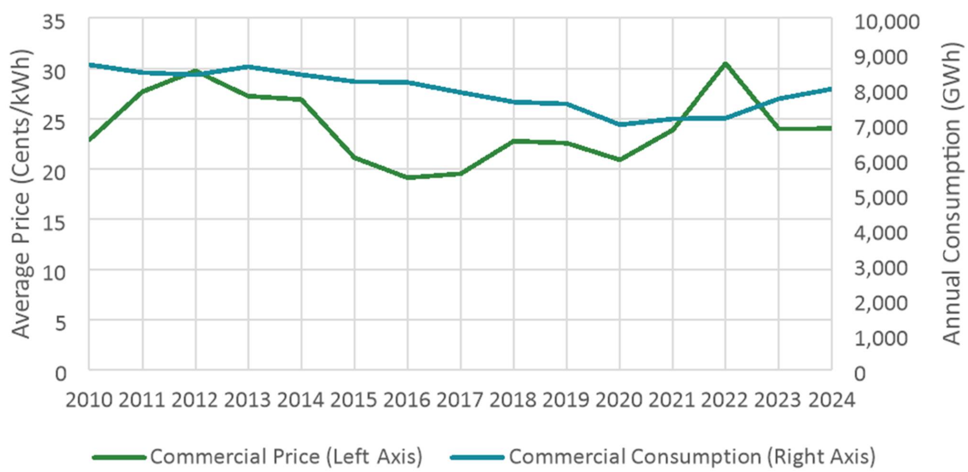

Other load forecast methodologies that were recently published and that do not model energy consumption as a direct function of prices include:

- **Portland General Electric (PGE).** Refer to Exhibit 72.01, at ¶ 2.
- **ISO New England.** See Section 3 ("Energy Forecasts") of the May 2024 Forecast Modeling Procedure for the 2024 CELT Report: ISO New England Long-Run Energy and Seasonal Peak Demand Forecasts (Refer to Exhibit 72.01, at ¶ 3).
- **DTE Electric Company.** See, for example, Q20 (PDF page 12 of 556): "How was the Residential forecast developed?" of the direct testimony of DTE's lead forecaster for Case No. U-21534 (Refer to Exhibit 72.01, at ¶ 4).

One example of a utility that does include some proxy for electricity prices in its forecasting model is ComEd. (Commonwealth Edison Company-Refer to Exhibit 72.01, at ¶ 5 - Appendix A of the document Load Forecast for Five-Year Planning Period June 2025 – May 2030). This utility includes (for the Residential class only) a variable for average monthly billed amounts.

In early 2023, Guidehouse and the LUMA LFR team explored the possibility of implementing something similar as part of LUMA's load forecast. Specifically, we assessed whether we should include price as an explanatory variable in the analysis. Following further analysis, the Guidehouse team determined that doing so would be inappropriate given the counter-intuitive correlation between historical consumption and average prices (see, for example, a comparison of average price (cents per kWh) and annual consumption for Commercial customers in Figure 2 below). Despite a steady decline in the average commercial class price between 2012 and 2017, there is also a decline in total commercial consumption. The consumption data was remediated and did not count atypical events such as Hurricane María.

**Figure 2. Comparison of Commercial Average Price and Annual Consumption**




**Previous Studies on Elasticity in Puerto Rico & Empirical Data**

Dr. Cao's concerns about the importance of understanding how customers respond to rate changes are valid. However, existing research, such as the study An Analysis of the Economic Impact of Increasing the Electricity Rates in Puerto Rico conducted for the 2017 Rate Case (refer to LUMA Ex. 72.02), provided quantitative estimates of electricity demand elasticity by customer class. While it is true that no agreement with bondholders (RSA) has been finalized and that Puerto Rico's macroeconomic conditions have evolved significantly since the study (as reflected in rising employment, wages, and business activity), these changes warrant further study rather than invalidate the original findings.

The core insight remains electricity demand in Puerto Rico is relatively inelastic. That is, while rate increases may lead to modest reductions in consumption, the overall effect is small in percentage terms. Revenue trends also do not exhibit a corresponding pattern, suggesting that electricity remains a necessary good with limited short-term responsiveness to price changes.

An often-overlooked analysis is the composition of the electricity bill. The tariff structure consists of several components. Initially, it included a base charge and a fuel charge. In 2000, with the entry of one of the independent power producers, energy purchases were incorporated. Later, in the 2017 rate case, CELI charges and government-mandated subsidies were added. Most of these subsidies, required by Puerto Rico's laws, had previously represented revenue losses.

As the recession began, oil prices rose, and energy purchases and new charges such as CELI and subsidies were introduced, the base rate component began to decline, becoming increasingly dependent on fuel and purchased power adjustments. Since fiscal year 1996, the base rate has accounted for approximately 21% to 35% of the total amount billed to customers. This component had not been updated since 1989, until the approval of a base rate increases in the 2017 rate case, which was implemented through a provisional tariff in August 2016.

Despite this increase, data from the Puerto Rico Planning Board show that key economic indicators such as GNP and real disposable personal income ("YPD") did not reflect negative impacts on the economy. Past trends indicate that an increase in the base rate alone has not led to an economic crisis in Puerto Rico. It is important to recognize that other exogenous factors, such as geopolitical events affecting fuel prices and the availability of the generation fleet, have a greater influence on major tariff components. These factors directly impact the fuel and purchased power adjustments, which are recovered through the FCA and PPCA mechanisms on the bill.

LUMA believes that, in the long term, any savings in these components resulting from the implementation of the Integrated Resource Plan ("IRP"), which includes lower-cost dispatchable resources, should help offset any rate increases approved by the Energy Bureau in this proceeding.

The dataset, as shown in Figure 3 through 5 below, spans from January 2010 to August 2025, covering over 15 years of monthly electricity pricing and consumption data across Puerto Rico's three main customer classes: residential, commercial, and industrial. It includes average electricity costs (in ¢/kWh) and average usage per customer ("UPC") for each class, offering a rich time series to examine how consumption patterns have evolved in response to price changes, economic shocks, and broader structural shifts in the energy sector.

The following figure, Figure 3, illustrates the overall impact of the cost per kWh on consumption per customer. Prior to 2020, residential electricity usage per customer in Puerto Rico was remarkably stable, showing little variation despite fluctuations in average prices. Starting in 2020, however, there is a noticeable upward shift in consumption, while average prices remained relatively stable. This suggests a structural change in household electricity use, possibly linked to lifestyle adjustments during and after the pandemic. Overall, the data supports the conclusion that residential electricity demand is price inelastic, with consumption largely unresponsive to price changes.

**Figure 3: User per Customer Residential Consumption vs Residential Average Cost c/kWh**

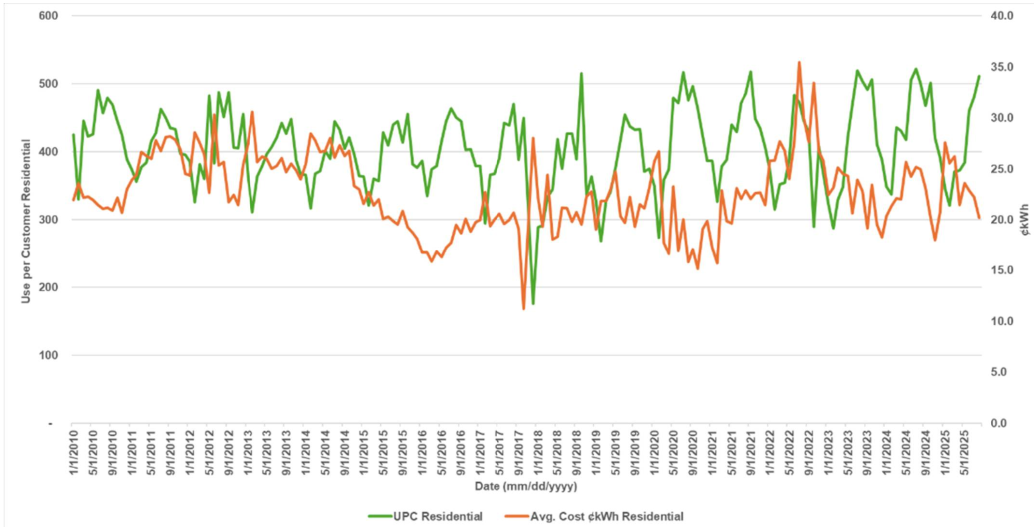
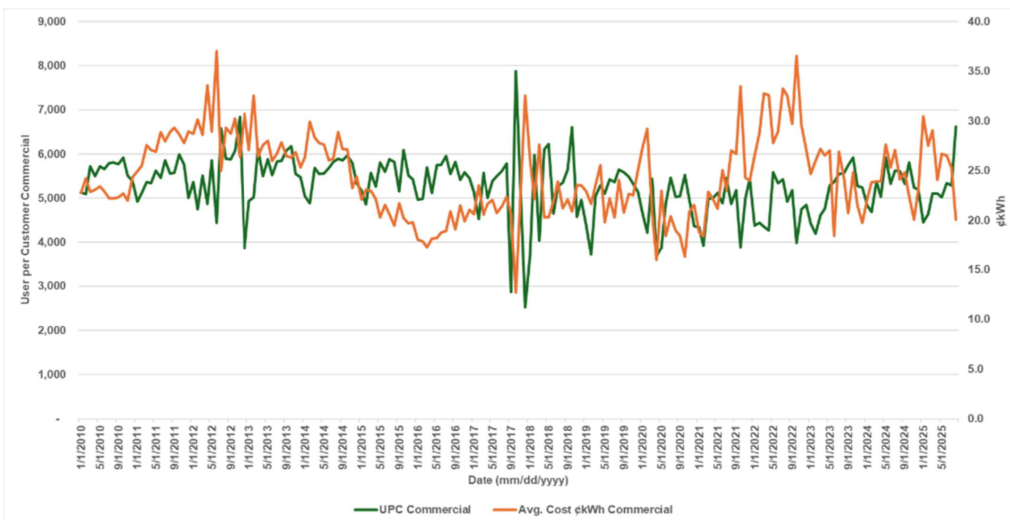
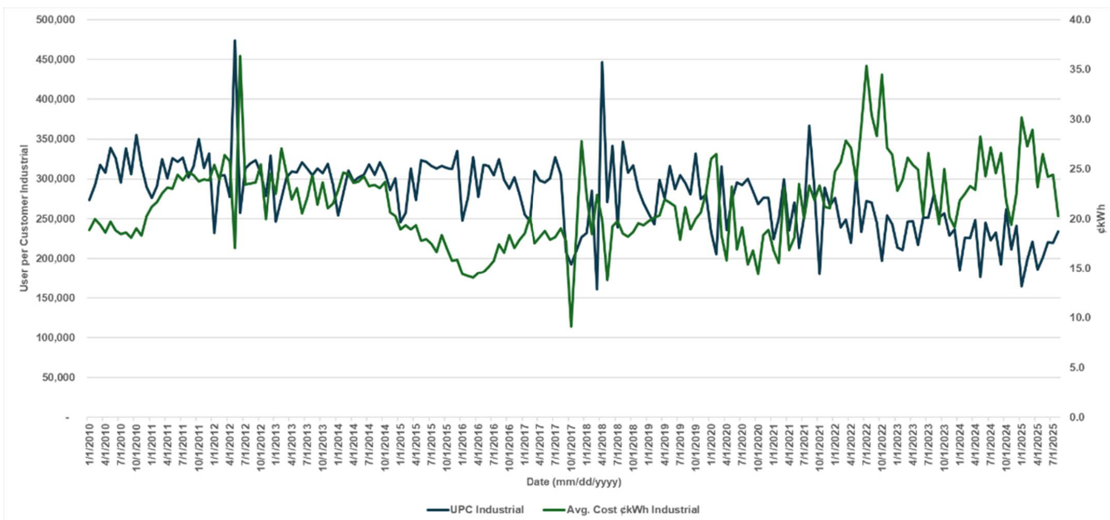



**Figure 4: User per Customer Commercial Consumption vs Commercial Average Cost c/kWh**




Based on Figure 4, commercial electricity use per customer (UPC) exhibits relatively modest fluctuations compared to the more pronounced changes in average commercial electricity prices, indicating inelastic demand. During periods of price increases, such as 2012, 2017, and 2022, commercial usage did not decline proportionally, suggesting that electricity remains an essential input for business operations. Likewise, when prices fell, consumption did not rise significantly, reinforcing the notion that demand is not highly sensitive to cost. Overall, the data implies that commercial electricity consumption in Puerto Rico is price-inelastic, with usage patterns shaped more by operational needs than by price signals.

**Figure 5: User per Customer Industrial Consumption vs Residential Average Cost c/kWh**




While industrial electricity demand, Figure 5, in Puerto Rico historically appeared price-inelastic, recent trends suggest a structural shift. Since 2021, average prices have increased while usage per customer has declined, breaking the earlier pattern of stable consumption. This divergence is likely not due to price responsiveness alone, but rather reflects a substitution effect: industrial customers are increasingly adopting on-site generation through PV systems and cogeneration to secure more reliable and cost-predictable energy during critical production periods.

This behavior represents a form of load displacement, where firms reduce their reliance on the utility by sourcing part of their electricity needs independently. Although these customers still rely on the grid, the observed reduction in metered consumption points to a changing relationship with the utility, one that will be explored further in the context of grid defection and distributed energy strategies.

**Macroeconomic Inputs Considerations**

Annual historical data indicates that, beginning with the recession in 2007 and the subsequent financial assistance received by the population, particularly through President Obama's ARRA program, the correlation between residential energy consumption and real disposable personal income (YPD) began to weaken—at times even showing an inverse relationship. Although the aid was intended to alleviate the effects of the economic downturn, it did not result in increased residential electricity consumption. In contrast, the data shows a stronger and more consistent correlation with Gross National Product (GNP) during the same period, even beyond the recession. Figures 6 and 7 illustrate the trends between consumption and both macroeconomic indicators.

**Figure 6: Residential Consumption (RGWH) and Personal Disposable Income (YPD) Constant 1954=100**

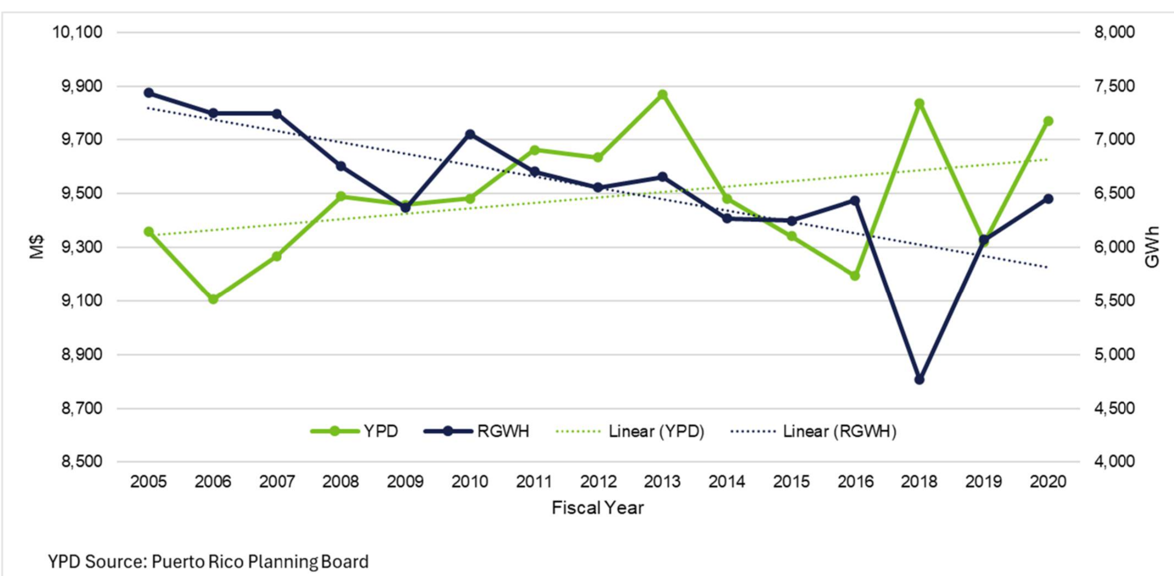
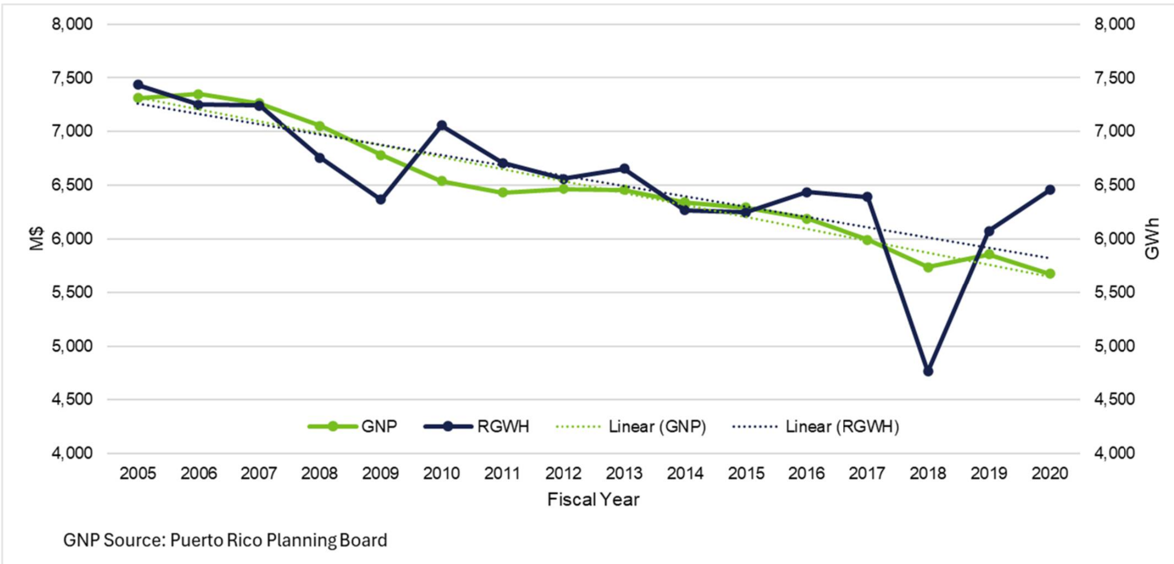


**Figure 7: Residential Consumption (RGWH) and Gross National Product (GNP) Constant 1954=100**




Figures 6 and 7 illustrate the trends between consumption and both macroeconomic indicators. While residential electricity consumption has historically shown a stronger correlation with GNP than with YPD, this relationship also aligns with the practical constraints of the forecasting process.

LUMA's forecasting methods are required to use only macroeconomic projections provided by the Financial Oversight and Management Board (FOMB), which does not publish forecasts for disposable personal income or net income. As a result, GNP is used in the regression equations as the primary macroeconomic driver.

However, while GNP may offer explanatory value in understanding historical consumption patterns, in our forecasting models it has a relatively lower impact on projected commercial and industrial consumption compared to other variables, such as sector-specific indicators or weather-related factors.

**Q. 16 On page 20 of the Cao Report, Dr. Cao wrote, "When more than two or three dummies are used in an equation, it is necessary to test for the independence of the independent variables." Do you agree?**

A. No.

**Q. 17 Please state and explain your response.**

A. All binary variables included in the models identify discrete periods of time. A binary variable is included, for example, for each month of the calendar year, to capture the conditional mean of class-level consumption specific to that month. This is standard practice in time-series forecasting. (Refer to Exhibit 72.01, at 70.01, at ¶ 6). No test of independence is required. It is fundamentally true that monthly binaries are dependent: February must always follow January.

**Q. 18 On page 20 of the Cao Report, Dr. Cao also admits that the use of dummy variables is an acceptable and useful practice in econometrics, but that their use "involves the risk of dummy variables trap," referring to the use of binary variables that are perfectly colinear with the intercept term. Does LUMA have a response?**

A. Yes.

**Q. 19 Please state and explain LUMA's response.**

A. As further explained in connection with the issue of intercepts below, LUMA's load forecasting equations excluded the intercept term for this reason and Dr. Cao's concern is unfounded. Dr. Cao also admits that not including intercepts is not unusual in forecasting models.

**Q. 20 On page 20 of the Cao Report, Dr. Cao noted that LUMA's load forecasting equations do not include intercepts. Does LUMA have a response?**

A. Yes.

**Q. 21 Please state and explain LUMA's response.**

A. Dr. Cao's report on this issue references the regression equations used by the LUMA load forecast. For convenience, the Residential model is reproduced here:

$$y_t = \sum_{m=1}^{M=12} \beta_{1,m} month_{m,t} + \beta_2 CDD_t + \beta_3 Pop_t + \beta_4 COVIDwin_t + \sum_{m=6}^{M=9} \beta_{5,m} month_{m,t} \cdot post2019_t \cdot CDD500_t + \beta_6 month_{m\in(5,10),t} \cdot post2019_t \cdot CDD500_t + \varepsilon_t$$

The first term in this equation is (as it is in all of the equations) this:

$$\sum_{m=1}^{M=12} \beta_{1,m} month_{m,t}$$

In this term, the "$month_{m,t}$" variable is defined as a set of twelve binary variables capturing monthly seasonality. This variable is equal to 1 when month of sample t is the *m*-th month of the calendar year, and zero otherwise. For example, variable $month_{1,t}$ is equal to one when month of sample t is January and zero otherwise.

The inclusion of 12 binary variables (one for each month) means that also including an intercept term would result in perfect multicollinearity, meaning that the moment matrix cannot be inverted, and that the parameter estimates would not be well-defined. This is the "dummy trap" that Dr. Cao himself cautions against. Put another way, the regression equations do not have a single intercept, but rather they have 12—a different one for each month of the year.

**Q. 22 On page 20 of the Cao Report, Dr. Cao states that LUMA's load forecasting equations "[d]o not provide estimated values for regression coefficients, not their standard deviations" and that the equations "[d]o not provide the standard goodness of fit statistics." Does LUMA have a response?**

A. Yes.

**Q. 23 Please state and explain LUMA's response.**

A. Regression outputs, including parameter estimates, standard errors, and goodness-of-fit statistics are reproduced below. Notably, in Dr. Cao's report, estimated parameter standard errors are called "standard deviations." The standard deviation is a measure of the variability of a set of observed values, while the standard error is an estimate of the precision of an estimated value. They are two different statistical concepts.

Parameter estimates for all customer classes were also included in the supporting documentation filed on July 3, 2025, under the file titled 'LUMA Exhibit 4.02 (7.03.25) – Load Forecast 2025 Update.xlsx'. The coefficients used to derive the base (unadjusted) forecast can be found in row 3 of the 'Residential 73rd Percentile', 'Commercial', and 'Industrial' tabs.

Guidehouse has included the standard summary output of each linear regression model, as produced by RStudio, the statistical computing environment used for model estimation. Figures 8 through 10 below illustrate the output.

**Figure 8. Residential Model Output.**

```
Coefficients:
                              Estimate Std. Error t value     Pr(>|t|)
cdd                             0.0568     0.0903    0.63      0.53081
cal_month_f8                  332.6355    84.8448    3.92      0.00015 ***
cal_month_f1                  231.5035    73.4917    3.15      0.00209 **
cal_month_f2                  166.5224    71.9912    2.31      0.02253 *
cal_month_f3                  224.0828    74.2429    3.02      0.00314 **
cal_month_f4                  232.9181    76.4253    3.05      0.00287 **
cal_month_f5                  274.6342    80.3916    3.42      0.00088 ***
cal_month_f6                  294.3413    81.8764    3.59      0.00048 ***
cal_month_f7                  327.5653    84.0690    3.90      0.00017 ***
cal_month_f9                  316.5475    84.0350    3.77      0.00026 ***
cal_month_f10                 303.1315    84.9352    3.57      0.00053 ***
cal_month_f11                 269.8583    77.8186    3.47      0.00074 ***
cal_month_f12                 245.9428    75.9469    3.24      0.00158 **
res_covid_winter_20_21         37.0617    11.5619    3.21      0.00175 **
population_thousands            0.0683     0.0157    4.36 0.0000290487 ***
post_2019_may_oct:cdd_over_500  0.9884     0.1538    6.43 0.0000000032 ***
cdd_over_500:post_2019_jun      0.9412     0.1875    5.02 0.0000019551 ***
cdd_over_500:post_2019_jul      1.0765     0.1729    6.23 0.0000000084 ***
cdd_over_500:post_2019_aug      0.5669     0.1404    4.04 0.0000991635 ***
cdd_over_500:post_2019_sep      0.9872     0.1644    6.00 0.0000000238 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 26.3 on 113 degrees of freedom
  (41 observations deleted due to missingness)
Multiple R-squared:  0.998,     Adjusted R-squared:  0.998
F-statistic: 2.94e+03 on 20 and 113 DF,  p-value: <0.0000000000000002
```

**Figure 9. Commercial Model Output**

```
Coefficients:
                            Estimate Std. Error t value            Pr(>|t|)
gnp_1954_millions_dollars    0.15181    0.00879   17.27 < 0.0000000000000002 ***
cdd                          0.14685    0.32732    0.45             0.65458
cal_month_f8              -318.36301  209.50720   -1.52             0.13157
cal_month_f1              -347.33590  141.08866   -2.46             0.01542 *
cal_month_f2              -251.54998  148.07793   -1.70             0.09227 .
cal_month_f3              -546.87020  175.02445   -3.12             0.00229 **
cal_month_f4              -477.46097  130.98154   -3.65             0.00041 ***
cal_month_f5              -271.78230  166.74333   -1.63             0.10605
cal_month_f6              -410.39730  139.89798   -2.93             0.00410 **
cal_month_f7              -255.06044  179.36192   -1.42             0.15792
cal_month_f9              -328.87768  174.37485   -1.89             0.06200 .
cal_month_f10             -357.07807  180.28905   -1.98             0.05020 .
cal_month_f11             -333.96129  191.28311   -1.75             0.08370 .
cal_month_f12             -498.82792  116.70211   -4.27            0.000042 ***
com_covid_binary_transitory -158.80259  34.40539  -4.62            0.000011 ***
cdd:cal_month_f1            -0.09563    0.45736   -0.21             0.83478
cdd:cal_month_f2            -0.40632    0.48929   -0.83             0.40815
cdd:cal_month_f3             0.48678    0.50320    0.97             0.33554
cdd:cal_month_f4             0.25853    0.42725    0.61             0.54639
cdd:cal_month_f5            -0.08704    0.43066   -0.20             0.84021
cdd:cal_month_f6             0.13229    0.39692    0.33             0.73957
cdd:cal_month_f7            -0.08365    0.43249   -0.19             0.84701
cdd:cal_month_f9             0.03009    0.42317    0.07             0.94345
cdd:cal_month_f10            0.10751    0.43093    0.25             0.80346
cdd:cal_month_f11           -0.00565    0.47268   -0.01             0.99049
cdd:cal_month_f12            0.31842    0.38481    0.83             0.40982
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 26.4 on 107 degrees of freedom
  (41 observations deleted due to missingness)
Multiple R-squared:  0.999,     Adjusted R-squared:  0.998
F-statistic: 3.28e+03 on 26 and 107 DF,  p-value: <0.0000000000000002
```

**Figure 10. Industrial Model Output**

```
Coefficients:
                          Estimate Std. Error t value            Pr(>|t|)
gnp_1954_millions_dollars    0.05799    0.00498   11.65 < 0.0000000000000002 ***
cal_month_f8             -139.96199   30.67937   -4.56          0.000012315 ***
cal_month_f1             -184.71584   30.87188   -5.98          0.000000023 ***
cal_month_f2             -176.58714   31.18083   -5.66          0.000000103 ***
cal_month_f3             -152.61644   30.85959   -4.95          0.000002497 ***
cal_month_f4             -168.78662   30.85275   -5.47          0.000000249 ***
cal_month_f5             -154.12112   30.61952   -5.03          0.000001713 ***
cal_month_f6             -155.45521   30.43673   -5.11          0.000001244 ***
cal_month_f7             -151.75411   30.58185   -4.96          0.000002325 ***
cal_month_f9             -149.95601   30.87594   -4.86          0.000003639 ***
cal_month_f10            -146.40652   31.28277   -4.68          0.000007600 ***
cal_month_f11            -152.33489   30.61981   -4.98          0.000002201 ***
cal_month_f12            -155.94387   30.77470   -5.07          0.000001481 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 16.2 on 120 degrees of freedom
  (41 observations deleted due to missingness)
Multiple R-squared:  0.994,     Adjusted R-squared:  0.993
F-statistic: 1.55e+03 on 13 and 120 DF,  p-value: <0.0000000000000002
```

**Q. 24 In Appendix 1 to the Cao Report, Dr. Cao reproduced Tables 2 to 7 from your direct testimony and compared LUMA's load forecasts with actual load values over time. Dr. Cao claims that this comparison demonstrates load forecasting errors ranging from -12.2% to 18.7%, and that such a margin of error is usually not acceptable in forecasting. Do you have a response?**

A. Yes. LUMA agrees with Dr. Cao's statement regarding the significant variance between the projections developed for fiscal years 2023 and 2024, which fall outside the acceptable margins of +3% or -3%. Precisely as part of the ongoing initiative to improve forecast accuracy, we proceeded to revise both the residential and industrial models for the rate review, as we will explain below.

**Q. 25 Please explain your response.**

A. The data included in my testimony, which compares actual load with the forecast, aims to demonstrate how, in recent years, the traditional exogenous variables that typically influence load have begun to lose their explanatory power relative to the evolving behavior of the load itself.

As a result, during the fiscal year, LUMA initiated an improvement project that is still ongoing, with the goal of enhancing forecast accuracy. Historically, exogenous variables have effectively explained trends in the commercial class. However, this has not been the case for the residential and industrial classes. To address this, LUMA revised the residential and industrial load forecasting models used in the rate review process.

Recently, the residential class has been significantly affected by weather conditions. Beginning in FY 2020, the impact became more pronounced due to the COVID-19 restrictions, which led many residential customers to work from home. Additionally, relief funds were used to purchase air conditioning units, which customers continue to use, especially during the current heat wave. As noted in my direct testimony (lines 409 and 469), following FY 2024, Puerto Rico experienced the highest number of cooling degree days in its recorded history. This extreme weather not only affected regular residential customers but also Net Metering customers, who increased their electricity consumption from both the grid and their self-generation systems.

Given that there have been five summers (as of February 2025) in which residential consumption has been materially higher than in pre-2020 summers, the LUMA-LFR team believes that it is now more prudent to treat this step-change not as a temporary shock, but as a permanent structural change.

This change does not impact the regression model specification. This remains the same as that provided for the 2024 PREPA fiscal plan and budget. Only the definition of one input variable, the $post2019_t$ variable, changes. This is shown below in the variable definitions. For reference, the regression model can be described in the following equation:

$$y_t = \sum_{m=1}^{M=12} \beta_{1,m} month_{m,t} + \beta_2 CDD_t + \beta_3 Pop_t + \beta_4 COVIDwin_t + \sum_{m=6}^{M=9} \beta_{5,m} month_{m,t} \cdot post2019_t \cdot CDD500_t + \beta_6 month_{m\in(5,10),t} \cdot post2019_t \cdot CDD500_t + \varepsilon_t$$

$y_t$ = Class-level billed consumption (GWh) of residential customers in month of sample *t*.

$month_{m,t}$ = A set of twelve binary variables capturing monthly seasonality. This variable is equal to 1 when month of sample t is the *m*-th month of the calendar year and zero otherwise. For example, variable $month_{1,t}$ is equal to one when month of sample *t* is January, and zero otherwise.

$CDD_t$ = Monthly cooling degree days (base 65 degrees Fahrenheit) observed in month of sample *t*. These are drawn from the National Weather Service as a monthly series for the San Juan Area.

$Pop_t$ = Estimated total population by month, derived from annual values obtained by LUMA from the U.S. Census.

$COVIDwin_t$ = A binary variable capturing the impact of COVID on consumption in the winter after the emergence of COVID to account for forecast over-prediction during the winter months. This variable is equal to one in the period beginning November of calendar year 2020 running through to the end of April of calendar year 2021, and zero otherwise.

$post2019_t$ = A binary variable capturing the step-change in Residential consumption starting in calendar year 2020. This variable is equal to one in calendar years 2020 and later, and zero otherwise. This variable is always multiplied by $CDD500_t$ and a monthly binary variable in the equation above. It controls for the observation by Guidehouse and the LUMA LFR team that after 2019, Residential customers appear to be more sensitive to higher temperatures. In combination with the monthly binary and CDD500t, it acts as a spline, meaning it lets the model treat very hot months differently. When monthly CDD are higher than 500 in the month identified by the monthly binary, then there is an incremental increase in consumption.

$CDD500_t$ = The number of monthly cooling degree days observed in month of sample *t* higher than 500. This variable takes a zero in months with cooling degree days under 500. These are drawn from the National Weather Service as a monthly series for the San Juan Area. This variable captures the observation that the relationship between consumption and CDD changes at higher values of CDD, and that (for example) an increase of one CDD from 450 to 451 will result in a smaller consumption increase than an increase of one CDD from 550 to 551.

$month_{m\in(5,10),t}$ = A binary variable to account for differences in consumption in May or October after the start of COVID. This variable is equal to one if month of sample *t* is either the fifth or the 10th month of the calendar year (May or October), and zero otherwise. That is, the parameter associated with the group of variables that begins with this one captures the post-2019 temperature-sensitive "bump" to residential consumption for the months of May and October. The model assumes that this relationship is the same for both May and October.

$\beta_{1,m}$, $\beta_2$, $\beta_3$, $\beta_4$, $\beta_{5,m}$, $\beta_6$ = Regression-estimated parameters (coefficients).

The result of the climatic change when incorporated in the regression model is that forecast monthly consumption no longer declines between the summers of calendar years 2024 and 2028 to revert to the pre-2020 pattern but instead remains at its post 2020 level.

Industrial customers, as discussed in my direct testimony, have been affected by the adoption of CHP systems. For the rate review, LUMA updated the industrial model to account for this factor and to produce a more accurate forecast. Some changes were applied to control for the rapid growth in self-generation from the CHP. The approach developed by Guidehouse estimated historical self-generation volumes to modify the historical industrial consumption used to estimate the industrial regression model. Including self-generation directly within the regression model will help to generate a projection of industrial consumption as if no self-generation was being used. This creates a cleaner baseline that reflects total underlying demand, allowing the model to isolate the true relationship between electricity use and its drivers without distortion from self-generation. This forecast would then be adjusted using an estimate of the self-generation associated with the cumulative installed self-generating capacity instead of (as previously) the incremental capacity.

Previously, when historical self-generation was relatively modest, it was not explicitly controlled either in the data or in the regression specification. The effects of such generation (when they are small) would be reflected in the estimated parameters, and any incremental generation in the forecast period would be controlled for by applying the forecast load modifiers. Because the volume of self-generation has grown so rapidly, the volume of the estimated load that has been displaced (historically) by self-generation is added back in to the consumption before the regression is estimated. This means that the load modifiers that are applied must be based on the total accumulation of self-generation, and not just the incremental adoption.

This methodology is consistent with how many jurisdictions in North America account for energy efficiency (EE) and demand side management (DSM) programs within load forecasting. For example, Independent System Operator for New England (ISO-NE) modifies observed loads, adding back in historical estimates of EE, demand response (DR), and photovoltaic (PV) self-generation in a process referred to as "reconstitution." Regressions are estimated using these reconstituted data, providing the "gross" forecast, which is subsequently adjusted (similar to LUMA's procedure) by applying forecast EE, DR, and PV to the gross forecast. See ISO New England Inc., *Forecast Modeling Procedure for the 2024 CELT Report: ISO New England Long-Run*

*Energy and Seasonal Peak Forecast*, May 2024 (available at https://www.iso-ne.com/system-planning/system-forecasting/load-forecast).

The Pennsylvania-New Jersey-Maryland Interconnection (PJM) also reconstitutes loads served by PV self-generation or offset by demand response prior to estimating its regression models. See Itron, prepared for PJM, *2022 Model Review: Final Report, 2022* (available at https://www.pjm.com/-/media/DotCom/planning/res-adeq/load-forecast/pjm-model-review-final-report-from-itron.pdf).

Using the inputs for the LUMA self-generation load modifier forecast, Guidehouse developed a "backcast" of estimated historical self-generation-displaced load. The backcast is the set of values applied to historical observed consumption to reconstitute gross load. The backcast approach is used rather than the empirical estimates of displaced load, developed previously by Guidehouse, to ensure consistency between backward and forward-looking assumptions regarding customer self-generation.

The backcast is estimated using the following three inputs:

**Self-generation capacity (kW).** The LUMA LFR team maintains a set of estimated values for the installed capacity of individual industrial customers' generation.

**Capacity Factor (%).** The LUMA LFR team's load modifier workflow applied a capacity factor of 72% for its forecast of FY2025 self-generation. Guidehouse understands this value was provided to LUMA by Siemens and has used this value for the backcast. For the budget forecast to be developed in early 2025, the Load Forecasting and Rates (LFR) team has elected to apply a 72% capacity factor through FY2025. For FY2026 through FY2028, capacity factors were derived based on current consumption patterns observed among CHP customers. The methodology is detailed in my direct testimony at lines 230 and 246, with supporting documentation provided in the response to PC Exhibit 58.03, PC-of-LUMA-LOAD_FOR-12, and the complete set of formulas available in LUMA Exhibit 4.03 (7.03.25) – *Load Forecast Modifiers FY2025*, specifically in the 'CHP CF customer' tab, cells B3 to G190.

**Self-Generation Install Date.** Guidehouse used one of three sources to determine the self-generation install date for each customer.

In each month the displaced load for each self-generating customer was estimated using the following equation:

**Equation 1. Backcast Calculation**

$$z_{i,t} = capacity_i \cdot capFactor \cdot hours_t$$

$z_{i,t}$ = The estimated displaced load from self-generation for customer *i* in month *t*.

$capacity_i$ = The installed generation capacity for customer *i.*

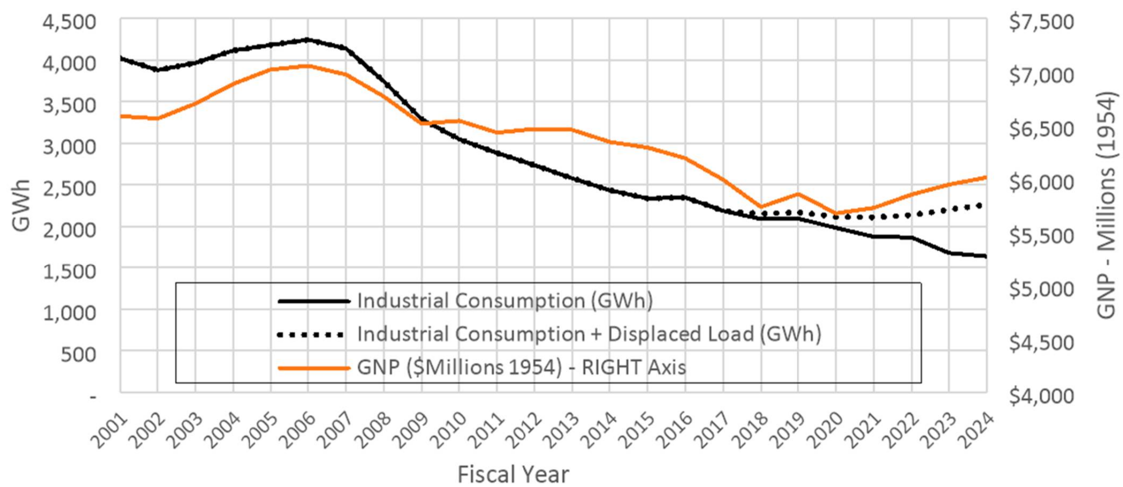
$capFactor$ = Assumed capacity factor (72%).

$hours_t$ = The number of hours in month *t* (if the generation was installed in month *t* then the number of hours in the month after the installation date).

Figure 11, reproduced below, compares observed historical consumption (solid black line) with historical reconstituted consumption (i.e., with historical displaced load added back in), the dotted black line, and with historical GNP (orange line, right axis).

Once the backcast is added to historical industrial consumption to create the reconstituted industrial load, it is once more closely correlated with GNP (i.e., both are increasing in the period since FY2021).

**Figure 11. Industrial Consumption, GNP, and Industrial Consumption + Displaced Load**




After adding the backcast of historical self-generation back into historical industrial loads (i.e., creating a "reconstituted" gross industrial load), Guidehouse re-estimated the industrial forecast regression model. Re-estimating the Industrial forecast model included two updates:

1. Adding the backcast historical self-generation to historical industrial consumption, as described above.

2. Removing the Industrial binary from the regression model, as described above.

Because historical Industrial consumption controls for historical self-generation, there is no longer a need for the Industrial binary within the regression model. The Industrial binary was included within the Industrial forecast as a temporary solution to account for the step-change in Industrial consumption starting in March of 2022. The correction applied by the inclusion of the backcast displaced load renders the binary variable obsolete. Additional information regarding the Industrial binary is included in Appendix A. Industrial Forecast Context.

Due to an unintentional error, the industrial equation included in my direct testimony was the one used in previous years. The following equation is the current one that was used to derive the industrial consumption forecast:

$$y_t = \sum_{m=1}^{M=12} \beta_m month_{m,t} + \beta_2 GNP_t + \beta_3 indBinary_t + \varepsilon_t$$

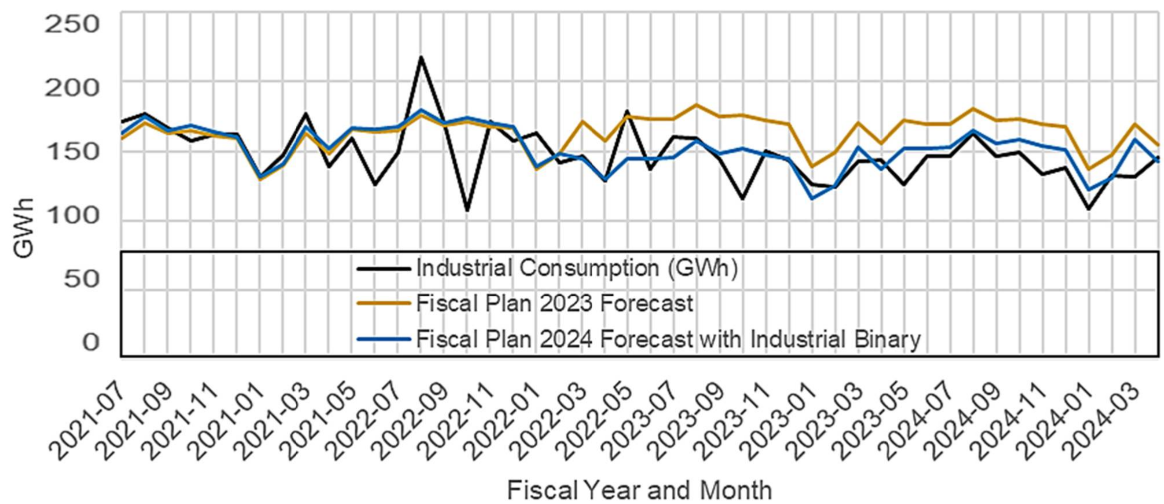
$indBinary_t$ = A binary variable capturing the step-change in Industrial consumption starting in March of 2022. This variable is equal to one if month *t* is March of calendar year 2022 or later, and zero otherwise.

$\beta_3$ = Regression-estimated parameter (coefficients).

And all other variables are as defined above.

The outcome of this model is shown in Figure 12 below. In this diagram, the black line represents actual observed industrial consumption, the yellow line represents the forecast using the previous model, and the blue line represents the forecast using the current model.

**Figure 12. Industrial Consumption, Fiscal Plan 2023 and 2024 Forecast**




**Q. 26 On page 7 of the Cao Report, Dr. Cao concludes that the proposed electricity rate increases in Puerto Rico would significantly exceed the affordability threshold set by the FOMB, which recommends that electricity costs not surpass 6% of household income. Using 2023 data, though, Dr. Cao concludes the average residential bill already exceeds this threshold on average and posits that the proposed rate increases would cause the burden to rise to 10.1% of median income under the "optimal" approach and 8.7% under the "constrained" approach. Dr. Cao argues this would disproportionately harm low-income households, encourage grid defection, and accelerate a financial "death spiral." Does LUMA have a response?**

A. Yes.

**Q. 27 Please state and explain LUMA's response.**

A. Dr. Cao raises valid concerns about affordability, but his conclusion that proposed rate increases would significantly exceed the FOMB's 6% affordability threshold does not fully reflect Puerto Rico's residential rate structure or the protections in place for low-income households. Using updated 2024 data, the average residential customer under current FY25 rates pays about $1,175 annually, roughly 4.3% of the median household income of $27,213, well below the 6% threshold. Even under the constrained scenario ($0.32/kWh), the average burden rises only to 5.9%, remaining within the recommended limit. Only under the optimal scenario ($0.37/kWh) does the average burden reach 6.9%, slightly exceeding the threshold.

These averages also overstate the impact on the most vulnerable customers. Many low-income households are enrolled in fixed-base or subsidized rate programs that cap monthly bills, often between $30 and $50, regardless of consumption. As a result, their electricity burden as a share of income is typically lower than the overall average and is largely insulated from the full effect of rate increases. Dr. Cao himself acknowledges that his affordability calculations do not account for these subsidies, which means his estimate of the burden on low-income customers is overstated.

Moreover, Dr. Cao's analysis does not account for net energy metering ("NEM") customers, who are credited at a 1:1 retail rate for energy exported to the grid. These customers are less exposed to rate increases and, in some cases, may even benefit from higher rates through increased credit value. This undermines the claim that rate hikes uniformly harm all customers or inevitably accelerate grid defection.

Finally, Dr. Cao uses 2023 income data, whereas LUMA's analysis relies on 2024 median household income, which better reflects current conditions. Even modest income growth can materially improve affordability ratios. Taken together, these factors show that under most scenarios average residential customers remain within or near the FOMB's affordability threshold, and that low-income protections and NEM policies significantly reduce the impact of rate increases on the most vulnerable and on solar-adopting customers.

**Q. 28 On page 8 of the Cao Report, Dr. Cao asserts that proposed electricity rate increases in Puerto Rico would significantly raise the cost of intermediate inputs across key industrial sectors, with the most pronounced impacts on wholesale and retail trade, government, manufacturing, mining and construction, and other services. Dr. Cao believes that, as a result, the costs are likely to be passed on to customers, claiming it could result in emigration, worsen fiscal strain on the government, erode competitiveness in the export market, and exacerbate the housing deficit. Does LUMA have a response?**

A. Yes.

**Q. 29 Please state and explain LUMA's response.**

A. Dr. Cao's concerns about rising electricity costs in key sectors such as manufacturing, construction, and commerce are understandable, but they overstate the risk of widespread grid abandonment or an economic collapse.

The evidence to date shows that commercial and industrial customers (Figures 13 and 14) are responding primarily through partial load displacement rather than full defection. For commercial customers, the 1:1 NEM credit structure creates a strong economic incentive to remain grid-connected, since it allows them to offset usage at the full retail rate and substantially lower their bills while still benefiting from grid reliability.

**Figure 13. Commercial consumption and cost per kWh**

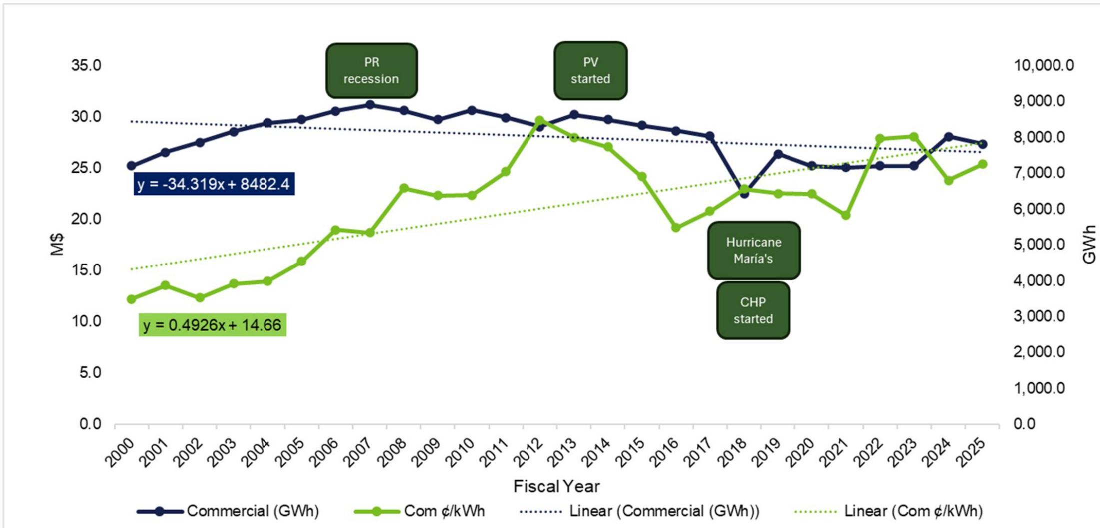
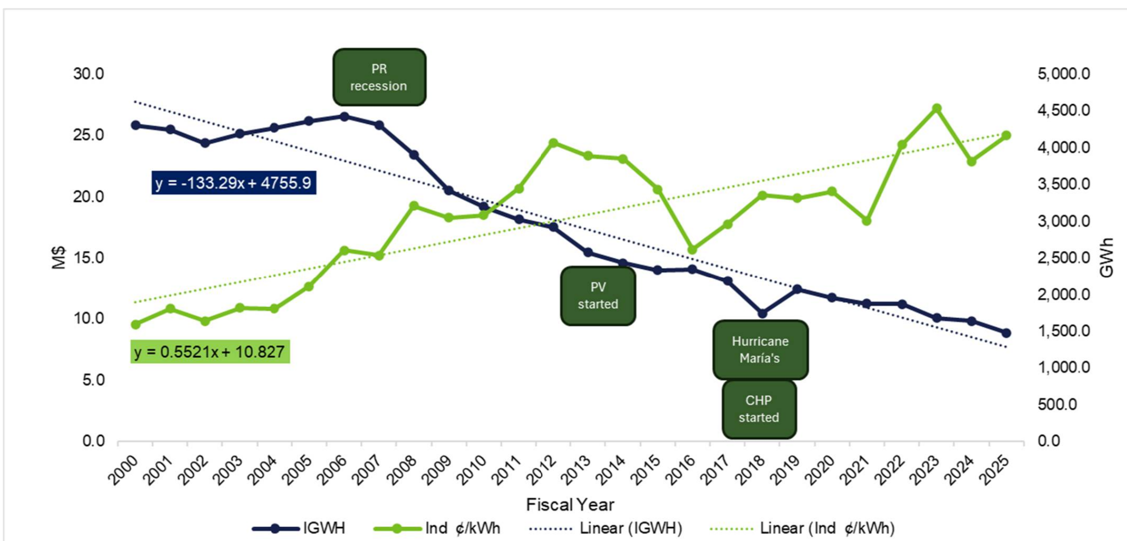



**Figure 14. Industrial consumption and cost per kWh**




On the industrial side, a 2023 Guidehouse analysis found that 43 large customers displaced about 34 GWh per month through combined heat and power (CHP) systems, yet fewer than five fully disconnected from the grid (please refer to LUMA Ex. 72.03). Most continue to rely on centralized power for backup and operational flexibility, underscoring the grid's ongoing importance even for heavy self-generators. These patterns indicate that although DER adoption is increasing, Puerto Rico's grid remains an essential part of the energy distribution.

Dr. Cao raises important concerns about the potential for electricity rate increases to contribute to broader economic challenges such as emigration, housing shortages, and fiscal strain. While higher electricity rates may increase operating costs for some sectors, the evidence suggests that many commercial and industrial customers are adapting through energy efficiency improvements and by leveraging rate design mechanisms, such as NEM and behind-the-meter generation, not only to maintain operational reliability, but also to reduce electricity costs or even generate new revenue streams. These adaptive strategies reduce the likelihood of full cost pass-through to consumers. Moreover, structural challenges like housing deficits, migration trends, and fiscal pressures are shaped by a complex mix of factors, including demographic shifts, state and federal policy, macroeconomic conditions, limited construction activity, and rising input costs (e.g, pharmaceutical raw materials, cement, equipment). Migration, for example, is more closely tied to long-term economic opportunity and industrial development than to utility rates alone. Attributing these systemic issues primarily to electricity prices overstates their role and overlooks the broader economic context in which they occur.

Dr. Cao based his conclusion on Input-Output (I-O) model which is a widely used tool for estimating the total economic impact, direct, indirect, and induced, of a change in demand. The I-O model is a quantitative economic analysis tool that represents the supply-chain dynamics between different sectors of an economy. It uses a matrix format to show how the output from one industry (e.g., steel) becomes an input for another (e.g., construction), allowing them to trace how changes in one sector ripple through others.

However, the methodology is inherently static, relying on fixed technical coefficients derived from historical data. In this case, the Input-Output matrix being used was last updated in 2013, meaning it does not reflect over a decade of economic, technological, and structural changes. While this version is outdated, it is important to note that a more recent I-O matrix from 2017 is available.

Although still not fully up to date, the 2017 matrix may offer a more accurate reflection of Puerto Rico's evolving economic landscape, including industrial composition, labor market dynamics, or other macroeconomic shifts occurring within the island. Choosing to rely on an even older version, such as the 2013 matrix, increases the likelihood of producing biased or less representative results, particularly when evaluating the economic impacts.

These coefficients assume that the structure of production remains unchanged over time, holding consumer preferences, government policies, technologies, and relative prices constant. The model also assumes no substitution between inputs in production and excludes broader general equilibrium effects, such as offsetting gains or losses in other sectors or regions.

In today's rapidly evolving economic environment, these assumptions are increasingly unrealistic and can lead to misleading conclusions.

When the underlying I-O data is outdated, the resulting analysis can be significantly flawed. Key risks include:

1. Flawed multiplier estimates: multipliers derived from obsolete economic relationships may overstate the impact of expansionary policies or investments. For example, they may not reflect modern production processes that are more efficient and require fewer inputs.
2. Distorted investment assessments: economic impact assessments for projects such as infrastructure development may be inflated if based on an outdated industrial structure. This can lead to misallocation of resources and poor policy outcomes.
3. Rigid production functions: outdated I-O models assume that industries use the same combination of inputs to produce outputs, regardless of technological change. This assumption fails to reflect the evolving nature of production processes.

Technological progress continuously reshapes the structure of production (Refer to Exhibit 72.01, at ¶ 15). When I-O matrices are not updated to reflect these changes:

1. Production coefficients become inaccurate, as they assume constant input proportions across sectors.
2. Emerging industries and products are excluded, leading to underrepresentation of dynamic sectors. For example, despite acknowledging significant changes in Puerto Rico's energy landscape, including solar adoption, remote work, and combined heat and power (CHP) systems, these developments are not captured in decades-old I-O tables.

3. Technological stagnation is implied, as the same production technology is assumed across all outputs of an industry (Refer to Exhibit 72.01, at ¶ 16).
4. Production functions become outdated, representing a weighted average of inputs for primary and secondary products that no longer reflect current practices.

Even when inflation adjustments are applied, the relative weights used, such as those from the Consumer Price Index, may be based on benchmarks as old as 2006, further compounding inaccuracies.

Over time, the structure of the economy changes significantly (Refer to Exhibit 72.01, at ¶ 17):

1. Sectoral shifts occur, with services often gaining prominence over manufacturing. An older Input-Output table may overemphasize manufacturing while understating the economic impact of the modern service industry. The same quantity of inputs is needed per unit of output, regardless of the level of production (Refer to Exhibit 72.01, at ¶ 18).
2. Consumption patterns change, and fixed household spending assumptions may no longer reflect reality, leading to poor estimations of induced effects.

Finally, I-O models assume unlimited availability of inputs, raw materials, and labor (Refer to Exhibit 72.01, at ¶ 15). This assumption may not be held in real-world scenarios, particularly when analyzing large-scale impacts or supply-constrained environments.

In conclusion, while I-O models remain a valuable analytical tool, their effectiveness is severely compromised when based on outdated data. Policymakers and analysts must exercise caution and ensure that the data used reflects the current economic structure, technological landscape, and consumption behavior.

**Q. 30 On pages 10 and 11 of the Cao Report, Dr. Cao argues that increasing electricity rates will directly raise intermediate costs across all industrial sectors, leading to higher consumer prices and contributing to cost-push inflation in Puerto Rico. Dr. Cao describes the disruptive effects of inflation, such as distorted resource allocation, reduced investment and savings, increased income inequality (especially harming those on fixed incomes), and greater social and labor instability. Using official expenditure weights, Dr. Cao estimates that the Consumer Price Index (CPI) would rise by 3.0% under the "optimal" rate increase scenario and by 1.8% under the "constrained" scenario, both significantly above Puerto Rico's recent average inflation rate of 1.5%. Dr. Cao believes that even the lower scenario would more than double the typical inflation rate, and the higher scenario would triple it, noting that these electricity-driven price increases would coincide with recent federal import tariff hikes, further compounding inflationary pressures in an economy heavily reliant on imports. Does LUMA have a response?**

A. Yes.

**Q. 31 Please state and explain LUMA's response.**

A. Although increases in electricity rates can contribute to cost-push inflation, the evidence contained in the appendices cited by Dr. Cao suggests that the direct impact on Puerto Rico's CPI is far smaller than Dr. Cao estimates. According to Appendix 5, electricity accounts for only 2.84% of the CPI basket, one of the smallest weights among all categories, while housing, transportation, and food dominate the index. Even a very large electricity price increase would therefore translate into a relatively modest direct effect on the CPI. To reach a 3% increase in the index from electricity alone would require either implausibly large rate hikes or unsubstantiated assumptions about economy-wide multiplier effects.

Historical data for Puerto Rico suggests that while electricity rate increases can contribute to cost-push inflation, the relationship is not straightforward or consistently observed. Notably, in 2017, a year in which the electricity base rate increased, inflation remained subdued or even declined in the following fiscal and calendar years. For instance, fiscal year inflation was just 0.6% in 2017 and 0.0% in 2020, while calendar year inflation was 1.8% and -0.5%, respectively.

| Inflation Rate (y-o-y) | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|---|---|---|---|---|---|---|---|---|
| Fiscal Year | 0.6% | 1.6% | 0.5% | 0.0% | 0.2% | 4.6% | 5.4% | 2.4% |
| Natural Year | 1.8% | 1.2% | 0.1% | -0.5% | 2.4% | 6.1% | 3.4% | 2.0% |

Source: Puerto Rico Department of Labor (2025)

The more pronounced inflationary pressures observed in 2022 and 2023, with calendar year inflation reaching 6.1% and 3.4%, coincided with global supply chain disruptions, pandemic-related fiscal stimuli, and commodity price shocks, rather than being driven solely or primarily by local electricity rate adjustments. These dynamics reflect broad-based demand and supply shocks, not isolated cost-push effects from electricity prices.

Therefore, attributing recent inflation trends in Puerto Rico directly to electricity rate increases oversimplifies a complex macroeconomic environment. The data suggests that while electricity prices may play a role, they are not the dominant driver of inflationary outcomes.

We must not lose sight of the fact that the PREB is evaluating an increase in the base rate, a component that, as previously mentioned, has historically represented less than 35% of the total electricity bill in Puerto Rico. In contrast, the Integrated Resource Plan (IRP) can more accurately define the future costs of fuel and purchased power, which together account for approximately 60% to 70% of the total bill. Therefore, future lower-cost dispatch scenarios could help offset any base rate increases approved by the PREB.

In addition, firms rarely pass input cost changes straight through to final prices at a one-for-one rate. They typically adjust production methods, improve efficiency, substitute inputs, or absorb part of the cost in margins, especially in competitive markets. This elasticity and substitution dampen the transmission of electricity cost changes into consumer prices and makes simple proportional calculations misleading.

Puerto Rico's inflation is also multi-causal and overwhelmingly shaped by factors beyond local electricity rates. Because the island imports most goods and raw materials, global commodity prices, shipping costs, supply-chain dynamics, and U.S. tariff policy exert a far stronger and more volatile influence on the general price level than electricity does. Singling out electricity as the primary driver of future inflation oversimplifies the issue and overstates its contribution.

Dr. Cao's analysis also appears to treat all customers as fully exposed to the tariff increase, yet in practice a rapidly growing share of residential, commercial, industrial, and agricultural customers participates in Puerto Rico's NEM program or have behind-the-meter solar and storage systems. These customers experience much lower effective electricity rates, sometimes approaching zero at the margin, which dilutes the average cost shock across the economy and further weakens the pass-through to the CPI.

Finally, the very instability in U.S. tariff and commodity prices cited in Dr. Cao's analysis underscores how multiple external factors already produce larger swings in intermediate costs for Puerto Rico's industrial sector than electricity does. Against this backdrop, projecting a CPI increase of 3.0% from electricity alone, more than double Puerto Rico's recent average inflation of 1.5%, appears to overstate the true inflationary impact. A more balanced view would treat electricity as one of several cost drivers, acknowledge the small direct weight of electricity in the CPI, incorporate realistic substitution and efficiency responses, and account for the mitigating effect of distributed generation. Under such assumptions, the inflationary effect of electricity rate increases would be far more limited than Dr. Cao suggests.

**Q. 32 On page 11 of the Cao Report, Dr. Cao asserts that increases in electricity prices are likely to negatively impact Puerto Rico's economic activity and employment, since electricity is a fundamental input for the production of goods and services. Dr. Cao argues that the existing Gross National Product ("GNP") models are outdated and so cannot provide reliable quantitative forecasts. Based on this, Dr. Cao concludes that the effects of electricity rate increase on GNP and employment cannot be responsibly estimated with current tools, yet concludes there would be an adverse impact. Does LUMA agree?**

A. No.

**Q. 33 Please state and explain LUMA's response.**

A. Dr. Cao argues that electricity price increases are likely to depress Puerto Rico's economic activity and employment because electricity is a fundamental production input, but he maintains that reliable quantitative estimates cannot be produced with current GNP models, which he says are outdated and fail to capture factors such as large federal disaster and pandemic relief funds, the economy's structural contraction, and the rapid adoption of distributed generation and remote work.

While these concerns about model limitations are valid, GNP still functions as a relevant, though no longer dominant, indicator in forecasting commercial and industrial electricity demand, since aggregate economic output remains tied to energy use in these sectors. It is not used for residential load, where consumption depends more on weather and behavioral factors.

Recent internal analyses show that although GNP has continued to rise, commercial and industrial electricity consumption has stagnated or declined, indicating a weakened historical relationship due to distributed generation, efficiency improvements, and structural shifts such as remote work. Updated forecasting models for the rate review reflect this decoupling. For example, data after FY 2020 shows that commercial and industrial loads are now less sensitive to estimated GNP. In the case of the commercial class, demand is also influenced by weather. Although GNP has exhibited sustained growth, electricity consumption from the grid by the Industrial customer class has declined, largely attributable to the adoption of on-site CHP systems. Figures 15 and 16 below depict the relationship between GNP and electricity consumption (not remediated) across customer classes:

**Figure 15. Commercial consumption and Gross National Product**

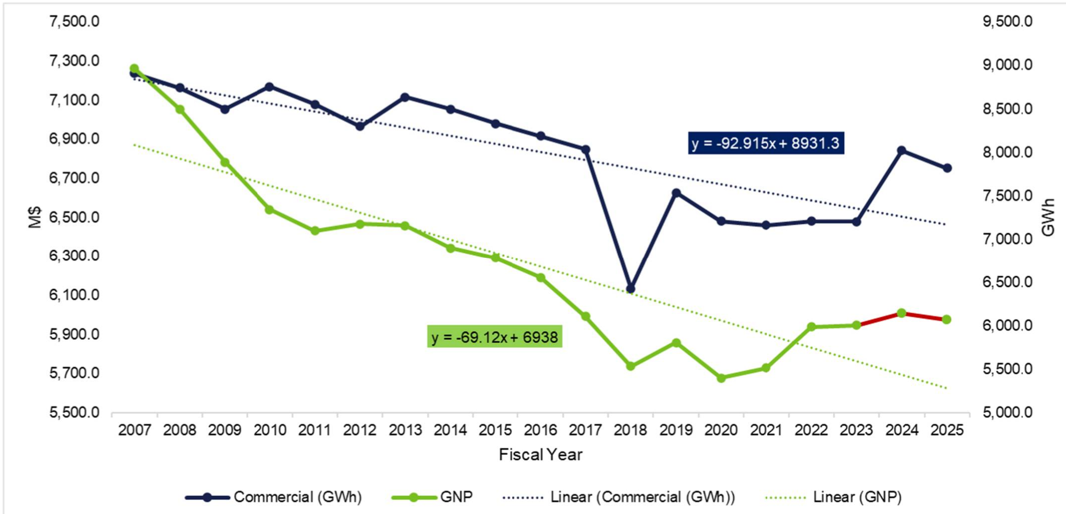
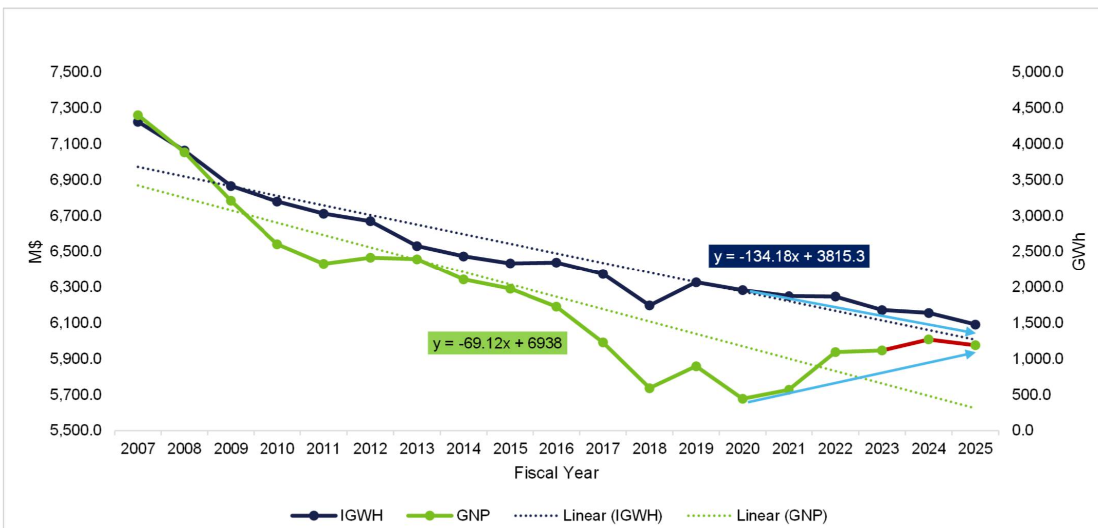



**Figure 16. Commercial consumption and Gross National Product**




Moreover, the GNP forecasts used in these models are not produced internally but supplied by the Fiscal Oversight and Management Board (FOMB), whose projections are expected to incorporate the very structural changes Dr. Cao highlights. Thus, the forecasting framework already adjusts for these limitations rather than ignoring them.

GNP remains a useful macroeconomic anchor when combined with other variables in an adaptive modeling framework and should not be discarded outright.

**Q. 34 On page 13 of the Cao Report, Dr. Cao states that the "death spiral" is a phenomenon that occurs when a utility "increases the price charged to its customers and some of them drop out from the service of the utility. A reduced number of customers and diminished levels of consumption by remaining customers given the large fixed costs characteristic of electric power utilities, induces the utility to further raise price, fueling a spiral of increasing price, reduced quantity demanded, rising prices again and so on, until the utility goes bankrupt." Does LUMA have a response?**

A. Yes.

**Q. 35 Please state and explain LUMA's response.**

A. Dr. Cao's concern is most appropriately addressed not through the base consumption forecast, but through the forecast adoption of load modifiers (e.g., distributed solar generation supported by battery storage, or large customer fossil fuel-based self-generation).

Dr. Cao characterizes a "death spiral" as the dynamic where rising utility prices cause customers to leave, which in turn forces further price increases and ultimately threatens the utility's viability. In Puerto Rico, however, the current adoption of distributed energy systems is driven less by rising electricity rates and more by concerns over grid reliability, particularly its resilience during and after severe weather events or widespread outages caused by failures in the electric system. This concern is more appropriately addressed through the forecast of load modifiers such as distributed solar with battery storage or large-scale fossil-fuel self-generation rather than through the base consumption forecast. LUMA estimates that, in 2023, an average residential NEM customer displaced about 278 kWh per month, roughly 4% of total residential consumption, based on an engineering comparison of simulated PV generation with actual export data. Although this represents modest load displacement today, continued NEM growth will increase its system-wide impact. (Refer to LUMA Ex. 72.04).

Full grid defection remains economically and technically impractical for most households due to the storage needed for reliability during low-solar periods. For example, an 800 kWh/month household would need about five 13.5 kWh batteries and sixteen 400-W panels to cover two cloudy days, at an estimated lease cost of \$535/month (\$0.73/kWh), compared with roughly \$200/month at current grid rates (\$0.25/kWh). A hybrid approach, solar plus storage while staying grid-connected, typically costs about \$248/month (\$0.31/kWh), a price that customers are willing to pay in exchange for greater energy autonomy.

The PREPA Fiscal Plan projects an average rate around \$0.31/kWh by FY2026, closing the cost gap between grid power and partial self-sufficiency. NEM customers also benefit from a 1:1 retail credit that offsets usage, reducing bills to the basic service fee of about \$4/month (projected to \$8/month by FY2027), maintaining a strong incentive to remain connected. Even with rates projected to rise to ~\$0.45/kWh by FY2040 and ~\$0.55/kWh with debt recovery, NEM customers can continue offsetting most increases, making partial grid defection, not full disconnection, the likely path for most residential users in the near and medium term. Affordability constraints and future changes in financing, interest rates, and technology costs will influence adoption, underscoring the importance of sensitivity analyses to assess consumer response, determine key economic thresholds, and forecast grid defection. These insights are critical to evaluating the long-term viability of Puerto Rico's NEM program and guiding policy and infrastructure planning. While these insights are valuable for informing key assumptions in forecasting consumption and long-term planning, they do not support the overstated conclusions advanced by Dr. Cao and the ICSE, which appear to significantly overestimate the likelihood of widespread grid defection or a collapse in electricity demand.

A parallel trend is emerging among large industrial and commercial customers adopting CHP systems. Most remain grid-connected for backup during outages but are generating most of their own electricity, significantly reducing volumetric consumption. Guidehouse's 2024 analysis identified 43 such customers displacing about 34 GWh/month (over 400 GWh annually) in 2023, with an average installed capacity of ~3.95 MW, sufficient to meet full onsite needs (please refer to LUMA Ex. 72.03). While fewer than five have completely ceased volumetric purchases, the resulting revenue loss from large-load customers is material and has implications for cost recovery, rate design, and long-term planning. The analysis, based on monthly billing data, would benefit from higher-resolution metering for more precise impact assessment. Reliability, rather than economics, is cited as the primary motivation for CHP adoption: LUMA's 2023 survey found all CHP-equipped industrial clients ranked reliability first. This aligns with broader island trends, including expanded LNG infrastructure and manufacturers' declarations of energy independence, signaling a shift toward self-sufficiency and resilience among Puerto Rico's largest energy users.

Caution should be exercised when relying on Dr. Cao's estimates of potential price impacts resulting from base rate increases, as the analysis likely overstates the dollar effects due to its reliance on outdated economic data that no longer reflects Puerto Rico's current economic structure. The following information is based on data published by the Puerto Rico Planning Board.

Between 2000 and 2025, Puerto Rico underwent a significant structural transformation in its economy, particularly in terms of GDP composition, price levels, and employment patterns. The island's economic profile in 2025 differs markedly from that of 2008.

Historically, Puerto Rico's industrial model was centered on manufacturing for U.S. markets, evolving from textiles to chemicals, electronics, and ultimately pharmaceuticals. By the late 1990s and early 2000s, Puerto Rico had become a leading U.S. exporter of pharmaceutical and medical products. Benchmarking with U.S. trade data confirms this trend, with pharmaceutical exports exceeding $30 to $40 billion in 2019, and the sector accounting for a substantial share of both output and manufacturing employment.

Between 2000 and 2025, Puerto Rico underwent a qualitative transformation in its industrial composition. While the island preserved, and in some respects deepened, its high-value, export-oriented manufacturing base, particularly in pharmaceuticals and medical devices, employment patterns shifted markedly toward the service and government sectors, and away from traditional manufacturing and other tradable goods industries.

This transformation reflects the combined effects of multinational corporate behavior, including tax-driven relocation of capital and intangible assets; a prolonged economic contraction and demographic decline, particularly between 2006 and 2017; institutional restructuring under the PROMESA framework; and major natural disasters, most notably Hurricane María.

Given these profound changes, any economic impact analysis that relies on outdated structural data risks misrepresenting the true magnitude and distribution of price effects. Updated, sector-specific data and a modern understanding of Puerto Rico's economic dynamics are essential for accurate modeling.

The phase-out of the federal tax benefit known as Section 936 (and related corporate tax changes) is widely identified in the empirical literature as a major structural inflection: firms reorganized, some production relocated, and the island's earlier catch-up model weakened. Econometric and working-paper studies find the repeal had measurable negative effects on manufacturing establishments and investment. That policy change set in motion a long reallocation of firms and assets that continued to affect composition after 2000 (Refer to Exhibit 72.01, at ¶ 20). The following describes the economic structure shift between 2008 to 2024:

1. Structural change in GDP composition profits:
    a. In 2008, Puerto Rico's Gross Domestic Product (GDP) was primarily driven by the manufacturing sector, which accounted for approximately 46% of total output. Real Estate and Rental and Leasing contributed around 14%, while agriculture, construction, and government represented 1%, 3%, and 5%, respectively. By 2024, manufacturing's share had increased slightly to 47%,

while Real Estate and Rental and Leasing declined marginally to 13%. Agriculture and construction also experienced modest declines. These shifts reflect a gradual transformation in the island's economic structure, characterized by a move toward high-value manufacturing, notably in pharmaceuticals and biotechnology, alongside the emergence of a more robust service sector, including finance, healthcare, and professional services. This evolution signals a broader trend of economic modernization and diversification, as documented by the Puerto Rico Planning Board and the Financial Oversight and Management Board for Puerto Rico (2020).

2. Structural change in employment composition

    a. Between 2008 and 2023, Puerto Rico experienced a notable shift in employment patterns. The share of employment in manufacturing declined from approximately 18.4% to 12.1%, while employment in the service sector increased significantly, from 55% to 65%. Meanwhile, agriculture and government employment shares declined, and construction saw a modest increase. This trend underscores a key structural dynamic: although manufacturing continues to contribute substantially to GDP, it now employs fewer workers, reflecting its evolution into a more capital-intensive and technologically advanced sector. In contrast, the service sector has become the dominant source of employment, driven by demographic shifts, fiscal restructuring, and changing labor market demands industry (Refer to Exhibit 72.01, at ¶ 21).

3. Economic and Social Context

a. From the early 2000s through 2008, Puerto Rico's economy was heavily reliant on tax incentives, most notably Section 936, which supported the island's manufacturing dominance. However, the economic structure began to shift significantly following a series of major shocks: the phase-out of Section 936 by 2006, the global financial crisis in 2008, Hurricane María in 2017, the 2020 earthquake sequence, and the COVID-19 pandemic. These events intensified long-standing recessionary trends, contributed to a shrinking labor force, and deepened fiscal instability. In response, Puerto Rico initiated structural reforms aimed at diversifying the economy, enhancing productivity, and expanding the service sector to build greater economic resilience.

4. Demographic Challenge

a. Puerto Rico has experienced a notable shift in its birth trends, closely tied to the island's broader economic transformation, from a predominantly agricultural economy to an industrialized one. These demographic patterns remained relatively stable until the early 2000s, when the expiration of key tax incentives for foreign corporations, including Section 936, triggered the closure of many manufacturing enclaves. The 1990s marked the beginning of a period of economic instability, driven by a series of exogenous shocks and the onset of deindustrialization. These developments disrupted long-standing economic and demographic trends, contributing to structural changes that continue to shape Puerto Rico's economic and social landscape today (Refer to Exhibit 72.01, at ¶ 22).

The post-María period represents a phase of temporary structural distortion, driven by reconstruction-related spending, superimposed on longer-term shifts in economic composition. These structural changes, particularly in dollar terms, are not captured in traditional "pass-through" I-O analyses.

Puerto Rico underwent significant demographic and economic changes between approximately 2006 and 2017. During this period, the island experienced a prolonged economic contraction, GDP declined cumulatively (with estimates varying by baseline), and population loss accelerated due to sustained out-migration to the U.S. mainland.

This combination of weak aggregate demand, mounting fiscal pressures (including rising public debt), and population decline led to a structural reduction in both domestic employment and labor force participation. The impact was particularly pronounced in routine manufacturing, retail, and construction sectors, which are more sensitive to cyclical and structural downturns.

In contrast, employment in the pharmaceutical sector, a capital and knowledge-intensive industry, did not decline in proportion to manufacturing's overall share of GDP (Refer to Exhibit 72.01, at ¶ 23). This reflects the sector's reliance on automation, specialized labor, and export-driven production, which insulated it to some extent from broader labor market contractions.

Puerto Rico's trajectory reflects a hybrid model that combines an externally mediated industrialization, led by multinational corporations, premature deindustrialization, where manufacturing employment declines before full industrial maturity is reached and a domestic economic retrenchment, with a shift toward public-sector and service-based employment, as migration and fiscal constraints limit private-sector job creation.

## III. REBUTTAL TO DATTA TESTIMONY

**Q. 36 On page 8, lines 12–13, and page 9, lines 1–24 of the Datta Testimony, Mr. Datta argues that LUMA's concern about "lost revenues" relating to NEM customers' reduced consumption despite the grid update costs needed to accommodate those customers is flawed because, he argues, the reduced consumption cannot create recoverable costs and would be economically inefficient. Does LUMA have a response?**

A. Yes.

**Q. 37 Please state and explain LUMA's response.**

A. Revenue adequacy is often misunderstood, but it is a cornerstone of sound utility regulation, not a euphemism for guaranteed profits (Refer to Exhibit 72.01, at ¶ 7). Regulatory frameworks are designed to ensure that utilities can recover the costs necessary to maintain a safe and reliable electric grid. When a large share of fixed costs, such as grid maintenance, vegetation management, and system operations, is recovered through volumetric rates, NEM customers who reduce their net consumption may inadvertently cause the utility to under-recover these essential costs.

This isn't about protecting utility profits (Refer to Exhibit 72.01, at ¶ 8); it's about ensuring that the infrastructure everyone relies on is adequately funded. Although we have seen that the use of NEM customers with batteries installed could have applications for the grid, even when NEM customers export excess energy during the day and import at night, effectively using the grid as its substitute, they still depend on the system but may not contribute proportionally to its upkeep.

While it's true, as Datta points out, that "lost revenue" is not a cost, it serves as a useful proxy for identifying imbalances in cost allocation. From an economic perspective, it signals a disconnect between who causes costs and who pays for them (Refer to Exhibit 72.01, at ¶ 8). ~~If NEM customers avoid paying for grid services they continue to use, the financial burden shifts to non-NEM customers.~~ This creates a cross-subsidization issue, which is particularly concerning in Puerto Rico, where the grid is both fragile and underfunded, rooftop solar adoption is high, and the utility is navigating bankruptcy. In such a context, ensuring fair cost recovery becomes even more critical.

Mr. Datta is right to highlight that modern rate design tools, such as minimum bills or time-of-use ("TOU") rates, can address these issues. However, acknowledging the availability of solutions does not negate the existence of the problem. LUMA's concerns about lost revenue are not unfounded; they are symptoms of outdated rate structures that have not kept pace with the growth of distributed energy resources ("DERs"). The appropriate economic response is not to dismiss these concerns, but to modernize tariffs in a way that reflects cost causation, grid usage, and fairness across all customer classes.

Finally, unrecovered grid upgrade costs deserve serious consideration. As NEM penetration increases, it can trigger the need for additional investments in voltage regulation, backflow protection, and transformer upgrades. These are real marginal costs associated with integrating DERs into the grid. While it is incumbent upon LUMA to quantify these costs transparently, dismissing them outright overlooks the physical and operational realities of grid management in a high-DER environment.

**Q. 38 On page ~~8, line 14; page 11, lines 3–30; and page~~ 12, lines 8–28, and page 13, lines 1–7~~ of the Datta Testimony~~, Mr. Datta argues that LUMA's concern about NEM customers ~~"cost-shifting" to non-NEM ratepayers~~ creating additional costs to LUMA that are not offset by benefits is flawed because, he argues, ~~the assertion relies on incomplete data, ignores potential benefits to the grid, and lacks empirical evidence~~LUMA has not adequately considered or analyzed avoided energy and capacity costs, reduced line losses, deferred infrastructure investments, and resilience. Does LUMA have a response?**

A. Yes.

**Q. 39 Please state and explain LUMA's response.**

~~A. Cost shifting is a legitimate concern under volumetric rate structures, particularly from a regulatory economics standpoint (Refer to Exhibit 72.01, at ¶ 8). It occurs when one group of customers pays less than their actual cost to serve, and the resulting shortfall is recovered from others. In Puerto Rico, this issue is especially relevant because most grid costs are recovered through per-kilowatt-hour charges. As NEM customers significantly reduce their net consumption, the financial burden of maintaining the grid shifts to non-NEM customers. This is not a political argument, it is a mechanical outcome of how rates are currently designed in the face of growing DER adoption.~~

A. From an economic and regulatory standpoint, the burden of proof applies equally to claims of both net benefits and net costs. While Mr. Datta rightly points out that LUMA has not yet quantified all the potential benefits of DERs, he simultaneously assumes significant benefits without empirical support. In regulatory proceedings, potential value is not equivalent to realized value.

While Mr. Datta is right to emphasize the importance of a comprehensive cost-benefit analysis, it is critical to recognize that the absence of quantified benefits does not negate the presence of measurable costs. NEM customers may avoid paying for grid services they continue to rely on, such as backup capacity, frequency control, and voltage regulation (Refer to Exhibit 72.01, at ¶ 9). Additionally, their participation can trigger local grid upgrades, and they often export energy during periods of low marginal value, such as midday solar surpluses (Refer to Exhibit 72.01, at ¶ 10). These are real marginal costs that must be acknowledged and fairly allocated. Ignoring them simply because benefits have not yet been quantified introduces analytical bias; both sides must be measured to ensure sound policy.

~~Empirical evidence from other jurisdictions with high DER penetration supports the concern about cost shifting, such as studies from California (Refer to Exhibit 72.01, at ¶ 11). The state's experience illustrates how cost shifting can persist and even intensify as DER adoption grows. California initially transitioned from NEM 1.0 to NEM 2.0 due to concerns that full retail rate compensation for exported solar energy allowed participating customers to avoid paying their share of fixed grid and public program costs, shifting those burdens onto non-participating ratepayers. However, subsequent evaluations of NEM 2.0 revealed that the cost shift remained significant and disproportionately impacted low-income customers. In response, the California Public Utilities Commission adopted a successor tariff that replaces retail export compensation~~

~~with values derived from the Avoided Cost Calculator and introduces high differential import rates to better reflect grid conditions and encourage solar-plus-storage adoption. These reforms aim to reduce the cost shift, promote equity, and ensure that DER compensation aligns more closely with the value provided to the grid.~~

~~Mr. Datta's critique regarding the lack of customer load data is valid, as historical data limitations have made it difficult to precisely measure the extent of cost shifting. However, this gap is being addressed through a comprehensive load profile study currently underway (Refer to Response to Request for Information SESA-of-LUMA-LOAD_FOR-3: Permanent Rates Load Forecasting (NEPR-AP-2023-0003). This study covers customers with and without CHP and PV systems across Puerto Rico. It will provide empirical insights into consumption patterns, export behavior, and system impacts under real operating conditions. These findings will directly inform cost allocation, benefit quantification, and future tariff design.~~

~~In this context, it is premature to dismiss cost shifting as a mere "narrative." The prudent approach is to acknowledge the theoretical basis for concern while relying on empirical studies, such as the ongoing load profile analysis, to determine the actual magnitude of the issue. Only then can Puerto Rico move toward a rate design that is both equitable and economically sustainable.~~

~~**Q. 40 On page 12, lines 8-28, and page 13, lines 1-24, Mr. Datta argues that LUMA's concerns about NEM customers creating additional costs to LUMA that are not offset by benefits to non-NEM ratepayers is flawed because, he argues, LUMA has not adequately considered or analyzed avoided energy and capacity costs, reduced line losses, deferred infrastructure investments, and resilience. Does LUMA have a response?**~~

~~A. Yes.~~

~~**Q. 41 Please state and explain LUMA's response.**~~

~~A. From an economic and regulatory standpoint, the burden of proof applies equally to claims of both net benefits and net costs. While Mr. Datta rightly points out that LUMA has not yet quantified all the potential benefits of DERs, he simultaneously assumes significant benefits without empirical support. In regulatory proceedings, potential value is not equivalent to realized value.~~

DERs may offer theoretical system benefits, but these must be demonstrated with data rather than inferred. If NEM customers are imposing measurable costs, such as those related to voltage regulation (Refer to Exhibit 72.01, at ¶ 8), transformer upgrades, or protections for bidirectional power flow, those costs are real and immediate. Unless they are offset by quantified and attributable benefits, they represent a net burden that must be addressed through appropriate cost recovery mechanisms.

It is also important to recognize that the benefits of DERs are highly context dependent (Refer to Exhibit 72.01, at ¶ 8). Their value hinges on three key factors: location (whether DERs are installed on constrained versus unconstrained feeders), timing (whether exports align with peak demand periods), and penetration level (whether the system is approaching diminishing returns). In Puerto Rico, the grid peaks in the evening, while most rooftop solar is non-dispatchable and lacks storage. Consequently, NEM exports often occur when the marginal value of energy is low, and the grid already has surplus capacity. This means that the most valuable avoided costs, such as capacity deferral during evening peaks, are largely unrealized or minimal under current conditions. While DERs can indeed provide benefits, their magnitude in Puerto Rico's present configuration is likely modest.

Mr. Datta's critique hinges on the absence of a comprehensive cost-benefit study. LUMA is currently conducting a NEM economics study, along with load profile analyses ~~that include~~ . The comprehensive load profile study currently underway (Refer to Response to Request for Information SESA-of-LUMA-LOAD_FOR-3: Permanent Rates – Load Forecasting (NEPR-AP-2023-0003) covers customers with and without ~~PV and~~ CHP and PV systems across Puerto Rico. It will provide empirical insights into consumption patterns, export behavior, and system impacts under real operating conditions. These efforts are intended to provide the empirical foundation necessary for future rate design and policy decisions.

LUMA's testimony appropriately highlights the incremental grid costs associated with NEM growth, including voltage regulation and protection equipment, reverse power flow upgrades, and transformer replacements or reconfigurations. These are not hypothetical concerns, they are observed consequences of increased distributed generation. When these costs are not recovered from NEM customers, they are effectively socialized across non-participants, creating a cross-subsidy and undermining cost causation principles.

~~**Q. 42 On page 14, lines 1–24, and page 15, lines 1–9, Mr. Datta argues that LUMA does not adequately credit NEM customers with providing system-wide reliability benefits. Does LUMA have a response?**~~

~~A. Yes.~~

~~**Q. 43 Please state and explain LUMA's response.**~~

~~A. While many NEM customers now pair PV systems with batteries, the mere presence of storage does not guarantee reliability value. Most behind-the-meter batteries are operated for self-consumption or backup power, not for coordinated grid support. As such, they function more as private resilience devices than as dispatchable system resources.~~

~~To provide measurable reliability benefits, these batteries must be aggregated, scheduled, and dispatched in alignment with system needs, particularly during evening peaks when solar output is negligible and system stress is highest. This is the operational gap that LUMA's Customer Battery Energy Sharing (CBES) program seeks to address.~~

~~LUMA's CBES program is a demand-side grid service designed to shave peak demand and facilitate smoother generation ramping during Puerto Rico's evening peak hours. The program operates on an opt-out basis, meaning customers are enrolled by default and must actively choose to opt out. This design has enabled high enrollment and participation rates, particularly under the enhanced CBES+ platform.~~

~~Recent dispatch data from summer 2025 demonstrates the program's operational maturity:~~

(Del)

| Month | Average Enrollment | Average Participation Rate |
|---|---|---|
| June | 12,225 | 86% |
| July | 67,165 | 69% |
| August | 73,188 | 82% |

~~These figures indicate that CBES+ is not merely a pilot or theoretical construct, it is a functioning, large-scale DER program. However, seasonal variation in customer behavior remains a constraint. During the summer, many customers prioritize battery use for personal reliability, which can reduce the volume of energy available for grid dispatch. This behavioral dynamic introduces variability in the program's effective contribution to system reliability.~~

~~From an economic standpoint, CBES dispatch currently carries a fixed cost of approximately $1.25 per kWh, based on the incentive paid to participating customers. In contrast, the short run marginal cost of dispatching a conventional peaker plant is estimated at around $0.23 per kWh . While CBES may offer environmental or resilience co-benefits, these are not yet monetized or formally evaluated. As such, CBES is currently more expensive on a per-kWh basis, and its economic competitiveness relative to centralized alternatives remains uncertain without a comprehensive economic impact study.~~

~~To that end, LUMA is also pursuing the Accelerated Storage Addition Program (ASAP), which aims to deploy utility-scale battery energy storage systems (BESS) across the island. These installations are expected to provide firm, centrally dispatched capacity that can complement or substitute for distributed programs like CBES. In parallel, the Integrated Resource Plan (IRP) process is underway to evaluate a portfolio of generation~~

~~and storage options that can meet Puerto Rico's reliability needs while minimizing long-term costs to consumers.~~

~~Finally, while Mr. Datta's use of Loss of Load Hours (LOLH) and Value of Lost Load (VoLL) to estimate avoided outage costs is theoretically valid, it assumes that DERs consistently discharge during forecasted load shedding events. The CBES+ data shows meaningful dispatch activity, but not all enrolled customers discharge fully or consistently, and seasonal opt-out behavior can reduce available capacity. As such, the implied $2–$5 billion per year in avoided outage costs likely overstates the realized reliability benefits under current operational conditions.~~

## IV. REBUTTAL TO HOPKINS REPORT

**Q. 40** ~~Q. 44~~ **In Section 3.2 of the Hopkins Report, Dr. Hopkins concludes that no "additional corrective factor" or "adjustments" to LUMA's forecast model are necessary to account for non-programmatic efficiency. Does LUMA agree with this conclusion?**

A. Yes.

**Q. 41** ~~**Q. 45**~~ **In Section 3.2 of the Hopkins Report, Dr. Hopkins states that LUMA "does not include an exogenous variable (a driver of the regression load forecast) that reflects" the expected impact of "contributing entities" other than LUMA on Puerto Rico's energy efficiency goal, nor "similar changes in energy efficiency (such as an exogenous variable reflecting decreasing energy intensity of the economy over time)." The premise for Dr. Hopkins' analysis is that "LUMA should incorporate the impact of [broader energy efficiency policies and programs] in its load forecast." Does LUMA have a response?**

A. Yes.

**Q. 42** ~~**Q. 46**~~ **Please state and explain LUMA's response.**

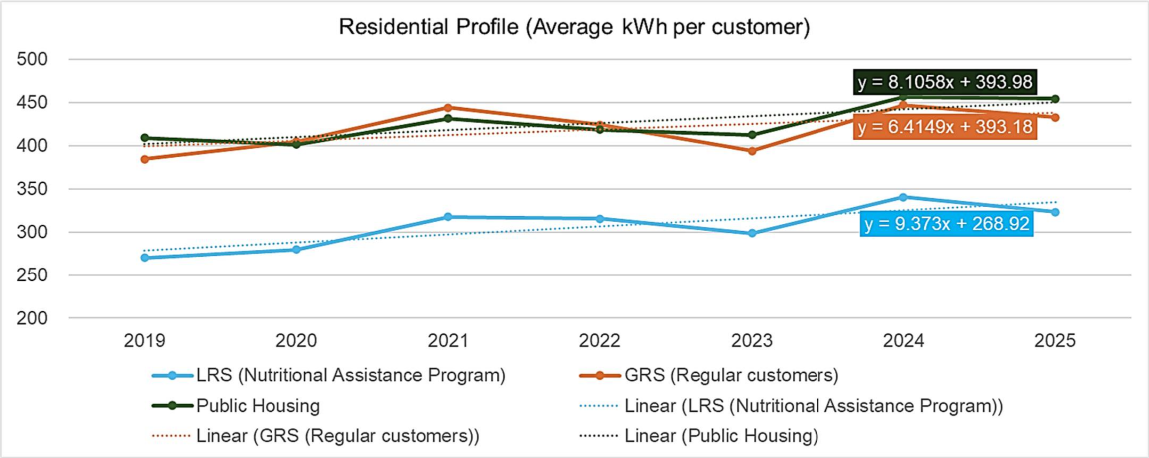
A. LUMA's base load forecast (unadjusted model) incorporates reductions in energy consumption due to EE measures already embedded in historical consumption data. These include:

1. Government Sector Reductions Mandated by Act 57-2014
   a. Municipalities – As per Regulation 8818.
   b. Local Government Entities – Required to reduce consumption by 40% by FY2022, using FY2013 as the baseline
   c. Legislature – Targeted 12% reduction based on 2013 consumption levels.
2. Lighting Efficiency Programs
   a. Replacement of incandescent bulbs with LED lighting across residential, commercial, and industrial sectors, initiated by PREPA in 2008.
3. Customer-Initiated Energy Efficiency Measures

a. Residential Sector: Replacement of window or standard mini-split A/C units with inverter mini-splits; Adoption of solar water heaters, incentivized by government tax credits in the 2000s; Replacement of household appliances with more energy-efficient models.

Historical data shows that average consumption by residential customers increased, particularly the low-income customers, even with some federal and local EE programs deployed in or after 2023:

**Figure 17: Residential Consumption Profile 2019-2025**




b. Commercial and Industrial Sectors: Implementation of various EE measures contributing to observed consumption reductions, particularly customers with substantial consumption in transmission voltage level (Refer to Exhibit 72.01, at ¶¶ 13 & 14).

However, the major contributor to the reduction is the distributed generation. The following figures depict the trends of those classes by voltage level:

**Figure 18: Commercial and Industrial Transmission Voltage Level 2019-2025**

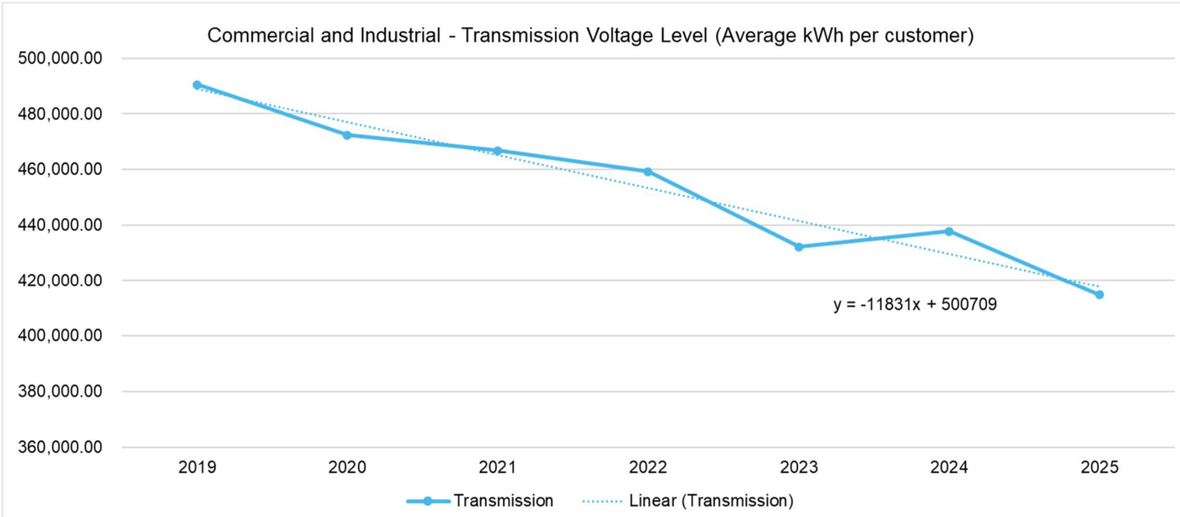
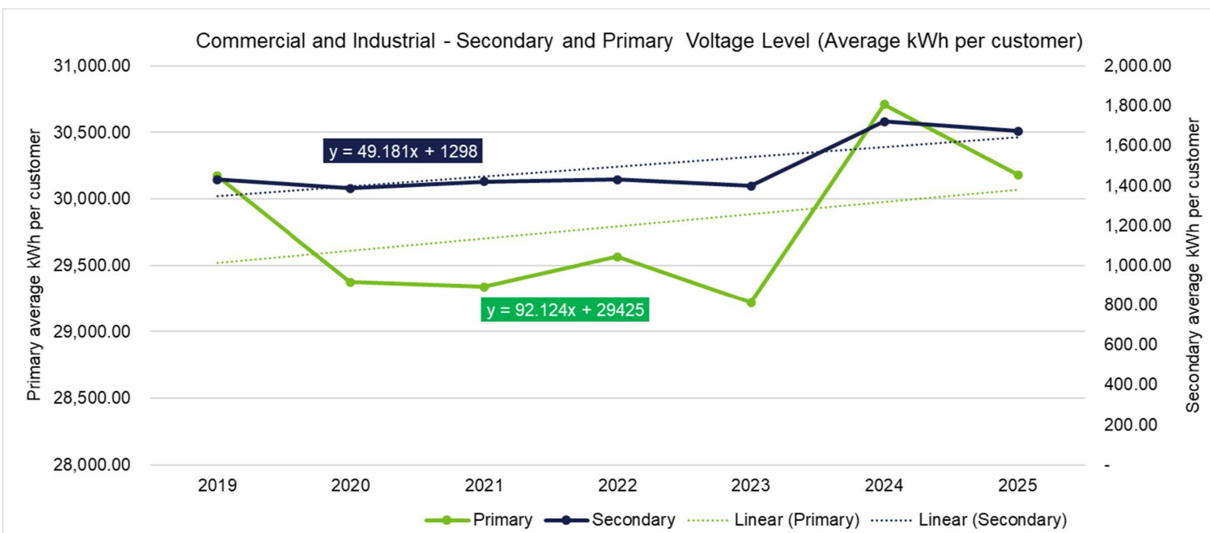



**Figure 19: Commercial and Industrial Secondary and Primary Voltage Level 2019-2025**




c. Streetlighting Adjustments

Post-Hurricane María, most streetlights were replaced with LED fixtures. In April 2019, the Puerto Rico Energy Bureau (PREB) ordered PREPA to manually adjust streetlighting consumption to reflect the gradual restoration of the system. This manual adjustment continued until October 2023, when operational data confirmed full restoration. Despite the LED replacements, the billing system continued to reflect sodium and mercury vapor bulb consumption until PREB approves a new rate design for LED lighting. This manual offset significantly reduced the apparent consumption savings from LED adoption. Since 2023, LUMA has been measuring sodium and mercury consumption, and a further reduction in the public lighting class is expected once the new LED rate structure is approved.

In short, most of the reductions described above are already embedded in the historical consumption data used to calibrate the load forecast models by customer class. The adjusted forecast used in the rate review includes reductions mandated by PREB for specific years. These adjustments account not only for LUMA's EE programs but also for broader government-mandated initiatives.

Finally, the EE Market and Potential Study (Puerto Rico Energy Efficiency Market Baseline and Potential Study – September 24, 2025) was completed after the development of these projections. Currently, LUMA technical staff are reviewing and preparing comments related to the study, as we have preliminarily identified certain deficiencies. Once the Energy Bureau confirms the results of the study, LUMA can proceed to incorporate its impact into future forecasts in alignment with the study's findings.

## V. REBUTTAL TO MING REPORT

**Q. 43** **~~Q. 47~~ On page 21 of the Ming Report, Mr. Ming states that binary variables, which LUMA used in its regression analysis to reflect key impacts on the rate forecast, are standard for capturing categorical factors and Dr. Cao's concern over their use is "not persuasive." Does LUMA agree?**

A. Yes.

**Q. 44** **~~Q. 48~~ On page 21 of the Ming Report, Mr. Ming states that LUMA's decision to use the 73rd percentile of median monthly CDD data for the residential model is inconsistent with the assumption used for other customer classes, like the 50th percentile for CDD used for the commercial model. Mr. Ming argues that the higher sensitivity of residential load regarding CDD data should be accounted for using a different coefficient for CDD, not using a higher percentile for CDD data. Later, on Page 23, Dr. Ming argues that "it is not reasonable for LUMA to use different CDD scenarios in the residential and commercial regression models" and LUMA should use the same percentile scenario for CDD in both the commercial and residential models. Do you have a response?**

A. Yes.

**Q. 45** **~~Q. 49~~ Please state and explain your response.**

A. LUMA respectfully disagrees with Mr. Ming's recommendation to apply the 50th percentile approach to the residential model, as was done for the commercial sector. The 50th percentile scenario results in an unsupported reduction in the FY 2026 forecast.

Adjusting the CDD coefficient is not deemed an appropriate solution, as the regression model is based on a monthly time series beginning in 2010.

Residential customers tend to exhibit a distinct pattern of electricity use in response to high temperatures. Many households turn off their cooling systems when they leave for work, allowing their homes to heat up throughout the day. Upon returning in the late afternoon or evening—often during peak demand hours—they ramp up usage by turning on air conditioning and other appliances simultaneously. This behavior leads to sharp spikes in residential load during hot days, particularly when extreme weather events occur. Using a higher percentile of CDD in the residential model helps capture this sensitivity and better reflects the upper-bound demand that utilities must be prepared to serve. It also aligns with recent years' weather trends, which show more frequent and intense heat events that amplify this load pattern.

The historical period used in the regression model primarily reflects average weather conditions, which skews the model's weighting toward typical climate patterns. As a result, it does not sufficiently account for the more extreme climate variability observed in several of the past five fiscal years.

**BASELINE FORECAST ASSUMPTIONS**

Over the past several forecast periods, LUMA has utilized the Guidehouse-developed 50th percentile CDD forecast as the baseline scenario. This scenario was considered for the rate review load forecast. However, the resulting 9.5% reduction in FY 2026 (after applying modifiers) was not supported, especially when compared to the 3.1% estimated reduction in FY 2025.

**ALTERNATIVE SCENARIOS EVALUATED**

To improve forecast accuracy, LUMA analyzed two additional CDD scenarios:

1. 73rd percentile CDD forecast: FY 2026 load reduction = 7.2%

2. 80th percentile CDD forecast: FY 2026 load reduction = 6.2%

The interannual variance across all evaluated scenarios for fiscal years 2027 and 2028 appears consistent. LUMA calculated the 10-year Average Growth Rate (AGR) based on observed data. The AGR for the 73rd percentile scenario is positive in FY 2026 and aligns with the observed AGR in fiscal years 2024 and 2025. Moreover, the average AGR for the 73rd percentile scenario over fiscal years 2026–2028 (-0.3%, the average of 0.22%, -0.31%, and -0.77%) is closer to the average observed AGR over the past three years (0.8%, the average of 0.52%, 1.56%, and 1.27%) than the 50th percentile scenario (-0.5%, the average of -0.03%, -0.52%, and -0.98%), supporting the selection of the 73rd percentile scenario. Even when compared to the unadjusted models, the 73rd percentile scenario demonstrates a better fit, with an average growth rate (AGR) of 0.8% (average of 0.79%, 0.84%, and 0.78%) across the three forecast years. In contrast, the 50th percentile scenario yields a lower AGR of 0.6% (see tables below).

**Figure 20: Comparison of CDD Modifiers to Adjusted Load Forecast**

**Adjusted Load Forecast - Modifiers applied %**

| FY | Actual | Interannual CDD 50th percentile | Interannual CDD 73th Percentile | Interannual 80th Scenario | AGR 10-year Actual | AGR 10-year CDD 50th percentile | AGR 10-year CDD 73th Percentile | AGR 10- year 80th Scenario |
|---|---|---|---|---|---|---|---|---|
| 2020 | 6.3 | | | | (0.88) | | | |
| 2021 | 6.9 | | | | 0.29 | | | |
| 2022 | (0.4) | | | | 0.47 | | | |
| 2023 | (8.1) | | | | (0.52) | | | |
| 2024 | 15.9 | | | | 1.56 | | | |
| 2025 e | (3.1) | | | | 1.27 | | | |
| 2026 | | (9.5) | (7.2) | (6.2) | | (0.03) | 0.22 | 0.32 |
| 2027 | | (5.4) | (5.8) | (5.2) | | (0.52) | (0.31) | (0.14) |
| 2028 | | (5.4) | (5.3) | (5.2) | | (0.98) | (0.77) | (0.61) |

* AGR FY 2028 compared with FY 2017 to avoid impact hurricane María to the load.

e=estimate: observed data up to February 2025

**Figure 21: Comparison of CDD Modifiers to Unadjusted Load Forecast**

Unajusted Load Forecast

| Date | FY | Interannual CDD 50th percentile | Interannual CDD 73th Percentile | Interannual 80th Scenario | AGR 10-year Actual | AGR 10- year CDD 50th percentile | AGR 10-year CDD 73th Percentile | AGR 10- year 80th Scenario |
|---|---|---|---|---|---|---|---|---|
| 2020 | 6.3 | | | | (0.88) | | | |
| 2021 | 7.3 | | | | 0.32 | | | |
| 2022 | (0.7) | | | | 0.47 | | | |
| 2023 | (8.1) | | | | (0.52) | | | |
| 2024 | 15.9 | | | | 1.56 | | | |
| 2025 e | (3.1) | | | | 1.27 | | | |
| 2026 | | (4.1) | (1.8) | (0.8) | | 0.55 | 0.79 | 0.89 |
| 2027 | | 0.3 | (0.2) | 0.3 | | 0.65 | 0.84 | 0.99 |
| 2028 | | 0.2 | 0.2 | 0.3 | | 0.61 | 0.78 | 0.92 |

* AGR FY 2028 compared with FY 2017 to avoid impact hurricane María to the load.
e=estimate: observed data up to February 2025

The selected scenario provided a more reasonable outlook and aligned better with observed trends. Final residential consumption in FY 2025 decreased 4.3%, a little deeper than the estimated, and in FY 2026 as of September 2025 (preliminary), the data reflects an approximate 2% reduction, which substantiates LUMA's decision for a scenario with a less pronounced decline, aligned with the 73$^{rd}$ percentile forecasted decrease.

**OBSERVED CDD TRENDS AND HISTORICAL CONTEXT**

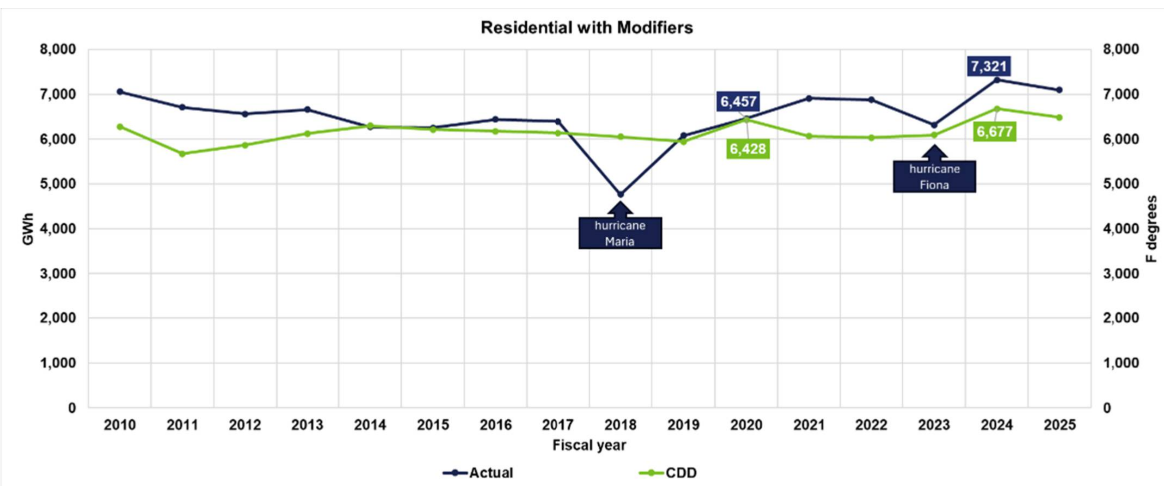
Historically, a spike in CDD was followed by a decline the next year. This trend did not hold in FY 2020 and 2024, indicating a shift in climate patterns and sustaining warmer conditions.

Since May 2023, Puerto Rico has experienced a prolonged heat wave, with record-breaking temperatures through at least March 2025. June 2023 recorded 625°F CDD, surpassing the previous high in June 2014. Each month following ranked among the top three historically in terms of CDD. FY 2024 recorded the highest fiscal year CDD on record: 9.6% (585°F) higher than FY 2023, and 3.9% (249°F) higher than FY 2020 (previous record).

**IMPACT ON RESIDENTIAL CONSUMPTION**

Residential energy consumption increased significantly in FY 2024, consistent with elevated CDD. The following figure illustrates the correlation between observed consumption and CDD. While an apparent decoupling between the two variables is evident during fiscal years 2021 and 2022, the correlation strengthens notably beginning in FY 2023, coinciding with rising temperatures.

**Figure 22: Residential Consumption and CDD Comparison**




**COMMERCIAL LOAD FORECAST PERFORMANCE**

The commercial model has demonstrated strong performance, with a FY 2025 variance of only 0.75% relative to the forecast. This high level of accuracy provides no justification for modifying its current specification. Furthermore, the model exhibits lower sensitivity to CDD fluctuations compared to the residential model.

**Q. 46 ~~Q. 50~~ On page 22, Mr. Ming states that LUMA "failed to adjust the residential regression to account for historical effects of load modifiers such as DG, EE, and EV's. As a result, the final consumption forecast risks overcounting the effect of load modifiers. LUMA designed its regression model using the historical between consumption and the independent variables. DG, EE, and EV affect historical consumption data that the regression relationship is based on. Therefore, the regression results already implicitly include potential future of these load modifiers." As a result, Mr. Ming believes PREB should "update its regression model so it takes into account the historical impact of these load modifiers in future load forecast efforts." Does LUMA agree?**

A. Partially.

**Q. 47 ~~Q. 51~~ Please state and explain LUMA's response.**

A. As stated in this testimony, since 2023, LUMA has been engaged in a continuous improvement process to enhance the accuracy of its demand forecasts. In 2024, the industrial model was modified with this objective. As explained in this testimony (see rebuttal to Dr. Cao's Report), the load displaced by CHP systems was estimated from historical data, added to the actual consumption, and then added back into the forecasts. In the case of the industrial model, the displacement associated with net metering systems was deemed insignificant, and therefore, this load was not removed from the model.

The residential model, on the other hand, exhibited significant variance in previous years, as discussed in this testimony (refer to rebuttal to Dr. Cao's Report). In response, we adjusted the model components related to temperature, which have been identified as the primary factor influencing this behavior. In 2025, LUMA, in collaboration with Guidehouse, initiated a new phase of model evaluation for the residential class, similar to the approach taken with the industrial class. This phase began in October 2025, and it involves assessing a residential model that excludes distributed generation ("DG") displacement from historical data. Based on the results of this evaluation, LUMA may adopt this revised model in the next forecasting cycle.

Finally, the commercial model has demonstrated high accuracy to date, and as such, no changes are currently recommended.

Empirical evidence also supports the validity of LUMA methodology. For example, the significant under-forecast of residential consumption in FY2024 was not due to unmodeled DG, EE, or EV effects, but rather to record-high temperatures and a persistent post-2020 behavioral shift in residential electricity use. Similarly, the FY2025 industrial forecast error was primarily driven by unmodeled self-generation, which has since been addressed through explicit adjustments. Notably, the commercial forecast errors in both FY2024 and FY2025 were within 2%, further demonstrating that the exclusion of explicit price or load modifier variables does not inherently compromise forecast accuracy.

Currently, load reduction or increase associated with the modifiers is already embedded in the consumption data used in the regression models for the main customer classes. In other words, LUMA accounts for the historical impact of these load modifiers in the development of the regression model. However, future integration (in terms of net metering capacity and customers) is considered an incremental impact of the displaced load, which is applied incrementally to the unadjusted forecast to avoid double counting.

As a result, the historical impact informs the baseline, while the incremental count of load modifiers appropriately accounts for future impacts.

**DISTRIBUTED GENERATION AND NET METERING**

The forecasted load displacement is explained in my direct testimony, notably at lines 197 to 228. As explained, the observed data already includes the load displacement from customers participating in the net metering program. LUMA is aware of the need to avoid double counting this modifier. For the forecasted years, LUMA applies the incremental load reduction as the DG modifier, using the difference in displaced load from fiscal year 2025 as the baseline to avoid the double counting. (See following table.)

**Residential DG-NM (GWh)**

| Fiscal Year | Total Load Displacement | Reduction applied (FY-FY2025) |
|---|---|---|
| 2025 | 1,319.0 | |
| 2026 | 1,709.6 | 390.6 |
| 2027 | 2,074.1 | 755.1 |
| 2028 | 2,405.2 | 1,086.2 |

In the future, once more robust tools are available to isolate and quantify the actual impact of EE programs, LUMA will be able to refine and update the methodology accordingly

Aware of recent changes in the drivers influencing load trends, in 2023 LUMA launched the Load Forecasting Improvement Project. Recently, as part of this project and due to the significant deviation between industrial observed data and the forecast, the methodology for the industrial model was updated. Specifically, the impact of CHP systems was excluded from historical data, and after estimating the model coefficients, the CHP impact was reintroduced as a modifier. LUMA does not rule out updating the residential model in a similar manner in the future, excluding the impact of distributed energy displacement from historical consumption, as the Net Metering program continues to significantly affect the load.

**ENERGY EFFICIENCY**

With respect to energy efficiency (EE), LUMA acknowledges that, at the time the load forecast was developed, the most appropriate approach was to apply the percentage adjustment as directed by PREB. EE forecast used in the rate review includes reductions mandated by PREB for the rate review period. These adjustments account not only for LUMA's EE programs but also for broader government-mandated initiatives.

Historical data indicates that average customer consumption has increased, particularly among low-income customers and those served at the low-voltage level, despite the implementation of certain federal and local EE programs after 2023.

**ELECTRIC VEHICLES**

Finally, due to the lack of localized data to quantify the impact of EVs in Puerto Rico, LUMA relied on information from the PR100 study. Forecasting EV adoption remains a challenge—not only for LUMA, but for jurisdictions across the United States.

In conclusion, the regression model does not overcount the effects of DG, EE, or EVs. It reflects the net historical relationship between consumption and its drivers, and any future adjustments are applied cautiously and only when warranted by external data. This ensures that the forecast remains both empirically grounded and methodologically sound.

**Q. 48 ~~Q. 52~~ On page 22, Mr. Ming "agree[d] with Dr. Cao's argument that LUMA should include electricity price in the residential regression." Mr. Ming opined that electricity price "impacts a customer's consumption" and impacts "the customer's adoption of DG or EE, later arguing on page 27 that the "consumption forecast should investigate customer price elasticity" by including electricity price as a regression variable. Does LUMA have a response?**

A. Yes.

**Q. 49 ~~Q. 53~~ Please state and explain LUMA's response.**

A. Mr. Ming adopted Dr. Cao's idea that electricity price should be included as a regression variable because it can influence both electricity consumption and customer adoption of DG or EE measures. While these assumptions are theoretically sound in the context of microeconomic demand modeling, the empirical evidence and practical forecasting considerations in Puerto Rico suggest that including electricity price in the residential regression would not improve forecast performance. In fact, it may introduce statistical complications. One such complication lies in how the projected price per kWh would be derived, as it is directly related to the projected load, creating a circular dependency in the forecast.

Moreover, all studies reviewed indicate that electricity consumption is price inelastic. For example, between FY2021 and FY2022, the average residential electricity price increased by approximately 30%, yet total residential consumption declined by only 0.4%. This weak relationship indicates that price is not a strong explanatory variable for short- to medium-term consumption behavior in this context.

Furthermore, out-of-sample testing conducted in 2023 showed that including electricity price in the regression did not improve forecast accuracy. In fact, the inclusion of price introduced concerns related to endogeneity and multicollinearity with other macroeconomic variables, such as income and economic activity, which can bias coefficient estimates and reduce model reliability.

It is also important to note that many U.S. utilities, including those regulated by state commissions, do not include electricity price in their long-term load forecasting models. A 2016 study by Lawrence Berkeley National Laboratory (Refer to Exhibit 72.01, at ¶ 1) found that only about half of load-serving entities explicitly modeled price elasticity in their forecasts. Utilities such as Portland General Electric (Refer to Exhibit 72.01, at ¶ 2), ISO New England, and DTE Electric (Refer to Exhibit 72.01, at ¶ 3) have published methodologies that exclude price as a direct input, yet their forecasts are accepted by regulators and used for integrated resource planning.

In conclusion, while electricity price is conceptually relevant, its empirical contribution to forecast accuracy in Puerto Rico's residential sector is minimal. LUMA's decision to exclude price from the base case regression model is grounded in empirical testing, statistical rigor, and alignment with industry best practices. The model remains robust, transparent, and fit for purpose in supporting long-term planning and regulatory review.

**Q. 50** ~~**Q. 54**~~ **On page 22, Mr. Ming disagreed with Dr. Cao about including disposable personal income in the regression and instead supports "LUMA's decision to use GNP as the key economic variable" as a reasonable choice. Does LUMA agree.**

A. Yes.

**Q. 51** ~~**Q. 55**~~ **On page 25, Mr. Ming states, "LUMA forecasted annual peak demand applying historical load factors to the consumption of each customer class. LUMA's approach inappropriately ignores the load shape of load modifiers. Load modifiers affect usage at different times of day; therefore, a simple load factor without a more detailed load shape cannot capture their impact on peak demand. In particular, DG likely produces some energy during peak hours that potentially shifts the system peak demand later in the day." Does LUMA agree?**

A. No.

**Q. 52** ~~**Q. 56**~~ **Please state and explain LUMA's response.**

A. LUMA respectfully disagrees with Mr. Ming's statement. However, regarding his recommendation, once the load profile study is completed, LUMA intends to update the load factors by rate category, incorporating a more refined customer segmentation (for example, between GRS Regular and GRS Net Metering customers).

**DETERMINATION OF ANNUAL MAXIMUM LOAD**

To estimate the annual maximum load, LUMA allocated energy consumption by customer class and rate category based on the most recent 12-month proportional distribution of consumption by rate. Once the consumption was distributed, load factors by rate (the same used in the approved 2020 IRP) were applied. Finally, the non-coincident load by rate was totaled for each fiscal year. To determine the forecasted annual peak load, the annual variance of the total non-coincident load is applied to the most recently observed peak demand, usually from the fiscal year in which the projection is made.

It is also important to consider Puerto Rico's load profile. While DG systems, particularly solar PV, typically generate electricity during daylight hours and may reduce peak demand in some jurisdictions, this is not the case in Puerto Rico. The island's system peak occurs between 6:00 PM and 9:00 PM, after solar generation has largely ceased. As a result, DG does not reduce peak demand during these critical hours. In fact, by lowering mid-day load and leaving evening demand unchanged, DG may inadvertently increase the relative height of the peak. This is precisely why LUMA relies on historical load factors, which already reflect the net impact of DG on peak demand under local conditions.

LUMA initiated a load profile study in March 2024, selecting a sample of approximately 60 customers from different rates (different customer characterization) with hourly meter readings. Preliminary load profile data from this study were incorporated into the forecasting procedure. However, due to ongoing data collection challenges, the dataset remains incomplete. At the time the forecast was developed, there was insufficient data to update the load profiles for each rate category. In particular, LUMA has not yet been able to collect hourly data for certain critical rate classes, most notably primary voltage customers. These data limitations have also delayed the imputation process needed to address missing values across several months, further constraining the completeness and accuracy of the load profiles.

**Q. 53 ~~Q. 57~~ Does this complete your testimony?**

A. Yes

**LUMA Ex. 72.01**

**APPENDIX 1 TO SURREBUTTAL TESTIMONY OF JOSELINE N. ESTRADA RIVERA**

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**LUMA Ex. 72.02 (*An Analysis of the Economic Impact of Increasing the Price of Electricity in Puerto Rico*, prepared by Navigant Economics, August 19, 2016 )**

**LUMA Ex. 72.03 (Improvement 5 CHP Report 2024-05-23)**

# LUMA Ex. 72.04 (Improvement 5 Report - Solar PV 2024-04-29)

**LUMA Ex. 72.05 (Attachment 1 to LUMA's Response to SESA-of-LUMA-DIST-26).**

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