IN THE UNITED STATES DISTRICT COURT

DISTRICT OF PUERTO RICO

In re: THE FINANCIAL OVERSIGHT AND MANAGEMENT BOARD FOR PUERTO RICO, as representative of THE COMMONWEALTH OF PUERTO RICO, *et al.*, Debtors.[1]	PROMESA Title III Case No. 17-BK-3283-LTS (Jointly Administered)
In re: THE FINANCIAL OVERSIGHT AND MANAGEMENT BOARD FOR PUERTO RICO, as a representative of PUERTO RICO ELECTRIC POWER AUTHORITY, Debtor.	PROMESA Title III Case No. 17-BK-4780-LTS

DECLARATION OF WILLIAM P. ZARAKAS IN RESPECT OF CONFIRMATION OF CORRECTED FOURTH AMENDED TITLE III PLAN OF ADJUSTMENT FOR THE PUERTO RICO ELECTRIC POWER AUTHORITY

FEBRUARY 12, 2024

[1] The Debtors in these Title III Cases, along with each Debtor's respective Title III case number and the last four (4) digits of each Debtor's federal tax identification number, as applicable, are the (i) Commonwealth of Puerto Rico (Bankruptcy Case No. 17-BK-3283-LTS) (Last Four Digits of Federal Tax ID: 3481); (ii) Puerto Rico Sales Tax Financing Corporation (Bankruptcy Case No. 17-BK-3284-LTS) (Last Four Digits of Federal Tax ID: 8474); (iii) Puerto Rico Highways and Transportation Authority (Bankruptcy Case No. 17-BK-3567-LTS) (Last Four Digits of Federal Tax ID: 3808); (iv) Employees Retirement System of the Government of the Commonwealth of Puerto Rico (Bankruptcy Case No. 17-BK-3566-LTS) (Last Four Digits of Federal Tax ID: 9686); (v) Puerto Rico Electric Power Authority (Bankruptcy Case No. 17-BK-4780-LTS) (Last Four Digits of Federal Tax ID: 3747); and (vi) Puerto Rico Public Buildings Authority (Bankruptcy Case No. 19-BK-5523-LTS) (Last Four Digits of Federal Tax ID: 3801) (Title III case numbers are listed as Bankruptcy Case numbers due to software limitations).

I, William P. Zarakas, hereby declare, pursuant to 28 U.S.C. § 1746, that the following statements are true and correct:

1. I am a Principal with The Brattle Group ("Brattle"), an economic consulting firm, where I lead the firm's practice relating to utility regulatory analysis and business models. I have approximately 40 years of experience working in the electric utility and telecommunications industries, primarily in the areas of regulatory economics, utility ratemaking, regulatory frameworks and utility business models. My work in these areas involved the modeling of electricity load, embedded and marginal costs, revenue requirements and rates. I have also worked on matters involving alternative regulatory mechanisms, performance based rates (PBR) and performance incentive mechanisms (PIMs). Prior to my employment with The Brattle Group and other consulting firms, I worked as an economist for the New York Power Authority, where my responsibilities included electric utility revenue requirement modeling and ratemaking, and economic analyses of large customer load requirements.

2. I have also worked on a wide range of regulatory issues in the telecommunications industry, initially traditional revenue requirements and rate cases, and then access pricing, marginal cost pricing, price caps and performance based rates. My recent work in the telecommunications industry primarily involves competition and antitrust matters, frequently relating to mergers and acquisitions.

3. I have provided expert reports and/or testimonies before numerous state regulatory commissions, the Federal Communications Commission (FCC), the Federal Energy Regulatory Commission (FERC), the Securities and Exchange Commission (SEC) and the Copyright Royalty Judges (Library of Congress).

4. I hold a Masters degree in economics from New York University and a Bachelor of Arts degree in economics from the State University of New York. My curriculum vitae is included as **Appendix A**.

5. The Financial Oversight and Management Board for Puerto Rico (the "Oversight Board"), as the Title III representative of the Puerto Rico Electric Power Authority ("PREPA" or the "Debtor"), pursuant to Section 315(b) of the Puerto Rico Oversight, Management, and Economic Stability

Act ("PROMESA"), retained Brattle to serve as advisor to the Oversight Board in connection with the Oversight Board's duties under PROMESA, including its task of developing a plan of adjustment of PREPA's debts pursuant to Title III of PROMESA. In that regard, applying my experience, I led the development of the Revenue Envelope and Legacy Charge Model and advised the Oversight Board regarding related matters.

6. Specifically, the Oversight Board retained Brattle to assist it in determining the incremental revenues that PREPA could reliably derive through incremental rate charges to its customers (*i.e.*, a charge in addition to the pre-debt service rates projected in PREPA's 2023 Certified Fiscal Plan (the "2023 Fiscal Plan")), without making it overly expensive to live and do business in Puerto Rico and without making it "impossible to terminate Puerto Rico's negative economic growth and to achieve sufficient positive growth to restore Puerto Rico's overall economic health."[2] This amount, after the adjustments discussed below, could then be used to fund new bonds that will be provided to creditors and provide sufficient financial resources for debt service proposed in the Plan (the "New Bonds"). Brattle was asked to apply utility regulatory, ratemaking and business practice and considerations to its analysis to the extent possible.

7. I submit this declaration ("Declaration") in respect of confirmation of the *Corrected Fourth Amended Title III Plan of Adjustment of the Puerto Rico Electric Power Authority*, dated December 29, 2023 [Case No. 17-4780, ECF No. 4345] (as the same may be amended or modified, including all exhibits and supplements thereto, the "Plan").[3]

8. My statements set forth in this Declaration are based on my personal knowledge and experience except where I reference specific documents or communications as the basis of my statements. In those instances where I reference a specific document or communication, the specific document or communication either is not being offered to prove the truth of the matter asserted in the statement or, as I am informed, is otherwise admissible because, for instance, it is a self-authenticating public record or can be otherwise authenticated and shown to be admissible.

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[2] Notice of Filing of Statement of Oversight Board Regarding PREPA's Title III Case, July 2, 2017, ECF 2, ¶21.

[3] All ECF references are to the Case No. 17-BK-4780, unless otherwise noted.

9. Where this Declaration provides opinion testimony, in addition to the above, the opinions set forth herein are based on (i) my understanding of information shared with me by other members of the Brattle team working directly with me or under my supervision and direction; (ii) additional information of the types generally relied on by others who have similar experience and expertise in my field such as information provided by the Oversight Board and its advisors, and other interested parties and their respective advisors concerning the restructuring, and/or (iii) my experience in my field as described above.

10. My Declaration is composed of four sections. In Section I, I describe the methodology that Brattle employed to address the Oversight Board's request, *i.e.*, to determine the incremental revenues that can be raised by PREPA within specified constraints, as indicated above and discussed in greater detail later in this declaration. In that section I also describe the model that Brattle developed and used to calculate the incremental revenues that could be raised by PREPA to pay its legacy debt, referred to as the Revenue Envelope and Legacy Charge Model. In Section II, I describe the derivation of the Revenue Envelope portion of the model. In Section III, I describe the Legacy Charge portion of the model. In Section IV, I discuss model results and sensitivities.

I. INCREMENTAL REVENUE METHODOLOGY

11. As indicated above, the Oversight Board retained Brattle to assist it in determining the incremental revenues that PREPA could reliably derive through incremental rate charges to its customers (*i.e.*, a charge in addition to the pre-debt service rates projected in the 2023 Fiscal Plan), subject to certain constraints, which I discuss further later in this declaration.

12. In general terms, electric utility rates are traditionally derived by estimating the total annual costs required for the utility to provide reliable service to its customers (referred to as the utility's revenue requirements) and then dividing those costs by the kWh sales projected for the associated year.[4] The utility's total annual revenue requirement typically includes all of the

[4] In revenue requirement modeling, the per kWh rate is equal to the average revenue requirement per kWh. Dr. Tierney describes these standard ratemaking practices in her expert report dated December 18, 2023. Expert

utility's annualized costs, including operating and maintenance expenses, the costs of fuel and purchased power, the depreciation of assets, as well as the costs associated with capital, including debt service and, for investor owned utilities (IOUs), a return on equity capital.

13. Utilities also use revenue requirement models as financial planning tools. These models assume that rates charged to utility customers are adjusted (*e.g.*, via a rate increase) on an annual basis by the associated regulatory authority, even though rate case schedules may be less predictable than the timing assumptions included in a revenue requirement model.

14. In Puerto Rico, the Puerto Rico Energy Bureau (PREB) has rate making authority over PREPA. PREPA charges to customers are structured under tariffs. The basic revenue component of each tariff includes a fixed monthly customer charge and a rate schedule of volumetric charges, plus demand-related charges for the majority of non-residential customers. Together, these charges are referred to as "Basic Revenue" in PREPA's Fiscal Plan revenue requirement model. In practice, the rates on which Basic Revenues are determined in a "rate case" before PREB, and may not be adjusted to match the revenue requirement included in PREPA's Fiscal Plan. In addition, PREPA charges customers additional charges referred to as "riders," which are cost areas that are flowed-through to customers via quarterly (or, in some instances, more frequent) adjustments based on PREPA's actual incurred costs. PREPA's annual revenues have not kept pace with its revenue requirements.

15. Under normal conditions, utilities and regulators include all of the utility's costs in the rates derived under the revenue requirement methodology; *i.e.*, they include the utility's cost of capital inclusive of debt service. Concerns that regulators may have with steep and/or overly burdensome rate increases, under normal circumstances, are sometimes addressed by having the utility moderate its capital investments and/or reduce the magnitude of its operating costs.[5] As

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Report of Susan Tierney, PhD, December 18, 2023, ¶¶43-48. *See* Mark. T. Bryant "Ratemaking in the U.S," Public Utility Commission of Texas, July 23, 2009, available at https://pubs.naruc.org/pub.cfm?id=53768A01-2354-D714-517A-DC3B4EC72920. *See* Tom Frantz "Overview of Electric Utility Ratemaking," New Hampshire Public Utilities Commission, October 4, 2019, available at https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/2020-01/20191004-puc-presentation.pdf.

[5] This point is also made by Dr. Tierney in her expert report. *See* Expert Report of Susan Tierney, PhD, December 18, 2023, ¶45. "To the extent that utilities and their regulators exercise restraint to address

indicated earlier, in its Title III filing on behalf of PREPA, the Oversight Board explained its concern that increases in the electricity rates that PREPA charges its customers may have adverse impacts on consumers and businesses in Puerto Rico and potentially on the overall Puerto Rican economy. However, given PREPA's exceptionally low system reliability and aging infrastructure,[6] such cost moderation and/or deferral options are not available without risking further deterioration of Puerto Rico's electric system and an associated further decline in service quality.

16. This left the Oversight Board with limited options to increase rates to service legacy debt obligations. Notably, Title III allowed the Oversight Board to consider reducing PREPA's repayment of legacy debt. At the Oversight Board's direction, Brattle developed a model to determine the incremental revenues that can be raised by PREPA through rate increases, above those projected in the 2023 Fiscal Plan, with consideration of (i) the affordability of electricity to residential customers in Puerto Rico and (ii) generally applied regulatory and ratemaking practices, particularly the practice that the revenue requirement for each rate class follows the cost of serving such rate class.

17. I and experts for the Oversight Board have made clear that determining the maximum level for utility rates based on affordability is not a standard approach used in utility ratemaking.[7] A more common practice is for utilities and regulators to determine the utility's revenue requirement based on all of its costs, and then develop subsidy arrangements for the segment of residential customers that is subject to an affordability constraint. In these cases, residential customers

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affordability issues at the revenue-requirement step, they do so by moderating the pace and degree of investment programs (e.g., to modernize the utility's infrastructure, or to improve its call centers) or extraordinary expenses (e.g., storm-recovery expenses) consistent with the need to keep the system safe and reliable." In addition to the options described by Dr. Tierney, in some cases, regulators have deemed certain utility investments to be imprudent and disallowed cost recovery in whole or in part; for investor-owned utilities, the brunt of such a ruling is typically borne by equity holders. Overall, however, in normal circumstances, a utility's cost of capital is fully included in its revenue requirements and resulting rates.

6 *See* discussion regarding PREPA's performance compared to those of similar public utilities at 2023 Fiscal Plan at 23-24 ("In 2021 PREPA's customers experienced 7.8 service interruptions, approximately seven times as many service interruption as customers of the median US utility, based on IEEE benchmarks. Similarly, the average duration of power outages was approximately 11.5 times longer for PREPA customers than for median mainland customers in 2021").

7 Deposition of William Zarakas, December 12, 2023 at 333:5-13. Expert Rebuttal Report of Jurgen Weiss, PhD, January 12, 2024, ¶¶27-28.

subject to affordability concerns constitute a relatively small portion of total residential customers served by the utility. The Oversight Board stressed its concern about residential customer affordability because a comparably high percentage of PREPA's residential customers already face affordability issues and/or would find electricity unaffordable if rates were set based on a revenue requirement including full repayment of PREPA's legacy debt.[8]

18. Brattle and the Oversight Board adopted two parameters for determining residential customer affordability: (i) affordability analysis should be conducted on a representative household living in Puerto Rico on a permanent basis (*i.e.*, not a part-time or vacation home) and earning median income as reported by the U.S. Census Bureau (specifically through the most recent Puerto Rico Community Survey ("PRCS")); and (ii) the affordability threshold is such that household spending on home energy should be no more than 6% of household income. The affordability concept, in general, and the 6% share of wallet and median income parameters, in particular, were being used by the Oversight Board and by Bondholders during mediation, prior to Brattle's involvement in this case.[9]

A. MEDIAN INCOME HOUSEHOLDS

19. The median-income household was selected as the reference case for conducting an affordability analysis because: (i) the median-income household is typically used as a reference to assess issues of economic welfare, as it represents the center of the income distribution and thus a "typical" or "representative" household; and (ii) for PREPA, as discussed below, the median-income household also represents the first tier of residential customers by income subject to the full Legacy Charge.

20. As reported in its 2023 Fiscal Plan, in FY2025, the first year when the Legacy Charge is expected to be implemented, PREPA is expected to have 1,378,874 residential customers. Of these, we estimate that 757,447 or 55% of PREPA's residential customers will be subject to the

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[8] Expert Rebuttal Report of Jurgen Weiss, PhD, January 12, 2024, ¶¶17-20.

[9] Deposition of Maureen Chakraborty, January 30, 2024 at 106:1-18.

full Legacy Charge and 621,427 or 45% will be exempted from the Legacy Charge.[10] Therefore, the first tier of residential customers by income subject to the full Legacy Charge earn an annual income close to the median income.

21. Accordingly, we performed the affordability analysis focusing on the median-income household living permanently in Puerto Rico and receiving non-subsidized electricity service from PREPA; *i.e.*, the first tier of PREPA residential customers that are expected to pay the full residential Legacy Charge. The 2022 PRCS reports that the median annual household income in Puerto Rico was $24,002 for calendar year ("CY") 2022.[11] We estimated the median annual household income in Puerto Rico in FY2025 (the anticipated start year of bill increases pursuant to the Plan) by applying the inflation assumptions included in the 2023 Fiscal Plan.[12] This resulted in an estimated median income in FY2025 of approximately $25,520. We next analyzed the total bill that the median-income household is expected to be able to afford in FY2025.

22. I am aware that the expert for the Bondholders, Dr. Chakraborty, has concluded that changing the reference case (in the affordability module of Brattle's Revenue Envelope and Legacy Charge Model) to a household income strata higher than median income, would, mechanically, cause the model to report higher Legacy Charge Revenues – although the Bondholders' expert does not specifically recommend doing so.[13] However, applying the 6% share of wallet to the 55th percentile of Puerto Rico households misapplies the share of wallet concept. Specifically, it seeks to increase rates so that customers with above median incomes are brought to the energy

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[10] Revenue Envelope and Legacy Charge Model, tab "Residential Classes." Residential customers to be exempt from the Legacy Charge include 260,509 customers receiving electricity service under PREPA subsidized tariffs, RH3, LRS, and RFR, and an additional 360,918 residential customers who are eligible for Medicaid (as estimated through EITC filings) but likely not in PREPA's subsidized tariff classes. Customers exempt from the Legacy Charge are exempt from the Customer Charge (fixed monthly charges) portion of the Legacy Charge and the Volumetric Charge portion of the Legacy Charge for consumption up to 425 kWh per month; *i.e.*, they are only subject to the Volumetric Charge portion of the Legacy Charge for consumption above 425 kWh per month at a reduced rate compared to that of non-exempt customers.

[11] The PRCS is an annual census data survey published by the U.S. Census Bureau as part of its American Community Survey. The median annual household income of $24,002 is a five-year average for the period CY2018-2022, expressed in 2022 dollars. This five-year average was included in the PRCS in order to avoid inconsistent reporting of transfer payments due to inclusion of non-recurring federal income support such as COVID relief and stimulus payments, supplemental unemployment insurance benefits and advance child tax credit payments as advised FOMB Advisor EY. *See* https://data.census.gov/table/ACSST5Y2022.S1903?q=Puerto%20Rico%20household%20income.

[12] Revenue Envelope and Legacy Charge Model, tab "Income Input."

[13] Expert Rebuttal Report of Maureen M. Chakraborty, PhD, January 12, 2024, ¶¶16-19.

burden level. This is inappropriate. As discussed below, the Oversight Board has already stretched the applicability of the 6% electricity share of wallet as an affordability threshold beyond its original intention – that is, as a threshold as to when lower income households should avail themselves of support – which resulted in expanding the number of households in Puerto Rico that will be at or near energy burden levels.

B. 6% HOME ENERGY SHARE OF WALLET

23. Spending on home energy, or the home energy "share of wallet," refers to the spending on electricity and other fuels in the home as a percentage of gross household income. For purposes of the affordability analysis, we assume that electricity represents the only material home energy expenditure for households in Puerto Rico, despite that some households may also use propane (for cooking, water heating and/or other uses) and diesel fuel to power back-up generators. Thus, the assumption that electricity encompasses the entirety of home energy consumption likely overstates the appropriate affordable share of wallet for electricity.

24. The Oversight Board has adopted a home energy share of wallet of 6% for use in the affordability analysis of median-income households in Puerto Rico, based on home energy spending levels specified by regulators and policymakers in various U.S. jurisdictions (such as New York, Illinois and Colorado)[14] as an indicator of energy burden.[15] In those jurisdictions, 6% of household income spent on home energy represents the point at which affected customers (typically, *low-income* households) become eligible for financial support to ensure adequate

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[14] For instance, New York State established an energy affordability target for the state of 6% in 2016. *See,* "Understanding and Alleviating Energy Cost Burden in New York City, NYC Mayor's Office of Sustainability and the Mayor's Office for Economic Opportunity August 2019, available at https://www.nyc.gov/assets/sustainability/downloads/pdf/publications/EnergyCost.pdf. In January 2023, New York Governor Kathy Hochul proposed the Energy Affordability Guarantee, legislation that would ensure that participating New Yorkers do not pay more than 6% of their incomes on electricity. (*See* "Governor Hochul announces transformative investments in energy affordability, building efficiency, and clean air and water." January 10, 2023, Governor Kathy Hochul, https://www.governor.ny.gov/news/governor-hochul-announces-transformative-investments-energy-affordability-building-efficiency.)

[15] *See,* Brown, Marilyn A., et al. "High energy burden and low-income energy affordability: Conclusions from a literature review." Progress in Energy 2.4 (2020): 042003.

access to essential energy services.[16] That is, application of the 6% home energy share of wallet is not an aspirational goal – that all, or even all low- and moderate-income households can afford to spend or should spend 6% of their household incomes on home energy – rather, it is the threshold at which affected customers can avail themselves of social programs (whether implemented by the utility or otherwise) to supplement their home energy spending.

25. The affordability analysis included in the Revenue Envelope and Legacy Charge Model intentionally differs from the applications described above and is used to address the specific circumstances before the Oversight Board. That is, it is designed to determine the maximum additional incremental revenues that can be raised by PREPA through the rates it charges to its customers, balancing the objective to repay as much of legacy debt as possible and the need to remain as true as possible to the concepts underlying the energy wallet share as it is applied in other U.S. jurisdictions. The 6% home energy share of wallet in the case of PREPA differs from that of other jurisdictions in two primary regards. First, the 6% home energy share of wallet in the affordability analysis module of the Revenue Envelope and Legacy Charge Model is applied to *median*-income households, rather than to the low- and moderate-income households to which the 6% home energy share of wallet is typically applied. With this use of the 6% home energy share of wallet, the Oversight Board *increased* the electricity bill level usually applied when applying home energy shares of wallet by using a higher level of household income; that is, using median household incomes, which are higher than low or moderate household incomes. Second, the Oversight Board is using the 6% home energy share of wallet applied to median-income households as a mechanism to *increase* PREPA's rates in order to repay legacy debt. In contrast, other jurisdictions use the 6% home energy share of wallet as a method mainly to

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[16] For decades, researchers have used a threshold of 6% of total household income to delineate consumers that experience high energy burdens. Furthermore, several states in the U.S. provide financial assistance to consumers who spend 6% or more of their household income on energy bills. *See* Drehobl, Ariel, Lauren Ross, and Roxana Ayala. "How high are household energy burdens? An Assessment of National and Metropolitan Energy Burdens across the US." (2020), https://www.aceee.org/sites/default/files/pdfs/u2006.pdf, and Washington State Department of Commerce. Low-Income Energy Assistance 2023 Legislative Report (March 6, 2023), https://app.leg.wa.gov/ReportsToTheLegislature/Home/GetPDF?fileName=CommerceReports_2023_Energy_Energy%20Assistance%20Report_Final_5001c308-6921-403b-b140-bd6e15d1a31a.pdf.

identify low-income customers that should have their utility bills *reduced*, either through subsidized electricity rates or other programs.

26. Furthermore, the 6% home energy share of wallet applied to median-income households in Puerto Rico is much higher than what similarly situated households spend on electricity elsewhere in the United States. For context, U.S. median-income households on average spent approximately 2.5% of household income on electricity in CY2022, while Puerto Rico median-income households spent approximately 5.6% during the same year before any legacy debt service.[17] In addition, households elsewhere in the U.S. enjoy significantly superior energy reliability compared to Puerto Rican households; that is, households in Puerto Rico paid more for electricity service while receiving lower quality service. Finally, given already high electricity rates in Puerto Rico, the 6% of income dedicated to the purchase of electricity buy substantially less electricity than could typically be purchased in other jurisdictions.

27. The Bondholders' expert, Dr. Chakraborty, disagrees with the Oversight Board's use of a 6% home energy share of wallet in her December 18, 2023 report, and claims that a home energy share of wallet greater than 6% is more appropriate for an electricity affordability analysis in Puerto Rico.[18] Dr. Chakraborty acknowledged a home energy share of wallet of 6% was used in various jurisdictions, but also indicated that its derivation can be traced back to studies that showed home energy share of wallet to be 20% of shelter cost, which, in turn, was estimated to be 30% of household income.[19] Dr. Chakraborty claims that shelter costs are lower in Puerto Rico than is the case elsewhere in the U.S., and that an affordable home energy wallet share should be greater than 6% in Puerto Rico.[20] Dr. Chakraborty's criticism is misplaced.

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[17] 2.5% and 5.6% represent the trimmed mean (after removing top and bottom 5%) electricity share of wallet for median-income households across the U.S. and in Puerto Rico, respectively, based on data from the 2022 American Community Survey and the 2022 PRCS. The median electricity share of wallet for U.S. and Puerto Rico median-income households is 2.3% and 4.9%, respectively. *See* Expert Rebuttal Report of Jurgen Weiss, PhD, January 12, 2024, Figure 13.

[18] Expert Report of Maureen M. Chakraborty, PhD, December 18, 2023, ¶49.

[19] Expert Report of Maureen M. Chakraborty, PhD, December 18, 2023, ¶49.

[20] Expert Report of Maureen M. Chakraborty, PhD, December 18, 2023, ¶49.

28. First, as discussed above, a 6% home energy share of wallet is commonly used in other U.S. jurisdictions on a standalone basis, without reference to shelter costs. Second, as Dr. Weiss demonstrated in his expert rebuttal report, median-income households in Puerto Rico that pay rent or have a mortgage reported a much higher shelter share of wallet than Dr. Chakraborty presented, close to or exceeding 30%.[21] Therefore, these households likely cannot afford a home energy share of wallet greater than 6%. Third, Dr. Chakraborty failed to consider the cost of other household essentials in Puerto Rico relative to other U.S. jurisdictions. For instance, the prices of food, clothing, and gasoline in Puerto Rico may be similar in absolute dollar terms compared to the rest of the U.S., or even higher.[22] For these reasons, Dr. Chakraborty's partial expansion of the affordability analysis to consider housing costs but not other living costs is incomplete. The home energy share of wallet on a standalone basis is more appropriate for the affordability analysis.

C. RATE INCREASE PROPORTIONALITY

29. The amount of rate increase and incremental revenues that PREPA can raise from a Legacy Charge imposed on commercial and industrial customers was based on scaling the rate increase percentages developed for PREPA's residential class of customers to the commercial and industrial classes of customers. That is, the incremental rates applied to PREPA's commercial and industrial customers developed in the Revenue Envelope and Legacy Charge Model was *not* based on an affordability analysis for these customer segments. The scaling approach used to determine incremental rate increases for PREPA's commercial and industrial was applied for two reasons.

30. First, Brattle and the Oversight Board agreed that generally accepted ratemaking principles should be applied to the extent possible. One of those principles involves allocating costs among customer classes such that cost recovery via rates for each customer class is proportional to the

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[21] Expert Rebuttal Report of Jurgen Weiss, PhD, January 12, 2024, Figure 6.

[22] Expert Rebuttal Report of Jurgen Weiss, PhD, January 12, 2024, ¶¶50-51.

utility's cost of serving that customer class.[23] PREPA's current rates for its various customer classes are based on a previously conducted cost of service analysis. We use the distribution (*i.e.*, proportions) of projected revenue requirements and revenues for each of PREPA's customer classes as included in PREPA's 2023 Fiscal Plan as representative of the costs of providing service to those classes (in percentage terms). We use these percentage distributions as the basis for determining Revenue Envelope and Legacy Charge rates and revenues for PREPA's commercial, industrial and government customer classes.

31. Second, to my knowledge, there is no approach to determining the affordability of rates for non-residential customer analogous to the residential share of wallet concept described above. There is therefore no existing framework that could be used to attempt such an analysis. Developing and implementing approaches for assessing the affordability of rates to non-residential customers faces significant conceptual issues. For example, there are a wide range of customers within a commercial or industrial class, with a wide range of profit margins, making determining incremental rates based on affordability challenging and quite possibly leading to damage to the commercial and industrial sectors in Puerto Rico. Furthermore, regulatory practices generally require that the same rates be charged to similarly situated customers (*i.e.*, those in the same class of service based on the type of service received), rather than being based on affordability or willingness of customers to pay.

32. Increasing rates to commercial and industrial customers beyond the proportional increase discussed above could also have negative impacts on the Puerto Rico economy. As Prof. Simon Johnson states in his expert report, a portion of any increase in a firm's costs (whether electricity rates or otherwise) will be passed on to customers (including other businesses and/or residential consumers), and these pass-throughs tend to have economic consequences, notably in the form of reduced macroeconomic output.[24]

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[23] Bondholder expert Dr. Tierney describes the cost allocation process in her December 18, 2023 report at page 27: "A standard principle of utility ratemaking is that customers should pay their fair share of the utility's cost of service, and this serves as a key principle affecting both cost allocation and rate design. There are standard technical studies and analyses that inform the allocation of different types of costs to different types of customers, and other studies that inform the pricing of utility services, so that the rates charged to customers produce the utility's revenue requirement." Dr. Tierney cites National Association of Regulatory Utility Commissioners, "Primer on rate design for cost-reflective tariffs," January 2021.

[24] Expert Rebuttal Report of Professor Simon Johnson, January 12, 2024, ¶¶165-182.

33. A subset of commercial and industrial customers is proposed to be exempt from the Legacy Charge. These include municipal customers (served under PREPA's commercial tariffs) and Public Lighting, Agricultural and Other customer categories (served under specific tariffs other than residential, commercial and industrial). Municipal customers account for 0.5% of total PREPA customers and 2.3% of total kWh sales as of FY2021, based on data provided by LUMA.[25] The Board's advisors indicated that Municipal customers compensate PREPA for electricity via Contributions In Lieu of Taxes (CILT), such that Municipalities are exempted from paying for electricity consumption up to a cap in exchange for PREPA's exemption from paying taxes to the Municipalities. Based on the 2023 Fiscal Plan, as of FY2025, Public Lighting, Agricultural and Other customers account for 0.2% in terms of numbers of total PREPA customers, less than 2% of PREPA's total kWh sales, and 2% of PREPA's total revenues.[26]

D. REFERENCE YEAR

34. Brattle selected FY2025 as the reference year for conducting the residential customer affordability analysis for developing the Legacy Charge rates for non-exempt residential customers. The Legacy Charge rates for PREPA's commercial and industrial customers were then developed based on the proportionality discussed above. Brattle and the Oversight Board used a single reference year as the basis for setting Legacy Charge rates for three reasons.

35. First, the Oversight Board did not view the 6% share of wallet (that was used to determine residential customer affordability and, in turn, determine residential Legacy Charge rates) as an equilibrium or aspiration goal – in line with the way the 6% share of wallet is viewed by policymakers and regulators elsewhere in the U.S. This is in contrast to views that electricity

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[25] Revenue Envelope and Legacy Charge Model, tab "RE_Inputs." The revenues that would be raised by Municipal customers were included in the calculation of incremental Revenue Envelope. As Municipal customers were exempted from payment of legacy debt, these revenues were proportionately redistributed to PREPA's residential, commercial, government and industrial customers for Legacy Charge Revenues calculation purposes.

[26] Revenue Envelope and Legacy Charge Model, tab "Rate_Revs" cells N10:N13, N19:N22 and tab "Calc_Revs" cells G148:G151.

rates should be adjusted upward to ensure that a 6% share of wallet for reference residential customers is maintained throughout the 35-year term of the Legacy Charges.[27]

36. Second, the Oversight Board's financial advisor advised that keeping the Legacy Charge rate constant would potentially allow PREPA to have capacity to raise new capital in the future in case PREPA would need to address unforeseen expenditures.

37. Third, as a check on Revenue Envelope and Legacy Charge implementation, an electricity share of wallet analysis was conducted for each year in the 28 year term of the 2023 Fiscal Plan, based on inflation-adjusted annual household incomes, downward-adjusted monthly kWh usage for representative median income households, and the electricity rates projected in the 2023 Fiscal Plan.[28] As shown in Section IV (Model Results and Sensitivities) of this declaration, after the imposition of the Revenue Envelope and Legacy Charge, the electricity share of wallet for median-income households in Puerto Rico is projected to remain near 6% throughout the 28-year period, and in some years is projected to exceed 6%.

E. MODEL AND DATA

38. The Brattle team used the Revenue Envelope and Legacy Charge Model to determine the incremental revenues that can be used to fund the New Bonds. The model accomplishes three primary tasks. First, the Revenue Envelope and Legacy Charge Model calculates the total amount of incremental revenues that PREPA can raise subject to the affordability and cost of service proportionality constraints discussed above. This total amount is referred to as the "Revenue Envelope." Second, the model determines the amount of the Revenue Envelope that can be used to repay creditors, taking into account price elasticity of demand. Electric utility customers including PREPA customers typically respond to higher rates by reducing consumption, all else equal. As a result, when implementing the incremental Revenue Envelope rates, PREPA is expected to experience incremental declines in electricity sales and may not fully cover the fixed cost portion of its electric system as planned for in the 2023 Fiscal Plan.

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[27] The 2023 Fiscal Plan contained projections over a 28-year period. I discuss the extrapolation of the Revenue Envelope to 35 years later in this declaration.

[28] Expert Rebuttal Report of Jurgen Weiss, PhD, January 12, 2024, Figure 2.

Therefore, a portion of the Revenue Envelope needs to be set aside to cover the expected fixed cost underrecovery. The remaining revenues available to repay creditors, referred to as the Legacy Charge Revenues, are calculated as the Revenue Envelope less the portion that needs to be set aside to cover PREPA's fixed cost underrecovery. Third, the model provides a Legacy Charge rate schedule for the various PREPA residential, commercial and industrial rate classes that, when implemented, is expected produce the Legacy Charge Revenues.

39. The Revenue Envelope and Legacy Charge Model relies on two primary data sources: (i) the 2023 Fiscal Plan and accompanying financial model (the "Fiscal Plan Model"),[29] and; (ii) the 2022 PRCS.

40. The 2023 Fiscal Plan and the Fiscal Plan Model provide data on PREPA's projected costs, kWh sales, revenues and rates for the period FY2024 through FY2052, segmented by customer class (*e.g.*, residential, commercial and industrial). PREPA's annual cost projections (*i.e.*, revenue requirements) are presented in the aggregate and by category (*e.g.*, basic revenues, necessary maintenance expenses, fuel and purchased power), before and after legacy debt service.[30] The Fiscal Plan Model provides annual revenue requirements in absolute dollars and in terms of rates, which are calculated as the annual revenue requirements in dollars divided by the kWh sales projected for that year.[31] PREPA's projected revenue requirements, kWh sales and rates (for PREPA overall and for individual customer classes) are particularly important inputs into the Revenue Envelope and Legacy Charge Model because (i) PREPA's revenue requirements and rates provide the basis for the electricity bills that PREPA's customers are projected to pay prior to consideration of repayment of legacy debt – which becomes the starting point for residential customer affordability analysis; and (ii) PREPA's customer count and load forecasts (*i.e.*, its projections of annual kWh sales) provide the basis upon which the Legacy Charge rates can be applied.[32] PREPA's fiscal plans are updated each year prior to the commencement of the

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[29] "June 2023 PREPA Fiscal Plan – Financial Model" (06.30 - PREPA FY2024 Fiscal Plan Model_vSHARE.xlsx).

[30] Fiscal Plan Model, tab "Calc_Revs."

[31] Fiscal Plan Model, tab "Calc_Revs."

[32] As will be discussed later in this declaration, the design of Legacy Charges includes a fixed Customer Charge and a set of Volumetric Charges assessed on each kWh consumed. PREPA's load forecast affects the Legacy

new fiscal year. The 2023 Fiscal Plan superseded PREPA's 2022 fiscal plan, which required Brattle to update the Revenue Envelope and Legacy Charge Model dated March 2023.

41. The PRCS is an annual survey of Puerto Rican residents conducted by the U.S. Census Bureau as part of the American Community Survey ("ACS").[33] The 2022 PRCS reports summary level information, as well as respondent-level data known as the Puerto Rico Public Use Microdata Sample (the "PRCS microdata"), which provides details associated with the 28,944 individual survey respondents from 17,112 households. The 2022 PRCS summary data includes median household income for a single year (2022) and for a five-year (2018-2022) average in 2022 dollars. Median household income is an important input into the affordability module of the Revenue Envelope and Legacy Charge Model. The 2022 PRCS microdata also reports monthly household electricity spending (but not monthly kWh consumption) in Puerto Rico. These monthly electricity spending data, along with other data sources (discussed below), were used to determine the representative monthly kWh consumption for a median-income household in Puerto Rico. The PRCS is updated (in installments) each year.[34] The release of the 5-year average median household income in December 2023 required that Brattle update the residential affordability module of the Revenue Envelope and Legacy Charge Model, which resulted in an increase of approximately $200 million in Legacy Charge Revenues (in present value term over 35 years) compared to the November 2023 version of the model.[35]

42. Also, additional data sources were used in determining several model inputs, notably the electricity consumption of the reference median-income residential customer and the price

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Charge Revenues generated from the imposition of the Volumetric Charges; PREPA's forecast of the number of customers affects the Legacy Charge Revenues generated from the imposition of the Customer Charge.

[33] U.S. Census Bureau, About the Puerto Rico Community Survey, https://www.census.gov/programs-surveys/acs/about/puerto-rico-community-survey.html.

[34] For instance, the 2022 PRCS 1-year summary data was released in September 2023, followed by the microdata release in October 2023. Subsequently, in December 2023, the 5-year average summary data was published. *See* U.S. Census Bureau, 2022 Data Release Schedule, https://www.census.gov/programs-surveys/acs/news/data-releases/2022/release-schedule.html.

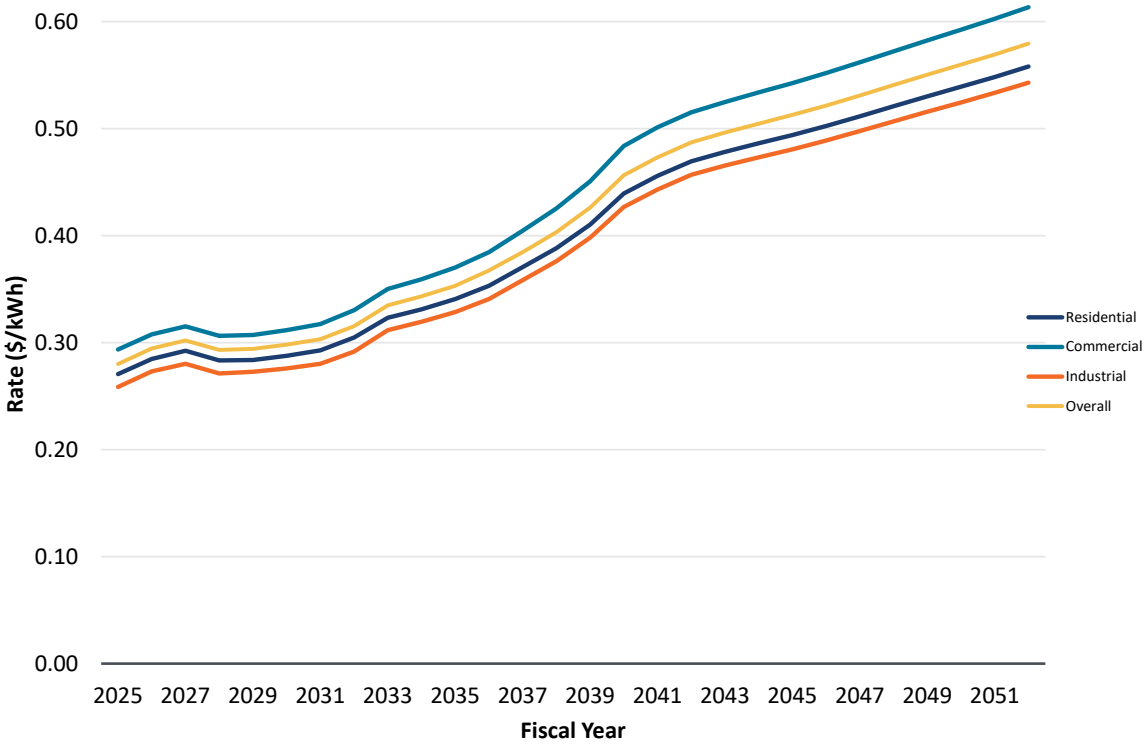
[35] The November 2023 version of the Revenue Envelope and Legacy Charge Model relied on an estimated 2018-2022 average median household income provided by the Oversight Board's advisor based on the mostly recent PRCS data at the time, which resulted in an approximately $80 million increase in Legacy Charge Revenues (in present value terms over 35 years) compared to the June 2023 version of the model. The December 2023 version of the model thus represents an approximately $280 million increase in Legacy Charge Revenues (in present value terms over 35 years) compared to the June 2023 version of the model.

elasticity of demand. LUMA provided detailed monthly electricity consumption data for PREPA's residential customers and the U.S. Energy Information Administration ("EIA") publishes the results of its surveys and analysis of electricity usage by appliance type for the U.S. mainland. These data, along with the above referenced PRCS data concerning monthly household spending on electricity, were used to estimate the monthly kWh consumption for median-income households in Puerto Rico. Research (academic and otherwise) on the price elasticity of demand was used to estimate the response that PREPA's customers may have when presented with incremental rate increases (*i.e.*, resulting from imposition of the Revenue Envelope and beyond the annual rate increases projected in the 2023 Fiscal Plan).

II. REVENUE ENVELOPE ANALYSIS

43. The calculation of the Revenue Envelope begins with the 2023 Fiscal Plan, which, as indicated above, uses a revenue requirement approach to estimate the average per kWh rate for PREPA's residential, commercial, industrial, and other customer classes on an annual basis. The per-kWh rates for PREPA overall and for the residential, commercial and industrial customer classes (before legacy debt service) provided in the 2023 Fiscal Plan is shown in Figure 1 below.

FIGURE 1: PREPA 2023 FISCAL PLAN PROJECTED CUSTOMER CLASS RATES



Source: 2023 Fiscal Plan.

44. Based on the rates for PREPA's residential customers projected in the 2023 Fiscal Plan, and the resulting monthly electricity bill, Brattle determined the maximum incremental rates that can be charged to the non-exempt residential customers without violating the affordability constraint described earlier. These incremental rates (to be applied to PREPA's GRS customers) were then scaled to the commercial, industrial and government customers. This resulted in a Revenue Envelope rate schedule.

45. The Revenue Envelope rate schedule, in combination with the forecasts of the number of PREPA's customers and load contained in the 2023 Fiscal Plan, determined the amount of the incremental revenues that can be generated under the Revenue Envelope. The 2023 Fiscal Plan contains projections through FY2052, while the term of the New Bonds and the Revenue Envelope and Legacy Charge that support the New Bonds is 35 years (*i.e.*, FY2025 through

FY2059). Therefore, Brattle calculated the Revenue Envelope by assuming the annual cash flows generated by the Revenue Envelope rate schedule in FY2053-FY2059 equal that of FY2052.

A. RESIDENTIAL "HEADROOM" ANALYSIS

46. Brattle determined how much a median-income household in Puerto Rico will likely spend on PREPA-supplied electricity in FY2025, prior to the inclusion of an additional charge for servicing PREPA's legacy debt, in whole or in part. The difference between the median income household pre-Legacy Charge monthly electricity bill and 6% of their household income ($127.60 per month) is referred to as the household's "headroom."[36] Calculating such headroom requires multiplying the rates that PREPA is expected to charge for electricity (prior to the imposition of an additional charge for the repayment of legacy debt) by the typical monthly electricity consumption of a median-income household permanently residing in Puerto Rico and receiving non-subsidized electricity service from PREPA. Our analysis indicates that 425 kWh per month is a reasonable estimate of the typical monthly consumption by such a representative household, which, when multiplied by the appropriate rates applicable to PREPA's GRS residential customers, results in a monthly electricity bill of $119.32, allowing for headroom of $8.28 per month ($127.60 – $119.32 = $8.28).[37] Brattle's analysis supporting the use of 425 kWh per month as representative of the consumption for a median-income household in Puerto Rico is discussed more fully below.

1. Monthly kWh Consumption

47. Estimates of monthly electricity consumption for a customer segment, in this case median-income households in Puerto Rico, can be "built up" by modeling the electricity usage deemed necessary to meet a stated living standard (an approach used for example by the UK Government

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[36] Under the 6% electricity share of wallet constraint discussed above, a PREPA residential customer representative of a median income household should spend no more than $127.60 per month on electricity in FY2025. 6% of $25,520 is approximately $1,531 per year or $127.60 per month.

[37] Revenue Envelope and Legacy Charge Model, tab "Affordability."

to develop fuel poverty metrics)[38] or can be derived empirically based on electricity actually consumed by the subject customer segment. We derived the monthly kWh consumption for a representative median income customer in Puerto Rico by analyzing available data concerning actual electricity consumption. However, it is likely that an empirically derived consumption estimate understates the electricity usage needed to provide reasonable and desired comfort levels for these households, as evidenced by the fact that our empirical estimate of typical actual household electricity consumption is well below the monthly electricity consumption for similarly situated households located elsewhere in the U.S. That is, median-income households in Puerto Rico likely ration their usage of electricity due to the combination of low household incomes and high electricity rates.

48. Our research on electricity usage data indicates that there is no data source that provides both household income and kWh usage data. PREPA (through LUMA, its operating agent) has provided data regarding its customers' tariff classes, consumption and electricity bills, but not their income levels. In contrast, the PRCS provides data concerning Puerto Rico residents' household income and electricity bills, but not their consumption levels or tariff classes. Due to the disconnect in these data sources, we estimated the typical consumption and the resulting electricity bill of the median-income household permanently living in Puerto Rico from three data sources: (i) the 2022 PRCS; (ii) monthly consumption data for individual PREPA residential customers provided by LUMA; and (iii) the 2020 Residential Energy Consumption Survey (RECS) administered by the U.S. Energy Information Administration (EIA). These data sources corroborated that a typical median-income household in Puerto Rico consumes approximately 425 kWh of electricity per month. The derivation of this representative level of electricity consumption is described in detail in the Expert Rebuttal Report of Dr. Jurgen Weiss and in his declaration being concurrently filed with mine. I provide a summary of this data analysis below.

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[38] "Fuel Poverty Methodology Handbook (Low Income Low Energy Efficiency)", Department of Home Energy & Net Zero, February 28, 2023, page 45. The UK's Office of National Statistics provides an explanation of the use of modeled over empirically derived estimates of home energy spend: "There have been changes over time in how fuel poverty has been measured, based on changes in the interpretation of fuel poverty and legislation. In the 2001 Fuel Poverty Strategy, the UK government set out an affordability metric that looked at the ratio between a household's income and their required energy bills. This calculation is based on required spend rather than actual spend, to mitigate against the fact some households may limit their usage. Office of National Statistics, "How fuel poverty is measured in the UK," March 2023, page 3 and Section 3.

49. The 2022 PRCS microdata (*i.e.*, survey respondent-level data) provides data on annual household incomes and monthly household spending on electricity. These data can be used to estimate the monthly kWh consumption for median-income households in Puerto Rico by using PREPA residential rate information to convert the reported monthly electricity spending (*i.e.*, monthly bills) into kWh. Examination of monthly electricity spending microdata reveals that some of the reported bills – overall across all household income strata and for households within an income range around median – likely reflect unusually low reported monthly electricity bills or subsidized rates. For example, (i) reported electricity bills of $4 per month are unreasonably low given the fixed monthly customer charge of $2 to $4 and (ii) reported monthly bills of $30, $40, and $50 likely represent some customers who pay fixed amounts for any electricity consumption up to 600, 800, and 1,000 kWh per month, respectively, under PREPA's subsidized RFR tariff.[39] The presence of these report monthly bills suggests that dividing reported monthly spending by PREPA's average residential electricity rate may lead to distorted results.

50. Data anomalies, such as those described above, can be addressed by using a "trimmed average." For this case, we (i) selected several ranges around median income (from +/- $250 around median income to +/- $1,250 around median income); (ii) trimmed the lowest and highest 5% of monthly electricity bill for each data set; and (iii) calculated the average, or mean, for the remaining ("non-trimmed") observations in each data set. The results of this analysis are shown in Figure 2 below.

[39] Puerto Rico Electric Power Authority, Electric Service Rates and Riders, https://lumapr.com/wpcontent/uploads/2023/02/Tariff-Book-Electric-Service-Rates-and-Riders-Revised-by-Order-05172019-Approved-by-Order-05282019.pdf.

FIGURE 2: ANALYSIS OF 2022 PRCS DATA
MEDIAN-INCOME HOUSEHOLD MONTHLY SPENDING ON ELECTRICITY

		2022 PRCS		
		No. of Observations [D]	Average Monthly Electricity Bill [E]	Monthly kWh Consumption [F]
All Households	[1]	12,255	$150	587
Removing top and bottom 5% of top and bottom Monthly Electricity Bills for:				
Households With Income Equal to the Median Income	[2]	21	$137	535
Households With Income Equal to Median Income +/- $250	[3]	86	$113	442
Households With Income Equal to Median Income +/- $500	[4]	175	$111	435
Households With Income Equal to Median Income +/- $750	[5]	234	$110	431
Households With Income Equal to Median Income +/- $1000	[6]	400	$111	435
Households With Income Equal to Median Income +/- $1250	[7]	449	$111	433
Average of [4] - [7]	**[8]**			**434**

Sources: 2022 Puerto Rico Community Survey.

Notes: Excludes households with electricity bills reported as 2 (N/A) and/or household income reported as -60000 (N/A).

51. Figure 2 shows that the average monthly electricity bills within the trimmed samples range from $110 to $137, with $111 being the most common average of trimmed samples considered. The figure also shows the monthly kWh consumption estimated to be associated with the monthly electricity bills. This was accomplished by dividing the subject monthly electricity bills by PREPA's average electricity rate for residential customers for CY2022,[40] the period covered by the 2022 PRCS. We calculated this rate to be $0.25566 per kWh,[41] which resulted in estimated monthly kWh consumption of from 431 to 435.

[40] We used the overall residential rates as provided in the 2023 Fiscal Plan, because the estimated trimmed average electricity bill for a median-income household may reflect the bills paid by both subsidized and non-subsidized residential customers.

[41] The electricity bills provided in the PRCS were in calendar years, while PREPA's effective rates were provided on a fiscal year basis. Accordingly, Brattle estimated the effective rate that should be applied to the electricity bills for CY2022 (as provided in the microdata for the 2022 PRCS) using the weighted average of the Fiscal Plan rates for FY2022 and FY2023. This calculation was based on the assumption that responses to the 2022 PRCS were collected uniformly over the CY2022. That is, 1/12 of survey responses would have been collected in January 2022; the PRCS survey question concerning electricity bills requests the last monthly electricity bill any customer would have received, which would most likely be the bill from December or November 2021, *i.e.*, one or two months prior. Specifically, we used weights of 7.5/12 for FY2022 and 4.5/12 for FY 2023 (*i.e.*, assuming a one-and-a-half month lag).

52. A second data source, provided by LUMA, includes detailed data of the monthly metered electricity consumption of PREPA's residential customers for the 24-month period spanning July 2020 through June 2022 (the "LUMA data").[42] The dataset includes over 33 million individual observations, including 27 million individual observations for PREPA's residential customers served under the GRS (General Residential Service) tariff. As indicated earlier, the LUMA data provides monthly kWh consumption data by residential tariff but does not provide any indications of household income or occupancy. Thus, additional analysis is required to estimate the monthly kWh consumption for a representative median income household residing in Puerto Rico on a full-time basis.

53. Monthly electricity usage, by itself, provides an indication of residence status. Specifically, full time residences use minimum basic appliances (such as a refrigerator, lighting, etc.) over the course of a year, and their average monthly electricity consumption should reflect such minimal usage, even if the subject household is away (on vacation or otherwise) for a few weeks each year. According to EIA RECS data, which I discuss later in this declaration, a household using only a refrigerator, lighting and a cook top consumes more than 75 kWh per month in geographies with similar climates to Puerto Rico. Adding a few more appliances (*e.g.*, a microwave and a television) would increase this consumption to 100 kWh per month, and could easily surpass 125 kWh per month. As is shown below, these usage levels are a small portion of the electricity consumed each month by low- and moderate-income households in the EIA's Hot-Humid and South Atlantic geographic segments – where monthly electricity consumption is at least 900 kWh for low-income households.

54. As is shown in Figure 9 of the Expert Rebuttal Report of Jurgen Weiss, the median monthly electricity consumption for PREPA's GRS customers – the majority of whom will be subject to the full residential Legacy Charge – and who use a minimum of from 75 to 125 kWh per month is from 402 to 450 kWh per month, with a mid-point of roughly 425 kWh per month.[43]

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[42] Brattle received four datasets from LUMA between December 2022 and May 2023. Certain earlier datasets contained errors and/or data issues, and were superseded by later productions in whole or in part.

[43] Expert Rebuttal Report of Jurgen Weiss, PhD, January 12, 2024, Figure 9.

55. The third and final data source considered in estimating the typical monthly electricity consumption for a median-income household in Puerto Rico was the RECS data. The 2020 RECS data was published by the EIA in June 2023 and contains information on 18,496 households occupied as primary residences in all 50 U.S. States and the District of Columbia, but not Puerto Rico. Therefore, instead of attempting to directly estimate the electricity consumption in Puerto Rico from RECS data, we used RECS data to understand the minimum monthly electricity consumption required to operate a full-time household and to provide a check on our conclusions from the PRCS and LUMA data analyses.

56. The EIA's RECS provides detailed average annual electricity consumption levels for a range of electric appliances for household types segmented by geography, household size and income levels. The appliances surveyed include refrigerators, televisions, lighting, ceiling fans, air conditioning, water heating, and electric cooking appliances, among others. A summary of the results from the RECS for two segments (South Atlantic) and two annual household income groups ($20,000-$24,999 and $60,000-$74,999) are provided in Figure 3 below.

FIGURE 3: AVERAGE MONTHLY KWH CONSUMPTION BY APPLIACE IN SOUTH ATLANTIC AND HOT-HUMID REGIONS

Household Income Range	$20,000 - $24,999		$60,000 - $74,999	
	South Atlantic	**Hot-Humid**	**South Atlantic**	**Hot-Humid**
Trimmed Mean Total Consumption of Households in Income Range	900	943	1,030	1,115
Number of Households in the Sample	150	113	306	284
Average Consumption for Households with Consumption within 100 kWh of Average Consumption				
Space Cooling	191	232	261	338
Water Heating	174	204	149	140
Space Heating	116	66	56	107
All Refrigerators	73	70	81	87
End Uses other than Space Heating, Space Cooling, Water Heating, and Refrigerators	356	368	471	440
Total as Reported in RECS data	910	941	1,019	1,112
Total without Space Heating or Cooling	568	608	657	615
Break-down of "End uses other than space heating, space cooling, water heating, and refrigerators"				
All TVs and Related Peripherals	54	51	61	62
Lighting	41	37	78	58
Clothes Dryer	32	27	48	34
Furnace Fans for Cooling	29	31	39	47
Cooking	21	23	27	17
Freezer	15	13	19	17
Ceiling Fans	16	21	23	26
Microwave	9	7	10	9
Swimming Pool Pumps	6	2	3	3
Dishwashers	4	6	7	5
Furnace Fans and Boiler Pumps	5	3	5	5
Clothes Washers	5	3	5	5
Humidifiers	2	1	2	3
Dehumidifiers	1	1	12	14
Hot Tub Heaters	1	0	2	1
Hot Tub Pumps	0	0	2	0
Electric Vehicle Charging	0	0	0	0
Other Electricity Usage	115	141	128	135
Total "Other end uses"	356	368	471	440
Bottom-up Total	910	941	1,019	1,112

Source: 2020 RECS data.

Notes: Total without Space Heating or Cooling exclude Space Heating, Space Cooling, Furnace Fans for Cooling, and Furnace Fans and Boiler Pumps.

57. The figure shows that households in these segments use at least 900 kWh per month, with residential consumers in Hot-Humid segments using more electricity than consumers in the South Atlantic States, and higher income consumers using more electricity than lower income households. Furthermore, the RECS data for these segments indicates that households around the average usage levels in these segments use at least 600 kWh per month on appliances other than space conditioning (*i.e.*, heating and cooling). The RECS also shows that consumers use a notable amount of electricity on various non-major appliances, referred to as "Other Electricity Usage," from 115 to 141 kWh per month (for, *e.g.*, charging of devices, sometimes referred to as "plug load").

58. These levels of monthly electricity consumption are considerably greater than the levels observed in either the PRCS electricity bill or the LUMA monthly consumption data sets, suggesting that median-income households in Puerto Rico are likely rationing their consumption of electricity due to the combination of low household incomes and high rates for electricity.

59. The three data sources used to estimate monthly electricity consumption for a representative median-income household in Puerto Rico indicate usage above the 425 kWh per month that we derived from superseded data sets.[44] Analysis of monthly electric spending for median-income households in Puerto Rico included in the 2022 PRCS indicates that electric consumption for the reference customer set is 434 kWh per month. This is within the range of median observations in the LUMA monthly consumption data set for PREPA's residential customers and is considerably lower than the monthly electric usage of low- and moderate-income households in the EIA's Hot-Humid and South Atlantic segments. Ultimately, we selected 425 kWh as a conservative estimate for the typical consumption of the representative median-income household for FY2025, resulting in increase to the Revenue Envelope and amount available for creditor recovery.

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[44] The Revenue Envelope and Legacy Charge Model dated March 2023 relied on the 2021 PRCS data and the 2015 RECS data, which were superseded by the 2022 PRCS data and the 2020 RECS data, respectively.

2. GRS Customer Electricity Rates

60. PREPA's residential customers receive electric service under nine tariff classes: RFR 105, 106 and 107; RH3 103 and 104; LRS 109 and 110; and GRS 111 and 112. Only PREPA residential customers that receive service under GRS 112 are charged full rates, while the eight residential tariff classes receive electricity service at rates less than the full cost of service (*i.e.*, they receive subsidized electricity service). PREPA residential customers that receive service under GRS 111 receive a slight discount from full rates, while the discount is much higher for the other seven residential tariff classes.[45] PREPA's 2023 Fiscal Plan provides actual and projected revenue requirements and rates for the residential customer class overall and does not break down rates among tariff classes.

61. In prior versions of the Revenue Envelope and Legacy Charge Model, Brattle used the average residential rate included in PREPA's Fiscal Plans as a proxy for the rate paid by GRS 111 and 112 customers, even though it was apparent that, arithmetically, these customers must pay more than the average rate; *i.e.*, residential customers served under subsidized rates pay less than the customers who pay the full rate. However, a more recent review of the LUMA and PREB websites revealed information that allowed Brattle to calculate the effective rates for PREPA's various residential tariff classes.[46] Specifically, using LUMA data which provided tariff class and monthly usage for all of PREPA's residential customers, in combination with the newly found information on PREPA's rate riders, Brattle was able to calculate the effective rate for each of PREPA's residential tariff class. The results of that analysis are shown in Figure 4 below.

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[45] General Residential Service (GRS) applies to residential customers who use electricity for domestic uses in structures that are intended for residential purposes. GRS 111 customers receive a fuel subsidy for consumption up to 500 kWh per month. GRS 111 is available only to customers who are designated as elderly, students and/or disabled. Puerto Rico Electric Power Authority, Electric Service Rates and Riders, https://lumapr.com/wp-content/uploads/2023/02/Tariff-Book-Electric-Service-Rates-and-Riders-Revised-by-Order-05172019-Approved-by-Order-05282019.pdf.

[46] Such information includes historical values of various riders and formulas for applying them. *See* https://lumapr.com/wp-content/uploads/2022/07/Table-of-factors-english1.xlsx and https://lumapr.com/wp-content/uploads/2023/02/Tariff-Book-Electric-Service-Rates-and-Riders-Revised-by-Order-05172019-Approved-by-Order-05282019.pdf.

FIGURE 4: EFFECTIVE RESIDENTIAL ELECTRICITY RATE BY TARIFF CLASS (FY2022)

	Sum of Calculated Monthly Electricity Bills ($)	Sales Volume (kWh)	Electricity Rate ($/kWh)
RH3 103	$ 3,964,931	19,973,606	$ 0.199
RFR 105	$ 2,872,735	26,118,319	$ 0.110
RFR 106	$ 21,689,976	214,836,802	$ 0.101
RFR 107	$ 3,395,644	34,180,197	$ 0.099
LRS 110	$ 122,080,233	584,430,025	$ 0.209
GRS 111	$ 186,131,622	789,821,836	$ 0.236
GRS 112	$ 1,237,408,416	5,087,225,407	$ 0.243
All Res. Customers	$ 1,577,543,557	6,756,586,192	0.233
All GRS Customers	$ 1,423,540,038	5,877,047,243	0.242
% Diff. Between Avg. GRS Rate and Avg. Res. Rate			**3.74%**

Source: LUMA data.

Note: LUMA data (which reflects *monthly* customer data) differ from customer counts and consumption included in PREPA's annual fiscal plans (which includes reconciled year end customer data).

62. As Figure 4 demonstrates, the effective rate paid by PREPA's GRS customers is 3.74% higher than the average rate paid by all of PREPA's residential customers. Based on this analysis, Brattle, in its affordability analysis, adjusts the average rate for residential customers for FY 2025 by 1.0374 to better reflect the effective rate paid by unsubsidized GRS customers, who are the reference class in the affordability analysis.

3. GRS Customer Monthly Electricity Bill

63. Figure 5 below displays the derivation of the headroom for the representative median-income customer in FY2025.

FIGURE 5: MEDIAN INCOME HOUSEHOLD HEADROOM ANALYSIS

Reference Fiscal Year	2025
Representative Annual Income	$25,520
Representative Volumetric Consumption (kWh)	425
Maximum Affordable Bill as Percent of Income	6%
Maximum Affordable Bill	$127.60
Expected Charges (2023 Fiscal Plan)	
Basic Revenue ($/kWh)	$0.07654
Fuel & Purchased Power ($/kWh)	$0.14575
CILT ($/kWh)	$0.00697
Subsidies ($/kWh)	$0.01412
ERS Pension ($/kWh)	$0.02389
Energy Efficiency ($/kWh)	$0.00337
Total Fiscal Plan Rate	$0.27064
Adjustment for Effective GRS Rate	3.74%
Effective GRS Rate	$0.28076
Total Bill (Excluding Debt Service)	$119.32
Gap to maximum affordable bill (Headroom)	$8.28

Source: Revenue Envelope and Legacy Charge Model, tab "Affordability."

Note: Basic Revenue ($/kWh)" of $0.07654 is the average Basic Revenue rate for PREPA's residential customers as provided in the 2023 Fiscal Plan. The Basic Revenue $/kWh used in the Affordability of the Revenue Envelope and Legacy Charge Model is $0.08666, which represents the implied effective Basic Revenue rate for a GRS customer. Including $0.08666 results in a Total Fiscal Plan Rate equal to the Effective GRS Rate ($0.28076).

64. As discussed earlier, the headroom analysis begins with a calculation of the maximum bill deemed affordable for the purposes of the affordability analysis. Figure 5 shows that applying a maximum electricity share of wallet of 6% to the estimated median income of $25,520 results in a maximum monthly bill affordable to the representative customer of $127.60 ($25,520 x 6% x 1/12).

65. The figure also shows the average rate for PREPA's residential customers in FY2025 is projected (in PREPA's 2023 Fiscal Plan) to be $0.27064 per kWh, composed of a basic revenue component equal to $0.07654 per kWh and rates associated with the various PREPA riders equal to $0.19410 (with the rider for fuel and purchased power covering $0.14575 per kWh). Adjusting the average residential rate upward by 3.74% results in an effective rate of $0.28076 for GRS

customers and an expected electricity bill of $119.32, calculated by multiplying the monthly electricity consumption representative of the median-income household (425 kWh) by the effective GRS rate.

66. Finally, the figure shows that the headroom available for the Revenue Envelope (*i.e.*, the difference between the maximum affordable bill and the expected bill) is therefore $8.28 per month ($127.60 - $119.32).

B. REVENUE ENVELOPE RESIDENTIAL CUSTOMER RATE SCHEDULE

67. The next step in the development of the Revenue Envelope concerns the rate design – *i.e.*, the combination of fixed customer charges and volumetric (or per kWh) rates – through which the $8.28 headroom can be charged to PREPA's residential customers. Brattle referenced PREPA's current rate design structure for guidance in determining the Revenue Envelope rate design. PREPA's GRS tariffs currently includes a monthly fixed customer charge ($4.00 per month) and a two-tier, inclining block volumetric structure for basic revenues; *i.e.*, $0.04944 per-kWh rate for each of the first 425 kWh and a slightly higher rate of $0.05564 per kWh for usage above 425 kWh on a monthly basis. Customers are charged additional per kWh rates for the various riders; GRS 112 customers are currently charged for up to 13 riders, which sum to the majority of a customer's monthly bill from PREPA.

68. Fixed customer charges produce a predetermined amount of revenue for the utility, given the number of customers, irrespective of the customers' electricity consumption. In contrast, utility revenues derived from volumetric rates are dependent on kWh sales; *i.e.*, revenues will increase if sales increase and vice versa. Determining the appropriate combination of fixed charges and volumetric rates has received increased attention in recent years as consumer options for electricity consumption have evolved, notably through the option of self generation from rooftop photovoltaics (*i.e.*, solar panels). Most users of rooftop photovoltaics prefer to remain connected to the grid, because of attractive pricing for selling their excess generation into the electricity grid (known as "net metering") and/or the need for procuring electricity at times when their photovoltaics are not producing sufficient electricity. Prioritizing fixed customer charges relative to volumetric charges benefits a utility in two ways: (i) it allows the utility to receive revenues

when customers fulfill part of their load requirements with their own generation and (ii) it reduces the financial incentive for customers to seek out self generation options. To this latter point, the economic attractiveness of installing rooftop photovoltaics is a function of the cost of such installation and the cost of the grid-supplied electricity that can be avoided. As customers prefer to remain connected to the utility electric grid, they can avoid volumetric charges but not fixed customer charges.

69. In designing a rate structure for the Revenue Envelope and Legacy Charge, we found that high volumetric rates would produce higher Revenue Envelope and Legacy Charge Revenues, all else equal. However, high volumetric rates would also increase the incentive for load defection,[47] by increasing the cost of grid-supplied electricity that may be avoided with self generation. This required that we balance the objective of maximizing Revenue Envelope and Legacy Charge Revenues with the risk that overly high volumetric rates would result in additional load or grid defection. Brattle designed the Revenue Envelope rate schedule to include a high-block volumetric charge of no more than $0.03 per kWh (roughly 11% of the average residential rate projected for FY2025 in PREPA's 2023 Fiscal Plan) and a low-block volumetric charge of no more than $0.0075 per kWh (forming a 1:4 inverted block rate structure) for PREPA's GRS customers; *i.e.*, the residential customers expected to pay the Legacy Charge. The remaining headroom was then captured through a $5.00 monthly customer charge.[48]

70. The Revenue Envelope rate schedule for PREPA's residential customers is shown in Figure 6 below. Under the residential rate schedule shown in the figure, PREPA's GRS customers will be subject to the full Revenue Envelope charges; PREPA's subsidized tariff classes, as well as customers eligible for Medicaid but likely not in PREPA's subsidized tariff classes, will be exempt from paying the Revenue Envelop fixed monthly customer charge and the volumetric

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[47] We refer to "load defection" as reduced kWh sales while a customer remains connected to the grid (and continues to pay monthly fixed customer charges), and "grid defection" as terminating the customer's account with the utility *(i.e.*, "cutting the cord").

[48] To be consistent with generally applied rate design conventions (which are not required precedent or legally binding), we set the customer charge at quarter-of-a-dollar increments. $5.00 was the nearest quarter-of-a-dollar that captures the most of the headroom. Due to this convention, the Revenue Envelope rate design for the GRS customers captures $8.19 out of $8.28 of the headroom.

charge for the first 425 kWh per month of electricity usage. As discussed earlier, for purposes of this analysis, we assume that the lower income households in Puerto Rico are served under PREPA's subsidized residential tariffs, and that 55% of PREPA customers will be subject to the full Revenue Envelope charges. The households subject to the full Revenue Envelope charge likely correspond to the upper 55% of all household by income in Puerto Rico.[49]

FIGURE 6: RESIDENTIAL REVENUE ENVELOPE RATE SCHEDULE

	Customer Charge ($/month)		Volumetric Charge (</=425 kWh, c/kWh)	Volumetric Charge (>425 kWh, c/kWh)
RESIDENTIAL				
RH3, LRS, RFR	$	-	-	1.500
GRS 111/112 (Subsidy-eligible)	$	-	-	1.500
GRS 111/112 (General)	$	5.00	0.750	3.000

71. Applying the Revenue Envelope charges shown in Figure 6 to the residential customer counts and kWh sales projected in PREPA's 2023 Fiscal Plan results in incremental revenues of $113 million in FY2025 and a present value of revenues of $1.345 billion over the course of the 35 year term of the Legacy Charge (FY2025 through FY2059, discounted to FY2025 using a rate of 6%).

72. The increase in the volumetric rates of electricity, however, will likely have the effect of lowering PREPA kWh sales to its customers. Consumer responsiveness to changes in price is referred to as the price elasticity of demand, a basic concept in microeconomics, with higher prices typically resulting in reduced sales.[50] For a given product, the magnitude of the price elasticity of demand is correlated with the availability and relative cost of substitutes with which consumers may replace the product. Historically, the price elasticity of demand in the electricity sector had been comparably low because consumers,[51] notably residential and small commercial

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[49] In practice, residential tariff assignment and household income are not completely correlated. For example, a household earning median income or higher may be eligible for public housing and served under PREPA tariff RFR.

[50] N. Gregory Mankiw, "Principles of Microeconomics" 7th edition, 2014, Chapter 5.

[51] The price elasticity of demand is typically a negative number, which indicates that an increase in price is accompanied by a decline in demand. When making comparisons, a "low" price elasticity of demand typically refers to the associated absolute values.

customers, had few options other than conservation or, in some cases, fuel switching. More recently, consumer options have expanded, especially through the availability and cost competitiveness of rooftop photovoltaics, batteries and energy-saving appliances.

73. The load forecast included in the 2023 Fiscal Plan indirectly includes price elasticity of demand effects through its use of exogenous models (*i.e.*, separate from PREPA's econometrically based load forecasting model), which are referred to as "load modifiers." Specifically, PREPA's econometrically based load forecasting model is based on historic relationship among variables and kWh sales, whereas the load modifier models forecast the forward-looking effects for energy efficiency, electric vehicles and distributed generation, which mainly concerns the installation of rooftop photovoltaics.[52]

74. Additional volumetric charges to customers are expected to alter the price signals sent to customers and considered in the load forecast included in the 2023 Fiscal Plan. Accordingly, we estimated the expected reduction in residential load associated with the Revenue Envelope volumetric charges by applying specific price elasticities of demand for each of PREPA's residential customer classes. The price elasticities of demand applied are (i) intended to be forward looking, and accordingly higher than historically observed price elasticities of demand for grid-supplied electricity and (ii) phased in over 10 years, with short term price elasticities of demand at or close to historically observed levels and gradually increasing to specified long term higher levels over the course of 10 years. For PREPA's residential customers, we applied a short term price elasticity of demand of -0.2 and a long term price elasticity of demand of -1.7. A fuller discussion concerning derivation of the price elasticities of demand that we use in this analysis in detail in **Appendix B**.

75. The kWh sales for PREPA's residential customers that are expected to be lost due to the incremental increase in volumetric rates is shown in Figure 7 below.

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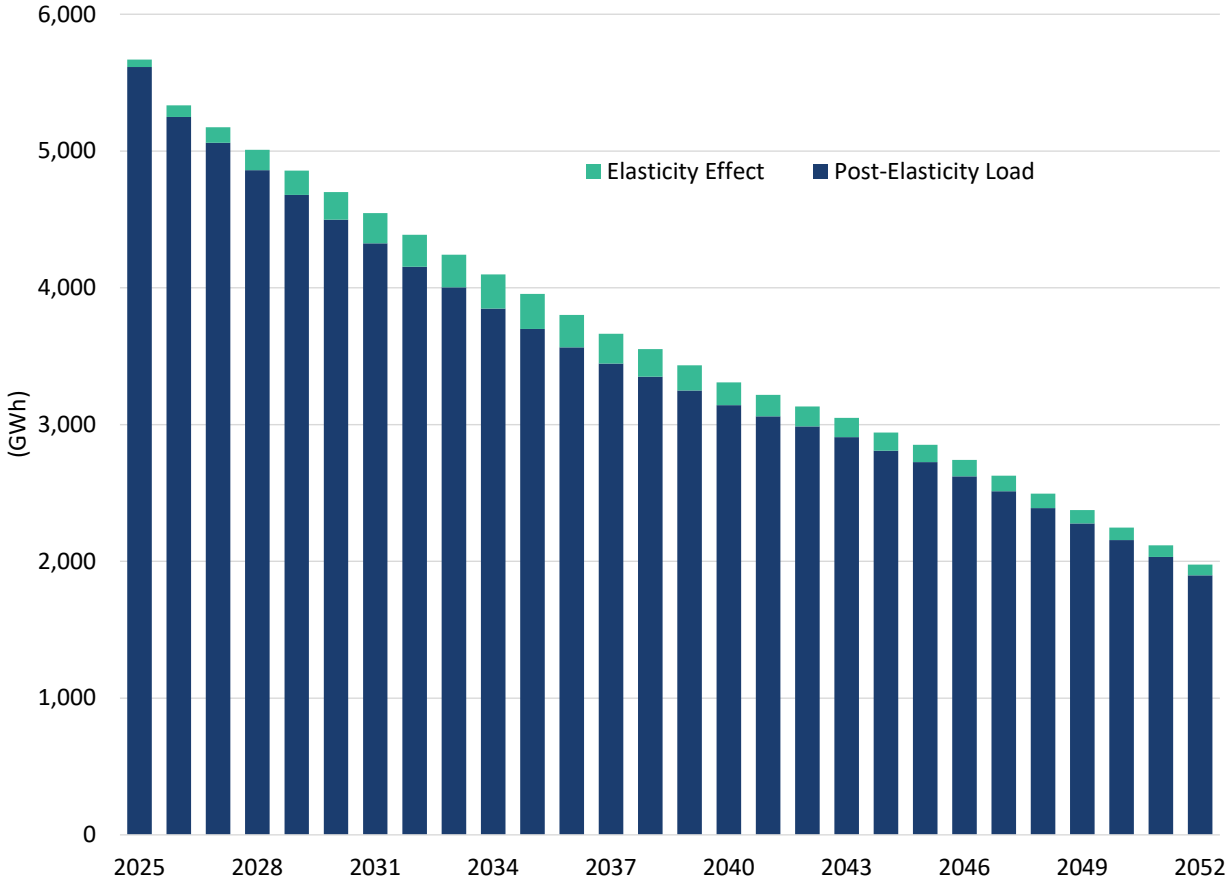
[52] PREPA 2023 Fiscal Plan, p. 118.

FIGURE 7: PREPA RESIDENTIAL LOAD FORECAST (WITH EFFECT OF INCREMENAL PRICE ELASTICITY OF DEMAND)



Source: Revenue Envelope and Legacy Charge Model.

76. The figure shows that the incremental volumetric rate increases due to implementing the Revenue Envelope rate schedule for PREPA's residential customers are expected to result in modest reductions in sales. Taking into account the sales reductions, Revenue Envelope charges are expected to generate a present value of revenues of $1.312 billion from its residential customers over the course of 35 years (FY2025 through FY2059, discounted to FY2025 using a rate of 6%) through the implementation of the Revenue Envelope rate schedule, approximately $33 million less due to price elasticity of demand.

C. REVENUE ENVELOPE NON-RESIDENTIAL CUSTOMER RATE SCHEDULE

77. Brattle developed the Revenue Envelope for PREPA's commercial customers (which includes government and municipalities) and industrial customers by scaling the rate increase percentages that were developed for the GRS rate class. Brattle did not conduct an affordability analysis for these non-residential customer classes as we did for the residential rate class, for the reasons discussed earlier.

78. As a first step, in determining the fixed monthly Revenue Envelope customer charges for PREPA's non-residential customers, we scaled the current non-residential customer charges by the same multiple that was implied in the incremental Revenue Envelope customer charge for GRS customers. Specifically, the incremental Revenue Envelope customer charge for GRS customers was set at $5.00 per month, which is 1.25 times the current customer charge for such customers of $4.00 per month (resulting in a total fixed monthly charge for GRS customers of $9.00). We applied the 1.25x multiple to the nine PREPA tariffs used to serve PREPA's non-residential customers served under: General Service Secondary (GSS 211 and GSS 311); General Service Primary (GSS 212 and GSP 312); General Service Transmission (GST 213 and GST 313); Time-of-Use (TOU) tariffs T-363 and T-963; and, Large Industrial Service (LIS 333).

79. The results of applying the 1.25 multiplier are shown in Figure 8 below.

FIGURE 8: INCREMENTAL CUSTOMER CHARGES

Class	Current Customer Charge	Multiple	Incremental Customer Charge	Total Customer Charge
GRS 112 (General)	$4	1.25x	$5	$9
GSS 211	$5	1.25x	$6	$11
GSP 212	$200	1.25x	$250	$450
GST 213	$450	1.25x	$563	$1,013
GSS 311	$5	1.25x	$6	$11
GSP 312	$200	1.25x	$250	$450
GST 313	$450	1.25x	$563	$1,013
TOU-T 363	$450	1.25x	$563	$1,013
LIS 333	$450	1.25x	$563	$1,013
TOU-T 963	$450	1.25x	$563	$1,013

Source: Revenue Envelope and Legacy Charge Model.

80. We then calculated the incremental volumetric rates that could be charged to PREPA's non-residential customers under the Revenue Envelope. For this step, we used the incremental Revenue Envelope volumetric rates that were applied to PREPA's GRS customers, averaging the low and high block rates by consumption, as a reference.[53] The reference average volumetric rate was then adjusted for differences in the price elasticities of demand across PREPA's nine non-residential tariff classes.

81. Brattle derived long term price elasticities of demand for each of PREPA's tariff classes. For non-residential customers, long term price elasticities of demand were derived based on the level of customer options and responsiveness compared to the price elasticities of demand estimated for PREPA's GRS customers. The relative ranking of price elasticities of demand for the non-residential customer classes (compared to the GRS customer class) in percentage terms and the resulting log term price elasticities of demand for each customer class is shown in Figure 9 below. Additional discussion on the determination of price elasticities of demand is provided in **Appendix B**.

[53] The average consumption of non-exempt GRS customers was 609 kWh per month as of FY2021, based on LUMA data. The average Revenue Envelope volumetric rate for these customers is thus calculated as (425 x $0.0075 + (609 – 425) x $0.03) / 609 = $0.0143. Revenue Envelope and Legacy Charge Model, tab "RE_Inputs," cell AF17.

FIGURE 9: "RELATIVE" PRICE ELASTICITIES OF DEMAND ELASTICITIES

	Reference Long Run Elasticity	Relative Long Run Elasticity	Long Run Elasticity
GSS 211	-1.7	40%	-0.68
GSP 212	-1.7	70%	-1.19
GST 213	-1.7	100%	-1.70
GSS 311	-1.7	50%	-0.85
GSP 312	-1.7	50%	-0.85
GST 313	-1.7	75%	-1.28
TOU-T 363	-1.7	75%	-1.28
LIS 333	-1.7	75%	-1.28
TOU-T 963	-1.7	75%	-1.28

Source: Revenue Envelope and Legacy Charge Model.

82. We examined small commercial customers (GSS 211) separately from PREPA's other and larger non-residential customers. PREPA's GSS 211 customers have an average monthly electricity usage of approximately 1,500 kWh, while the average usages of customers served under PREPA's GSP, GST, LIS and TOU tariffs are much higher. GSS 211 customers account for 90% of PREPA's roughly 125,000 commercial, industrial, government, and municipality customers as of FY2021 based on LUMA data.[54] We developed the incremental volumetric rates for PREPA's GSS 211 customers consistent with the design of the incremental volumetric rates for PREPA's GRS customers, using two blocks of incremental volumetric rates.

83. As discussed above, the incremental volumetric rates developed for PREPA's GRS customers are: (i) $0.0075 per kWh for consumption up to 425 kWh per month; and (ii) $0.03 per kWh for consumption above 425 kWh per month. We estimate that PREPA customers served under GSS 211 have lower price elasticities of demand than is the case for PREPA's GRS customers (*i.e.*, 40% of the long-term price elasticity of demand applied to GRS customers, as shown in Figure 9). Accordingly, we adopted a higher rate for the first volumetric block: we selected $0.015 per kWh for consumption up to 425 kWh per month for GSS 211 customers (in contrast to the $0.0075 per kWh that was used for non-exempt GRS customers). We applied the same per kWh

[54] Revenue Envelope and Legacy Charge Model, tab "RE_Inputs," column G.

rate for the second incremental volumetric block as we used in our analysis of the residential class; *i.e.*, $0.03 per kWh for consumption above 425 kWh per month.

84. Other than GSS 211, PREPA's tariffs for non-residential classes *(i.e.*, GSP 212 and 312, GST 213 and 313, GSS 311, T-363 and T-963, and LIS 333) involve multiple (and sometimes complex) billing components; *i.e.*, other than the fixed monthly customer charges and two tiers of volumetric rates applied to PREPA's GRS and GSS 211 customers.[55] For example, PREPA's GST 213 tariff includes volumetric rates per kW of maximum demand, a monthly demand charge (as a rate per kVA), a excess demand charge (as a rate per kVA if maximum demand exceeds contracted load) and a minimum bill requirement, in addition to a monthly fixed customer charge.[56]

85. We developed a single per-kWh Revenue Envelope volumetric rate for these larger non-residential customers, based on the "effective" Revenue Envelope volumetric rate charged to GRS customers of $0.0143, as described earlier. We estimated the effective volumetric rate for an average GRS customer that will be subject to the full Revenue Envelope charges to be $0.0143 per kWh. We then used the relative price elasticities of demand for each of the tariff groups (as discussed above) as the basis for increasing, decreasing or not modifying this rate. The incremental Revenue Envelope volumetric rates for PREPA's commercial, industrial, government, and municipality customers is shown in Figure 10 below.

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[55] Billing components included in residential tariffs typically include a monthly fixed customer charge and rates for volumes of kWh consumed. Utility tariffs for larger customers (including many in served under commercial, industrial and government tariffs) also include demand components (measured in kW of kVA), that charge for the maximum amount of electrical power that needs to be generated (a measure of capacity) to meet a customer's demand requirements over the course of a month. kVA = kilovolt-ampere.

[56] Puerto Rico Electric Power Authority, Electric Service Rates and Riders, https://lumapr.com/wp-content/uploads/2023/02/Tariff-Book-Electric-Service-Rates-and-Riders-Revised-by-Order-05172019-Approved-by-Order-05282019.pdf, pp. 14-15.

FIGURE 10: NON-RESIDENTIAL VOLUMETRIC RATES

	Relative Long Run Elasticity	Reference Avg. Volumetric Adder	Volumetric Adder
GSP 212	70%	$0.0143	$0.0205
GST 213	100%	$0.0143	$0.0143
GSS 311	50%	$0.0143	$0.0286
GSP 312	50%	$0.0143	$0.0286
GST 313	75%	$0.0143	$0.0191
TOU-T 363	75%	$0.0143	$0.0191
LIS 333	75%	$0.0143	$0.0191
TOU-T 963	75%	$0.0143	$0.0191

Source: Revenue Envelope and Legacy Charge Model.

86. The figure indicates that we estimated that the price elasticities of demand for PREPA's non-residential customers are equal to or lower than the price elasticity of demand estimated for residential customers. Thus, the incremental Revenue Envelope volumetric rate applied to PREPA's non-residential customers are higher than the effective volumetric rate for PREPA's GRS customers subject to the full Revenue Envelope charge used for reference.

87. Applying the customer charges and volumetric rates to PREPA's commercial, industrial, government, and municipality customers and load (including the effects of lower sales due to the incremental Revenue Envelope rate increase) results in incremental revenues of approximately $122.25 million in FY2025. Applying the same incremental rate structure throughout 35 years produces a present value of approximately $5.05 billion (FY2025 through FY2059, discounted to FY2025 at a rate of 6%).

88. As discussed earlier in this declaration, the incremental Revenue Envelope charges to PREPA's non-residential customers were scaled from the incremental rates charge to PREPA's residential customers. As a test of the maintenance of the proportionality of revenue, we compared the distribution of revenues among PREPA's customer classes (i) projected in PREPA's 2023 Fiscal Plan, before any debt service and (ii) expected to be generated through the imposition of Revenue Envelope charges. Over the term of the 2023 Fiscal Plan, in present value terms, approximately 38% of PREPA's revenue requirement is associated with residential customers,

and the remaining 62% comes from commercial, industrial and government customers. The distribution of Revenue Envelope revenues is in line with the 2023 Fiscal Plan revenue distribution, with 34% of the Revenue Envelope generated from residential customers and the remaining 66% from commercial, industrial and government customers, over the same 28-year term and in present value terms.[57]

D. TOTAL REVENUE ENVELOPE

89. Combining the Revenue Envelope calculations for PREPA's residential and non-residential customers results in a total Revenue Envelope of approximately $337 million in FY2025, and, in present value terms, $3.8 billion over 35 years (FY2025 through FY2059, discounted to FY2025 using a rate of 6%).[58]

90. The rate schedule that is expected produce these incremental revenues generated under the Revenue Envelope is shown Figure 11 below.

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[57] Revenue Envelope and Legacy Charge Model, tab "Distribution of Revenues."

[58] Based on elasticity-adjusted load. Revenue Envelope and Legacy Charge Model, tab "Revenues Available," cell G124 and tab "Summary," cell D12. The 2023 Fiscal Plan provides forecasts through FY2052. We assumed the annual Revenue Envelope cash flows FY2053-FY2059 equals that of FY2052 in order to develop the 35 year cash flows.

FIGURE 11: REVENUE ENVELOPE RATE SCHEDULE

	Customer Charge ($/month)	Volumetric Charge (</=425 kWh, c/kWh)	Volumetric Charge (>425 kWh, c/kWh)
RESIDENTIAL			
RH3, LRS, RFR	$ -	-	1.500
GRS 111/112 (Subsidy-eligible)	$ -	-	1.500
GRS 111/112 (General)	$ 5.00	0.750	3.000
COMMERCIAL			
GSS 211	$ 6.25	1.500	3.000
GSP 212	$ 250.00	2.045	2.045
GST 213	$ 562.50	1.431	1.431
GOVERNMENT			
GSS 211	$ 6.25	1.500	3.000
GSP 212	$ 250.00	2.045	2.045
GST 213	$ 562.50	1.431	1.431
MUNICIPALITIES			
GSS 211	$ 6.25	1.500	3.000
GSP 212	$ 250.00	2.045	2.045
GST 213	$ 562.50	1.431	1.431
INDUSTRIAL			
GSS 311	$ 6.25	2.862	2.862
GSP 312	$ 250.00	2.862	2.862
GST 313	$ 562.50	1.908	1.908
TOU-T 363	$ 562.50	1.908	1.908
LIS 333	$ 562.50	1.908	1.908
TOU-T 963	$ 562.50	1.908	1.908

Source: Revenue Envelope and Legacy Charge Model.

III. LEGACY CHARGE ANALYSIS

91. The Revenue Envelope analysis provides the highest level of incremental revenues that can be raised from PREPA customers without exceeding affordability constraints for median-income residential customers or overly incentivizing load defection, while generally maintaining the proportionality of PREPA's revenue requirements among customer classes. However, not the entire amount of the Revenue Envelope could be used to repay PREPA's creditors. Because the imposition of an increase in volumetric rates as contemplated by the Revenue Envelope is expected to reduce PREPA's kWh sales levels projected in the 2023 Fiscal Plan, a portion of the

Revenue Envelope needs to be set aside to fund the underrecovery of PREPA's fixed costs, as is explained further below.

A. FIXED COST UNDERRECOVERY

92. As discussed earlier, the incremental volumetric rate increases associated with implementing the Revenue Envelope rates are expected to cause a reduction in sales due to the price elasticity of demand. This reduction has two effects. First, it reduces the incremental revenues that are available to pay creditors because sales are lower than the pre-elasticity estimates.[59] The second effect of reduced sales concerns PREPA's recovery of fixed costs, which I discuss more fully below.

93. PREPA's annual revenue requirements in the 2023 Fiscal Plan include both fixed and variable costs. Variable costs, such as those associated with fuel and purchased power, increase or decrease as sales increase or decrease, respectively. These costs account for over 50% of PREPA's annual costs. Other costs, such as the costs associated with operating and maintaining PREPA's transmission and distribution system, tend to remain fixed even when sales change. For example, the costs associated with operating and maintaining poles and wires (sometimes referred to as "wires" costs) do not change by any noticeable amount when sales decline.[60] Both fixed and variable costs are included in the revenue requirements projected in the 2023 Fiscal Plan, and the rates included in the 2023 Fiscal Plan are derived by dividing PREPA's projected annual revenue requirements by projected annual kWh sales. Thus, a reduction in sales levels without an accommodating reduction in revenue requirements means that PREPA will under-recover a portion of tits fixed costs.

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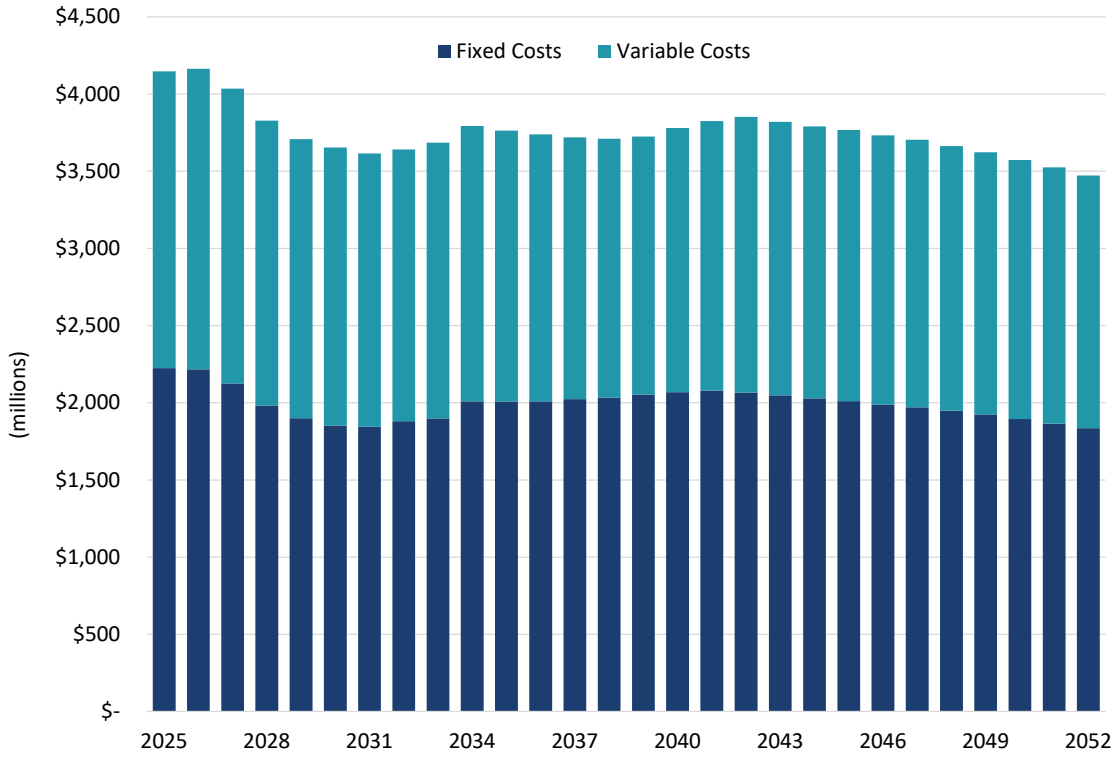
[59] For instance, as derived earlier, the incremental revenues generated from residential customers under the Revenue Envelope are $1.345 billion based on the 2023 Fiscal Plan load and $1.312 based on the elasticity-adjusted load, respectively.

[60] Large changes in sales may impact the cost of operating and maintaining the wires portion of the business. For example, increased sales due to the addition of a new housing development will require the extension of poles and lines which will, in turn, lead to additional costs. In contrast, however, the loss of customers that are already located on the existing wires network will not lead to a noticeable decline in operating and maintenance costs.

94. The composition of PREPA's projected annual revenue requirements for the 28 years provided in PREPA's 2023 Fiscal Plan, broken down between fixed and variable costs, is shown in Figure 12 below.[61]

FIGURE 12: PREPA FIXED AND VARIABLE COSTS

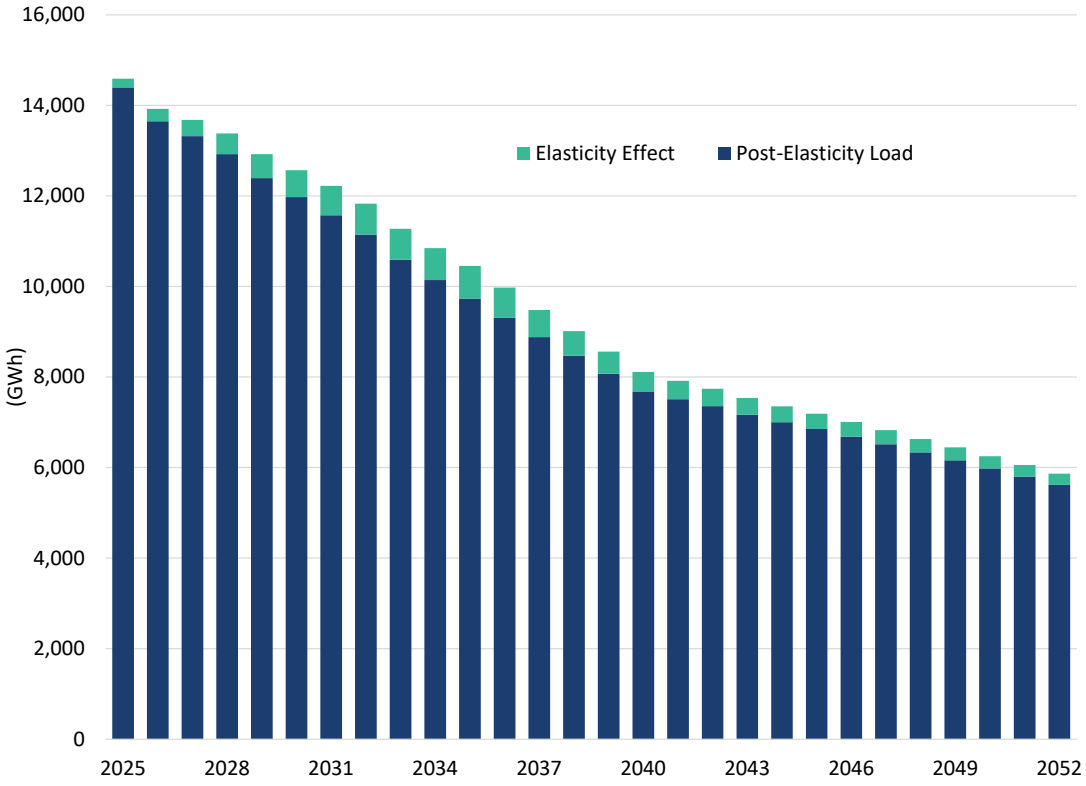


Source: Revenue Envelope and Legacy Charge Model.

95. The impact on PREPA's projected sales of applying the price elasticity of demand (associated with the incremental volumetric charges of implementing the Revenue Envelope) is summarized in Figure 13 below.

[61] In determining the composition of PREPA's fixed and variable costs, we assume that PREPA's: 1) costs of labor, other operating expenses, necessary maintenance expenses, and pension expenses are 100% fixed; and 2) costs of fuel and purchased power (through the Fuel Adjustment Clause and the purchased power adjustment clause) are 10% fixed and 90% variable. We also assume that PREPA's costs associated with CILT and subsidies are 97.5% fixed, because sales to municipal and subsidized customers will likely decline slightly as prices increase, however the majority of the costs (that need to be recovered by other customer classes) will remain intact.

FIGURE 13: IMPACT OF PRICE ELASTICITY OF DEMAND ON SALES PROJECTIONS



Source: Revenue Envelope and Legacy Charge Model.

96. The elasticity effect shown in the figure above is a function of the incremental Revenue Envelope volumetric rate increases for each of PREPA's customer classes and the price elasticity of demand associated with each class. For PREPA customers overall, the average incremental volumetric rate increase from imposition of the Revenue Envelope charges is 7.54% above the volumetric portion of PREPA's overall rates projected in the 2023 Fiscal Plan for FY2025, and 3.61% for FY2052.[62] Applying the price elasticities of demand for each customer class that were introduced earlier, results in a 1.33% decline in sales in FY2025 and, on a cumulative basis, a 4.18% decline in sales in FY2052.[63] That is, applying a long-term price elasticity of demand to incremental price increases is expected to reduce PREPA's projected load over the long term;

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[62] Rate increases applied to individual PREPA tariff groups also vary by year, because "base" rates embedded in PREPA's 2023 Fiscal Plan change year to year. Representative rate increases for FY2025 are: 6.47% for non-subsidized residential customers (GRS 112), 5.88% for large commercial (GST 213), and 10.00% for small commercial customers (GSS 211).

[63] Revenue Envelope and Legacy Charge Model, tab "Revenues Available," cells G51 and AH51.

percentage reductions in any year are not incremental and are not intended to be added together over time.

B. REVENUES AVAIABLE FOR LEGACY DEBT

97. We calculated the revenues available to creditors under the imposition of a set of Revenue Envelope charges by subtracting from the Revenue Envelope the funds needed to cover PREPA's fixed costs underrecovery. This amount is referred to as the Legacy Charge Revenues. A summary of the present values of the Revenue Envelope, the deduction for fixed cost underrecovery, and the Legacy Charge Revenues is shown in Figure 14 below.

FIGURE 14: REVENUE ENVELOPE AND LEGACY CHARGE REVENUES ($ IN MILLIONS)

	2025–2059
Revenue Envelope	
Customer Charge Revenues	$1,342.90
Volumetric Charge Revenues	$2,464.96
Total Revenues	$3,807.86
Fixed Cost Underrecovery	($1,167.37)
Revenues Remaining	$2,640.49
Legacy Charge Revenues (Fiscal Plan Load)	$2,756.87

Source: Revenue Envelope and Legacy Charge Model.

C. LEGACY CHARGE RATES

98. Brattle determined that the rate structure for the Legacy Charge should be designed such that a majority of revenues would be generated from the incremental volumetric component. The use of a volumetric rate component in the Legacy Charge provided greater revenue generation compared to a Legacy Charge relying solely on customer charges and allowed for additional revenues if PREPA's realized kWh sales were higher than its load forecast in the 2023 Fiscal Plan.

99. For GRS customers, the incremental Legacy Charge high-block volumetric rate was set at $0.02988 per kWh and the low-block Volumetric Charge was set at $0.00747 per kWh, very close to the Revenue Envelope volumetric rates used for these customers (*i.e.*, $0.03 per kWh for the high volumetric block and $0.75 per kWh for the low volumetric block). The remaining Legacy Charge revenues from GRS customers would be from a fixed incremental Customer Charge of $1.00 per month.[64]

100. The Legacy Charge rates for GRS customers were then scaled proportionally to PREPA's non-residential customer classes, in the same manner of scaling the Revenue Envelope rates. The revenues available to creditors (*i.e.*, $2.757 billion, as shown in Figure 14) was developed by applying the Revenue Envelope rate schedule to PREPA's residential, commercial and industrial customers, including municipality customers. However, because of the operation of CILT, the Oversight Board, decided to exempt municipality customers from the Legacy Charge. Accordingly, we developed the Legacy Charge rate schedule such that PREPA's residential, commercial (including government but excluding municipality customers), and industrial customers are expected to generate the same $2.757 billion revenues available to creditors. The resulting Legacy Charge rate schedule is shown in Figure 15 below.

[64] The practice of setting a customer charge at whole dollars or quarter-of-a-dollar increments is a frequently used as a rate design convention.

FIGURE 15: LEGACY CHARGE SCHEDULE

	Customer Charge ($/month)	Volumetric Charge (</=425 kWh, c/kWh)	Volumetric Charge (>425 kWh, c/kWh)
RESIDENTIAL			
RH3, LRS, RFR	$ -	-	1.494
GRS 111/112 (Subsidy-eligible)	$ -	-	1.494
GRS 111/112 (General)	$ 1.00	0.747	2.988
COMMERCIAL			
GSS 211	$ 1.25	1.494	2.988
GSP 212	$ 50.00	2.036	2.036
GST 213	$ 112.50	1.426	1.426
GOVERNMENT			
GSS 211	$ 1.25	1.494	2.988
GSP 212	$ 50.00	2.036	2.036
GST 213	$ 112.50	1.426	1.426
INDUSTRIAL			
GSS 311	$ 1.25	2.851	2.851
GSP 312	$ 50.00	2.851	2.851
GST 313	$ 112.50	1.901	1.901
TOU-T 363	$ 112.50	1.901	1.901
LIS 333	$ 112.50	1.901	1.901
TOU-T 963	$ 112.50	1.901	1.901

Source: Revenue Envelope and Legacy Charge Model.

101. Applying the Legacy Charge rate schedule to PREPA's load as projected in the 2023 Fiscal Plan (without taking into account incremental load reductions due to price elasticity of demand) results in Legacy Charge Revenues equal to those presented in Figure 14 above, which serves as the basis for issuing New Bonds to repay legacy debt.

102. The distribution of the Legacy Charge Revenues across customer classes is generally proportional to the distribution of revenues projected in the 2023 Fiscal Plan.[65] The Legacy Charge Revenues consist of 30% generated from residential customers, 57% from commercial and government customers, and the remaining 13% from industrial customers.[66] This compares

[65] The Legacy Charge is applied to PREPA's residential, commercial, government, and industrial customers, not municipality, public lighting, agricultural and other customer classes.

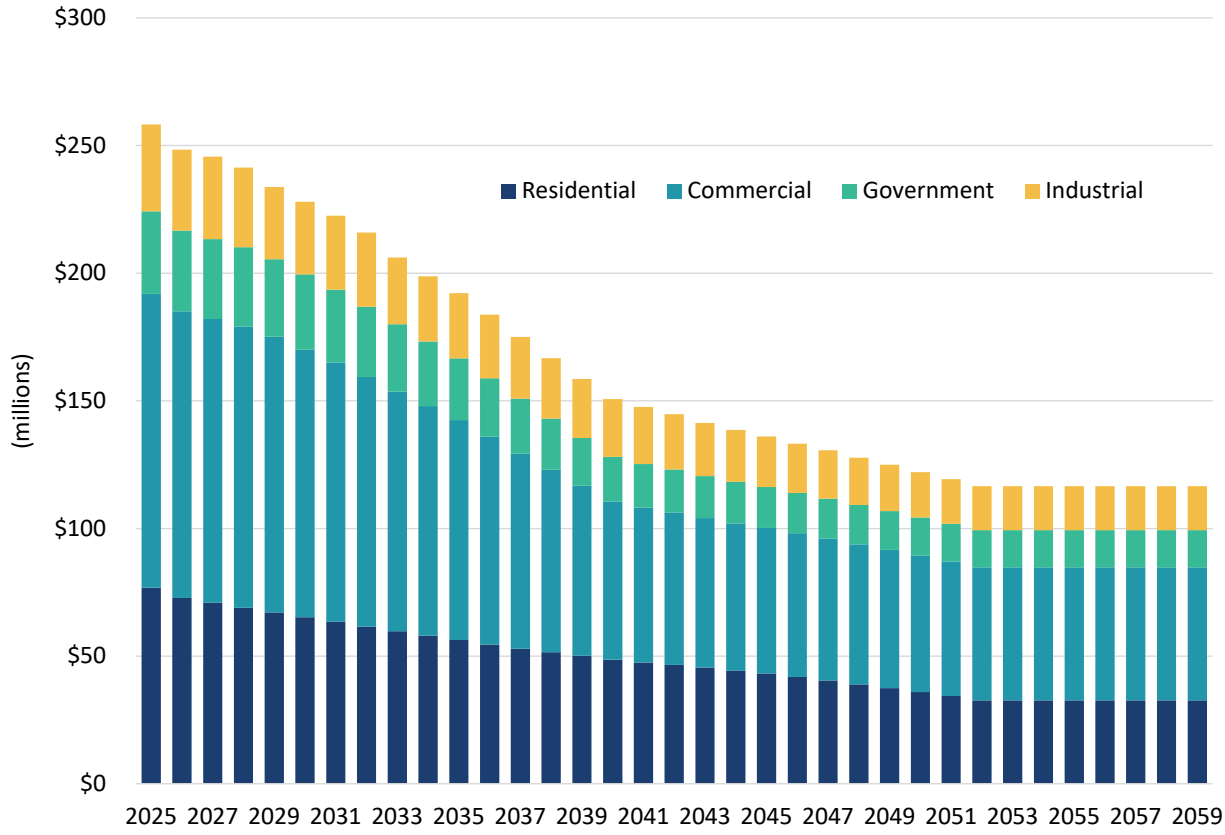
[66] Over the 28-year period of the 2023 Fiscal Plan (FY2025-FY2052), in present value terms. Revenue Envelope and Legacy Charge Model, tab "Distribution of Revenues (LC)."

to the distribution of the 2023 Fiscal Plan revenue requirement of 38%, 50%, and 13% generated from residential, commercial (in combination with government), and industrial customers, respectively.[67] The slightly higher percentage of Legacy Charge Revenues generated by PREPA's commercial customers reflects the lower price elasticities of demand estimated for that sector, and the emphasis on volumetric rates as the vehicle for revenue generation.

IV. MODEL RESULTS AND SENSITIVITIES

103. Applying the Legacy Charge rate schedule to PREPA's customer count and kWh sales forecasts included in the 2023 Fiscal Plan results in annual Legacy Charge Revenues as shown in Figure 16 below.

FIGURE 16: LEGACY CHARGE REVENUES (FISCAL PLAN LOAD)



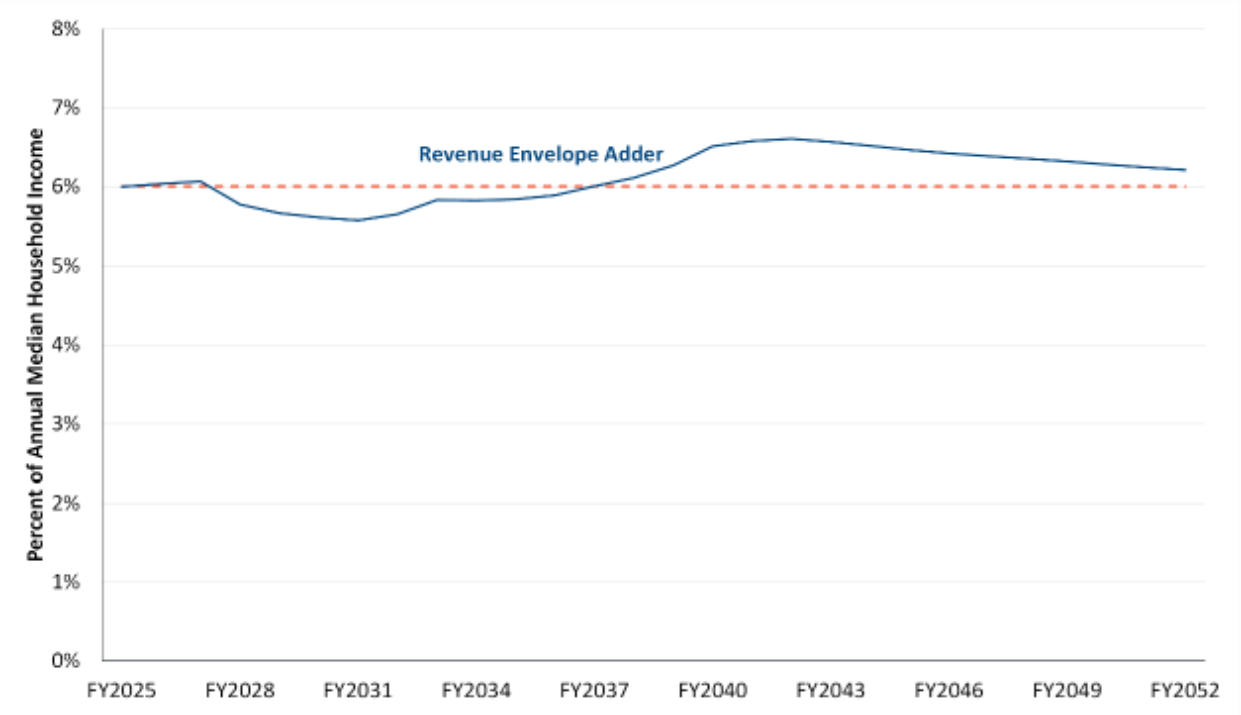
Source: Revenue Envelope and Legacy Charge Model.

[67] Over the 28-year period of the 2023 Fiscal Plan (FY2025-FY2052), in present value terms.

A. MEDIAN INCOME HOUSEHOLD AFFORDABILITY

104. As indicated earlier, the Legacy Charge rates applied to PREPA's residential customers were derived from an affordability analysis for representative median-income households as of FY2025, the reference year. Affordability analyses were not conducted for years beyond FY2025 within the Revenue Envelope and Legacy Charge Model. That is, the Legacy Charge was not designed to be adjusted such that the electricity share of wallet for the representative household would stay at 6% each year within the 35 year term of the Legacy Charge. However, as indicated in my deposition and in the expert rebuttal report of Dr. Weiss, Brattle and the Oversight Board examined affordability levels outside of the Revenue Envelope and Legacy Charge Model framework, as is shown in Figure 17 below.

FIGURE 17: EXPECTED MEDIAN INCOME HOUSEHOLD ELECTRICITY SOW

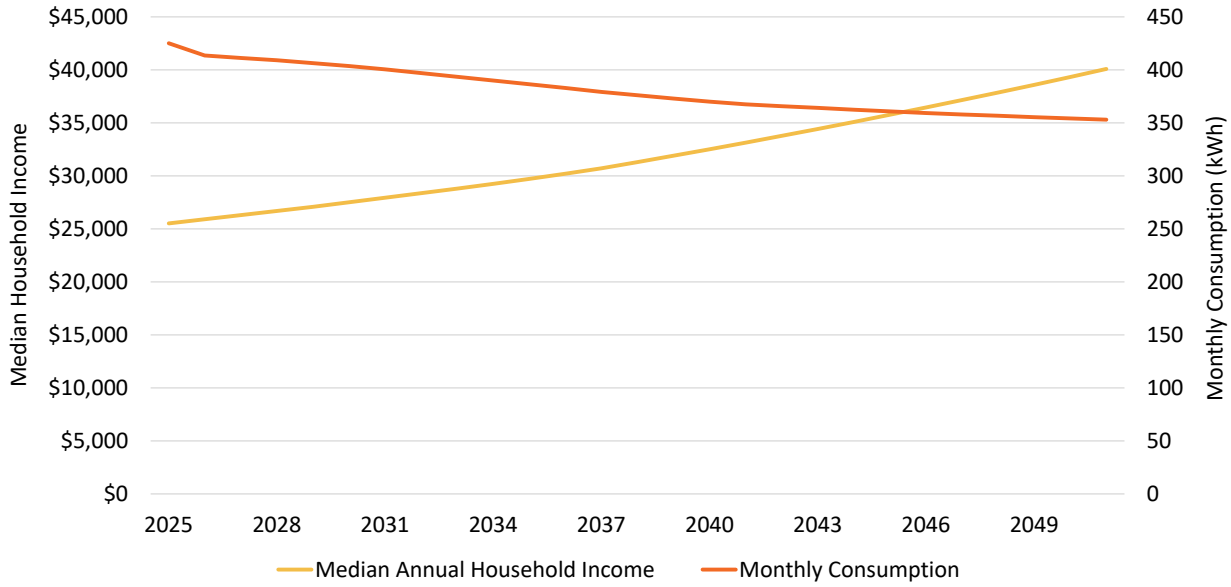


Sources: 2023 Fiscal Plan Model and Revenue Envelope and Legacy Charge Model.

105. As described in Dr. Weiss's expert rebuttal report, "SOW for median-income households in Puerto Rico is projected to remain near or above the 6% electricity SOW target under the Oversight Board's proposed Legacy Charge rate plan, even though (i) the median household income levels for FY2026-FY2052 grow at the rate of inflation and (ii) the median-income

household's consumption declines over time."[68] Figure 18 below shows (i) the increasing annual median incomes and (ii) the decreasing monthly kWh consumptions over the course of the study period, both of which were taken into account in projecting the median-income household electricity share of wallet in Figure 17.

FIGURE 18: MEDIAN HOUSEHOLD INCOME AND REPRESENTATIVE CONSUMPTION PROJECTIONS



Source: 2023 Fiscal Plan Model and Revenue Envelope and Legacy Charge Model.

B. MODEL INPUTS AND SENSITIVITIES

106. The Revenue Envelope and Legacy Charge Model results are sensitive to certain model inputs, notably the pre-debt service rates for electricity projected in PREPA's fiscal plans), the median household income in Puerto Rico (provided in the PRCS) and the representative monthly kWh consumption (derived from the PRCS, LUMA data and the EIA RECS data). PREPA's fiscal plan and the PRCS are updated annually, and the RECS is updated periodically.[69] Updates to these inputs have necessitated updating the Revenue Envelope and Legacy Charge Model.

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[68] Expert Rebuttal Report of Jurgen Weiss, PhD, January 12, 2024, ¶41.

[69] The most recent RECS was released in 2023 and includes survey responses and analysis from 2020. The previous RECS was based on survey results and analysis from 2015.

107. The 2023 Fiscal Plan released in June 2023 projected higher revenue requirements, lower kWh sales and higher rates than the superseded 2022 fiscal plan. The update to the Revenue Envelope and Legacy Charge Model (in June and August of 2023) resulted in a reduction in the present value of Legacy Charge Revenues available to creditors from $5.75 billion to $2.48 billion. Since then, the release of the 2022 PRCS provided higher median household incomes than the previous 2021 PRCS, which, together with updated analysis concerning monthly electricity bills, led to an update to the Revenue Envelope and Legacy Charge Model in November and December of 2023. In this case, higher median household incomes resulted in an increase in the present value of revenues available to creditors, from $2.48 billion to $2.76 billion. In this update, information of PRPEA's rates and rider values allowed for the update of the effective GRS rate used in the affordability analysis module of the Revenue Envelope and Legacy Charge Model.

108. Determining the revenues that may be generated under the Legacy Charge is dependent, in part, on the design of the Legacy Charge itself (*i.e.*, the combination of fixed monthly customer charges and volumetric rates). The volumetric portion of the Legacy Charge applied to PREPA's residential customers (GRS 111 and 112) and small commercial customers (GSS 211) includes a two-tier inverted block rate structure, in which a lower rate per kWh is applied to monthly consumption up to a certain level (a "break point") and a higher rate is applied to consumption above that point. PREPA's GRS tariff (which determines PREPA's Basic Revenues) uses 425 kWh as the break point between low and high rate blocks. We initially used a 500 kWh break point for the volumetric portion of the GRS 111 and 112 and GSS 211 Legacy Charge rates because the data that we relied upon (residential consumption data provided by LUMA aggregated in 250 kWh increments) did not allow the implementation of a rate design with a 425 kWh break point.[70] Subsequently, we received the detailed, customer-level monthly consumption data from LUMA as described earlier, which allowed us to implement a 425 kWh break point. Modifying the break point for the volumetric rate blocks in the GRS and GSS Legacy Charges had the effect of increasing Legacy Charge revenues.

[70] Revenue Envelope and Legacy Charge Model dated March 2023.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information, and belief.

Dated: February 12, 2024

Boston, Massachusetts

William P. Zarakas

Principal, The Brattle Group

APPENDIX A: CV OF WILLIAM ZARAKAS

William Zarakas is an expert on economic and regulatory matters in the electric utility and telecommunications industries. Analyses, expert reports and testimonies provided by Mr. Zarakas have been admitted before: state and federal regulatory commissions (including the Federal Communications Commission, the Federal Energy Regulatory Commission and the Securities and Exchange Commission), courts of law (including the United States District Courts Southern District of New York, Southern District of Florida, District of New Mexico and District of Puerto Rico), the Copyright Royalty Judges (Library of Congress), the US Congress, arbitration panels, and foreign governments and courts of law. Mr. Zarakas has led many of Brattle's engagements that apply expertise in utility and telecom economics, integrated resource planning, cost analysis regulatory structures and ratemaking, competition and antitrust and bankruptcy and restructuring.

Mr. Zarakas holds a leadership role in Brattle's Energy and Regulatory practice and leads much of Brattle's work related to utility economics and regulatory and business models. This includes regulatory frameworks, revenue requirement analysis and ratemaking, resource planning, and benefit-cost analyses, particularly with respect to investments in grid modernization, reliability and resilience. He continues to work on the development of performance-based regulation (PBR) and incentives designed to improve efficiencies and advance policy goals. He has authored a wide range of reports and articles on PBR, "utility of the future" specification and implementation, the utility platform and multi-sided markets, and competition in the retail electricity sector.

Mr. Zarakas also holds a leadership role in Brattle's Telecommunications practice. He has provided expert reports and testimonies in a range of regulatory proceedings concerning forbearance from price regulation; infrastructure access, sharing and pricing arrangements; the economics and financial feasibility of deploying broadband networks; economic analysis of mergers and acquisitions among telecom carriers and media companies; competition in telecom markets; analysis and valuation of wireless spectrum bands and holdings; and the distribution of royalties and retransmission fees in the cable and satellite TV industries.

Utility Resource, Business and Regulatory Models.

Analyzed, advised and/or testified on matters concerning utility resource planning, business models and regulatory frameworks, including integrated resource plans (IRPs) and performance-based ratemaking (PBR) frameworks.

- Led development of the 2022 Integrated Resource Plan (IRP) for PSEG-Long Island (subsidiary of Public Service Electric & Gas) on behalf of the Long Island Power Authority (LIPA). Development of LIPA's 2022 IRP requires comprehensive load forecasting and capacity expansion modeling in compliance with the utility and economy-wide decarbonization goals set out in New York's Climate Leadership and Community Protection Act (CLCPA) and associated scoping studies and plans.
- Expert witness on numerous matters before state regulatory commissions concerning electric utility regulatory frameworks, incluiding application of alternative regulatory mechanisms (e.g., forward test years, reconciliations), performance based regulation (PBR) and performance incentive mechansims (PIMs).
- Analyzed, advised and/or testified on matters concerning performance incentive mechanism (PIMs), including proceedings concering the initiation of multi-year rate plans (MRPs) and PBR in Maryland and the District of Columbia (on behalf of Pepco), New York's "earnings adjustment mechanisms" (on behalf of New York's six investor owned utilities) and performance measures and incentive structures on behalf of the Hawaiian Electric Companies (HECO).
- Provided reports and testimonies concerning the application of alternate regulatory mechanisms (ARMs) and PBR frameworks on behalf of a group of US electric utilities. Scope of analysis included multi-year rate plans (MRPs), performance incentive mechansims (PIMs) and the U.K.'s "RIIO" model.
- Expert witness and lead advisor on numerous engagements with electric utilities involving revenue requirements and load forecasting.

- Engaged by Chair of New York Public Service Commission to analyze implementation of New York's Reforming the Energy Vision (REV) by modeling the economics of the utility platform model, access pricing and financial impacts of retail competition on utility.
- Benchmarked and analyzed regulatory approaches to setting electric distribution reliability standards around the world on behalf of the Australian Energy Market Commission (AEMC).
- Modeled multi-variate "utility of future" scenarios using system dynamic approach on behalf of utilities and industry groups.
- Advised Board of Directors of a major generation and transmission (G&T) cooperative and its member electric distribution cooperatives on matters concerning: asset valuations, risk management strategy, merger and acquisition options, and outlook for retail electric markets.

Infrastructure, Investment Analysis.

Analyzed and testified on matters concerning infrastructure economics and financial feasibility.

- Led benefit-cost and economic "break-even" analysis of utility system reliability and resilience investment using a value of lost load (VOLL) methodology on behalf of Public Service Electric & Gas Company (PSE&G).
- Led multiple Brattle due diligence engagements concerning the whole or partial acquisition of electric and natural gas operating utilities, including electric utilities in the northwestern US, electric transmission companies in the central and southeastern US, and combination electric and gas utilities in the southern US. Due diligence conducted on behalf of buyer; analysis included comprehensive sales, revenue, and operating and capital cost modeling and scenarios.
- Led numerous analyses of the values of wireless spectrum in the U.S., Canada, the Middle East and North Africa (MENA), and other geographic markets. Scope of analyses included: PCS, AWS, 2.3-2.5 GHz, SMR, PLMR, IVDS, MSS and Big Leo spectrum bands, among others, for purposes of planning, transactional analysis, regulatory proceedings, domestic and international arbitration, and commercial litigation.
- Conducted analyses and authored expert reports concerning utility use of private networks vs. leased spectrum, and valuations of 900 MHz spectrum.

- Conducted financial feasibility analysis concerning deployment of a broadband communications network for an Asian electric utility.
- Analyzed economics and financial feasibility of providing telecommunications (wholesale) transport and (retail) broadband services for multiple U.S. electric utilities.

Bankruptcy and Restructuring.

Led Brattle teams and provided expert reports and testimonies in matters concerning bankruptcies and restructurings involving electric utilities and telecommunications companies.

- Expert report and testimony concerning the bankruptcy and restructuring of Uniti Group, specifically involving litigation by plaintiff Windstream with respect to telecommunications network investments (Febraury 2020).
- Engaged by Special Committee of Board of Led in investigation of "swap" transactions (of ocean crossing high capcity fiber optic circuits) leading to bankruptcy and restructuring of Global Crossing. Provided reports to Global Crossing Borad of Directors and Bondholder. (2002-2003).

Megers, Acquisitions, Competition and Antitrust.

- Conducted merger simulation analysis, submitted testimony and provided ongoing support on the potential effects of the merger of mobile wireless carriers Sprint and T-Mobile, under review before the US Federal Communications Commission, the Department of Justice, and various state Attorneys General on behalf of DISH Network.
- Conducted merger analysis, submitted testimony and provided ongoing support on the potential effects of the merger of Sinclair Broadcast Group and Tribune Media, under review before the US Federal Communications Commission on behalf of DISH Network.
- Conducted merger analysis, submitted testimony and provided ongoing support on the potential effects of the mergers of Comcast-Time Warner Cable; AT&T-Time Warner; and, Disney-Fox.
- Conducted competitive analysis, submitted testimony, and provided expert support in a regulatory proceeding before the Federal Communications Commission on competition

issues in dedicated internet bandwidth services, including possession of market power and assessment of market power abuse on behalf of Sprint Corporation.

- Analyzed effectiveness of retail competition in U.S. electricity markets.
- Analyzed market structure and degree of competition in U.S. retail telecom markets and authored expert reports with regard to Petitions for FCC to forbear from price regulating resale services and UNEs on behalf of Granite Telecom and Incompas.
- Analyzed acquisition price premium in merger of cross-state gas and electric utilities on behalf of TECO Energy, Inc., New Mexico Gas Company, Inc in a matter before the New Mexico Public Regulatory Commission.
- Analyzed prospective merger savings and divestiture losses for electric and gas utilities in merger applications before the U.S. Securities and Exchange Commission (SEC).

Telecom Regulatory and Compliance.

- Analyzed and provided testimony in matters concerning access to incumbent carrier networks and forebearance of network elements and services in matters before the FCC.
- Developed cost and revenue models to estimate costs, feasibility and customer rates associated with deploying wireless broadband to Alaska and rural areas in the continental U.S. on behalf of GCI Communications for FCC proceedings regarding the Connect America Fund and Mobility Fund.
- Provided expert reports and testimonies on matters concerning pole attachment rates before the FCC on behalf of multiple electric utilities.
- Led comprehensive modeling concerning costs and rates for unbundled network elements (UNEs), undertaken in fulfillment of requirements associated with the Telecommunications Act of 1996, using the Total Element Long Run Incremental Cost (TELRIC) methodology

Other Regulatory Analyses.

- Analyzed markets for and costs of providing utility pole attachments in multiple matters before the Federal Communications Commission and state regulatory commissions.

- Calculated total factor productivity (TFP) and X factors in price regulation proceedings involving utilities before state regulatory commissions and incumbent telecommunications carriers before the FCC.
- Analyzed costs and value of retransmitted television programming in cable and satellite video markets on behalf of Music Claimants in proceedings involving distribution of royalty funds.
- Examined impact of regulatory fees and constraints on economic output in 22 countries in the Middle East and Africa for international mobile carrier.

Management Analysis and Audits.

Recent work includes:

- Led strategic organizational options analysis for the Board of Trustees of the Long Island Power Authority (LIPA).
- Led management and/or regulatory audits of utilities and telecommunications carriers on behalf of state regulatory commissions Alabama, Kentucky, Maryland, New York and Pennsylvania.

Expert Testimony

- Economics of the FCC's Spectrum Screen: Relevance and Proposed Modifications," with Coleman Bazelon and Paroma Sanyal, Prepared for DISH Network, in response to FCC's Public Notice, DA 23-891, WT Docket No. 23-319, RM-11966, Brattle Reply Comments, November 8, 2023.
- Expert reports ("Comments on Commissioner Anthony's Principles for Performance Incentive Mechanisms") Before the Rhode Island Public Utilities Commission (May 7, 2020).
- Expert report in re: Windstream Holdings Inc., et al Debtors, Windstream Holdings, Inc., and Windstream Service LLC, Plaintiffs vs. Uniti Group, Inc., et al. Chapter 11 Case No. 19-22312 (RDD)

- (Jointly Administered) Adversary Proceeding Case No. 19-08279 Before United States Bankruptcy Court Southern District of New York (February 21, 2020).
- Declaration of William Zarakas Verizon Maryland LLC, Complainant v. The Potomac Edison Company, Defendant, in a Pole Attachment Complaint Before the Federal Communications Commission, Proceeding No. 19-355, Bureau ID No. EB-19-MD-009 (February 1, 2020)
- Declaration of William Zarakas Verizon Pennsylvania LLC and Verizon North LLC, Complainants v. Metropolitan Edison Company, Pennsylvania Electric Company, and Penn Power Company, Defendant, in a Pole Attachment Complaint Before the Federal Communications Commission, Proceeding No. 19-354, Bureau ID No. EB-19-MD-008 (February 1, 2020)
- Declaration of William P. Zarakas BellSouth Telecommunications, LLC d/b/a AT&T Florida, Complainant, v. Florida Power & Light Company, Respondent, in a Pole Attachment Complaint Before the Federal Communications Commission, Proceeding No. 19-187, Bureau ID No. EB-19-MD-006 (September 12, 2019).
- Direct Testimony of William Zarakas In the Matter of the Application of Potomac Electric Power Company for the Authority to Implement a Multiyear Rate Plan for Electric Distribution Service in the District of Columbia, Formal Case No. 1156 (May 30, 2019); Second Supplemental Direct Testimony (January 21, 2020); Rebuttal Testimony (April 6, 2020).
- Declarations of Coleman Bazelon, Jeremy Verlinda, and William Zarakas Before the Federal Communications Commission In the Matter of Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, WT Docket No. 18-197
  - May 1, 2019, Response to Israel, Katz, and Keating April 12, 2019 Declaration
  - March 28, 2019, Response to Compass Lexecon February 20, 2019 Declaration and Mark McDiarmid March 6, 2019 Declaration
  - March 25, 2019, Response to Applicants' February 7 Filings on Diversion Ratios

  - March 18, 2019, Reply to Cornerstone's "Response to Dish's February 19 and 25 Submissions"
  - February 19, 2019, Reply to Cornerstone "Response to Dish and CWA Comments"
  - February 4, 2019, Network Model's Sensitivity to Millimeter Wave Adjustments
  - January 28, 2019, Response to Applicant Filings on Diversion Ratios
  - December 4, 2018, Further Reply Declaration of Coleman Bazelon, Jeremy Verlinda, and William Zarakas

- Declaration (August 27, 2018) and Reply Declaration (October 31, 2018) of Joseph Harrington, Coleman Bazelon, Jeremy Verlinda, and William Zarakas Before the Federal Communications Commission In the Matter of Applications of T-Mobile US, Inc. and Sprint Corporation for Consent to Transfer Control of Licenses and Authorizations, WT Docket No. 18-197

- "The Role of Competitive Bidding Based Prices in Determining the Rural Rate," William Zarakas and Augustin J. Ros, In the Matter of Promoting Telehealth and Telemedicine in Rural America, Before the Federal Communications Commission, WC Docket No. 17-130 (May 24, 2019).

- Response to PC 51 Request for Comments, Prepared for Joint Utilities of Maryland, Prepared by William Zarakas, Sanem Sergici, Pearl Donohoo-Vallett, and Nicole Irwin in Exploring the Use of Alternative Rate Plans or Methodologies to Establish New Base Rates for an Electric Company of Gas Company Before the Public Service Commission of Maryland, PC 51 (March 29, 2019).

- Declaration of William Zarakas and Dr. Eliana Garces Before the Federal Communications Commission In the Matter of Tribune Media Company (Transferor) and Nexstar Media Group, Inc. (Transferee) Consolidated Application for Consent to Transfer Control, MB Docket No. 19-30 (March 18, 2019).

- Expert Report of William P. Zarakas On Behalf of BC Hydro, BC Hydro Fiscal 2020—Fiscal 2021 Revenue Requirements Application to the British Columbia Utilities Commission (February 8, 2019).

- Direct and Rebuttal Testimony of William P. Zarakas On Behalf of Public Service Company of Oklahoma Before the Corporation Commission of the State of Oklahoma In the Application of the Public Service Company of Oklahoma For an Adjustment To Its Rates and Charges and the Electric Service Rules, Regulations and Conditions of Service For Electric Service in the State of Oklahoma, Cause No. PUD 201800085 (September 21, 2018, February 5, 2019).
- Declaration of William P. Zarakas Before the Federal Communications Commission In the Matter of Petition of USTelecom for Forbearance Pursuant to 47 U.S.C. § 160(c) to Accelerate Investment in Broadband and Next-Generation Networks WC Docket No. 18-141, Opposition of Granite to USTelecom's Forebearnace Petition (August 6, 2018).
- Declaration of William P. Zarakas Before the Federal Communications Commission In the Matter of Petition of USTelecom for Forbearance Pursuant to 47 U.S.C. § 160(c) to Accelerate Investment in Broadband and Next-Generation Networks WC Docket No. 18-141, Opposition of Incompas, FISPA, Midwest Association of Competitive Communications, and the Northwest Telecommunciations Association (August 6, 2018)
- Expert report on behalf of GCI Communications "Rate of Return Analysis of GCI's TERRA Network," by William P. Zarakas, Agustin J. Ros, and Nicholas E. Powers. Prepared for GCI Communication Corp., March 30, 2018, in connection with the FCC's investigation of the Rural Health Care Telecommunications Program.
- Expert report on behalf of GCI Communications before the Federal Communications Commission, In the Matter of Connect America Fund and Universal Service Reform, WC Docket No. 10-90 and WT Docket No. 10-208A: analysis of the FCC's Rural Health Care Program Funding and Recipients, by William Zarakas, Augustin Ros, David Kwok, and M. Elaine Cunha, September 2017.
- Declaration (August 7, 2017) and Reply Declaration (August 29, 2017) of William P. Zarakas and Jeremy A. Verlinda Before the Federal Communications Commission In the Matter of Tribune Media Company (Transferor) and Sinclair Broadcast Group, Inc. (Transferee), Consolidated Applications for Consent to Transfer Control, MB Docket No. 17-179.

- Before the State of New York Public Service Commission In the Matter of Earnings Adjustment Mechanism and Scorecard Reforms Supporting the Commission's Reforming the Energy Vision, Case 16-M-0429, On Behalf of the New York Joint Utilities (Central Hudson Gas and Electric Corporation, Consolidated Edison Company of New York, Inc., New York State Electric & Gas Corporation, Niagara Mohawk Power Corporation d/b/a National Grid, Orange and Rockland Utilities, Inc., and Rochester Gas and Electric Corporation), Report: "Assessment of Load Factor as a System Efficiency Earnings Adjustment Mechanism," William Zarakas, Sanem Sergici, et. al. (February 10, 2017).

- Declaration of William P. Zarakas Before the Federal Communications Commission In the Matter of Business Data Services in an Internet Protocol Environment, Investigation of Certain Price Cap Local Exchange Carrier Business Data Services Tariff Pricing Plans, Special Access for Price Cap Local Exchange Carriers, AT&T Corporation Petition for Rulemaking to Reform Regulation of Incumbent Local Exchange Carrier Rates for Interstate Special Access Services, WC Docket No. 16-143, WC Docket No. 15-247, WC Docket No. 05-25, RM-10593. Declaration of William P. Zarakas and Susan M. Gately (January 27, 2016); Supplemental Declaration of William P. Zarakas (March 24, 2016); Declaration of William P. Zarakas and Jeremy Verlinda (June 28, 2016, Attachment D to Comments of Sprint Corporation); Declaration of David E. M. Sappington and William P. Zarakas (June 28, 2016, Attachment E to Comments of Sprint Corporation); Further Supplemental Declaration of William P. Zarakas (August 9, 2016, Attachment A of Reply Comments of Sprint Corporation).

- Declaration of William P. Zarakas Before the Federal Communications Commission In the Matter of Verizon Virginia. LLC and Verizon South, Inc., Complainants, v. Virginia Electric and Power Company d/b/a Dominion Virginia Power, Docket No. 15-90, File No. EB-15-MD-006 (November 18, 2015).

- Declaration of William P. Zarakas and Matthew Aharonian in the United States Court for the District of Columbia Circuit United States Telecom Association, Petitioner, v. Federal Communications Commission and the United States of America, Respondents, Case No. 15-1063 (and consolidated cases) (May 22, 2015).

- Declarations Before the Federal Communications Commission In the Matter of Application of Comcast Corporation, General Electric Company and NBC Universal, Inc. for Comcast to Assign or Transfer Control of Licenses, Federal Communications Commission, MB Docket No. 10-56. Analysis of the FCC's Vertical Foreclosure and Nash Bargaining Models Applied To The Proposed Comcast-Time Warner Cable Transaction (December 21, 2014) and Supplemental Declaration: Analysis of the FCC's Vertical Foreclosure and Nash Bargaining Models Applied To The Proposed Comcast-Time Warner Cable Transaction (March 5, 2015).
- Before the Public Utilities Commission of the State of Hawaii, In The Matter of Public Utilities Commission Instituting an Investigation to Reexamine the Existing Decoupling Mechanisms for Hawaiian Electric Company, Inc., Hawaii Electric Light Company, Inc., and Maui Electric Company, Limited, Docket No. 2013-1041, On Behalf of the Hawaiian Electric Companies. Report: "Targeted Performance Incentives: Recommendations to the Hawaiian Electric Companies," Prepared For The Hawaiian Electric Companies, William P. Zarakas and Philip Q Hanser (September 15, 2014).
- Before the New Mexico Public Regulatory Commission, In The Matter Of The Application of TECO Energy, Inc., New Mexico Gas Company, Inc. and Continental Energy Systems, LLC, For Approval of TECO Energy Inc.'s Acquisition of New Mexico Gas Intermediate, Inc. and For All Other Approvals and Authorizations Required To Consummate and Implement The Acquisition, Utility Case No. 13-00231-UT, On Behalf of TECO Energy, Inc., New Mexico Gas Company, Inc. and Continental Energy Systems, LLC, Joint Applicants (March 2014).
- "Analysis of Benefits: PSE&G's Energy Strong Program," by Peter Fox-Penner and William P. Zarakas Before the New Jersey Board of Public Utilities In the Matter of the Petition of Public Service Electric and Gas Company for Approval of the Energy Strong Program, Docket No. EO13020155 and GO13020156 (October 7, 2013).
- "Review and Analysis of Service Quality Plan Structure In The Massachusetts Department of Public Utilities Investigation Regarding Service Quality Guidelines For Electric Distribution Companies and Local Gas Distribution Companies." Philip Q Hanser, David E. M. Sappington and William P. Zarakas, Massachusetts D.P.U. 12-120 (March 2013).

- "Alaska Mobile Broadband Cost Model, Before The Federal Communications Commission In The Matter Of Connect America Fund and Universal Service Reform – Mobility Fund. WC Docket No. 10-90 and WT Docket No. 10-208A." William P. Zarakas and Giulia McHenry (February 2013; updated May 2016, with David Kwok).
- Expert Report of William P. Zarakas In The United States District Court For The Northern District of Florida MCI Communications Services, Inc., Plaintiff v. Murphree Bridge Corporation, Defendant, Case No. 5:09-cv-337 (February 19, 2010).
- Testimony of William P. Zarakas Before The Copyright Royalty Judges, Library of Congress, Washington D.C. In The Matter of Distribution of the 2004 and 2005 Cable Royalty Funds, Docket No. 2007-3 CRB CD 2004-20 (June 1, 2009).
- Declaration of William P. Zarakas In The Circuit Court of Fairfax County, Virginia In The Matter of Sharon Dougherty, Plaintiff Vs. Thomas J. Dougherty, Defendant Case No. CL 2007-008757 (October 2008).
- Expert report Public Service Company of New Mexico vs. Smith Bagley, Inc. and Lite Wave Communications LLC In The United States District Court For The District of New Mexico (March 2007).
- "Comparative Market Value Analysis of Upper 700 MHz Public Safety Spectrum" Before the Before the Federal Communications Commission In the Matter of The Development of Operational, Technical and Spectrum Requirements for Meeting Federal, State and Local Public Safety Communications Requirements Through the Year 2010, WT Docket No. 96-86 (June 2006).
- "Analysis of Potential Lost Profits Associated With The Alleged Breach of Contract Between Orbcomm and Orbcomm Asia Limited" Before the American Arbitration Association (May 2006).
- Expert report Before the Federal Communications Commission In Petition of ACS of Anchorage, Inc. Pursuant to Section 10 of the Communications Act of 1934, as amended, for Forbearance from Sections 251(c)(3) and 251(d)(1) In the Anchorage LEC Study Area, WC Docket No. 05-281 (January 9, 2006).

- Letter report of William Zarakas and Dorothy Robyn Before the U.S. House of Representatives Committee on Energy and Commerce and the U.S. Senate Committee on Commerce, Science and Transportation regarding the value of wireless spectrum in the 700 MHz band (May 18, 2005).
- Expert report in MCI WorldCom Network Services, Inc. v. MasTec, Inc. Before the United States District Court Southern District of Florida, Case No. 01-2059-CIV-GOLD (May 2002).
- Direct and Rebuttal testimony Before the Federal Communications Commission In the Matter of Virginia Cable Telecommunications Association v. Virginia Electric and Power Company, d/b/a Dominion Virginia Power and Dominion North Carolina Power, PA No. 01-005 (December 21, 2001).
- "Analysis Of The Economic Impact Of A Divestiture Of The Gas Operations Of Rochester Gas And Electric Corporation" Before the U.S. Securities and Exchange Commission included in Form U-1 Application/ Declaration Under The Public Utility Holding Company Act of 1935 in the combination of Energy East Corporation with RGS Energy Group, Inc. (June 20, 2001) in Exhibit J-1 (May 15, 2001).
- "Analysis Of The Economic Impact Of A Divestiture Of The Gas Operations Of Sierra Pacific Resources" Before the U.S. Securities and Exchange Commission included in Form U-1 Application/ Declaration Under The Public Utility Holding Company Act of 1935 in the acquisition by Sierra Pacific Resources of Portland General Electric Company, 2000 in Exhibit H-1 (January 31, 2000).
- "Analysis Of The Economic Impact Of A Divestiture Of The Gas Operations Of Energy East" Before the U.S. Securities and Exchange Commission included in Form U-1 Application/ Declaration Under The Public Utility Holding Company Act of 1935 in the combination of Energy East Corporation with CMP Group, Inc. and with CTG Resources, Inc. in Exhibit J-1 (October 29, 1999).
- Supplemental Affidavit of William Zarakas Before the Supreme Court of the State of New York, County of Niagara in Village of Bergen, et al. vs. Power Authority of the State of New York, February 1999.

- Direct (December 15, 1997) and Rebuttal (March 9, 1998) Panel Testimony of William P. Zarakas and D. Daonne Caldwell Before the North Carolina Utilities Commission In Re: Proceeding to Determine Permanent Pricing for Unbundled Network Elements, Docket No. P-100, SUB 133D.
- Direct (November 3, 1997) and Rebuttal (November 25, 1997) Panel Testimony of William P. Zarakas and D. Daonne Caldwell Before the South Carolina Public Service Commission In Re: Proceeding to Review BellSouth Telecommunications, Inc.'s Cost Studies for Unbundled Network Elements, Docket No. 97-374-C.
- Direct Panel Testimony of William P. Zarakas and D. Daonne Caldwell Before the Florida Public Service Commission In Re: Petition of AT&T, MCI, and MFS for Arbitration with BellSouth Concerning Interconnection, Rates, Terms and Conditions of a Proposed Agreement, Docket Nos. 960757-TP/960833-TP/960846-TP/960916-TP/971140-TP (November 13, 1997).
- Direct (October 10, 1997) and Rebuttal (October 17, 1997) Panel Testimony of William P. Zarakas and D. Daonne Caldwell Before the Tennessee Regulatory Authority In Re: Contested Cost Proceeding to Establish Final Cost Based Rates for Interconnection and Unbundled Network Elements, Docket No. 97-01262.
- Direct (August 29, 1997) and Rebuttal (September 12, 1997) Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Alabama Public Service Commission In Re: Generic Proceeding: Consideration of TELRIC Studies, Docket No. 26029.
- Direct (April 30, 1997) and Rebuttal (September 8, 1997) Panel Testimony of William P. Zarakas and D. Daonne Caldwell before the Georgia Public Service Commission In Re: Review of Cost Studies, Methodologies and Cost-Based Rates for Interconnection and Unbundling of BellSouth Telecommunications Services, Docket No. 7061-U.
- Diraect (July 11, 1997) and Rebuttal (September 5, 1997) Panel Testimony of William P. Zarakas and D. Daonne Caldwell Before the Louisiana Public Service Commission In Re: Review of Consideration of BellSouth Telecommunications, Inc.'s TSLRIC and LRIC Cost Studies to Determine Cost of Interconnection Services and Unbundled Network Components,

to Establish Reasonable, Non-Discriminatory, Cost-Based Tariff Rates, Docket Nos. U-22022/22093.

- Direct and Rebuttal Testimony Before the Virginia State Corporation Commission on Behalf of United Telephone - Southeast, Inc. and Centel Corporation (May 1994).
- Direct and Rebuttal Testimony Before the Tennessee Public Service Commission on Behalf of United Telephone - Southeast, Inc., Docket No. 93-04818 (January 28, 1994).
- Direct and Rebuttal Testimony Before the Florida Public Service Commission on Behalf of Southern Bell Telephone & Telegraph Company, Docket No. 920260-TL (December 10, 1993).
- Direct and Rebuttal Testimony Before the Tennessee Public Service Commission on behalf of South Central Bell, Docket Nos. 92-13527 and 93-00311 (March 22 and March 29, 1993).

Papers,Publications and Presentations

- Washington D.C. Performance Based Regulation Workshop, presented by William Zarakas, Sanem Sergici and Pearl Donohoo-Vallett, September 19, 2018.
- Hawaii Public Utilities Commission Performance Based Regulation Workshop, PBR Tools and Experience Panel, "The Intersection of Utility Platforms and PBR," William Zarakas, Honolulu, HI, July 23-24, 2018.
- "A New Face for PBR: Aligning Incentives in the Electric Utility Ecosystem" by William Zarakas, *Public Utilties Fortnightly*, December 2017.
- "Two-sided Markets and the Utility of the Future: How Services and Transactions Can Shape the Utility Platform," by William P. Zarakas, *The Electricity Journal*, Volume 30 (2017) 43-46.
- Performance Based Regulation: Plans Goals, Incentives and Alignment, by William Zarakas, Toby Brown, Léa Grausz, Heidi Bishop and Henna Trewn, prepared for DTE Energy, December 6, 2017.
- PBR: Applications and Future, presented by William Zarakas to the Michigan PSC PBR Collaborative, Lansing, Michigan, November 8, 2017.

- "DER Incentive Mechanisms as a Bridge to the Utility of the Future," by William P. Zarakas, Frank C. Graves and Heidi Bishop, presented at SNL Knowledge Center's Energy Utility Regulation Conference: Strategies for Profit and Reliability, December 14, 2016.
- "Electric Utility Services and Evolving Platforms in the Mid-Atlantic Region," by William Zarakas, presented at the Mid-Atlantic Conference of Regulatory Utilities Commissioners (MACRUC) 20th Annual Education Conference, Williamsburg, VA, June 23, 2015.
- "Growth Prospects and Shifting Electric Utility Business Models: Retail, Wholesale and Telecom Markets," by William P. Zarakas, *The Electricity Journal*, Volume 28, Issue 5, June 2015.
- "Do We Need a New Way to Regulate Electric Utilities?," by William P. Zarakas, presented at the Energy Bar Association 2015 Annual Meeting, Washington, DC, May 6, 2015.
- "Investing In Electric Reliability and Resiliency," by William P. Zarakas, presented at the NARUC 2014 Summer Meeting - Joint Electricity and Critical Infrastructure Committees, Dallas, TX, July 15, 2014.
- "Utility Investments in Resiliency: Balancing Benefits with Cost in an Uncertain Environment," by William P. Zarakas, Sanem Sergici, Heidi Bishop, Jake Zahniser-Word and Peter S. Fox-Penner, *The Electricity Journal,* Volume 27, Issue 5, June 2014.
- "Infrastructure and Competition in the Electric Delivery System," by William P. Zarakas, *The Electricity Journal*, Volume 26, Issue 7, September 2013.
- "Low Voltage Resiliency Insurance, Portable small-scale generators could keep vital services on line during a major power outages," by William Zarakas, Frank Graves, and Sanem Sergici, *Public Utilities Fortnightly* September 2013.
- "Finding the Balance Between Reliability and Cost: How Much Risk Should Consumers Bear?," by William P. Zarakas and Johannes P. Pfeifenberger, presented at the Western Conference of Public Service Commissioners, Santa Fe, NM, June 3, 2013
- "The Utility of the Future: Distributed or Not?," by William P. Zarakas, presented at Advanced Energy 2013, New York, NY, April 30, 2013

- "Rates, Reliability, and Region," by William P. Zarakas, Philip Q Hanser, and Kent Diep, *Public Utilities Fortnightly*, January 2013
- "Approaches to Setting Electric Distribution Reliability Standards and Outcomes," by Serena Hesmondhalgh, William P. Zarakas, and Toby Brown, The Brattle Group, Inc., January 2012
- "Analysis of Strategic Organizational Options for the Long Island Power Authority," by William P. Zarakas, Frank C. Graves, and Michael J. Beck, prepared for the Board of Trustees, Long Island Power Authority, October 2011.
- "Measuring Concentration In Radio Spectrum License Holdings," by Coleman Bazelon and William Zarakas, presented at the Telecommunications Policy Research Conference (TPRC), George Mason University, September 26, 2009.
- "Structural Simulation of Facility Sharing: Unbundling Policies and Investment Strategy in Local Exchange Markets," White Paper, July 2005 (with Glenn A. Woroch, Lisa V. Wood, Daniel L. McFadden, Nauman Ilias, and Paul C. Liu).
- "Betting Against The Odds? Why broadband over power lines (BPL) can't stand alone as a high-speed Internet offering." Public Utilities Fortnightly, April 2005, pp. 41-45 (with Kenneth J. Martinian).
- "The Impact of the Number of Mobile Operators on Consumer Benefit," White Paper, March 2005 (with Kenneth J. Martinian and Carlos Lapuerta).
- "Wholesale Pricing and Local Exchange Competition", Info, Volume 6, Number 5, 2004, pp. 318-325 (with Lisa V. Wood and David E. M. Sappington).
- "Regulatory Performance Measurement Plans and the Development of Competitive Local Exchange Telecommunications Markets", Working Paper, November 2003 (with David E. M. Sappington, Lisa V. Wood and Glenn A. Woroch).
- "FCC Pole Attachment Rates: Rebutting Some of the Presumptions," presented to utility regulators, March 2003 (with Lisa V. Wood).
- "The Concurrent Exchange of Fiber Optic Capacity and Services Between Global Crossing and its Carrier Customers," prepared for Special Committee on Accounting Matters of the Board of Directors of Global Crossing Ltd., January 2003.

APPENDIX B: PRICE ELASTICITY OF DEMAND ANALYSIS

This appendix provides more detail regarding the basis for the price elasticity of demand assumptions used in the Revenue Envelope and Legacy Charge model and discussed in my declaration.

B.1 INTRODUCTION

1. Price elasticity of demand is one of the key concepts in microeconomic theory, and a measure of consumers' response to changes in the price of a good.[71] Formally, price elasticity is the ratio of the percentage change in the quantity demanded of a good to the percentage change in price. The price elasticity of demand for a given good depends on factors such as the availability of close substitutes, whether the good is a necessity or a luxury, and the time horizon.[72] For most goods, including electricity, price elasticity is negative, as consumers reduce their consumption because of a price increase.

2. PREPA's load forecasts are composed of (i) an econometrically based "gross" load forecast and (ii) "load modifiers," which together form a "net" load forecast upon which PREPA's revenue requirements and rate projections are based. The econometric model that PREPA uses to develop its gross load forecast includes explanatory variables (such as Puerto Rico economic output and a weather related variable), and does not include a price variable, and thus does not provide a price elasticity of demand coefficient. However, PREPA's net load forecast indirectly includes price elasticity of demand effects through its use of exogenous (*i.e.*, not determined within the model) load modifier models.

3. Econometrically based load forecasting models are often based on historical relationships among variables and kWh sales, whereas the load modifier models used by PREPA (and many other

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[71] N. Gregory Mankiw, "Principles of Microeconomics" 7th edition, 2014, Chapter 5.

[72] *Ibid.*

electric utilities)[73] forecast the forward-looking effects of energy efficiency, electric vehicles and distributed generation (DG), which mainly concerns the installation of rooftop photovoltaics (PV).[74] An important element of the analysis underlying the load modifier forecast involves the projected economics of the load modifier (*e.g.*, self generation, electric vehicles) relative to the cost of grid power, for which the price of electricity is an important factor.

4. The ultimate price of electricity can be calculated by an "effective" (also referred to as an "all-in" or "blended" rate) rate (*i.e.*, $ per kWh), which is the sum of the various billing components divided by the kWh consumed. Specifically, electric utility customers are billed for electricity under tariffs, which include a combination of fixed customer charges, one or more blocks of volumetric charges, and, for large usage customers, demand and/or others charges. The billing components and the above-described effective rate include costs that are "avoidable" and others that are "unavoidable" to a customer, assuming that the customer would like to generate a portion of its electricity usage (*e.g.*, via rooftop PV) and remain connected to the grid. Volumetric charges are avoidable, while fixed customer charges are not – assuming that the customer prefers to remain connected to the grid. Thus, the price we use for calculations relating to the price elasticity of demand involves only the avoidable volumetric charges.[75]

5. The Revenue Envelope and Legacy Charge rate schedules include (i) an incremental fixed monthly customer charge (*i.e.*, a charge that is non-avoidable as long customers remain connected to PREPA's grid); and (ii) one or more tiers of volumetric charges (*i.e.*, charges that can be avoided in whole or in part if the customer uses a non-grid electric power supply such as rooftop PV). Increasing PREPA's volumetric rates (to be used to repay creditors) beyond the rates projected in the 2023 Fiscal Plan requires that some adjustments be made to PREPA's load forecast to account for the incremental impacts on electricity consumption of the incremental volumetric rates.

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[73] For example, New York State's electric utilities use a load forecasting methodology that includes an econometrically based gross load and load modifiers. The individual electric utility forecasts are then compiled into the annual Load & Capacity Data report by the New York Independent System Operator (NYISO), referred to as the "Gold Book." *See*, 2023 Load & Capacity Data Report, April 2023, New York Independent System Operator, Inc., https://www.nyiso.com/documents/20142/2226333/2023-Gold-Book-Public.pdf.

[74] PREPA 2023 Fiscal Plan, p. 118.

[75] Because volumetric charges may also be subject to multiple tiers in a rate schedule, an "effective" volumetric rate can also be used.

6. We examined research, primarily academic journal articles, for insight and benchmarks as to historical price elasticities of demand. However, as indicated above, the availability of substitutes is a key determinant of the price elasticity of demand and, historically, few substitutes for electricity were available to most consumers. Thus, historically, the price elasticity of demand was comparatively moderate (in absolute value terms). That is, due to the relative scarcity of economically attractive close substitutes prior to the widespread availability of solar rooftops (and potentially batteries), the observed change in electricity consumption associated with an increase in electricity prices was modest.

7. Cost competitive technological developments available to consumers have continued to expand, including (i) solar PV technology (typically in the form of solar PV panels situated on rooftops, but also elsewhere); (ii) battery storage, which can be used in combination with rooftop PV or on a stand-alone basis; and, (iii) microgrids, used in combination with PV and batteries. These developments provide options for consumers to substitute electricity provided by utilities over the grid, in whole or in part. Other options available to consumers in responding to higher electricity prices include the reduction of energy consumption using durable assets and the deployment of energy efficiency enhancing devices (*e.g.*, smart thermostats). In addition, higher electricity prices may inhibit the cost competitiveness of electric vehicles by increasing the point at which owning and operating an EV is equally economical compared to owning and operating a vehicle with an internal combustion engine.

8. Thus, changes in the cost competitiveness, availability, and general consumer acceptance of alternative technologies suggest that estimates of price elasticities of demand based on historical data do not fully reflect such elasticities going forward. Specifically, given the change in availability and economic attractiveness of substitutes, price elasticities of demand based on historical data almost certainly under-estimate future price elasticities of electricity demand.

9. Two additional considerations must also be addressed when developing price elasticities of demand for use in the Revenue Envelope and Legacy Charge Model. First, PREPA's customer base is composed of residential, commercial (including government and municipality customers) and industrial customers. Each of these groups face different options and costs to deploy

alternatives to PREPA-supplied electricity. Thus, price elasticities of demand (both historical and expected) differ among the various customer segments.

10. Second, price elasticities of demand also vary depending on the time frame considered. Given that some responses to higher prices cannot be made instantly, the economic literature often differentiates between "short-run" and "long-run" elasticity. However, the time frame associated with each is typically not fully specified. In practice, consumer response to a price increase is determined by (i) whether the price increase is considered sustained and (ii) the requirements associated with adopting a substitute. For example, a consumer may immediately decide not to purchase a readily substituted product at a supermarket due to a price increase of the product. In contrast, adopting PV as a substitute for grid-supplied electricity requires the purchase (or lease) and installation of PV panels, the economics of which depend, in part, on expectations concerning the sustained price of electricity. For the case at hand, we apply short-run price elasticities of demand in the first year of the anticipated implementation of the Legacy Charge and assume that long-run price elasticities of demand will be realized in year 10. We phase-in the long-run price elasticity linearly over the 10-year period.

11. The impact of new economically attractive substitutes, such as rooftop PV involve making longer-term investment decisions, and hence are expected to affect long-term elasticities more than short-term elasticities.[76] We relied on existing academic research to inform the short-term price elasticities of demand used in the Revenue Envelope and Legacy Charge Model. These research papers span a range of data vintages (*e.g.*, data through 2000, 2010, 2015, *etc.*), with some covering recent consumer adoption of alternatives to grid-supplied power more so than others. The Brattle team referred to the long-term price elasticities of demand estimated in these research papers as "Pre-PV" or "Pre-New Consumer Options," or "Historical," in recognition of the historical nature of the data sets and the evolving consumer options, which will likely be more widely available and more cost-competitive going forward.

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[76] Short-term elasticity is often defined as changes in demand within a year of the price change. While decisions to install a rooftop PV likely take more time than other short-term responses (such as modifying thermostat settings) and therefore manifest themselves most fully over longer time periods, they likely do effect short-term elasticities as well.

12. We used the most recent research available (which includes working papers) together with our professional knowledge to determine the appropriate long-term price elasticities of demand used in the model. The Brattle team referred to these long-term price elasticities of demand as "Post-PV" or "Post-New Consumer Options," or "Forward Looking Elasticities."

B.2 HISTORICAL PRICE ELASTICITIES OF DEMAND

13. Considerable empirical analysis has been conducted concerning short-run price elasticity of electricity consumption by residential customers.[77] Paul et al. (2009) and Alberini and Filippini (2011) reported both their own estimates and estimates from the prior studies for a short-run price elasticity of electricity consumption for residential customers between -0.13 and -0.35.

14. Several empirical studies have also estimated the long-run price elasticities of demand for residential electricity customers.[78] Estimates from these studies, which were summarized in papers by Paul et al. (2009) and Alberini and Filippini (2011), ranged from -0.3 to -1.1. Burke and Abavasekara (2018) also summarized previous studies and reported that the long-run price elasticity of demand ranged from -0.4 to -1.0. Burke and Abavasekara also conducted their own empirical analysis and estimated a long term price elasticity of demand for residential customers equal to -1.0.[79] We use Burke and Abavasekara (2018) long-run price elasticity of demand in the Revenue Envelope and Legacy Charge Model because this study uses relatively recent data (*i.e.*, from 2003 through 2015) and incorporates insights from previous empirical analyses and literature. A long-run price elasticity of demand of -1 means that, given sufficient time to respond to a sustained price increase, consumers will decrease their consumption by 10% for a 10% increase in prices.

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[77] *See,* Paul, Anthony C., Erica C. Myers, and Karen L. Palmer A Partial Adjustment Model of U.S. Electricity Demand by Region, Season, and Sector, RFF Discussion Paper 08-50, Resources for the Future, 2009; *See also*, Alberini, Anna, and Massimo Filippini, Response of residential electricity demand to price: The effect of measurement error, Energy Economics 33, no. 5 (2011): 889-895.

[78] *See*, Paul, Anthony C., Erica C. Myers, and Karen L. Palmer Anthony Paul et al., "A Partial Adjustment Model of U.S. Electricity Demand by Region, Season, and Sector," RFF Discussion Paper 08-50, Resources for the Future, 2009; *See also*, Alberini, Anna, and Massimo Filippini, Response of residential electricity demand to price: The effect of measurement error, Energy Economics 33, no. 5 (2011): 889-895;

[79] Paul J. Burke and Ashani Abayasekara, The price elasticity of electricity demand in the United States: A three-dimensional analysis, The Energy Journal, Vol. 39, No. 2 (March 2018), pp. 123-146.

15. Empirical analysis of the short-run price elasticities of demand for commercial and industrial electricity customers estimate elasticities in the 0.0 to -0.22 range.[80] For the Revenue Envelope and Legacy Charge Model, we used a short-run price elasticity of demand of -0.2 for commercial and industrial electricity customers, identical to the short-run price elasticity of demand we used for residential customers.

16. Long-run price elasticity of demand estimates for commercial and industrial customers were slightly smaller in magnitude than -1.0, with some low estimates (*e.g.*, -0.32 from a 2005 study) and some very high estimates (*e.g.*, -1.63 and -3.26) from studies in the late 1970's and mid 1980's.[81]

17. For the historical long-run price elasticities of demand, we relied on Burke and Abavasekara (2018), a study that estimated long-run price elasticities of demand for residential, commercial, and industrial customer classes (as well as a "General" estimate) using data from 2003 to 2015.[82] The price elasticities of demand provided in that study are: (i) -1.0 for residential customers; (ii) -0.3 for commercial customers; (iii) -1.2 for industrial customers; and, (iv) -0.9 for the general category.[83] The results suggest that, for the period studied, residential and industrial customers had more options and substitutes available to them than commercial customers.

B.3 FORWARD LOOKING PRICE ELASTICITIES OF DEMAND REFERENCES

18. The Revenue Envelope and Legacy Charge Model includes a 35-year term (from FY2025 through FY2059), with 28 years included in the 2023 Fiscal Plan extended to align with the term of the New Bonds. The term of analysis exceeds the term of most utility financial and capital planning models, and is longer than the typical periods covered by research on price elasticities

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[80] *See*, Table 5. in Paul, Anthony C., Erica C. Myers, and Karen L. Palmer A Partial Adjustment Model of U.S. Electricity Demand by Region, Season, and Sector, RFF Discussion Paper 08-50, Resources for the Future, 2009.

[81] Ibid.

[82] Paul J. Burke and Ashani Abayasekara, The price elasticity of electricity demand in the United States: A three-dimensional analysis, The Energy Journal, Vol. 39, No. 2 (March 2018), pp. 123-146.

[83] These elasticities are the lowest elasticity estimates in in Burke and Abayasekara, rounded to one decimal place and used as our estimates for pre-PV long-run elasticity of demand by customer class.

of demand. Developing an estimate of price elasticity of demand over the 35 years thus requires a forward looking estimate, especially since the likelihood that options available to consumers to substitute for electricity purchased from PREPA and/or their cost effectiveness are expected to improve over time.

19. Connecting research of non-grid electricity options to estimates of the long-run price elasticity of demand for electricity is a work in progress. We used a recent working paper (the Buchsbaum working paper) as a starting point for estimating the incremental impact of solar PV on long-run price elasticity.[84] Brattle recognizes that this working paper is not a perfect fit for estimating the price elasticities of grid-supplied electricity demand in Puerto Rico, because the study is based on a data set of consumers in California and is not fully conclusive in explaining the causes of its calculated price elasticities of demand. However, it is exceedingly rare that published research is perfectly applicable to any particular real-world problem. Nonetheless, the working paper is based on a data set that is more current (with data through 2020) than other studies we reviewed and is in a jurisdiction where consumer options, in particular distributed generation (mainly rooftop PV) and batteries, are being advanced by market forces and State policy. We do not use the results of this study blindly; instead we consider it along with the historical studies discussed above and the Brattle team's experience in analyzing the economics of alternative DG options.

20. The Buchsbaum working paper estimated the long-run price elasticity of demand for residential electricity customers to be -2.4.[85] Even though the Buchsbaum paper itself is unable identify a relationship between higher prices and higher adoption of rooftop PV,[86] the paper covers a

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[84] Jesse Buchsbaum, Long-Run Price Elasticities and Mechanisms: Empirical Evidence from Residential Electricity Consumers, Energy Institute at HAAS (October 2022), WP 331.

[85] The Buchsbaum working paper summarizes its findings in Table 5 with three results, with -2.4 being the middle of the three results. In the October 2022 draft of the paper available when the Revenue Envelope and Legacy Charge model was first designed, this middle value was highlighted in the abstract and text of the paper. In the October 20, 2023 revision of the paper, the three results remain unchanged, but the smaller value -2.24 is highlighted in the abstract of the paper. Since this update did not imply a revision to the results of the study, but only a change in presentation, we did not judge a change in our elasticity assumptions was required. See also, Jesse Buchsbaum, "Are Consumers More Responsive to Prices in the Long Run? Evidence from Electricity Markets," (October 20, 2023), Job Market paper.

[86] Dr. Buchsbaum notes in his working paper that this ability to identify a relationship between higher prices and rooftop solar PV is at odds with other literature. It is unclear why this discrepancy exists. It is however clear that over the period covered by his dataset availability and economic attractiveness of rooftop solar PV increased. It

period during which consumers began having more economical substitutes for grid power available to them. The robust long-term elasticity identified in the paper therefore implies that a sustained increase in electricity prices will lead to higher levels of load reduction than had previously been estimated. Specifically, a sustained price increase of, say, 10% may lead to a decline in grid supplied kWh of up to 24%.

B.4 PRICE ELASTICITIES OF DEMAND IN THE REVENUE ENVELOPE AND LEGACY CHARGE MODEL

21. The difference between a historical long-term price elasticity of demand for residential electricity customers (-1.0) and the more recent long-term price elasticities of demand estimated in the above referenced working paper for a California data set (-2.4) is -1.4. We refer to this difference as "incremental price elasticity," which can be attributed to recent cost-efficient options available to consumers, notably rooftop PV. This may be particularly relevant to Puerto Rico because the technical potential for distributed solar PV is high, the grid-supplied electricity rates are high, and the grid system reliability is low.

22. For purposes of the Revenue Envelope and Legacy Charge Model, we recognized that a price elasticity of demand equal to -2.4 may be perceived to be high. As a conservative step, we used the mid-point of the difference between historical elasticity estimates (from Burke and Abavasekara) the more recent estimate by Buchsbaum; that is, (i) -2.4 – (-1.0) = -1.4, and (ii) -1.4 x 50% = -0.7. We then added this amount to the historical long-term price elasticity of demand described above; that is -1.0 (from Burke and Abavasekara) plus + -0.7 (the mid-point described in this paragraph) = -1.7. We used this as the reference case forward looking price elasticity of demand in the Revenue Envelope and Legacy Charge Model.

23. We are unaware of any empirical analysis incorporating the impact of evolving DG options into estimates of long-run price elasticity for commercial and industrial electricity customers. We therefore determined the incremental price elasticity of demand for each PREPA tariff class

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is also possible that the unique dataset at his disposal, a dataset where prices were higher for a sustained period of time along narrow geographic demarcation lines, allowing a comparison of the electricity demand of households who are very similar in all respects other than the price of electricity they face, allows for a better estimation of long-term price elasticities than had previously been possible.

based on our understanding of the applicability of DG options to the various types of customers. Specifically, we ranked customer types by their relative levels of motivation and incentives to install DG options. We assigned a percentage of incremental price elasticity to each of the groups; that is, each group was assigned a percentage of the -1.7 incremental elasticity described in the preceding paragraph. The percentages assigned by rank order are shown in the table below.

FIGURE 19: RANKING OF INCREMENTAL LONG-RUN PRICE ELASTICITY OF DEMAND (100% = -1.4)

Rate Class	Classification	Percentage of Incremental Elasticity
GST 213	Large Commercial	100%
GSP 212	Medium Commercial	67%
RH3, LRS, RFR	Subsidized Residential	50%
GRS 111	Residential	50%
GRS 112 (LC Subsidy eligible)	Residential	50%
GRS 112 (General)	Residential	50%
GSS 311	Small Industrial	40%
GSP 312	Medium Industrial	40%
GSS 211	Small Commercial	25%
GST 313	Large Industrial	5%
TOU-T 363	Large Industrial	5%
LIS 333	Large Industrial	5%
TOU-T 963	Large Industrial	5%

24. Residential customers are assigned a percentage of 50%, in line with our determination that the incremental long-run price elasticity of demand for PREPA's residential electricity customers is -0.7 (*i.e.*, 50% of -1.4) and the total long-run price elasticity of this class of customers equals -1.7 (*i.e.*, -1.0 historical long-run price elasticity plus -0.7 incremental long-run price elasticity).

25. We assigned lower percentages to industrial customers based on potential issues and options facing these customers. These customers are served under PREPA tariff classes GST 313, TOU-T 363 and 963, and LIS 333. We assumed that these large industrial customers have sizable power supply requirements not readily provided by DG options. We also assumed that combined heat and power (CHP) options are available, but these are typically expensive, given the absence of readily available supply of natural gas and cost of fossil fuels in Puerto Rico more generally. The incremental long-run price elasticity of demand for PREPA's largest industrial

electricity customers are assumed to be -0.07 (*i.e.*, 5% of -1.4), resulting in a total long-run price elasticities of demand of -1.27 (-1.2 historical estimate plus -0.07).

26. Small and medium industrial customers are served under PREPA tariff classes GSS 311 and GSP 312. These customers are similar to medium-sized commercial customers (also served under the GSS and GSP tariffs). We also assumed that DG options such as PV provide a more attractive supplement for medium and small industrial customers and estimated an incremental long-run price elasticity of demand of -0.56 (*i.e.*, 40% of -1.4) for small and medium industrial customers, resulting in a total long-run price elasticities of demand -0.86 for these customers. (-0.3 historical estimate plus -0.56).

27. The electricity usage for a sizable portion of PREPA's small commercial customers is equal to or below the average usage for PREPA's residential customers. This suggests that these customers occupy small spaces and do not own the buildings where they are located. We assigned a percentage of the incremental price elasticity of demand of 25% to those customers, half the effect for residential customers. This translated into an incremental long-run price elasticity of demand of -0.35 and a total long-run price elasticity of demand of -0.65 (-0.3 historical estimate plus -0.35).

28. Medium commercial customers face better prospects for installing DG alternatives. Nonetheless, since in general commercial PV adoption has lagged residential adoption, we assigned a 67% percentage, which translated into an incremental long-run price elasticity of demand of -0.93 and a total long-run price elasticity of demand of -1.23 (-0.3 historical estimate plus -0.93).

29. Large commercial customers include large box stores and distribution centers, which have large roofs and parking areas. Some of these stores have taken action or indicated interest in installing PV on their building and/or in or above their parking areas. We assigned a 100% percentage to this class of customers, which translated into a long-run price elasticity of demand of -1.7 (-0.3 historical estimate plus an incremental -1.4).

B.5 ADDITIONAL CONSIDERATIONS

30. We applied our assumed elasticities of demand in the Revenue Envelope and Legacy Charge Model to the average incremental volumetric rate increases resulting from imposition of the Revenue Envelope and Legacy Charges rates. There is substantial literature dedicated to exploring whether consumers react to *marginal* or *average* price signals. This is relevant to the model because the Revenue Envelope and Legacy Charge rate structures includes two volumetric blocks for residential and small commercial customers. As a result, the realized marginal and average price changes differ from one another for the affected customers. There is evidence that electricity consumers respond more to average prices more than they respond to marginal price signals – even though traditional economic theory suggests that consumers are expected to react to marginal price signals.[87]

31. We estimated a short-run elasticity of -0.2 for all rate classes. We are not aware of a general consensus on the definition of a time period associated with a long-un elasticity. We applied a 10-year period for a linear transition from the short-run to the long-run price elasticities of demand for each PREPA tariff and customer segment as calculated above and summarized in Brattle's LT Elasticity workbook. This transition period provides sufficient time for customers to respond to sustained price changes and is in line with the studies referenced earlier.

32. The incremental price elasticity of demand effects are calculated based on applying the price elasticity of demand to kWh sales for a given customer class. However, in practice, customer response is "lumpy," with some customers having very high price elasticities of demand and others being relatively inelastic (*i.e.*, having a price elasticity closer to 0). Specifically, as highlighted above, a customer that significantly reduces their kWh sales due to the installation of rooftop PV (because higher rates for grid-supplied electricity make it cost efficient to do so) has a very high price elasticity of demand. That is, a small percentage of customers installing rooftop PV in response to price increases can materially increase the total segment's price elasticity of demand (in absolute value terms).

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[87] Koichiro Ito, Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing, American Economic Review 2014, 104(2): 537–563.