GOVERNMENT OF PUERTO RICO
PUBLIC SERVICE REGULATORY BOARD
PUERTO RICO ENERGY BUREAU

IN RE: PUERTO RICO TEST FOR DEMAND RESPONSE AND ENERGY EFFICIENCY	**CASE NO.:** NEPR-MI-2021-0009 **SUBJECT:** Responses to LUMA's questions and comments on the Avoided EE Cost Study and scheduling a Technical Conference.

RESOLUTION AND ORDER

I. Introduction

On August 13, 2021, the Energy Bureau of the Puerto Rico Public Service Regulatory Board ("Energy Bureau") issued a Resolution and Order ("August 13 Order") ordering the Puerto Rico Electric Power Authority ("PREPA") and LUMA Energy ServCo, LLC ("LUMA") to provide responses to the request for information included as Attachment A therein. The purpose of the request for information was to gather data for the development of the Avoided Cost Study for Energy Efficiency ("Avoided Cost Study").

On August 17, 2021, LUMA filed a document titled *Motion Requesting Energy Bureau to Stay Resolution and Order of August 13, 2021 and Schedule Technical Conference* ("August 17 Request"). In the August 17 Request, LUMA asked the Energy Bureau to stay the August 13 Order and to schedule a technical conference to resolve issues and questions related to the development of avoided cost estimates for use in benefit-cost analysis of energy efficiency programs.

On October 27, 2021, the Energy Bureau issued a Resolution and Order ("October 27 Order") ordering LUMA to attend a Technical Conference held November 3, 2021, as requested in the August 17 Motion. On October 30, 2021, LUMA filed a document titled *Motion Requesting Energy Bureau to Reschedule Technical Conference Set for November 3, 2021* ("October 30 Request"), in which LUMA requested the Technical Conference be rescheduled either November 18 or 19, 2021. On November 2, 2021, the Energy Bureau issued a Resolution and Order ("November 2 Order") rescheduling the Technical Conference to be held November 18, 2021 ("November 18 Technical Conference")

The November 18 Technical Conference was held as scheduled and addressed questions on avoided energy efficiency costs and clarified the scope, process, and schedule for this work effort.

On December 14, 2021, the Energy Bureau issued a Resolution and Order ("December 4 Order") in which it sent updated requests for information to LUMA and PREPA and scheduled a virtual technical conference which was held February 8, 2022 ("February 8 Technical Conference"). The purpose of the February 8 Technical Conference was to review draft avoided energy cost results with LUMA and other stakeholders and to solicit feedback.

In addition to soliciting general feedback, the Energy Bureau invited stakeholders to respond to the following three questions:

1. Are the fuel cost projections reasonable?
2. How should the study reflect uncertainty regarding the (counterfactual) resource mix and procurement schedule?
3. What is the best approach for calculating avoided costs beyond 2038 (i.e., extrapolating model results)?

On February 7, 2022, the Energy Bureau issued a Resolution and Order ("February 7 Order") in which it requested public comments on the proposed PR Test Framework as specified in

its Attachment A and ordered LUMA to file its responses to the request for information on or before March 7, 2022.[1]

On March 7, 2022, LUMA filed a document titled *Motion Submitting LUMA's Comments on Attachments A and B of Energy Bureau Resolution and Order of February 7, 2022, and on Avoided Cost Modeling Presentation* ("March 7 LUMA Comments") submitting LUMA's responses to Attachments A and B of the February 7 Order and questions and comments on the avoided cost modeling presentation delivered during the February 8 Technical Conference. LUMA's feedback included a request for time to review the Energy Bureau's responses to LUMA's questions and comments and for LUMA to provide feedback on the Energy Bureau's responses. No other stakeholders provided written feedback related to the Avoided Cost Study.

The Energy Bureau thanks LUMA for its participation and feedback during the February 8 Technical Conference, and hereby presents its responses to the comments and questions raised by LUMA. The Energy Bureau notes that LUMA's feedback informed updates to the avoided energy cost modeling. The responses to LUMA's questions and comments are provided in Appendices A, B, and C of this Resolution and Order.

- Appendix A of this Resolution and Order provides the Energy Bureau's written response to LUMA's questions and comments.
- Appendix B, in Excel, contains more detailed data requested by LUMA in questions 2, 11, 14, and 17.
- Appendix C contains an updated, more condensed version of the February 8 presentation and includes new slides to address questions 4, 18, and 19.

II. Technical Conference

The Energy Bureau orders LUMA to attend a Technical Conference focused on the Avoided Cost Study, to be held on **June 22, 2022, at 10:00 a.m.** Other interested parties are welcome to join as well. The Energy Bureau will hold the Technical Conference through the Microsoft Teams platform. The log in information will be provided through a separate communication. Interested parties should email secretaria@jrsp.pr.gov on or before 3:00 p.m. on June 21, 2022, to obtain the link and instructions for participation. The Technical Conference will also be streamed on the Energy Bureau's YouTube channel.

The Energy Bureau will publish the agenda for the Technical Conference at a later date. LUMA should review the Energy Bureau's responses to its questions and comments in advance of this Technical Conference and be prepared to present its follow up questions. The Energy Bureau will use part of the time to discuss the responses to LUMA's questions and solicit additional feedback from LUMA and other stakeholders. The Energy Bureau will use the remaining time to present its avoided capacity cost methodology and draft results and solicit feedback from stakeholders.

Be it notified and published.

Edison Avilés Deliz
Chairman

Ángel R. Rivera de la Cruz
Associate Commissioner

Lillian Mateo Santos
Associate Commissioner

Ferdinand A. Ramos Soegaard
Associate Commissioner

Sylvia B. Ugarte Araujo
Associate Commissioner

[1] February 7 Order, p. 4.

CERTIFICATION

I hereby certify that the majority of the members of the Puerto Rico Energy Bureau has so agreed on June 6, 2022. I also certify that on June 6, 2022 a copy of this Resolution and Order was notified by electronic mail to the following: margarita.mercado@us.dlapiper.com, kbolanos@diazvaz.law and laura.rozas@us.dlapiper.com. I also certify that today, June 6, 2022, I have proceeded with the filing of the Resolution and Order issued by the Puerto Rico Energy Bureau.

For the record, I sign this in San Juan, Puerto Rico, today June 6, 2022.

Sonia Seda Gaztambide
Clerk

NEGOCIADO DE ENERGÍA DE PUERTO RICO
JUNTA REGLAMENTADORA DE SERVICIO PÚBLICO

Appendix A

Question 1: Slide 7 – Project Overview

LUMA Comment/Question:

While the focus of the Synapse presentation and LUMA's comments is on avoided energy costs, it is critical to understand the potential interactions between the three types of avoided costs, particularly between avoided energy and avoided capacity costs. LUMA believes that avoided energy costs cannot be considered appropriately in isolation of the other components of avoided costs and may provide additional comments on avoided energy costs when information on the other types of avoided costs is available.

Response:

We agree that there are interactions between the three types of avoided costs, and that it is important for all values to captured once and only once. The modeling results presented for the "No EE" scenario include the effect of additional capacity resources (battery and fossil) coming online over the planning period. Battery capacity resources in particular serve both capacity needs (i.e., provide energy during peak periods) and the requirement to store daytime solar PV energy production for later periods. We are in the process of completing a "Full EE" scenario comparison to the "No EE" scenario, which allows for a planning-horizon comparison of the overall avoided energy and capacity costs associated with the effect of energy efficiency resource installations (lower energy loads, and lower peak demands). We will present this modeling at a future technical conference and request stakeholder comment at that time.

Question 2: Slide 11 – Method: Avoided Energy

LUMA Comment/Question:

LUMA requests that the Energy Bureau provide the values and source for the technical loss assumption.

LUMA requests that the Energy Bureau confirm that the energy costs are marginal costs for each hour and that any weighting across hours is based on hourly generation.

Response:

The source for the technical loss assumption is the *PREPA 2018 IRP LTCE RESULT - Scenario 3 Strategy 2 No EE with Eco New Contract.* The values are highlighted in the *Q2 –Technical Losses* tab of Appendix B and are used to calculate the annual System Peak Generation values.

The energy costs are marginal costs for each hour and there is no load weighting of the energy prices at the hourly level. Hourly weighting by load is used to calculate an average price over many hours, for example when calculating average monthly or annual energy prices.

Question 3: Slides 15 and 16 – Pre and Post 2021 Retirements

LUMA Comment/Question:

The units listed as retired on slide 15 have not been retired and the model should be adjusted to reflect the best currently available information. LUMA recommends remodeling to show that plants are not retired in the current planning horizon even though they may be utilized less. The Renewable Procurement Tranche 1 will not replace these units as they are peakers. LUMA's Resource Adequacy study will propose a preliminary schedule for these retirements and the retirements will be further investigated through the next IRP process.

Response:

We agree that the model should reflect the best currently available information and do not assume these units are retired in our updated results.

Question 4: Slide 17 – Illustrative Generation Fleet Dispatch Stack

LUMA Comment/Question:

LUMA recommends that the Energy Bureau present the fleet dispatch stack for 2025, 2030, and 2038, along with the corresponding peak day demand and hourly price heatmaps (as shown in slides 40 through 43).

Response:

We provide the updated illustrative fleet dispatch stack for 2021, 2025, 2030 and 2038 in slides 23 – 26 of Appendix C. We provide the updated peak day dispatch for 2025, 2030, and 2038 in slides 19 – 21. We provide the updated hourly price heatmaps for 2025, 2030, and 2038 in slides 16 - 18.

Question 5 Slide 18 – PREPA System Peak Demand – No EE vs. Full EE

LUMA Comment/Question:

The forecast presented in the slides is from the 2018 IRP and has not been updated for actual values and changing macroeconomic factors. PREPA and LUMA have updated the forecasts since the 2018 IRP for the PREPA fiscal plan. The updated forecast can be found in Energy Bureau Case No. NEPR-MI-2020-001 and the fiscal plans.

Response:

We have taken PREPA's recommendation and updated our load and peak demand forecast to be consistent with the load forecast in PREPA's FY 2021 Fiscal Plan. See slide 7 of Appendix C for a direct comparison of our previous and updated load and peak forecasts.

Question 6 Slide 19 – PREPA System Load – No EE vs. Full EE

LUMA Comment/Question:

The data on slide 19 assumes that EE started in 2017 and it did not. LUMA recommends adjusting the model to reflect this. EE scenarios should be based on the latest regulatory timelines, which vary dramatically from the 2018 IRP scenarios.

Response:

We agree with this recommendation and have updated the model to assume EE effects on load begin gradually in 2022-23, aligned with the Transition Plan Period, before ramping up to a steady level necessary to reach the 2040 EE requirement. See slides 6 and 7 of Appendix C for a direct comparison of our previous and updated "No EE" load forecast, and a trajectory of the effect of energy efficiency on load. The Full EE case is not used to develop the avoided energy costs.

Question 7 Slide 21 and 24 – Fuel Prices: Natural Gas and Oil

LUMA Comment/Question:

LUMA recommends that the fuel forecast align with the fuel forecasts used in Energy Bureau Case No. NEPR-AP-2018-0004, the Unbundling of the Assets of the Puerto Rico Electric Power Authority.

Response:

We have updated our fuel price projection to incorporate LUMA's recommendations including calibrating the fuel prices with actual fuel receipts in the last year, provided by the Energy Bureau in Case NEPR-MI-2020-0001, as well as LUMA's fuel forecast in NEPR-AP-2018-0004.

Question 8 Slide 29 – Fuel Prices: Calibration

LUMA Comment/Question:

LUMA suggests updating this calibration to cover all of 2021 or, at a minimum more than 5 months.

Response:

See our response to question 7. We have calibrated our fuel price forecast for all of 2021.

Question 9 Slide 30 – Technology Capital Costs

LUMA Comment/Question:

LUMA would like to confirm to what extent have these costs been adjusted to reflect higher costs for delivery, installation, and commissioning in Puerto Rico as opposed to the mainland US. Best available information would be based on recent construction and contract experience in Puerto Rico.

Furthermore, LUMA would like to confirm that costs have also been adjusted for the inflationary period. Please provide the inflation assumptions used.

Of the four combined cycle gas turbine (CCGT) technologies listed, which technology was assumed for the new CCGT additions? What was the basis for this selection as compared to the other three CCGT technologies shown?

Response:

For the renewable energy and fossil fuel technology capital costs, we did not include any locational cost adders to reflect higher costs for these energy resources being delivered, installed, and commissioned in Puerto Rico as opposed to the mainland United States. PREPA adopted the U.S. Department of Defense Area Capital Cost Factor of 16 percent to increase the cost of all technologies, with the exception of utility-scale storage, under the assumption that the development and deployment of energy generation technologies is more expensive in Puerto Rico than on the U.S. mainland.[2] However, we did not adopt this Capital Cost Factor because the Puerto Rico Energy Bureau ordered PREPA not to rely on a cost factor, but rather to base its analysis on the results of actual solicitations and market available prices for development and installation in Puerto Rico.[3] Given that this information is currently unavailable, we did not incorporate any locational cost adders for any generation technologies. However, we acknowledge that there are additional costs for construction of generators in Puerto Rico, such as those related to transportation of materials by sea from the U.S. mainland.

For the representative combined cycle gas turbine (CCGT) new resource candidates, we used the capital costs provided by Siemens in the 2019 IRP, removing the 16 percent locational adder, and scaled the future capital cost trend for the gas units so that it was based on NREL 2021 ATB Data instead of NREL 2018 ATB Data. We used National Renewable Energy

[2] Puerto Rico Integrated Resource Plan 2018-2019. Siemens Industry. June 2019. pp. 6-11, 6-23.

[3] Final Resolution and Order of the Puerto Electric Power Authority's Integrated Resource Plan, p. 132.

Laboratory's (NREL) *2021 Annual Technology Baseline* (ATB) data[4] for modeling the capital costs (2020$/kW$_{AC}$) of grid-scale solar (Single-Axis Tracking), grid-scale battery storage (2, 4, and 6-hour), and onshore wind. We based all NREL ATB resource capital costs on the moderate case.

We used an inflation rate of two percent to escalate the renewable and fossil fuel resource capital costs.

In the No EE scenario, seven GE LM2500 GTs were built in 2021 (totaling 147 MW) and two 302 MW GE S107F.04 CCGTs were built in 2025 and 2026, respectively. We note that the 4 CCGT options in the IRP were also made available to the model as expansion resources, though the model only chose the GE S107F.04 GT.

Question 10: Slide 31 – Renewable Portfolio Standard

LUMA Comment/Question:

This extrapolation of RPS for the No EE schedule assumes a linear increase according to the new law in Act 17-2019 and is not reflective of the likely actual schedule. The extrapolation should use a stepwise schedule in the first few years that reflects a realistic schedule.

Response:

We agree with LUMA's comment regarding the RPS extrapolation. To better reflect the procurement delays and the general "lumpiness" involved with procuring solar and batteries, Energy Bureau staggered the allowed buildout of solar and batteries.

As an example, Table 4 below (which focuses on the solar build), shows no immediate builds in the next few years. The net impact of this approach has been that the proportion of renewable generation over time follows a non-linear trajectory as seen in Figure 1, and under the "no EE" scenario, falls short of meeting the 2025 requirement shown in Table 3.

Table 1: Puerto Rico RPS targets

Year	Tier 1
2025	40%
2040	60%
2050	100%

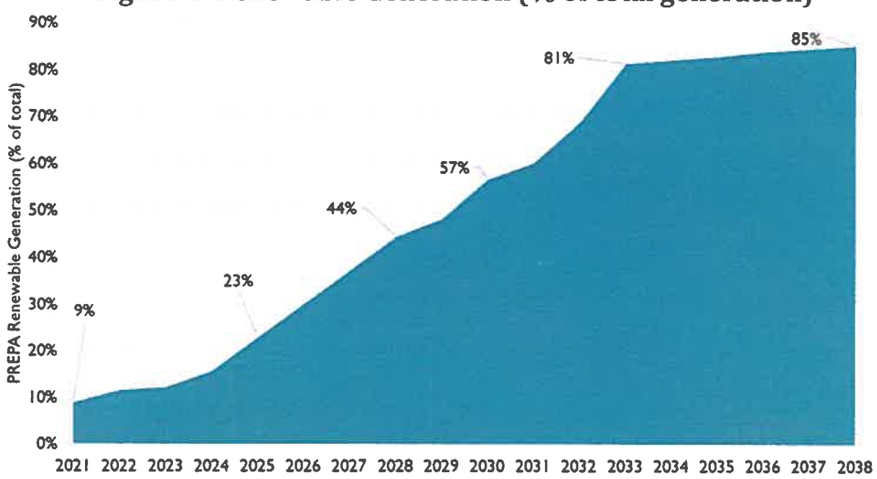
[4] NREL 2021 ATB Data. https://atb.nrel.gov/electricity/2021/data

Source: Mitigation, Adaptation and Resilience to Climate Change Act (Act 33-2019)

Table 2: Puerto Rico Solar PV Builds

Year(s)	Solar PV Capacity (MW)
2021-2023	0
2024	300
2025	1,020
2026	1,740
2027	2,460
2028	3,180
2029	3,540
2030	4,380
2031	4,680
2032	5,520
2033	7,050
2034	7,050
2035	7,050
2036	7,050
2037	7,050
2038	7,050

Figure 1: Renewable Generation (% of total generation)



Question 11 Slide 32 – Ancillary Services

LUMA Comment/Question:

Does the avoided cost reflect the cost impact of providing ancillary services?

Puerto Rico experienced significant levels of unserved energy in 2021, suggesting that the operational reliability and availability of the existing fleet is lower than used in the analysis. Additionally, the older generation units generally have lower levels of thermal responsiveness than newer units. What generation outage rates and ramp rates were used in the analysis? Please share the generation data set and LUMA can review compared to actual on-island operational experience to improve the accuracy of the assumptions and the forecast.

Response:

Yes, the avoided energy cost reflects the impact of providing ancillary services. EnCompass modeling of ancillary services includes regulation (up and down), spinning and non-spinning reserves, and supplemental reserves (up and down).

The *Q11 – Ancillary Services* tab of Appendix B contains the San Juan fossil fuel resource ramp rates (MW/min) and forced outage rates (%).

Question 12 Slide 35 – Modeling Results: No EE Capacity Comparison

LUMA Comment/Question:

LUMA requests the following:

- *Information about the assumed capacity factors (annual energy output) and effective capacity (contribution to meeting peak demand) from the solar and wind generation.*
- *The expected round trip efficiency and assumed cycle life of the batteries and how these factors were reflected in the avoided energy costs.*
- *As noted on slide 30, please state which technology (of the four CCGT technologies shown) was assumed for the new CCGT additions? What was the basis for this selection as compared to the other three CCGT technologies shown?*

The bulk of the energy demand in the long term is expected to be met by a combination of utility solar and batteries. It is unclear whether it would be economic to build these plants based on the information provided. While further comments will require detailed information on the interaction between energy and capacity costs, please share any details about how the likely Power Purchase and Operating Agreement (PPOA) contracts and payment structure was reflected in the avoided energy cost calculation. The contract structure for renewable PPOAs is evolving in Puerto Rico but based on recent experience, it is likely that there will continue to be a relatively high variable rate ($/MWh) in future contracts. Also, please share calculations regarding the financial viability of new suppliers entering into such contracts based on local construction costs, typical financing structure, and required return on investment.

Response:

Error! Reference source not found. below lists the assumed capacity factors and firm capacity from existing solar and wind generation in Puerto Rico; Table 6 contains the same information for wind and solar expansion resources. We note that the firm capacity percentage greater than zero for existing wind resources is unintended and will be corrected in future modeling runs to reflect a zero value (as is used for new wind resources shown in Table 6). The Energy Bureau expects this unintended difference to have a fractional impact on the results given that in aggregate, existing wind capacity as modeled was only 101 MW.

We also note that the wind builds in the Energy Bureau No EE case is lower than the Siemens No EE case. Similarly, we anticipate this to have a fractional impact on the results given that most renewable generation is associated with new solar and battery.

The roundtrip efficiency for the battery storage system (2, 4, and 6-hour) modeled in EnCompass is 92 percent and the assumed operating (cycle) life of the battery is 15 years.[5] These factors were reflected in the avoided energy costs since the battery resources were modeled in EnCompass and built out in the No EE Scenario.

Please see the response to question 9 for a response regarding the CCGTs.

We did not incorporate any price adjustments for contracting structures and made no assumptions nor calculations that assess the financial viability of new suppliers entering into such contracts.

[5] Most Li-ion batteries have a minimum warrantied lifespan of approximately 10 years, or a cycle life of 10,000 cycles, whichever comes first. Source: https://www.solarreviews.com/blog/are-lithium-ion-the-best-solar-batteries-for-energy-storage#:~:text=Most%20lithium%20ion%20solar%20batteries,10%2C000%20cycles%20%2D%20whichever%20comes%20first

Table 3: Existing Solar and Wind Capacity Factors and Firm Capacity

Name	Resource Type	Capacity (MW)	Firm Capacity (%)	Capacity Factor (%)
AES Ilumina	Solar PV	20	0	22
Fonroche Energy	Solar PV	40	0	22
Horizon Energy	Solar PV	10	0	27
San Fermin Solar (Coqui Power)	Solar PV	20	0	22
Windmar (Cantera Martino)	Solar PV	2.1	0	24
Windmar (Vista Alegre/Coto Laurel)	Solar PV	10	0	22
Yarotek (Oriana)	Solar PV	45	0	25
Go Green (Punta Lima)	Wind	26	20	24
Pattern (Pattern Santa Isabel)	Wind	75	20	23

Table 4: New Solar and Wind Capacity Factors and Firm Capacity

Name	Resource Type	Capacity (MW)	Firm Capacity (%)	Capacity Factor (%)
New Grid-Scale Solar (Single-Axis Tracking)	Solar PV	30	0	22
New Onshore Wind	Wind	30	0	24

Question 13 Slide 36 – Modeling Results: Capacity Calibration

LUMA Comment/Question:

LUMA notes that the results do not seem to reflect the schedule presented on slide 31 for solar.

Response:

Please see Energy Bureau's response to question 10; Energy Bureau interprets this comment to suggest that the solar schedule is insufficient to meet the RPS target in 2025. Given procurement delays, Energy Bureau believes that within the context of a No EE case PREPA is unlikely to meet the 2025 RPS target. This discrepancy is noted and discussed in our response to question 10.

Question 14 Slide 40 – Modeling Results: Gas/Oil Capacity

LUMA Comment/Question:

LUMA would like to reiterate the earlier point about the retirement/addition schedule reflecting actual experience and most current procurement activity and plans.

As noted on comments for slide 32, Puerto Rico experienced significant levels of unserved energy in 2021, suggesting that the operational reliability and availability of the existing fleet is lower than used in the analysis. Please share the generation dataset and LUMA can review compared to actual on-island operational experiences to improve the accuracy of the forecasting assumptions and forecast.

LUMA recommends also considering other alternatives like fixed tilt solar and reciprocating engines with biodiesel.

Response:

See Appendix B on the tab labeled *Q14 - Capacity Calibration* for Energy Bureau's generation data for all units across the modeling horizon.

Question 15 Slide 40 – Modeling Results: Avoided Energy Costs

LUMA Comment/Question:

As noted on slide 17, it would be helpful to present the fleet dispatch stack for 2025, 2030, and 2038, along with corresponding peak day demand and hourly price heatmaps.

Response:

Please see Synapse's response to LUMA's question 4 for this information.

Question 16 Slide 42 – Modeling Results: Peak Day in 2030

LUMA Comment/Question:

Does this reflect local construction costs, the current inflationary period and current and expected PPOA contract price structures for renewable fossil generation?

Response:

Synapse's projections do include the inflationary period but do not incorporate local construction costs and PPOA contract structures. As explained in Synapse's response to question 9, we use the NREL ATB costs exclusively.

Question 17 Slide 44 – Modeling Results: Marginal Hours

LUMA Comment/Question:

Recent experience suggested that Puerto Rico's existing hydro generation may have approximately 15% capacity factor, and there does not appear to be any new hydro generation planned. What capacity factor and what level of dispatchability has been assumed for the existing hydro generation?

Similarly, what proportion of hydro output is infra-marginal and not impacting marginal energy cost.

Response:

LUMA notes that Puerto Rico's existing hydropower plant generation may have a capacity factor of approximately 15 percent. The hydropower plant monthly capacity factor used in Synapse's EnCompass model for each year of the planning horizon (2021-2038) is listed in Table 5 **Error! Reference source not found.**. The average annual aggregate hydroelectric plant capacity factor modeled is 28 percent, based on the projected improvement in capacity factor from the IRP (Exhibit 4-10). Hydroelectric generation data is available in Appendix B tab *Q14 – Capacity Calibration*. Appendix B also has a summary of the marginal hours by unit type by year (for the No EE scenario) in the *Q17 – Marginal Hours* tab which provides an indication of the extent to which any given unit type is marginal during the year (multiple units can be marginal in any given hour). The hydro resources are seen to be part of the group of marginal units for a portion of the hours of the year, reflecting a degree of limited dispatchability over any given period.

Table 5: Puerto Rico Hydro Plant EnCompass Capacity Factor

Month	Capacity Factor (%)
January	27
February	25
March	18
April	25
May	32
June	30
July	35
August	32
September	31
October	25
November	28
December	29
Average	**28**