

**COMMONWEALTH OF PUERTO RICO
PUERTO RICO ENERGY COMMISSION**



**IN RE: INTEGRATED RESOURCE PLAN FOR
THE PUERTO RICO ELECTRIC POWER
AUTHORITY**

CASE NO.: CEPR-AP-2015-0002

SUBJECT: Final Resolution and Order.

**FINAL RESOLUTION AND ORDER
ON THE FIRST INTEGRATED RESOURCE PLAN
OF THE PUERTO RICO ELECTRIC POWER AUTHORITY**



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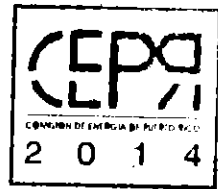
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I. INTRODUCTION

1. On July 7, 2015, the Puerto Rico Electric Power Authority ("PREPA") submitted to this Commission its first Integrated Resource Plan ("IRP").¹ In this Final Resolution and Order, the Commission **DISAPPROVES** the Integrated Resource Plan submitted by PREPA, **APPROVES** a Modified Integrated Resource Plan, **ORDERS** PREPA to submit such Modified Integrated Resource Plan with specific elaborations, and **ORDERS** PREPA to develop and carry out internal procedures to ensure that its future IRPs comply with its legal obligations and satisfy professional standards.

2. This **Part I** summarizes the Commission's decisions on the features of PREPA's IRP and its compliance with our rules. It describes the basics of integrated resource planning: the Legislature's vision, the principles and practices of integrated resource planning and the Commission's requirements. It then describes the participation in this proceeding by intervenors, *amici curiae* and the public—all of whom we thank deeply for their efforts and assistance.

3. **Part II** discusses the unique considerations affecting PREPA's IRP—financial constraints, capital uncertainty, PREPA's difficulties in complying with the U.S. Environmental Protection Agency's ("EPA") Mercury and Air Toxics Standard ("MATS"), the reliability challenges posed by PREPA's aging generating units and the consumer burdens imposed by volatile fossil fuel prices.

4. **Part III** summarizes the elements of the various IRPs submitted by PREPA.

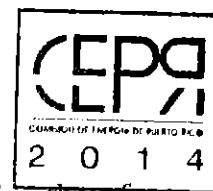
5. **Part IV** details seven major shortcomings in those submissions, including failing to use a capacity expansion model, relying on a single fuel price forecast rather than creating a range of forecasts, and projecting renewable energy costs unrealistically.

6. **Part V** contains our official determinations on PREPA's compliance or non-compliance with each provision of our IRP Rule.

7. **Part VI** announces our findings and directives relating to specific resource options.

8. **Part VII** solves the central problem presented in this proceeding: Given PREPA's multiple non-compliances, we cannot lawfully approve the IRP it submitted. But for Puerto

¹ PREPA filed the IRP under Article 6B of Act No. 83 of May 2, 1941, as amended, known as the Electric Power Authority Act ("Act No. 83 of May 2, 1941"); Article 6.23 of Act 57-2014, as amended, known as the Puerto Rico Energy Transformation and RELIEF Act; Act No. 170 of August 12, 1988, as amended, known as the Uniform Administrative Procedure Act ("UAPA"); Regulation No. 8543, known as the Regulation on Adjudicative, Notice of Noncompliance, Rate Review and Investigation Procedures; and Regulation No. 8594, known as the Regulation on Integrated Resource Plan for the Puerto Rico Electric Power Authority.



Rico to improve its energy situation, there must be an IRP, now. The Commission therefore describes and approves a Modified IRP, while requiring PREPA, 30 days from today, to submit to the Commission that same Modified IRP with specified elaborations.

9. Following Part VII appear **Findings of Fact and Conclusions of Law.**

10. This Final Resolution and Order will affect the revenue requirement PREPA proposed in Case No. CEPR-AP-2015-0001, *In Re: Puerto Rico Electric Power Authority Rate Review*. In that proceeding, the Commission will direct PREPA to make the necessary adjustments to its Petition, testimony and exhibits.

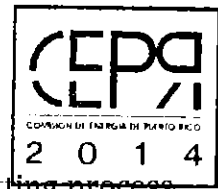
A. Summary of Commission decisions

11. The Commission makes findings in two main categories: the features of PREPA's proposed resource plan, and the extent of PREPA's compliance with the Commission's rules.² The Commission also approves a Modified IRP, and directs PREPA to take internal actions that help prepare for future IRPs.

1. Determinations relating to PREPA's proposed resource plan

- a. The Commission APPROVES continued permitting, engineering, and planning activities related to the Aguirre Offshore Gas Port (AOGP) project, subject to a \$15 million spending limit starting from the date of the issuance of this order. This spending limit applies to the total combined spending associated with AOGP and the gas conversions of the existing generating units at Aguirre (discussed in Part VI(A)(2) below). Until further notice, the Commission expressly DISAPPROVES the construction of AOGP, or any other AOGP-related expenditure beyond the \$15 million spending cap.
- b. Any benefit associated with converting the generating units at Aguirre to burn natural gas can materialize only if AOGP is constructed. Because the Commission is not approving construction of AOGP at this time, the Commission DISAPPROVES the conversions of the existing Aguirre steam and combined cycle units to run on natural gas; but, as noted in Part VI(A)(2) below, PREPA may continue permitting efforts relating to such conversions, subject to the same \$15 million cap noted immediately above.

² This is a summary only. Details appear in Parts IV, V, VI and VII of this Final Resolution and Order.



- c. The Commission APPROVES PREPA to begin a permitting process for a new dual-fuel-capable combined cycle unit at Aguirre to be completed by 2020 or 2021. The Commission ORDERS PREPA to develop and file for Commission review a proposed calendar for the development of such unit, which shall include all development stages, including competitive bidding. PREPA is NOT AUTHORIZED, however, to commit to a contractor or to commence any form of construction of a new unit at Aguirre until the Commission states otherwise.
- d. The Commission APPROVES the replacement of turbines (also referred to as "repowering") of the two combined cycle units at Aguirre.
- e. The Commission APPROVES permitting for three small dual-fuel capable combined cycle units at Palo Seco. The Commission APPROVES the construction of one of the three dual-fuel capable combined cycle units at Palo Seco.
- f. The Commission APPROVES the retirement of Costa Sur 3 and 4, Palo Seco 1 and 2 and San Juan 7 and 8. PREPA should complete the retirement of these units as soon as feasible.
- g. The Commission APPROVES the designation of San Juan 9 and 10 as "limited use" under MATS.
- h. PREPA SHALL PURSUE those investments in its transmission and distribution systems that, consistent with prudent utility practice, are required for system stability and operability.
- i. PREPA SHALL CONDUCT a detailed audit of all existing renewable energy contracts for projects which are not yet operational. PREPA SHALL PURSUE renegotiation of or exit from these contracts, to the extent lawful and appropriate, as detailed further in Part VII.
- j. PREPA SHALL COMMENCE a competitive bidding process pursuant to Section 6B(a)(iii) of Act 83 and the Joint Regulation approved by the Commission and PREPA, in order to procure new renewable energy projects that are eligible for inclusion in Puerto Rico's Renewable Portfolio Standard ("RPS").
- k. The Commission APPROVES the energy efficiency ("EE") resources described in the Supplemental IRP.

2. Determinations relating to PREPA's compliance with Commission's IRP rules

12. The Commission's IRP Rule, Regulation No. 8543, reflects the standard tools, techniques and practices used by mainland utilities and regulators to achieve the goal of least cost, reliable electric systems. Our IRP Rule is clear and conventional.

13. PREPA's compliance with our IRP Rule was unsatisfactory. Despite multiple Commission orders identifying deficiencies in PREPA's submissions, PREPA's performance in this proceeding remained non-compliant. We are aware of no instance, among the many IRP proceedings in the many mainland states, of such a large gap between regulatory expectation and utility response. Together with its chief consultant, Siemens Power Technologies International ("Siemens PTI" or "Siemens"), PREPA disregarded our rules, failed to use standard planning techniques, delayed the production of required information, and displayed insufficient appreciation of the potential for energy efficiency and demand response. These behaviors led PREPA and Siemens to reach conclusions that over-emphasized costly construction, while under-emphasizing the roles of renewable energy technologies and consumer behavior as ways to achieve the energy independence envisioned by Act 57. A related result of this behavior was a proceeding that took many more months, and cost the Commission and consumers many more dollars, than should have been necessary. The Commonwealth needs PREPA and its energy system to be flexible, nimble and cost-effective. PREPA has a great distance to go.

14. In two orders issued this year, the Commission approved a Transition Charge and a Provisional Rate.³ Our message has been unmistakable: The public interest requires that PREPA have the resources necessary to comply with its financial and operational obligations. That same public interest also requires an electricity system that is cost-effective, reliable and environmentally responsible. PREPA will achieve that result only if its integrated resource planning process is conducted professionally, objectively and openly. Only with such a process will PREPA avoid the unnecessary costs and customer dissatisfaction that could undermine PREPA's financial and operational recovery. Taken together, our Transition Charge order, our Provisional Rate order and today's IRP order seek to produce the fiscal health and professional excellence PREPA needs to satisfy its obligations to its bondholders and its customers.

15. This Part I.A.2 summarizes our determinations concerning PREPA's compliance, sequenced according to the requirements of IRP Rule § 3.04(A)(1).

- a. Regarding the completeness of the IRP, the IRP **did not comply**. PREPA's proposed IRP is incomplete in many ways, as summarized in Part V.A of this Order.

³ *Restructuring Order*, CEPR-AP-2016-001 (June 21, 2016); *Order Establishing Provisional Rates*, CEPR-AP-2015-001 (June 24, 2016).

- b. Regarding the requirement to develop a range of viable alternatives, the IRP **did not comply**. Contrary to an explicit Commission rule, PREPA failed to use a capacity expansion model. This failure precluded both a reasonable exploration of alternative resource portfolios and a rigorous means of optimizing them. PREPA's methodology and the range of alternatives it produced are unsatisfactory.
- c. Regarding the requirement to assess the planning environment, the IRP **complied**. PREPA adequately identified most of the environmental and other policy drivers that impact electricity system planning in general and adequately identified those policies that PREPA anticipated would impact its long-term resource planning.
- d. Regarding the requirement to forecast load, the IRP **did not comply**. PREPA failed to compare historical actual load with historical forecasts, failed to substantiate adequately how it developed its forecasts, and did not explore a reasonable set of future uncertainties, particularly a lower demand consistent with anticipated energy efficiency programs and other factors.
- e. Regarding the requirement to perform a reliability assessment, the IRP **did not comply**. A prediction of loss of load hours is not an adequate substitute for establishment of a specific planning reserve margin.
- f. Regarding the requirement to assess existing supply-side resources, the IRP **complied**. PREPA adequately described its existing generation fleet by providing information on resource type, nameplate and peak available capacity, capacity factors for its units, fuel types, heat rates, operational costs, capital expenditures, and expected retirement dates for certain resources.
- g. Regarding the requirement to assess existing demand-side resources, the IRP **complied**, in this limited respect: PREPA adequately described its existing demand-side management programs and the amount and kind of existing distributed generation. This description should not be confused with a true professional assessment of the potential for demand-side actions.
- h. Regarding the requirement to assess existing advanced meters and grid technologies, **no finding is necessary** because this requirement was waived by the Commission.
- i. Regarding the requirement to assess existing transmission facilities, the IRP **complied**. PREPA adequately described its transmission facilities, along with the single and double contingency tests it conducted and the

upgrades that it determined are required to remove transmission constraints affecting existing and future projects.

- j. Regarding the requirement to assess existing distribution facilities, the IRP **complied**. PREPA adequately described, at a high level, its distribution system's ability to increase penetration of distributed generation.
- k. Regarding the requirement to assess new generation options, the IRP **complied**. PREPA identified and evaluated a range of new thermal and renewable options.
- l. Regarding the requirement to assess new transmission facilities, the IRP **complied**. PREPA identified new transmission facilities necessary to address transmission constraints and critical contingencies.
- m. Regarding the requirement to assess new distributed generation and demand-side options, the IRP **complied**. PREPA included a forecast of new distributed generation and assessed the impact of new distributed generation on the distribution system. The requirement to identify a wide range of energy efficiency and demand response resources was waived by the Commission.
- n. Regarding the requirement to use a Capacity Expansion Model or similar model structure to develop least cost resource plans, the IRP **did not comply**. PREPA used a production cost model, which does not perform the functions of a capacity expansion model and does not optimize the resource additions or retirements.
- o. Regarding the requirement to submit an Action Plan which includes certain elements and which reflects the Preferred Resource Plan, the IRP **did not comply**. PREPA proposed an Action Plan which does not accurately reflect all elements of its Preferred Resource Plan and whose associated actions and dates do not accurately reflect PREPA's current planning.
- p. Regarding the requirement to file an Energy Efficiency and Demand Response Plan and Report, **no finding is necessary** because this requirement was waived by the Commission.
- q. Regarding the requirement to establish and meet targets for performance, **no finding is necessary** because performance metrics have not yet been established by the Commission.
- r. Regarding the requirement to describe and supply all models, methodologies and workpapers used in the production of the IRP,

PREPA **did not comply**. PREPA failed to provide sufficient and timely access to functional workpapers, models, or modeling files.

- s. Regarding the requirement to allow for competitive bidding, PREPA **complied**. PREPA's Action Plan included an intent to procure new generation at Palo Seco and Aguirre, and Aguirre combined cycle gas turbine replacement, through competitive bidding.
- t. Regarding the requirement that the IRP be consistent with statutory objectives with respect to energy efficiency, renewable energy, and the performance of fossil fuel generation, PREPA **did not comply**. PREPA assumed incomplete compliance with the RPS and failed to consider 100% compliance with the governmental energy efficiency program.
- u. Regarding the requirement that the IRP be in the public interest and beneficial to all customers, given the many deficiencies and noncompliances detailed in this Final Resolution and Order, PREPA **did not comply**.

3. Approval of a Modified IRP

16. Absent further action, our disapproval of PREPA's proposed IRP would leave Puerto Rico with no IRP. To have no IRP is unacceptable, because the Commonwealth's energy needs are urgent. Because PREPA today is not yet capable of preparing an IRP—not one that meets the Commonwealth's energy policy goals—the Commission in this Final Resolution and Order approves a Modified IRP, consisting of an Action Plan and resource planning information.

4. Preparation for the next IRP cycle

17. PREPA must improve its resource planning process. This Final Resolution and Order directs PREPA to (a) make internal improvements to its planning procedures; (b) select a new IRP consultant competitively, subject to Commission oversight and approval; and (c) develop procedures for collecting key data on the performance of its electric system.

B. Statutory goals and requirements

18. In the "Statement of Motives" accompanying Act 57-2014, the Legislature stated in pertinent part:

[T]here is a broad consensus on the need to evolve our dependence on fossil fuels and use to the maximum extent possible the Island's energy resources such as the sun and the wind, conservation, and efficiency.

The high cost of energy limits our ability to stimulate the economy, strengthen small- and medium- sized businesses, as well as to attract private sector investors from abroad, develop commercial, industrial and manufacturing activities, and improve the quality of life for all Puerto Ricans. This prevents our island from becoming a competitive and attractive place in all aspects. We have been held as hostages of a poorly efficient energy system that excessively depends on oil as a fuel and that does not provide the tools to promote our Island as a place of opportunities in the global market. The current cost per kilowatt of approximately twenty-seven cents (\$.27) is extremely high when compared to other jurisdictions that compete with Puerto Rico to attract investors and severely affects the pockets of local consumers.

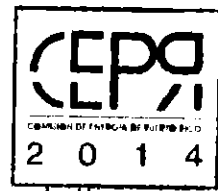
After more than seventy (70) years of its creation, and after more than three decades of having achieved the total electrification of the Island, PREPA has become a monopoly that regulates itself; sets its own rates without actual oversight; incurs operational, managerial and administrative deficiencies, whose actual cost at the end of the day, is borne directly by customers; and whose governance lacks transparency and citizen participation. All of the above contributes to Puerto Rico being among the top U.S. jurisdictions with the highest energy cost.

19. Essential to carrying out this legislative intent is a plan and a planning process, directed and overseen by the Commission. Act 57 thus requires PREPA to submit, and the Commission to approve, an integrated resource plan, defined as—

a plan that considers all reasonable resources to satisfy the demand for electric power services during a specific period of time, including those related to the offering of electric power, whether existing, traditional, or new resources, and those related to energy demand, such as energy conservation and efficiency, or demand response and localized energy generation by the customer.⁴

The Commission's definition is similar: a "plan that considers all reasonable resources to satisfy the demand for electric power services during a specific period of time, including those relating to the offering of electric power, whether existing, traditional, and/or new

⁴ Act 57-2014 § 1.3(ee).



resources, and those relating to energy demand such as energy conservation and efficiency or demand response and localized energy generation by the customer."⁵

20. The IRP must "describe the combination of energy supply and conservation resources that satisfies in the short-, medium-, and long-term the present and future needs of the energy system both of Puerto Rico and of their customers *at the lowest cost possible*."⁶ The plan must reflect a comprehensive evaluation of the electricity system. That evaluation must include a range of forecasts, and must address, but is not limited to, the following topics: conservation resources; conventional and nonconventional generation resources, both existing and future (including their operation efficiencies and remaining useful lives); transmission and distribution capacity; system reliability and stability; the need to diversify supply sources and stabilize energy costs; environmental impacts, including air, water and solid waste; and the procedures for and costs of interconnecting renewables and other independent power plants.⁷

21. Every three years, PREPA must revisit the approved IRP, amending it as necessary to account for "substantial change[s] in the energy demand or group of resources."⁸

22. Act 57 also mandates Commission oversight and public participation: "Every integrated resource plan shall be subject to the rules established by the Commission and approved by the same. Every plan shall be devised with broad participation from citizens and other interested groups."⁹

23. The Commission issued the required rules and conducted the required evaluation through a public process described in Appendix A.

C. Integrated resource plans and planning: Goals and objectives

24. An integrated resource plan is the culmination of a process. The *process* "evaluates the merits of using different kinds of energy resources to meet forecasted future

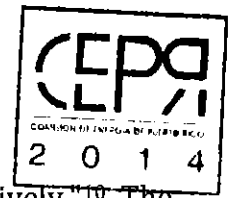
⁵ IRP Rule § 1.08(B)(20). The U.S. Environmental Protection Agency describes IRPs as "utility plans for meeting forecasted annual peak and energy demand, along with some established reserve margin, through a portfolio of supply-side and demand-side resources over a specified future period." U.S. EPA. (2015). *Energy and Environment Guide to Action, Chapter 7.1: Electricity Resource Planning and Procurement*. Retrieved from <https://www.epa.gov/statelocalclimate/energy-and-environment-guide-action>.

⁶ Act 57-2014 § 6.23(a) (emphasis added).

⁷ Act 57-2014 § 2.9(h)(ii).

⁸ Act 57-2014 § 2.9(h)(i).

⁹ Act 57-2014 § 1.3(ee).



demand for electricity with the goal of meeting demand reliably and cost effectively."¹⁰ The *plan* is the roadmap—to providing least-cost electric service over a planning horizon, typically 20 years. "Least-cost" means the least-cost revenue requirement, calculated at net present value from the present day to the end of the analysis period.

25. To create its roadmap, the utility first assesses whether its resources are sufficient to comply with its obligations to consumers. The utility's *resources* include supply-side generation (owned by the utility or procured from an independent power producer), transmission and distribution infrastructure, energy efficiency programs, demand-response programs, and customer-owned or customer-sited resources like distributed generation. The utility's obligations are to satisfy, reliably, both customer consumption¹¹ and customer load.¹² Using historic information, the utility creates forecasts of consumption and loads. It then determines what resources, both existing and future, are necessary to meet the forecasted consumption and loads. In assessing those resources, the utility must consider certain constraints, such as limits on power plant operations (due to physical limits or environmental regulations), along with other policy goals such as obligations to interconnect with renewable energy generators.

26. Together, this plan and process have this objective: to inform regulators of infrastructure needs and their costs, before those needs become emergencies and before those costs are incurred. Integrated resource planning allows the utility to expose its forecasts of needs and costs to scrutiny by regulators, interested stakeholders, consumers and the public. It addresses uncertainties by producing alternative plans, then assessing those plans for their robustness—their ability to succeed under multiple plausible future scenarios. It allows regulators to assess, guide, and where necessary direct the utility's decision-making procedures.

27. To be effective, this planning process must occur in public, transparently, so that those affected by the decisions, and those with expertise and perspectives to contribute to the decisions, have a full opportunity to share their concerns and contribute their expertise.

28. An IRP is a living document. It must reflect the best knowledge available at the time it is prepared, and the best possible decisions in light of that information. It must account for risk and uncertainty. While an IRP addresses needs of the long-term, it also must guide actions in the short term. As new information emerges—such as information about new technologies and new customer needs—the plan must evolve. Consequently, our IRP Rule calls for a triennial process—one in which PREPA, the Commission and the

¹⁰ *Kentucky Coal Association, Inc. v. Tennessee Valley Authority*, 68 F. Supp. 3d 703, 707 (W.D. Ky 2015).

¹¹ "Consumption" in this context means the amount of electricity consumed over a given period of time in a utility's electric service territory. It is measured in gigawatt-hours (GWh). IRP Rule § 1.08(B)(13).

¹² Electricity "load" (sometimes called "demand") means the amount of electricity required by customers at any given moment of the year. It is measured in megawatts (MW). IRP Rule § 1.08(B)(14).

public revisit the existing plan, incorporate the new information, and develop a new action plan. Periodic reconsideration, revision and reinvention are essential to a robust planning process.

29. While the planning process is conducted by the utility, it is guided and overseen by the Commission. In this first process—and in every future process—the Commission's priority will be cost-effectiveness: providing for Puerto Rico's energy needs at the lowest feasible cost. Actions taken by PREPA and its customers will affect costs for decades. And because the construction of new generation capacity often requires long lead times, uncertainty is unavoidable. Each decision therefore must be based on the best available information at the time the decision is made. This fact underscores the importance of an IRP that is robust—that is flexible enough to accommodate realities that depart from expectations. PREPA must do its best to avoid saddling its customers with unnecessary costs when lower-cost options are available.

30. For Puerto Rico, the goal, in short, is to replace old, costly plants with lower-cost options: more efficient plants, renewable resources, energy efficiency, demand response and distributed generation technologies—some of which empower consumers to manage their own costs, all of which reduce environmental damage as well as customers' exposure to fuel price volatility. Properly designed and continuously executed, an integrated resource planning process will carry out the Legislature's intent to evolve the energy sector into one that relies less on imported fossil fuels and more on Puerto Rico's own resources.

D. The Commission's requirements

31. IRP Rule Section 2.04(A) requires PREPA to conduct an analysis that compares its customers' needs with available resources, and then to fill any gap in need through specific planning scenarios.¹³ This analysis has five distinct (and required) steps: the development of forecasts, uncertainties and scenarios; the use of a capacity expansion model to develop resource plans; the testing of resource plans through rigorous scenario and sensitivity analyses; the selection of a Preferred Resource Plan; and the development of an Action Plan. We explain each step next.

1. Development of forecasts, uncertainty and scenarios

32. To develop a resource plan, the analyst must forecast changes to key variables, such as consumption, demand, fuel prices, construction costs and finance costs.¹⁴ Because forecasting necessarily involves uncertainty, the utility must "develop a group of scenarios

¹³ "Scenario" refers to a "combination of system requirements needed to serve load, commodity prices, capital costs and risks that influence the choice of resources serving the utility's future load." IRP Rule § 1.08(B)(36).

¹⁴ IRP Rule § 2.04(B)(1)(c).

that encompass the reasonable range of possible outcomes for uncertain forecasts."¹⁵ In incorporating uncertainty into its forecasts,¹⁶ the utility must seek to capture a wide range of possible futures,¹⁷ while identifying a clear "reference case" (also known as "base case"). This base case is the utility's best estimate of the most likely future outcomes with respect to uncertain variables, such as fuel cost. It represents the basis from which the utility seeks to make key resource decisions.

33. The range of possible futures is incorporated, either individually or together, into "scenarios." Each scenario represents a set of uncertainties that fall within a range of plausible outcomes. By building resource plans under both the reference case and alternative scenarios, the utility can examine which decisions are robust (meaning, they remain cost-effective under multiple plausible futures), and which are less robust—*i.e.*, likely to perform poorly if actual facts depart from forecasted facts.

2. Use of a capacity expansion model to develop resource plans

34. The rule requires that "PREPA shall use a Capacity Expansion Model or similar model structure to develop least cost resource plans."¹⁸ Capacity expansion models are "tool[s] that determine the optimal generation capacity and/or transmission network expansion in order to meet an expected future demand level and comply with a set of regional/state specifications (reliability requirements, renewable portfolio standards, CO₂ emissions limits, etc.)."¹⁹ This requirement ensures that least-cost resource plans are *developed and evaluated* through a computer algorithm capable of considering a wide range of potential variables for multiple elements, such as fuel costs, load, capital costs and commodity prices. Without a capacity expansion model that automatically (and objectively) assesses numerous plans, an analyst would be confined to merely testing *subjectively handpicked scenarios*. It should come as no surprise that different assumptions about future fuel prices, emissions prices or demand will produce different plans. By testing a sufficiently large number of resource plans based on a wide range of possible futures, a capacity expansion model helps identify scenarios that are most likely to be least-cost to consumers. That is the meaning of *optimization*: Getting the best possible outcome based on the structure of the system and information about the future. Determinations regarding

¹⁵ *Id.*

¹⁶ *Id.*

¹⁷ IRP Rule § 2.04(B)(1) requires the utility to "...develop a range of possible outcomes for those forecasts encompassing at least the fifth (5th) and ninety-fifth (95th) percentile outcomes as understood by the utility."

¹⁸ IRP Rule § 2.04(B)(2)(a).

¹⁹ Fisher, J., Santen, N., Luckow, P., De Sisternes, F., Levin, T. & Botterud, A. (2016). *A Guide to Clean Power Plan Modeling Tools: Analytical Approaches for State Plan CO₂ Performance Projections*; Synapse Energy Economics and Argonne National Laboratory. Retrieved from <http://www.synapse-energy.com/sites/default/files/Guide-to-Clean-Power-Plan-Modeling-Tools.pdf>.

the least-cost, least-risk combination of decisions about existing resources (e.g., whether to retire, and if so, when) and the selection of new resource options are, in this case, best accomplished through a capacity expansion model.

35. As we will explain in Part IV(A)(1), PREPA did not observe the requirement for a capacity expansion model. It chose the "handpicked" approach—a subjective selection of candidate resource plans. Its approach left it, and the Commission, unable to evaluate the full range of potential options and thus unable to ensure that its plan was a least-cost plan.

3. Testing resource plans through rigorous scenario and sensitivity analyses

36. Resource plans can be created using different forward-looking assumptions—assumptions about fuel price trajectories, load forecasts, construction costs and financing costs. Such plans can, in theory, all appear to be optimal (i.e., least cost), depending on the specific set of assumptions used to evaluate the plan. Scenario and sensitivity analyses clarify the robustness of these scenarios under a variety of different futures. For example, does a resource plan that appears to be least-cost under an assumption of low gas prices continue to perform well under other gas price scenarios? Alternatively, would a plan determined to be least-cost under high gas prices perform better under those other gas price scenarios? *Scenario analysis* evaluates plans under a range of reasonably feasible assumptions about the future. That evaluation then helps identify those plans that are least-cost and least-risk.²⁰ *Sensitivity analysis* ascertains the effect of one particular input assumption on the performance of candidate resource plans. It can be used to refine or inform selection of a preferred resource plan.²¹ Sensitivity analysis is typically performed after a main scenario analysis. It may be informed by the results of the scenario analysis, which can be used to identify the key assumptions and resource plans that merit further investigation. The IRP Rule requires that PREPA perform these types of analyses.

4. Selection of preferred resource plan

37. The rule directs PREPA to select and recommend the plan that performs the best under the scenario and sensitivity analyses.²² PREPA may modify that plan if PREPA can demonstrate that the modified plan is of comparable cost and sufficiently robust.²³

²⁰ IRP Rule § 2.04(B)(1)(c).

²¹ IRP Rule § 2.04(B)(3).

²² IRP Rule § 2.04(B)(5).

²³ IRP Rule § 2.04(B)(4).

5. Development of a five-year action plan

38. The rule requires PREPA to identify the discrete set of actions that it must perform over the five years following the publication of the IRP, basing these actions specifically on the Preferred Portfolio.

39. The Commission designed its IRP Rules to ensure a disciplined analysis whose bases are transparent. Compliance with the rules ensures that each plan is robust, transparent, clearly linked to need, and consistent with consumers' interests. Significant deviations from the rules will obscure analytical processes and the bases for resource proposals, increasing the risk that plans and investments conflict with consumers' interests. As will be clear from the ensuing discussion, PREPA's deviations were significant, largely inexcusable and ultimately inconsistent with the vision established in Act 57.

E. Expressions of public concern

40. Consistent with the need for transparency, the Commission opened this proceeding to the public in two ways.²⁴ First, the Commission allowed participation in the evidentiary proceedings by intervenors and *amici curiae*. Second, the Commission held two public hearings open to all citizens.

1. Participation by intervenors and *amici curiae*

41. The Commission was pleased to have the participation of intervening organizations and their experts, as well as *amici curiae*. These participants brought important technical questions and concerns to the Commission's attention. Those questions and concerns are addressed throughout this Final Resolution and Order.

42. **Intervenors:** Asociación Puertorriqueña de Energía Verde ("APEV"); NRG Energy, Inc. and its affiliates, York Capital Management Global Advisors, LLC, and ITC Holdings Corp. ("Consortium Members"); EcoEléctrica, L.P. ("EcoEléctrica"); Enlace Latino de Acción Climática, El Puente Williamsburg, Inc., and Comité de Diálogo Ambiental, Inc. ("ELAC"); Instituto de Competitividad y Sostenibilidad Económica de Puerto Rico ("ICSE-PR" or "PRECSEI"); Instituto Nacional de Energía y Sostenibilidad Isleña de la Universidad de Puerto Rico ("INESI"); La Mesa de Diálogo Energético de Puerto Rico ("Mesa"); National Public Finance Guarantee Corp. ("National") and Assured Guaranty Corp. and Assured Guaranty Municipal Corp. ("Assured"); Oficina Estatal de Política Pública Energética ("OEPPE"); Pattern Santa Isabel LLC ("Pattern"); PVP Properties, Inc., Coto Laurel Solar Farm, Inc.; Windmar PV Energy, Inc. ("Windmar"); and Oficina Independiente de Protección al Consumidos ("OIPC").²⁵

²⁴ A timeline for the proceeding appears in Appendix A.

²⁵ The positions and perspectives of the intervenors are summarized in Appendix B.

43. *Amici curiae*: Energy Answers, LLC ("Energy Answers"); and Sunnova Lease Vehicle 3, LLC, Sunnova Asset Portfolio 4, LLC and Sunnova Asset Portfolio 5 LLC ("Sunnova").

2. Participation by members of the public

44. To maximize public participation and insight, the Commission held two public hearings. Both hearings were held in Spanish and were live-streamed and recorded. The first hearing was held on May 18, 2016 in the City of San Juan. A total of 14 participants addressed the Commission. To receive comments from those who work during the day or do not reside in the metropolitan area, the Commission held a second public hearing on the evening of June 14, 2016 in the City of Ponce. In this second hearing, a total of 12 participants addressed the Commission.

45. Some citizens criticized the education and information procedures that both the Commission and PREPA used to inform the citizens about the IRP process. They asserted that PREPA and the Commission need to implement an education program in which citizens are informed about the purposes of an IRP, what integrated resource planning entails, the specifics of PREPA's proposed IRP, and the effects of Commission approval of an IRP. Particularly, the entity *Espacios Abiertos* stressed the importance of not only making the information available, but also publishing that information in an intelligible format, understandable by all citizens regardless of their expertise.

46. Some citizens argued that PREPA's demand forecast was unrealistically high; that a lower future demand is more likely. They also asserted that that demand-side management (DSM) strategies during the peak time could lead to a lower demand forecast. They criticized PREPA for failing to incorporate DSM strategies and mechanisms into its load forecast. They also asserted that PREPA failed to address the issue of the night-time peak in demand (discussed further in Section IV.D.2, pertaining to demand response), and did not give sufficient weight to energy efficiency or demand-side management efforts, all of which could help manage this peak and thereby lower the Commonwealth's dependence on fossil fuels.

47. Many also critiqued the Preferred Portfolio's assumption of incomplete compliance with the Renewable Portfolio Standard ("RPS"), as well a lack of a meaningful consideration of renewable projects and continued reliance on fossil-fuel generation. In particular, ELAC asserted that PREPA is basing its plan in the substitution of natural gas for oil—a strategy that will require large investments necessary to build several fossil fuel plants, including the project of Aguirre Offshore Gas Port ("AOGP"). Citizens advocated for increasing the role of renewable energy, particularly solar, wind and water. A few suggested that PREPA build its own energy farms, and stay away from paying third parties under expensive long-term contracts.

48. When discussing AOGP, several organizations expressed concerns with regards to the real cost of building the terminal. They also discussed the problems PREPA has faced

in securing the necessary permits from state and federal agencies. Furthermore, citizens expressed a concern about the possibility that this project would be linked to a gas pipeline built across the Island—an idea which has already faced strong opposition.

49. Citizens criticized PREPA's purchases of electricity from AES because its coal plant, they asserted, produces contaminating ashes that are detrimental to the health and the environment. Several argued in favor of cancelling the contract with AES during the renegotiation process. Similarly, many opposed the implementation of Energy Answers's waste-to-energy plant. More generally, concerns were expressed about the health and environmental effects of burning fossil fuels, particularly the emissions produced from the use of coal. Another concern was the misuse of water resources from the aquifers. ELAC expressed concern about the amount of water used to cool down the plants and the discharges of thermally polluted water waste back to the aquifer, contaminating important water sources that serve many citizens.

50. Some citizens emphasized that the IRP should be prepared alongside a Programmatic Environmental Impact Statement ("EIS") prior to its approval. They argued that Article 4 (B) of Act 416-2004, as amended, known as the "Environmental Public Policy Act of Puerto Rico" ("Act 416-2004"), requires that an EIS be prepared for PREPA's IRP.

51. Citizens were also concerned about Siemens's involvement in the IRP, focusing on the risk of bias, because the IRP was prepared by Siemens PTI while the Preferred Plan recommended specific combined cycle units manufactured by another wing of Siemens AG.

3. Commission comments on public participation

52. In the evidentiary hearing and the public hearings, intervenors and citizens declared their deep and legitimate concerns about the environmental effects of electricity production. High on the list of concerns was coal ash produced by the AES project, as well as the potential for the release of environmental contaminants from Energy Answers's proposed waste-to-energy project. Some argued that the Commission should prevent the renewal of PREPA's contract with AES,²⁶ and in fact nullify that contract.

53. Our statutes give us no legal power to nullify existing contracts. Nor do we have the legal power to order solutions to health problems or environmental harms—matters for the Legislature to place with the appropriate agencies.²⁷ As for the Energy Answers

²⁶ The renewal of AES's existing contract does not become an issue before 2027.

²⁷ Art. 4 B(3) of Act 416-2004, as amended, known as the "Environmental Public Policy Act of Puerto Rico," requires that prior to taking any government action or promulgating a government decision which significantly affects the environment, the proponent agency must comply with the environmental planning process and consider the environmental impact of its actions. Act 161-2009, as amended, known as the "Puerto Rico Permit Process Reform Act" delegated the environmental reviewing authority of Act 416-2004 to the Permit Management Office (*Oficina de Gerencia de Permisos*), which granted a Categorical Exclusion of

project, in this Final Resolution and Order the Commission makes no determination about its appropriateness. PREPA's submitted IRP stated that PREPA's PPOA with Energy Answers would qualify for inclusion in PREPA's RPS compliance. PREPA did not, however, assume the project would become operational during the planning period. Neither the Energy Answers project nor any generic waste-to-energy projects were included in the fleet of generating units modeled in the IRP. Consequently, our Final Resolution and Order makes no determination about the appropriateness of this project.

54. The IRP is required, of course, to evaluate "the environmental impacts of PREPA related to air emissions and water consumption, solid waste, and other environmental factors"²⁸—issues we address in Part VII of this Final Resolution and Order. Furthermore, the Commission has exclusive jurisdiction over the quality, reliability and cost of electric service. To the extent sellers of electricity behave in a manner that will subject them to fines and penalties, or shutdowns by environmental authorities, those events can affect the quality, reliability and cost of electric service. Behavior that increases the risk of such events does fall within the Commission's jurisdiction.²⁹

55. The Commission will address the possible financial costs of environmental compliance in the pending rate case and in future IRP cases. Furthermore, in the IRP setting we must take into account, when comparing resources for cost-effectiveness, the probability that certain resources will someday be subject to costly environmental regulation (such as carbon taxation). The Commission's revised IRP Rule will address these topics. Until then, it is necessary to ensure that on these topics PREPA develops full knowledge and expertise, and demonstrates full sensitivity to the concerns of our citizens. As described Part VII below, therefore, we will direct PREPA to prepare a report on environmental litigation risks associated with its actions.

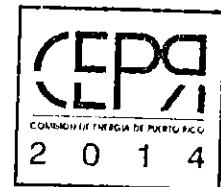
56. During the Technical and Public Hearings, intervenors and the general public argued the lack of environmental justice as a deficiency in PREPA's IRP. Specifically, they argued that PREPA's proposed IRP failed to integrate and consider environmental justice implications in the selection of their preferred resources.³⁰ The Commission acknowledges the importance of ensuring the fair integration of environmental policies as part of its decision-making.

Art. 4 B(3) to PREPA's IRP. *Determinación de Cumplimiento Ambiental mediante Exclusión Categórica para el Plan Integrado de Recursos de la Autoridad de Energía Eléctrica*, No. 2016-DEC-00014 (Aug. 8, 2016).

²⁸ Act 57-2014, § 2.9(h)(ii)(H).

²⁹ See, e.g., *National Association for the Advancement of Colored People v. Federal Power Commission*, 425 U.S. 662, 668 (1976) (holding that the Commission "clearly has the duty to prevent its regulatees from charging rates based upon illegal, duplicative, or unnecessary labor costs. To the extent that such costs are demonstrably the product of a regulatee's discriminatory employment practices, the Commission should disallow them.").

³⁰ Environmental justice refers to the concern that the environmental effects of government actions not fall disproportionately on vulnerable populations.



57. The Commission recognizes the concerns expressed by some intervenors and public commenters with regards to the potential negative impact that certain proposed projects may have on the environment. To address these concerns, the Commission issued specific instructions to PREPA stating that it must comply with all applicable environmental requirements prior to commencing the development of any such projects, including, but not limited to, seeking permits from the appropriate environment-related government agencies. In addition, throughout this proceeding the Commission has integrated environmental considerations in its assessment of PREPA's proposed IRP, pursuant to the requirements of Act 83.³¹ All of the determinations made herein by the Commission are the result of a comprehensive analysis of PREPA's proposal, intervenors' comments and briefs, comments from the general public and the documents contained in the record, in light of the public policy forwarded by Act 57, which contemplates a wide range of technical, operational, economic and environmental considerations.

58. The Commission is grateful to the citizens of Puerto Rico for bringing forth these important issues.

59. Finally, Intervenor raised several issues that are important to consumers but are outside the statutory scope of integrated resource planning. One of such issues is hedging strategies, which are relevant to PREPA's near-term procurement plans but are not part of a long-term planning process. For example, such strategies should be examined in rate cases, where we determine how fuel costs (including the cost of hedging strategies) should be accounted for in PREPA's rates. Other issues raised by Intervenor were retail wheeling, competitive supply, and generation ownership. These issues all relate to market structure, *i.e.* the types of sellers and buyers of electricity services, the mechanisms by which they offer and are paid for such services, and their responsibilities as market participants. While a competitive electricity market might offer value in Puerto Rico, an IRP proceeding is not the appropriate forum to evaluate that option. An IRP proceeding addresses the mix of power resources that is appropriate for Puerto Rico. The types of market structures mostly to produce that mix cost-effectively is a subject for separate proceedings.

60. Intervenor also raised concerns regarding the impact that PREPA's resource plan would have on rates. The Commission's IRP rule requires that PREPA seek plans that minimize the present value of the total system cost, rather than minimize near-term rates. While costs do of course affect customer rates, the appropriate proceeding to ensure fair and reasonable rates is a rate proceeding. Actions approved in this IRP Order that affect rates will therefore be considered in Case No. CEPR-AP-2015-0001, *In Re: Puerto Rico Electric Power Authority Rate Review*, and in future rate cases.

³¹ Section 6B(h)(ii)(H) of Act 83, as amended by Act 57-2014.

61. We hope intervenors who brought these issues to our attention will participate in those proceedings where we address them.

II. UNIQUE CONSIDERATIONS FOR THIS IRP

A. Description of PREPA's electricity resources

62. PREPA has access to 5,659 MW of generating capacity, some of which is owned by PREPA while the remainder is purchased.³² PREPA owns and operates 14 steam electric units with a total capacity of 2,892 MW, distributed among four sites, including Aguirre, Costa Sur, Palo Seco and San Juan; four combined cycle (CC) units (Aguirre 1 and 2 CC and San Juan 5 and 6 CC) with a total capacity of 920 MW; and 26 gas turbine (GT) units (including Cambalache 1-3, Mayagüez 1-4, and a distributed gas turbine fleet), with a total capacity of 826 MW.³³ Aside from the Costa Sur steam units, all of PREPA's remaining thermal fleet burns fuel oil or diesel fuel.

63. A portion of PREPA's capacity and energy is purchased from the owners of two third-party thermal generators under the terms and conditions of Purchased Power Operating Agreements (PPOAs).³⁴ These purchases include 507 MW of gas-fired capacity from EcoEléctrica, L.P. and 454 MW of coal-fired capacity from AES.³⁵ According to PREPA, these base-load units have production costs among the lowest of all units on the Island.³⁶ EcoEléctrica began commercial operation in March 2000. It is the only combined cycle plant on the Island that operates using natural gas.³⁷

64. Pursuant to Act 82-2010, PREPA signed renewable energy PPOAs currently totaling approximately 1,600 MW, of which 163.1 MW are in operation.³⁸ PREPA also has approximately 60 MW of installed distributed generating capacity, 71% of which is located

³² Revised IRP, Volume I, Section 3.1, Table 3-1, p. 3-3. The IRP states that PREPA has a "nominal" (assumed to mean "nameplate") capacity of 5,839 MW. The nameplate capacity of a generator represents its original design maximum output, while the 5,659 MW value represents the maximum realistic thermal power plant output available to PREPA.

³³ *Id.*

³⁴ *Id.*

³⁵ *Id.*; Supplemental IRP, Section 10.5, p. 9-5.

³⁶ *Id.*; Revised IRP, Appendix B, Tables B-5 - B-6.

³⁷ EcoEléctrica uses natural gas received as liquefied natural gas (LNG) at its existing gas terminal.

³⁸ Revised IRP, Volume I, Section 4, Table 4-2. PPOAs with PREPA include the following: AES, Ilumina, LLC; Pattern Santa Isabel, LLC; Punta Lima; San Fermín Solar, LLC; Windmar Renewable Energy, Inc.

in the North where the load is concentrated.³⁹ Most of this distributed generation is photovoltaic and includes net-metered and non-net-metered generation.⁴⁰

B. Financial constraints and capital uncertainty

65. PREPA's financial problems are well known, as detailed in the Commission's Restructuring Order concerning the Transition Charge.⁴¹ It is uncertain when PREPA will have access to the capital markets; and when it does have that access, in what amounts and at what cost. These constraints affect PREPA's planning over the near- and long-term. High interest rates increase the risk of bias against investments with larger upfront costs but larger long-term benefits.

C. Mercury and Air Toxics Standard (MATS) compliance

66. Noncompliance with MATS⁴² financial penalties and citizen exposure to unlawful emissions. PREPA is behind schedule for compliance. At Oral Argument (May 13, 2016), PREPA indicated it would not be able to comply until mid-2021 or mid-2022.⁴³ PREPA is negotiating with EPA on how to comply without incurring penalties. Completion of those negotiations, PREPA has asserted, is contingent in part on its having an approved IRP. Uncertainty over compliance dates and compliance methods affects PREPA's planning decisions.

D. Reserve margin, forced outage rates and reliability

67. A reserve margin is the portion of existing capacity that a vertically integrated utility, such as PREPA,⁴⁴ holds in excess of the amount of capacity needed to serve expected peak load. Some surplus is necessary to enable the utility to meet peak requirements even if some units are experiencing a forced (unexpected) or unforced (scheduled) outage that occurs coincidentally with high load hours. Utilities typically distinguish between their

³⁹ Revised IRP, Volume I, Section 4, Table 4-8, at p. 4-7.

⁴⁰ *Id.*

⁴¹ *Restructuring Order*, Docket No. CEPR-AP-2016-0001 (June 21, 2016).

⁴² The Mercury and Air Toxics Standard (MATS) is a set of rules promulgated by U.S. EPA on February 16, 2012 under Sections 111 and 112 of the Clean Air Act (42 U.S.C. §7401 *et seq.*). MATS sets limits on the allowable emissions rates of mercury and certain other Hazardous Air Pollutants ("HAPs") from certain classes of existing and new power plants.

⁴³ PREPA Oral Argument Presentation (May 13, 2016) at pp. 3-4.

⁴⁴ A vertically integrated utility owns the full set of physical assets necessary to produce and deliver electricity: generation, transmission and distribution. While PREPA is vertically integrated, it does not produce all the power its customers consume. It buys some power from independent power producers.

actual reserve margin (the margin of surplus capacity held at a particular time), and the *planning* reserve margin (the target amount of surplus capacity that is appropriate for purposes of ensuring reliability).

68. The Commission's IRP Rule requires that PREPA determine and document a planning reserve margin – *i.e.*, the margin of surplus capacity that must be held by PREPA to ensure reliable service on a year-to-year basis.⁴⁵ The planning reserve margin is a target that may adjust over time in response to the composition of the fleet and changing peak demands. It is a critical element of least-cost planning, because it dictates the surplus capacity that must be held by the utility. Construction and/or maintenance of each surplus megawatt imposes a cost on customers. As the reliability of PREPA's fleet improves, the amount of surplus capacity that PREPA must plan to hold is will decrease, resulting in reduced costs to customers.

69. Planning reserve margin requirements are typically determined through a resource adequacy assessment. To perform that assessment, a rigorous production cost model is "calibrated," *i.e.*, adjusted, to account for the forced outage rates of existing units, as well as other available resources (such as resources available from independent power producers or even from customers). The production cost model also takes into account the impacts of peak demands, hourly demands, unit operating costs and unit output. Using a stochastic model,⁴⁶ the utility's planners determine how much of its load can be met with existing resources under a wide variety of conditions, and how much additional capacity might be needed to meet future requirements. An "optimal" planning reserve margin can be determined by finding the reserve margin that minimizes total system costs, while accounting for the impacts of "unserved energy" (*i.e.*, the amount of electricity that would not be provided to customers as a result of insufficient capacity). These models typically assume, based on historical data on scheduled and forced outages, that the vast majority of the existing system continues to be available and to operate as needed.

70. PREPA's system differs from those on the U.S. mainland because it is not interconnected to a large, diverse network. Such a network has multiple generating units that can share the region's full reliability requirements. (If everyone in a neighborhood could share cars, the number of cars needed by that neighborhood would be fewer.) PREPA does not have transmission interconnections with other regions; therefore, it must provide fully for its own reliability needs. Nor does PREPA have access to significant customer-side curtailment or emergency energy options. Instead, PREPA's relatively small system is highly dependent on the availability of a small number of units. Under these

⁴⁵ IRP Rule § 2.03(B)(4).

⁴⁶ Stochastic models test a system under uncertainty by drawing variables, such as demand, fuel price and forced outages, randomly from a probability distribution. The model runs multiple times to determine the range of system responses. In a resource adequacy assessment, the stochastic model tests under what conditions, and how often, the system fails to provide sufficient generation.

circumstances, one would expect PREPA to have reserve margins exceeding those of mainland U.S. utilities.

71. And that is the case. PREPA's current reserve margin is 90%; meaning, its existing generating fleet, if fully available, can serve nearly twice its peak load.⁴⁷ This amount of surplus capacity is extraordinarily large relative to other U.S. utilities, even considering Puerto Rico's unique conditions. The North American Electric Reliability Council typically assumes approximately a 15% planning reserve margin for thermally powered electric systems on the U.S. mainland.⁴⁸

72. Because Puerto Rico is an island, it is reasonable to expect PREPA's planning reserve margin to exceed that typical of mainland utilities. But PREPA's reserve requirement would likely be lower if its generating units did not have such high forced outage rates. PREPA needs more-than-normal capacity to keep the lights on when inevitable generating outages occur.⁴⁹ As an example, PREPA lists 1,647 MW of installed capacity with forced outage rates of 10% or higher.⁵⁰ These relatively high forced outage rates imply that these units shut down, on average, three days per month due to technical faults, breakages, or operator error. According to PREPA's modeling in the IRP, the system begins incurring loss of load hours (*i.e.*, an inability to meet demand in all hours) as the reserve margin drops below approximately 70%.⁵¹ PREPA's higher reserve requirement results not only from its island status but from the condition of its generating fleet.

E. Fossil fuel price volatility

73. PREPA's system costs are dominated by fossil fuel costs.⁵² In PREPA's IRP, many of the near-term actions are specifically designed to lower exposure to those costs. Thus,

⁴⁷ Revised IRP, Table 3-1 (5,659 MW nameplate capacity), p. 1-1. "The most recent peak observed on October 2, 2014 at the 21st hour was 3,030 MW."

⁴⁸ NERC. (2016). M-1 Reserve Margin. Retrieved from <http://www.nerc.com/pa/RAPA/ri/Pages/PlanningReserveMargin.aspx>.

⁴⁹ Revised IRP, Appendix B.

⁵⁰ *Id.* Includes Aguirre CCs (20%), San Juan CCs (21% and 10%), San Juan ST 1 (10%), Cambalache 1-3 (10%), and GT units (15%).

⁵¹ Revised IRP, Appendix C-19, LOLH (Loss of Load Hours) in 2020; Appendix E-7, Reserve Margin Including Cambalache and Old GTs in 2020. Results pertain to resource plan "P3F1," which was PREPA's preferred plan in the Revised IRP. Similar results are seen for the year 2019 in modeling results for PREPA's updated preferred plan, "P3MF1M," as tabulated in Appendix C-1 of the Supplemental IRP.

⁵² Sources:

- PREPA. (December 15, 2014). *December 2014 Business Plan*. Draft IRP Attached Documents\Answer 6 Supp\201412-Business Plan Report.pdf, page 54.

the forecast cost of fuel is critical in determining the best course of action. The phenomenon of falling fossil fuel prices has affected many utilities' planning processes. PREPA's planning process is no exception.

III. SUMMARY OF PREPA'S IRP SUBMISSIONS

74. Having explained the statutory commands, the IRP's purposes and the Commission's rules, we turn to PREPA's submission. This Part III will describe PREPA's methodology and conclusions.

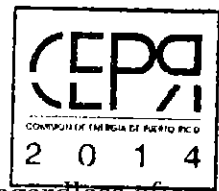
75. *A note on terminology and process:* During this multi-month proceeding, PREPA and its consultant Siemens submitted multiple versions of an IRP, the latter versions usually in response to Commission directives to correct various deficiencies. These various versions and their dates are noted in Appendix A, "Timeline and History of the Proceeding." The major steps were: a First Stage Integrated Resource Plan (prepared by Leidos Engineering—this document was not submitted officially in this proceeding but was produced in response to a Requirement of Information from the Commission); a "Draft IRP" (PREPA's initial official submission); a "Revised IRP," also referred to as the "Base IRP" by PREPA and several intervenors; a "Supplemental IRP"; and an "Updated Fuel IRP." The Commission makes its evaluations here based on the best and most complete set of evidence available across all of PREPA's IRP submissions.

76. *Second note on terminology:* PREPA's IRP process was led by Siemens PTI. PREPA stated that Siemens "performed the IRP,"⁵³ and that "the Siemens team worked closely with PREPA management and its financial advisors in defining meaningful and plausible future scenarios and designing feasible supply portfolios."⁵⁴ During the discovery process, technical hearings and oral argument, many answers to Commission's Requirements of Information came from Siemens. At no time did PREPA indicate a disagreement with Siemens's process, assumptions, findings or recommendations. Consequently, the distinction between PREPA's judgments and Siemens's judgments is unclear. For purposes of brevity, this Final Resolution and Order will usually refer to PREPA, even though elements may have been introduced, recommended or executed by

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- Revised IRP, Appendix C-7 (P3F1). Fuel is 58 percent of system costs in 2016; 28 percent by 2035. System costs include generation fuel, O&M, and capital, purchase power agreements, and transmission costs. They do not include distribution services, retail services, pension, or debt services.
 - PREPA. Docket No. CEPR-AP-2015-0001, *Initial Filing*, Exhibit 3.02. As of June 2015, fuel accounted for an estimated \$1.4 billion of \$4.6 estimated 2017 total revenue requirement (30%); as of May 2016, fuel accounted for 26% of estimated 2017 revenue requirement.

⁵³ Revised IRP, page 1-2.

⁵⁴ *Id.*



Siemens. PREPA bears the full responsibility for the entire contents of its IRP, regardless of which entity was responsible for specific assumptions, methods employed, findings or recommendations.

A. Overview of PREPA's approach

77. Overall purpose: PREPA's IRP focuses on reconfiguring its existing generating fleet to meet environmental requirements (especially the EPA's MATS), increase reliability, upgrade aging infrastructure, reduce reliance upon oil, and satisfy Puerto Rico's renewable portfolio standard (RPS).⁵⁵

78. The role of AOGP: Under most scenarios it analyzed, PREPA assumed that it would complete the Aguirre Offshore Gas Port (AOGP) project in southern Puerto Rico. This project would accept shipments of liquefied natural gas, thereby allowing much of PREPA's southern generation fleet to run on natural gas rather than fuel oil or diesel. PREPA assumed that AOGP would provide two main benefits: First, converting generating units from oil to natural gas would allow those units to meet the MATS rule, due to the lower rates of emissions of metals and other toxic pollutants associated with combustion of natural gas. Second, PREPA assumed that gas prices would be lower than fuel oil prices. Much of PREPA's planning judgments flowed from the assumed presence of, and benefits from, AOGP. In particular, all of PREPA's candidate resource portfolios assumed the operation of AOGP.

79. Generation options: For fossil generating units not compliant with MATS, PREPA considered three fates: retirement, "limited use" status, and conversion to natural gas. PREPA assessed different combinations of retirements and conversions, focusing on plants at the Aguirre and Costa Sur locations in southern Puerto Rico. To replace retiring units, PREPA's IRP examined new fossil resources—usually restricted to diesel or natural gas-fired combined cycle units of different sizes and capabilities, including small (72 MW⁵⁶) SCC-800 units and two larger combined cycle types: 369 MW F-Class units and 393 MW H-Class units.⁵⁷

⁵⁵ Act 82 § 2.3 requires PREPA to supply a growing percentage of retail sales from eligible renewable energy resources by 2035. The statute requires PREPA to meet a target of 12 percent from 2015-2019, 15 percent from 2020-2027, and 20 percent by 2035, with interim targets in between. Eligible renewable energy can include solar, wind, biomass municipal solid waste, landfill gas, tidal and wave generation, small hydroelectric, and other renewable energies.

⁵⁶ PREPA modeled two different generating capacities for each of its new generating options, depending on whether the unit in question is assumed to fire diesel or natural gas. For example, each unit of the SCC-800 has a capacity of 70 MW when run using diesel and 72 MW when run using natural gas. While PREPA's approach is correct from a technical standpoint, we refer to the natural gas-fired capacities of units at all times in this Final Resolution and Order to avoid confusion.

⁵⁷ The terms "F-Class" and "H-Class" refer to different generations of combined-cycle turbine technology with different operational and performance characteristics. For long-term planning, the key differences between F-Class and H-Class units are that H-Class units have higher capacity and greater efficiency, but have a higher

80. **Futures, portfolios and resource plans:** To examine different strategies to meet MATS and the RPS, PREPA developed plans based on what the utility termed "futures" and "portfolios." PREPA designed four "futures." Each future described different sets of assumptions about fuel availability and demand. PREPA also designed three resource selection "portfolios." Each combination of future and portfolio resulted in a "resource plan."

81. **Assumptions:** Implicitly or explicitly, PREPA incorporated several assumptions into its resource planning process, maintaining these assumptions across all of its plans and sensitivities. Specifically: (a) natural gas will remain inexpensive while fuel oil costs will rise substantially; (b) in the near term, natural gas will likely be available only in the South (*i.e.*, at Aguirre or Costa Sur)—and thus new gas-fired generation intended to satisfy near-term needs must be located in the South; (c) wind would be unavailable as a resource due to "local opposition;"⁵⁸ and (d) no thermal generating units other than diesel- or gas-fired combined-cycle units⁵⁹ would be cost-effective.⁶⁰

82. **Locations and timing:** PREPA determined that the majority of new generation should be located in the South,⁶¹ to co-locate with or replace existing generation, harness the assumed availability of AOGP in most of the assumed "futures," and use the existing transmission system. PREPA did not consider locations other than those with existing generation. The timing of resource additions was determined based on Siemens's evaluation of PREPA's access to capital and PREPA's ability to execute multiple major construction projects at one time.⁶² The retirement of non-MATS compliant units was

total cost. The SCC-800, by contrast, can be installed in smaller and more modular unit sizes than either F-Class or H-Class units but is less efficient than both. The SCC-800 is more appropriate when the option to add capacity in small increments is beneficial.

⁵⁸ Revised IRP, pp. 4-3.

⁵⁹ PREPA did not consider, for example, the use of simple-cycle combustion turbines to satisfy reserve margin requirements at a lower capital cost than a combined-cycle unit. PREPA did perform limited analysis of portfolios that included reciprocating engines, which are small generators that are commonly used for combined heat-and-power or backup power applications rather than for utility applications. These analyses found that reciprocating engines were more expensive than the SCC-800 while contributing no incremental benefit. PREPA's approach to these analyses, however, assumed a set number of reciprocating engines at a central location; PREPA did not determine the best amount and distribution of units.

⁶⁰ Revised IRP, pp. 8-11.

⁶¹ Revised IRP, Vol. I, Section 7-4 to 7-8.

⁶² Siemens did not employ a specific capital constraint on the procurement of new resources.

assumed to occur as quickly as feasible consistent with maintaining reliability,⁶³ while "limit[ing] major generation project implementation to one or two at any given time."⁶⁴

83. **Modeling:** PREPA did not use a capacity expansion model to select least-cost plans. PREPA instead relied on the subjective opinions of its engineers and consultants to choose retirements and resource additions that it believed would support system reliability and reduce costs.⁶⁵ PREPA thus created its resource plans by "manually" selecting the size and timing of units to be added to one of PREPA's four main existing generation sites (Aguirre, Costa Sur, Palo Seco, and San Juan/North Metro).⁶⁶

84. For each plan, PREPA developed a cost estimate using a production cost model⁶⁷ called PROMOD.⁶⁸ Each plan was run once through the model for each year of the 20-year planning period, 2016-2035. This step produced, for each of those 20 years, an evaluation of total production costs for the entire PREPA system.⁶⁹ The total system cost for the entire 20-year period, including capital expenditures, was determined on both a yearly and a net present value (NPV) basis (2016-2035) using a spreadsheet-based financial model.⁷⁰

⁶³ Revised IRP, Vol. I § 7-5.

⁶⁴ PREPA's Response to Question 2 of the Commission's Second Requirement of Information, January 12, 2016.

⁶⁵ *Id.* "Siemens established the proposed new resources and timing based on expert opinion and professional judgment to weigh numerous important criteria."

⁶⁶ Technically speaking, in electric system resource planning, resources can be selected either by a computer algorithm that seeks a specific least cost plan, or by subjective expert opinion (*i.e.*, manually). PREPA's IRP uses a manual selection process rather than a computer algorithm. As explained in Part IV(A)(1) below, only the former is appropriate for an IRP.

⁶⁷ Production cost models are tools that determine the optimal output of a given set of generating units in every hour (or sub-hourly period) within a specific timeframe (one day, one week, one month, one year, etc.). These models generally include a high level of detail on the unit commitment and economic dispatch of specific units, as well as on their physical operating limitations. They are not, however, designed to determine the optimal addition of new resources to meet future capacity requirements or the retirement of non-economic units.

⁶⁸ Revised IRP, § 8.

⁶⁹ Production costs include costs that vary with the amount of consumption. For PREPA, these costs include: fuel, operations and maintenance costs, emissions costs and power purchases. In non-island jurisdictions, production costs may also include energy market sales and purchases.

⁷⁰ The present value of PREPA's system costs is equivalent to what is referred to in other jurisdictions as "present value of revenue requirement" or PVRR. In other jurisdictions, a utility's calculation of revenue requirement may include both costs and revenues (for example, sales of excess energy or capacity to neighboring utilities). The revenue requirement is calculated as being "net" of spending and revenue and its present value is therefore referred to as a "net present value" ("NPV"). PREPA's calculation of system costs does not include any sources of revenue (for example, PREPA has no neighboring utilities to which it can sell energy or capacity). However, we refer to the present value of system costs as "NPV" for clarity as this is the

PROMOD outputs were also used to determine other system performance metrics, such as renewable curtailment levels,⁷¹ emissions, and "loss of load hours."⁷² Each plan was also tested with a transmission system planning model called PSS@E to verify whether transmission capacity was sufficient for each portfolio/future combination.⁷³

85. Out of its three proposed candidate portfolios, PREPA selected the portfolio called "Portfolio 3" (sometimes referred to as P3). PREPA proposed an "action plan," as required by this Commission, based on the resource plan represented by the combination of Portfolio 3 and the set of future assumptions called "Future 1." The Commission understands Future 1 to be PREPA's "base case": PREPA's view of what circumstances are most likely to occur in the future. The combination of Portfolio 3 and Future 1, also called "P3F1," is PREPA's preferred resource plan.

86. ***Fossil fuel vs. renewables and demand-side management:*** In its IRP filings, PREPA did not explicitly examine a tradeoff between new or existing fossil generation on the one hand and renewable energy or energy efficiency on the other. Rather, PREPA's IRP filings incorporated renewable energy to the extent required to satisfy its assumed RPS targets. Put another way, PREPA viewed renewable energy as a legal obligation to satisfy, rather than a resource that could compete with fossil-fired generation. PREPA also assumed that new renewable energy would involve a cost comparable to PREPA's currently held renewable energy contracts. The Revised IRP did not consider demand-side management—either energy efficiency or demand response—for peak reductions.

B. Detailed summary of portfolios, futures, and sensitivities

87. The Revised IRP presented three resource selection portfolios. These portfolios were tested under four sets of future assumptions,⁷⁴ as well as three sensitivities⁷⁵ on the

industry standard terminology and PREPA may conceivably include sources of revenue (such as wheeling charges) in future calculations of system costs.

⁷¹ As will be discussed in Part IV(D)(2) below, "curtailment" is necessary when the contracted-for renewable projects would (along with all other available generating units) provide more output than the customers' load. Because system stability requires constant equivalence of output and consumption, the utility must "curtail"—meaning, order some generators not to produce electricity.

⁷² Revised IRP, Section 8.

⁷³ While PREPA may have tested plans that did not provide minimum reliability or transmission adequacy requirements, these plans were not disclosed or discussed; nor did PREPA discuss how failing plans were modified to create plans that were reliable or adequate.

⁷⁴ PREPA's main scenario analysis included eleven sets of results instead of the twelve that would be expected if PREPA had tested every possible portfolio/future combination. PREPA did not test the combination of Portfolio 1 and Future 2 because it determined that this scenario was not realistically feasible.

⁷⁵ Sensitivities are targeted investigations meant to isolate the impact of varying one particular input factor on the outcome of an analysis.

preferred portfolio (*i.e.*, Portfolio 3 or P3). The Supplemental IRP created and tested an additional eight plans, all of which were based on a modified version of the P3 portfolio, and either of Future 1 (F1) or Future 2 (F2).⁷⁶ What PREPA called the "Updated Fuel IRP" does not present any new plans, but rather re-analyzes the costs of seven plans from both the Revised and Supplemental IRPs using updated fuel price forecasts.

1. Portfolios

88. The three portfolios used by PREPA represent different approaches to the selection of new thermal resources for providing generation during the planning horizon:⁷⁷

Portfolio 1 focuses on efforts to improve the operating characteristics of PREPA's existing resources, with only minimal additions of new units. New generation is added in the North in the form of three small (72 MW) CC units at Palo Seco, but generation at Aguirre and Costa Sur is repowered rather than replaced.⁷⁸

Portfolio 2 focuses on increasing operational flexibility through the addition of small combined cycle units, including three SCC-800 units in the North and five total 369 MW F-Class units as replacements for generation at Aguirre and Costa Sur.

Portfolio 3 focuses on using only larger capacity units, placing one F-Class unit in the North and replacing generation at Aguirre and Costa Sur with four 393 MW H-Class units. PREPA also developed a "modified" version of Portfolio 3 that includes increased energy efficiency, three SCC-800 units in the North, and three H-Class units at Aguirre and Costa Sur.

The specific resource makeup of these portfolios, in terms of the timing and locations of resource additions, varied in the different futures.⁷⁹ For example, Portfolio 2, while focusing on smaller combined cycle units, makes different recommendations for the retirement and/or replacement date of Aguirre and Costa Sur Steam Units, depending on

⁷⁶ Plans included in the Supplemental IRP include an "M" in the name of the plan to denote that both the portfolio and the future have been "modified" as compared to those in the Revised IRP. For example, the plan based on modified Portfolio 3, modified Future 1 in the Supplemental IRP is referred to as "P3MF1M."

⁷⁷ Revised IRP, Vol. I, Section 7, at 7-1.

⁷⁸ "Repowering" in this context is the process of replacing or upgrading existing generators with new turbines. Siemens assumed that this process would improve a unit's heat rate, reduce operations and maintenance costs, improve the ability of the unit to ramp effectively, and reduce forced outages.

⁷⁹ Revised IRP, Vol. I, Section 7, at Table 7-2, Table 7-3, and Table 7-4.

the future considered.⁸⁰ All plans examined by PREPA in the Supplemental and Updated Fuel IRP are based on Portfolio 3.

2. Futures

89. PREPA developed plans based on each portfolio for four sets of input assumptions. These sets of inputs assumptions are called "Futures."⁸¹ These Futures represent variations in factors that PREPA assumed are not under its direct control. Specifically:

Future 1: AGOP is built in the beginning of the 20-year planning horizon,⁸² *i.e.*, 2015.⁸³ The Commission understands this Future to be PREPA's "base case."⁸⁴

Future 2: AOGP is not built. This Future assumes a different natural gas price forecast than Future 1's forecast but the same load forecast and cost of capital.⁸⁵

Future 3: AGOP is built. Gas becomes available in the North starting in 2022, and is used to fuel any new generating units. While PREPA discussed several alternative methods by which gas could be delivered to the North,⁸⁶ it included no particular method in Future 3.⁸⁷ This Future assumes the same load forecast, fuel price forecasts, and cost of capital as Future 1.⁸⁸

⁸⁰ Revised IRP, Vol. I, Section 7, at Table 7-3.

⁸¹ Revised IRP, Vol. I, § 6.

⁸² While AOGP is, in part, under PREPA's direct control, PREPA considered the fate of the port outside of its control because of permitting and counter-party risk.

⁸³ PREPA's proposed dates and timelines in the Revised IRP and all subsequent versions are based on an IRP approval date of July 2015 or earlier. PREPA did not update its timelines or milestone dates. The dates discussed in the Revised, Supplemental, and Updated Fuel IRPs are therefore not realistic. The Commission addresses this issue in its directives to PREPA. See Parts VI and VII below.

⁸⁴ Revised IRP, Vol. I, Section 6.1.

⁸⁵ Revised IRP, Vol. I, Section 6.2.

⁸⁶ Including a north-south pipeline, a gas terminal in the North, and delivery of LNG by shipping containers. Revised IRP, Vol. I, § 5.

⁸⁷ Therefore, in calculating system costs under this future, PREPA did not include the costs of any additional gas infrastructure.

⁸⁸ Revised IRP, Vol. I, Section 6.3.

Future 4: AOGP is built but PREPA assumes a lower demand and increased distributed generation, both resulting in moderately lower requirements for capacity and generation. This Future assumes the same fuel price forecasts and cost of capital as Future 1.⁸⁹

In the Supplemental and Updated Fuel IRPs, all plans examined by PREPA were based on Futures 1 and 2.

3. Sensitivities

90. PREPA explored a number of sensitivity cases assessing the impact of the RPS, resource choices, the impact of demand response, and the renewal of PREPA's long-term PPOAs. The sensitivity cases were all modified versions of Portfolio 3. They reviewed fuel availability and demand based on assumptions in Futures 1 and 2.⁹⁰ These sensitivity cases varied PREPA's base case by changing single input decisions PREPA will face in the coming years. PREPA's main scenario analysis assumed, for example, that none of the candidate resource portfolios would comply with the full RPS requirement.⁹¹ PREPA included several sensitivities to test the impact of varying levels of RPS compliance, ranging from freezing the level of renewable penetration at present-day levels to full RPS compliance. PREPA also tested a case in which no incremental renewables were required,⁹² and a case in which full RPS compliance was assisted by load-shifting from demand response programs.⁹³ Sensitivities were also included to test variations in PREPA's resource selection, by replacing assumed new small combined cycle units in the North with reciprocating engines or by reducing the amount of new generation at Aguirre.⁹⁴ In addition, PREPA used a range of sensitivities to test the cost-effectiveness of its Purchased Power Operating Agreements (PPOAs) with EcoEléctrica and AES, based on the scenario in which AOGP is available and the scenario in which it is not.⁹⁵

⁸⁹ Revised IRP, Vol. I, Section 6.4.

⁹⁰ Revised IRP, § 8. Supplemental IRP, § 8. Updated Fuel IRP, § 8 & 9

⁹¹ Revised IRP, Vol. I, Section 4, p. 2.

⁹² Revised IRP, Volume I, Section 9.2.

⁹³ Supplemental IRP, Section 8.7.

⁹⁴ Revised IRP, Volume I, Section 8.2.

⁹⁵ Revised IRP, Volume I, Section 9.3.



IV. SHORTCOMINGS OF PREPA'S PROPOSED IRP

91. This IRP represents PREPA's first attempt at structuring a long-term resource plan subject to Commission oversight. While the Commission's requirements may be new to PREPA, the tools and methods for implementing electric resource planning are standard, well-documented industry practices.⁹⁶ In the continental United States, 33 states have rules or regulations requiring an IRP.⁹⁷ Multiple organizations have discussed best practices in long-term planning.⁹⁸ All this information was available to PREPA and Siemens.

92. Despite the availability of this information, PREPA's proposed IRP had multiple flaws, in seven categories: modeling framework; fuel, price and capital sensitivities; sharing of model and workpapers with the Commission and intervenors; demand-side resources; environmental compliance; renewable energy assumptions; and action plans. We address each of these problems here.

A. Modeling: Tools and techniques

1. Substitution of production cost model for capacity expansion model

93. Our IRP Rule requires:

PREPA shall use a Capacity Expansion Model or similar model structure to develop least cost resource plans that meet customer needs under the reference case scenario and various future scenarios.⁹⁹

⁹⁶ See, for example, Wilson, R., and Biewald, B. (2013) *Best Practices in Electric Utility Integrated Resource Planning Examples of State Regulations and Recent Utility Plans*. The Regulatory Assistance Project. www.raonline.org.

⁹⁷ U.S. E.P.A., 2015. *Energy and Environment Guide to Action*, Chapter 7.1 (Electricity Resource Planning and Procurement).

⁹⁸ See, for example:

- *Id.*
- Wilson, R., and Biewald, B. (2013) *Best Practices in Electric Utility Integrated Resource Planning Examples of State Regulations and Recent Utility Plans*. The Regulatory Assistance Project.
- Binz, R., Sedano, R., Furey, D., and Mullen, D. (2012). *Practicing Risk-Aware Electricity Regulation: What Every State Regulator Needs to Know*. CERES and The Regulatory Assistance Project.

⁹⁹ IRP Rule § 2.04(B)(2)(a).

94. In electricity system planning, the phrase "capacity expansion model" has a standard definition. Its use is standard practice. It is a model capable of automatically choosing among multiple resource options to find a least-cost, or near least-cost, portfolio of resources—a portfolio that meets customer requirements and other constraints. "Least cost" is defined as lowest net present value of revenue requirements. To eliminate any doubt, the Commission defined "capacity expansion model" in the IRP Rule.¹⁰⁰ Our consultants reiterated this definition to PREPA, in detail, during the Technical Conference Call.¹⁰¹

95. Similarly, U.S. EPA's *Electricity and Environment Guide to Action* (2015) describes the centrality of capacity expansion models to the IRP process:

IRPs are designed to produce a single "preferred" set of resources to serve customer requirements, including new resources, changes to existing resources, and demand-side resources expected to be required over the planning period. Capacity expansion modeling typically results in one or more sets of suitable resource mixes for a utility—i.e., resources that meet customer requirements and, under some set of circumstances, are least cost. Further analyses of these resource mixes, which examine total cost, risk and uncertainty, and (sometimes) rate impacts, produce a single preferred portfolio. Portfolios are evaluated under different scenarios, which represent distinct policy or risk outcomes, and different sensitivities, which represent uncertainty around specific input variables.¹⁰²

96. Instead of using a capacity expansion model, PREPA relied on PROMOD, which is a production cost model, not a capacity expansion model. The distinction is critical, and well-understood in the electricity industry. A capacity expansion model is capable of selecting resource options (given a set of constraints) that meet customer needs over a long period of time (*e.g.*, twenty years). A production cost model, in contrast, is capable only of

¹⁰⁰ IRP Rule § 1.08(B)(4). Utility-scale capacity expansion models are tools that determine the optimal (i.e., least-cost) generation capacity expansion in order to meet an expected future demand level and comply with a set of regional/state specifications (*e.g.*, reliability requirements, renewable portfolio standards, CO₂ emissions limits). They are designed to choose the best combination of specific new resources (and/or retirements) to meet a least cost criterion. These programs are able to resolve the dynamics of specific individual generating units. In contrast, "regional" scale capacity expansion models often cluster similar unit types, may not distinguish as many transmission constraints, and model fewer hours of the year. For more information on the differences between model types, see Fischer, J., Santen, N., Luckow, P., de Sisternes, F., Levin, T., and Botterud, A., *Guide to Clean Power Plan Modeling Tools: Analytical Approaches for State Plan CO₂ Performance Projections*, (2016), available at <http://www.synapse-energy.com/sites/default/files/Guide-to-Clean-Power-Plan-Modeling-Tools.pdf>.

¹⁰¹ Technical Call between the Commission consultants and PREPA, with stakeholder attendance, December 22, 2015.

¹⁰² U.S. E.P.A., *Energy and Environment Guide to Action* (2015), Chapter 7.1: Electricity Resource Planning and Procurement. Available at <https://www.epa.gov/statelocalclimate/energy-and-environment-guide-action>.

determining detailed generation dispatch, and only for a specific period of time (*e.g.*, one week, one year), given a predetermined set of generators, prices, operating constraints and hourly demand.¹⁰³ The production cost model used by PREPA *has no capability to select, objectively, appropriate new resources or choose to retire non-economic units consistent with a least-cost constraint.* Yet that is the very purpose of an IRP.

97. In 2014, PREPA commissioned the Leidos firm to produce a "First Stage IRP," which was not submitted as part of PREPA's the initial IRP submission. This First Stage IRP was developed using the STRATEGIST® capacity expansion model.¹⁰⁴ That IRP analyzed eleven different scenarios, including a base case.¹⁰⁵ Only after they emerged from the capacity expansion model were the portfolios analyzed under the PROMOD production cost model—for purposes of arriving at detailed yearly estimates of unit operations and costs. Leidos's analytical procedure would have complied with the Commission's requirement to use a capacity expansion model. That is not what happened in PREPA's IRP. Siemens simply "reviewed" the First Stage IRP, and then it manually developed plans based on its analysts' judgment.¹⁰⁶ These subjectively derived plans were analyzed with the PROMOD production cost model. PREPA's method can be described as a heuristic approach¹⁰⁷ rather than a rigorous approach. As such, it is inappropriate under our IRP Rule.

98. Production cost models are appropriate for certain purposes. Where a *specific resource decision* with a limited set of possible alternative options is being tested, a production cost model can determine the generation-related costs of each option with a high degree of detail, thus comparing apples to apples. A production cost model is also

¹⁰³ To explain in more detail: A production cost model determines the optimal output of a *specified set* of generating units over a specific time period (one day, one week, one month, one year). The model optimizes unit-specific generation from a pre-determined set of units within time blocks of a given length. Normally, hour-long time blocks are used. These models usually include a high level of detail on the unit commitment and economic dispatch of specific units, as well as on their physical operating limitations. They are not, however, designed to determine the optimal addition of *unspecified new resources* to meet future capacity requirements or to replace retiring non-economic units.

¹⁰⁴ PREPA's Response to Question 2 of the Commission's Second Requirement of Information, January 12, 2016.

¹⁰⁵ First Stage IRP, Table ES-1.

¹⁰⁶ PREPA's Second Information Submission and Answers to Request for Production of Documents, Question 3, January 2016: "PREPA uses the capacity expansion optimization modeling software Strategist® for long term planning. PREPA has not experienced load growth since 2006, thus no generating system adequacy studies have been required lately. The First Stage IRP of November 28, 2014 included a representation of the PREPA system in Strategist®. The Strategist® model was used to develop the capacity expansion plan for each of the three base case variations, as explained in the First Stage IRP report."

¹⁰⁷ A heuristic approach is any approach to problem solving, learning, or discovery that employs a practical method not guaranteed to be optimal or perfect, but sufficient for the immediate goals. As such, it would be inferior to a capital expansion model that is designed to obtain optimal scenarios.

appropriate for examining the costs and operations of a known set of resources under different conditions. But in cases where there are *many complicated, inter-related decisions involving multiple resource candidate choices*, such as the retirement of resources, new construction requirements, and high uncertainty in demand, fuel prices, capital constraints, and emissions constraints—precisely PREPA's situation—a production cost model is insufficient.

99. We explained above that Siemens's use of PROMOD required it to select several key modeling variables "manually"—variables like the dates in which existing generators would retire; and which units, or combinations of units, could be built in the alternative. Unless Siemens's employees tested an extraordinarily large number of portfolios (numbering in the hundreds, or more), it is nearly impossible for them to have identified a portfolio of options that is optimal, *i.e.*, that minimizes the cost to consumers. A capacity expansion model, in contrast, is able to make those decisions on the basis of objective constraints, like cost and reliability, and not on the basis of human judgment. The capacity expansion model can make those judgments by simultaneously testing hundreds or even thousands of combinations to find optimal outcomes.

100. Because the production cost approach necessarily leaves numerous options unidentified, and therefore untested, PREPA's failure to use a capacity expansion model left it, and the Commission, unable to evaluate, rigorously and transparently, whether a given plan minimizes cost to consumers. An IRP Best Practices guide specifically calls out this deficiency:

It is important that the integrated model does not inadvertently exclude combinations of options that deserve consideration ... [such as] in the instances that future resource portfolios are user-defined, rather than selected by an industry model.¹⁰⁸

101. Highlighting the impact of this deficiency was PREPA's inability to provide, in a timely manner, portfolios responsive to different load requirements or fuel prices. PREPA insisted, during the Technical Conference Call,¹⁰⁹ that its modelers would continue modeling Portfolio 3 (rather than allow the model to create a series of optimal portfolios). It contended that additional modeling requirements under the Commission's December Order¹¹⁰ could take upwards of 2,000 hours and six to eight months to produce.¹¹¹ If that

¹⁰⁸ Wilson, R and B. Biewald, *Best Practices in Electric Utility Integrated Resource Planning: Examples of State Regulations and Recent Utility Plans* (2013), available at <http://www.raponline.org/document/download/id/6608>.

¹⁰⁹ Technical Call between the Commission consultants and PREPA, with stakeholder attendance, December 14, 2015.

¹¹⁰ Commission Order. (December 8, 2015). The Order required PREPA to file additional materials and additional modeling runs.

statement is true, it is true only because PREPA failed to comply with the Commission's requirement to use a capacity expansion model. A standard capacity expansion model would not require nearly as much effort, because its very purpose is to analyze (*i.e.*, estimate the cost of), simultaneously, many different resource scenarios.

2. Reliability criteria in PREPA's IRP

102. A key constraint on electricity planning is reliability. Lights must stay on. To maintain reliability, resources must exceed load at all times, so that if some part of the system becomes unavailable, or if load exceeds the level predicted, there are resources available to make up the difference. All utilities must therefore maintain enough capacity to meet peak demand plus a buffer. This buffer is called a planning reserve margin.

103. The IRP Rule requires PREPA, in its planning and system modeling, to propose and use a planning reserve margin.¹¹² It is standard practice for utilities to set their reserve margins using a resource adequacy assessment. In that assessment, the utility tests its system's sufficiency under various hypothetical stressed conditions. These tests determine how much surplus capacity must be available to keep the lights on. A planning reserve margin assessment would have provided the Commission a standard industry benchmark with which to assess the purpose, value and timing of PREPA's resource choices.

104. Instead of complying with the Commission's requirement to use a planning reserve margin, PREPA used PROMOD to calculate potential future loss of load hours ("LOLH"). LOLH is, we acknowledge, a proxy reliability measure. It states the number of hours in which the utility's system is unable to meet customer demand. PREPA identified a threshold of four (4) LOLH per year, above which they would consider the system to have insufficient generation capacity.¹¹³ PREPA's consultants then adjusted plans until they met the LOLH threshold.

¹¹¹ PREPA's Motion to Reconsider the December 4, 2015 Order as Modified by the January 28, 2016 Order. (2,080 hours, 22-24 weeks, paragraphs 13-14); PREPA's Motion to Reconsider the December 4, 2015 Order on IRP Compliance and Intervenor Comments. December 24, 2015. (7 months to complete, plus one month to negotiate contract, paragraph 13).

¹¹² IRP Rule § 2.03(B)(4).

¹¹³ PREPA's IRP neither discussed nor explained its choice of four (4) LOLH per year as the reliability constraint. There are, however, multiple references to this value; *i.e.*, references implying that portfolios were designed to keep LOLH at or below four hours per year. Revised IRP, Section 8.3.3. ("Of these years only FY 2022 exceed significantly the target of 4 hours, with 9 hours reported, and it was investigated further"); Revised IRP, Section 8.4.3. ("As before only in 2022 the threshold of 4 hours was exceeded and further investigation indicated that it was due to multiple unit outages."); and Revised IRP Section 8.10.3 ("The portfolio performs well in terms of reliability with zero loss of load hours in most years and always at or below the threshold of 4 hours."). We note that the four hour per year is substantially less stringent than the "one day in ten year" standard used by many reliable authorities.

105. LOLH is not necessarily an inappropriate measure of reliability, but it does not meet this Commission's requirement to produce a transparent planning reserve margin assessment. In addition, PREPA's use of the LOLH metric was flawed, rendering the metric far less useful.

106. First, in the real world, loss of load hours are caused by forced outages at major generating units, transmission system faults, or a combination thereof. These circumstances arise randomly; they do not follow a fixed, predicted or predictable schedule. When conducting a modeling-based analysis, it is possible to capture the effects of this randomness by using "stochastic" modeling that can vary key factors according to a statistical representation of randomness. By performing a sufficient number of stochastic modeling runs, a robust conclusion can be reached about a system's response to random events.

107. PREPA did not use the production cost model in a stochastic framework.¹¹⁴ Instead, PREPA's modeling assumed a single pre-determined schedule of forced outages. The outcomes generated by the modeling, therefore, are only those outcomes that would occur given forced outages all occurring exactly on the schedule used by PREPA.¹¹⁵ But as noted above, in the real world forced outages are random and unpredictable. The results of a single model run are therefore insufficient to indicate the number of loss of load hours that would occur in any given year under a particular resource plan.¹¹⁶ If PREPA had run the model with multiple stochastic runs, it may have provided a more robust indication of the years in which chronic shortages are present. But PREPA did not.

108. Second, by failing to assess the tradeoff between achieving a certain LOLH and the cost of unserved energy, PREPA failed to determine if the LOLH measure was derived reasonably. PREPA's LOLH analysis did not compare the benefit of increased reliability to the cost of adding generation necessary to produce that benefit. Nor did PREPA provide support for its choice of a reliability metric. Benefit-cost comparison is a necessary feature of planning—even for something as important as reliability. In those years when PREPA's model forecasts more than zero LOLH, the total amount of energy not served is small – less than one-hundredth of one percent of annual energy. To keep LOLH below four hours per

¹¹⁴ PREPA's First Information Submission and Answers to Request for Production of Documents, Response to 29(c), October 2015.

¹¹⁵ Because forced outages occur randomly, chronological production cost models typically choose a randomly generated "schedule" of outages that meets the statistical expectation (i.e. number of outage hours per year). When used to assess reliability, as in PREPA's case, these models are typically run many times with randomly drawn forced outage schedules. PREPA ran the model only once.

¹¹⁶ For example, it is possible that the forced outage schedule in this single model iteration fails to coincide with any peak customer demand period, thus falsely indicating that PREPA maintains reasonable capacity. It is equally possible that the forced outage schedule in this single model iteration coincides perfectly with peak demand, thus overemphasizing the potential of outages and requiring PREPA to unreasonably hold excess capacity.

year, PREPA sometimes had to add to its resource plans substantial and costly generating capacity. Since PREPA never stated the value of a LOLH (*i.e.*, the cost to customers of forgoing electricity for that hour), PREPA could not know whether the cost of the new generation necessary to keep LOLH below four hours per year is justified by the benefit to consumers.

3. Siemens's role

109. The PREPA IRP was written and constructed almost entirely by Siemens PTI. During the Technical Conference Call, Technical Hearing, and Oral Argument, the majority of responses and explanations were provided by employees of Siemens.¹¹⁷ Discovery responses were often provided by Siemens, rather than PREPA. We infer from these facts, as well as from explicit discussions in the IRP¹¹⁸ and discovery responses,¹¹⁹ that numerous decisions and assumptions in the IRP were informed by Siemens rather than PREPA.

110. Siemens PTI was familiar with PREPA's system because it had provided transmission planning and renewable integration consulting to PREPA in the past.¹²⁰ So it was logical for Siemens PTI to bid on conducting PREPA's IRP analysis. But Siemens PTI is owned by Siemens AG, which is also the parent company of a manufacturer of generating units. A key purpose of an IRP is to determine the need for and type of generating units. The purpose of a least-cost resource planning process is to minimize system costs over the long term. The process must be impartial, relative to the specific resources or manufacturers of generation or demand resources. The typical approach, therefore, describes resource options in generic terms only. While the characteristics of generic resources should be informed by real industry data, a choice of specific manufacturers or project specifications is typically considered only after generic resource choices have been selected; *i.e.*, after the IRP process is concluded. Where the consultant conducting resource planning has a business interest in resource selection, there is risk of bias, intentional or unintentional. That risk rises when the modeling technique used by the consultant involves subjectivity. Given that risk, it is especially important for the utility that hires the consultant to oversee the consultant and inject its own independent judgments. Utility deference to a consultant with a potential for bias is not a prudent practice.

111. In this IRP, Siemens was involved in the selection of both methodology and resources – a role especially influential given PREPA's lack of IRP experience. And its

¹¹⁷ As noted in Part III above.

¹¹⁸ For example, Revised IRP, Vol I, Sections 3.2.3, 3.2.4, and 3.2.5.

¹¹⁹ PREPA's Response to Questions 2 and 3 of the Commission's Second Requirement of Information, January 12, 2016.

¹²⁰ PREPA's Response to Question 1 of the Commission's Second Requirement of Information, January 12, 2016.

analysis did not speak solely in terms of generic units. Rather, it described specific units manufactured by Siemens, along with those of several other companies.¹²¹ PREPA conducted a screening study that included turbines from seven manufacturers,¹²² including Alstom, GE, Hitachi, MHI, Rolls-Royce, and Wärtsila, in addition to Siemens. But the thermal resource selection process conducted by Siemens PTI reviewed closely only three options: one from GE and two from Siemens technologies.¹²³

112. We acknowledge that Siemens's witness asserted that the consulting arm of Siemens was "independent" of the manufacturing arm. However, both arms are commonly owned.¹²⁴ At a time of deep citizen concern about PREPA's rates and performance, perceptions of bias or favoritism matter. If and when PREPA seeks to purchase new generation equipment, the Commission will require, and will ensure, that PREPA's process for procurement is competitive and objective.

B. Sensitivities: Variations in fuel price, load and capital

113. The IRP Rule required that PREPA consider a range of uncertainties—not only in load forecasts,¹²⁵ but also in such factors as economic conditions, customer generation, fuel prices and construction costs.¹²⁶ PREPA was required to "identify key factors that will influence the most important forecasts ... and develop a range of possible outcomes for those forecasts encompassing at least the 5th and 95th percentile outcomes as understood by the utility."¹²⁷ PREPA had to "develop a group of scenarios that encompass the

¹²¹ Revised IRP, Vol. I, p. 3-17.

¹²² Revised IRP, Vol. I, Table 3-12.

¹²³ Revised IRP, Vol. I, Table 3-3. It does not appear that either the reciprocating engines or the GE LM6000PG SPRINT SC units were actually considered in the plan development process. Revised IRP at Vol. I, p. 8-11: "Given that for Future 1, the results with the SCC-800 and the Wärtsila reciprocating engines are very similar, it is recommended that the reciprocating engines be discarded as an option for the IRP purposes and the analysis focus on the SCC-800 for Portfolio 1 and 2." The SPRINT unit is never discussed in the context of plan development.

¹²⁴ Siemens PTI is a part of the Siemens Smart Grid Solutions and Services division, which itself falls under the Energy Management wing of Siemens. (<http://w3.usa.siemens.com/smartgrid/us/en/transmission-grid/consulting-and-design/Pages/consulting-and-design.aspx>). This wing is separate from the Power and Gas wing, which is responsible for the manufacturing of generating units. (<http://www.siemens.com/about/en/businesses/power-and-gas.htm>). However, both wings are part of the parent company, Siemens AG (<http://www.siemens.com/press/pool/de/homepage/Siemens-company-presentation.pdf>).

¹²⁵ IRP Rule § 2.03(B)(2)(c).

¹²⁶ IRP Rule § 2.04(B)(1).

¹²⁷ *Id.*; A 5th percentile outcome is a forecast well below PREPA's estimate of the most likely future outcome. It is defined as being so low that PREPA believes there is only a five percent chance that the actual outcome will fall below this value. In contrast, the 95th percentile outcome means that PREPA believes there is only a

reasonable range of possible outcomes for uncertain forecasts,"¹²⁸ so as to "create a sufficient number of scenarios to both describe feasible or likely sets of forecasts, as well as capture a wide range of more extreme risks."¹²⁹ The Rule then required PREPA to use these various future scenarios in developing the resource plans.¹³⁰ These requirements reflect a fundamental feature of planning: To create a robust resource plan, the utility must understand how outcomes are affected by changes in key variables.

114. PREPA did not comply with these requirements. Its IRP explored an inappropriately narrow range of assumptions for fuel prices, customer load and capital availability. Yet each of these factors contributes significant uncertainty, particularly in PREPA's current context, as described in Part IV.B.1 of this Final Resolution and Order. By ignoring this requirement and thus limiting its analysis, PREPA precluded the Commission from assessing the appropriateness of different resource portfolios under a range of uncertainties, including how the utility's preferred portfolio fares (in terms of cost-effectiveness) under those uncertainties. Combined with PREPA's failure to use a capacity expansion model, this distinct omission rendered the Commission unable to assess alternative futures—including ones with a reasonable likelihood of occurring.

115. PREPA's IRP explored four "futures," described in Part III.B.2 above. These futures varied from each other by only a few factors: the presence or absence of AOGP, the provision of gas to the north of the island, and a "slightly lower load forecast."¹³¹ Relying on this framework as the sole means of varying input assumptions provided an inappropriately narrow range for three factors required under the Rule:¹³² gas prices, customer load, and capital availability. In the assessment, none of these factors was varied sufficiently to test the effects on PREPA's system of unexpected outcomes, which is one of the key goals of sensitivity analysis. Without this variation, we are unable to evaluate the risks posed to PREPA by high fuel prices, changes in load, or low capital availability. We are also unable to ascertain the robustness of PREPA's preferred portfolio with respect to variations in these factors. More detail follows.

five percent chance that the actual outcome will fall above this value. These values serve as lower and upper bounds, respectively, on uncertain estimates. Their purpose is to allow observers to understand the impact of a deliberately wide range of outcomes, and not just what PREPA believes to be the most likely outcome. While a result below the fifth or above the ninety-fifth percentile value is, by definition, very unlikely to occur, these bounds allow PREPA and observers to understand how the system might change or react at extreme ends of uncertainty.

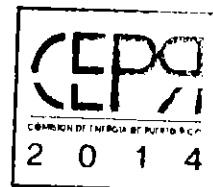
¹²⁸ IRP Rule § 2.04(B)(1)(c).

¹²⁹ IRP Rule § 2.04(B)(1)(c)(ii).

¹³⁰ IRP Rule § 2.04(B)(2)(a).

¹³¹ Revised IRP, pp. 1-3. (Section 1.2).

¹³² IRP Rule § Section 2.04(B)(1)(a).



1. Gas and oil cost variations in the 2015 IRP

116. PREPA's preferred resource strategy relied on construction of AOGP, subsequent conversion of existing oil-fueled units to run on natural gas, and construction of additional natural-gas fired units. PREPA viewed these actions as a low-cost option based on its assumption that oil prices will remain relatively high while gas prices will remain relatively low. However, as the multiple versions of PREPA's IRP revealed, the economic advantage of AOGP, compared to other resource choices, varied significantly with different fuel price assumptions. PREPA's fuel price assumptions were deficient in three ways: (a) PREPA relied only on a single fuel price forecast, (b) that forecast deviated substantially and without explanation from widely-used price forecasts produced by the U.S. Energy Information Administration (EIA), and (c) PREPA assumed that building AOGP would compel EcoEléctrica to lower the price of gas provided to Costa Sur. We discuss each problem here.

117. *The single forecast:* PREPA's initial submission relied on a single forecast of fuel prices, covering the period 2016 to 2035. Its consultants created one specific market price trajectory for each of the major fuels delivered to PREPA: diesel, heavy fuel oil, and natural gas. Neither PREPA nor PREPA's consultants provided any alternative fuel price forecasts, implying that there is *no uncertainty about what oil and gas prices will be for this entire 20-year period*. Yet the history of fossil fuel prices since 1973—in Puerto Rico, the United States and globally—has shown that oil and gas prices are not only volatile; they are prone to tremendous uncertainty. Fossil fuel prices are affected greatly, and often unpredictably, by changes in technology (such as hydraulic fracturing), regulations, and global supply and demand. Relying on only a single price trajectory for each fuel implies a certainty about costs that is not consistent with physical, technological and economic realities.

118. On June 5, 2015, PREPA asked the Commission to waive its requirement that PREPA "identify key factors that will influence the most important forecasts ... and develop a range of possible outcomes for those forecasts,"¹³³ including forecasts of fuel prices. PREPA argued that it could not obtain the necessary data because its "methodology" differed from what the Commission required. On June 26, 2015, we denied PREPA's request. We required that PREPA provide a range of possible outcomes for its forecasts. PREPA did not do so.

119. On March 21, 2016, PREPA said it had prepared a revised fuel price forecast (calling it a "Low Oil Price" scenario).¹³⁴ Whether one views this revised forecast as a replacement for the initial forecast, or instead as a second data point on a purported "range" of forecasts, the revised forecast did nothing to move PREPA closer to compliance

¹³³ PREPA Application for Waiver, June 5, 2015; Subsection 2.04(B)(1).

¹³⁴ PREPA's Response to Question 1(c) of the Commission's Fourth Requirement of Information, March 21, 2016.

with the explicit requirement to have a "range of possible outcomes for [fuel price] forecasts encompassing at least the 5th and 95th percentile outcomes." On April 13, 2016, the Commission ordered PREPA to file scenarios analyzed with this new fuel price forecast. On April 19, 2016, PREPA submitted its Updated Fuel IRP, testing several key scenarios with the lower fuel price projections. The results of these scenarios indicated a substantial reduction in the economic benefit of the AOGP project. This change in results underscored the necessity of testing a range of fuel price forecasts rather than relying on a single trajectory. PREPA's failure to assess multiple independent fuel price trajectories does not comply with our IRP rule,¹³⁵ is inconsistent with standard electricity resource planning practices, and constrains our ability to assess the cost, risks and uncertainties associated with PREPA's plan to build AOGP.

120. Alternative fuel price forecasts would have tested the robustness of PREPA's AOGP decision. The primary benefit of AOGP, PREPA has claimed, is the reduced spending on fuel that results from substituting natural gas for fuel oil at Aguirre, and by lowering the price of gas delivered to EcoEléctrica and Costa Sur (as we discuss below). The decision to replace fuel oil with natural gas is attractive when the price differential between the two is high. As oil prices fall, however, the economic benefit from the price differential falls also. This effect can be seen by examining three data points the Commission received to test the cost effectiveness of AOGP. In PREPA's unfiled First Stage IRP (November 28, 2014), the implied value of AOGP is approximately \$5.5 billion.¹³⁶ In the Revised IRP (July 7, 2015), the benefit of AOGP dropped to \$2.5 billion,¹³⁷ primarily due to falling fuel prices. The Updated Fuel IRP (April 19, 2016) showed a smaller AOGP benefit of only \$0.2 billion.¹³⁸ This repeated drop in the economics of AOGP demonstrates the purpose of creating fuel price sensitivities. PREPA's failure to use a range of fuel price forecasts, either initially or in its updates, made the purported support for AOGP unreliable, while precluding the Commission and intervenors from thoroughly assessing PREPA's resource decisions.

121. *The deviation from credible public forecasts:* As stated before, the fuel price forecast in PREPA's Revised IRP deviated substantially, without explanation, from widely-used price forecasts produced by the EIA, an independent analysis arm of the U.S. Department of Energy. EIA publishes its forecasts in the Annual Energy Outlook (AEO), a detailed assessment of U.S. energy markets and energy requirements. AEO forecasts are subject to public scrutiny, and are often used in the energy industry as a benchmark for

¹³⁵ IRP Rule § 2.04(B) states: "Forecasts should include exogenous elements *beyond the utility's control*" (emphasis added).

¹³⁶ This value represents the difference between a scenario optimized without AOGP in operation ("Status Quo") and one optimized with AOGP in operation. First Stage IRP, p. ES-13, Table ES-2. Scenario 3 (Status Quo + AOGP): \$49.3 billion NPV. Scenario 9 (Status Quo): \$54.8 billion NPV.

¹³⁷ Revised IRP, p. 1-7, Table 1-3. P3F1 (base): \$26.84 billion NPV. P3F2 (no AOGP): \$29.30 billion NPV.

¹³⁸ Updated Fuel IRP, p. 1-6, Table 1-4. P3MF1MFuel (base): \$22.70 billion NPV. P3MF2MFuel (no AOGP): \$22.92 billion NPV.

third-party forecasts. Deviations from AEO forecasts can be appropriate when explained and justified. But it is unusual to have private forecasts—here, produced by Siemens—deviate substantially from EIA's published data without explanation.

122. Following standard industry practice, PREPA derived its price trajectory for fuels delivered to Puerto Rico using two steps. First, PREPA determined a "fundamental" price trajectory that described the prices of fuels traded in commodity markets. Second, PREPA modified this fundamental trajectory to reflect the additional costs associated with its actual fuel purchases and delivery. PREPA's adders included shipping costs, infrastructure or "capacity" charges, and fees imposed by the "financial restrictions" on PREPA.¹³⁹

123. PREPA's forecast of prices for natural gas delivered to Puerto Rico is derived from trading prices at the "Henry Hub," which is a primary trading location in mainland U.S. For industry analysts and contracting parties, Henry Hub prices often form the basis for forward commodity contracts and fuel price forecasts. Market participants adjust these Hub prices to make predictions about regional prices. For example, in the region proximate to Henry Hub, delivered prices are similar to the Henry Hub price; in other regions the price may be higher or lower depending on the availability of local gas supply.

124. PREPA's forecast gas prices in both the Revised IRP and the Updated Fuel IRP were well below EIA's estimates. In the Revised IRP, PREPA's forecast of Henry Hub prices was \$1 to \$2/MMBtu, or about 30% below EIA's 2015 reference case forecast of the same Hub prices (see Figure 1).¹⁴⁰ In 2016, both PREPA and EIA revised their fuel price forecasts downwards: PREPA's Updated Fuel IRP later reduced the Henry Hub gas price forecast by roughly \$1/MMBtu. EIA published the 2016 "early release" report, which contained a forecast of gas prices that was itself approximately \$1/MMBtu below EIA's 2015 forecast, shortly thereafter.¹⁴¹ The updated fuel price forecast used by PREPA was therefore still roughly 30% below EIA's data.

125. PREPA's forecasts for oil prices, based on the fundamental price of a widely-traded crude oil grade known as "West Texas Intermediate," were consistent with EIA's 2015 report in the Revised IRP. However, PREPA's Updated Fuel IRP forecasted far lower oil prices over the long run, estimating prices anywhere from 30% to 40% below the more recent EIA estimates (see Figure 2).

¹³⁹ Revised IRP, Vol. III, pp. 2-15 through 2-16.

¹⁴⁰ AEO 2015. April 14, 2015. Report Number: DOE/EIA-0383(2015). Note: PREPA's Revised IRP was filed August 17, 2015.

¹⁴¹ AEO 2016 Early Release. May 17, 2016. Report Number: DOE/EIA-0383ER(2016). Note: PREPA's Updated Fuel IRP was filed April 19, 2016.

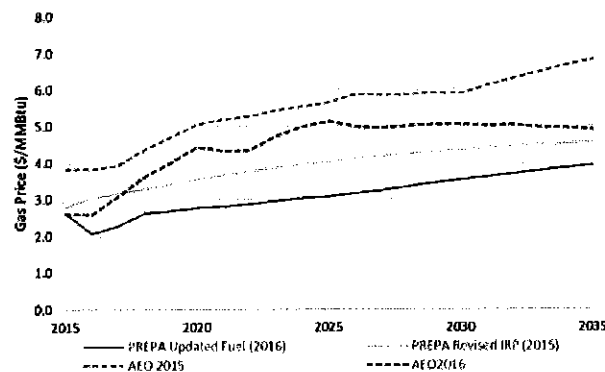


Figure 1. Henry Hub natural gas prices in PREPA 2015 IRP and AEO forecasts (\$/MMBtu)

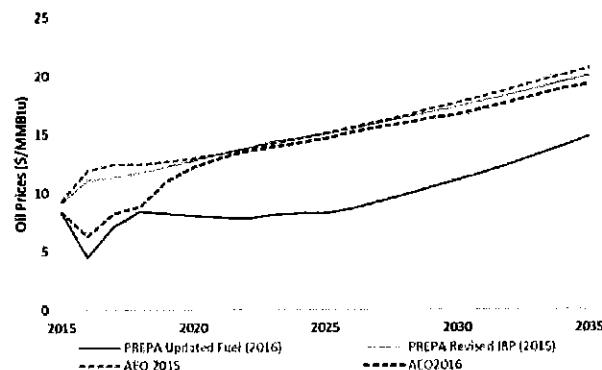


Figure 2. West Texas Intermediate oil prices in PREPA 2015 IRP and AEO forecasts (\$/MMBtu)

126. PREPA offered no explanation as to why its natural gas forecasts deviated so much from EIA's, despite stating that AEO 2015 forecasts were used "as a reference for validation of assumptions, analysis, and results."¹⁴² Since our discussion here focuses on PREPA's fundamental price forecasts and not its delivered price forecasts, the deviations cannot be explained by Puerto Rico-specific factors.

127. Because PREPA's resource decisions depend on its assumptions about future fuel prices, the significant deficiencies of its forecasts substantially undermine the credibility of its resource decisions.

¹⁴² Revised IRP, Vol. III, p. 2-9.

128. *The EcoEléctrica contracts:* EcoEléctrica sells PREPA two things: electricity produced by EcoEléctrica's combined cycle unit, and natural gas imported by EcoEléctrica and used by PREPA to fuel the Costa Sur plant. PREPA's payments for electricity produced at EcoEléctrica are based in part on the price of liquefied natural gas (LNG) delivered to the site. PREPA views the provisions of both contracts as unfavorable. PREPA estimates that it currently pays over \$9/MMBtu for gas delivered to Costa Sur, and over \$17/MMBtu for a portion of the gas burned at EcoEléctrica¹⁴³—prices that are three to five times higher than trading prices on the mainland. While some of this price differential is attributable to liquefied gas transport costs, much of the remainder is based on the structure of PREPA's contract with EcoEléctrica.

129. Based on the 2014 First Stage IRP,¹⁴⁴ PREPA initially assumed that with AOGP in place, competition from the new gas port would compel EcoEléctrica to reduce the premium charged to PREPA for natural gas consumed at the EcoEléctrica and Costa Sur plants.¹⁴⁵ Based on that assumption, PREPA attributed to the AOGP project fuel cost savings at Costa Sur and EcoEléctrica of 20% and nearly 60%, respectively.¹⁴⁶ PREPA thus viewed AOGP as the source of three benefits: reduced generation costs at Aguirre, and fuel cost reductions at Costa Sur and EcoEléctrica. Attributing these benefits to AOGP ignores the possibility that PREPA could gain the same or similar benefits by renegotiating the EcoEléctrica contracts. About that possibility, PREPA said nothing.

2. Load forecast variation in the PREPA 2015 IRP

130. PREPA used two different load forecasts in the Revised IRP. Future 1 through 3 are based on the same load forecast, whereas "Future 4 [of four total Futures considered by PREPA] assumes the lowest and most recent [of] PREPA's official gross load forecast, which shows a slight acceleration of the load decline."¹⁴⁷ This statement indicates that the main difference between the load forecast used in Futures 1 through 3—PREPA's "base" forecast— and the "lower" load forecast used in Future 4, is the dates on which these two

¹⁴³ See document labeled "Q3 Attachment.xlsx," provided in response to question 3 of the Commission's Fourth Requirement of Information. Note: As structured in PREPA's current PPOA with EcoEléctrica, PREPA is charged a higher price (\$17/MMBtu in mid-2016) for the portion of the gas burned by EcoEléctrica to fuel their generating unit when the unit is dispatched at more than a 76% capacity factor. Further explanation is provided in PREPA's responses to questions 3(b) and 4(a) of the Commission's Fourth Requirement of Information.

¹⁴⁴ First Stage IRP, pp. 4-9 through 4-11.

¹⁴⁵ PREPA asserted that this assumption constituted a test of variation in fuel price. As the prior sections make clear, an adjustment of contractual terms is not a variation in fuel prices. Fuel prices depend not only on company-specific circumstances but also on the global fuel market.

¹⁴⁶ First Stage IRP, pp. 4-9 through 4-11.

¹⁴⁷ Revised IRP, Vol. I, Section 6, pp. 4-5.

forecasts were prepared. PREPA explained during the Technical Hearing that in preparing its load forecasts, it used recent consumption data and measures of local economic activity. According to PREPA, forecasts prepared on two different dates will therefore vary somewhat from one another, because they rely on different input data. However, PREPA's description implies that their base and low load forecasts were prepared using the exact same methodology and assumptions.

131. Relying on forecasts from two different dates is not an appropriate approach to developing variation in forecasts. The IRP Rule directs PREPA to prepare load forecasts representing PREPA's "best understanding of expected circumstances," as well as low and high cases where load is "significantly below" and "significantly above" expectations.¹⁴⁸ Instead, PREPA's forecasts reflect PREPA's best understanding of expected circumstances at two different points in time. While the requirement to prepare low and high cases was waived for the purposes of this proceeding, we cannot accept PREPA's assertion that use of forecasts of two different vintages constitutes "variation" in the spirit of the IRP Rule. A reasonable range of assumptions about the circumstances that affect load, such as weather, penetration of distributed generation, or economic growth and industrial activity, is the appropriate way to capture the variation in load forecasts.

132. Meanwhile, PREPA's most recent forecast should have been used as the "base" forecast because it was based on the best and most current information available. Moreover, the "low" load forecast is not substantially lower than the outdated "base" forecast employed by PREPA in Futures 1, 2, and 3. At its lowest, the Future 4 forecast is 0.6% below the base case, and averages only 0.3% below the base case. Considering that the base load forecast itself anticipates a demand loss of about 5% by 2035, the fact that the "variation" in forecasts provides a range of only 0.6% means that the IRP did not, and cannot, test a variety of possible outcomes or capture the impact of more significant declines in load.

133. Therefore, we agree with the concern raised by multiple intervenors, that PREPA's low load forecast was not substantially lower than the "base" forecast,¹⁴⁹ since a substantially lower forecast could be justified, at the least, by the recent loss of population from Puerto Rico.¹⁵⁰ A lower forecast would reduce the need for some replacement capacity, while allowing PREPA to build smaller and/or more flexible units to replace non-compliant MATS units. Intervenor Consortium correctly pointed out that when PREPA incorporated an efficiency-reduced forecast in the Supplemental IRP, the Action Plan

¹⁴⁸ IRP Rule § 2.04(B)(2)(c).

¹⁴⁹ ELAC; ICSE-PR; MESA; Consortium.

¹⁵⁰ See, U.S. Census Bureau, Population Division, Annual Estimates of the Resident Population for Selected Age Groups by Sex for the United States, States, Counties, and Puerto Rico Commonwealth and Municipios: April 1, 2010 to July 1, 2015 (2016), <https://www.census.gov/popest/data/state/totals/2015/tables/NST-EST2015-01.xlsx>.

reduced the requirement for generation at Palo Seco from as much as 369 MW¹⁵¹ as 72 MW.¹⁵² Alternative (and lower) load forecasts could defer the need for incremental new capacity, reduce requirements during certain hours of the day, and change the amount of renewable energy needed to meet Puerto Rico's RPS requirements.¹⁵³ While the requirement to prepare both low and high cases was waived for the purposes of this proceeding, PREPA was still required to present a high load forecast case in addition to their base case.¹⁵⁴ Instead, PREPA presented only a low load forecast case. Even if we accept this deviation from the Commission's explicit instructions, which we do not, we cannot accept PREPA's assertion. PREPA failed to examine a substantially higher load forecast in its IRP, as explicitly directed by the Commission. Moreover, the "low" load forecast presented in the IRP did not differ substantially from the "base" load forecasts. PREPA's failure to incorporate any substantial variation in load forecasts for its IRP was a significant deficiency.

3. Capital availability uncertainty

134. As noted in Part IV(B)(3), PREPA faces constraints on its ability to raise capital. These financial constraints become planning constraints. To satisfy customer demand and comply with MATS, PREPA might need to lean unduly toward actions requiring less capital—actions such as choosing smaller, more modular units, substituting retrofits for new generation, buying power from independent power producers rather than financing its own construction, and enlisting customer-based generation. Under more favorable capital conditions, PREPA could rely on larger capital projects with extended payback periods. (We do not intend in this paragraph to favor one outcome over another; we do emphasize that a proper planning analysis must consider financial constraints.) Capital constraints did not enter PREPA's modeling mechanism with appropriate care. PREPA described Future 3, in which gas is assumed to be available in the North, as a scenario exploring "increased capital."¹⁵⁵ In this Future, PREPA assumed it would have "more access to capital"¹⁵⁶ and therefore spend more on capital projects (namely, the construction of new units). However, PREPA assumed the *cost* of that capital to be the same as in every other scenario.¹⁵⁷ This assumption is not a reasonable or industry-standard representation

¹⁵¹ In P3F1.

¹⁵² In P3MF1M.

¹⁵³ The RPS requires that PREPA supply a certain percentage of its sales with renewable energy, rather than mandating an absolute amount of energy per year. If PREPA's sales decrease, the amount of renewable energy needed to satisfy the percentages required by the RPS will therefore decrease as well.

¹⁵⁴ Commission Resolution on Waiver Request. June 25, 2015, Paragraph 2.

¹⁵⁵ Revised IRP, Vol. I, Table 6-1.

¹⁵⁶ Revised IRP, Vol. I, p. 6-5.

¹⁵⁷ In other words, Future 3 costs are based on the same discount rate as costs in Futures 1, 2, and 4.

of capital availability, which implies constraints on both the amount of money a utility is able to borrow and the interest rate the utility is charged by lenders. The cost of capital is a key factor in long-term planning because it determines the relative impact of near-term expenditures versus future expenditures. Given its current financial situation, PREPA should have made varied and explicit assumptions about both, the limits and the cost of capital, then determined how those constraints affected its resource options. PREPA failed to do so.

4. Conclusion on sensitivities

135. Claiming it had insufficient data to produce a range of forecasts, PREPA sought a waiver from its obligation to consider sensitivities. The Commission denied the request, warning that "PREPA's forecast will be evaluated on its merits."¹⁵⁸ PREPA still did not comply. This noncompliance prevented the Commission from assessing how each uncertainty could affect customers; and more technically, how robust PREPA's IRP decisions would be in response to uncertainties. In particular, the gap in analysis left the Commission unable to determine the economic value of AOGP – one of the more important short-term decisions facing PREPA today. This is not an acceptable outcome.

C. Provision of IRP model and workpapers to the Commission

136. Sections 2.04(B)(6)(a)-(c) of our IRP Rule require that PREPA provide:

- a) "Any computer model including the software and licensure necessary for the Commission, or its consultants, to independently run any analysis relied upon by PREPA,"
- b) "Copies of [proprietary programs or applications] must be provided to the Commission with explanations and instructions adequate to replicate the results," and
- c) "Workpapers ... electronically in native format. Electronic copies shall be clearly legible and complete. All formulae and viable links shall be left intact for all electronic files."

137. PREPA did not provide workpapers with its IRP, nor provide access to its modeling tools. PREPA instead sought waivers of items (a) and (b) above, stating that the models used were "proprietary," and that the required information was "critical energy infrastructure information" ("CEII") protected by rules of the U.S. Department of Homeland Security. A third argument was that the Commission had no need to replicate the models

¹⁵⁸ Commission Resolution on Waiver Request, June 25, 2015, Paragraph 18.

because the modeling work was done by licensed engineers.¹⁵⁹ The Commission denied PREPA's request for waiver.¹⁶⁰

138. Providing regulators access to proprietary IRP models and associated data is a common electricity industry practice. In multiple jurisdictions, regulators require and intervenors request confidential access to utility data, workpapers and modeling files. For example, the Georgia Public Service Commission (GPSC) requires that Georgia Power Company provide, as part of its IRP filing, full, working copies and licensures to all models used. The GPSC's staff then uses those models to test the utility's plan against the GPSC's requirements. Similar commission access is standard practice in rate cases, proceedings for approval of infrastructure investments (such as Certificates for Public Convenience and Necessity), EPA lawsuits relating to New Source Review, state-level pricing proceedings under Section 210 Public Utility Regulatory Policies Act of 1978, fuel procurement investigations and issuances of requests for proposals for new power supply. Where the proprietary model licenses are not provided or otherwise available, intervenors and staff acquire licenses to utility models and are provided modeling data through discovery responses. To protect proprietary status, intervenor and staff routinely sign non-disclosure agreements. Here, the Commission's denial of PREPA's request for waiver was consistent with standard industry practice.

139. As for critical energy infrastructure information, PREPA's primary IRP document contained little. The PROMOD model contained no information typically considered CEII (the location of critical infrastructure, or information leading to the ability to disrupt energy production). PREPA may have components of CEII data in transmission models, but should have identified specific information believed to be CEII and cooperated with the Commission to ensure that the information went only to authorized individuals under conditions that protected the information. There was no need to over-designate information as CEII or withhold it from properly authorized experts.

140. Nor did PREPA's workpapers or financial model deserve the secrecy PREPA sought. The Commission required access to the model, with all formulas and links intact, so its experts could examine PREPA's assumptions and calculations, scrutinize specific decisions, and test a range of assumptions and variables. PREPA did not comply. PREPA instead provided a version of the financial model for only a limited number of scenarios. In numerous instances PREPA had pasted into the model information from other locations, with no indication of their source or derivation. Furthermore, as new information became available from PREPA, the Company did not update either its discovery responses or its model runs. This resistance to ordinary discovery practices caused the Commission unnecessary expense and time. PREPA neither requested nor received a waiver of the relevant regulation (Section 2.04(B)(6)(c) of the IRP Rule), and failed to follow its

¹⁵⁹ PREPA Application for Waiver, June 5, 2015.

¹⁶⁰ Commission Resolution on Waiver Request, June 25, 2015. Paragraph 23.

requirements. PREPA also failed to follow the requirements of Sections 2.04(B)(6)(a) and (b), despite the fact that the Commission had denied its request for waiver of those sections with a detailed explanation.

141. The Commission was not the only entity concerned and impeded by PREPA's behavior. The Consortium, ICSE-PR, and others persuasively described the costs and inconveniences to them. The Commission invites all parties to propose procedures, standards and consequences the Commission can use to induce PREPA to create the internal culture that will result in cooperation during future Commission proceedings. Active, vigorous, efficient participation by intervenors will benefit the Commission, the public, and PREPA.

142. To ignore a Commission order, or dismiss it as unnecessary, and to ignore or seek waiver of standard rules, are unacceptable behaviors. They are disrespectful of the Commission and the public interest, and counterproductive to PREPA's own goals, which depend on favorable decisions from a Commission that trusts its utility. Leaving the Commission (and the public) in the dark is no way to gain trust.

D. Demand-side resources

143. Any competently prepared IRP must consider demand-side management ("DSM")—a way of influencing customer behavior to reduce the need for more expensive supply-side infrastructure. Act 57-2014 and our IRP Rule thus require PREPA to consider DSM—energy efficiency programs, demand response programs, and distributed generation—throughout the IRP process.¹⁶¹ Among other filing and modeling requirements, DSM is built into our rule's definitions of Integrated Resource Plan,¹⁶² Resource Plan,¹⁶³ and Capacity Expansion Model.¹⁶⁴

144. Except for a superficial treatment of distributed generation, both the Draft IRP and the Revised IRP ignored DSM's potential. Instead, PREPA asked the Commission to waive nearly all DSM-related requirements, saying it could provide only an implementation strategy but could not assess how DSM might affect the capacity expansion plan. The Commission granted these waiver requests, except for requiring a description of existing DSM programs.¹⁶⁵ The Draft and Revised IRPs thus do not address the effects, existing and potential, of DSM, outside of a previously-mandated, small-scale energy efficiency program

¹⁶¹ IRP Rule § 1.08(B)(9).

¹⁶² IRP Rule § 1.08(B)(20).

¹⁶³ IRP Rule § 1.08(B)(35).

¹⁶⁴ IRP Rule § 1.08(B)(4).

¹⁶⁵ IRP Rule § 2.03(B)(7); Commission Resolution on Waiver Request, June 25, 2015. Paragraph 11.

addressing consumption by governmental entities. The Revised IRP does include a rough calculation for potential savings associated with a commercial lighting program,¹⁶⁶ a brief note that efficient appliances may offer savings,¹⁶⁷ and three sentences regarding the potential implementation of DSM through rebates, financing, and customer education.¹⁶⁸

145. PREPA did evaluate different levels of distributed generation, including how it might affect the distribution network. But neither energy efficiency nor demand response was explored until the Supplemental IRP—and then only as a result of the Commission's December Order.¹⁶⁹ More detail follows.

1. Energy efficiency

146. Energy efficiency includes a range of techniques, technologies, and practices used to allow consumers to enjoy the same degree of energy *services* while actually consuming less energy. The use of LED lightbulbs rather than incandescent lightbulbs, for example, can provide the same amount of light to consumers while using only a small fraction of the energy.

147. In approaching energy efficiency, PREPA identified three difficulties: (a) PREPA has never previously implemented any form of energy efficiency program; (b) PREPA has not conducted a study of energy efficiency potential; and (c) the benefit from energy efficiency programs would likely be low because Puerto Rico's per-capita consumption is below that of U.S. mainland customers. PREPA also argued—without any supporting data—that efficiency was unlikely to change PREPA's capacity planning assumptions.

148. PREPA also said it lacked sufficient time to conduct a study on DSM potential, and did not have data on customer end uses. The Commission granted waivers on multiple aspects of DSM required by the IRP Rule, including: Section 2.03(B)(13), requiring the identification of new demand-side resources; Section 2.04(B)(2)(a)(ii), requiring that DSM be considered in a competitive framework with supply-side resources; and Section 2.04(B)(2)(d)(ii), requiring that IRP resource plans include DSM programs at a variety of price points.

149. However, this "waiver did not ... permit PREPA to refrain from incorporating low cost demand-side resources in the IRP filing, [since refraining would be] inconsistent

¹⁶⁶ Revised IRP, Volume III, Section 3.2.2.1.

¹⁶⁷ *Id.*, Section 3.2.2.2.

¹⁶⁸ *Id.*, Section 3.2.2.3.

¹⁶⁹ Commission Order, December 8, 2015.

with reasonable least-cost planning."¹⁷⁰ The December Order thus required that PREPA "find a mechanism of incorporating these [DSM] resources into its plan development."¹⁷¹ The December Order also required that PREPA incorporate into the IRP the effects of a moderate energy efficiency program having a specified adoption rate and cost. PREPA's Supplemental IRP thus reviewed the impact of adding energy efficiency at cost of \$0.045/kWh, ramping up to reach savings equal to 1.5% of electricity sales.

150. When PREPA's Supplemental IRP incorporated these energy efficiency assumptions into "modified" portfolios, the outcomes were universally lower cost than PREPA's initial portfolios (which had excluded energy efficiency). During the Technical Hearings, PREPA acknowledged both that the Commission's assumptions on energy efficiency costs were within a reasonable range, and that the cost savings displayed made efficiency worth pursuing.

151. Energy efficiency also affected PREPA's action plan. In PREPA's Supplemental IRP, the Commission's energy efficiency assumption reduced the need for a near-term (2020) capacity resource at Palo Seco from a 369 MW F-Class combined cycle (CC) unit in the Revised IRP¹⁷² to a 72 MW SCC-800 unit.¹⁷³ The assumed energy efficiency profile also eliminated the need for one H-Class unit (out of four) by the end of the planning period.¹⁷⁴ As PREPA stated:

The investments in the recommended Portfolio 3 can be modified to adapt to the reduced demand [resulting from the energy efficiency assumption]. The only change recommended based on this study is not to consider the use of an F Class combined cycle in the north but rather a smaller SCC-800 or similar unit; as proposed in Portfolio 2. This will give the flexibility required for adapting to the reduced demand.¹⁷⁵

152. Reasonable assumptions about energy efficiency thus had a tangible effect: reducing the generating capacity needed at Palo Seco. This conclusion contradicts the First

¹⁷⁰ *Id.*, p. 2.

¹⁷¹ *Id.*

¹⁷² Revised IRP, Vol. I, p. 1-4 (Section 1.3: Recommended Supply Portfolio) states: "Key elements of the incremental changes to PREPA's current generation system in the recommended Supply Portfolio include... One F Class combined cycle unit at Palo Seco to replace Palo Seco 3 or 4."

¹⁷³ Supplemental IRP, p. 8-2, Table 8-2, Section 8.1.1) states: "The new fossil fueled generation resources include [an] SCC-800 1x1 CC with diesel as [the] primary fuel at Palo Seco by July 1, 2020."

¹⁷⁴ As this change occurs in the later part of the planning horizon, it does not affect PREPA's Action Plan, which focuses on the short term.

¹⁷⁵ Supplemental IRP, p. 2-1. Section 2.

Stage IRP's assertion that "incremental DSM program measures implemented at PREPA would not materially impact the capacity additions associated with either the IRP Base Case or any of the scenarios."¹⁷⁶

2. Demand response

153. Demand response (DR) describes a range of techniques, technologies, and practices used to affect the *timing* of consumers' energy consumption rather than the actual amount of energy consumed. The timing of consumption matters because utility systems must be designed and operated to satisfy the highest instantaneous demand for energy, otherwise known as "peak demand." Demand response, designed cost-effectively, can reduce the need for costly infrastructure, increase reliability, and reduce renewable curtailment.

154. Demand response has special potential to resolve the problems posed by Puerto Rico's bimodal peak demand. PREPA experiences one peak at mid-day (roughly 10 a.m. to 4 p.m.), and another one during the evening (around 9 p.m. to 10 p.m.). The midday peak is met, in part, by solar photovoltaics (PV). According to PREPA, the evening peak cannot be met by solar PV.¹⁷⁷ Therefore, the evening peak must be met by fossil generation. As more citizens add distributed solar capacity that generates electricity during the middle of the day, they increase the need for expensive, fast-ramping fossil capacity to meet the evening peak, since the solar capacity will not be available in the night, given the current absence of energy storage assets. This problem has been seen in other jurisdictions with relatively high solar penetration.

155. So there is a clear benefit to reducing the evening peak, through means such as storage and demand response. Yet PREPA's Revised IRP failed to consider these potential contributions. After the December Order, PREPA did consider demand response, but its treatment was both insufficient and erroneous in several respects.

156. First, the December Order required PREPA to "co-optimize the expected renewable energy load shape and demand response programs," and "assess opportunities for highly cost effective commercial and industrial-scale programs."¹⁷⁸ In response, PREPA's Supplemental IRP included an assessment of the impact of a DR program normally defined as "load shifting": increasing demand during the middle of the day, coincident with

¹⁷⁶ First Stage IRP, pp. 4-4 through 4-5.

¹⁷⁷ Draft IRP, Vol. I, Section 2.2. Also PREPA Renewable Generation Integration Study (February 14, 2014). Page 16: "PREPA's system can accommodate relatively large amounts of renewable generation, but this carries a cost as there is a reduction in dispatch of efficient units while expensive units must stay online to meet the evening peak when the renewable generation is greatly reduced."

¹⁷⁸ December Order, p. 3.

the availability of PV generation, while reducing demand during the evening peak.¹⁷⁹ PREPA assumed that the program would be designed and sized to reduce renewable curtailment as its primary objective. While this objective has merit, it is not the primary cost driver in PREPA's system. The primary cost driver is the thermal generating capacity needed to meet the evening peak. So the primary goal is not to reduce renewable curtailment but to avoid new generating capacity and to retire existing capacity, where that capacity is currently necessary to meet the evening peak. In other words, PREPA's DR analysis focused on the secondary value of DR (mitigating curtailment), but ignored the primary value (mitigating the need for generation capacity that operates only during a few peak hours).

157. Furthermore, PREPA's assumption that DR would serve only to reduce renewable curtailment rather than to optimize demand meant that the benefit of DR is dependent on the electric system's overall flexibility.¹⁸⁰ Because a more flexible fleet can adjust to the intermittency of renewable generation more easily, increased flexibility reduces the need for curtailment. If DR is used only to reduce curtailment, it becomes less useful as fleet flexibility increases. PREPA plans to replace its current inflexible units with new, more flexible generators implies that flexibility will increase over time, while the generation fleet will remain less flexible in the early years of the plan. Therefore, high penetrations of DR would be required in those early years.¹⁸¹ Realistically, however, a DR program will require several years to ramp up—years in which the generation fleet is becoming more flexible, thereby lowering the value of DR if used only to reduce curtailment.

158. This dynamic makes it more difficult for a DR program to be cost-effective if it offers only curtailment mitigation. This logic is reflected in PREPA's DR assumptions: DR penetration peaks in 2020 before ramping down over the rest of the planning period as renewable curtailment remains at PREPA's target of 2% per year.¹⁸² PREPA's assumption that DR can be used only as a substitute for flexibility in its generation fleet undervalues DR as a resource in its own right, and suggests that PREPA sees a future in which it will have no need of DR. This suggestion is not in accordance with the behavior of a modern utility.

159. Second, PREPA's accounting for the cost of DR was erroneous. When comparing the cost of the DR scenario against its preferred portfolio (P3), PREPA found

¹⁷⁹ Supplemental IRP, pp. 1-2, states: "The required demand response could be managed through shifting demand from the day-peak to the mid-day to increase the ability to integrate renewables."

¹⁸⁰ The flexibility of a generator or fleet of generators refers to the ability to rapidly adjust output in response to changing conditions (for example, rapid changes in load or in the availability of renewable generation). PREPA's current generating fleet has slow ramp rates, meaning that the present units cannot change their output rapidly.

¹⁸¹ Supplemental IRP (April 19, 2016), Table 7-1.

¹⁸² *Id.*

that the DR scenario was more expensive by \$224 million (net present value).¹⁸³ But the comparison was flawed in an obvious way: The preferred portfolio did not include meeting the full RPS requirements and all associated costs, while the DR scenario did. A proper analysis of DR would compare the cost of scenarios with and without DR, with each scenario assuming full compliance with the RPS. The proper comparison produced a net benefit from the DR program of \$27 million.¹⁸⁴ Albeit positive, this value is relatively low because of the error described above: designing the DR merely to avoid renewable curtailment instead of designing it to avoid evening capacity. Had PREPA properly created a portfolio that optimized DR under a scenario with full compliance with the RPS, the value of DR would have been higher as it would have allowed PREPA to avoid both, paying for excess generation during the day (because of curtailment) and the use of expensive thermal generation during the night peak. PREPA's error on DR cost is illustrated by its description of the value of DR:

Note however that from the outset we do not expect demand response to be economic, even assumed that it has zero cost and considering the absolute minimum cost for PV generation presented in the previous section at \$110/MWh - \$130/MWh, which is significantly higher than the cost of conventional generation on a H Class combined cycle unit (average variable cost of \$67/MWh and all in costs – including fixed costs and amortized capital costs – of \$93/MWh).¹⁸⁵

160. This reasoning is not accurate. The "high cost" PV considered in this scenario is not a function of the DR program. The PV generation would be used to meet demand or it would be curtailed. In either case, PREPA would pay the full cost of the PV under contract regardless of the DR program. On the other hand, the incremental DR allows the PV *for which PREPA has already paid* to actually supply energy to consumers and displace some of the highest-cost fossil fuel resources that are maintained to meet the evening peak. The DR program would cost \$20/MWh and have a displacement value of at least \$67/MWh;¹⁸⁶ therefore, it would save at least \$47/MWh when operational. PREPA acknowledged its error during the Technical Hearings, but failed to correct this error in the Updated Fuel IRP filed afterwards.

161. To summarize: If PREPA had designed the DR program to allow retirement of a non-economic unit earlier, defer the need for incremental new capacity used exclusively for the evening peak, or incorporate more low-cost renewable energy onto the system more

¹⁸³ Supplemental IRP, Table 8-6.

¹⁸⁴ \$26,060 million NPV (Supplemental IRP, Table 8-6) compared with \$26,087 million NPV (Supplemental IRP, Table 8-7; *Typographical error in table title as "S1" rather than "S5"*).

¹⁸⁵ Supplemental IRP, p. 7-4.

¹⁸⁶ The lowest anticipated variable cost unit. Supplemental IRP, p. 7-4.

rapidly, the savings from a DR program would be higher than what was estimated in its scenarios. Demand response thus could affect PREPA's near-term decisions to replace various thermal units. PREPA's failure to examine a reasonable value for demand response, and its failure to incorporate demand response into its near-term action plan, is inconsistent with sound IRP practices, noncompliant with the Commission's direction, and contrary to the public interest.

E. Environmental compliance

162. Section 2.9(h)(ii)(H) of Act 57-2014 requires the IRP to include an "evaluation of the environmental impacts of PREPA related to air emissions and water consumption, solid waste, and other environmental factors." PREPA's treatment of this subject was insufficient.

163. A primary driver of PREPA's planning is compliance with recently promulgated national air emissions policies, including MATS. Given the severity of its non-compliance position (as discussed in Part II(C) above), and the effect of compliance on capacity options, PREPA should have provided more detailed information on the likely outcomes of its negotiations with EPA. PREPA's IRP also failed to discuss the effects of other relevant air emissions standards, including the National Ambient Air Quality Standards (NAAQS) and potential air permitting issues at AOGP.

1. Mercury and air toxics standards

164. MATS requires significant reductions in emissions of heavy metals and acid gases, including emissions of mercury, particulate matter, and sulfur dioxide (SO₂). The rule was released in early 2012 and required initial compliance by April 16, 2015.¹⁸⁷ Utilities were able to request an extension from EPA, not to exceed two years, on a unit-by-unit basis. One-year extensions were granted readily by EPA on the basis of a need for more time to install controls. Two-year extensions were generally limited to utilities with valid reliability concerns. PREPA discusses the availability of such extensions in the Revised IRP, but does not state explicitly whether it has been granted extensions.¹⁸⁸ As such, PREPA's current MATS compliance deadline is not clear from the record. This information is critical, since the one-year extension deadline of April 2016 has already passed and the two-year extension deadline is approaching. Notwithstanding, none of PREPA's proposed Action Plans achieves full MATS compliance before 2020.

¹⁸⁷ National Association of Clean Air Agencies. March 17, 2015. Survey on MATS Compliance Extension Requests
http://www.4cleanair.org/sites/default/files/Documents/MATS_extension_requests_table_March_2015.pdf.

¹⁸⁸ Revised IRP, Vol. IV, Section 1.1.1.

165. PREPA identified fourteen (14) PREPA units, primarily oil-fired steam units, that are affected by MATS. PREPA proposes to retire, or designate as "Limited Use,"¹⁸⁹ ten (10) of these units and to convert two others to run on natural gas.¹⁹⁰ Each option is a way to comply with MATS. However, the "Limited Use" designation requires that facilities have a capacity factor below 8%, meaning the facilities can be used for peak periods only. According to the Action Plan in the Supplemental IRP, PREPA does not expect its full generation fleet to comply with MATS until December 2020 at the earliest. PREPA expects to retire the last oil-fired steam units, Palo Seco 3 and 4 and San Juan 9 and 10, by December 31, 2020,¹⁹¹ well after EPA's compliance deadline. To the extent that the retirement of these units, or the conversion of Aguirre 1 and 2 steam units to natural gas, depends on the successful permitting and construction of AOGP, PREPA's compliance could occur even later. PREPA's Action Plan in the Supplemental IRP thus indicates that "[c]ompliance with MATS at Aguirre 1 and 2 steam units depends on the availability of natural gas to be supplied by the AOGP."¹⁹²

166. Because PREPA will certainly miss the MATS compliance deadline of April 2017, PREPA will need to negotiate a settlement with EPA, face fines, or both. PREPA's analysis assumed no penalties or fines for non-compliance, which may have impacted the relative economic performance of different scenarios. During Oral Arguments, PREPA asserted that EPA is waiting for the IRP order before finalizing settlement terms with PREPA. To assist the Commission's decision making, PREPA's IRP should have provided more details on its current compliance position and likely resolution of MATS requirements. For example, PREPA should have provided its understanding of alternative compliance pathways, potential penalties for non-compliance, or other restrictions that EPA might require.

2. National ambient air quality standards

167. The National Ambient Air Quality Standards (NAAQS) require states and territories to meet certain minimum air quality standards for specific harmful pollutants to human health and the environment, including ozone, particulate matter, sulfur dioxide (SO₂), lead, and carbon monoxide. Where a geographic area is non-attainment, state and territorial air quality managers must develop plans that reduce emissions of these pollutants—or of those chemicals that lead to the creation of those pollutants. One common feature of these plans is emissions limits imposed on electric power generators. PREPA has previously been required to limit the sulfur content of fuel burned at plants in

¹⁸⁹ PREPA Revised IRP, Vol. IV, Table 1-1.

¹⁹⁰ According to PREPA, Costa Sur units 5 and 6 (which burn a blend of fuel oil and natural gas) are already MATS-compliant. Revised IRP, Vol. I, Table 7-5.

¹⁹¹ Supplemental IRP, p. 10-5.

¹⁹² Supplemental IRP, p. 10-4.

Puerto Rico, as well as the total operating hours of these plants, to meet fine particulate requirements.¹⁹³ At this time, PREPA's fleet is not specifically involved in new programs to improve air quality in Puerto Rico.

168. PREPA's IRP does not discuss NAAQS requirements, nor does it assess whether any of its resource portfolios would trigger NAAQS requirements. Even though PREPA's generating fleet currently complies with NAAQS, its IRP should have discussed these requirements and their potential implications for future resource portfolios.¹⁹⁴

3. Other environmental issues

169. While PREPA did discuss the MATS rule and the Clean Power Plan (CPP),¹⁹⁵ its IRP included only limited discussion of other environmental matters. The IRP does present estimated reductions in specific air pollutants—oxides of nitrogen (NO_x) and sulfur dioxide (SO₂)—but it does not discuss water consumption, solid waste production, disposal, or leakage, or any other environmental factors. In addition, there are numerous ancillary environmental questions associated with both existing and potential new facilities, including the disposal of coal ash from the AES facility and the potential consumption and/or contamination of water from the AOGP facility. The IRP does not address any of these questions.

170. These issues affect IRP planning in that: (a) they affect the public, in terms of health and economic cost; (b) they are subject to environmental regulation (either new or existing) and thus could trigger costs greater than zero (costs ignored by PREPA); and (c) they are important considerations under Act 57-2014.

F. Assumptions about the cost of renewable energy

171. In making assumptions about the cost of renewable energy, PREPA's IRP made overlapping errors in four areas: the cost of RPS compliance, contract purchase costs, the cost of "curtailment," and the cost of existing renewable contracts.

¹⁹³ 60 F.R. 28333. May 31, 1995. Memoranda of Understanding signed between Puerto Rico Environmental Quality Board and PREPA.

¹⁹⁴ IRP Rule § 2.01 (B)(1) requires PREPA to provide a description of significant planning regulatory factors that affect the environment, such as environmental regulations and standards and standards that impact existing resources or resource choices during the planning horizon.

¹⁹⁵ The Clean Power Plan (CPP) is a rule, issued by the U.S. EPA under Section 111(d) of the Clean Air Act. Under the CPP, the U.S. electric sector would reduce CO₂ emissions from 2005 levels by about 32 percent nationwide by 2030. To achieve this result, the rule established emission performance standards for electric generating unit technologies and set targets for U.S. states. The final rule did not set CO₂ emissions performance goals for Alaska, Hawaii, Guam or Puerto Rico, but has announced the EPA's intent to do so. The rule has set no target for Puerto Rico, so PREPA has no current compliance obligation. In addition, the rule has been stayed by the courts.

1. The cost of RPS compliance

172. Puerto Rico's statutory Renewable Portfolio Standard compels PREPA to supply a certain percentage of its energy sales using renewable energy, such as wind or solar power. The RPS requires that PREPA supply twelve percent (12%) of its sales using renewable energy in 2015, rising to fifteen percent (15%) in 2020.

173. In addressing its RPS obligations, PREPA made three errors. First, in utility planning, the standard practice is to assume the utility's compliance with all applicable legal obligations. Applying standard practice, PREPA's evaluation of different resource portfolios should have assumed that PREPA would meet the statutory targets. The possibility that full compliance would be too expensive or operationally impractical is worth considering, but the proper place for that consideration is in supplemental analyses or sensitivity modeling.

174. In the Revised IRP, however, PREPA assumed that its RPS obligations would be lower than the statutory requirements. PREPA's base case assumptions, which it used to compare different resource portfolio options, therefore included a set of reduced RPS targets. Using these assumptions, PREPA compared proposed resource portfolios and selected Portfolio 3 as its preferred portfolio. PREPA then tested full RPS compliance only as a sensitivity case, rather than as a base case. In this sensitivity analysis, PREPA investigated the impact of full RPS compliance on the costs of its preferred portfolio (Portfolio 3) only. PREPA never investigated the costs of its other candidate portfolios given an assumption of full RPS compliance. It is therefore impossible to evaluate how PREPA's other proposed portfolios would perform if required to comply with PREPA's current legal obligations.

175. Second, PREPA presented its sensitivity results for a single year (2035) rather than for the entire planning period. Based on these results, PREPA concluded that "full RPS compliance will add significant costs to the PREPA system" and that full RPS compliance is therefore not practical. PREPA based this conclusion on its finding that the full RPS compliance sensitivity produces higher costs in 2035 than the base case in every Future.¹⁹⁶ The single-year cost values used by PREPA to form this conclusion are not discounted by PREPA's assumed discount rate and therefore do not reflect the present value of costs incurred in 2035. (However, like all cost figures presented in the IRP, the 2035 system cost results presented as part of the RPS sensitivity analysis are shown in real 2015 dollars).

176. Relying on non-discounted value for a single year to evaluate the cost of RPS compliance is neither analytically sound nor standard industry practice. By their nature, estimates of future costs in future years are more uncertain than estimates of costs in the near term. When considering ongoing spending over a lengthy time period, it is standard practice to compare the total costs of different scenarios on a discounted (net present

¹⁹⁶ Revised IRP, Vol. I, Section 9.1.

value) basis. Comparing total scenario costs, inclusive of spending in every year of a planning period (each year's spending discounted to the present), allows for a comprehensive view of the entire period, as well as apples-to-apples comparisons of different cost trajectories. Discounting of future-year costs, meanwhile, places the appropriate emphasis on near-term versus long-term cost values. It is PREPA's own practice to compare the value of resource portfolios by computing total system costs for the entire planning period on a net present value basis, as demonstrated in its main portfolio evaluation analysis.¹⁹⁷

177. Indeed, the appendices of the IRP (although not the main text) show that on a net present value basis, the sensitivity that fully complied with the RPS¹⁹⁸ was estimated to cost *\$130 million less than* the comparable base case scenario—the scenario that is not fully compliant with the RPS.¹⁹⁹ PREPA never explained why it concluded that compliance with the full RPS is more expensive than compliance with reduced targets, particularly why it drew this conclusion in light of the fact that the net present value of total planning period costs for the full RPS sensitivity is shown to be lower than the net present value of total planning period costs in the base case (with reduced targets). PREPA also failed to justify the choice to present only year 2035 findings.

178. Third, while PREPA usually presents its results in terms of fiscal years,²⁰⁰ it presented the yearly results for the sensitivity case of full RPS compliance in terms of calendar years. This inconsistency complicates efforts to compare costs between the sensitivity and base cases. This type of inconsistency is not found in a competently prepared IRP.

2. Contract purchase costs

179. In determining the future cost of renewable energy purchases, PREPA considered two types of projects: projects associated with existing contracts, and future generic projects. For the generic projects, PREPA assumed prices for the future planning period that it claimed were consistent with the contract prices it agreed to between 2010 and 2013. In those existing contracts, PREPA pays a price for energy, plus a per-megawatt-hour premium that PREPA refers to as "renewable energy credit" (REC). (This use of the term "REC" does not reflect the typical use of the term. A REC reflects the "renewable attribute" of the energy produced. A REC has value only when there is an organized market for RECs. There is no such market in Puerto Rico.) The contractual energy price (*i.e.*, the price without the so-called REC) sufficiently covers the prudent costs of constructing and

¹⁹⁷ Revised IRP, Vol. I, Section 1.3.

¹⁹⁸ Revised IRP, Vol. I, Appendix C-11.

¹⁹⁹ Revised IRP, Vol. I, Appendix C-7.

²⁰⁰ PREPA's fiscal years commences on July 1 and ends on June 30.

financing the projects plus a reasonable profit to their owners. The REC premium is therefore in excess of that reasonable profit.

180. In terms of going-forward assumptions concerning generic projects, if the assumed price of energy from a renewable generator is sufficient to compensate the seller for its reasonable costs and a reasonable profit, there is no reason to assume a policy or practice that will grant generators more compensation. Moreover, if PREPA conducts an appropriate competitive bidding procedure to select renewable energy sellers, it is reasonable to assume that competitive forces will discipline prices down to the level of reasonable cost (including reasonable profit). We recognize that renewable sellers may seek a different pricing treatment from the Legislature or the Commission in the future. The Commission commits to listen carefully to such positions when they are advanced. But there is no evidentiary basis for assuming that a premium, such as that built into PREPA's existing contracts, will be required in future contracts, either by law or by competitive forces. Moreover, even if it were appropriate to assume that PREPA would pay for RECs, PREPA's REC price exceeds that of other United States jurisdictions, despite the absence of a REC market in Puerto Rico.

3. "Curtailment" cost

181. In the context of renewable contracts, "curtailment" refers to an action taken by the utility when one or more projects are poised to provide more output than the system needs to supply customers' load. This situation presents a problem, because in an interconnected electricity system without significant storage capacity, the quantity generated must equal the quantity consumed at all times. So in this situation, the utility must "curtail"—meaning, order some generators not to produce electricity (or if they produce it, "dump" it rather than inject it into the interconnected network). Under certain renewable contracts, such as "take-or-pay" contracts, PREPA is obligated to pay the curtailed generator for electricity it was able to produce but was ordered not to produce. This payment is sometimes called "curtailment cost."

182. PREPA assumed that it will always be obligated to pay the full costs of curtailment. In designing and evaluating its candidate resource portfolios, PREPA sought to avoid the circumstances that necessitate curtailment and thereby reduce these costs. In doing so, PREPA caused the curtailment-avoidance goal to prevail over other goals, such as RPS compliance. PREPA set a target of curtailing two percent or less of the renewable energy generated by all facilities with which it has a PPOA.²⁰¹ However, PREPA did not explain how it arrived at this target. This self-imposed, unexplained limit on curtailment led it to favor reduced quantities of renewable energy capacity in its candidate portfolios.

183. It is true that curtailment can cause costs to PREPA. But reducing curtailment costs should not be an overriding purpose; rather, it should be a cost that is examined in

²⁰¹ Revised IRP, Section 2.

balance with other system costs and benefits. Planning should seek to minimize *total* system costs, not simply one component of those costs. PREPA's approach thus failed to assess whether portfolios with curtailment exceeding 2% might achieve cost savings that outweigh any increase in curtailment cost. By allowing higher levels of curtailment, for example, the additional renewable capacity on the system could displace other planned capital expenditures, saving more money than the increase in curtailment cost. Furthermore, the additional renewable capacity could be combined with other means of avoiding curtailment, such as storage, demand response, or generation with fast-ramping capabilities. Indeed, PREPA's amortized capital costs are at least an order of magnitude higher than its assumed curtailment costs, even in years where PREPA predicts relatively high curtailment costs.²⁰² This fact alone suggests that PREPA overemphasized curtailment costs as a cost driver.

4. Existing renewable contracts for projects which are not operational

184. Between 2010 and 2013, PREPA signed a large number of contracts for renewable energy projects (primarily utility-scale photovoltaic projects). The total capacity of these contracted projects exceeds the amount needed to meet PREPA's RPS obligations through 2030. However, only a fraction of these contracts has led to operational projects. For the modeling process, contracts for unrealized projects pose two distinct challenges: their likelihood of completion and their high prices. The contracts limit PREPA's ability to add cost-effective new renewable energy to its system. In terms of modeling, uncertainty about the cost and availability of these contracts makes it difficult to know whether, and to what extent, PREPA can lower its future purchase costs—and thus attain for renewable energy its appropriate priority in the IRP. The problem is clear from PREPA's own words:

All projects with existing contracts (operational and new) have high prices, and these prices are not likely to drop significantly if the developers actually go forward with the new projects. In order for PREPA to be able to solicit any new renewable generation projects with new lower updated prices, it would require new projects with existing contracts, PPOAs, and Master Agreements not to go forward.²⁰³

We will address completion uncertainty first, then pricing.

²⁰² For example, in Appendix C-7 of the Revised IRP (which tabulates costs for P3F1), curtailment costs range between \$0.9 million and \$28 million while capital costs are between \$134 million and \$615 million for the years shown.

²⁰³ Supplemental IRP, p. 5-6.

185. *Project completion:* A substantial number of the contracts are for renewable energy projects that are not presently operational.²⁰⁴ A subset of those not-yet-operational contracts, PREPA says, will likely not be constructed.²⁰⁵ Overall, PREPA lists 1,056 MW of renewable energy contracts that are not yet operational (of which a portion is currently under construction), but were included in modeling. PREPA describes an additional 600 MW of contracted capacity that was not included in modeling.

186. *Pricing:* The prices in the existing contracts exceed PREPA's own estimates of the reasonable all-in cost for new solar electricity. PREPA lists the costs of the existing photovoltaic contracts as ranging from \$160 to \$185/MWh.²⁰⁶ Yet PREPA also says that the currently expected cost of new contracts in 2021 would be only \$130/MWh.²⁰⁷ This \$130/MWh figure is itself too high, because it reflects not only reasonable cost and reasonable profit (stated on a levelized basis), but also a payment for RECs. As discussed in Part IV(F)(2) above, including a REC price in any contract price that is already fully compensatory is excessive. PREPA's use of that REC-increased levelized cost of energy figure thus understates the extent to which new projects would cost PREPA less than its existing contracts—if PREPA can withdraw from those existing contracts. By taking the REC portion out, we conclude that PREPA could sign new renewable contracts at approximately 55-65% of the prices of the existing contracts assumed in the IRP.²⁰⁸

187. *Conclusion:* Given the uncertainties over both project completion and above-cost prices, PREPA should have determined, to the extent feasible, the status of each project before modeling renewable energy costs. Specifically, PREPA should have determined with more certainty whether a given project will be completed and operational during the planning horizon, then include only those projects in the modeling. PREPA should also have discussed its efforts to renegotiate or exit from these contracts, and the range of plausible outcomes of those efforts. For those projects whose future remained truly uncertain, PREPA should have used sensitivity case analysis; *i.e.*, conducted modeling using the assumptions that all, none, and at least one reasonable intermediate percentage of such projects would come online during the planning period. The results of this analysis should have been presented clearly and explicitly and the implications discussed in the IRP. Such an analysis would have informed PREPA, and the Commission, of the level of risk of exposure to high prices.

²⁰⁴ Revised IRP, Vol. I, Table 4-2.

²⁰⁵ PREPA's Memorandum on Section II, No. 1 in response to the December Order. (February 26, 2016). Pages 7-8; PREPA's Response to Question 17(a) of the Commission's First Requirement of Information, October 15, 2015.

²⁰⁶ Supplemental IRP, Table 5-6.

²⁰⁷ Supplemental IRP, Table 6-2.

²⁰⁸ \$130/MWh less a \$30/MWh REC price suggests an approximate \$100/MWh LCOE, which is 56% of the highest-priced existing contract (\$185/MWh) and 63% of the lowest-priced contract (\$160/MWh).

188. PREPA says it modeled a case in which "most" of the existing contracts become operational, as well as a case in which "some" of the projects "do not materialize" and are therefore replaced with the generic new projects discussed here.²⁰⁹ This claim does not absolve PREPA of the criticism we level here, for two key reasons. First, the scenarios described in the Supplemental IRP are defined too vaguely to be useful. "Some" and "most" are not acceptable descriptors in the absence of actual quantitative information. Second, and crucially, in the Supplemental IRP the difference in costs between these two scenarios is never discussed. Indeed, PREPA fails to indicate which of the two scenarios is actually represented in the portfolio evaluation results in the Supplemental IRP. Addressing this issue so superficially is not consistent with a competently-performed IRP; nor does it satisfy the substantial evidence test. Ultimately, PREPA's treatment of these signed-but-unrealized contracts leaves the Commission with insufficient knowledge about the extent to which PREPA will be able to substitute newer, low-cost contracts for the existing high-cost contracts. As a result, PREPA cannot readily determine the benefits of adding new renewable energy to PREPA's system.

G. Action plan

189. Section 2.04(B)(7) of our IRP Rule required that PREPA present an Action Plan. PREPA requested a waiver of this requirement on the grounds that presentation of an Action Plan would interfere with its negotiations with its creditors. The Commission denied PREPA's request. Still, the Revised IRP did not include an Action Plan. Following an explicit directive in the December Order, PREPA included two Action Plans in the Supplemental IRP.²¹⁰

190. These Action Plans are deficient in several respects. The first Action Plan²¹¹ does not accurately reflect the resource decisions implicit in P3MF1M, which replaced P3F1 as the preferred portfolio after the analyses required by the December Order. In particular, the first Action Plan suggests that PREPA still plans to build an F-Class NGCC at Palo Seco, instead of one or more SCC-800 units as indicated in P3MF1M. PREPA explained during both the Technical Hearing and the Oral Argument that it in fact plans to follow the resource decisions of P3MF1M, not P3F1. However, PREPA's first near-term Gantt chart references P3F1.²¹² The Action Plan in the Supplemental IRP must be clear and comprehensible. It must represent the actions, and only the actions, that PREPA intends to take in reality.

²⁰⁹ Supplemental IRP, p. 5-5.

²¹⁰ Supplemental IRP, Tables 10-1 and 10-2.

²¹¹ *Id.*, Table 10-1.

²¹² *Id.*, Table 10-3.

191. Neither Action Plan includes energy efficiency efforts, even though the results of the analyses contained in the Supplemental IRP are predicated on achieving the levels of energy efficiency indicated in the December Order (as discussed in Part IV(D)(1) above). While the Commission may ultimately decide that energy efficiency programs should be handled by a third-party administrator rather than by PREPA, PREPA should still incorporate into its Action Plan whatever actions are necessary to accomplish energy efficiency-related goals (for example, coordination with such an administrator). As a result, the Action Plan in the Supplemental IRP is neither accurate nor comprehensive.

192. Finally, the Action Plan in the Supplemental IRP uses dates that are neither realistic nor representative of PREPA's actual plans. In the Supplemental IRP, PREPA states:

All dates unless otherwise noted in the Supplemental IRP are kept consistent with the Base IRP that is all process [sic] for near term projects are started in July 2015.²¹³

193. We interpret this statement, as well as PREPA's presentation and discussion during Oral Argument, to mean that the dates in the Action Plan do not represent the *actual* dates on which PREPA plans to execute different elements of its Action Plan. During the Technical Hearing and Oral Argument, PREPA justified this presentation choice as intending to allow ready comparison between the Revised IRP and the Supplemental IRP. PREPA confirmed that dates in the Supplemental IRP, such as the completion of AOGP by the second quarter of 2017, were outdated and unlikely to be met. Ultimately, PREPA's approach defeats the purpose of having an Action Plan.

194. The Commission needs an accurate understanding of PREPA's *actual* plans, including the likely timeframes and costs. PREPA's decision to present its Action Plan without the actual dates makes it difficult for the Commission to evaluate the effects of PREPA's actions, determine likely spending schedules, evaluate milestones and performance, or anticipate key decisions to be made by PREPA.

V. DETERMINATIONS OF COMPLIANCE WITH THE IRP RULE

195. Section 3.04 of our IRP Rule requires the Commission to determine whether PREPA complied with specific elements. We present those determinations here, in the sequence set forth in the IRP Rule. The support for each of these determinations appears above in Part IV, "Shortcomings in PREPA's Proposed IRP."

²¹³ *Id.*, Section 10.1.

A. Completeness²¹⁴

196. PREPA's IRP was incomplete in at least seven ways.

1. It used only two load forecasts, rather than a range of forecasts, such as ones that would examine how economic factors, land use restrictions, and types of consumer uses affect demand and consumption.
2. Its discussion of demand-side resources and programs was unnecessarily limited, and contained no evaluation.
3. Its evaluation of the range of conventional and non-conventional generation technologies, expressly required by Act 57-2014, did not adequately address the range of renewable energy resources or discuss storage options.
4. It did not make clear when PREPA will comply with MATS, and failed to account for other essential environmental factors as discussed above.
5. It failed to fully and properly evaluate the portfolios' effects on air emissions, water consumption, solid waste and other environmental factors.
6. It did not provide information on the useful life or retirement dates of MATS compliant plants.
7. Most of the portfolios analyzed in the IRP, including the Preferred Resource Plan, assumed less than full compliance with the statutorily mandated renewable portfolio standard.

197. **Finding:** *PREPA did not comply with the requirement of completeness.*

B. Development of viable alternatives²¹⁵

198. PREPA failed to use a capacity expansion model. This failure precluded both a reasonable exploration of alternative resource portfolios and a rigorous means of optimizing them. Using a production cost model was an inadequate substitute. PREPA's methodology and the range of alternatives it produced is unsatisfactory.

199. **Finding:** *PREPA did not comply with the requirement of developing viable alternatives.*

²¹⁴ IRP Rule § 3.04(A)(1).

²¹⁵ IRP Rule § 3.04(A)(2).

C. Planning environment, load forecast, and assessment of system reliability²¹⁶

1. Planning environment

200. PREPA adequately discussed critical environmental and other policy drivers. Volume IV of the Revised IRP listed PREPA's view of the main air regulatory policy drivers: EPA's Mercury and Air Toxics Standards (MATS), the proposed Clean Power Plan (CPP), Greenhouse Gas Standards (GHG), New Source Performance Standards (NSPS), and the New Source Review/Prevention of Significant Deterioration (NSR/PSD) requirements for new major sources and major modifications to major sources.²¹⁷ PREPA also described Act 82-2010's establishment of Renewable Portfolio Standards, and referred to PREPA's Renewable Generation Integration Study (February 2014), which discussed the requirements and feasibility of the RPS.²¹⁸ Finally, PREPA adequately explained Act 57-2014's energy efficiency consumption requirement for public entities.²¹⁹

201. **Finding:** *PREPA complied with the requirement on planning environment.*

2. Load forecast

202. PREPA initially provided historic peak demand information covering the ten-year period prior to the first year of the IRP planning period (2015). PREPA also provided the total annual electricity consumption for the utility and for each customer class, including the load factor for each customer class. PREPA's forecast also accounted for line losses. However, PREPA failed to compare historical actual load with historical forecasts, as required by the IRP Rule.²²⁰

203. PREPA also failed to substantiate adequately how it developed its forecasts. Nor did it explore a reasonable set of future uncertainties, particularly a lower demand consistent with recent reductions and anticipated energy efficiency programs.²²¹ We agree with arguments by ICSE-PR and IEEFA (on behalf of ELAC) on these points. We also agree with Mesa's argument that PREPA's financial situation, as well as changes in population and consumption, were not properly accounted for, either in the load forecast or in the

²¹⁶ IRP Rule § 3.04(A)(3).

²¹⁷ Revised IRP, Vol. IV, at 1-3; Revised IRP, Vol. I, Section 7, p. 7-10.

²¹⁸ Revised IRP, Vol. I, Section 4; Revised IRP, Vol. I, Section 9.

²¹⁹ Revised IRP, Vol. III, Section 3.2.1.

²²⁰ Compare IRP Rule § 2.03(B)(2)(b) with Revised IRP, Vol. III.

²²¹ Compare IRP Rule § 2.03(B)(2)(c) with Revised IRP, Vol. III.

resource mix plans. These omissions left PREPA unable to assess the risk of overbuilding the system.

204. PREPA did not describe the impact that existing and future demand-side management strategies, or current and planned line loss reduction programs, could have on the load forecast. As detailed in Volume III of the Revised IRP, PREPA assumed an achievement of 80% of the energy efficiency program for government agencies and public corporations, but did not anticipate energy efficiency measures that could produce a lower load forecast. (We did, however, grant PREPA a waiver from the requirement to submit a low case and a high case for customer electricity demand.²²²) By including a moderately aggressive energy efficiency assumption, as directed by the Commission, PREPA's model showed a reduced need for replacement generation at Palo Seco.²²³

205. PREPA did not include demand response until after the December 8 Order; what it included then was lacking. PREPA examined a single hypothetical load-shifting demand response program—a program whose focus was reducing renewable energy curtailment rather than reducing the evening peak. Furthermore, the assumed energy efficiency profile also eliminated the need for one H-Class unit (out of four) over the longer term.²²⁴

206. **Finding:** *PREPA did not comply with these requirements on load forecast.*

3. Reliability assessment

207. Rather than establishing a specific planning reserve margin, PREPA tracked loss of load hours using only a single, non-stochastic model run. PREPA did not support its target loss of load hours value with a benefit-cost assessment.

208. **Finding:** *The IRP did not comply with the requirement for reliability assessment.*

²²² Commission Resolution on Waiver Request. June 25, 2015. Paragraph 4.

²²³ Supplemental IRP, p. 10-2.

²²⁴ Supplemental IRP, p. 8-2 states, "The new fossil fueled generation resources include [an] SCC-800 1X1 CC with diesel as [the] primary fuel at Palo Seco by July 1, 2020."



D. Assessment of existing resources²²⁵

1. Existing supply side resources

209. PREPA's description of its existing supply-side resources was waived, yet PREPA still included the information on resource type, nameplate and peak available capacity, capacity factors for its units, fuel types, minimum run times,²²⁶ forced outage rates, heat rates, operational costs, capital expenditures, expected retirement dates for certain resources,²²⁷ and schedules for some units' compliance with current and proposed air regulations.²²⁸

210. **Finding:** *The IRP complied with the requirement to describe existing resources.*

2. Existing demand-side resources²²⁹

211. The IRP Rule required PREPA to describe its existing demand-side resources. The Commission granted nearly all of PREPA's requests for waivers regarding DSM, with the exception of the requirement that PREPA report on its existing DSM programs.²³⁰ In response, PREPA stated that it has two DSM programs linked to rate schedules: a time-of-use pricing program and an interruptible rate plan.²³¹ The time-of-use (TOU) program is divided into two time periods (on-peak and off-peak). It is available only for commercial and industrial customers.²³² As of 2013, PREPA had 23 customers participating in the TOU program and no customers in the interruptible rate.²³³

²²⁵ IRP Rule § 3.04(A)(4).

²²⁶ Some intervenors argued that PREPA's minimum run time assumptions were unrealistically high, while PREPA asserts that the values used in modeling were an accurate representation of the capabilities of the existing fleet. Without historical hourly by-unit generation data, we are unable to evaluate either claim. We direct PREPA to start collecting such data in Section VII(C)(3) below.

²²⁷ Revised IRP, Vol. I, Table 3-1.

²²⁸ Revised IRP, Vol. IV, Table 1-2; *see also* Supplemental IRP, Section 10.4, p. 9-4.

²²⁹ IRP Rule, Section 2.03(B)(7).

²³⁰ Commission Resolution on Waiver Request. 25 June 2015. Paragraph 11.

²³¹ Revised IRP, Vol. III, Section 3.3.1, p. 3-7.

²³² *Id.*

²³³ *Id.* PREPA notes that the TOU rates date back to 1989, when PREPA's load pattern was different than present day.

212. **Finding:** *The IRP complied* with the requirement to describe existing demand-side resources. This finding does not mean, however, that those resources are adequate.

3. Existing advanced meters and grid technologies²³⁴

213. **Finding:** *No finding is necessary because a waiver was granted.*

4. Existing transmission facilities²³⁵

214. The IRP Rule required PREPA to describe its transmission lines and facilities, and to identify any transmission constraints and contingencies that warranted upgrades. PREPA described its transmission facilities, along with the single and double contingency tests it conducted.²³⁶ In both the Updated IRP and the Supplemental IRP, PREPA showed that the current transmission system needs to be upgraded: to remove transmission constraints affecting existing and future projects, to allow for greater operational flexibility, and to accommodate the interconnection of distributed generation and demand-side resources to the network without reducing reliability.²³⁷ PREPA also submitted schematic maps of the transmission and subtransmission network showing transfer limits,²³⁸ and a map showing the actual physical routing of the transmission and subtransmission lines.²³⁹

215. **Finding:** *The IRP complied* with the requirement to describe existing transmission facilities.

5. Existing distribution facilities²⁴⁰

216. The Rule required PREPA to "provide, at a minimum, a characterization of its constraints within the distribution system, including where the distribution system is

²³⁴ IRP Rule § 2.03(B)(8).

²³⁵ IRP Rule § 2.03(B)(9).

²³⁶ Revised IRP, Vol. II. The Commission previously determined that Vol. II of the Revised IRP and the Transmission Analysis portion of the Supplemental IRP (submitted on March 28, 2016), which discuss PREPA's transmission facilities, are "confidential." *Resolución y Orden, Descubrimiento de Prueba; Confidencialidad*, Appendix A, at 20.

²³⁷ Revised IRP, Vol. II, Section 1; *see also* Supplemental IRP, p. 1-5.

²³⁸ *See generally* Revised IRP, Volume II; *see also* Supplemental IRP, *Transmission Analysis*, *supra*.

²³⁹ PREPA *Electrical System Diagram* and *Electrical System Map* (July 16, 2015) as part of PREPA's Submittal of Answers and Documents in Response to Resolution on Waiver Request. PREPA requested confidential treatment for these maps; however, PREPA's request was considered waived because these maps are public as part of PREPA's Capital Improvement Plan. PREPA, *Capital Improvement Plan*.

²⁴⁰ Commission Resolution on Waiver Request. June 25, 2015, Paragraph 14.

strained." PREPA described, at a high level, its distribution system's ability to increase penetration of distributed generation, particularly intermittent distributed generation.²⁴¹ PREPA also tested a sample of seven (7) feeders, which it claimed are representative of PREPA's distribution system, against increased integration of distributed PV generation.²⁴² PREPA identified the limits for PV generation on existing distribution feeders, and identified capital system improvements needed for additional PV.²⁴³

217. PREPA determined that increasing distributed generation at the distribution level would affect voltage regulation, frequency, and its ability to handle reverse power flows.²⁴⁴ PREPA also determined that certain improvements would be necessary to enable distributed generation to supply the entirety of a feeder's peak demand,²⁴⁵ and noted that additional studies are needed before higher levels of distributed generation are incorporated into the system.²⁴⁶ For purposes of this IRP evaluation, PREPA sufficiently identified key challenges and solutions for integrating distributed generation.

218. **Finding:** *The IRP complied with the requirement to describe existing distribution facilities.*

E. Assessments of new generation, fuel, transmission and demand-side resources²⁴⁷

1. New generation options

219. PREPA identified and evaluated a range of new thermal (including small and large combined cycle units) and renewable options.²⁴⁸ For these new units or repowering options, PREPA identified the resource type (fossil, renewable, EE, DSM), the units' capacity (MW/per unit), the fuel sources (if applicable), the units' heat rates, the units' availability

²⁴¹ Revised IRP, Vol. V.

²⁴² Revised IRP, Vol. V, p. 1-1.

²⁴³ *Id.*

²⁴⁴ Revised IRP, Vol. V, Table 5-1.

²⁴⁵ Revised IRP, Vol. V, pp. 3-33 & 5-2 (protection relays replacements at feeder head; substation transformer LTC controls' upgrades; integration of voltage control systems capable of monitoring and controlling a feeder's voltage profile, such as volt/var control systems; integration of a dedicated voltage regulator at each feeder head).

²⁴⁶ *Id.*, p. 1-2. PREPA projects that 61 MW of distributed generation will be added by 2015, and up to 322 MW by 2035. *See also* Supplemental IRP, Section 4, p. 3-1; Revised IRP, Vol. I, Section 4.3, p. 4-7.

²⁴⁷ IRP Rule, Sec. 3.04(A)(5).

²⁴⁸ Revised IRP, Vol. I, Sections 3.2 and 4.

and capacity factors, the units' costs (site, operations and maintenance and capital costs), their construction lead time and anticipated life, and constraints on the units' acquisition or construction.²⁴⁹

220. PREPA also evaluated repowering and fuel conversion options that would make certain units capable of burning two types of fuels. PREPA did not, however, extensively consider retrofits for each unit in its generating fleet that might otherwise bring those units into MATS compliance without switching fuels. During the Oral Argument, PREPA explained emission controls as a pathway to compliance, but found these options not cost effective. PREPA did not provide evidence of this consideration or analyses indicating that retrofits were not cost effective.

221. PREPA also reviewed various new fuel infrastructure options apart from AOGP. In its Future 3 scenarios, PREPA analyzed the impact of natural gas availability in the North, but did not model any specific means of gas delivery to the North. PREPA did not model the expansion of the existing EcoEléctrica gas terminal.²⁵⁰ During the Technical Hearing, PREPA explained that a substantial expansion in generation at EcoEléctrica or Costa Sur would not be viable due to transmission and right-of-way constraints.²⁵¹ While PREPA discussed the potential for a pipeline route from Costa Sur to Aguirre, this option was not analyzed. Availability of natural gas at Aguirre was modeled as being supplied through AOGP.

222. PREPA also evaluated the ability of renewable energy projects and other independent power producers to interconnect to PREPA's grid, taking into account the schedule necessary to comply with Act 82-2010.²⁵² PREPA considered twenty-seven (27) renewable energy projects, the majority of which were PV, along with some wind and landfill projects.²⁵³ PREPA identified the technology, capacity, and capacity factors.²⁵⁴

²⁴⁹ Revised IRP, Vol. I, Section 3, Table 3-2.

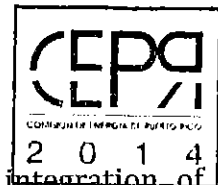
²⁵⁰ Revised IRP, Vol. I, Section 5.

²⁵¹ Several intervenors asserted that expansion of the EcoEléctrica gas terminal and/or construction of a pipeline between Costa Sur and Aguirre would be cost-effective. Because these assertions were not accompanied by technical evidence, they are not sufficient to rebut PREPA's conclusions.

²⁵² Revised IRP, Vol. I, Section 4, at 4-2.

²⁵³ Revised IRP, Vol. I, Section 4, Table 4-2, 4-3; Supplemental IRP, Section 5, at 4-5, and Table 5-6, at 4-6. Although PREPA has signed PPOAs with eighteen (18) additional renewable projects, it did not consider those as "new" sources in the IRP evaluation. Supplemental IRP, Section 4, at 4-5. "PREPA has 9 contracts with a total capacity of 261.9 MW in wind power, 2 contracts with 3.5 MW of Landfill Gas, 5 contracts with a total of 150 MW of solar power, and 2 contracts with 89 MW of Waste to Energy, and 8 Master Agreements with total availability of 600 MW, for a grand total of renewable energy in existing contracts, PPOAs, and Master Agreements of 2,160.1 MW." *Id.*

²⁵⁴ Supplemental IRP, Section 5, Table 5-6.



However, PREPA did not describe all system impacts associated with integration of intermittently-available renewable generation, such as changes in the need for frequency regulation or voltage support. Instead, PREPA referenced its 2014 Renewable Integration Study, which addressed these issues in detail.

223. PREPA incorporated by reference the energy storage analysis conducted in its 2014 Renewable Integration Study (conducted by Siemens PTI).²⁵⁵

224. **Finding: The IRP complied.** The IRP Rule does not require PREPA to consider all possible resources, only a sufficient range of resources.²⁵⁶

2. New transmission facilities

225. PREPA identified new transmission facilities necessary to improve reliability and address transmission constraints and critical contingencies.²⁵⁷

226. **Finding: The IRP complied with the requirement to assess new transmission facilities.**

3. New distributed generation and demand-side options

227. Regarding distributed generation, the IRP Rule requires PREPA to include in the IRP a projection of the expected types and amounts of customer owned distributed generation.²⁵⁸ PREPA included a forecast of new distributed generation in Volume I²⁵⁹ of the Revised IRP and assessed the impact of new distributed generation on the distribution system in Volume V.²⁶⁰

228. Regarding energy efficiency programs and demand response, the requirement to identify a wide range of these resources in the IRP was waived. PREPA was directed to include a specific trajectory for energy efficiency and perform a demand response analysis

²⁵⁵ Revised IRP, Volume I, Section 4.2 and Volume V, p. 3-57.

²⁵⁶ Intervenor Consortium argues in its brief that PREPA erred by not considering Consortium's alternative resource plan, which it describes as including a range of thermal and renewable resources as well as transmission infrastructure. Because a detailed description of this plan, including an assessment of its reliability and cost, did not appear in evidence, the Commission cannot consider its merits.

²⁵⁷ Revised IRP, Vol. II, Section 11.

²⁵⁸ IRP Rule, § 2.04(B)(12).

²⁵⁹ Revised IRP, Vol. I, Section 4.3.

²⁶⁰ Revised IRP, Vol. V.

in the Supplemental IRP. Energy efficiency was included in all scenarios in the Supplemental IRP.²⁶¹ Demand response was studied in sensitivity P3MF1M S4.²⁶²

229. **Finding:** *The IRP **complied** with the requirement to include projection of distributed generation and demand-side options.*

F. Scenarios, plans and sensitivities²⁶³

230. The IRP Rule requires PREPA to "use a Capacity Expansion Model or similar model structure to develop least cost resource plans." As already explained, PREPA used a production cost model, which is not "similar" to a capacity expansion model. PROMOD is not capable of selecting appropriate new resources or identifying non-economic units for retirement. By using the wrong tools and techniques, PREPA left the Commission with resource plans on which we cannot rely.

231. **Finding:** *The IRP **did not comply** with the requirement to use a capacity expansion model.*

G. Action plan²⁶⁴

232. PREPA requested a waiver of this requirement on the grounds that presentation of an Action Plan would interfere with its negotiations with its creditors. The Commission denied PREPA's request²⁶⁵ and directed PREPA to comply.²⁶⁶ In response, PREPA included an Action Plan in the Supplemental IRP, supported by two different near-term capital expenditure plan.²⁶⁷ The deficiencies in this approach were discussed in Part IV(G).

233. **Finding:** *The IRP **did not comply** with the requirement to file an adequate Action Plan.*

²⁶¹ Supplemental IRP, Section 3.

²⁶² Supplemental IRP, Sections 7 and 8.7.

²⁶³ IRP Rule. §3.04(A)(6).

²⁶⁴ IRP Rule. §3.04(A)(7).

²⁶⁵ Commission Resolution on Waiver Request, June 25, 2015.

²⁶⁶ *Id.*

²⁶⁷ Supplemental IRP, Section 9.

H. Energy efficiency and demand response: Report and plan²⁶⁸

234. Article IV of the IRP Rule required PREPA to file with the Commission in each calendar year an Energy Efficiency and Demand Response Annual Report (EE & DR Annual Report) and an Energy Efficiency and Demand Response Plan (EE & DR Plan). The first EE & DR Annual Report must be filed on completion of the first full year of energy efficiency and demand response programs. The first EE & DR Plan must be filed within 120 days of selecting the third-party administrator.²⁶⁹

235. The Commission waived this requirement, determining that further information on the development of demand-side resources would be postponed until later IRP filings.²⁷⁰ Energy efficiency and demand response are important elements of the Company's IRP, and will be key resources for serving customers' needs. The Commission directs PREPA to include the EE & DR Annual Report and EE & DR Plan in the next IRP, unless the Commission requires submission at an earlier date.

236. **Finding:** *This requirement was **waived** by the Commission for this IRP and deferred.*

I. Performance metrics²⁷¹

237. Article V of the IRP Rule requires the Commission to open a docket within sixty (60) days of the decision on the IRP. In that new docket, the Commission will establish targets for the performance areas identified in Article V, among other things. PREPA's performance will be evaluated against those targets.²⁷² Stakeholders will have an opportunity to file comments.

238. Since the performance docket will not start until after the final decision on this first IRP, PREPA is not required to comply with Article V in this first IRP.

239. **Finding:** *This requirement is **not applicable** to this proceeding.*

²⁶⁸ IRP Rule § 3.04(A)(8).

²⁶⁹ IRP Rule § 4.01 (B), (C).

²⁷⁰ Commission Resolution on Waiver Request. June 25, 2015. Paragraph 21.

²⁷¹ IRP Rule § 3.04(A)(9).

²⁷² IRP Rule § 5.01 (C), (D).



J. Models, methodologies and work papers²⁷³

240. Section 2.04(B)(6) of the IRP Rule required PREPA to describe all models and methodologies used in performing the IRP, and provide its reasons for choosing them. That obligation includes any computer model, proprietary program, and functional workpapers. (Functional workpapers allow the Commission to substitute alternative values, with the spreadsheet then performing calculations automatically to display new outcomes.) Without that information, the Commission would be unable to verify PREPA's analyses.

241. PREPA sought a waiver, which was denied. The Commission later granted trade secret protection over the PROMOD inputs; however, this decision did not exempt PREPA from providing the Commission PROMOD inputs and functional workpapers.

242. PREPA failed to provide sufficient access to its functional workpapers or its financial models. In particular, workpapers initially provided were nonfunctional. Functional workpapers were not provided to the Commission until March 2, 2016, and then only after three separate Commission Requirements of Information.

243. **Finding:** *The IRP did **not comply** with the requirement to describe and provide all models, methodologies, and workpapers.*

K. Competitive bidding to procure additional resources²⁷⁴

244. Competitive bidding, performed properly, induces prospective sellers to offer high quality at reasonable cost. In the context of PREPA's IRP, opportunities for competitive bidding include the provision and construction of new generation, supply of purchased power, and generation repowering and modernization. In its Supplemental IRP, PREPA's Preferred Portfolio (as modified) included an intent to procure new generation at Palo Seco, Aguirre CC gas turbine replacement, and new generation at Aguirre through competitive bidding.

245. **Finding:** *The IRP **complied** with the requirement to conduct competitive bidding.*

L. Energy efficiency, renewable energy and the performance of fossil fuel generation²⁷⁵

246. Chapter IV of Act 57 requires Commonwealth government agencies, the judiciary, the Legislative Assembly and municipalities to reduce their energy consumption by stated amounts over specified time periods. PREPA's IRP needed to take into account

²⁷³ IRP Rule § 3.04(A)(10).

²⁷⁴ IRP Rule § 3.04(A)(11).

²⁷⁵ IRP Rule § 3.04(A)(12).

those mandatory reductions, along with reasonably forecasted reductions by consumers at large due to other energy efficiency measures.

247. In its Revised IRP, PREPA assumed that only 80% of the mandatory governmental reduction would occur, and excluded any other type of energy efficiency attributable to other consumers. This treatment was inappropriate. That document should have incorporated a rough estimate of long-term energy efficiency savings from all consumer categories, for the entire 20-year planning period. The Commission ordered PREPA to modify its load forecast by adding in a reasonable estimate of efficiency savings that could be achieved through energy efficiency programs.

248. PREPA's Supplemental IRP incorporated these energy efficiency programs into the modified portfolios. Yet, this Supplemental IRP still failed to consider a scenario reflecting 100% compliance with the governmental energy efficiency program. PREPA also evaluated the potential for renewable energy resources, including those provided by independent power producers, to comply with the RPS. However, PREPA tested full RPS compliance only as a sensitivity case, rather than treat it as the legal obligation that it is.

249. **Finding:** *The IRP did not comply with the requirement to assess compliance with relevant statutory requirements.*

M. Benefit to customers and public interest²⁷⁶

250. The preceding subsections have identified numerous instances of noncompliance. These omissions, particularly the lack of capacity expansion modeling, the narrow approach to fuel price forecasts and the limited load forecasts used, render the Commission unable to determine that the proposed IRP is in the public interest.

251. **Finding:** *The IRP did not comply and the Commission is unable to determine that it is in the benefit to customers and public interest.*

VI. FINDINGS AND DIRECTIVES RELATED TO SPECIFIC RESOURCE OPTIONS

252. This Part specifies the actions under the submitted IRP that PREPA must take, and the limits on those actions. PREPA shall not take actions inconsistent with those limits. Furthermore, while this Final Resolution and Order approves actions, it does not determine the reasonableness of costs associated with those actions. The Commission will examine the reasonableness of costs in a rate case. This Final Resolution and Order does not preclude PREPA from seeking a Commission decision regarding the reasonableness of particular costs before PREPA incurs those costs. Furthermore, the Commission reserves

²⁷⁶ IRP Rule § 3.04(A)(13).

its power to require PREPA, in particular circumstances, to obtain permission from the Commission before incurring costs.

253. Each directive described in this Part VI is incorporated, along with specific deadlines and supplemental reporting requirements, in the Modified IRP approved in Part VII below.

A. Generation

1. Continued permitting, and only permitting, of Aguirre Offshore Gas Port

254. The Commission APPROVES continued permitting, engineering, and planning activities related to the AOGP project, subject to a \$15 million spending cap starting from the date of the issuance of this order. This spending applies to the total combined spending on (1) permitting, engineering and planning activities associated with AOGP; and (2) the gas conversions of the existing generating units at Aguirre (discussed in Part VI(A)(2), below). The Commission is expressly DISAPPROVING the construction of AOGP, or any other expenditure relating to AOGP, at this time. The term "AOGP" refers only to the Aguirre Offshore Gas Port itself. It expressly excludes any additions to or modifications of the generating fleet located at the Aguirre site.

255. The Commission cannot conclude that AOGP represents a least-cost, least-risk path for serving customers' needs and meeting Puerto Rico's energy policy goals based on the facts presented in this proceeding. There are three main reasons.

256. **Unreliable fuel forecasts:** As explained in Part IV(B), PREPA failed to examine a range of fuel prices trajectories. The analysis initially presented in the First Stage IRP indicated that the benefit of AOGP was approximately \$2.5 billion. By the close of the IRP proceeding, the drop in both oil and gas prices reduced the relative benefit of AOGP to approximately \$200 million—a low benefit for a project occupying such a large role.

257. **Failure to test alternative portfolios:** Even that small positive value does not support AOGP, because as explained in Part IV(A)(1), PREPA's failure to use a capacity expansion model meant that that scenarios incorporating AOGP were not tested against portfolios that were optimized without AOGP, such as portfolios that satisfied MATS at a potentially lower cost and without reliance on gas. Without comparing AOGP to optimized alternative scenarios, it would be irresponsible to approve or undertake major capital expenditure on this project.

258. **Permitting uncertainty:** Permitting alone has delayed AOGP's completion by two years. While the First Stage IRP anticipated an online date of first quarter 2016,²⁷⁷

²⁷⁷ First Stage IRP, p. 3-1 (Aguirre Offshore Gas Port).

PREPA now envisions operations beginning mid-to-late 2018.²⁷⁸ Permits required by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, submitted in August 2013, are in the third year of review; as of February 2016 there were unresolved issues in the Draft Biological Assessment. A separate permitting process with the U.S. Army Corps of Engineers, initiated in July 2013, is on hold until a benthic resources mitigation plan is resolved. When permit resolutions will occur is uncertain.

259. **Conclusion:** A thorough and competent benefit-cost analysis may favor AOGP, by showing that the project can provide net benefits to PREPA's ratepayers, reduce emissions and help meet MATS requirements. But the risks of delay and escalating costs are real and significant. The project also creates a long-run dependency on imported natural gas, whereas the statutory and commonsense goal is to reduce our dependence on fossil fuel imports.

260. Indeed, by increasing penetration of renewable energy and making energy efficiency a priority, PREPA's need for fossil generation will decrease substantially. Figure 3 shows that under the scenario in which energy efficiency increases modestly ("P3MF1M"), PREPA's anticipated natural gas consumption is projected to decline back to today's consumption levels by the early 2030s. In 15-20 years, PREPA could be consuming fossil fuel only from its purchase power arrangements (AES and EcoEléctrica, or equivalents), and Costa Sur. Under this reasonable and appropriate future scenario, AOGP's value would have been short-lived.

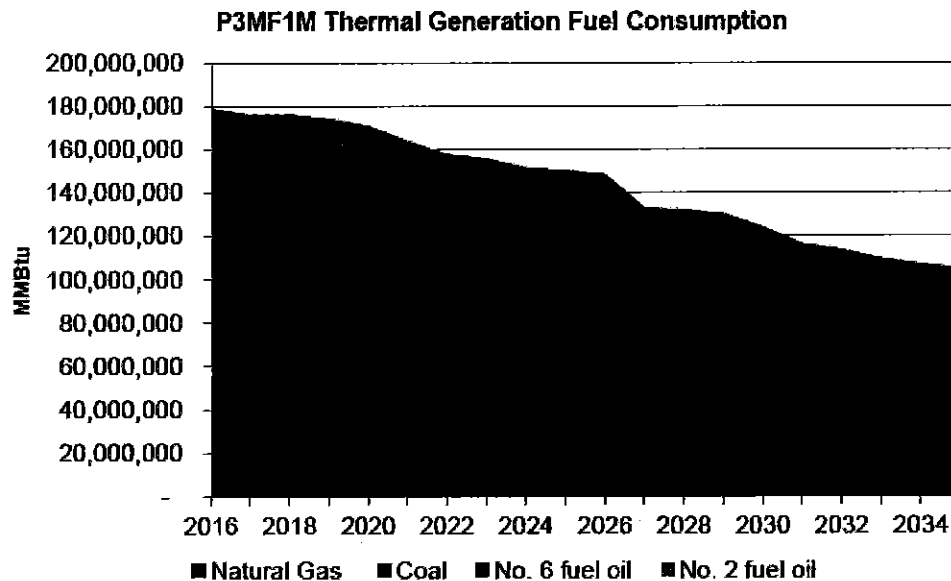


Figure 3. Fuel consumption from P3MF1M, Figure 8-4 in Supplemental IRP.

²⁷⁸ As discussed during the Oral Arguments, May 13, 2016.



261. PREPA may ask the Commission for permission to exceed, or make commitments that will cause it to exceed, the \$15 million cap. The Commission will grant such permission only on review of a sound economic analysis of AOGP in comparison to optimized alternative options. On receiving such a request from PREPA, the Commission will provide guidance on the type of information the Commission must receive to support the requested permission. If that information and the accompanying analysis demonstrate AOGP to be part of a least cost resource plan, then the Commission may grant PREPA permission to move forward with the project beyond the stated \$15 million cap.

2. Deferral of conversions of Aguirre steam units 1 and 2 and CC units 1 and 2 to natural gas

262. Any benefit associated with converting the generating units at Aguirre to natural gas can materialize only if AOGP is constructed. Because the Commission is not approving construction of AOGP at this time, we DISAPPROVE the conversions of the existing Aguirre steam and combined cycle units to run on natural gas. The Commission will approve proposed gas conversions only if we approve AOGP as cost-effective, and if we also determine that conversion of the existing units to run on natural gas is part of a least cost plan. PREPA may continue permitting, engineering, and planning activities related to these conversions, subject to the same \$15 million total spending cap discussed in Part VI(A) above. PREPA may not enter into any new contractual agreements regarding these conversions without permission from this Commission.

3. Permitting for large dual-fuel capable combined cycle unit at Aguirre

263. The Commission APPROVES for PREPA to begin a permitting process for a new large (over 100 MW) dual-fuel-capable combined cycle unit at Aguirre to be completed by 2020 or 2021. The Commission ORDERS PREPA to develop and file for Commission review a proposed calendar for the development of such unit, which shall include all development stages, including competitive bidding. PREPA is NOT AUTHORIZED, however, to commit to a contractor or commence any form of construction of a new unit at Aguirre until the Commission states otherwise.

264. Without AOGP, PREPA's near-term action plan requires a path to MATS compliance—one that does not entail converting existing units to run on natural gas. In every portfolio considered by PREPA, a new large combined cycle unit at Aguirre replaces the existing Aguirre steam units. In Future 1, the steam units are fired by gas for an interim period until 2026, at which point they are replaced by a new large combined cycle unit. In Future 2, the large combined cycle unit is built in 2020, with the retirement of the existing facilities occurring a year later. Together, these analyses support a new combined cycle unit at Aguirre, regardless of whether it is ultimately fired with natural gas (with AOGP) or with diesel (as in Future 2).

4. Turbine replacement at Aguirre combined cycle units 1 and 2

265. The Commission APPROVES the replacement of turbines (also referred to as "repowering") of the two combined cycle units, Aguirre 1 and 2.

266. Turbine replacement will allow this facility to continue operating, with more flexibility. Turbine replacements for the Aguirre 1 and 2 combined cycle units come at a moderate cost, but provide a 21% improvement in heat rate and a three-fold increase in capacity factor. The total development time is also a year shorter than that required to build a new large combined cycle unit. Especially given the need to reduce reliance on the Aguirre steam turbines in preparation for retirement of these non-MATS compliant units, (as explained in Part IV(E)(1)), we find that repowering of the Aguirre CC units is a sound investment.

5. Permitting for three dual-fuel-capable combined cycle units at Palo Seco; construction of one dual-fuel-capable combined cycle unit

267. The Commission APPROVES permitting for three small (under 100 MW) dual-fuel capable combined cycle units at Palo Seco. The Commission APPROVES the construction of one of the three dual-fuel capable combined cycle units at Palo Seco.

268. Regardless of the ultimate decision on AOGP, the combination of MATS requirements and transmission constraints requires new generation in the North. Pursuing permitting for three small units rather than a single larger combined cycle is the appropriate course. Doing so will also help reduce future reserve margin requirements.

269. The amount of new generation optimally located in the North depends on many factors, including whether AOGP is constructed and whether load changes over time. By approving the construction of only one small unit at Palo Seco, we preserve the option of approving additional units while reducing the risk of excess capacity.

6. Retirement of oil-fired steam units: Costa Sur 3 and 4, Palo Seco 1 and 2, San Juan 7 and 8

270. The Commission APPROVES the retirement of Costa Sur 3 and 4, Palo Seco 1 and 2 and San Juan 7 and 8. PREPA should complete the retirement of these units as soon as feasible.

271. PREPA's current generation fleet is mostly oil-fired steam generation. Constructed in the 1960s and 1970s, these units are approaching the end of their service lives. With the exceptions of Costa Sur 5 and 6, they do not comply with MATS. They are also inflexible in their operations, with high minimum run rates and runtimes, slow ramp rates, and high forced outage rates. These operational characteristics both damage PREPA's reliability and present barriers to the integration of renewable energy sources. The high heat rates of these units, averaging around 10,000 MMBTU/kWh, cause them to

consume more fuel than PREPA's more-efficient combined cycle units. Because fuel is the single largest component of PREPA's system costs, reducing fuel consumption is key to a lower-cost future. In short, retiring these units will lower costs, improve reliability and help achieve MATS compliance.

7. Designation of San Juan 9 and 10 as "limited use"

272. The Commission APPROVES the designation of San Juan 9 and 10 as "limited use" under MATS.

273. San Juan 9 and 10 are not MATS compliant. PREPA asserts that it must maintain these units as "limited-use" for the sake of system stability in times of exceptional need. Given PREPA's plans to rely increasingly on generation in the South, the Commission agrees that maintaining these units for limited use is appropriate. However, in 2015, PREPA violated the 8% capacity factor limit that defines limited use. We direct PREPA to avoid such violations in the future.

B. Investment in transmission and distribution projects

274. PREPA SHALL PURSUE those investments in its transmission and distribution systems that, consistent with prudent utility practice, are required for system stability and operability.

275. PREPA's IRP proposes almost \$2 billion in spending on transmission infrastructure. It places this spending into three categories: Main Projects, which are required to integrate new generation and strengthen South-to-North transfer capacity; Other Projects, which include general maintenance projects necessary for the sound operation of every level of the transmission system; and Support Projects, which include ancillary spending necessary to complete the other two project categories (such as equipment purchases).

276. The Commission in this proceeding did not evaluate PREPA's proposed transmission and distribution investments on a project-by-project basis. Based on the information presented in this IRP proceeding only, the Commission concludes that PREPA's proposed transmission investments are, for the most part, not contingent on changes to PREPA's generation fleet. They are, instead, primarily deferred maintenance projects. We defer a more detailed review of PREPA's proposed spending to the pending rate case. In the interim, and based on the information presented in this IRP proceeding only, we direct PREPA to continue necessary maintenance investments in its transmission and distribution system consistent with prudent utility practice. We further direct PREPA to maintain detailed and accurate records of any transmission- or distribution-related spending that occurs prior to the conclusion of the pending rate case. More detail on these requirements appears in Part VII.

C. Assessment of existing renewable energy contracts for non-operational projects

277. PREPA shall conduct a detailed audit of all existing renewable energy contracts for projects which are not yet operational, and pursue renegotiation of or exit from these contracts as appropriate, as detailed further in Part VII.

D. Pursuit of energy efficiency and demand-side management

278. The Commission APPROVES the energy efficiency resources described in the Supplemental IRP.

279. PREPA estimates the cost of fuel and purchased power at \$0.08 to \$0.13/kWh, whereas the cost for energy efficiency is about \$0.04/kWh.²⁷⁹ Energy efficiency not only avoids fuel costs; it also reduces the need for new capital investment for generation facilities (especially for capacity added to meet demand peaks), as well as capital investment for upgrading transmission and distribution infrastructure. Energy efficiency can also help PREPA comply with multiple environmental requirements. To reduce its high reliance upon expensive and volatile fossil fuel and purchased power costs, and to improve its financial situation, PREPA must increase the role of energy efficiency.

VII. APPROVAL OF MODIFIED IRP

A. Overview: The need for action, now

280. Acting under Section 3.03(A)(3) of the IRP Rule, the Commission DISAPPROVES the IRP submitted by PREPA. PREPA's IRP suffers from numerous shortcomings, as described in Part IV; fails to comply with the Commission's IRP Rule in multiple ways, as described in Part V; and includes some resources that the Commission has disapproved, as described in Part VI.

281. This disapproval creates a problem. If we take no further action, there will be no approved IRP. Given the urgent need to reform the Commonwealth's electric system, the absence of an IRP is unacceptable. PREPA needs an integrated resource plan, now. But this proceeding has made clear that PREPA is not presently capable of preparing an IRP that satisfies Act 57-2014, complies with the Commission's Rule, meets the Commonwealth's energy policy goals, and serves electricity customers' best interests. Over the past 14 months,²⁸⁰ we gave PREPA many opportunities to comply with our Rule. We

²⁷⁹ Affirmed by PREPA as reasonable during the Technical Conference.

²⁸⁰ Starting from July 2015, when PREPA submitted the Draft IRP.

accepted three revisions to the original submission, waived multiple requirements, and allowed deviations from standard industry planning procedures. We gave PREPA and its consultants detailed and repeated guidance on the Commission's expectations. Yet PREPA was unable to produce an IRP of the quality our citizens deserve.

282. Under these circumstances, asking PREPA to fix its proposed IRP will only delay this process without guaranteeing success. Consequently, the Commission will fill the gap caused by PREPA's noncompliance. The Commission itself will issue and approve a "Modified IRP." Under Section 6.23(c) of Act 57-2014, the Commission has an explicit duty to "review, approve, and modify [an IRP], to ensure full compliance with the public policy on energy of the Island and the provisions of this Act." This language requires the Commission, in the absence of a compliant plan from PREPA, to issue a Modified IRP that satisfies the statute. We do so in this Final Resolution and Order.

283. The Modified IRP, described in Part VII.B below, will enable PREPA to meet its obligations to the people and businesses of Puerto Rico. While this Modified IRP does not represent the level of detail or analysis expected by this Commission for future IRPs, it is a practical necessity given the unique conditions described in Part II, the shortcomings documented in Part IV and the non-compliances determined in Part V. PREPA is facing extraordinary financial and capital constraints and demands. Its infrastructure has not been adequately maintained. Its generation fleet violates MATS. Its customers are hostages of volatile fuel pricing and environmental degradation from fossil fuels.

284. In sum, by specifying decisions on actions and expenditures, this Modified IRP will put PREPA on a positive path. We must push PREPA from the past into the future, with a decisive plan that aligns its investments and actions with the Commonwealth's evolving needs. There cannot be, and will not be, any more delays.

B. The Modified IRP

285. The modified IRP described in this Part VII(B) consists of two segments. Segment 1 is the Action Plan; Segment 2 is Resource Planning Information. After presenting these two segments, we provide directives in Part VII(C), requiring PREPA to submit to the Commission an update to this Modified Plan, along with certain elaborations. In Part VII(D) we issue directives to improve PREPA's performance in the next IRP planning cycle.

1. Modified IRP segment 1: Action plan

286. This Modified Action Plan consists of specific directives to PREPA. It incorporates elements of the Action Plan proposed by PREPA in the final version of its Updated Fuel IRP,²⁸¹ as well as the Commission's findings and decisions in this Final

²⁸¹ Particularly with regard to Section 10 (regarding thermal generation) and Sections 6 and 8 (regarding transmission).

Resolution and Order. We describe here actions PREPA shall take over the next five fiscal years. Actions that PREPA would take after FY-2021 are not discussed in this Plan. (Thus, the elements absent from this Modified IRP include the potential construction of new generation at Aguirre and Costa Sur, and the potential extension of PREPA's contracts with AES and EcoEléctrica, all of which are discussed in PREPA's proposed Action Plan.) This Modified Action Plan will remain in place until another Action Plan is approved by the Commission.

287. Inclusion of specific actions or investments in this Modified Action Plan does not constitute pre-approval of those actions or investments by this Commission, nor is PREPA guaranteed recovery of costs related to those actions or investments. PREPA must submit to the Commission specific requests, whether in a rate case or other proceeding, for approval of individual actions and investments. Such requests must be accompanied by documentation and analysis.

288. For many of the directives listed below, PREPA must submit to the Commission detailed information, such as progress reports, and, when required, draft RFPs, pursuant to Section 6B(a)(iii) of Act 83 and the Joint Regulation approved by the Commission and PREPA to that effect. PREPA must comply with the terms and conditions of such Joint Regulation when conducting any public procurement processes performed to comply with the dispositions of this Final Resolution and Order. The Commission will exercise its powers to review and guarantee that PREPA undertakes a public procurement process which fully complies with the goals and objectives of the Modified IRP, this Final Resolution and Order and all applicable laws and regulations related to procurement processes. The Commission will not approve any competitive bidding process that do not conform to the objectives and directives set forth herein.

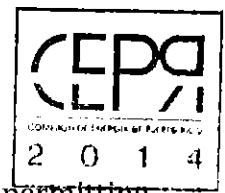
289. According to the above, we provide a deadline for each of the reports requested. If PREPA finds that it is unable to meet any of the deadlines, the Company shall provide notice to the Commission no less than 10 business days prior to the deadline. Any such notice shall include a justification for the delay and a proposal for a new deadline. Following the narrative that appears next, a Table provides a summary of the Modified Action Plan.

290. For each the items below, a first paragraph states the general purpose; the secondary paragraphs state the specific actions.

a. AOGP

291. PREPA shall pursue permitting, engineering, and planning for AOGP, subject to a \$15 million spending cap on these activities.

1. By December 31, 2016, and every three months thereafter, PREPA shall submit to the Commission a report detailing the permitting status of AOGP and any changes in that status that have occurred since the previous update.



For the first such report, PREPA shall detail any changes in the permitting status of AOGP that have occurred since the Oral Arguments in this proceeding (May 13, 2016).

2. PREPA may request permission from the Commission to exceed the \$15 million cap. PREPA shall accompany such request with a detailed economic assessment of the AOGP project, assessing a range of fuel forecasts, demand requirements, and alternative mechanisms of meeting MATS requirements in a timely fashion. As discussed in Part VI(A), the Commission will provide further details as to the requirements for this assessment upon receipt of PREPA's request.
3. If PREPA declines to pursue AOGP, PREPA shall submit a motion to the Commission in a timely manner stating its intent to cease activities relating to the project, after which no additional reporting regarding the project will be required.
4. Regardless of its plans for AOGP, PREPA must pursue a MATS compliance strategy diligently.

b. New Aguirre combined cycle unit

292. PREPA shall pursue permitting for one large, dual-fuel capable combined cycle unit at Aguirre, so that this generation resource option will be available in the event that AOGP is found to be not cost-effective.

1. By December 31, 2016 PREPA shall submit to the Commission a detailed plan for the evaluation, siting, permitting and public procurement process for a new dual-fueled combined cycle unit to replace the Aguirre steam units.
2. By March 31, 2017, and every six months thereafter, PREPA shall submit to the Commission a report detailing the permitting status of a new large, dual-fuel capable combined cycle unit at Aguirre and any changes in that status that have occurred since the previous update.

c. Aguirre 1 and 2 combined cycle repowering

293. PREPA shall pursue permitting and start a competitive bidding process pursuant to Section 6B(a)(iii) of Act 83 and the Joint Regulation approved by the Commission and PREPA to that effect, for the repowering of the Aguirre 1 and 2 CC units with new, dual-fuel capable turbines.

1. By December 31, 2016, and every six months thereafter, PREPA shall submit to the Commission a report detailing the permitting status of repowering the existing combined cycle units at Aguirre and any changes in that status that have occurred since the previous update.

2. By June 30, 2017 PREPA shall start a competitive bidding process pursuant to Section 6B(a)(iii) of Act 83 and the Joint Regulation approved by the Commission and PREPA to that effect, for the procurement and installation of new turbines at the existing Aguirre combined cycle site.

d. Palo Seco small dual-fuel combined cycles

294. PREPA shall pursue permitting for three small (under 100 MW) dual-fuel capable combined cycle units at Palo Seco. PREPA shall start a competitive bidding process pursuant to Section 6B(a)(iii) of Act 83 and the Joint Regulation approved by the Commission and PREPA to that effect, for the procurement of one of those small combined cycle unit at Palo Seco.

1. By March 31, 2017 and every six months thereafter, PREPA shall submit to the Commission a report detailing the permitting status of three new small, dual-fuel capable combined cycle units at Palo Seco and any changes in that status that have occurred since the previous update.
2. By June 30, 2017 PREPA shall start a competitive bidding process pursuant to Section 6B(a)(iii) of Act 83 and the Joint Regulation approved by the Commission and PREPA to that effect for the procurement of one small combined cycle unit at Palo Seco.

e. Oil-fired steam retirements

295. PREPA shall retire Costa Sur units 3 and 4, Palo Seco units 1 and 2, and San Juan units 7 and 8 as soon as feasible.

f. San Juan units 9 and 10

296. San Juan units 9 and 10 shall be treated as follows:

1. PREPA shall designate San Juan 9 and 10 as "limited use" units.
2. If PREPA cause to operate San Juan 9 and 10 at a level exceeding the "limited use" designation, it shall notify the Commission of such action in advance if possible, but no later than fourteen (14) days from the initiation of such action. Ninety (90) days after its notice to the Commission, PREPA shall file a report detailing the extent to which its use of San Juan 9 and 10 has exceeded the "limited use" designation and the primary causes of the exceedance.

g. Environmental compliance litigation

297. By March 31, 2017 and every six months thereafter, PREPA shall submit to the Commission a report detailing the status of all current environmental compliance litigation relevant to PREPA, as well as any substantial risks of such litigation.

h. Transmission and distribution

298. PREPA shall pursue those investments in its transmission and distribution systems that, consistent with prudent utility practice, are required for system stability and operability.

1. By March 31, 2017 PREPA shall submit to the Commission a transmission maintenance and improvement plan and a distribution maintenance and improvement plan, including a detailed budget.
2. Every six months thereafter, PREPA shall submit to the Commission a report describing the progress made on the transmission maintenance plan and the distribution maintenance plan, as well as information on spending to date compared to the budget.

i. Existing renewable energy contracts for projects which are not operational

299. PREPA shall conduct an independent audit of its existing renewable energy contracts pertaining to projects which are not currently operational. PREPA shall pursue renegotiation of, or exit from, contracts that are not cost-effective and those which are not likely to reach completion, to the extent such actions are lawful.

1. By June 30, 2017 PREPA shall submit to the Commission an assessment of each unfulfilled renewable energy contract currently held by PREPA, and PREPA's plans to seek renegotiation of or exit from such contracts.
2. Every six months thereafter, PREPA shall submit to the Commission a progress report on its efforts to renegotiate or exit from such contracts.

j. New renewable energy contracts

300. PREPA shall start a competitive bidding process pursuant to Section 6B(a)(iii) of Act 83 and the Joint Regulation approved by the Commission and PREPA to that effect, for new renewable energy projects located on the Island, and seek agreements consistent with such competitive bidding process. Eligible projects shall include all technologies which qualify as renewable under Puerto Rico's Renewable Portfolio Standard.

1. By June 30, 2017 PREPA start a competitive bidding process pursuant to Section 6B(a)(iii) of Act 83 and the Joint Regulation approved by the Commission and PREPA to that effect for the procurement of new renewable energy resources.
2. Every six months after the Commission approves the public procurement process, PREPA shall submit to the Commission a progress report describing

the results of its efforts to obtain agreements with developers of renewable energy projects.

k. Energy efficiency, demand response and energy storage

301. Energy efficiency, demand response and energy storage shall be treated as follows:

1. PREPA shall cooperate with one or more Commission-appointed third-party administrators in the preparation of a potential study (or studies if necessary) regarding energy efficiency and demand response.
2. PREPA shall cooperate with one or more Commission-appointed third-party administrators in designing and implementing, cost-effective, state-of-the art energy efficiency and demand response programs.
3. PREPA shall submit an updated analysis of the potential for energy storage in the next IRP (unless the Commission order such analysis to be produced at an earlier date), with updated costs assumptions and an improved modeling approach and valuation methodology.

l. MATS compliance and environmental concerns generally

302. By December 31, 2016, and every six months thereafter, PREPA will submit to the Commission a report (which may be confidential only to the extent confidentiality is required by law), on the status of its discussions with EPA with regards to MATS compliance and any other pending environmental litigation.

Summary of Modified Action Plan

Resource	Action	Reporting to Commission
AOGP	Pursue permitting	Economic analysis; as needed but no later than 6/30/17
New Aguirre CC	Pursue permitting	Execution plan; 12/31/16; Permitting updates; 3/31/17
Aguirre CC 1 and 2	Pursue permitting Start competitive bidding process	Permitting updates; 12/31/16; Draft RFP; 6/30/17
Palo Seco Three Small CCs	Pursue permitting	Permitting updates; 3/31/17
Palo Seco One Small CC	Start competitive bidding process	Draft RFP; 6/30/17
Palo Seco 1 and 2	Retire	Confirmation of retirement; 12/31/20
Costa Sur 3 and 4	Retire	Confirmation of retirement; 12/31/20
San Juan 7 and 8	Retire	Confirmation of retirement; 3/31/22
San Juan 9 and 10	Designate "limited use"	Notification of and report explaining exceedances of limited use; as needed
Environmental Litigation		Status report; 3/31/2017
Transmission	Pursue proposed investments	Transmission plan; 3/31/17
Distribution	Pursue proposed investments	Distribution plan; 3/31/17
Existing Renewable Energy Contracts	Assess unfulfilled contracts	Status report; 6/30/17
New Renewable Energy Projects	Start competitive bidding process	Draft RFP; 6/30/17
Energy Efficiency	Support potential study	Potential study; date dependent on third-party administrator
Demand Response	Support potential study	Potential study; date dependent on third-party administrator
MATS Compliance	EPA negotiations	Quarterly reports; 12/31/16

2. Modified IRP segment 2: Resource planning information

303. Under Section 6.C(h)(ii) of Act 57, every IRP shall include the following information: a range of future demand forecasts; an evaluation of conservation resources; an evaluation of the range of conventional and non-conventional generation technologies; an evaluation of transmission capacity and reliability; a comparative evaluation of energy supply resources, including transmission and distribution; an evaluation of resources to promote diversification, stabilize energy costs; and improve reliability and stability; an evaluation of the existing electric power plants; evaluation of environmental impacts of PREPA; and evaluation of the interconnection of renewable energy and independent power producer projects.

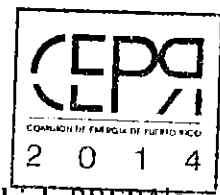
304. Technically, PREPA's IRP included the information required by Act 57. However, as detailed in Part V of this Final Resolution and Order, PREPA's IRP does not comply with several of the specific requirements in the Commission's IRP Rule. That non-compliance is due to deficiencies in PREPA's analytical methodology and evaluations, and in the application of the information it did provide. PREPA's IRP complies, nominally with Act 57-2014, but in its present form does not fulfill the objectives of the Act.

305. For purposes of approving this Modified IRP, given PREPA's nominal compliance with the afore-stated statutory list, the Commission will deem included in this Modified IRP the resource planning information provided in the final version of the Updated Fuel IRP. That information provides the Commission with sufficient understanding of PREPA's system and resource options to create the Modified Action Plan described above. Therefore, the combination of that planning information and the Modified Action Plan produces a Modified IRP that the Commission can approve, consistent with the statute and our IRP Rule, thus allowing PREPA to move forward.

3. Submission by PREPA

306. This Final Resolution and Order approves the above-described Modified IRP. Its effective date is the date this Final Resolution and Order is published. Pursuant to IRP Rule § 3.03(A)(3), PREPA shall, no later than thirty (30) days from such effective date, **SUBMIT TO THE COMMISSION THIS MODIFIED IRP**, with any additional dates and details that PREPA determines will assist the Commission and the public to hold PREPA accountable for its performance of the responsibilities described therein. Once the Commission determines that such PREPA-submitted Modified IRP is consistent with this Part VII, the Commission will declare that such Modified IRP, as submitted by PREPA, has replaced the Commission's Modified IRP as the approved IRP. But until the Commission issues such declaration, the Commission's Modified IRP established in this Part VII is PREPA's approved IRP.

307. We make this finding for an obvious reason: To await PREPA's affirmative approval until an IRP has been legally approved would return us to the status quo, of having no IRP until PREPA finds its way to complying with our clear obligations. Such a result would not be consistent with the IRP statute, the IRP Rule, or the public interest. The



Commission will not accept, and the public will not tolerate, a situation in which PREPA's noncompliance leaves the Commonwealth with no IRP. Effective today, this Modified IRP is the approved IRP.

C. Preparing for the next IRP cycle

308. Future IRP proceedings must take less time, produce more value, and result in an IRP that the Commission can approve. PREPA must improve its resource planning process so that future IRPs comply with the statute and our rule, while matching or exceeding industry standards. The Commission will address the Company's resource planning performance in a forthcoming proceeding on performance.²⁸² In the meantime, and to start the improvement process, the Commission issues the three groups of directives described next.

1. **Internal improvements:** PREPA shall submit to the Commission, no later than 90 days from the date of this Final Resolution and Order, a report describing how it will improve its resource planning process. The report shall include, at a minimum, the following:
 - a. The (i) specific steps PREPA intends to take correct all deficiencies identified in this Final Resolution and Order, (ii) names and positions of PREPA executives and managers responsible for taking those steps, (iii) dates by which those steps will be taken.
 - b. A description of the modeling framework PREPA will use in the next IRP, including a discussion of how PREPA will use capacity expansion modeling capabilities.
 - c. A description of which internal departments will have responsibilities in the development of the next IRP, a description of those responsibilities, and the names of such departments' leaders.
 - d. A description of the professional development efforts PREPA will make to ensure that its internal personnel are sufficiently educated and expert on the requirements of Act 57-2014, our IRP Rule, and standard industry practices regarding long-term resource planning.
 - e. A description of how the Company will improve its record-keeping practices, including how it will (i) save, in digital form, vital communications, memoranda, white papers and contracts, and (ii) ensure clear lines of control and authorship for all data and analyses.

²⁸² IRP Rule § 5.01(A) states that within sixty days of the approval of the first IRP, the Commission shall open a docket to establish performance mechanisms that will apply to PREPA.

2. **Selection of IRP consultant:** This proceeding demonstrated the influence that an outside consultant can have on the quality of PREPA's submissions to the Commission, and on the efficiency with which those submissions are created and disseminated. A prerequisite to improving the IRP process, therefore, is that PREPA work with an IRP consultant whose experience, skills and objectivity ensure that PREPA produces an IRP that complies with the Commission's rules and satisfies industry standards. Choosing an appropriate consultant is especially important given that the cost of the consultant is borne by PREPA's customers. Accordingly, PREPA's next selection of an IRP consultant will be subject to the following procedure:
 - a. At a time of the Commission's designation, and subject to any guidance the Commission provides, PREPA shall submit to the Commission a draft Request for Qualification (RFQ) for IRP consulting services. Such draft RFQ shall set forth the minimum qualification requirements for providing IRP-related consulting services. The Commission will review and, if necessary, modify the draft RFQ.
 - b. Once the RFQ is approved by the Commission, PREPA will issue such RFQ and shall receive responses from interested potential consultants. PREPA will qualify respondents based on the requirements contained in the approved RFQ.
 - c. PREPA shall submit to the Commission a pool of potential consultants, accompanied by a certification from a responsible PREPA executive that each member of the pool satisfies the requirements of the RFQ. PREPA shall also provide to the Commission any documents relied on by PREPA in determining such certification.
 - d. Upon a determination by the Commission that the members of the pool satisfy the requirements of the RFQ, PREPA shall have discretion to choose one or more consultants from the pool.
3. **Data collection:** In preparation for the next IRP and other proceedings, and in keeping with utility best practices, PREPA shall immediately begin collecting accurate and comprehensive data on its generation, transmission and distribution facilities, as well as its customers' consumption patterns and needs.²⁸³ PREPA must keep its data in a centrally-accessible electronic format. Records should be clearly labeled with key information, including but not limited to the date on which data were collected and the units in which data are presented. These records should include at least the following information:

²⁸³ The Commission will address the Company's data and record keeping capabilities and opportunities for improving them in the forthcoming performance proceeding.

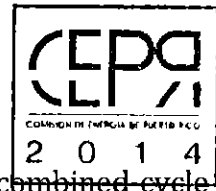
- a. Hourly net and gross generation by generating unit in MWh.
- b. Hourly heat input by generating unit in MMBtu.
- c. Hourly emissions of CO₂, SO₂, and NO_x by generating unit for all units which are currently equipped with continuous emissions monitors.
- d. Outage data by generating unit, including the date and start and end hour of all outages, a classification of each outage as either planned or unplanned, and the primary cause of the outage.
- e. Monthly fuel information by generator and fuel type, including beginning inventory balance (quantity and cost), purchases (quantity and cost), consumption (quantity and cost) and ending inventory (quantity and cost)..
- f. Monthly expenditures on PPOAs by fuel type.
- g. Hourly over-generation or curtailment experienced by renewable generators, by facility.
- h. Hourly consumption by customer class on each distribution system feeder.
- i. Monthly peak demand by customer class, including the date and hour on which the peak occurred.
- j. Service interruption data by affected feeders or substations, including the date and start and end time of all service interruptions, the number of customers by class affected by the interruption, and the primary cause of the interruption.

VIII. FINDINGS OF FACT

1. In developing resource options, PREPA did not use a capacity expansion model. A capacity expansion model is designed to find optimal (that is, least-cost) resource combinations objectively. It considers such factors as demand, unit prices and fuel prices under specific constraints such as reliability, emissions and capital limits.
2. Instead, PREPA developed resource portfolios by "manually," *i.e.*, subjectively, selecting units to be added to one of its main three generation sites (Aguirre, Costa Sur and Palo Seco/North Metro). PREPA selected these units based on its expectation that they would improve system reliability while lowering total costs.
3. For each of these subjectively designed resource portfolios, PREPA estimated generation costs using a single PROMOD run. Total system costs, including capital expenditures, were then determined on both a yearly and a net present value basis, using a spreadsheet-based financial model.
4. PROMOD is a production cost model. A production cost model determines generation dispatch for a specific period of time, such as one week or one year, given a predetermined set of generators, prices, operating constraints and hourly demand. The production cost model used by PREPA has no capability to determine a long-term, least-cost resource mix by selecting new resources and retiring existing resources.

5. PREPA iterated PROMOD results using a transmission system planning model called PSS@E to verify transmission adequacy for each portfolio/future combination.
6. The IRP Rule requires PREPA, when forecasting load, to consider a sufficient range of significant uncertainties, along with such factors as economic conditions, lower demand, customer generation, anticipated energy efficiency, fuel prices and construction costs. Instead, PREPA's IRP explored insufficient variation in market fuel prices, customer load and capital availability. Nor did PREPA compare actual load and historical forecasts.
7. After being directed by the Commission, PREPA explored a variety of sensitivity cases, all of which are based on Portfolio 3 and either Future 1 or Future 2. Portfolio 3 was PREPA's preferred portfolio.
8. PREPA incorporated several faulty assumptions into its resource planning process. Among them were these:
 - a. that natural gas will be less expensive than fuel oil or diesel;
 - b. that over the course of the planning horizon, natural gas will likely be available only in the South, such as at Aguirre or Costa Sur;
 - c. that wind was not a plausible resource due to what PREPA called "local opposition;" and
 - d. that reciprocating engines, built at centralized locations in clusters, were too expensive.
9. PREPA's resource plans were neither comprehensive nor complete, because they did not include energy efficiency, demand response or other plausible substitutes for the infrastructure PREPA's plans did include. In response to Commission orders, however, PREPA modified Portfolio 3 to include a modest level of energy efficiency.
10. In designing plans, PREPA made decisions concerning the timing of resource additions based on, among other things, access to capital and the ability to execute multiple major construction projects at one time. Retirement of non-MATS compliant units was assumed to occur as quickly as feasible, to improve reliability while not exceeding PREPA's practical and financial ability to replace units.
11. PREPA assumed that its renewable portfolio standard (RPS) obligations would be lower than the statutory requirements. PREPA then tested full RPS compliance only as a sensitivity case rather than as a base case. PREPA did not investigate the costs of its other candidate portfolios given an assumption of full RPS compliance. It is therefore impossible to determine at this time how PREPA's other proposed portfolios would perform if required to comply with PREPA's RPS obligations.
12. PREPA presented its sensitivity results for a single year (2035) rather than for the entire 20-year planning period (2016-2035). Based on these results, PREPA concluded that "full RPS compliance will add significant costs to the PREPA system" and that full RPS compliance therefore was not practical.

13. Relying on a non-discounted value for a single year to evaluate the cost of RPS compliance is neither analytically sound nor standard industry practice.
14. PREPA has no definitive plan for how to address the high costs of existing renewable energy contracts.
15. PREPA overestimated the costs of future renewable energy contracts.
16. PREPA's surplus capacity is 90%, which means its existing generating fleet can serve nearly twice its peak load. This amount of surplus capacity is large relative to other U.S. utilities; they typically plan is based on a 15% planning reserve margin. Only some of this surplus can reasonably be attributed to Puerto Rico's lack of interconnections with other geographic areas.
17. PREPA's system costs are dominated by fossil fuel costs.
18. PREPA is behind schedule for compliance with the Mercury and Air Toxics Standards (MATS). PREPA is unable to comply until mid-2021 or mid-2022 and is currently negotiating with U.S. EPA on how to reach compliance without incurring penalties.
19. PREPA faces constraints on its ability to raise capital. These constraints affect its resource planning. To meet customer demand and comply with MATS, PREPA needs to consider a wider range of resource options requiring less capital. Those options include choosing smaller, more modular units, substituting repowering for new generation, entering into power purchase agreements and enlisting customer-based generation.
20. PREPA's Action Plan was incomplete, because it did not incorporate all of PREPA's planned actions and resources (in particular, lacking consideration of energy efficiency) and did not set forth realistic and accurate dates and timelines.
21. The IRP Rule required PREPA to file a single Action Plan reflecting the near-term components of its long-term Preferred Plan. PREPA instead submitted two different action plans. One was consistent with the Preferred Plan; the other was not.
22. There is insufficient evidentiary basis for finding that AOGP is part of a least-cost plan, in part due to the absence of appropriate fuel forecasts and model runs. There is sufficient merit in the possibility of AOGP being economic to authorize spending of up to \$15 million to pursue permitting.
23. Because of the uncertainty of AOGP, it is necessary to defer the conversion to natural gas at the Aguirre steam units 1 & 2 and combined cycle units 1 & 2.
24. The evidence supports beginning a permitting process for a new dual-fuel Aguirre combined cycle unit at Aguirre, to be completed by 2020 or 2021.
25. The evidence supports replacing the turbines of the two combined cycle units at Aguirre.



26. The evidence supports permitting for three small dual-fuel capable combined-cycle units at Palo Seco, as well as the construction of one of the three dual-fuel capable combined cycle units at Palo Seco.
27. The evidence supports the retirement of Costa Sur 3 & 4, Palo Seco 1 & 2 and San Juan 7 & 8.
28. The evidence supports designation of San Juan 9 & 10 as "limited use" under MATS.
29. The evidence supports making investments in PREPA's transmission and distribution systems, to the extent consistent with prudent utility practice for purposes of system stability and operability.
30. The evidence supports requiring PREPA to conduct a detailed audit of all existing renewable energy contracts for projects which are not yet operational, and to pursue renegotiation of or exit from such contracts where lawful and appropriate.
31. The evidence supports pursuing the energy efficiency resources described in the Supplemental IRP.
32. The evidence supports requiring PREPA to prepare for its next IRP cycle by (a) creating a plan for internal improvement of its planning processes, (b) using a request for qualifications process, overseen by the Commission to select its next IRP consultant, and (c) gathering essential planning data about its electricity system.

IX. CONCLUSIONS OF LAW

1. Article 6.3 (b) and (c) of Act 57-2014 grants the Commission the authority to adopt and implement regulations necessary to "guarantee the capacity, reliability, safety, efficiency, and reasonability of electric rates." Section 6B(h)(iii) of Act 83, as amended by Act 57-2014, authorizes the Commission to establish the rules applicable to the development of PREPA's IRP. Pursuant to such provisions, the Commission adopted Regulation 8594, which sets forth the regulatory framework and filing requirements applicable to the submission by PREPA and the review by the Commission of PREPA's first IRP.
2. Section 6B(h)(i) of Act 83, as amended by Act 57-2014, and Article 6.23 of Act 57-2014, require PREPA to submit for Commission's review and approval an IRP on or before July 1, 2015.
3. Section 6B(h)(ii) of Act 83, as amended by Act 57-2014, requires that the IRP contain the following: (i) a range of future demand forecasts; (ii) an evaluation of conservation resources available in the market; (iii) an evaluation of the range of conventional and non-conventional generation resources available in the market; (iv) an evaluation of transmission capacity and reliability of the system; (v) a comparative evaluation of energy supply resources including transmission and distribution; (vi) an evaluation of the combination of resources designated to promote energy diversification, stabilize energy costs and improve the stability and

reliability of the grid; (vii) an evaluation of existing PREPA plants which estimates improvements in operational efficiency, useful lives, retirements and decommissioning costs; (viii) an evaluation of environmental impacts including air, water solid waste and other environmental factors; and (ix) an evaluation of the interconnection of renewable energy for compliance with Act 82-2010 and other independent power projects to PREPA's electricity system.

4. As required by Article 6.23(c) of Act 57-2014, Section 6B(h)(iii) of Act 83 and Regulation 8594, the Commission has reviewed the IRP. The Commission disapproves the IRP for the reasons stated in this Final Resolution and Order.
5. As required by Article 6.23(c) of Act 57-2014 and Section 3.04 of Regulation 8594, the Commission is approving a Modified Integrated Resource Plan, and ordering PREPA to submit such document with certain elaborations.
6. The Commission has no power to nullify a contract or order PREPA to exit a contract. The Commission can, and does here, order PREPA to develop a plan for seeking to renegotiate certain contracts.
7. Pursuant to Paragraph B(3) of Article 4 of Act 416-2004, as amended, known as the "Environmental Public Policy Act", the Permits Management Office ("OGPe", for its Spanish acronym) issued on August 8, 2016 a Determination of Environmental Compliance by Categorical Exclusion (Case No. 2016-DEC-00014) with regards to the IRP proceeding.
8. OGPe's determination is limited to the Commission's approval of the Modified IRP and is not applicable to any individual action undertaken by PREPA pursuant to the Modified IRP approved herein. The Commission's approval of the Modified IRP does not authorize PREPA to engage in any activities that require approval from any other government agency, including the Environmental Quality Board and OGPe, without having obtained such approval. In the context of any IRP, including the Modified IRP, the Commission's "approval" of a project means that such project, if certain assumptions are supported by facts, can be part of a least-cost plan. "Approval" does not mean that such project is consistent with laws, such as environmental laws, over which this Commission does not have jurisdiction.

* * *

Any party adversely affected by this Final Resolution and Order may file a motion for reconsideration before the Commission, pursuant to Section 11.01 of Regulation 8543 and the applicable provisions of Act No. 170 of August 12, 1988, as amended, known as the Uniform Administrative Procedure Act (UAPA). Said motion must be filed within twenty (20) days from the date in which copy of the notice of this Final Resolution and Order has been filed. Said motion must be filed at the Commission's Clerk's Office, temporarily located at the Puerto Rico Telecommunications Regulator Board, 500 Ave. Roberto H. Todd, San



Juan, PR 00907-3941. Copy of the motion as filed must be sent by email to all the parties notified of this Final Resolution and Order within the timeframe established herein.

The Commission shall have fifteen (15) days from the date in which said motion is filed to consider it. If the Commission rejects it forthright or fails to act upon it within said period of fifteen (15) days, the term to seek judicial review shall begin on the date in which the Commission notifies such denial or the date in which said fifteen (15) day expires, whichever occurs first. If the Commission considers the motion, the term to seek judicial review shall commence from the date a copy of the notice of the Commission's resolution definitively resolving the motion for reconsideration is filed. Such resolution shall be issued and filed within ninety (90) days after the motion for reconsideration has been filed. If the Commission's considers the motion for reconsideration but fails to take any action with respect to such motion within ninety (90) days of its filing, it shall lose jurisdiction to consider it and the term to seek judicial review shall commence upon the expiration of said ninety (90)-day term, unless the Commission, for just cause and within those ninety (90) days, extends the term to resolve for a period that shall not exceed thirty (30) days.

In the alternative, any affected party may file a petition for review before the Court of Appeals within a term of thirty (30) days from the date a copy of the notice of this Final Resolution and Order was filed in the record of the Commission. This in accordance with Section 11.03 of Regulation No. 8543, the applicable dispositions of UAPA and the rules and regulations of the Court of Appeals.

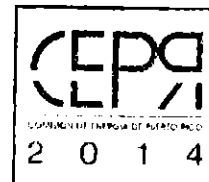
For the benefit of all the parties involved, the Commission issues this Final Resolution and Order in both Spanish and English languages. Should any conflict between each version arise, the English version shall prevail.

Be it notified and published.

Agustín F. Carbó Lugo
Chairman

Ángel R. Rivera de la Cruz
Associate Commissioner

José H. Román Morales
Associate Commissioner

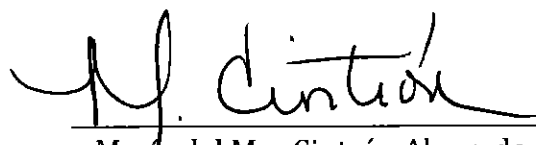


CERTIFICATION

I hereby certify that the Puerto Rico Energy Commission has so agreed on September 23, 2016. I also certify that on this date a copy of this Resolution was notified by electronic mail to the following:

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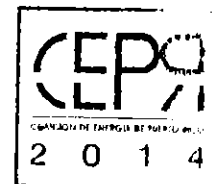


Marfa del Mar Cintrón Alvarado
Clerk

I certify that this is a true and exact copy of the Resolution issued by the Puerto Rico Energy Commission. I further certify that today, September __, 2016, I have proceeded with the filing of the Resolution and I have sent a copy thereof to:

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For the record, I sign this in San Juan, Puerto Rico, today, September __, 2016.

Jessica Fuster Rivera
Clerk of the Puerto Rico
Telecommunications Regulatory Board

APPENDIX A

TIMELINE AND HISTORY OF THE PROCEEDING

- **IRP Regulations Enacted:** May 22, 2015. Regulation No. 8594, known as the Regulation for the Puerto Rico Electric Power Authority First Integrated Resource Plan ("Regulation 8594"), approved and enacted by the Commission. Regulation 8594 established the filing requirement for PREPA's first IRP.²⁸⁴ Regulation 8594 was enacted pursuant to the emergency procedures set forth in the Uniform Administrative Procedures Act, as authorized by Article 6.20 of Act 57-2014.
- **Request for Waiver:** June 5, 2015. Pursuant to Section 2.06 of Regulation 8594, PREPA filed a request seeking waiver from compliance with twenty-five filing requirements set forth in Regulation 8594.
- **Response to Waiver Request:** June 25, 2015. The Commission issued an Order addressing PREPA's request for waiver. The Commission granted ten requests for waiver, partially granted four requests and denied the remaining eleven requests for waiver.
- **Initial 2015 Integrated Resource Plan ("Draft IRP"):** July 7, 2015. PREPA filed its Draft IRP as part of its initial filing pursuant to Regulation 8594. The Draft IRP was prepared by Siemens Power Technologies International ("Siemens").
- **Interventions:** July 29, 2015 – November 3, 2015. The Commission received fourteen (14) requests for intervention.²⁸⁵ The Commission granted intervention to: Grupo Windmar, EcoEléctrica, L.P., ICSE-PR, OEPPE, the Consortium, Mesa de Diálogo, ELAC, El Puente, Comité de Diálogo, National-Assured, APEV, Pattern Energy and INESI.²⁸⁶

²⁸⁴ The term "first IRP" refers to the fact that prior to this proceeding, PREPA did not have in place an integrated resource plan and PREPA's IRP, as approved by the Commission pursuant to this proceeding, would be PREPA's first ever integrated resource plan.

²⁸⁵ The following entities filed requested intervention: Windmar Group, EcoEléctrica L.P., Instituto de Competitividad y Sostenibilidad Económica de Puerto Rico (ICSE-PR), Oficina Estatal de Política Pública Energética (OEPPE), Consortium formed by York Capital Management Global Advisors LLC; ITC Holdings Corporations and NRG Energy (Consortium); Mesa de Diálogo Ambiental (Mesa de Diálogo), Enlace Latino de Acción Climática (ELAC), El Puente de Williamsburg, Inc. (El Puente), Comité de Diálogo Ambiental (Comité de Diálogo), Inc., National Public Finance Guarantee Corp. junto con Assured Guarantee Corp. y Assured Guarantee Municipal Corp. (National-Assured), Asociación Puertorriqueña de Energía Verde (APEV), Pattern Energy, and Instituto de Energía y Sostenibilidad Isleña (INESI).

²⁸⁶ On 18 March 2016, GPG filed a motion requesting to intervene in this proceeding. On 4 April 2016, the Commission denied GPG's request given the advanced stage of the proceedings and that GPG's motion was filed after the due date set forth by the Commission for requesting intervention.

- **Order on Deficiencies:** August 3, 2015. The Commission issued an Order finding that PREPA's Draft IRP was deficient. The Commission identified the deficiencies found in PREPA's IRP filing and ordered PREPA to make the changes necessary to comply with Regulation 8594.
- **Revised 2015 Integrated Resource Plan ("Revised IRP"²⁸⁷):** August 17, 2015. In response to the Commission's Order on Deficiencies, PREPA filed a Revised IRP which, according to PREPA, addressed the deficiencies identified by the Commission in PREPA's Draft IRP. The revised IRP was also prepared by Siemens.
- **Commission Issues Procedural Timeline:** September 30, 2015. The Commission issued the Procedural Timeline for the IRP proceeding. The Procedural Timeline was subsequently amended to accommodate intervenors' motions and PREPA's revisions to its IRP.
- **Commission Order on Intervention and Amicus Participation:** October 23, 2015. The Commission issued a Resolution and Order ruling on the motions to intervene and petitions for Amicus.
- **Amicus Curiae:** October 30, 2015 – November 3, 2015. Sunnova Energy Corporation, Energy Answers LLC and Mr. William Driscoll filed motions seeking to participate as *amicus curiae*. The Commission granted Sunnova and Energy Answer's requests on November 18, 2016 and denied Mr. Driscoll's petition on the same date.
- **Discovery:** November 2, 2015 – March 21, 2016. The Commission Staff, PREPA and approved Intervenor had the opportunity to conduct discovery related to a diverse range of subjects related to PREPA's proposed IRP and intervenor testimony.
- **Commission Issues Notice of Deficiencies ("December Order"):** December 8, 2015.²⁸⁸ The Commission issued an Order identifying further deficiencies in PREPA's Revised IRP and ordered PREPA to make the necessary revisions to its IRP filing. The December Order also requested intervenors to comments on various subjects identified therein.
- **Intervenor Responses:** December 17, 2015. Intervenor ICSE-PR, INESI and the Consortium formed by Mesa de Diálogo Ambiental, Enlace Latino de Acción Climática, El Puente de Williamsburg, Inc., and Comité de Diálogo Ambiental, Inc. filed their responses to the December Order.
- **Technical Conference Call:** December 22, 2015. The Commission Staff held a Technical Conference Call to clarify the Commission's requirements as set out in the

²⁸⁷ This document is also referred to as the "Base IRP" by PREPA and Siemens.

²⁸⁸ This order was initially issued on 4 December 2015 but was officially notified on 8 December 2015.

December Order, as well as the timeline for completion and any technical barriers to completion. Both PREPA and intervenors were present.

- **PREPA Submits a Motion to Reconsider the December Order:** December 24, 2015. PREPA filed a Motion to Reconsider the December Order arguing that, given the breadth and scope of the information required of PREPA by the Commission in its December Order, the Commission should grant PREPA additional time to prepare and supply the information requested. PREPA sought an additional seven months in order to provide the information required by the December Order.
- **Commission Order on PREPA's Motion to Reconsider the December Order:** January 19, 2016. The Commission denied PREPA's request for an approximately seven-month extension to respond to the December Order. The Commission ordered PREPA to provide the information required by the December Order on or before March 28, 2016.
- **PREPA Submits its First Interim Memorandum in Response to the December Order:** February 26, 2016. PREPA's first interim memorandum addressed its assumptions regarding distributed generation, and the impact of the Commission's mandated energy efficiency assumptions on the load forecast to be used in PREPA's filing pursuant to the December Order.
- **Intervention by OIPC:** March 9, 2016. The Oficina Independiente de Protección al Consumidor (OIPC) filed a motion requesting intervention. The Commission granted OIPC's request on March 18, 2016.²⁸⁹
- **PREPA Submits its Second Interim Memorandum in Response to the December Order:** March 18, 2016. PREPA's second interim memorandum addressed its approach to constructing portfolios in compliance with the December Order, a list of portfolios and sensitivities to be analyzed in its filing pursuant to the December Order, and an analysis of the transmission implications of these new portfolios.
- **PREPA Submits Supplemental 2015 Integrated Resource Plan ("Supplemental IRP"):** March 28, 2016. PREPA filed a Supplemental IRP addressing the deficiencies identified by the Commission's December Order. The areas addressed through the Supplemental IRP include an evaluation of AOGP, EcoEléctrica, AES, a modified Renewable Portfolio Standard (RPS) compliance schedule, demand response, and energy efficiency adoption trajectory.
- **Technical Hearing:** April 6, 2016, San Juan, Puerto Rico. The Commission held a Technical Hearing to address IRP assumptions, methodology, and considerations.

²⁸⁹ The Commission granted OIPC's request in light of its specific responsibilities pursuant to Act 57-2014.

- **PREPA Submits Supplemental 2015 Integrated Resource Plan with Fuel Sensitivity ("2nd Supplemental IRP"):** April 25, 2016. PREPA filed a 2nd Supplemental IRP which included portfolio evaluations employing updated fuel forecasts previously provided by PREPA in response to the Commission's Fourth ROI.
- **Intervenor Briefs:** April 29, 2016. Comments and legal briefs received from intervenors.
- **Oral Argument:** May 13, 2016, San Juan, Puerto Rico. The Commission held an Oral Argument Hearing which included presentations from PREPA and intervenors and questions from Commission Staff, PREPA, and other intervenors on the methodology, inputs, and findings of the IRP.
- **Public Hearings:** May 18, 2016, San Juan, P.R., and June 14, 2016, Ponce, P.R. The Commission held public comment hearing in order to promote public participation and allow the general public to express their opinions, concerns and recommendations with regards to PREPA's proposed IRP.

APPENDIX B

SUMMARY OF INTERVENORS' POSITIONS

Consortium

The Consortium is a group consisting of private equity firm York Capital Management Global Advisers LLC and the ITC Holdings Corp., parent company of an independent owner/operator of transmission systems.²⁹⁰ The Consortium raises several procedural and substantive concerns relating to the IRP. They recommend that the Commission reject the IRP with a number of recommendations and requirements.

The Consortium argues that PREPA's dilatory tactics and lack of transparency in the discovery process failed to provide the Commission with a full record. They also object to the form and substance of the information made available by PREPA and to PREPA's claims of confidentiality, arguing that PREPA's claims of confidentiality were overly-broad and not consistent with procedures set forth by the Commission, including allowing intervenors to execute Non-Disclosure Agreements (NDA). The Consortium concludes that a lack of full and timely access to critical energy infrastructure information (CEII) impeded their ability to analyze and provide recommendations in the case and thus the Commission should reject the IRP.

The Consortium also argues that PREPA did not consider all reasonable resources in forming their portfolios, citing third-party partnerships or public-private partnerships as an example. The Consortium contends that third-party involvement could abbreviate construction schedules significantly. The Consortium also points out that none of PREPA's scenarios consider an expansion of the existing EcoEléctrica LNG terminal. The Consortium further argues that the IRP as filed does not explore a sufficient range of sensitivities and highlights that an optimization framework was not employed. The Consortium asserts that the minimum run times used in PREPA's modeling are unrealistically high and that this assumption biases the IRP in favor of existing generation.

EcoEléctrica

EcoEléctrica is the owner/operator of the only existing natural gas-fired combined-cycle unit in Puerto Rico, as well as the only operational liquefied natural gas terminal. EcoEléctrica endorses distributed generation and argues that PREPA should have given stronger consideration to an expansion of its LNG terminal and the construction of a pipeline to transport gas to Aguirre (in lieu of the development of the proposed AOGP). EcoEléctrica also argues that PREPA's system operations activities should be operationally segregated from its generation for the sake of system stability and of fostering competition

²⁹⁰ NRG Energy, Inc., an owner/operator of generation infrastructure, was briefly a member of the Consortium. NRG left the Consortium prior to the filing of the intervenor briefs.

in the Island's energy system. EcoEléctrica also specifically criticizes the manner in which PREPA's fuel price forecasts are structured, which it is not in line with industry-standard assumptions, as well as asserting that minimum run times used in PREPA's modeling are unrealistically high and that this assumption biases the IRP in favor of existing generation. EcoEléctrica further argues that PREPA's more flexible generation resources will have to provide significant frequency regulation services if high levels of intermittent renewable generation are integrated into the electric grid and that the costs of doing so should be taken into account in PREPA's analysis. Finally, EcoEléctrica contends that PREPA's assumptions regarding minimum unit runtime, heat rates, and operation and maintenance costs should be altered, although no specific information is provided in relation to this matter.

ELAC

This group of intervenors includes Enlace Latino de Acción Climática and intervenors El Puente de Williamsburg, Inc., and Comité Diálogo Ambiental Inc. (herein collectively referred to as ELAC). ELAC sponsored experts from the Institute for Energy Economics and Financial Analysis (IEEFA) during the technical hearing and included a report from IEEFA in their brief.

ELAC argues that the IRP should have incorporated an analysis of water usage and the risks presented to PREPA by a scarcity of water on the Island. ELAC contends that PREPA's load forecast is inaccurate and that the IRP did not sufficiently consider energy efficiency, demand response, renewable energy or energy storage. ELAC also argues that PREPA's renewable energy cost assumptions were inflated and that PREPA's portfolios excessively rely on fossil-fired generation. ELAC further expressed concerns about the impact of PREPA's preferred portfolio on rates and suggests that an analysis of the rate impact of various supply options should have been included in the IRP.

ELAC's brief includes remarks on environmental problems caused by coal ash from AES and argues that PREPA should not only refuse to renew its contract with AES but should terminate the existing contract as soon as possible using claims of non-performance. ELAC objects to the proposed Energy Answers waste incineration project on environmental grounds. In addition, ELAC suggests the existence of a conflict of interest with regards to Siemens since it is affiliated to entities engaged in the manufacturing and sale of generation equipment. ELAC further contends that a decoupling mechanism to separate PREPA's income from its thermal generation should be implemented to ensure an unbiased administration of PREPA's resources.

Finally, ELAC argues that construction of the AOGP will result in increased carbon dioxide emissions at Aguirre and in the northern portion of Puerto Rico, as well as an increase in the risk of methane leakage. They suggest that the capacity factors modeled for generation resources at AOGP would require more throughput of natural gas at AOGP than the project is currently permitted for and that the capacity factors modeled by PREPA would trigger an environmental review under the Prevention of Significant Deterioration program.

IEEFA's report, which is appended to ELAC's brief, argues that PREPA's assumptions of load and the cost and capacity value of different resources has skewed their portfolios towards overbuilding Puerto Rico's grid with excessive amounts of almost-exclusively fossil-fired resources. IEEFA asserts that PREPA's load forecast is unrealistic and excessive. IEEFA disagrees with PREPA's treatment of capacity and reserve margin calculations, arguing both that PREPA undervalues the ability of demand response and renewable energy to meet peak load and that PREPA's current generating fleet should either be considered to give higher capacity benefits in general or could cost-effectively be retrofitted to provide such benefits.

In addition to asserting that PREPA's estimates of capital cost for new thermal resources are low, IEEFA argues that PREPA's cost estimates of renewable resources and energy storage are high. Similarly, IEEFA argues that a demand response program focused on modifying consumption from air conditioning systems would be effective in load shifting and potentially peak shaving.

ICSE-PR

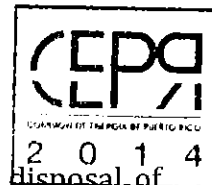
The Institute for Competitiveness and Economic Sustainability of Puerto Rico (ICSE-PR) is a non-profit organization whose main purpose is to improving the economic welfare and stability of Puerto Rico. ICSE-PR raises various procedural concerns related to discovery and argues that requiring PREPA to file revised IRP proposals contributed to a lack of clarity in the process. They argue that their ability to participate through the discovery process was limited due to PREPA's lack of cooperation, including PREPA's claims of confidentiality. ICSE-PR also asserts that the Commission did not provide intervenors easy access to interrogatories and the Commission's Requirements of Information and suggests that the Commission should access to such documents electronically. Finally, they suggest to the Commission holding a scheduling conference to develop the case schedule.

ICSE-PR also contends that PREPA proposed IRP prevents or fails to contemplate retail wheeling and a competitive energy market. While ICSE-PR argues that the IRP does not adequately consider variation in future fuel prices, their comments are generally focused on a lack of hedging strategies by PREPA.

ICSE-PR contends that PREPA's load forecast is high and that PREPA should conduct EE potential studies. ICSE-PR argues against PREPA's MATS compliance strategy and asserts that PREPA will remain in non-compliance for an extended period of time. Finally, ICSE-PR states that PREPA's IRP omits compliance with Act 57-2014's requirement that 60% of PREPA's fossil-fired generation be "highly efficient" by mid-2019 and contends that PREPA is capable of replacing the bulk of their thermal generation within a five-year timeframe.

INESI

The Instituto de Energía y Sostenibilidad Isleña (INESI) is an institute at the University of Puerto Rico focused on energy and sustainability. INESI argues that the IRP does not contain any evidence of PREPA having sought stakeholder input nor does it include a



comprehensive environmental impact analysis concerning issues such as the disposal of coal ash from AES' coal plant. INESI asserts that PREPA did not consider the impacts of climate change, renewable energy, demand-side management techniques or energy storage. INESI contends that PREPA should consider microgrids as a mechanism for integrating an increased amount of renewable energy and protect the system from climate change-related disruptions.

Mesa

Mesa de Diálogo Energético (Mesa) is a non-profit organization founded in 2008 to represent the interests of a variety of stakeholder groups, including environmental stakeholders. Mesa argues that PREPA's proposed IRP does not adequately incorporate energy efficiency, renewable energy or distributed generation. Mesa also argues that factors, such as PREPA's financial condition and changes in population and consumption patterns in Puerto Rico, have not been accounted for in the IRP's load forecast and resource mix plans. Particularly, Mesa argues that the moratorium on issuance of new bonds poses significant obstacles for PREPA's pursuit of MATS compliance, a factor that was not addressed in PREPA's proposed IRP. Mesa contends that the IRP should have contemplated the possibility that mid-sized commercial and industrial customers will seek to isolate themselves from the grid in light of increasing energy prices. Finally, Mesa argues that energy storage was not addressed in the IRP and that PREPA would be able to capitalize on its previous experience with an energy storage pilot program.

National and Assured

National Public Finance Guarantee Corp. (National) and Assured Guaranty Corp. and Assured Guaranty Municipal Corp. (Assured) are monoline insurers that have underwritten a group of PREPA's insured bonds. National and Assured contend that the IRP process was properly conducted, that PREPA's assumptions and analysis made in support of its proposed IRP are sound and that the IRP should be approved as filed. They endorse PREPA's treatment of energy efficiency and demand-side management. National and Assured also concur with PREPA that only a limited amount of renewable energy can be integrated into PREPA's system as it currently stands, that permitting is a major constraint on PREPA's ability to develop new generation and transmission infrastructure and that AOGP is the best alternative to comply with MATS.

OEPPE

The Oficina Estatal de Política Pública Energética (OEPPE) or State Office of Energy Public Policy is an office of the Government of Puerto Rican tasked with advising the Governor of Puerto Rico on matters related to the development of a coherent energy public policy. OEPPE's brief focuses on the cost-effectiveness of energy efficiency and criticizes the IRP for not including a scenario which incorporates energy efficiency. OEPPE argues that such a scenario should be incorporated in Volume III (Demand and Fuel Forecasts and Demand-Side Management) of the IRP.