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

IN RE: REVIEW OF THE PUERTO RICO ELECTRIC POWER AUTHORITY INTEGRATED RESOURCE PLAN	CASE NO. CEPR-AP-2018-0001 SUBJECT: Discovery Process

MOTION SUBMITTING EXPERT WITNESSES STATEMENTS

TO THE BUREAU:

NOW COME, CENTRO UNIDO DE DETALLISTAS (CUD); CAMARA DE MERCADEO, INDUSTRIA Y DISTRIBUCION DE ALIMENTOS (MIDA); PUERTO RICO MANUFACTURES ASSOCIATION (PRMA);UNIDOS POR UTUADO (UPU), Y EL INSTITUTO DE COMPETITIVIDAD Y SOSTENIBILIDAD ECONÓMICA DE PUERTO RICO (ICSE-PR) (hereinafter the not profit intervenors) represented by appearing counsel and respectfully allege and pray:

1. Appearing "Not For Profit Intervenors" submit with this motion the witness testimony of three expert witnesses:

   A. Eric Ackerman, Managing Director, New Regulation LLC.
   B. José O. Alemán,PE, MBA
   C. Dr. Eric C. Woychik, Senior Vice President, Willdan Corporation

2. Mr. Ackerman and Mr. Alemán statements are duly attested. Mr. Woychik is currently outside of USA jurisdiction and attestation will be submitted as soon as he returns, within the next three weeks.

WHEREFORE It is respectfully requested from the Energy Bureau to receive the testimonies submitted in accordance with applicable timetable.

CERTIFICATE OF SERVICE

We hereby certify that, a copy of the filling was sent via e-mail to the Energy Bureau Clerk and internal legal counsel to: secretaria@energia.pr.gov; wcordero@energia.pr.gov; legal@energia.pr.gov; and sugarte@energia.pr.gov. A hard copy of the foregoing will be filed with the Clerk of the Energy Bureau tomorrow.

In addition, the foregoing filing was sent via e-mail to the approved or pending intervenors (Arctas, Caribe GE, League of Cooperatives and AMANESER 2025, OIPC, EcoEléctrica, Empire Gas, Environmental Defense Fund, Local Environmental Organizations, National,

"Non Profits", Progression, SESA-PR, Renew, Shell, Sunrun, Wartsila, Windmar Group) and amicus (ACONER, AES-PR, RMI) at the following e-mail addresses: sierra@arctas.com, tonytorres2366@gmail.com, cfl@mcvpr.com; gnr@mcvpr.com, info@liga.coop, amaneser2020@gmail.com, hrivera@oipc.pr.gov, jrivera@cnslpr.com, carlos.reyes@ecoelectrica.com, ccf@tcmrslaw.com, manuelgabrielfernandez@gmail.com, acarbo@edf.org, pedrosaade5@gmail.com, rmurthv@earthjustice.org, rstgo2@gmail.com, larroyo@earthjustice.org, jluebkemann@earthjustice.org, acasellas@amgprlaw.com, loliver@amgprlaw.com, epo@amgprlaw.com, robert.berezin@weil.com, marcia.goldstein@weil.com, jonathan.polkes@weil.com, gregory.silbert@weil.com, maortiz@lvprlaw.com, rnegron@dnlawpr.com, castrodieppalaw@gmail.com, voxpopulix@gmail.com, paul.demound@shell.com, javier.ruajovet@sunrun.com, escott@ferraiuoli.com, mgrpcorp@gmail.com, aconer.pr@gmail.com, axel.colon@aes.com, rtorbert@rmi.org, kbolanos@diazvaz.law y n-vazquez@aeepr.com.

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In San Juan, Puerto Rico, this 22 day of October 2019.

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Direct Testimony of

ERIC ACKERMAN

Managing Director,

New Regulation LLC

TABLE OF CONTENTS

Testimony

I Introduction

A. Identification of Witness

Q. What is your full name and business address?

A. My name is Eric T. Ackerman. My business address is 3677 N. Harrison St., Arlington, Virginia 22207.

Q. On whose behalf are you appearing?

A. I'm testifying on behalf of Cámara de Mercadeo, Industria y Distribución de Alimentos (MIDA), Centro Unido de Detallistas (CUD), Unidos por Utuado, Inc., Puerto Rico Manufacturers Association and Instituto de Competitividad y Sostenibilidad Económica..

B. Purpose and Summary of Direct Testimony

Q. What is the purpose of your testimony?

A. To provide an independent review of the Integrated Resource Plan (IRP) submitted by the Puerto Rico Electric Power Authority on June 7 of this year.

Q. What, in sum, is your opinion of the IRP?

A. In my opinion the IRP does not comply with the recently enacted Public Energy Policy Law of Puerto Rico, Act 17, 2019 (SB 1121). As I will elaborate, the Plan:

- Makes no provision for the introduction of advanced grid planning methods;
- Does not include a comprehensive strategy for customer engagement;
- Over-invests in natural gas generation, making it difficult to transition to renewable energy sources;
- Does not include a strategy for facilitating the interconnection of distributed generators;

- Does not include a strategy for expanding energy efficiency and demand response; and
- Does not include a strategy for reducing rates to below $.20/kWh.

Recognizing that deficiencies in the June 7 IRP cannot be corrected fully until advanced grid planning methods have been implemented, the PREB should direct PREPA to substantially revise its approach to the design of Minigrids, and make only minimal investment in natural gas-fired turbines and LNG supply infrastructure until the results of advanced grid planning methods are available to inform optimal investment strategies.

C. Background and Qualifications

Q. By whom and in what position are you employed?

A. I am the Managing Director of New Regulation LLC, a consultancy I formed upon retiring from the Edison Electric Institute in December 2016. New Regulation gives advice to clients on regulatory policy and strategy.

Q. By whom and in what position were you employed before retiring?

A. I was the Director, Alternative Regulation, with the Edison Electric Institute, the national trade association of the investor-owned electric utility industry.

Q. What were your responsibilities as Director, Alternative Regulation?

A. I was chief strategist for retail energy delivery, providing national leadership on issues involving adaptive business strategy, alternative regulation, and cost of capital. I led the Alternative Regulation Working Group, composed of member executives responsible for adaptive business strategy. The Group's mission was to identify and promote regulatory innovations needed to enable members to adapt to markets which are changing under the

impact of new technologies. I also was a key member of EEI's Evolving Distribution Grid team, providing leadership on policy issues associated with grid modernization and the development of distributed energy resources at scale (e.g., rate reform, new market rules, regulatory models that allow increased pricing flexibility, new resource planning and approval procedures that mitigate regulatory risk, next-generation performance based regulatory incentives). I initiated and led EEI's participation in the US Combined Heat and Power (CHP) Collaborative, a pioneering effort to facilitate strategic alliances among EEI members and members of the combined heat and power, and district energy industries. I also co-led the Utility-Corporate Buyer Collaborative Forum, which was a strategic alliance among EEI members and Fortune 500 companies whose purpose was to improve renewable energy products while streamlining the regulatory approval process. This Forum sponsored a collaborative, unprecedented in the utility industry, that focused the needs of corporate buyers of renewable energy products, and developed a consensus strategy for improving such products going forward. The results of this collaborative are documented in *Creating Renewable Energy Opportunities: Utility-Corporate Buyer Collaborative Forum,* June 2016. In my capacity as Director of Alternative Regulation I also represented EEI at the Rutgers University Center for Research In Regulated Industries. I worked for many years with Dr. Michael Crew, former Director of CRRI, and more recently with Dr. Victor Glass, to develop conference and workshop agendas, and my own papers and presentations, that addressed current regulatory issues in the electric utility industry.

Q. **What experience have you had analyzing policies, procedures, and statutes associated with electric utility resource planning?**

A. As a member of the staff of the Edison Electric Institute I had extensive experience analyzing state and federal policies, procedures, and statutes. As Manager of Regulatory Policy, and later Director of Alternative Regulation I was intimately involved in analyzing state and federal regulatory policies, procedures, and statutes as they evolved over the decades. Looking back on my career I can discern several distinct eras, as follows. When I joined EEI in 1985 the industry was recovering from the impacts of the Public Utility Regulatory Policies Act of 1978. I managed surveys that analyzed in detail each state's approach to measuring avoided cost.

Also in the 1980's, as the last generation of nuclear generating stations came on line and applied for rate recovery, the industry had to deal with legislation addressing the cost overruns and evolving standards of prudence. During this period, I built a database of state decisions regarding the rate treatment to be accorded nuclear plant investments. I also developed a series of case studies involving the prudence of nuclear operating practices, and conducted a workshop for EEI members that provided a forum for sharing lessons learned.

In the late 1980s and 1990s, as policy makers looked to incentive policies to correct perceived deficiencies in cost of service regulation, I oversaw multiple national survey of state authorizing statutes, and state regulatory decisions approving specific kinds of

incentive mechanisms, and developed EEI comments responding to an investigation of incentive policies at the Federal Energy Regulatory Commission.

During the late 1990s and early 2000s, as some states passed legislation designed to introduce competitive choice in retail electricity markets, I oversaw the tracking of related state legislative and regulatory developments. A particular concern was state policies governing (and hopefully managing) the risk that incumbent utilities faced in providing Provider of Last Resort service to customers not served by the market. During this period, I also lead EEI members participating in the Uniform Business Practices project, a national public collaborative which developed best practices for implementing retail choice.

As concerns about climate change became inescapable I oversaw surveys that detailed state approaches to addressing this issue. In addition, I developed a set of case studies of generic state approaches, and oversaw the development of generic spreadsheet tools members could use to assess the impact of various policy approaches on their rates, and their financial performance. (see *Building Sustainable Efficiency Businesses*: *Evolution of Business Models*, EEI, 2008)

More recently, as the impacts of flat to negative sales growth on the utility financial model became apparent, I lead the Alternative Regulation Working Group, made up of senior executives responsive for business and regulatory strategy, in devising and promoting new policies to support needed capital investment and enable utilities to

respond to customer demand for increasingly differentiated (custom) services. (see *Regulatory Innovations to Enable The Utility of the Future*, EEI Alternative Regulation Working Group, June 2014) I also oversaw detailed analyses of related state precedent (*Alternative Regulation for Emerging Utility Challenges, 2015 Update)* Because this was ultimately part of an advocacy campaign to policy makers, I oversaw the development of a unique history designed to make regulators comfortable with trying new things (i.e., because they were part of a long tradition of regulatory innovation). (See *History of Cost of Service in The Investor-Owned Electric Utility Industry: A History of Adaptation,* 2012)

Most recently, the issues dominating strategic thinking by utilities and policy makers have been those associated with the growth of distributed energy resources (DER) at scale and the resulting need to modernize electricity grids with new technologies and capabilities. (See *Unbundling Distribution Grid Services*, 2015; *Use of Big Data in U.S. Electric Utilities: Evolution and Implications*, 2016). I co-lead an EEI engagement with a group of corporate buyers, for which we analyzed state precedent involving the sale of "green" electricity products. (See *Creating Renewable Energy Opportunities: Utility-Corporate Buyer Collaborative Forum Strategic Dialogue, 2015*) I also have had occasion to analyze state telecom precedent involving premium services for lessons that may be applied to electric utilities. (See *Class of Service/Reliability*, Rutgers University Eastern Conference, May 2018) And I recently analyzed state policies involving public purpose microgrids. (See *Evolution of the Public Purpose Microgrid*, Rutgers University Eastern Conference, May 2019)

Q. Have you had other energy-related experience?

A. Yes. Since retiring from EEI I helped the Hawaiian Electric Companies develop a holistic strategy for modernizing its grid; and subsequently, respond to a state mandate to develop a microgrid tariff. Before joining EEI I had significant experience assessing energy technologies. As a member of the technical staff of the MITRE Corporation, McLean, Virginia I participated in the Department of Energy's Technology Assessment of Solar Energy Project, and in a project to assess regulatory issues associated with coal gasification technology. Before that, as a member of the staff of JRB Associates, McLean, Virginia, I helped manage DOE's Nuclear Alternative Systems Assessment Program. I began my career as managing editor of *Energy Digest*, a Washington-D.C. based newsletter tracking federal R&D programs at the Energy Research and Development Administration. ERDA was the agency that preceded the U.S. Department of Energy.

Q. What is your educational background?

A. I hold a B.S. in History from Tufts University, Medford, Massachusetts, where I took a number of courses on the history of science; and an MBA, earned with honors at George Washington University, Washington, D.C.

II Requirements of Act 17, 2019 (SB 1121)

Q. What is the purpose of Act 17-2019?

A. To define an energy policy for Puerto Rico.

Q. How would you characterize the policy set forth in Act 17-2019?

A. Reflecting lessons learned from hurricanes Irma and Maria, and the current state of energy technologies, the policy set forth in Act 17-2019 intends to transition Puerto Rico to a power supply system that is significantly more reliable and resilient, that relies on renewable and distributed energy sources, that is open to participation by consumers and third parties; and which is economically efficient, so that the rates it charges are just and reasonable. Act 17 provides a road map to a state of the art integrated grid. If fully implemented, it will place Puerto Rico in a position of technical leadership among states in the U.S., along with Hawaii and California.

Q. Does Act 17-2019 provide any guidance on how to accomplish this transition that are relevant to the PREB's approval of the IRP?

A. Yes, the law provides specific guidance in terms of initial objectives set forth in Section 1.6. The most important of these objectives are the following:

1 - To promote the fastest and most efficient grid modernization [Section 1.6 1)];

2 - To enable "prosumers," defined as "Any user or consumer of the Electrical System that has the capacity to generate electric power for its own consumption and, in turn with the capacity to supply any surplus of energy through the electrical network" [Section 1.6 4)];

3 – To develop renewable energy sources to displace and eventually eliminate the use of fossil-fueled generation [Section 1.6 7)];

4 - To facilitate the interconnection of distributed generators [Section 1.6 8)];

5 – To encourage the use of energy storage technologies for all consumers [Section 1.6 9)];

6 - To promote energy efficiency and demand response programs [Section 1.6 10)]; and

7 -"[T]o establish the elements necessary for the People of Puerto Rico to attain their goal of having a new Electrical System with rates below twenty cents per kilowatt-hour ($0.20/ kWh) and clean, modern, and reliable energy which shall serve as the basis for the Island's sustainable economic development". [Article 1.6 16)].

These legislative priorities must be incorporated as PREPA and its succesor and the PREB begin the multi-year work of implementing the Plan.

III Deficiencies in the June 7 IRP

Q. Does PREPA's IRP comply with the foregoing requirements of Act 17-2019?

A. No, it does not. As previously mentioned, the first objective of Act 17 is to promote the fastest and most efficient grid modernization. Nevertheless, the June 7 Plan makes no provision for the introduction of Advanced Grid Planning methods, even though such methods are essential for managing the development of a modern, integrated grid that is reliable and cost-effective.

Also missing is any strategy for true customer engagement, even though effective customer engagement is critical for building customer trust and enabling foregoing objectives 2, 3, 4, and 5. The Plan invests heavily in natural gas infrastructure and generation, making it difficult to displace and eventually eliminate fossil fueled generation. The Plan also reflects no strategy for streamlining and facilitating the interconnection of customer-sided distributed energy resources, nor for actively promoting energy efficiency and demand response programs. Perhaps most importantly,

the Plan proposes to lock in rates of about $.25/kWh through 2038, suggesting that PREPA does not understand the urgency of the economic situation.

IV Recommendations for Improving the June 7 IRP

Q. How can the June 7 Plan be revised to comply with Act 17's requirement to promote faster and more efficient grid modernization?

A. To promote faster and more efficient grid modernization, PREPA needs to implement Advanced Grid Planning methods. This should be addressed in the action plan. Also, PREPA needs to be more forthcoming with its data. It needs to understand that enabling prosumers means giving them guidance on how to make economically efficient investments. As PREPA implements Advanced Grid Planning, it needs to share the results with consumers and third parties, so they know where to locate DER for greatest value to the grid. PREPA should look to California where data access issues have been addressed, and where policies have been enunciated that balance relevant concerns.

Q. What is advanced grid planning? How does it differ from traditional utility planning?

A. Advanced Grid Planning , known variously as Integrated Distribution Planning (*Integrated Distribution Planning*, prepared for the Minnesota Public Utilities Commission by ICF International, August 2016) and Integrated Grid Planning (*Integrated Grid Planning Workplan* submitted by the Hawaiian Electric Companies, December 2018) represents a significant evolution in traditional utility resource planning methods. Traditional utility planning methods such as those used to produce PREPA's

Integrated Resource Plans, involve "top-down" analyses whose goal is develop an optimal supply strategy that "integrates" supply-side and demand-side resource options. The supply options considered are central station resources, and power is assumed to flow in one direction: from the transmission system, through the distribution system, to end-use consumers. Advanced Grid Planning methods use "bottoms-up" analyses to evaluate loads at the distribution circuit-level, using new tools to simulate power flows across the distribution grid. They evaluate "hosting capacity" (i.e., the capacity of distribution circuits to integrate new DER without grid upgrades). They evaluate multiple DER growth scenarios to bound and manage this key source of planning uncertainty. They explicitly coordinate supply, transmission, and distribution planning. Most importantly, they evaluate the costs and benefits of new DER applications based on their location on the grid. Advanced Grid Planning techniques will allow PREPA and/or third parties to optimize the design of distributed energy applications (e.g,, microgrids/minigrids developed for increased reliability and resilience on critical loads). PREPA's failure to optimize the minigrids proposed in its June 7 IRP, a failure revealed by its inability to respond to probing questions asked by Bob Fagan at the Bureau's public hearing on August 13, reflects the fact that PREPA's June 7 IRP is the product of a top-down planning process.

Q. Why does Puerto Rico need Advanced Grid Planning to develop its electrical system?

A. Because Puerto Rico needs to build a Modern Integrated Grid, and needs to do it cost-effectively. Hurricanes Irma and Maria demonstrated clearly and unmistakably that Puerto Rico's legacy grid was vulnerable to the effects of high winds (150 mph) and

intense rain. To build a grid that is more reliable and resilient, Puerto Rico needs to build a new kind of grid, a "Modern, Integrated Grid." The concept of the Modern Integrated Grid was first described by the Electric Power Research Institute in *The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources* (2014). Modern Integrated Grids differ from traditional grids in that they are developed using a customer-centric strategy, and include components not present in traditional grids (e.g., advanced sensors, high-speed communications, and distributed control systems), which allow Modern Integrated Grids to accommodate two-way power flow (e.g., from the system to the end-user, and from the end-user back into the system) while maintaining voltage and frequency within established limits.

Because grid modernization investments will be made in an environment of expected negative load growth in Puerto Rico, they might put upward pressure on rates, making it critical that the PREB and PREPA's successor manage the modernization process efficiently. Advanced Grid Planning is being developed for this purpose. The goal of Advanced Grid Planning is to deploy new grid components and distributed energy resources where they are needed, when they are needed, and not before; kind of like just-in-time inventory management. Hawaii and California currently are leading the development of Advanced Grid Planning methods in the U.S.

Q. What needs to be done to implement Advanced Grid Planning for Puerto Rico's electric system?

A. Recognizing that the PREB conducted a stakeholder workshop on September 13 in preparation for issuing a draft regulation on Distributed Resource Planning, the facts remain, first, that Advanced Grid Planning is not separate from the Integrated Resource Planning process but needs to be an essential enhancement to it; second, that PREPA's June 7 IRP makes no mention of Advanced Grid Planning. Therefore, three tasks should be added to PREPA's IRP action plan, as follows:

1) Analyze Gaps – Conduct an audit that reviews PREPA's current planning capabilities in relation to the human and other resources needed to conduct Advanced Grid Planning. This will allow PREPA and the PREB to identify new resources and capabilities it needs to implement Advanced Grid Planning, and develop an efficient, multi-year plan for introducing Advanced Grid Planning. Results of this analysis should be reviewed by the PREB in a proceeding open to the public. Key resources needed to conduct Advanced Grid Planning include the following:

a) Circuit-level data – This includes, for example, loads on transformers, circuits, and substations; near real-time load-flows with integration of DERs and high voltage resources; hourly voltage and VAR levels at multiple points on the system; phase angle at multiple points for advanced, near-real-time diagnostics about grid power quality and stability; operating status of DER on the system;

b) Meter data management system - To store data and make it accessible to planners and customers;

c) Software tools to simulate loads and load flows at the distribution level and optimize DER applications This includes, for example, PLEXOS, a tool to define wholesale locational production cost, based on unit commitment, and capacity expansion;

DSMORE, a tool to chart cost-effectiveness of DER options which integrates probabilistic weather, loads, and prices to calibrate levels of uncertainty; Load SEER, a tool to integrate distribution load-flow, locational marginal costs, and enable batch-scenario analysis, including distribution circuit loads; IDROP, a tool to provide integrated, co-optimization at the planning level, as well as distribution system and DER dispatch at the operational level; and DER Optimizer, a tool to enable multiple scenarios of DER and supply resources; and

d) Staff with the skills and experience to analyze relevant data using advanced tools. PREPA's successor and/or the PREB may need to hire a third party with hands-on experience conducting Advanced Grid Planning to perform the foregoing tasks, unless the T&D concessionaire has such skills and experience. Participation in an Advanced Grid Planning User Group, below, will allow the PREB and PREPA to identify firms with Advance Grid Planning experience.

2) Conduct Training – Present a curriculum that provides a frame of reference for understanding Advanced Grid Planning; for example, the assumptions of traditional utility planning which are no longer valid, the sequence of analytic tasks that comprise generic Advanced Grid Planning, and the software tools needed to perform specific tasks. The curriculum should also involve hands on experience with some, or all, of the kinds of software tools described above. Training should include a focus on examples of data used as input, and data generated as output by the tools.

3) Create an Advanced Grid Planning User Group - Organize a Group composed of utility staff, regulatory staff, and other interested participants, from Puerto Rico, Hawaii, and California. The purpose of this group will be to share information on solutions to

common challenges of implementing AGP. This group can meet in person, through conference calls and on-line webinars.

Q. How can the June 7 Plan be revised to comply with Act 17's requirement to enable prosumers?

A. PREPA needs to develop and implement a comprehensive strategy for customer engagement. This too should be addressed in the action plan (i.e., Section 10.3 Engaging the Customer). Analyzing the T&D system is appropriate, but it is just the beginning. PREPA needs analyze its customers! PREPA needs to demonstrate its willingness to change; that it is no longer an organization that exists only for its own benefit, but that can become a utility which is truly "customer-driven." Given the success of last year's public collaborative,[1] a good way to start would be with a customer collaborative to develop a consensus on how best to enable prosumers. Customer education certainly should be a part of such a collaborative: customers need to understand the challenges, and the tradeoffs, involved in building a modern grid in Puerto Rico. Their input will be invaluable in designing a strategy for empowering consumers. Depending on customers' priorities, key elements of such a strategy might include initiatives to accomplish the following:

- Compensate Distributed Energy Customers for Grid Support (Ancillary Services) – In addition to generation, customers who have deployed distributed resources on their side of the meter should be compensated for any grid support services they may provide. These are specialized generation services which the distribution system operator uses to keep voltage and frequency within acceptable limits. As more variable generation (wind,

[1] *Public Collaborative for Puerto Rico's Energy Transformation*, Puerto Rico Institute for a Competitive and Sustainable Economy and Rocky Mountain Institute, 2018.

PV, etc.) is interconnected at the distribution level, distribution systems become more dynamic. A key aspect of "grid modernization" involves installing the controls and communications to manage these dynamics. Specific grid support services include the following: reactive power supply & voltage control, regulation and frequency response, energy & generator imbalance, synchronized & supplemental operating reserves, scheduling, forecasting and system control & dispatch. Advanced Grid Planning methods yield avoided costs for grid support services. Utility compensation for power and other grid support services may be critical to "making the numbers work" for consumer-sided distributed energy resources.

- Deploy Advanced Meters – Interval meters, which measure usage according to the time of day when consumption occurs, allow the utility to bill customers using time-of-use (TOU) rates. This empowers consumers to control their electricity costs by avoiding usage during high-cost periods. This is called "demand response." Of course, demand response programs depend on the development of TOU rates. Advanced meters also can measure power and other support services that customers may provide to the grid via customer-side DER.
- Compensate Customers For Demonstrated Grid Support – In addition to ancillary services, there are additional grid support services for which DER customers need to be compensated. These include the following: generation energy and capacity, and transmission capacity and losses which DER assets may allow PREPA to avoid. .
- Provider of Last Resort – For customers not served by the market (i.e., by market-based suppliers who have no obligation to serve), the most important aspect of "enabling prosumers" may be the continuation of regulated service by PREPA or

its successor. Certainly, the experience on the U.S. mainland has been that profit-oriented suppliers, unconstrained by any obligation to serve, are more interested in serving commercial and industrial customers than residential customers; particularly, low-income residential customers. So consumers may be very interested in knowing what provision is being made for reliable regulated service as Puerto Rico transitions to a modern grid.

- Streamline Interconnections. Although interconnection policies and procedures are extremely relevant to any strategy for enabling prosumers, I address them separately below, because they are the subject of another initial objective in Act 17-2019.
- Expand EE and DR Programs. Although an aspect of enabling prosumers, this objective also is addressed separately below because it is called out as an initial objective in Act 17-2019.

Q. How can the June 7 Plan be revised to comply with Act 17's requirement to develop renewable energy sources to displace and eventually eliminate the use of fossil-fueled generation?

A. PREPA should revisit its assumption that in designing Minigrids "…critical loads must be served by thermal resources only…" (Appendix 1_Section 2). There is no factual support for this assumption, and it results in a Plan that considers investing over two billion dollars (about $2.2billion) to develop 4 liquified natural gas terminals (3 ship-based and 1 land-based), and install at least 2 large scale Combined Cycles Units and 18 small scale natural gas turbines. What PREPA is proposing amounts to a natural gas future, not a renewable energy future – as required by Act 17-2029. Once these gas

facilities are built, they are not likely to be displaced by renewable sources. To comply with Act 17, PREPA should build fewer natural gas facilities, and instead be more creative in designing minigrids that integrate renewable sources (i.e., photovoltaics, wind, and hydro), and batteries. Certainly, there is precedent for this kind of innovation. The Bronzeville microgrid being built by Commonwealth Edison Company to support critical loads in Chicago is being configured with PV, battery storage, and diesel generators. The Potsdam microgrid being planned by National Grid would integrate hydro generation, PV, batteries, electric vehicles, diesel generators, and combined heat and power systems. PREPA's successor should engage a state of the art microgrid design firm (e.g., Pareto Energy, Washington, D.C.; Willdan Group; or others) to explore minigrid designs that make maximum use of renewable resources. After PREPA has examined the opportunities to develop micro/mini-grids using renewable sources, it should re-evaluate its need for thermal generation.

Q. How can the June 7 Plan be revised to comply with the Act 17's requirement to facilitate the interconnection of distributed generators?

A. I understand the PREB recently conducted two workshops on the subject of interconnection. Nevertheless, recognizing the fundamental public interest in preserving the safety and reliability of electric service, I expect much still can be done to remove unnecessary barriers to the interconnection of distributed generators. To comply with the requirements of Act 17-2019, PREPA or its successor should develop an explicit strategy for facilitating interconnections. The strategy and its execution should be included in the action plan. A reasonable strategy might look something like this: (1) implement advanced grid planning methods to identify hosting capacity (above), On an interim

basis (i.e., subject to final policies and procedures), process interconnection applications on circuits with additional hosting capacity on an expedited basis; (2) work with the National Association of Regulatory Utility Commissioners (NARUC) to survey relevant state precedent, focusing on the analytic tools used, the level of staff resources committed, and the redesigned processes implemented; (3) propose new interconnection policies and procedures for approval by the PREB.

Finally, as a note of caution about interconnection policy, I think both utility executives and regulators in Hawaii would agree that, based on their experience, a statutory mandate (page 58 of Act 17-2019) to interconnect photo voltaic applications below 25 kW "automatically" could be problematic, if interconnection requirements are not clearly defined. The Bureau should clarify this point so it is clearly understood that interconnection requests cannot be responded to without assessing the impacts of the requested interconnection on grid safety and reliability.

Q. How can the June 7 Plan be revised to comply with Act 17's requirement to promote energy efficiency and demand response programs?

A. As part of its strategy for ongoing customer engagement (above), PREPA's action plan needs to include initiatives to educate and motivate customers to participate in energy efficiency (EE) and demand response (DR) programs. Simply developing a list of measures and forecasting their possible impact does not satisfy the statutory requirement to "promote" demand-side programs. Promotion requires customer education. Therefore, initiatives to promote increased customer participation should be coordinated with the strategy for customer engagement (above). In order to identify additional options for EE and DR program design, PREPA should take advantage of the information available from

the American Alliance for An Energy Efficient Economy (www.aceee.org), and the North Carolina Clean Energy Technology Center, which is supported by the U.S. Department of Energy (www.dsireusa.org).

Q. How can the June7 Plan be revised to comply with Act 17's requirement to develop a strategy for reducing rates to below $.20/kWh?

A. PREPA needs to be more aggressive in reducing cost. The introduction of advanced grid planning methods will give PREPA, its successor, and the PREB a way to manage gird investments efficiently. PREPA needs to reconsider its approach to Minigrids. In addition to discarding its unreasonable insistence on the exclusive use of thermal generation to serve critical loads (above), PREPA should adopt a more balanced approach to investments in transmission versus distribution. The June 7 IRP proposes to spend over $14 billion over the next nine years (through 2028). Of this total almost 40% (39.7%) would be for Minigrid-related transmission lines, 12.7% for reliability-related transmission upgrades, and 6.1% for distribution upgrades. Minigrid-related transmission spending seems excessive, considering that only 7.2% of PREPA's T&D system involves transmission (2,478 circuit miles), while distribution accounts for 92.7% of the system (31,550 circuit miles). (Fourtieth Annual Report On The Electric Property of the Puerto Rico Electric Power Authority.)

Beyond Minigrids, PREPA should work with the American Public Power Association to benchmark its costs against those of other government-owned utilities. Utilities whose costs are below PREPA's should be examined in terms of system configuration, operating policies, business processes, staffing levels, etc. for ideas about how to reduce this component of PREPA's cost.

Regarding the cost of generation (about $.10 - .11/kWh, Exhibit 8-23), PREPA should explore increased reliance on renewable generation and batteries to reduce fuel cost. Fuel and purchased fossil generation accounts for over 56% of PREPA's base revenue requirement. (Puerto Rico Energy Commission, Final Resolution and Order, January 10, 2017, at 4: http://energia.pr.gov/wp-content/uploads/2017/01/Final-Resolution-and-Order.pdf)

V Conclusion

Q. Please summarize your overall conclusions concerning the June 7 IRP.

A. I have five overall conclusions, as follows:

1. The June 7 IRP is not compliant with Act 17. PREPA does not understand, or does not accept, that its role must change. To realize the vision enunciated in Act 17, PREPA and its successors must change from a vertically integrated monopoly supplier, to the operator of a system that integrates growing volumes of distributed energy from a variety of possible sources; and does so efficiently and reliably. PREPA must become a utility that enables prosumers, showing them how to make good, efficient decisions about how they use electricity. PREPA must develop, or procure, renewable resources; but it must also support consumers who wish to develop their own distributed resources. Before approving an IRP, the PREB should require that PREPA enhance its action plan by:

(a) adding a detailed strategy for introducing Advanced Grid Planning methods before the next IRP cycle,

(b) adding a comprehensive strategy for ongoing customer engagement and empowerment,

(c) reducing the commitment to natural gas-generators and natural gas supply infrastructure,

(d) including customer education designed to encourage participation in energy efficiency and demand response programs as part of the strategy for ongoing customer engagement and empowerment, and

(e) adding a strategy for aggressive cost reduction.

Until advanced grid planning methods have been implemented to guide efficient investment, the PREB should direct PREPA to substantially revise its approach to the design of Minigrids, and make only minimal investment in natural gas-fired turbines and LNG supply infrastructure.

2. No action plan, no matter how complete at the outset, will ensure compliance with Act 17. The Integrated Resource Plan will be implemented over a three year period before the next update. Because there are major, irreducible uncertainties associated with resource development over such an extended period, continuing PREB oversight will be critical to ensure compliance with Act-17.

3. To provide effective oversight, the PREB will need to identify a set of metrics it can use to measure progress. These might include the following:

a. Accomplishing the major tasks involved in implementing advanced grid planning, above;

b. Delivering a customer collaborative, above. (Tasks related to any consensus emerging from such a collaborative might suggest additional metrics);

c. Actual renewable generation as a percent of total generation;

d. Demand response as a percent of peak demand;

e. Average cost of service.

4. Information sharing is critical to enabling prosumers and developing a Modern Integrated Grid. PREPA's apparent unwillingness to share information suggests this will prove a key issue in transforming PREPA into a customer-centric utility.

5. While change is difficult, the benefits can be more than worthwhile. Indeed, Act 17 provides a road map to a future power supply system which is truly state of the art, and which will benefit all citizens of Puerto Rico. By staying focused on the requirements of Act 17, the PREB, PREPA, and PREPA's successor can propel Puerto Rico into a position of leadership within the electric utility industry. The world needs reliable, sustainable, economically efficient electricity systems. By fully implementing Act 17, Puerto Rico can join California and Hawaii in showing the rest of the world how to do it.

Q. Does this complete your testimony?

A. Yes it does.

ATTESTATION

Affiant, Eric Ackerman, being first duly sworn, states the following: The prepared Pre-Filed Direct Testimony I am sponsoring constitute the direct testimony of Affiant in the above-styled case. Affiant states that he would give the answers set forth in the Pre-Filed Direct Testimony if asked the questions propounded therein at the time of the filing. Affiant further states that, to the best of his knowledge, his statements made are true and correct.

Eric Ackerman

Affidavit *No.*_____

Acknowledged and subscribed before me by Maylisa Dey, Notary Public Eric Ackerman, in his capacity as Eric Ackerman who is personally known to me or whom I have identified by means of driver's license number VA DL T2656 8916, in Arlington, Virginia, *this* 11th *day* of October, 2019.

Public Notary

MAYLISA RENEE DEY
COMMONWEALTH OF VIRGINIA
REG. NO. 7566643 EXP. 05-31-2021
NOTARY PUBLIC

FORM 314 Certificate of Official Character

Commonwealth of Virginia

County of Arlington *To-wit:*

I, Paul Ferguson, Clerk of the Circuit Court of the County aforesaid in the State of Virginia, the same being a Court of record, so certify that MAYLISA DEY whose genuine signature is attached to the foregoing certificate, was at the time of signing the same a Notary Public in and for the Commonwealth of Virginia, duly commissioned and qualified, and duly authorized by virtue of her office, to take acknowledgements to deeds and other writings, and to administer oaths under the laws of this state. I further certify that the official acts of said MAYLISA DEY are entitled to full faith and credit; that I verily believe his signature to the foregoing proof or acknowledgement to be genuine; and that his attestation is in due form of law. I further certify that the laws of Virginia do not require the imprint of the Notary's seal to be filed with the authenticating officer.

In testimony whereof I have hereunto set my hand and affixed the seal of the said Court this 11th day of October, 2019, and in the 244th year of the Commonwealth.

Paul Ferguson, Clerk

REV. 12/07

Direct Testimony of

DR. ERIC C. WOYCHIK

Senior Vice President, Willdan Corporation

Q1: What are your background and qualifications with respect to integrated resource planning (IRP) in the United States and elsewhere?

A1: I have worked on evaluation and development of integrated resource plans (IRPs), earlier referred to as least-cost plans, since the early 1980's, formulated IRP methods, was lead author of the California Standard Practice Manual for demand side cost effectiveness (SPM) in 1983, led evaluation of the resource plans of all California investor-owned utilities from 1985 to 1990, published numerous papers and articles on IRP methods and tools, was appointed to Chair the Least Cost Planning group at National Association of Regulatory Commissioners in 1988, and have worked on electric and gas market formation in the context of IRPs since 1982. This includes work in six Canadian provinces and over 15 other countries, as well as at least 15 U.S. states, including Hawaii. I have become an expert and thought leader on regulatory policy, investment strategy, business models, geospatial valuation, wholesale energy markets, transformational change, and smart grid development. Overall this includes more than 40 years of experience with over 45 countries to develop clean energy and traditional markets with utilities, technology providers, control operators, energy companies, stakeholder groups, and state and national regulatory bodies. I have served in roles as Executive Consultant, CAISO Board member, Commissioner Advisor, developer, and a number of senior company positions, such as with Synergic Resources Corporation, Black & Veatch, Comverge, Itron, and Willdan. I hold a B.S in Environmental Policy Analysis and Planning from University of California Davis, a M.A. in Economics from New Mexico State University, and a Doctorate in Management from Case Western Reserve University. My Curriculum Vitae is attached.

Q2: What are some of the papers and publications you have authored or co-authored?

A2: A subset of IRP related papers and publications I have authored or co-authored is as follows:

- Distributed Energy Optimization: Steps and Results for Customer Value Capture in Layers, CRRI-Rutgers 32nd Annual Conference, Monterey California 26-28 June 2019 (coauthored)

- Smart Grids: Infrastructure, Technology, and Solutions, 2nd Addition, Stuart Borlase, Editor, CRC Press, 2018 (author of multiple chapters on markets, policy, and future vision).
- To Integrate and Optimize the Grid: Locate and Customize Distributed Energy Resources, Advanced Workshop in Regulation and Competition, CRRI-Rutgers, 30th Annual Western Conference, Monterey, CA, 28 June 2017 (coauthored).
- Integration and Optimization of Distributed Energy Resources; Big Data Analytics do the Job, Advanced Workshop in Regulation and Competition, CRRI-Rutgers, 36th Annual Eastern Conference, Annapolis, MD, 1 June 2017 (coauthored).
- *Seven Conditions Justify Smart Grid Investments,* Public Utilities Fortnightly, January 2017.
- Steps to Integrate and Optimize DERs, NARUC ERE Staff Subcommittee Webinar, 1 June 2016.
- Assessing Electric Utility Potential for a Distributed Energy Future – Scope and Scale from Value-Added Integration and Optimization, Advanced Workshop in Regulation and Competition: CRRI-Rutgers, 35th Annual Eastern Conference, Shawnee on Delaware, Pennsylvania, 11-13 May 2016, (coauthored).
- Utility Efficiencies with Distributed Energy Resources: Scope, Scale, and Dynamic Benefits, Edison Electric Institute, Alternative Regulation Group, Webinar, 11 April 2016.
- Locational Net Benefits Analysis: To Integrate and Optimize Distributed Energy Resources for Maximum Value, LNBA Methodology and Demonstration Workshop, California Public Utilities Commission, San Francisco, CA, 1 February 2016.
- The Integration and Optimization of DSM: Extraordinary Benefits when the Orchestra Plays Together, AESP National Conference, Orlando, Florida, 9-12 February 2015 (coauthored).

- IDSM Cost-Effectiveness: What Happened Outside of California? Results from Duke Energy, NVE, Avista … presentation in CPUC R. 14-10-003, 22 January 2015.
- Methods & Tools to Accomplish Distribution Resources Planning, CPUC DRP Workshop, presentation in CPUC R.14-08-013, 8 January 2015.
- Valuing Integrated Demand Side Management (IDSM) for Improved Cost Effectiveness, DistribuTech Conference, San Antonio, TX, 28 January 2014 (coauthored).
- *Integrated Demand Side Management Cost-Effectiveness: Is Valuation the Major Barrier to New "Smart-Grid" Opportunities?* American Council for an Energy-Efficient Economy, Monterey, CA 12-17 August 2012 (coauthored).
- *Integrated Demand-Side-Management Cost-Effectiveness Framework*, IDSM Task Force, San Francisco, CA, May 2011.
- *An Integrated Analysis of the Electricity Market: Does More Knowledge Enable Market Manipulation?* 8th Global Conference on Business and Economics, (Coauthored), Rome, Italy, 13 October 2007.
- *Toward a Standard Practice Approach to Integrated Least-Cost Utility Planning*, Public Utilities Fortnightly, Volume 121 No. 5, March 1988.
- *Integrated Least-Cost Electricity Planning Under Uncertainty: Issues and Progress*, Workshop on Energy Resources Planning for Electricity, Honolulu, Hawaii, May 1987.
- *Least-Cost Resource Plan Integration under Uncertainty: Toward a Standard Practice Approach*, California Public Utilities Commission, September 1986.
- *Standard Practice for Cost-Benefit Analysis of Conservation and Load Management Programs,* Joint Report of the California Public Utilities Commission and the California Energy Commission, 1982 (co-authored).
- *Perspectives and Issues in Least-Cost Planning: Toward a Standard Practice Approach*, Least-Cost Energy Planning in the Midwest: A Symposium, Electric Power Research Institute, March, 1982.

Q3: Have you previously provided expert testimony on IRP and related energy topics?

A3: Yes since the mid-1980's domestically and internationally, totaling over fifty occasions.

Q4: What is required to maximize value to customers from Puerto Rico's electricity system?

A4: A "design attitude" that enables best decisions among alternatives, with sufficient focus to choose the best possible outcomes from among the alternatives.[1]

Q5: What are the steps that enable a design attitude so that Puerto Rico can emerge with the best set of alternatives for its customers and electricity system?

A5: First avoid early closure of the problem-solving space, enable openness to collaborative solutions, and develop a vocabulary to explain truly great innovative ideas.

Q6: Is there a central principle to satisfy on best practices integrated resource planning (IRP), which Puerto Rico needs to adhere to given the current economics of energy resources?

A6: Yes, the central principle is to use best practice planning to properly integrate and optimize resources to avoid major stranded costs, as the costs of renewable and distributed energy resources are declining rapidly, which signals that most central station resources installed now will soon be uneconomic or "under water."

Q7: How does this central planning principle guard against bad energy investments and ensure Puerto Rico selects best practice energy investments?

A7: Properly executed, the integration and optimization of resources compares more flexible, higher value resources to less flexible, longer term resources to define the economic tradeoffs, specifically to show which resources should be invested in for Puerto Rico.

Q8: Does LNG-fired generation electric generation look to be economic in the near term or longer term compared to other resources?

[1] See, R. Boland and F. Collopy, Managing as Designing, Stanford U.P. 2004.

A8: No, the costs of LNG-fired generation is already well above the costs of utility-scale solar photo-voltaic, wind power, combined solar/wind plus battery storage resources, and distributed energy resources (DERs). Moreover, DERs look to be more flexible, have additional option value, and thus more economic.

Q9: Do longer-life centralized resources present greater risk and less favorable economics in the current economic environment compared to flexible, shorter-life, DERs?

A9: Yes, as flexible, shorter-life, DERs configured in optimal packages can be used for a set of purposes over time and can be adapted to meet new needs as circumstances change.

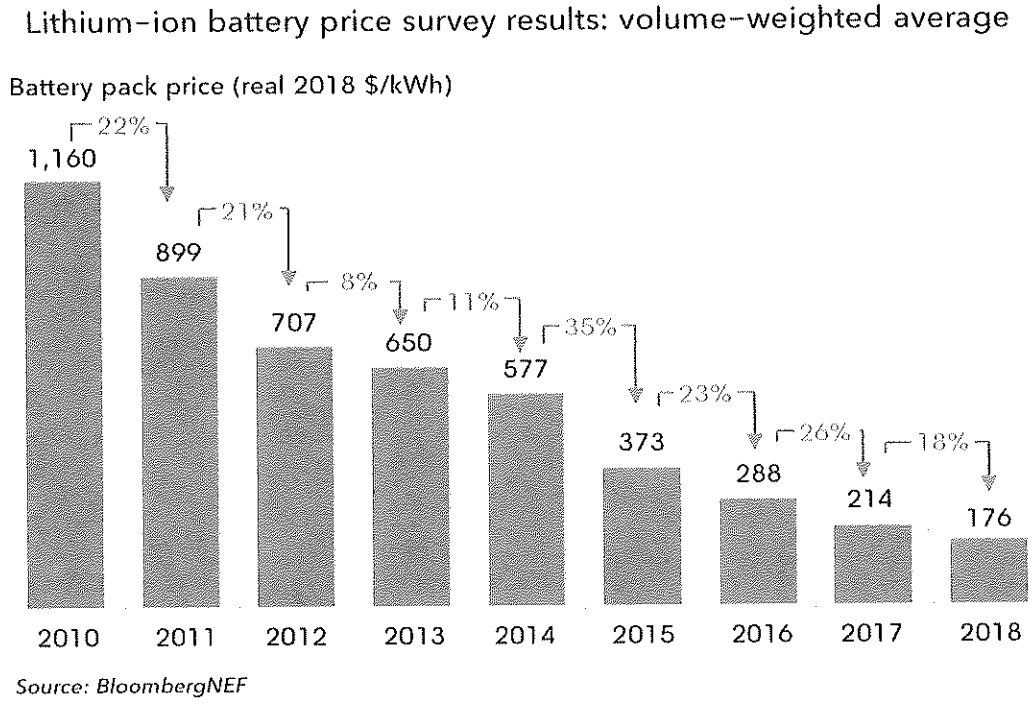
Q10: Can you share an example of flexible use of DERs over time to meet changing grid needs?

A10: Yes, Puerto Rico can benefit from the use of energy efficiency to reduce the size of 1) super-efficient heat pumps, 2) customer photovoltaic generation, 3) battery storage, and 4) smart inverters, which in turn can be used with time-of-use (TOU) rates to more cost effectively pre-cool/heat, use solar PV, enable charging or grid use of battery storage, and enable resiliency (with smart inverters) if grid power is lost. As customer, distribution circuit, and higher voltage loads change the above resources can be used in a multitude of ways, and altered incrementally. Additional benefits may be to directly defer future distribution, transmission, and central generation investments, while at the same time customer resiliency is increased.

Q11: Do you recommend meaningful projections of battery storage costs to supply Puerto Rico?

A11: Yes, a recent example of this is provided by Bloomberg[2], based on its battery price survey, which tracks the annual declining costs of batteries from 2010 to 2018:[3]

[2] Bloomberg in this testimony refers to "BloombergNEF (BNEF), Bloomberg's primary research service, covers clean energy, advanced transport, digital industry, innovative materials and commodities."
[3] See, https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/.



Q12: How much have battery and wind costs declined since 2018?

A12: According to another Bloomberg (BNEF) report "the benchmark levelized cost of electricity,[1] or LCOE, for lithium-ion batteries has fallen 35% to $187 per megawatt-hour since the first half of 2018. Meanwhile, the benchmark [Levelized Cost of Energy or LCOE] for offshore wind has tumbled by 24%."[4]

Q13: More recently, what does Bloomberg say about the costs of renewable resources, including battery storage?

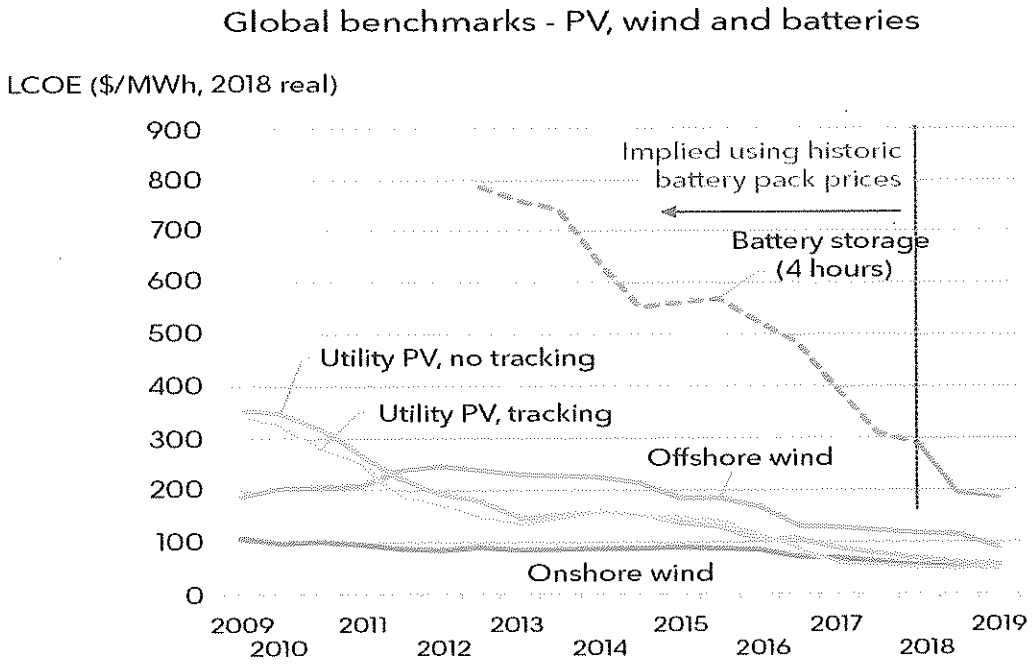
A13: Bloomberg explains as follows: *Our analysis shows that the LCOE per megawatt-hour for onshore wind, solar PV and offshore wind have fallen by 49%, 84% and 56% respectively since 2010. That for lithium-ion battery storage has dropped by 76% since 2012, based on recent project costs and historical battery pack prices. The most striking finding in this LCOE Update,*

[4]See, https://about.bnef.com/blog/battery-powers-latest-plunge-costs-threatens-coal-gas/.

for the first-half of 2019, is on the cost improvements in lithium-ion batteries. These are opening up new opportunities for them to balance a renewables-heavy generation mix.[5]

Q14: Does Bloomberg show these changes in costs in graphical terms?

A14: Yes, to further illustrate these points Bloomberg provides this graphic of global energy cost benchmarks in light of battery pack (storage) costs:



Q15: How does Bloomberg develop these cost estimates?

A15: As Bloomberg explains, "LCOE analysis is based on information on real projects starting construction and proprietary pricing information from suppliers. Its database covers nearly 7,000 projects across 20 technologies."[6]

Q16: What are the specific steps in advanced grid planning that are needed for Puerto Rico to attain maximum customer and grid benefits in its IRP process?

[5] Ibid.
[6] Ibid.

A16: The primary considerations that can enable Puerto Rico to succeed to maximize benefits for its customers and the grid are summarized in the following twelve points:

1. Pursue the Known Winning Formula: The much touted but general "winning formula" in electricity is to achieve maximum scale and scope economies. With respect to Distributed Energy Resources (DERs) this involves use of advanced analytics to leverage new clean resources. Scale is obvious; costs are lower as greater numbers of resources are provided in a given footprint. Scope economies result with right combinations of resources in right sizes that are jointly "orchestrated" (operated) to maximize value. Scale economies have been extraordinary in PVs, heat pumps, batteries, demand response (DR), electric vehicles, and metering, all of which add new capabilities and lower costs. Scope economies result with integration and optimization of multiple resources. Integration and optimization simply lift customer and grid efficiencies. A third part of this formula is electrification with greater fuel efficiency results. Electrification can be implemented at scale, and leverage scope benefits. Puerto Rico can benefit from purchase and installation of DERs at scale to provide "right packages" that then capture scope economies.

2. Avoid the Average Cost Effectiveness Focus: A key concern for all locales is to avoid use of an average solution for average customers. Customer load can and should be an asset to be managed, which can be made much more cost effective to serve. This should be part of the design attitude. How can a set of customer loads be aggregated to take advantage of customer load diversity, leverage this diversity, and provide community focused solutions? With detailed grid analytics this should be the focus for Puerto Rico. The focus should be to maximize the cost effectiveness of the portfolio, to deaverage and customize DER solutions for customers. This will cause DER cost effectiveness to increase and overall grid costs to decline.

3. Tap Zero Variable Cost DERs and Renewables: Puerto Rico's overall electricity price should decline significantly with greater use of zero marginal priced resources, especially photo-voltaics (PV), energy efficiency, demand response, betteries, and wind power. Energy efficiency and renewable resources, mainly solar PVs and wind, have zero fuel

costs, no feedstock needed. Technically, with fixed and finance costs absorbed (these are "sunk-costs"), renewable resources produce energy at virtually zero costs, which should be of greater value in Puerto Rico as it has few indigenous natural energy resources. These zero variable (marginal) cost resources in turn significantly reduce the average energy costs of Puerto Rico's energy supply. Likewise, the use of batteries for storage, energy efficiency, and demand response involve very small incremental costs for operations. These resources should be central to Puerto Rico's IRP to systematically lower costs going forward into the future.

4. Target EE & DER With Data & Analytics: Data and analytics can be used to target the most cost effective energy efficiency and DER (EE&DER) customers. With right analytics Puerto Rico can in fact leverage EE&DER to lower the costs of high peak (kW) and high use (Kwh) customers with meter data, weather data, and statistics. Puerto Rico can directly sort customers that have 1) the highest peak (capacity) loads, 2) the customers with the highest kWh (energy) use, and 3) the customers that are both high peak and high use. With use of SCE's granular smart meter data, these results can be combined with locational weather and "covariation analysis" to further increase the cost effectiveness of EE&DER. Accordingly EE&DER can be treated as a grid resource, when integrated and optimized with Puerto Rico's bulk grid to net greater cost effectiveness. With targeting a locational customer value map can be created that shows where the best EE&DER investments reside. Consumer engagement can be used to create long-term relationships, coach and market customers, and successfully install targeted EE&DER assets.

5. Target and Leverage Growing Capacity Needs: Electrical capacity costs, the second part of the value equation, should be a focus in Puerto Rico as they will increase to ensure greater levels of reliability and resiliency. Capacity resources (that provide as needed available kW) are obviously required to address grid uncertainties (contingencies) and compensate for the variability of renewable energy, including solar and wind. Unplanned power plant and line outages, considered "contingencies" by grid operators, can be compensated with available capacity, especially demand response and battery storage.

As customer loads change over the day, energy must match in power terms, and capacity must respond as needed to compensate for system changes and contingencies. This suggests Puerto Rico must focus more on ensuring adequate capacity resources. Puerto Rico should expect capacity costs to increase as energy costs decline. Capacity resources, especially flexible capacity is needed to provide the growing grid need for this "glue" of sorts. Technically, this is the ramp-up and ramp-down of available electrical capacity (kW), as renewables respond to the wind and the sun. Solar PVs increase output as the sun rises and solar of course reduces output as the sun sets. Clouds and rain though make PV generation uncertain, making back-up capacity essential.

6. Ramping Resources – More Value: The "net-load" on the grid then must be met with resources that ramp down in the AM and ramp-up in the PM to balance supply and demand. DERs can provide ramping and be compensated for it. The costs of renewable energy thus will decline and remain cheap, cheaper than fossil or nuclear energy. But electrical capacity, especially to ramp up and down to meet renewable needs, will be more variable and costly. This translates to more value from DER capacity, but more costs to serve these needs. This should be a specific focus for Puerto Rico, especially to obtain greater resiliency.

7. Local Transmission and Distribution: Local transmission and distribution needs must provide Puerto Rico with capacity, voltage compensation, and VAR (volts-amps-reactive). Needs for these resources will increase with more renewables, DERs, and electric vehicles (EVs) on the system, which if unmanaged will increase grid costs. Integration and optimization of the EE&DER portfolio is the best way to lower overall grid costs both in the short and the longer terms.

8. Develop Integrated DERs: This testimony fully supports use of distributed energy resources – EE, DR, DG, ST, and EV charging (DERs) – to best manage locational and net grid loads, lower utility costs, and meet Puerto Rico's policy goals. DERs can provide energy, and capacity to balance grid needs including ramping needs. Some DERs can be turned on and off quickly, so can be dispatched. Historically solar and wind

are considered "must-take" when they produce, but this should change. Puerto Rico's circumstances make demand response and storage at "right times" highly valuable as dispatchable resources. While EE is not dispatchable, it can be used to great advantage.

9. Downsize DERs With EE: It is important for Puerto Rico to recognize the strategic value of EE, and that it should not simply be compared to the variable costs of energy avoided. Puerto Rico can focus on and target the energy and capacity "footprint" of a building, to reduce its footprint in terms of kW and kWh with EE. This will reduce the sizes of needed "packages" of DERs. With customer end-uses (such as air conditioning) reduced and corresponding DER sizes reduced, this directly translates to increased EE and DER cost effectiveness. Pursued systematically, Puerto Rico's overall energy (kWh) and capacity (kW) use can be dramatically reduced with targeted EE. This is what smart grid analytics are for, and how they new extraordinary benefits. The size of the load, or kW, in any given hour is what the customer asks to be served, and over the month must be payed for (over all hours). EE can permanently reduce a customer's load during specific times to lower costs. This is strategic, "just in time," EE. Implemented *en-mass* across Puerto Rico, this translates to an extraordinary opportunity to reduce its overall costs. The modeling details are straightforward to produce these results. In short, the interactive benefits of EE and of DERs should be fully considered. The proper sizing of DERs, and thus the reduced sizes of selected DERs, should be captured for Puerto Rico. This means that the benefits of EE to reduce the sizes of selected DERs – which translate directly to lower first (capital) costs – must be recognized in full.

10. Leverage DER Scope Benefits of EE&DERs: EE has usually been implemented by itself, in a silo, separate from other DERs. Likewise, DR has been treated similarly. Scope economies – combining EE and DR with other DERS -- have not been harvested. Puerto presents no exception in this regard. A customer's combined needs for energy, including EE (energy reduction), and capacity can be optimized with new tool called DER Optimizer. This tool can determine the appropriate types of DERs to use and the appropriated sizing of DERs to use. Substantially lower overall costs are possible with "right" DER selection and sizing, including electrification options. In these

circumstances, EE properly configured with DERs typically reduces the need for capacity, including ramping. For customers that seek to have a smaller footprint, optimization of EE and other DERs offers both lower energy and lower capacity costs. In short, EE&DER can dramatically reduce the costs of capacity and the size of other DER needs when we can capture integration and optimization efficiencies, that is, scope benefits.

11. Granular Data & Analytics Are Required: Puerto Rico can realize EE&DER benefits most directly with use of granular data and analytics, which in turn provide greater accuracy and certainty. For example, where a commercial customers can use significant new lighting and insulation (EE), an efficient electric heat-pump (or A/C unit) that can be load-managed, and a time-of-use (TOU) tariff, the joint EE can then downsize the heat-pump (or A/C unit). With the heat-pump (or A/C unit) used at lower cost times in response to the TOU tariff, this will also lower the bulk grid ramping costs. With customer energy (kWh) costs reduced, battery storage and solar PV may be added more cost effectively, these have been downsized as well. This represents best practice customer and grid analytics to enable with major GHG and criteria pollution benefits.

12. Where Puerto Rico Can Be: Integration and optimization of EE&DER can successfully increase the cost-effectiveness of DERs in Puerto Rico and lower its overall electricity costs. These opportunities, at customer-specific locations, are compelling to maximize customer and grid value. Advanced grid analytics are proposed to leverage major scope and scale advantages with EE and DER delivery. Focused customer targeting and consumer engagement can further enable best-practice EE and DER optimization to best select and size EE-DERs. Financing and customer incentives can overcome customer issues with the initial costs of EE and DERs. Puerto Rico can provide direct guidance on where and when to provide EE and DERs to minimize customer and grid costs. In this way, Puerto Rico can meet its ambitious renewable and GHG goals at least costs for its customers and its economy.

Q17: What do you recommend to ensure that Puerto Rico avoids a major stranded cost legacy with adoption of new centralized electricity generation?

A:17: I strongly recommend that Puerto Rico approve only 1000 MW of central station generation that is lower in costs than combined solar and storage (battery) or wind and storage (battery) costs of $0.025/kWh.

Q18: Why do you recommend approval of only 1000 MW of central station generation at a minimum total LCOE of $0.025/kWh?

A18: These costs, as proven in more northern environments in the continental U.S., are attainable now. The costs of central station generation, even combined solar/wind and battery storage, are falling rapidly, as explained in response to Qs and As 11 to 14 above, will cause even this increment of central station generation to soon be uneconomic (under water) as clean energy costs continue to decline, adding to stranded costs.

Q19: Do you recommend a next round of IRP analysis to determine the balance of DERs and renewables that will be most economic for Puerto Rico?

A19: Yes, a new, rigorous IRP analysis is needed to properly define the best-practice, least cost options for Puerto Rico going forward, consistent with the testimony provided herein.

Q20: Does this conclude your testimony?

A20: Yes it does.

Direct Testimony of

Jose O, Aleman-Bermudez, PE, MBA

TABLE OF CONTENTS

I. INTRODUCTION AND SUMMARY

A. Witness Identification and Professional Background

Name and Business

Q. Please state your name and address:

A. My name is Jose O. Aleman-Bermudez. My business address is PO Box 366771, San Juan, Puerto Rico, 00936-6771.

Q. What is your educational background?

A. I earned a B.S. in Electrical Engineering, at University of Puerto Rico at Mayaguez in 1975 and a Master's Degree in Business Administration at the University of Puerto Rico at Rio Piedras in 1992. I am also a Registered Professional Engineer in Puerto Rico, License PE # 07847.

Q. On whose behalf are you testifying?

A. I am testifying on behalf of Cámara de Mercadeo, Industria y Distribución de Alimentos (MIDA), Centro Unido de Detallistas (CUD), Unidos por Utuado, Inc., Puerto Rico Manufacturers Association and Instituto de Competitividad y Sostenibilidad Económica.

Q. Have you previously provided testimony before the Energy Bureau?

A. No, I have not.

Q. Please describe your background and employment experience.

A. I was employed by the Puerto Rico Electric Power Authority (PREPA) for 27 years including working in the Hydro-Gas Division. My responsibilities included overseeing the operation of hydroelectric projects and facilities throughout the island. During that period, I was part of the operations team that managed a 100 MW of hydroelectric generation. Through my last 10 years in PREPA, I worked in management positions in generation plants, including serving as acting Head of the San Juan Plant. Since leaving PREPA in 2005, I have provided professional and consulting services in Puerto Rico. My consulting engagements have included subcontract projects with the U.S. Army Corps of Engineers (USACE) and the Federal Emergency Management Agency (FEMA).

II. Summary of Direct Testimony

Q. What are the purposes and subjects of your Direct Testimony?

A. The subject and purpose of my testimony is to provide the Puerto Rico Energy Bureau (PREB or Energy Bureau hereafter), an independent review of the proposed Integrated Resource Plan (IRP) as well as to provide recommendations on PREPA's last submitted version of the IRP Rev. 2 dated June 7, 2019 particularly with regard to hydroelectric generation.

Q. What is your opinion of the IRP?

A. In my opinion the IRP is flawed and lacking information, especially regarding hydroelectric units and related facilities and installations. This lack of information will not allow PREB and PREPA customers to make informed decisions on an IRP plan that will be in place for 20 years. I recommend that the Energy Bureau order PREPA to revise the IRP to include and prioritize hydroelectric generation as an important resource that should be counted on to satisfy the electric system demand, reliability and resilience. Absent additional information and fixing the flaws I describe below, the IRP as filed will deprive customers and stakeholders of potential cost reductions for electric power services during the twenty (20)-year period during which it is

expected to guide PREPA's resource decisions.

With the exception of the text provided in Section 4.2.1.4 and the data included in Exhibit 4-10, the IRP does not consider specific requirements, projects, assignments or cost estimates for the purpose of overhauling, restoring, repairing and/or upgrading the current hydroelectric generation facilities, generating units and associated water systems to benefit the Puerto Rico electric system. This omission is not only counter to the best interests of Puerto Rico's ratepayers within this planning process but is also directly contrary to the best interests of PREPA and its stakeholders.

In terms of hydroelectric generation action plans and proposed investments, the IRP only refers to a Request for Qualifications for a Long-Term Lease and Energy Sales Agreement(s) for Hydroelectric Power Plants Owned by Puerto Rico Electric Power Authority, issued on April 16 by the Puerto Rico Public-Private Partnerships Authority (P3), as indicated on footnote #18, page 4-8 of the IRP[1].

Neither the RFQ nor the information in the IRP constitute a specific plan to consider the actual integration of hydroelectric generation facilities, generating units and associated water system resources into the Integrated Resources Plan (IRP). Only the *Capacity, Availability and Capacity Factor* time frame goals included on the IRP Exhibit 4-10, *PREPA Operational Hydro Capacity Assumptions*, constitute information that can be used in a future action plan. The information on that Exhibit is included also as part of the April 16, 2019 RFQ. Notwithstanding, the information included on Exhibit 4-10 is neither explained nor justified, nor are specific directives, priorities or resources provided for each unit or site to be retrofitted.

Approving an IRP that does not includes specific plans for hydroelectric facilities, generating units and associated water systems deprives Puerto Rico's ratepayers, residents, customers and all stakeholders of an important renewable energy resource. Undoubtedly the integration of hydroelectric generation would not only reduce system costs and environmental impacts, but it

[1] Footnote #18, PREPA Proposed IRP, dated June 7, 2019:
[18 REQUEST FOR PROPOSALS: Long-Term Lease and Energy Sales Agreement(s) for Hydroelectric Power Plants Owned] by: Puerto Rico Electric Power Authority]

would also provide system reliability and resiliency at locations where the most socioeconomically vulnerable people live, that is, in the central mountain areas that were most affected by Hurricane Maria.

Further, not restoring nor adequately maintaining Puerto Rico's hydroelectric facilities including generation units, dams, reservoirs and related water systems creates a public safety issue. The IRP does not consider safety issues and their very real costs. As previously occurred with the Carraizo dam during hurricane Hugo in 1989 and recently with the Guajataca dam during hurricane María in 2017, the lives of many people were at risk during and after those natural disasters. This IRP needs to consider the restoration of those sites with the additional benefit of the well-being and safety of their region. If hydroelectric sites are not taken into account within this IRP review process, emergency response costs to be incurred by PREPA could be higher than refurbishing, repowering or restoration costs.

Q. Can you summarize your conclusions?

A. The IRP submitted by PREPA on June 7, 2019 and its Action Plan do not recognize the relevance and potential contributions of existing hydroelectric units, facilities and installations – some of which are still in operation after a century. This lack of consideration of the potential contributions of hydroelectric generation is not in the best interests of Puerto Rico's electricity consumers and it needs to be corrected.

In particular, the potential costs and benefits of including Puerto Rico hydroelectric facilities, generating units and associated water systems needs to be considered as part of this process. Even when compared with levelized costs of electricity for hydroelectric generation in the U.S., hydroelectric generation costs are lower than natural gas generation.

Hydroelectric power generation needs to be prioritized over fossil fuel supply sources, due to its low cost and additional environmental benefits. PREB should also require PREPA to include hydroelectric generation as part of the sensitivity analysis performed on the IRP, considering the impact of hydroelectric generation on the construction of additional natural gas generation facilities. This sensitivity analysis should consider:

- Generation Cost
- Low Cost of Hydroelectric Units (considering refurbishing of existing sites)
- Black-start Capabilities of Hydroelectric Generation

Further, the Bureau should order PREPA to conduct additional analysis to identify limitation factors in terms of hydroelectric generation, including:

- Generation limiting factors related to the Puerto Rico Aqueduct and Sewer Authority (PRASA).
- Generation limiting factors related to agricultural irrigation facilities and water sources, including operations and dredging costs.

Furthermore, the Bureau should order PREPA to expedite the gathering of information needed to analyze the overhaul of the 11 hydroelectric sites and 21 units that are part of the existing hydroelectric generation roster of PREPA. This information needs to include hydroelectric units and sites not currently in operation, comprising 19 additional units. In sum, PREPA's existing and former hydroelectric sites totalize **16 sites and 40 units. Refer to Table II, part of the Testimony Supplemental Information, attached to my Direct Testimony.**

In addition, recently built dams that can accommodate hydroelectric generation, such as the Cerrillos dam on south part of the island, should also be considered in revised IRP.

In summary, PREB should order PREPA to file as part of this proceeding a detailed plan including related sensitivity and cost impact analysis considering different scenarios of hydroelectric generation. Further, all hydroelectric and water resources decisions shall be evaluated, determined and documented within this IRP process, and not as part of a separate process. For this reason, the Bureau should instruct PREPA to hold any action in terms of the P3 Authority April 16 RFQ until this IRP review is completed.

PREPA's analysis is flawed and incomplete, the June 7th IRP lacks thorough consideration of comparative data and adequate modeling.

Therefore, the approval of the IRP should consider a detailed analysis of hydroelectric power generation due to its benefits to the electrical system and electricity consumers.

Q. Please describe how the rest of your testimony is organized.

My testimony includes additional information that can be included as part of this IRP review process, including: (1) comparison of hydrogeneration costs with fossil fuel generation sources, (2) benefits of hydroelectric generation to the electrical system and the electricity consumer, (3) additional benefits of hydroelectric plants localized generation in rural areas, (4) overhauling and repair of existing units, and (5) conclusions.

Our testimony is based on publicly available information, since operational data was requested to PREPA, but not provided. For that reason, our recommendation is that the PREB orders PREPA to conduct further analysis, to develop a specific and detailed Action Plan, including each and every hydroelectric generation site and units.

Also, the *Direct Testimony Supplemental Information*, attached hereto is organized as follows:

I. Existing Hydroelectrical Sites
II. Non-operational Hydroelectric Sites not Considered on Current Filing
III. Historic and Projected Cost of Hydroelectric Generation

Q. What justifies your request for further analysis?

A. Puerto Rico hydroelectric facilities, generating units and associated water systems, should be prioritized, as part of the IRP review process, over new natural gas generation, as I detail below. The cost, reliability and environmental benefits of hydroelectric generation should not be ignored.

Hydroelectric generation costs less than natural gas generation, especially in Puerto Rico.

With the exception of the Eco Eléctrica plant, which supplies natural gas for its own generation and to Costa Sur units 5 & 6, there is currently no natural gas utility scale supply capabilities at Puerto Rico, or local natural gas production. Adequate utility scale distribution facilities are also lacking near the proposed fossil fuel generation areas, especially on the north part of the island. To solve these issues would require a huge initial investment, as stated in the current and

previous IRP versions, estimated at over one billion dollars. These financial costs will have a direct impact on the cost of electricity.

Costs related to hydroelectric generation are substantially lower than those associated with any fossil fuel option, especially in Puerto Rico when considering the refurbishing of existing hydroelectric generation sites. **Hydroelectric generation marginal costs are close to zero** and levelized costs are also usually lower than natural gas generation.

There is no future fuel cost certainty. The cost of gas and fossil fuels costs may rise considerably and unexpectedly. This would make hydroelectric generation a better and more cost stable alternative than fossil fuel generation, including natural gas. The benefits of hydroelectric generation are even more compelling when considering construction, O&M and the environmental costs of fossil fuel generation.

Hydroelectric generation provides additional benefits:

Hydroelectric generation has been a proven, reliable power resource for many years. It can generate clean and stable renewable power. It is a renewable energy source that can operate as **base load**, supplementing solar and wind power sources.

Although, Puerto Rico's hydroelectric generation capacity probably cannot serve the total system island-wide **base load demand**, it can serve a relevant portion, ranging from a 100 MW (currently at 34 MW) to **possibly over 200 MW**, considering pump storage and capacity optimization.

This becomes even more relevant when considering the IRP projected demand reduction. In that situation, the advantages of hydroelectric generation become even more significant as the percentage of hydroelectric generation increases due to decrease in demand, and when considering that in such scenario additional infrastructure for fossil fuel generation may not be required. Because of demand reduction, the introduction of additional amounts of lower cost generation, such as hydroelectric, will have an impact on the overall cost of electricity.

Hydroelectric generation can also be utilized as a **full-system black-start source**. Hydroelectric units were used during the start-up of oil fueled plants in the aftermath of hurricane Maria and

previous natural disasters. Important to note is that hydroelectric generation does not require fuel, other than water flow, to operate at any condition including as a black-start source.

Hydroelectric generation presents a real power source to low load power customers in rural areas. Therefore, although hydroelectric units have relatively low power generation capabilities compared to large oil-fired plants, when operated through isolated micro and mini grids, including under emergency conditions, they may provide power to many low load rural customers, probably the most affected by hurricane Maria and any future natural disasters.

In summary, hydroelectric generation needs to be prioritized over fossil fuel generation due to the benefits of low costs, reliability and resilience that it provides. In other words, if the IRP models more hydroelectric output, many of the natural gas generation units proposed in the current IRP will not be required, especially hedge units.

Furthermore, the overhauling and revamping of hydroelectric sites and generating units and associated water systems, including lake and reservoir dredging, required to attain full power operation capabilities, normally cost substantially less than gas generation projects. Those analyses need to be conducted as part of this IRP review process.

Q. What do you recommend with regard to the overhauling, restoration, repairing and/or upgrading of the current hydroelectric generation facilities in the IRP?

The PREB should require PREPA to thoroughly explain why such a robust operating infrastructure was abandoned to current deteriorated condition.

PREPA has abandoned its responsibilities to satisfactorily operate and maintain many, if not all, hydroelectric units and facilities for which it has operational responsibility . This is apparently due to staffing and funding shortages causing deferred maintenance issues, resulting in a drastic decrease of hydroelectric generation from 100 to 34 MW. The PREB should consider penalizing PREPA for the abandonment of hydroelectric generation infrastructure.

The PREB should also require PREPA to develop a specific and detailed Action Plan for each and every hydroelectric generation site and unit as part of the IRP review process. This plan

should not only include the existing 21 units in operation, but also 19 additional units, not currently in operation, the Cerrillos dam and pump storage options.

II. DIRECT TESTIMONY CONCLUSIONS

Q. Why should have PREPA included hydroelectric generation facilities in the IRP?

PREPA should have included hydroelectric generation as part of the proposed IRP, as a minimum, for the reasons presented herein:

1) Hydroelectric generation **costs less than natural gas and can potentially reduce overall electricity costs** particularly in low demand scenarios.

2) Hydroelectric generation is a **renewable base load** source. Many sites recently operated at relatively full capacity and currently on partial capacity.

3) It is a **renewable full-system black-start source** that has been recently used to restore power in the aftermath of hurricane Maria.

4) Hydroelectric generation is **readily available to be incorporated to** mini and micro-grids, to provide electric service **to many low-income communities in rural areas, even immediately after natural disasters.**

5) If hydroelectric sites and units are not properly maintained and operated, the lack of maintenance may eventually result in **public safety risks, throughout the island**.

Q. What action or actions do you recommend that the PREB take as a result of this proceeding?

A. The PREB should order PREPA to conduct analysis and evaluations intended to prioritize hydroelectric generation in Puerto Rico.

The analysis should, at a minimum, include:

1. The cost of overhauling and repair of existing units. This should include a public report comprising field inspections of all operating 21 hydroelectric units and sites and the additional non-operational 19 units.

2. Hydroelectric generation cost projections and impact to the overall system costs.

The PREB should order PREPA to make available to the public all information related to hydroelectric generation at PREPA, including all information related to the P3 process and further public information including unsolicited proposal, submitted by Cube Hydro Partners, LLC and CSA Architects & Engineers, LLP in respect of the Hydropower System, dated May 25, 2017.

Q. Does this conclude your Direct Testimony?

A. Yes, it does.

Direct Testimony Supplemental Information

I. Existing PREPA Hydroelectric Power Generation Units, 21 Hydroelectric Units in 11 Sites

Table I. Current PREPA Hydroelectric Generation Units

Item	Unit(s)	Unit Capacity (MWs)	Site Capacity Capacity	Status per IRP Exh 4-1, p89, @2018
1	Rio Blanco 1-1	2.5		Not Available
2	Rio Blanco 1-2	2.5	5.0	Not Available
3	Toro Negro 1-1	1.5		
4	Toro Negro 1-2	1.5		
5	Toro Negro 1-3	1.5		
6	Toro Negro 1-4	4.0		
7	Toro Negro 2-1	2.0	10.5	Not Available
8	Caonillas 1-1	10.0		Not Available
9	Caonillas 1-2	10.0		Not Available
10	Caonillas 2-1	3.6	23.6	
11	Dos Bocas 1-1	5.0		
12	Dos Bocas 1-2	5.0		
13	Dos Bocas 1-3	5.0	15	
14	Garzas 1-1	3.6		
15	Garzas 1-2	3.6		
16	Garzas 2-1	5.0	12.2	Not Available
17	Yauco 1-1	25.0		Not Available
18	Yauco 2-1	4.5		
19	Yauco 2-2	4.5	34	
20	Patillas 1-1	0.80		Not Available
21	Patillas 1-2	0.64	1.44	Not Available
	Total Generation	101.74	101.74	

As indicated on IRP, current hydroelectric generation is 34 MW out of a maximum of approximately 100 MW, therefore, a 34% is well below the desired generation level. Although all sites count with generation equipment, approximately 6 out of the 11 sites are not operation.

II. Non-Operational Hydroelectric Sites Not Included on IRP Filing, 19 Units in 5 Sites

Table II. Non-operational PREPA Hydroelectric Generation Units

Item	Unit(s)	Units Capacity (MWs)	Site Capacity (MWs)	Status
1	Carraizo 1	1		Under PRASA responsibilty
2	Carraizo 2	1		Allegedly filled up with concrete
3	Carraizo 3	1		Proposed Rehab to 8 MWs
			3.0	
				OOS (Out of Service)
4	Comerio 1-1	2.0		OOS since 1972
5	Comerio 1-2	2.0		
6	Comerio 1-3	2.0		
7	Comerio 2-1	2.6		
			8.6	
8	Isabela 1-1	0.80		OOS since 1963
9	Isabela 1-2	0.80		
10	Isabela 2-1	0.625		
11	Isabela 2-2	0.625		
12	Isabela 3-1	0.50		
13	Isabela 4-1	0.50		
			3.85	
14	Carite 1-1	0.70		OOS since 1972
15	Carite 1-2	0.70		
16	Carite 1-3	0.70		
17	Carite 1-4	1.75		
18	Carite 2-1	0.64		
19	Carite 3-1	0.80		
			5.29	
	Total Generation	20.74	20.74	

Table III. New Hydroelectric Resources and Potential Generation

1	Cerrillos Dam	Recently constructed with Hydroelectric generation option declined
2	Pump storage	Various potential sites to be evaluated
3	Mini and Micro Hydro Generation	New Potential Hydroelectric Generation form 5 Kw to 1 MW

In terms of non-operational units, listed in Table II above, and not included in the IRP filing, there are 19 hydroelectric units throughout 5 sites. Some of these sites, currently do not include generating equipment in operational condition or those that lack substantial parts such as turbines and generators.

These 5 sites should be included in the IRP, whose restoration should be considered to provide additional hydroelectric generation. In addition, new hydroelectric generation resources should also be considered as part of the IRP review process, as included on Table III above:

1) Cerrillos dam, whose hydroelectric capability was considered but not included on project construction but can be reevaluated.

2) Potential pump storage capability throughout existing sites and units.

3) New potential hydroelectric generation from 5 Kw to 1 MW though Mini and Micro hydroelectric generation.

III. Historic and Projected Cost of Hydroelectric Generation

Listed below is available hydroelectric generation historical and projected costs, including Puerto Rico, U.S. mainland and international cost data.

1) Local PREPA hydroelectric generation costs is nearly 2 cents/kWh for 2012 as per PREPA's *Informe, Evaluación y Comentarios a la Resolución de la Cámara 1966* dated February 13, 2012 as per the Puerto Rico House of Representative Resolution 1966 dated December 20, 2011.

2) On the mainland, the U.S. Energy Information Administration (EIA), indicates in the *Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2019,* dated February 2019, that the estimated levelized cost of electricity for new generation resources entering in service in 2023 for hydroelectric generation is 3.9 cents/kWh.

3) As per the International Renewable Energy Agency (IRENA) 2012 data, the cost of electricity generated by hydropower is generally low although it varies depending on the site location. The levelized cost of electricity (LCOE) for hydropower refurbishments and upgrades ranges from as low as $0.01/kWh for additional capacity at an existing hydropower project to around $0.05/kWh for a more expensive upgrade project.

4) Based on the IRP projected cost data, on pages 8 - 41 and 8 - 60, any PREPA Hydroelectric power generation option cost will be substantially lower, when compared with PREPA/Siemens IRP generation projected costs. For example, the historical PR hydroelectric generation cost, equivalent to 2 Cents per kilowatt hour when compared with the generation costs in Exhibits 8 - 37 and 8 - 59 of nearly 12 Cents per kilowatt-hour, hydroelectric generation is nearly 80% less expensive than the average PREPA generation cost.

ATTESTATION

Affiant, José Orlando Alemán Bermúdez, being first duly sworn, states the following: The prepared Pre-Filed Direct Testimony I am sponsoring constitute the direct testimony of Affiant in the above-styled case. Affiant states that he would give the answers set forth in the Pre-Filed Direct Testimony if asked the questions propounded therein at the time of the filing. Affiant further states that, to the best of his knowledge, his statements made are true and correct.

Affidavit No. 615

Acknowledged and subscribed before me by José Orlando Alemán Bermúdez, of legal age, married, engineer and resident of Carolina, Puerto Rico, in his capacity as expert witness who is personally known to me or whom I have identified by means of driver's license number 762373, in Carolina, Puerto Rico, this 18 day of October, 2019.

Public Notary

RECIBO
4U18-03650109

Sello
MA BERRIOS SILVA
ADA-NOTARIO
9397
10/10/2019
$5.00

Sello de Asistencia Legal
80004-2019-1010-10576040