SECRETARIA
COMISION DE ENERGIA DE
PUERTO RICO

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GOBIERNO DE PUERTO RICO
COMISIÓN DE ENERGÍA DE PUERTO RICO

In re: PREPA's IRP

PROMOVENTE (S)

vs.

PROMOVIDO(S)

CASO NÚM.: CEPR-AP-2018-0001

ASUNTO: Presentación Conferencia Técnica

MOCIÓN

Comparece PREPA y muy respetuosamente, expone, alega, y solicita a esta Honorable Comisión que:

1. Se presenta escrito sobre Conferencia Técnica en el caso de referencia, señalada para esta fecha

2.

3.

Respetuosamente sometido por Lcda. Vazquez **el** 14 **de** agosto **de** 2018 **a la Comisión de Energía de Puerto Rico en San Juan, Puerto Rico. Certifico también que hoy** — **de** — **de** — **envié copia de esta Moción a:**
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[signature]
Firma

14-8-18
Fecha

PREPA PREC Technical Conference
Aug 14, 2018

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Disclaimer

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- This presentation with the PREC is based on preliminary IRP work, which is currently going through extended technical review, stakeholder inputs, discussions, and alignments.
- As such, many concepts, approaches, assumptions and results in this presentation should be considered preliminary and are subject to changes and adjustments as part of the ongoing IRP process.

PREC Technical Conference Agenda: Morning 8:30-12:30 Eastern Time

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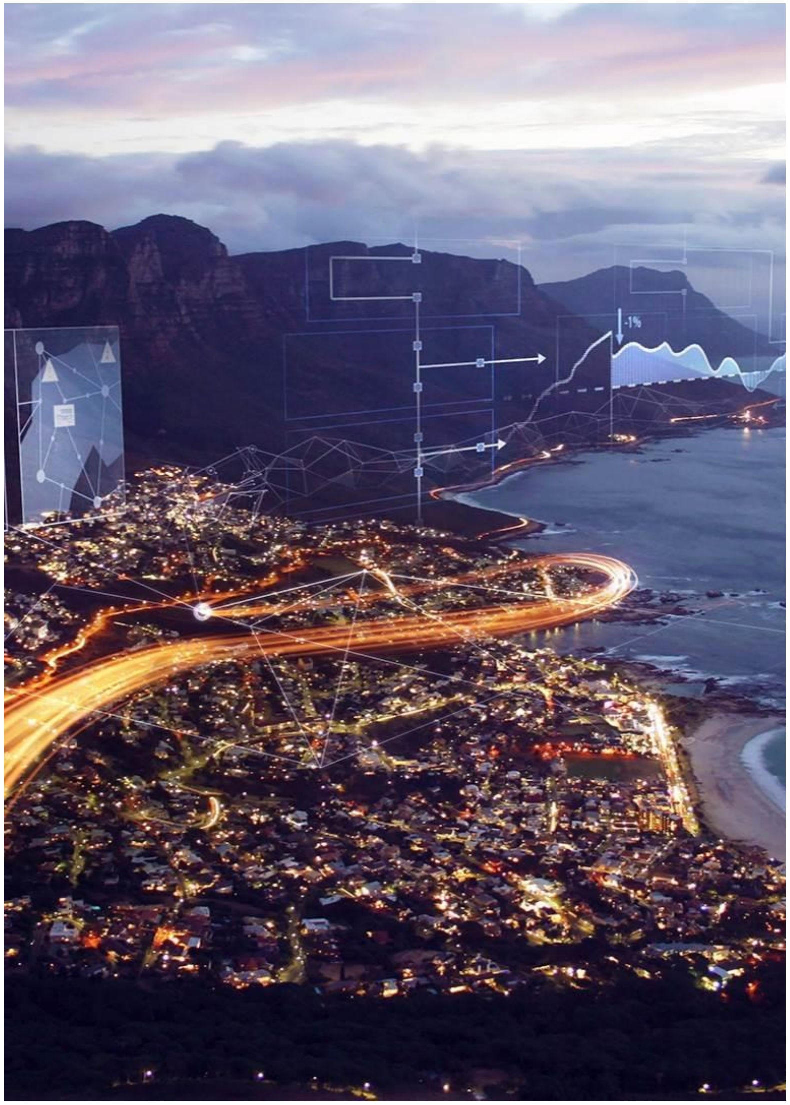
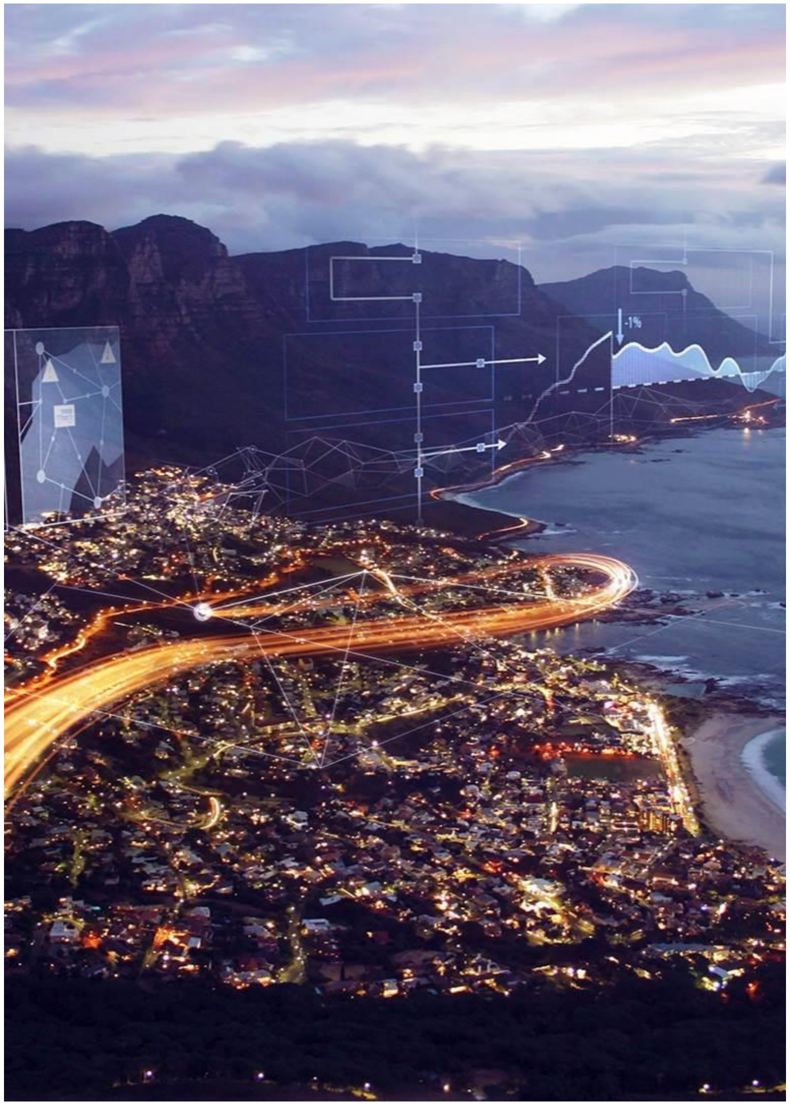


- Stakeholder Presentation
- Stakeholder Engagement Status
- Planning Environment
- Caveats and Limitations
- Resource Plan Development
- Resources Needs Assessment
- Transmission and Distribution
- Existing Resources
- New Resource Options

PREC Technical Conference Agenda: Afternoon 13:30- 16:30 Eastern Time



- Load Forecast 13:30-14:00
- Assumptions and Forecasts
  - Energy Efficiency & Demand Response 14:00-14:30
  - Environmental Review 14:30-15:00
  - Fuel Infrastructure and Forecast 15:00-15:30
  - Distributed Generation
  - Cost and Availability of Capital
- Action Plan

Stakeholder Engagement Status

	Date	Location	Stakeholder Groups
1	June 4	San Juan	Customer Associations and Academia
2	June 4	San Juan	Non-governmental Organizations (NGOs) and Environmental Organizations
3	June 6	San Juan	Suppliers and Developers
4	June 6	San Juan	General Public
5	June 8	San Juan	Rand Corporation
6	June 13	Remote	U.S. EPA, Junta de Calidad Ambiental de Puerto Rico (JAC), P3
7	June 20	Remote	Department of Energy National Labs
8	July 12	Remote	Pharmaceutical Associations- PIA
9	July 16	Remote	Creditors
10	July 20	Remote	TAC
11	July 25,31 Aug 3,7	Remote	FOMB
12	Aug 14	San Juan	PREC meeting

Planning Environment

PREPA IRP

Planning Environment

Policy	Analysis Implication
Renewable Portfolio Standard (RPS)	Act 82 of July, 2010 defines specific requirements to promote energy diversification by creating an RPS. This rule requires load serving entities to supply increasing shares of retail sales with qualified renewable and alternative sources starting at 12 percent in 2015 increasing to 15 percent in 2027 and 20 percent in 2035. PREPA has not met RPS targets to date. In the RPS statute there are grounds for non-compliance (Act 82-2010, Section 2.12(d)), e.g., “insufficiency of sustainable renewable energy or alternative renewable energy producers” and “the excessive cost of acquisition of the electric power generated by a renewable energy producer”.

Planning Environment

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Policy	Analysis Implication
Energy RELIEF Plan	Act 57-2014 requires PREPA to adopt Puerto Rico's RELIEF Plan which requires that within 3 years from July 1, 2014, at least 60 percent of the electricity generated in Puerto Rico from fossil fuels is generated in a highly efficient manner as defined by the Energy Commission.
Regulation on Microgrid Development	The final Microgrid Regulation of May 2018 is intended to set the legal and regulatory framework required to promote and encourage the development of microgrid systems in Puerto Rico, enable customer choice and control over their electric service, increase system resiliency, foster energy efficiency and environmentally sustainable initiatives and spur economic growth by creating a new and emerging market for microgrid services. It intends to promote the development of Microgrid systems by enabling their implementation through different business and operational models. PREPA could seek waiver of provisions of the regulation but has not yet made any decision to do so.

Planning Environment

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Policy	Analysis Implication
Mercury and Air Toxics Standard (MATS)	The MATS rule requires facility specific emission reductions of mercury, acid gases, and particulate matter. This is a command-and-control type of regulation with no allowance trading. Several PREPA facilities remain out of compliance and are required to run for reliability purposes. The IRP will inform pathways to MATS compliance for these units.
National Ambient Air Quality Standards (NAAQS)	EPA updated attainment designations for SO_2 based on detailed air quality monitoring in December 2017. The standard for SO_2 is 75 parts per billion. Puerto Rico must finalize a state implementation plan (SIP) by May 2019 addressing compliance for two areas designated as nonattainment. Emissions from all generating units will be modeled and reported in the IRP analysis.
Greenhouse Gas Emission Standards	The New Source Performance Standards (NSPS) for Electric Utility Generating Units was finalized in August of 2015 and sets a rate limit of 1,000lbs of CO_2/MWh for combined cycle natural gas plants and a limit of 1,400lbs of CO_2/MWh for coal plants.
Regulation in Integrated Resource Planning for the Puerto Rico Electric Power Authority (9021)	Regulation 9021 is intended to serve to make sure that the IRP is a useful tool to improve the system's reliability, resiliency, efficiency, and transparency, and offer electric power services at reasonable prices. Specifically, 9021 defines the required contents and organization of the IRP, the process with PREC, and performance metrics for PREPA following PREC's review and evaluation of the IRP.

Planning Environment

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Policy	Analysis Implication
PROMESA	The Puerto Rico Oversight, Management, ad Economic Stability Act (PROMESA), signed into law by President Obama on June 30, 2016, is a unique federal legislative enactment that includes a number of different provisions that apply to Puerto Rico in respect to its own financial situation.
PROMESA-Title III	As of May 3, 2017, Puerto Rico filed for bankruptcy under Title III of PROMESA. PREPA is a debtor under Title III of PROMESA. The Commonwealth and agencies are working to address the $70 billion debt. PREPA is working with the Puerto Rican Government and the Government's statutory fiscal agent for PREPA (the Fiscal Agency and Financial Advisory Authority, or the AAFAF) to reach restructuring and electric sector transformation.
PROMESA-Title V	Title V defines a Critical Project Process which promotes expedited permitting to advance major projects as those that could be identified in the IRP to develop local generation and/or hardened transmission or distribution facilities to provide resiliency.

Planning Environment

Policy	Analysis Implication
Fiscal Plan	PROMESA required the development of a fiscal plan and budget for Puerto Rico that will supersede previous fiscal plans. PREPA submitted its draft fiscal plan on February 21, 2017 and the latest plan was published, following updates after the post-hurricane restoration in April 2018. PREPA's fiscal plan aligns with the Government's fiscal plan and addresses areas specific to PREPA. The plan focuses on the need for privatization of assets, efficiency in expenditures and the need for being an economic growth engine for the Commonwealth.
PREPA Board Vision Statement	The PREPA Governing Board on February 1, 2018 released its Vision Statement to guide the future of the utility. This vision addressed the reliability and resilience of the system, the transition to a sustainable system – both financially and environmentally sustainable – and its importance in acting as an economic growth engine for the Commonwealth.
Privatization	The Governor of Puerto Rico has publically stated that the reconstruction and transformation of the electricity sector intends to involve the privatization of PREPA's generating facilities. This would include the generating assets and be complemented by the operation of the transmission and distribution system by a third party. The Law to Transform the Electric System of Puerto Rico was passed on June 12, 2018.

Caveats and Limitations

PREPA IRP

Caveats and limitations (Preliminary)

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- The IRP is conducted with extensive inputs from a broad group of stakeholders including the public, the customers, under an accelerated timeline, in parallel with many other activities, but may not consider or fully consider externalities that are critical for implementation or execution.
- The IRP evaluates the highest public good and the protection of the interests of the residents of Puerto Rico, which may not necessarily be identical to the interests of PREPA if viewed from a narrow utility perspective.
- The IRP does not directly address specific asset technology asset optimization, fuel optimization, procurement, contract re-negotiation, collective bargaining rights, site specifics, or ownership.
- The IRP does not set rate structures.

Caveats and limitations

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- The IRP does not directly address the debt restructuring process.
- The implementation of the Puerto Rico Electric System Transformation Act is a separate process outside the accelerated timeline of developing the IRP.
- FOMB’s “critical project” process under Section 503 of PROMESA is a separate process outside the accelerated timeline of the IRP development.
- The IRP is a planning tool to be used as a guide for the development of future resources in Puerto Rico and may not have all the details necessary for the actual RFP issuance (if necessary), contracting, and implementation.
- The IRP is not a Distribution Master Plan that would require a level of effort similar to the development of the IRP. Thus distribution investments are considered at a representative level.

Resource Plan Development

Strategies, Scenarios, Sensitivities

PREPA IRP

Potential Strategies Shared with Stakeholders

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Strategy 1

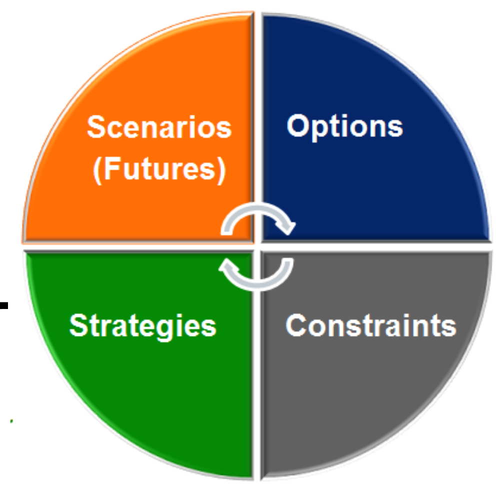
A traditional, centralized energy program; *Reliable & Economic*

Strategy 2

A distributed system of flexible generation, and micro or mini-grids and hardening of existing infrastructure around the island; *Resilient / Closer to Customer*

Strategy 3

A mixture of the first two strategies that embodies a combination of the benefits of each strategy



Uncertainties: Proposed Scenario, Risk Analysis, and Sensitivity

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Scenario

Scenario 1: no new gas-fired generation

Scenario 2: gas to north via land-based LNG at San Juan can achieve permitting approval

Scenario 3: gas to the east (Yabucoa) and west (Mayaguez) via floating LNG can achieve permitting

Scenario 4: gas to the east (Yabucoa) and west (Mayaguez) via floating LNG, and gas to the north through land-based LNG at San Juan

Risk Analysis

Stochastic analysis in Aurora Model will capture ranges and variability of the revenue requirement given uncertainties in load, DER penetration, fuel prices, and capital costs.

Monte Carlo simulations in PROMOD will capture loss of load hours (LOLH) and Energy Not Served (ENS) considering the expected performance of the forecasted generating fleet.

Sensitivity

Sensitivity 1: increased RPS with low cost of solar and storage (may focus on economic builds only)

Sensitivity 2: economic termination of PPOAs (AES and EcoEléctrica modeled subject to economic retirement)

Sensitivity 3: gas to the north: Floating LNG at San Juan

Additional important sensitivities as requested by the stakeholders

Uncertainty Factors, Scenario, Sensitivity and Risk Analysis - Part 1

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Category	Factor	Scenario				Sensitivity			Risk Analysis	
		1	2	3	4	1	2	3	Aurora Stochastics	Promod Monte Carlo
Fuel	Fuel forecast	X	X	X	X				X	
	Gas to the south: AOGP can achieve permitting approval.	Potential additional sensitivity								
	Gas to north: Land Based LNG can achieve permitting approval.		X							
	Gas to the north: Floating LNG can achieve permitting approval.							X		
	Gas to Yabucoa (east) and gas to Mayaguez (west) through floating LNG can achieve permitting approval.			X						
	Gas to Yabucoa (east) and gas to Mayaguez (west) through floating LNG, and gas to the north through land-based LNG at San Juan can achieve permitting approval.				X					
	Gas to the north and south: Eco to Aguirre to San Juan Pipeline can achieve permitting approval.	Potential additional sensitivity								
	LPG to the north can achieve permitting approval (technology option).	X	X	X	X					

Uncertainty Factors, Scenario, Sensitivity and Risk Analysis - Part 2

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Category	Factor	Scenario				Sensitivity			Risk Analysis	
		1	2	3	4	1	2	3	Aurora Stochastics	Promod Monte Carlo
Contracts	AES expires in 2027	X	X	X	X					
	AES Economic retirement regardless of contract terms						X			
	EcoEléctrica Economic retirement regardless of contract terms						X			
	EcoEléctrica renewal	X	X	X	X					
	AES renewal	Economic termination modeled instead								
	EcoEléctrica early termination	Economic termination modeled instead								
	AES and EcoEléctrica early termination	Economic termination modeled instead								
Weighted Average Cost of Capital	Private cost of capital for generation (equity & debt)	X	X	X	X					
	Only debt cost of capital for transmission	X	X	X	X					
	Low or high cost of capital for generation and/or transmission	Potential additional sensitivity								

Uncertainty Factors, Scenario, Sensitivity and Risk Analysis - Part 3

Category	Factor	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Sensitivity 1	Sensitivity 2	Sensitivity 3	Risk Analysis: Aurora Stochastics	Risk Analysis: Promod Monte Carlo
Load	Load forecast	X	X	X	X				X	
	DER penetration	X	X	X	X				X	
	Load forecasts based on other economic (e.g. GDP, population forecast)	Potential additional sensitivity								
Policy/ Regulatory	Policy: no new gas fired generation	X								
	Policy: no RPS	Potential additional sensitivity to assess impact								
	MATS compliance postponed	Potential additional sensitivity								
	Policy: increased RPS (e.g. max economic with large drop in cost)					X				
Market	Large drop in cost of renewable /storage					X				
	Base case cost of renewable /storage	X	X	X	X				X	
	New builds capital costs	X	X	X	X				X	
	Emissions prices (CO2)	Potential additional sensitivity to assess impact								
Weather	Weather impacts /climate change									X

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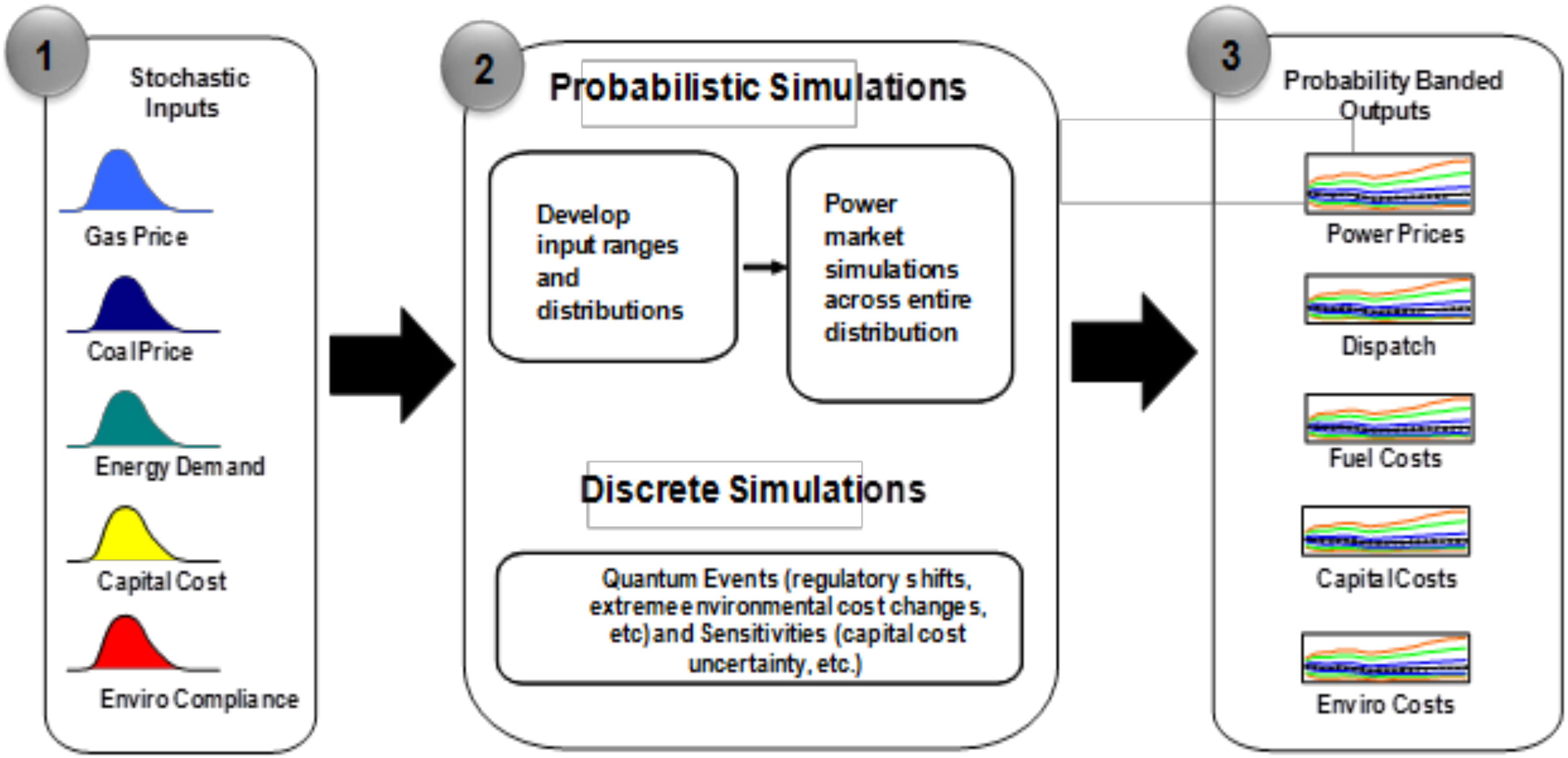
Portfolio Cases: Combination of Strategies and Scenarios

8 Portfolio Cases	**Strategy 2** *Distributed system of flexible generation, and minigrids (electrical islands) complemented by microgrids and hardening of existing transmission infrastructure*	**Strategy 3** *Hybrid of traditional and centralized energy program and Distributed system of flexible generation*
Scenario 1 *No new gas-fired generation*	**Portfolio Case 1** Strategy 2+ Scenario 1	**Portfolio Case 5** Strategy 3+ Scenario 1
Scenario 2 *Gas to north: Land-based LNG at San Juan can achieve permitting approval*	**Portfolio Case 2** Strategy 2+ Scenario 2	**Portfolio Case 6** Strategy 3+ Scenario 2
Scenario 3 *Gas to Yabucoa (east) and gas to Mayaguez (west) via floating LNG can achieve permitting approval*	**Portfolio Case 3** Strategy 2+ Scenario 3	**Portfolio Case 7** Strategy 3+ Scenario 3
Scenario 4 *Gas to Yabucoa (east) and gas to Mayaguez (west) through floating LNG, and gas to the north through land-based LNG at San Juan can achieve permitting approval*	**Portfolio Case 4** Strategy 2+ Scenario 4	**Portfolio Case 8** Strategy 3+ Scenario 4

Risk Analysis



Resource Needs Assessment

PREPA IRP

Risk Integrated IRP Methodology Overview

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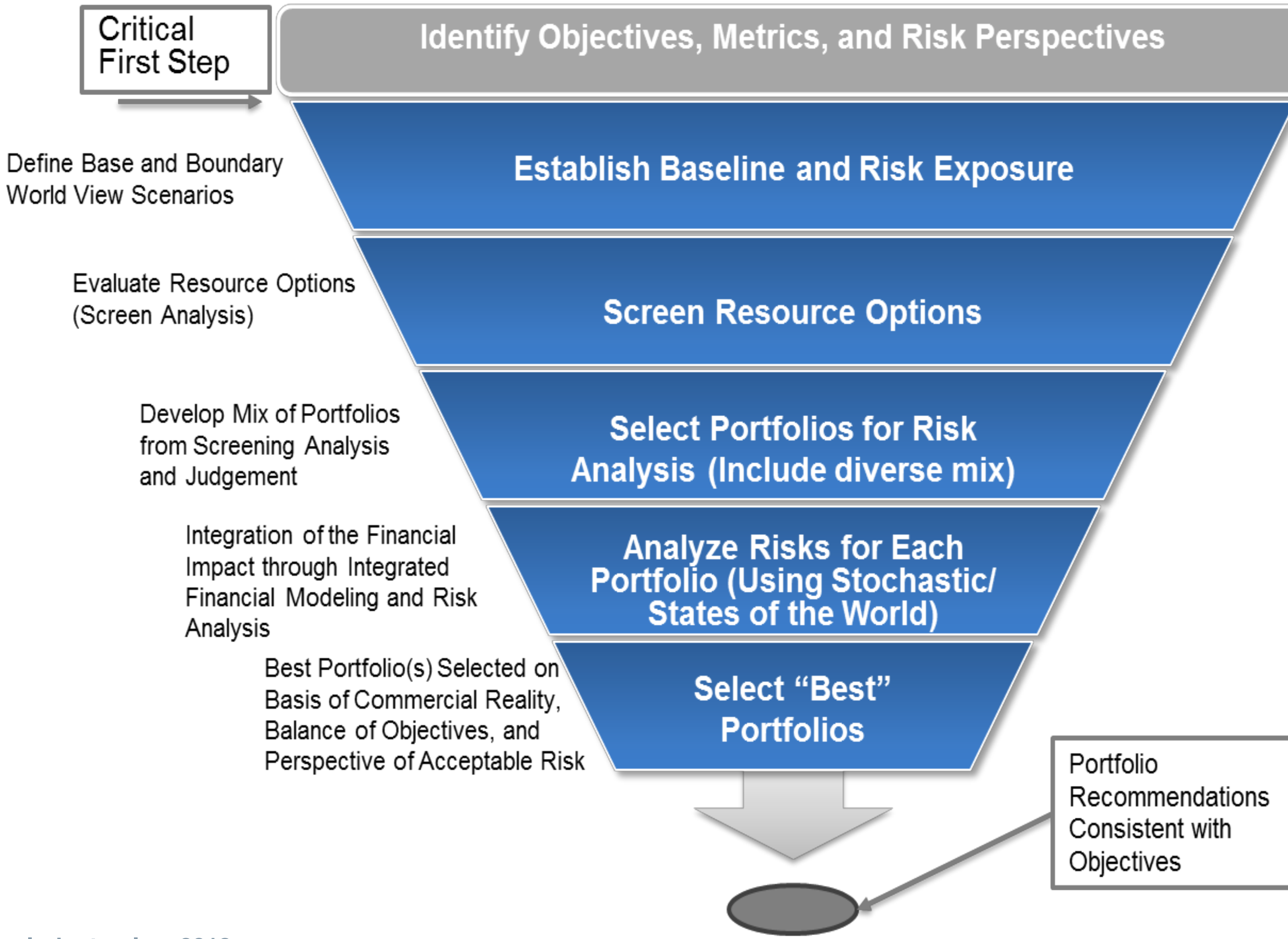
- The overall proposed method is the “planning under uncertainty” framework and methodology, which has been proven to be remarkably effective for the development of least-cost, integrated resource plans.
- Produces a strategy and an associated resource plan that has the highest likelihood of meeting all of PREPA’s stated objectives.
- Key to the successful application is the correct definition of *objectives, strategies, options, constraints, and scenarios.*
- These lead to the postulation of scenarios and stochastics which are derived from the possible options (actions or decisions that can be taken) combined in plans and the specific materializations of uncertainties *over a wide range of possibilities.*

Risk Integrated Planning Process



Technical Models in 2018 IRP: Assumptions Development

Models	Functions
GPCM® *(by RBAC)*	North American natural gas market modeling
Economic Model *(by PREPA)*	Distributed generation forecast
MATLAB Forecast Model *(by Siemens)*	Proprietary load forecasting model
GT Pro *(by Thermoflow)*	Assess thermal generation performance on site conditions

Technical Models in 2018 IRP: Power System Models

Models	Functions
Aurora *(by Energy Exemplar)*	▪ Long term capacity expansion (LTCE) ▪ Stochastic analysis of portfolio cases to assess risks and variabilities
PROMOD *(by ABB)*	▪ Security constrained unit commitment / security constraint economic dispatch ▪ LOLH and ENS
PSS®E *(by Siemens)*	▪ Power flow and system stability analysis for transmission system analysis

Assess Resource Needs: Integrated Generation & Transmission Modeling

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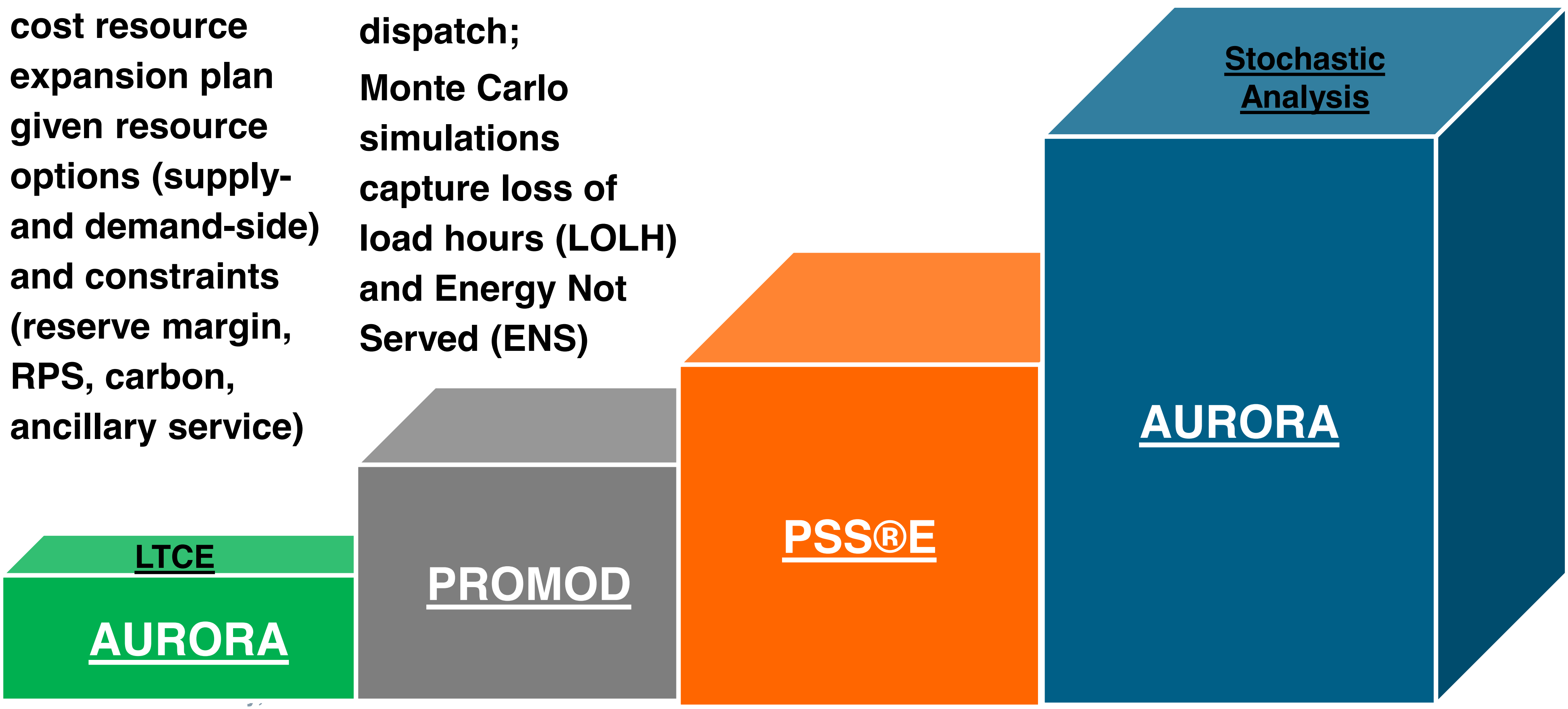
Long term capacity expansion (LTCE) produces a least cost resource expansion plan given resource options (supply- and demand-side) and constraints (reserve margin, RPS, carbon, ancillary service)

Security constrained unit commitment / economic dispatch;

Monte Carlo simulations capture loss of load hours (LOLH) and Energy Not Served (ENS)

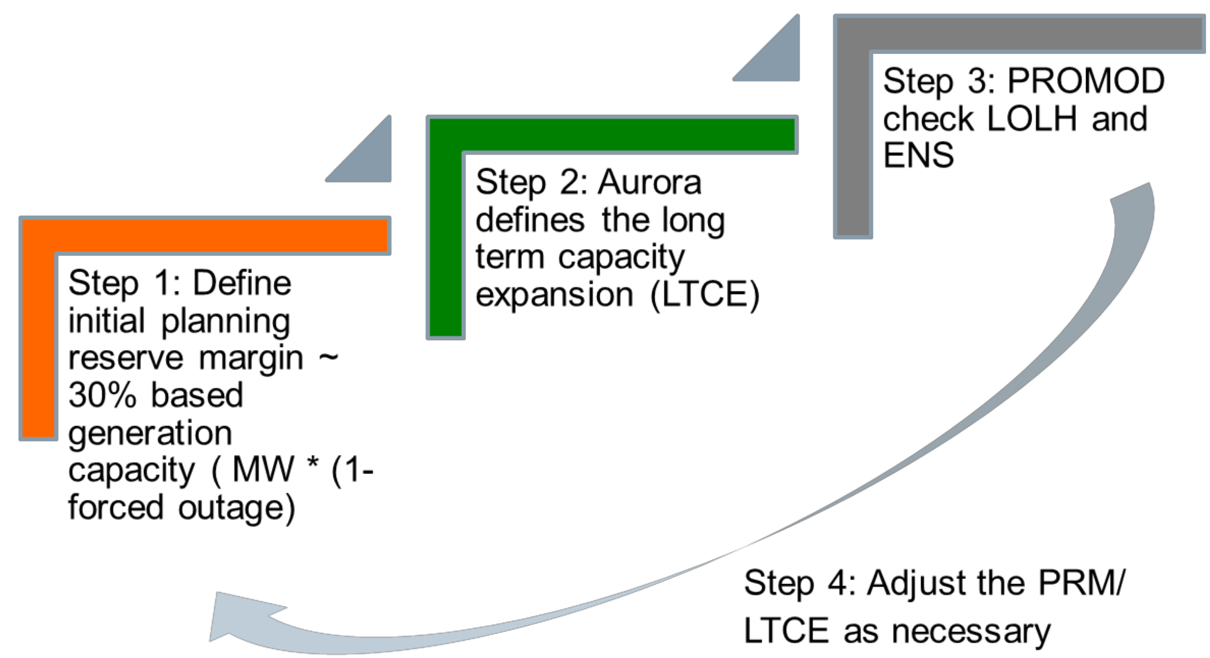
Power flow and contingency analysis

Capture uncertainties in load, DER penetration, fuel prices, and capital costs



Iterative Process to Define Planning Reserve Margin (PRM) and LTCE

- The PRM is determined to achieve a resource adequacy criteria. In the US this criteria is typically a LOLE of 1 in 10 years that can be practically achieved given the size of the interconnected system.
- In Puerto Rico the largest units represent an important percentage of the peak(15% or more) and to try to apply the same reliability criteria would result in unpractically large reserve margins.
- PREPA has used a criteria of maximum 4 lost load hours per year of (LOLH) and that we will be complemented by Energy Not Served (ENS) in the IRP.
- This criteria will be used to find the PRM using the procedure to the right.



Transmission and Distribution

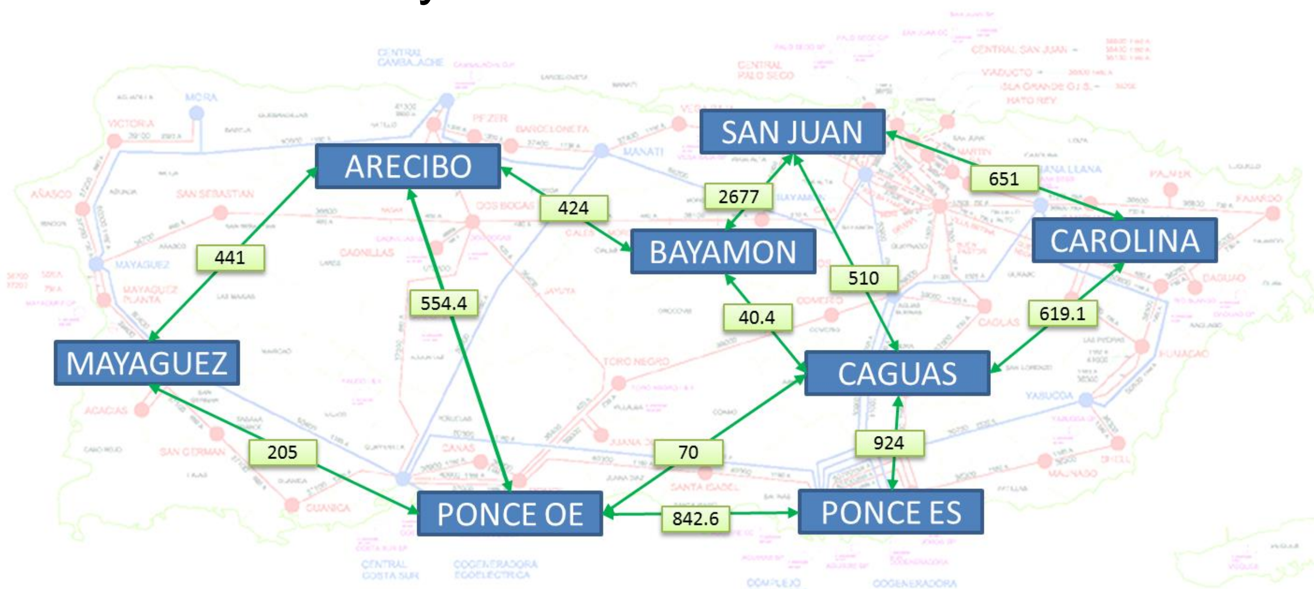
PREPA IRP

Transmission & Distribution Objectives & Procedures

The analysis of the Transmission System has the following objectives & procedures:

- Assess the performance and identify reinforcements under the new generation mixes and interconnected operation.

  - The LTCE is made considering transfer limits between zones so that major violations are avoided. Other restrictions on minimum generation required by zone can also be controlled this way.



Transmission & Distribution Objectives & Procedures

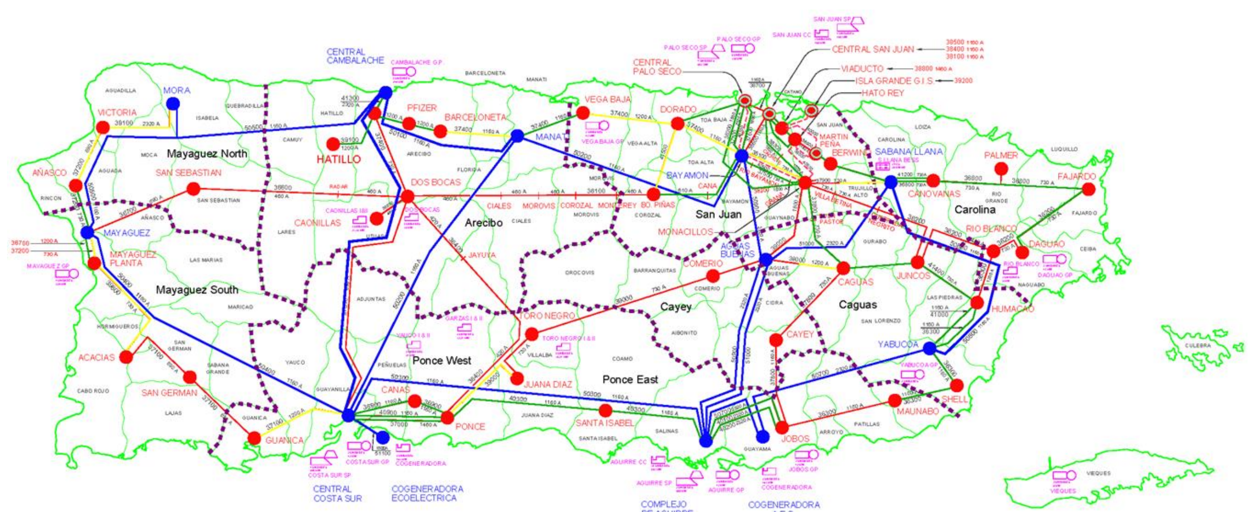
Transmission System study objectives & process(cont.):

- Performance of the transmission system under the new generation mixes (cont.).
  - Assess thermal and voltage violations including voltage stability and determine reinforcements needs under N-1, N-1-1, N-2 conditions.
    - *Reduced reinforcements expected due to the more distributed nature of the generation assets*
  - Assess system stability (frequency, angular, voltage) performance including effect of rapid loss of renewable generation.
    - *Challenges expected for high penetration scenarios. Storage expected to have a significant role in frequency regulation (primary and secondary-net load following)*
  - NERC TPL-001-4 standard followed

Transmission & Distribution Objectives & Procedures

Transmission System study objectives & process (cont.):

- Performance of the transmission system following a major event, such as hurricane class 4.
  - Determine which major transmission lines are likely to be out of service for a extended period of time after the event.
  - Determine areas in which the system naturally split and identify minimum transmission hardening to manage size of the resulting electrical islands



Transmission & Distribution Objectives & Procedures

Transmission System study objectives & process (cont.):

- Performance of the transmission system following a major event (cont.)
  - For each potential electrical island (minigrid) assess location of:
    - *Critical loads (hospitals, ports, first responders, shelters, communication)*
    - *Priority loads (commercial, industrial, large residential, water pumps, etc.).*
  - Determine reliable generation injection points within the minigrid.
  - Identify transmission (115 kV) and subtransmission (38kV) facilities the need to be hardened to connect generation with loads

Transmission & Distribution Objectives & Procedures

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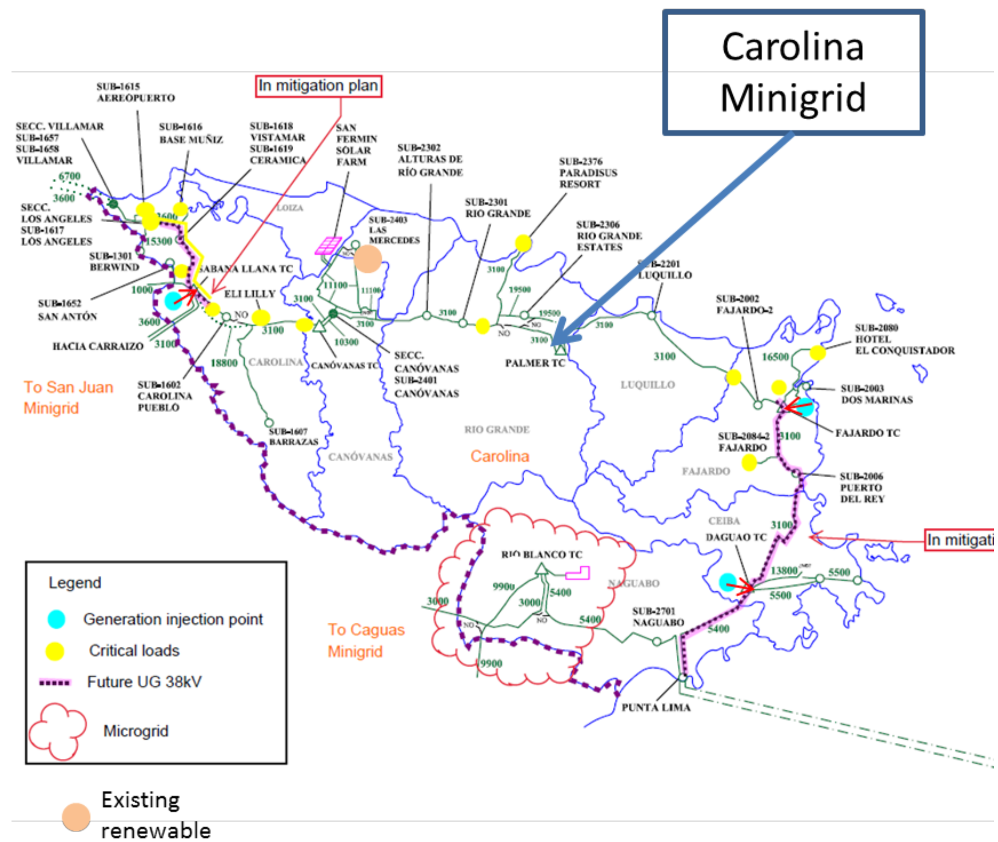
Transmission System study objectives & process (cont.):

- Performance of the transmission system following a major event (cont.)
  - Identify those areas that without major efforts in transmission hardening would be isolated and are candidates for microgrids.
  - Assess load generation balance including customer owned generation and determine generation needs to be factored on the LTCE
    - *100% of critical loads need to be locally covered from thermal resources*
    - *Not 100% of all loads may be locally covered (Strategy 3)*



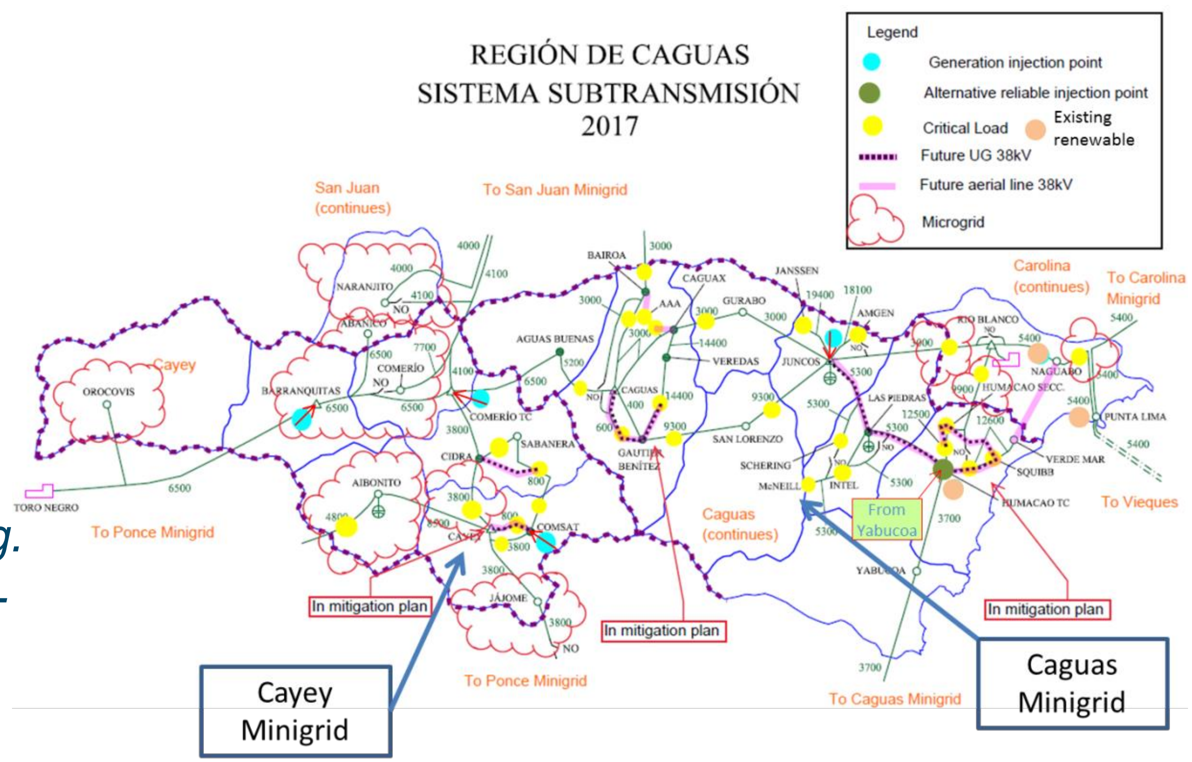
Transmission & Distribution Objectives & Procedures

Transmission System study objectives & process (cont.):

- Performance of the transmission system following a major event (cont.)

With the results of the capacity expansion plan evaluate performance of the minigrid under steady state contingency analysis and dynamic stability.

- *Day peak and night peak conditions to be assessed.*
- *Limited load shedding as a remedial action accepted.*
- *Condition after full minigrid consolidation to be considered.*
- *Minigrid interconnection condition to be assessed; e.g. Caguas – Carolina, Carolina-San Juan, Mayaguez North-South.*



Transmission & Distribution Objectives & Procedures

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Distribution study objectives & process

- Performance of the distribution system following a major event.
  - These studies seek to identify investments at distribution level required for hardening and reliability improvement with focus on critical loads and priority loads initially.
    - *Include undergrounding, creation of tie points for load transferring, 13.2 kV conversion and smart grid initiatives as for example FLISR and VoltVar controls.*
  - Coordination with the investments at generation, transmission and subtransmission level is being done to ensure reliable supply to the distribution level investments and target loads.
  - These distribution level studies are detailed covering a large number of feeders and are expected to extend well beyond the termination of the IRP studies.
  - Sample investments and coordination is expected to be included in the plan

Transmission & Distribution Objectives & Procedures

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Distribution study objectives & process

- DER hosting capability assessment.

- These studies seek to identify investments at distribution level to manage the large amounts of distributed generation (mostly PV) forecasted.
  - *Include voltage regulation, protection coordination review, 13.2 kV conversion, smart grid initiatives (VoltVar controls), smart inverters and distributed controls.*
- As before, these studies are substantial covering a large number of feeders and are expected to extend well beyond the completion of the IRP studies.
- Sample is expected to be included in the IRP plan. The forecasted levels of DG are considered to be implementable

Transmission & Distribution Status

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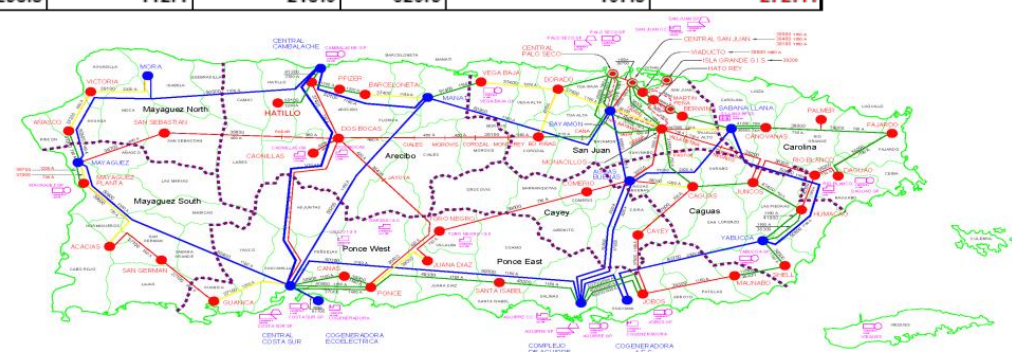
- Steady State models for the existing system with post Maria repairs in service, are completed and steady state analysis for 2019 conditions in progress (pending final load forecast)
- Stability model (V33) in progress; conversion of model for existing renewable.
- Minigrid definition advanced. Currently working with the regions to define critical and priority loads as well as transmission / subtransmission hardening needs.
- Preliminary load – generation balance (day and night peak) expected to be completed shortly after load forecast is finished.
- Regions assessing priority distribution projects and documenting example cases to be incorporated in the IRP documentation

Transmission & Distribution Status

- Currently there are 8 minigrids identified by analysis of the transmission and subtransmission system together with PREPA planning and engineering.

Minigrids	MW of Area Load in Minigrids: ARECIBO	BAYAMON	CAGUAS	CAROLINA	MAYAGUEZ	PONCE ES	PONCE OE	S.JUAN	AEE AUX GENS	2019 Load Forecast
Arecibo	188.8									189
Caguas			305.3			1.7				307
Carolina				278.7				2.9		282
Cayey			67.7							68
Mayaguez North	39.5				105.1					145
Mayaguez South					131.0					131
Ponce						90.4	198.5		76.8	366
San Juan		364.6						574.1	30.5	969
Total	**228.2**	**364.6**	**373.0**	**278.7**	**236.1**	**92.1**	**198.5**	**577.0**	**107.3**	**2,456**
Microgrids	**52.4**	**15.4**	**50.8**	**7.4**	**62.4**	**20.0**	**19.5**	**43.9**	**0.0**	**271.8**
Mini+Micro	280.6	380.0	423.8	286.2	298.5	112.1	218.0	620.9	107.3	2727.4



Existing Resources

PREPA IRP

PREPA Existing Units Included in the IRP

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	Generation Units	Maximum Modeled Capacity (MW)	Fuel	Heat Rate at Max. Capacity (BTU/kWh)	FOM (2018 $/kW-year)
MATS Affected Units	Aguirre 1 ST	450	No. 6 fuel oil	9,600	32.04
	Aguirre 2 ST	450	No. 6 fuel oil	9,700	32.04
	Costa Sur 5 ST	410	Natural gas	9,747	35.96
	Costa Sur 6 ST	410	Natural gas	9,747	35.96
	Palo Seco 3 ST	216	No. 6 fuel oil	9,725	46.47
	Palo Seco 4 ST	216	No. 6 fuel oil	9,725	46.47
	San Juan 7 ST	100	No. 6 fuel oil	10,497	49.02
	San Juan 8 ST	100	No. 6 fuel oil	10,445	49.02
Combined Cycle	Aguirre 1 CC	260	Diesel	11,140	22.64
	Aguirre 2 CC	260	Diesel	11,140	22.64
	San Juan 5 CC	200	Diesel	7,625	27.40
	San Juan 6 CC	200	Diesel	7,853	27.40
Gas Turbine	Cambalache 2 GT	83	Diesel	11,549	24.44
	Cambalache 3 GT	83	Diesel	11,549	24.44
	Mayagüez 1 GT	50	Diesel	9,320	10.64
	Mayagüez 2 GT	50	Diesel	9,320	10.64
	Mayagüez 3 GT	50	Diesel	9,320	10.64
	Mayagüez 4 GT	50	Diesel	9,320	10.64
	Daguao 2 GTs	42	Diesel	14,400	26.54
	Palo Seco GT11 & GT12	42	Diesel	14,400	26.54
	Palo Seco GT21 & GT22	42	Diesel	14,400	26.54
	Palo Seco GT31 & GT32	42	Diesel	14,400	26.54
	Aguirre GT21 & GT22	42	Diesel	14,400	0.00
	Costa Sur GT11 & GT12	42	Diesel	14,400	0.00
	Jobos GT11 & GT12	42	Diesel	14,400	0.00
	Yabucoa GT11 & GT12	42	Diesel	14,400	0.00
	Vega Baja GT11 & GT12	42	Diesel	14,400	0.00
Hydro	Hydro	34	Water	N/A	N/A
IPP Units	AES Coal 2 Units	454	Coal	9,791	79.46
	EcoEléctrica Plant	507	Natural gas	7,497	189.34
	Total	**5,010**			

PREPA Owned Steam Turbines

Parameters	Unit	Aguirre ST		Costa Sur ST	
		Unit 1	Unit 2	Unit 5	Unit 6
Fuel	Type	No. 6 fuel oil	No. 6 fuel oil	Natural Gas	Natural Gas
Maximum Capacity	MW	450	450	410	410
Minimum Capacity	MW	200	200	180	180
Fixed O&M Expense	2018 $/kW-year	32.04	32.04	35.96	35.96
Variable O&M Expense	2018 $/MWh	2.25	2.25	2.72	2.72
Heat Rate at Maximum Capacity	MMBtu/MWh	9.60	9.70	9.75	9.75
Heat Rate at Minimum Capacity	MMBtu/MWh	9.94	10.16	9.93	10.07
Forced Outage	%	10	10	2	4
Minimum Downtime	Hours	48	48	48	48
Minimum Runtime	Hours	720	720	720	720
Ramp Up Rate	MW/minute	5	5	5	5
Ramp Down Rate	MW/minute	5	5	5	5

Parameters	Unit	Palo Seco ST		San Juan ST	
		Unit 3	Unit 4	Unit 7	Unit 8
Fuel	Type	No. 6 fuel oil	No. 6 fuel oil	No. 6 fuel oil	No. 6 fuel oil
Maximum Capacity	MW	216	216	100	100
Minimum Capacity	MW	130	130	70	70
Fixed O&M Expense	2018 $/kW-year	46.47	46.47	49.02	49.02
Variable O&M Expense	2018 $/MWh	4.95	4.95	2.93	2.93
Heat Rate at Maximum Capacity	MMBtu/MWh	9.73	9.73	10.50	10.45
Heat Rate at Minimum Capacity	MMBtu/MWh	10.35	10.35	10.50	10.50
Forced Outage	%	9	9	5	5
Minimum Downtime	Hours	48	48	48	48
Minimum Runtime	Hours	720	720	720	720
Ramp Up Rate	MW/minute	3	3	3	3
Ramp Down Rate	MW/minute	3	3	3	3

All the steam units are subject to Mercury and Air Toxics Standards (MATS) compliance requirements.

PREPA Owned Combined Cycles (CC)

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Parameters	Unit	Aguirre CC		San Juan CC	
		Unit 1	Unit 2	Unit 5	Unit 6
Fuel	Type	Diesel	Diesel	Diesel	Diesel
Maximum Capacity	MW	260	260	200	200
Minimum Capacity	MW	46	46	155	155
Fixed O&M Expense	2018 $/kW-year	22.64	22.64	27.40	27.40
Variable O&M Expense	2018 $/MWh	6.79	6.79	2.22	2.22
Heat Rate at Maximum Capacity	MMBtu/MWh	11.14	11.14	7.63	7.85
Heat Rate at Minimum Capacity	MMBtu/MWh	11.42	11.42	8.46	8.86
Forced Outage	%	20	20	18	18
Minimum Downtime	Hours	0	0	48	48
Minimum Runtime	Hours	2	2	120	120
Ramp Up Rate	MW/minute	5	5	3	3
Ramp Down Rate	MW/minute	5	5	3	3

PREPA's four Combined Cycle (CC) units run on diesel. These units include Aguirre 1&2 CC (260 MW each) and San Juan 5&6 CC (200 MW each) with a total capacity of 920 MW.

PREPA Owned Gas Turbines (GT)

SIEMENS

Parameters	Unit	Cambalache CT		GT Units
		Unit 2	Unit 3	Each Unit
Fuel	Type	Diesel	Diesel	Diesel
Maximum Capacity	MW	83	83	21
Minimum Capacity	MW	50	50	21
Fixed O&M Expense	2018 $/kW-year	24.44	24.44	26.54
Variable O&M Expense	2018 $/MWh	5.52	5.52	20.19
Heat Rate at Maximum Capacity	MMBtu/MWh	11.55	11.55	14.40
Heat Rate at Minimum Capacity	MMBtu/MWh	11.55	11.55	14.40
Forced Outage	%	10.0	10.0	15
Minimum Downtime	Hours	7	7	0
Minimum Runtime	Hours	7	7	0
Ramp Up Rate	MW/minute	2	2	2
Ramp Down Rate	MW/minute	2	2	2

Parameters	Unit	Mayagüez CT			
		Unit 1	Unit 2	Unit 3	Unit 4
Fuel	Type	Diesel	Diesel	Diesel	Diesel
Maximum Capacity	MW	50	50	50	50
Minimum Capacity	MW	25	25	25	25
Fixed O&M Expense	2018 $/kW-year	10.64	10.64	10.64	10.64
Variable O&M Expense	2018 $/MWh	6.40	6.40	6.40	6.40
Heat Rate at Maximum Capacity	MMBtu/MWh	9.32	9.32	9.32	9.32
Heat Rate at Minimum Capacity	MMBtu/MWh	11.20	11.20	11.20	11.20
Forced Outage	%	9	9	9	9
Minimum Downtime	Hours	0	0	0	0
Minimum Runtime	Hours	0	0	0	0
Ramp Up Rate	MW/minute	6	6	6	6
Ramp Down Rate	MW/minute	6	6	6	6

24 GTs with a total capacity of 743 MW are included in the IRP: Cambalache GT 2&3 (83 MW each), Mayagüez 1-4 (50 MW each), and nine pairs of distributed GTs (21 MW each).

PPOA: AES and EcoElectrica

SIEMENS

Parameters	Unit	EcoEléctrica CC	AES Coal Plant	
		Unit 1	Unit 1	Unit 2
Fuel	Type	Natural Gas	Coal	Coal
Maximum Capacity	MW	507	227	227
Minimum Capacity	MW	275	166	166
Fixed O&M Expense	2018 $/kW-year	189.34	79.46	79.46
Variable O&M Expense	2018 $/MWh	0.00	7.23	7.23
Heat Rate at Maximum Capacity	MMBtu/MWh	7.50	9.79	9.79
Heat Rate at Minimum Capacity	MMBtu/MWh	8.31	9.93	9.93
Forced Outage	%	2	3	3
Minimum Downtime	Hours	8	48	48
Minimum Runtime	Hours	168	720	720
Ramp Up Rate	MW/minute	10	0	0
Ramp Down Rate	MW/minute	10	0	0

PREPA purchases power from two co-generators under the terms and conditions of PPOAs, including 507 MW gas-fired combined cycle plant from EcoEléctrica, L.P. and 454 MW coal-fired steam electric cogeneration station from AES.

58 Renewable PPOAs in Different Stages

- 11 PPOAs in either commercial operation or pre-operation (energized, under testing, and selling energy and renewable energy credits to PREPA). These projects represent 272.9 MW of capacity, including 147 MW of solar PV, 121 MW of wind, and 4.8 MW of landfill gas.
- 15 renegotiated PPOAs with a total capacity of 412 MW have not begun construction.
- 32 not-renegotiated PPOAs with a total capacity of 795 MW pending

PPOA Status	Number of Projects	Capacity (MW)
Operation	8	220.5
Pre-Operation	3	52.4
Renegotiated	15	412.3
Not-renegotiated	32	795.4
Total	**58**	**1,480.6**

PPOA Pricing Assumptions

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Operation & Pre-operation

- For the projects in operation or pre-operation PREPA will assume the following price conditions, where the Contract Price is inclusive of RECs and does not have escalation clauses.

Project	Assumed Price $/MWh
PV	150
Wind	125
Land fill gas	10

Renegotiated & Not-renegotiated

- Any project that is not in operation or pre-operation will be modeled in the IRP as potential new supply options (volumes and sites) with commercial conditions according to the forecast for new solar prices.
- Due to the compressed timeline, IRP will consider solar projects as representative renewable projects.

New Resource Options

PREPA IRP

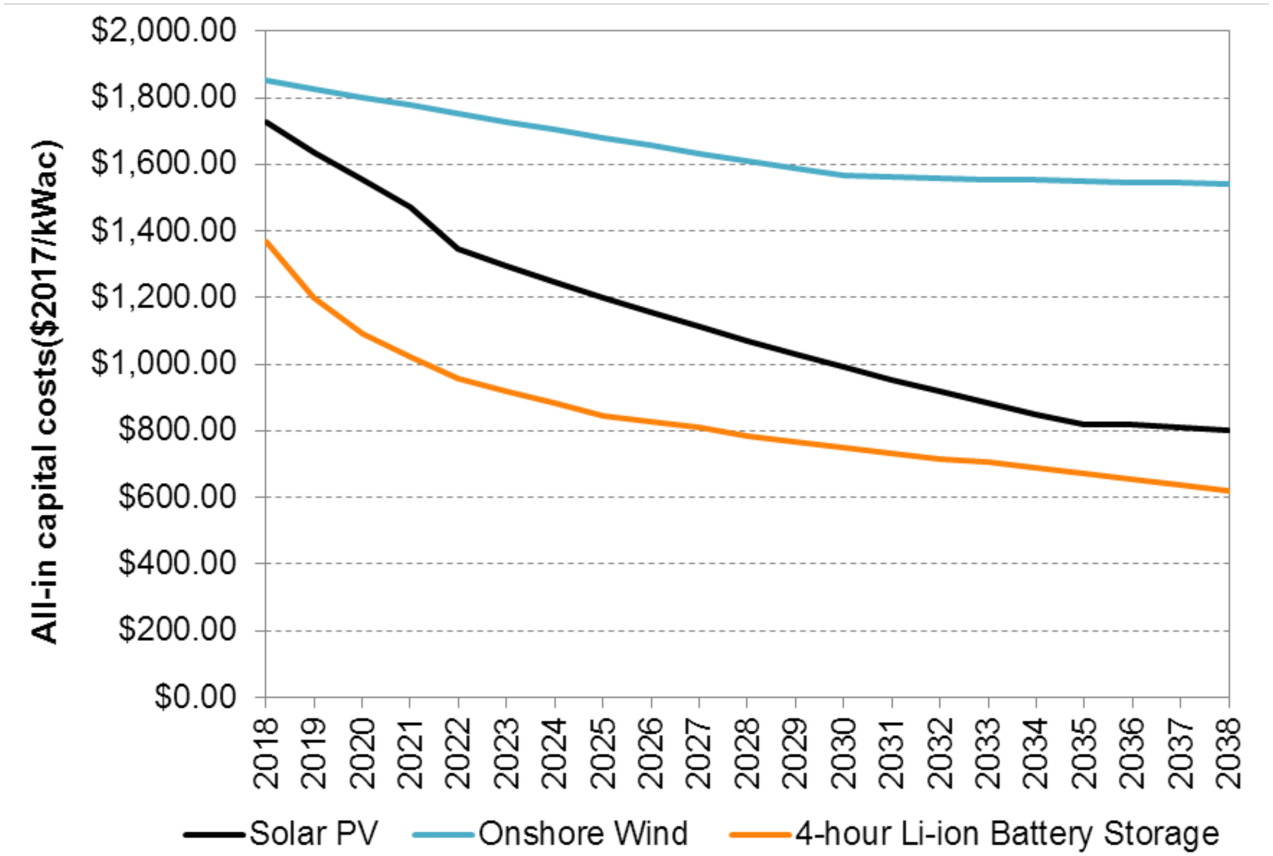
New Fossil-fueled Generation Resources Candidates

Representative New Resource Candidates	Capacity (MW)	Capital Costs (2018$/KW) Natural Gas	Capital Costs (2018$/KW) Diesel
F Class CC (GE S107F.04) (Duct Fired)	302	994.13	1,016.63
F Class CC (GE S107F.05) (Duct Fired)	369	926.74	948.09
Medium CC (Hitachi H-100) (Duct Fired)	144	1250.22	1,275.32
Small CC (GE LM6000 DLE) (Duct Fired)	66	1658.20	1,729.43
Small CC (GE LM2500+ G4 SAC) (Duct Fired)	47.7	1797.59	1,811.74
Small CC (GE LM2500 SAC) (Duct Fired)	35	2010.28	2,052.18
Aero/Small SC Peaker (GE LM6000 DLE)	41	1374.54	1,443.92
Aero/Small SC Peaker (GE LM2500 SAC)	22	1649.56	1,688.96
Small CHP (Solar Turbines Mars 100)	9	2651.15	2,639.46
RICE (Wartsila 18V50DF)	16	1389.4	N/A

- Uncertainties in capital costs will be captured through stochastic analysis.

Preliminary New Renewable Resources Capital Cost Assumptions

- Uncertainties in capital costs will be captured through stochastic analysis.



For renewable projects, based on the capital cost assumptions, Puerto Rico-specific land and interconnection costs will be added to derive specific PPA price estimates using 30 MW solar PV as a proxy.

Note: the solar and wind costs above are subject to change based on the newly released "US DOE NREL 2018 Annual Technology Baseline".

Load Forecast

PREPA IRP

Load Forecast Methodology

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- The gross energy demand forecast for the Residential, Commercial and Industrial Class was developed using a Classical Linear Regression Model using the ordinary least squares method in MATLAB as part of Siemens's proprietary model.

- The forecast was developed for each class independently using three underlying economic variables: GNP, population and manufacturing employment. The impact of weather, in particular cooling needs is represented by cooling degree days (CDD).

Independent Variables for Each Customer Class

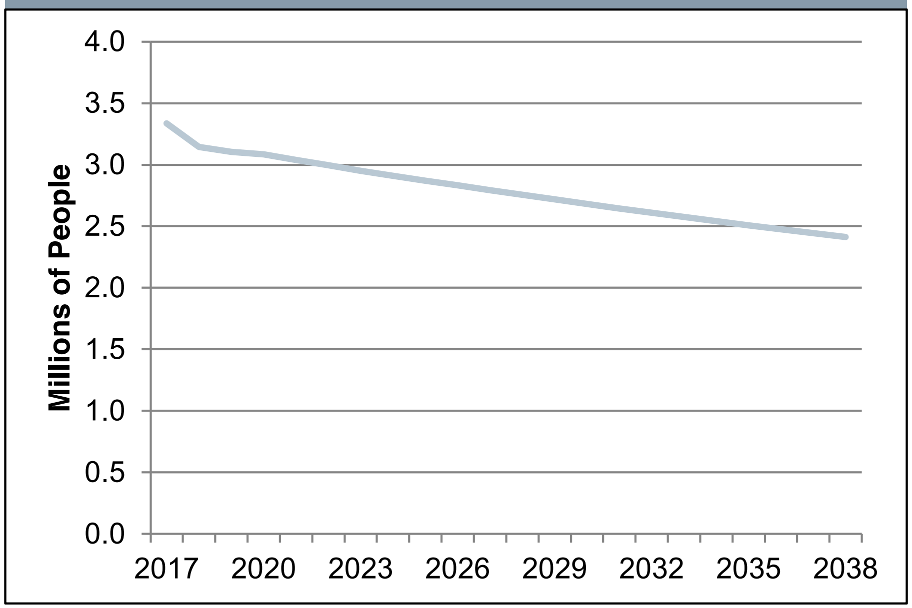
Residential	Commercial	Industrial
• CDD • GNP • Population • 12 month variables	• CDD • Population • 12 month variables	• CDD • GNP • Manufacturing Employment • 12 month variables

$$Demand = C_1 * V_1 + C_2 * V_2 \ldots \ldots \ldots C_{15} * V_{15} + b$$

Key Economic Drivers

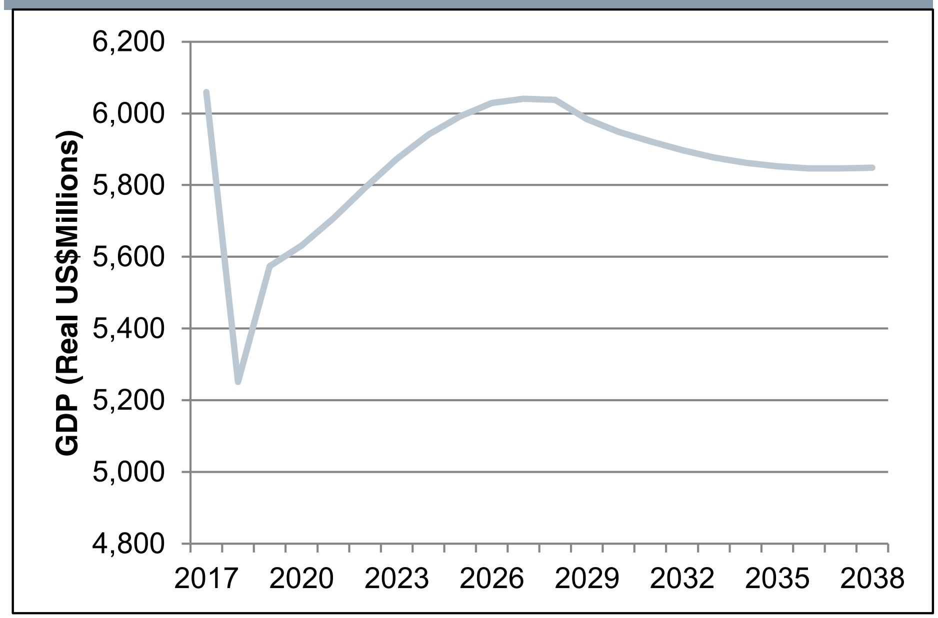
- GNP is estimated to decline 13% for fiscal year (FY) 2018, reflecting the impact of hurricanes Maria and Irma on the economy. For FY 2019, GNP is projected to grow at 6.1%.
- In the medium-term GNP is projected to increase at 1.6% per-year in 2019-2027. After 2027, GNP growth is projected to soften to -0.3% per-year.
- Population is estimated to decline by 5.8% in FY2018 due to hurricanes fatalities and net migration. Over the study period, population in Puerto Rico is projected to decline at 1.3% per-year in 2019-2038.

Population Forecast



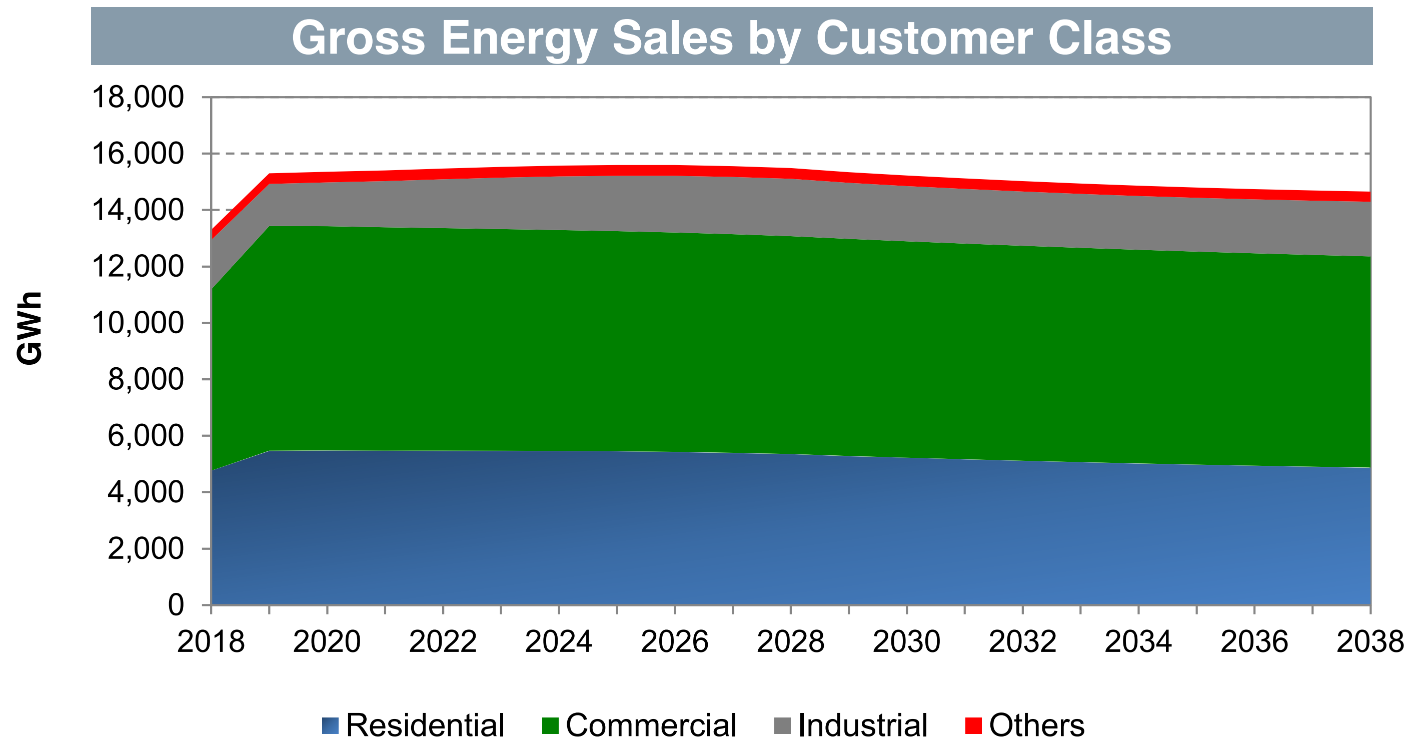
* Source: FOMB

GNP Forecast



* Source: FOMB

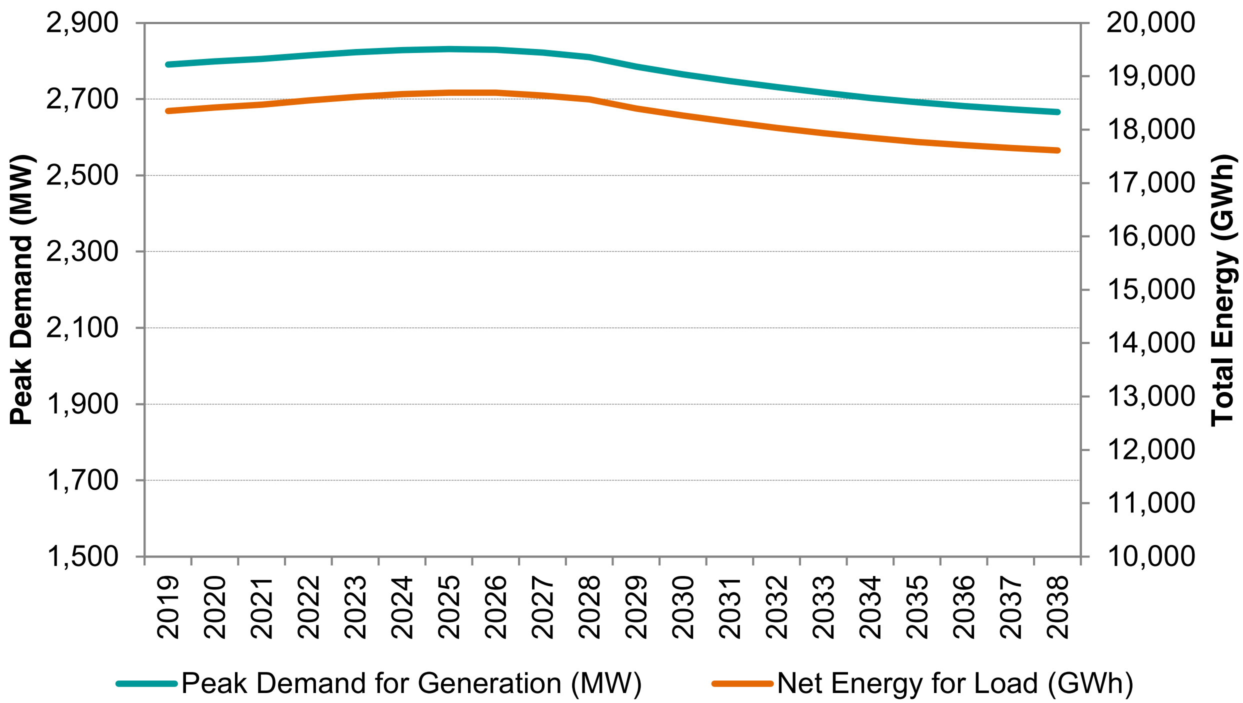
Gross Energy Sales Forecast by Customer Class



- The industrial customer class is projected to have the strongest growth at 1.4% per-year over the study period driven by growth in the economy through 2026. In contrast, the residential and commercial classes are projected to decline at 0.6% and 0.3% per-year, mostly driven by population declines.
- Gross energy sales are projected to increase 15% for fiscal year 2019 due to the projected recovery in the economy with GNP projected to rise by 6.1%.
- Over the study period, gross energy sales are projected to decline at 0.23% per-year driven by the continuous decline in population through the study period and softening in the GNP growth after 2027.

System Peak Demand and Net Energy for Load

Energy and Peak Demand for Generation



Note: above forecast includes loses, PREPA's own use, auxiliary demand, as well as any existing energy efficiency programs as reflected in sales.

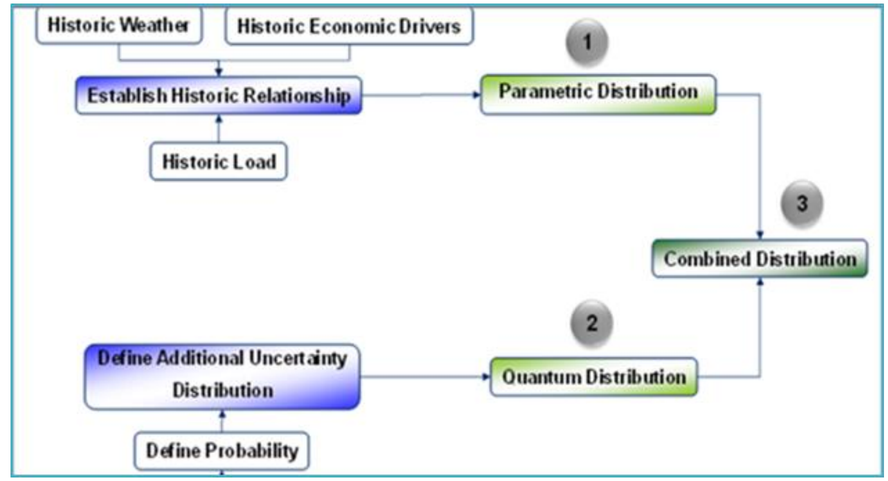
- Peak demand is projected to decline at 0.24% per-year over the study period, following the trend in energy demand.
- The load factor is projected to increase modestly throughout the study period driven by increased penetration from the commercial sector in total load. Commercial load peaks during the day, while the residential peaks at night, the last driving the system peak. A relative increase in the commercial load results in a reduction in the night peak relative to the overall energy in the system.

Illustrative Stochastics Load Forecast – Incorporating Uncertainty

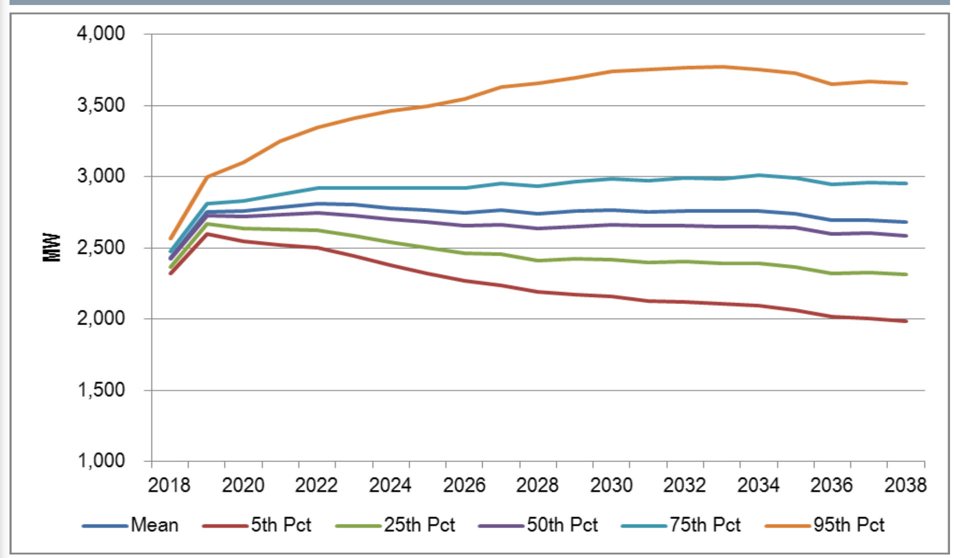
To generate scenarios for load growth, Siemens developed statistical distributions around the deterministic load forecasts to incorporate future uncertainties not captured by the historical data.

The process involves two steps:

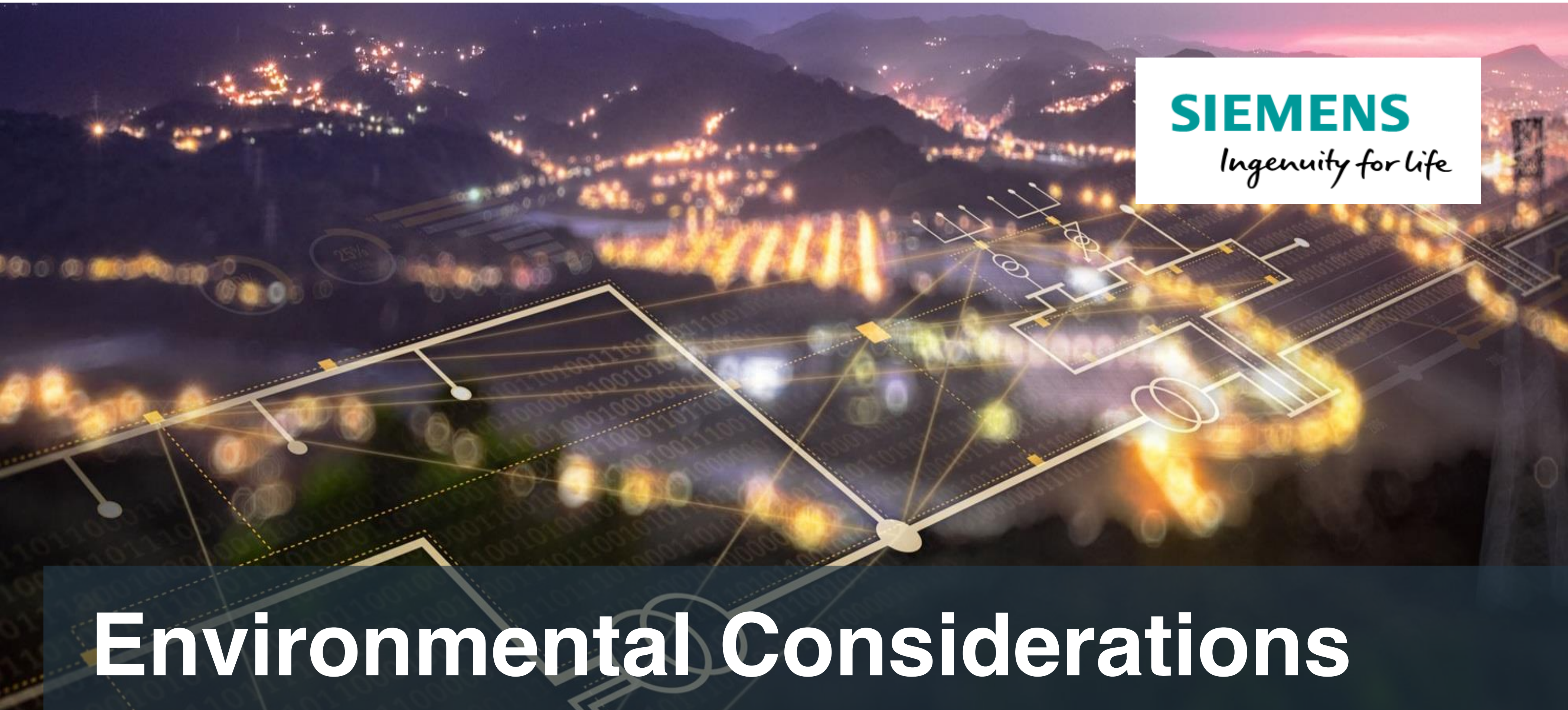
- Step 1: encompasses developing parametric distributions around the key fundamental variables.
- Step 2: Quantum distributions, which incorporate future uncertainties not captured by the historical data, such as high growth in electric vehicles or higher than anticipated energy efficiency programs.



Illustrative Peak Demand Stochastic Distribution



* Stochastic distributions shown are based on a preliminary forecast. To be revised



Environmental Considerations

PREPA IRP

Environmental Considerations

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Policy	Analysis Implication
Updated SO_2 National Ambient Air Quality Standards (NAAQS) Designations	SO_2 emissions will be tracked in IRP analysis to inform the State Implementation Plan (SIP) to address nonattainment areas of San Juan and Guayama Salinas.
Mercury and Air Toxics Standards (MATS)	Compliance for affected facilities will be considered including fuel switching to natural gas if possible, limited use, and retirement. Fuel blending was deemed through earlier analysis not to be an appropriate compliance approach for PREPA units and therefore will not be modeled.
Carbon Regulation	No CO2 cap is assumed in the analysis noting that at this time there is no existing or proposed policy capping or otherwise regulating CO2 emissions from power generators in Puerto Rico. Carbon pricing may be included as a sensitivity of the analysis to account for the implications of carbon regulation on future supply portfolios. The price of carbon proposed is based on a consensus of publicly available U.S. carbon price forecasts which starts around $10/ton CO2 in 2022 and increases to around $80/ton CO2 (nominal$).

Environmental Considerations

Policy	Analysis Implication
Puerto Rico Renewable Portfolio Standard (RPS)	Current RPS requirement for 12 percent of load served by renewable and alternative resources will be set starting in 2020, and increase along with the defined standard of 15 percent in 2027 and 20 percent in 2035. Additional sensitivities to be conducted with higher RPS targets. The costs to comply will be based on the cost of new build renewables, REC values are not an input. Distributed solar generation is not assumed to count towards RPS targets but will be tracked in the analysis.
Section 316(b) of the Clean Water Act **Puerto Rico Water Quality Standards Regulation**	All operating facilities with cooling water intake and water discharge maintain National Pollutant Discharge Elimination System (NPDES) permits

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Energy Efficiency & Demand Response Measures

PREPA IRP

New Energy Efficiency and Demand Response Measures

- New energy efficiency (EE) and demand response (DR) programs were modeled for the IRP.
- To date, limited programs to promote demand side energy savings were offered in Puerto Rico.
- To reasonably project EE and DR for the IRP, first a list of potential measures was developed based on effective programs implemented in similar climates and island settings that would yield measurable savings.
- Following screening of this initial list, this list and filtered down the measures to a subset which were deemed most appropriate for Puerto Rico.
- Total costs and energy savings for the filtered list of EE and DR measures were built up based on reasonable assumptions on costs of program implementation and utility incentives, eligible customer penetration, and resulting energy savings.

Energy Efficiency Programs Overview and Key Assumptions

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Programs	Program Description / Rationale	Key Assumptions	TRC*
Residential A/C	Incentivizes higher efficiency A/C units in existing homes. Eligible equipment types are central A/C systems and window units. Residential consumption represents ~ 35% of total energy consumption, and space cooling is a major component of this consumption. This measure provides rebates for the installation of higher efficiency A/C units: 16 SEER for central A/C and 12 EER for window A/C units.	Participation rates, energy savings, and program costs are based on comparable programs with adjustments made for Puerto Rico based on available data. An 85/15 breakdown is assumed for the use of window units to central A/C units.	3 - 4
Residential Lighting	This measure provides free LED bulbs to residential customers with 5 per customer and 60W equivalent bulbs. This measure offers participation to the nearly 1/3 of customers who rent their residence. Lighting projects have also been used in Barbados and Jamaica (Pilot).	Participation rates are ~1% annually, and assume that there are still significant numbers of incandescent bulbs in use.	4 - 5

Energy Efficiency Programs Overview and Key Assumptions

SIEMENS

Programs	Program Description / Rationale	Key Assumptions	TRC*
Commercial A/C	Incentivizes higher efficiency A/C systems in existing commercial buildings. This measure provides an incentive for the installation of more efficient (17 SEER) 5-ton A/C systems in commercial buildings. A prescriptive 5-ton unit size was used to model this measure. Comparable programs are offered by mainland U.S. utilities in Florida and in many other states.	This program model assumes typical commercial building A/C sizes in the absence of more granular data. Industry calculators were used to estimate the resulting savings from the higher efficiency A/C unit.	1 - 2
Commercial Lighting	This measure incentivizes high efficiency lighting to commercial customers by providing them with an incentive for efficient lighting retrofits which is based on a $/kW reduction in lighting demand resulting from the retrofit. This measure is open to different lighting technologies which can provide improved performance. This flexibility should make the measure applicable to more commercial customers.	The annual kWh savings per participant assumption is based on a review of comparable lighting programs due to limited Puerto Rico specific data availability.	3 - 4

Demand Response Programs Overview and Key Assumptions

SIEMENS

Programs	Program Description / Rationale	Key Assumptions	TRC*
Commercial Demand Response	This measure provides for commercial load management by enabling load control for commercial AC and lighting systems. Some programs have also included water heating. This measure can be implemented either automatically where the pre-designated loads are reduced under low-frequency conditions or manually by either utility or on-site operators when peak conditions are anticipated. Utility-controlled load curtailment is the most reliable implementation method. In all cases, the participant is notified in advance that loads will be shed. Most utility programs also require that participants identify a minimum of 50 KW for load curtailment. Typically, events are guaranteed to last no more than 1 hour.	While most commercial DR programs include some very large commercial and industrial customers, for PREPA, it is assumed that participants would most likely be small and medium-sized commercial establishments – especially in initial program years. Pharmaceuticals specifically noted that they would not likely participate in DR programs due to the need to maintain highly controlled environments for their operations. Typical participants include hotels/motels, office buildings, non-food retail establishments, and educational facilities.	1 - 2

Demand Response Programs Overview and Key Assumptions

SIEMENS

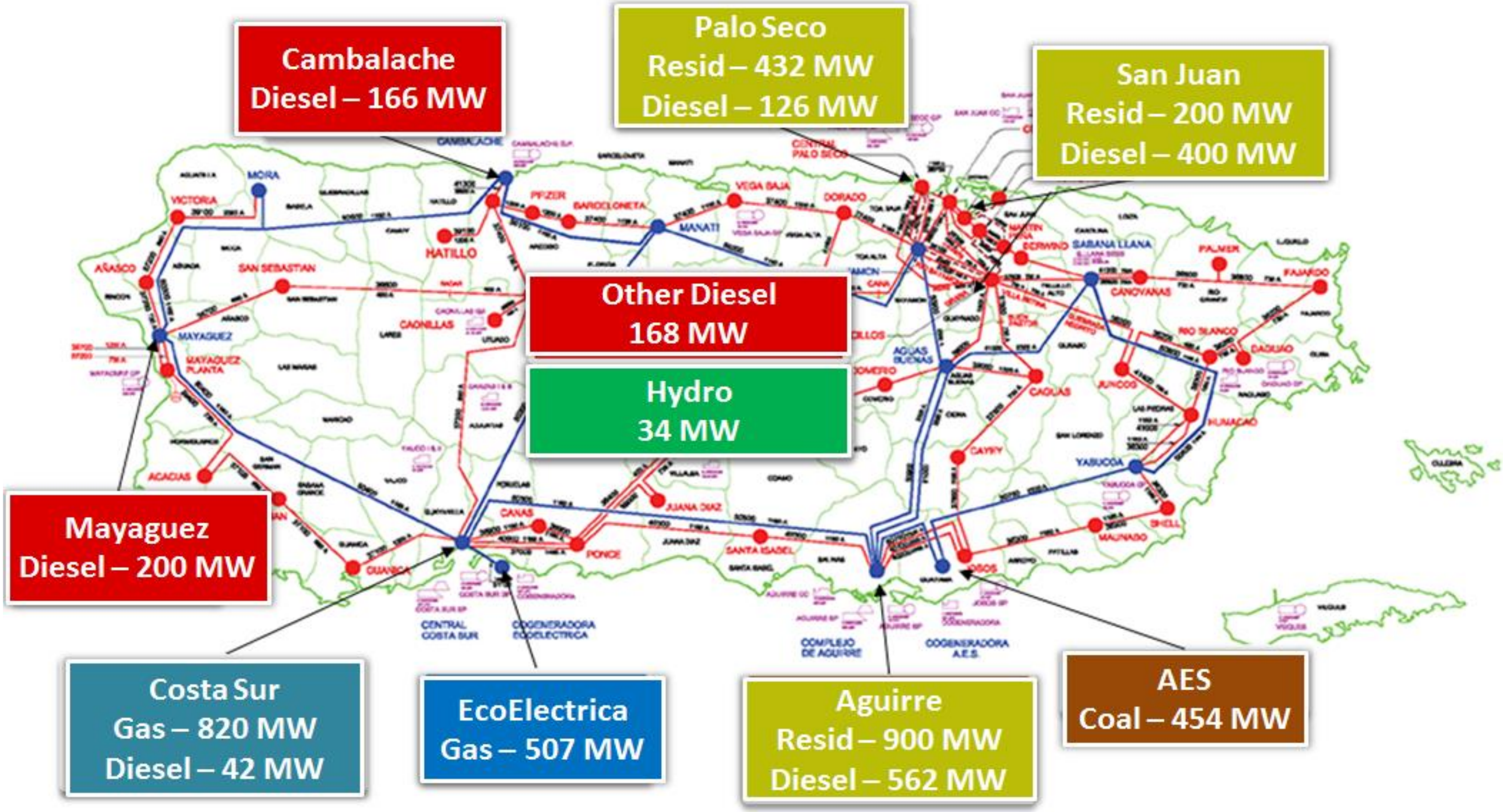
Program	Program Description / Rationale	Key Assumptions	TRC*
Residential Demand Response	This measure provides for residential load management by enabling load control for residential central A/C systems of participating customers via an installed communicating thermostat. Comparable programs are offered by mainland U.S. utilities in Florida and in other states as well as in Hawaii.	It is assumed that roughly 1/3 of PREPA residential customers have central A/C and would form the base of potential participants.	4 - 5

Total resource cost (TRC) is a measure of the avoided energy cost over the total program costs for each measure. These are estimated ranges, actual cost effectiveness might vary.

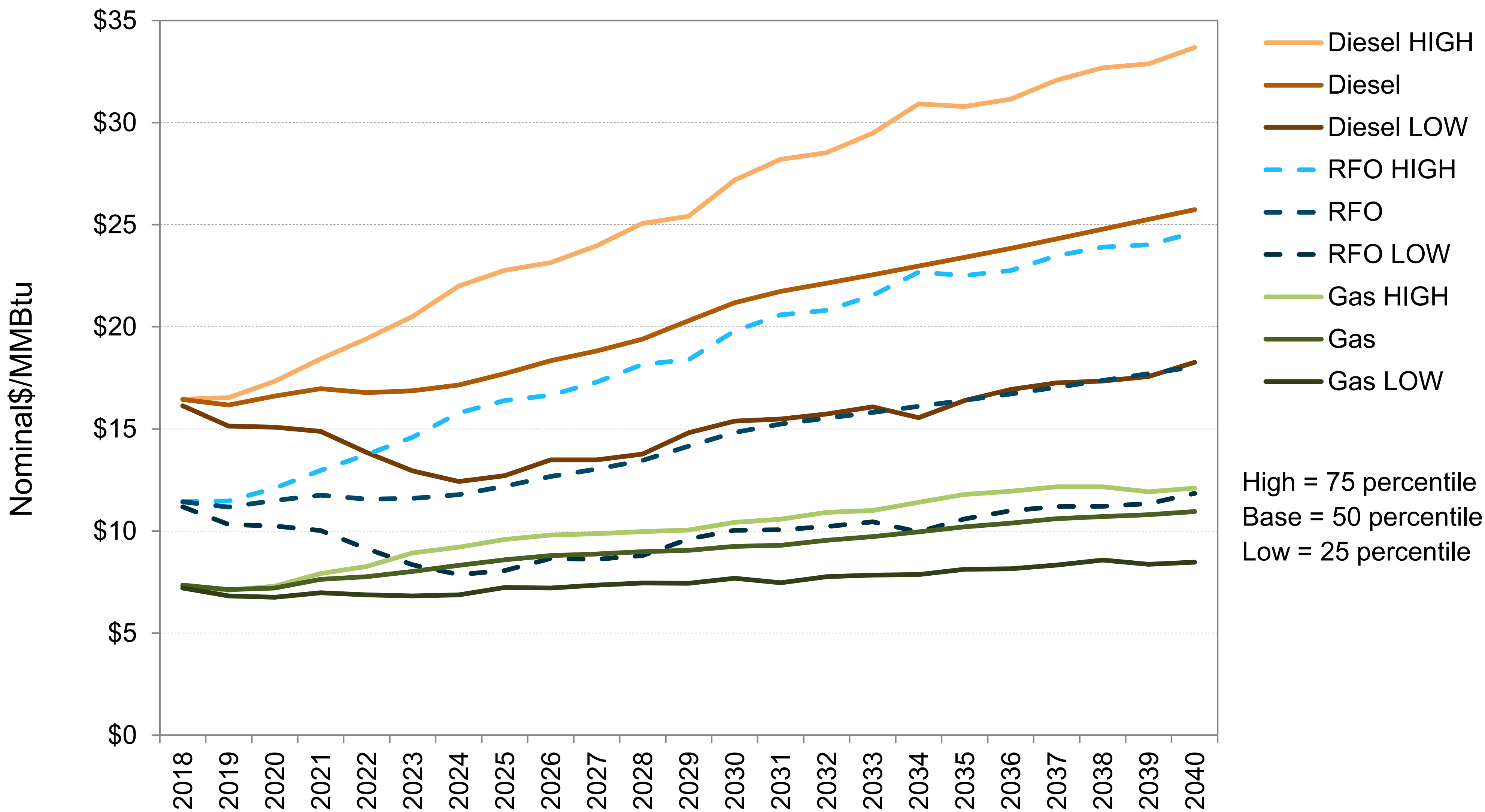
Fuel Forecast and Infrastructure

PREPA IRP

Existing Generation on the Island



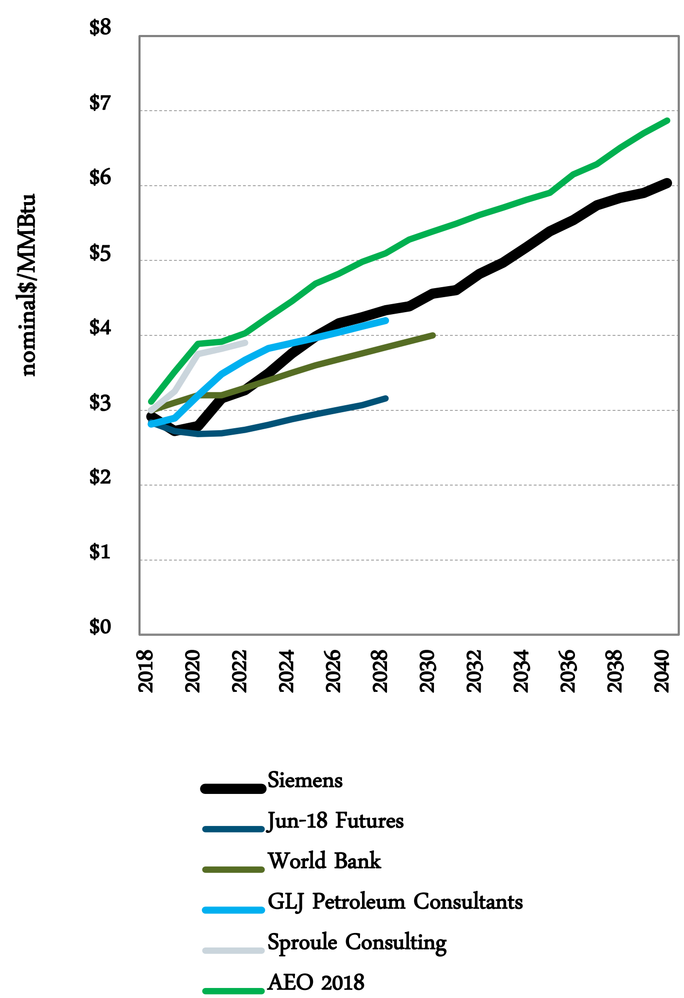
Delivered Fuel Forecasts for Each Plant – Aguirre Delivered Fuel Prices



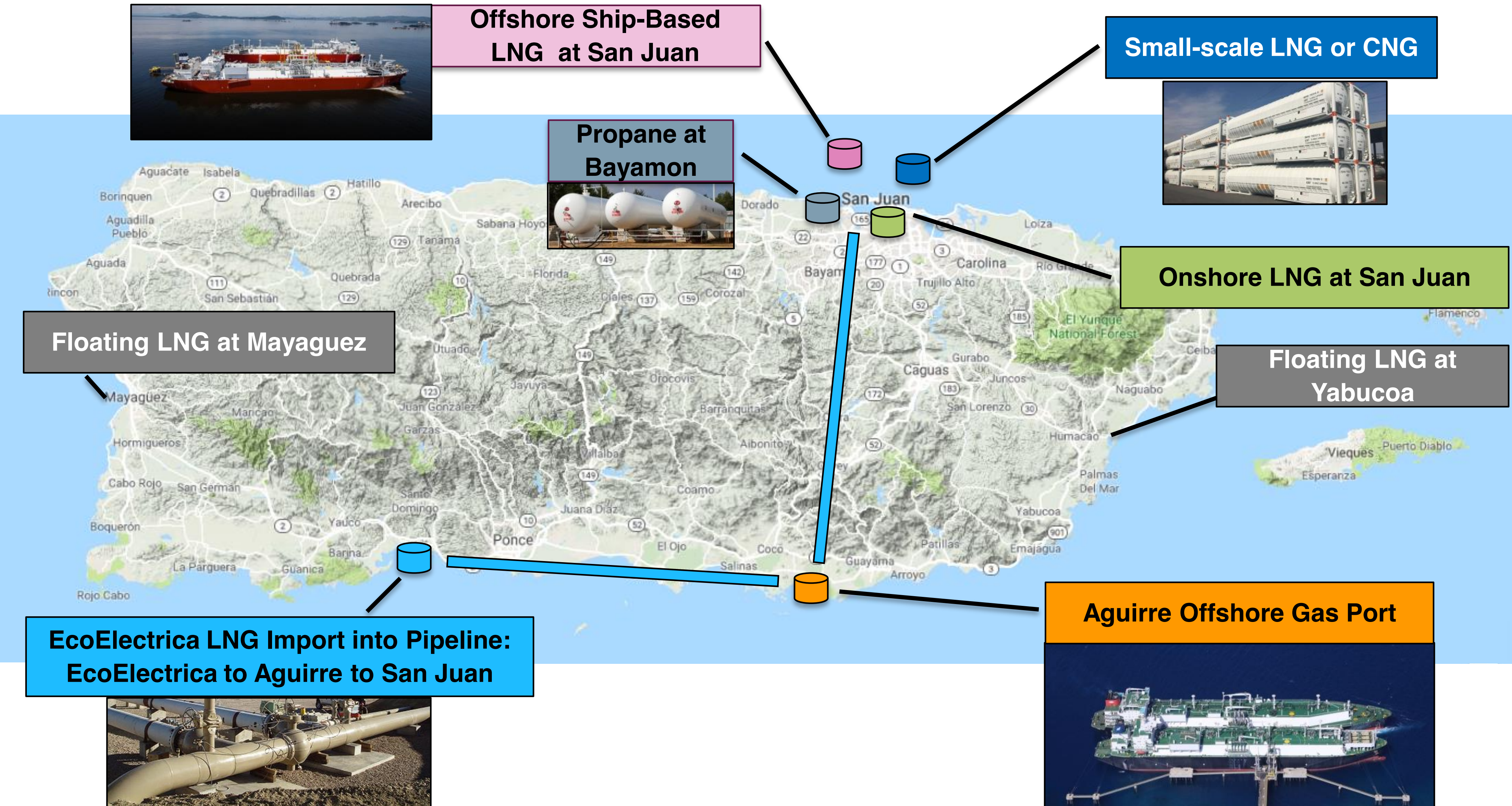
Gas Pipeline Competition Model (GPCM) Fundamentals Analysis

- GPCM, developed and licensed by RBAC, Inc., is an established, industry-standard natural gas fundamentals model that provides the ability to quantitatively analyze the complex interactions among producers, pipelines, storage facilities, gas marketers, and consumers in the highly integrated North American natural gas industry. The primary output of GPCM is natural gas price forecasts and natural gas trading hub basis differentials to the benchmark Henry Hub, but has a range of other outputs including pipeline usage, transportation zone pricing customer receipts, and storage balances.
- GPCM dynamically solves for economic rents, allowing cheaper supplies to be used before more expensive supplies and enabling customers willing to pay more to be served before those willing to pay less. By including the entire system of North American natural gas production, transmission, storage, consumption, and imports/exports, GPCM optimizes natural gas flows in an economically sensible order to produce an economically efficient, market-clearing solution. GPCM contains more than 250 existing and proposed pipelines, 440 storage areas, 85 production areas, 20 liquefied natural gas (LNG) import/export terminals, and 450 demand centers.
- Siemens' fundamentals assumptions: Supply figures are sourced from DrillingInfo's ProdCast tool. Demand figures are developed from regression analysis (Res/Com/Ind), project-by-project (LNG), or initially based on the AEO 2018 outlook (Elc) but allowed to adjust within GPCM due to the sector's price elasticity. Pipelines assumptions are assessed project-by-project as well.

Henry Hub Forecasts



Potential Fuel Infrastructure Options



Fuel Infrastructure Options Assessment

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Fuel Infrastructure Scenario	Capital & O&M Costs (Million 2018$)	Est. Vol. Required (MMcf/d)	Resiliency & Reliability	Environmental Impact	Public Concerns	Fatal Flaw
Ship-based LNG at San Juan Port with Pipeline to both plants	Onshore Regasificaction =$75 - Pipeline=$110 - Annual O&M=$45 (+fuel)	70 MMcf/d	Increase reliability from flexibility to burn gas or diesel (currently oil only). Resiliency could be challenged by hurricane damage to the ship.	Carbon and other emissions would be reduced. Increased vessel traffic could impact coastal marine life.	Harborview would be impacted by the parked ship.	N/A

Fuel Infrastructure Options Assessment cont.

SIEMENS

Fuel Infrastructure Scenario	Capital & O&M Costs (Million 2018$)	Est. Vol. Required (MMcf/d)	Resiliency & Reliability	Environmental Impact	Public Concerns	Fatal Flaw
Land-based LNG at San Juan Port with Pipeline to Palo Seco	Land-based LNG Terminal=$457 - Pipeline=$68 - Annual O&M=$45	125 MMcf/d	Increase reliability from flexibility to burn gas or diesel (currently oil only). Resiliency could be challenged by hurricane damage to onshore LNG port.	Carbon and other emissions would be reduced with LNG. Increased vessel traffic could impact coastal marine life.	Concerns over significantly increased vessel traffic, disruptive pipeline to Palo Seco.	N/A
Additional Regasification Capacity at EcoEléctrica and Costa Sur to Aguirre to San Juan Pipeline	Costa Sur to Aguirre Pipe=$184 - Aguirre to San Juan Pipe=$238 - Annual O&M=$40	*(125+245)=* 370 MMcf/d	Resiliency and reliability increased by transport via underground pipeline, providing flexibility to burn gas or diesel at converted generation plants. Additional regas capacity provided by private company.	Carbon and other emissions would be reduced with pipeline gas delivery and conversion to gas-fired generation.	Previous attempt to construct Costa Sur to San Juan pipeline was cancelled due to public concerns.	N/A
No New Gas Infrastructure	N/A	N/A	Existing generation plants lack flexibility in cleaner fuel choice. Onsite fuel storage more reliable than LNG deliveries susceptible to disruption.	Carbon and other emissions would remain higher than permissible/desired under current regulations.	Leaves space for increased renewables penetration and removes risk of stranded fossil fuel assets.	N/A

Fuel Infrastructure Options Assessment

SIEMENS

Fuel Infrastructure Scenario	Capital & O&M Costs (Million 2018$)	Est. Vol. Required (MMcf/d)	Resiliency & Reliability	Environmental Impact	Public Concerns	Fatal Flaw
Aguirre Offshore GasPort	GasPort=$401 - Annual O&M=$81 (+fuel)	*(1,462 MW)* - *(7,000 Btu/kWh)* - 245 MMcf/d	Increase reliability from flexibility to burn gas or diesel (currently oil only). Resiliency could be challenged by hurricane damage to AOGP or south-to-north power transmission.	Carbon and other emissions would be reduced with AOGP and conversion at Aguirre to gas-fired generation.	Infrastructure would be located away from population, but concerns over cost and stranded fossil fuel plant.	N/A
Gas to Yabucoa (east) and gas to Mayaguez (west)	Pending Analysis and Information					

Distributed Generation

PREPA IRP

Distribution and Transmission Level DG

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- The DG in Puerto Rico includes distribution level DG and transmission level DG. Both categories are primarily rooftop solar.
- IRP models DG as “lumped” generation resources, reflecting distribution DG and transmission DG separately by eight zone areas.
- Most of the DG is located in the north of the island, largely in parallel with the location of the load. Below table shows existing DG locations.
- Under current arrangements, DG is not eligible for the RPS compliance.

	Share	MW	Region
North	71%	122.76	S. Juan, Bayamón, Carolina, Caguas & Arecibo
South	16%	28.09	Ponce
West	13%	21.90	Mayagüez
Total	100%	172.75	

Distribution DG Forecast Approach

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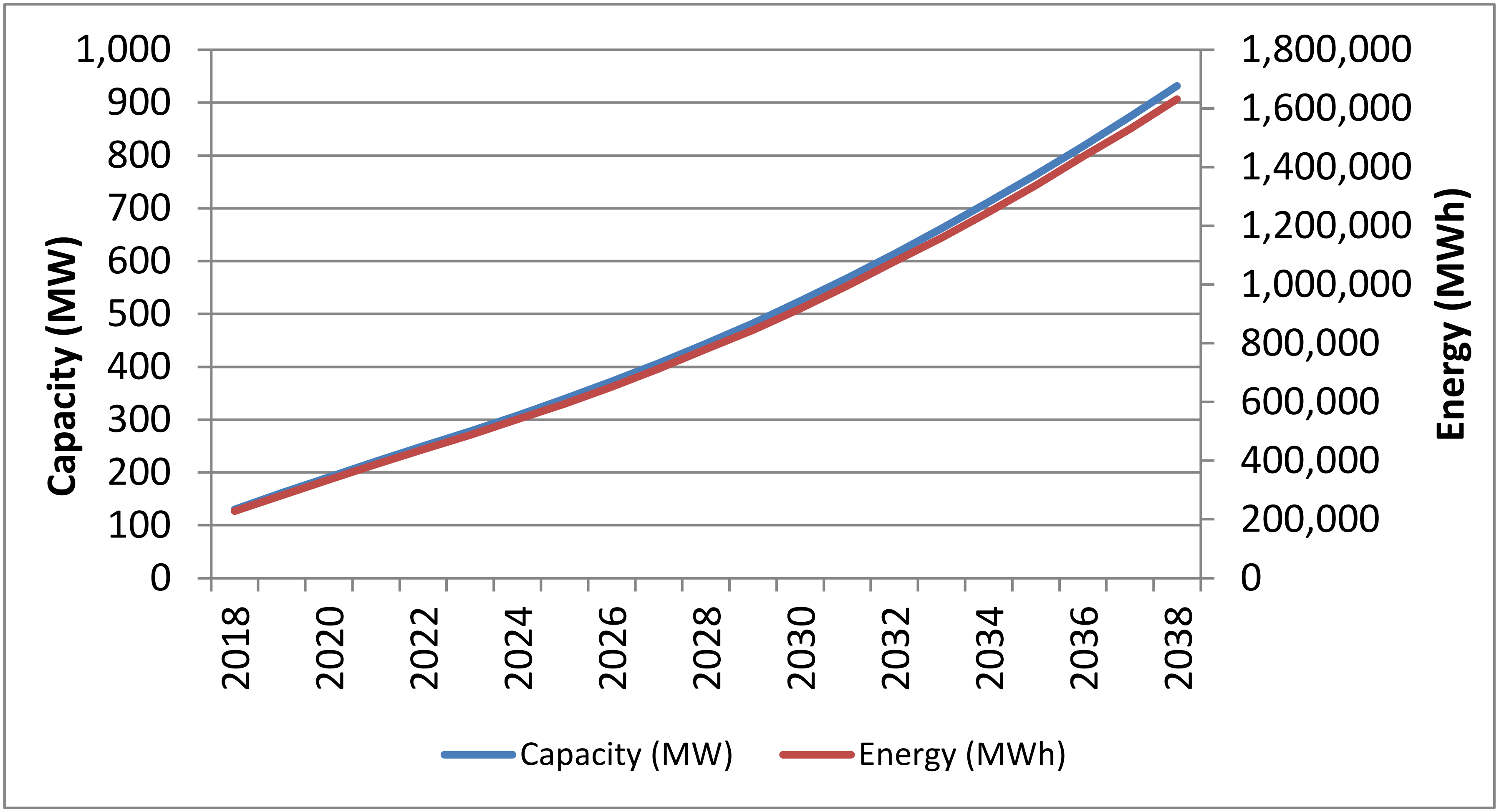
- The distribution DG projections were developed based on the Energy Information Administration (EIA) Annual Energy Outlook (AEO) for Residential Sector Equipment Stock and Efficiency, and Distributed Generation-Solar Photovoltaic Capacity.
- To develop the forecast the Annual Energy Outlook data was first separated in monthly values, using factors determined with the Short Term Energy Outlook from EIA for 2018 and 2019.
- PREPA's historical DG values were then used to create a model correlating PREPA's distribution level DG with the monthly AEO for small scale renewable generation developed as described earlier as the exogenous variable. The model showed fairly good correlation with historical data and was used to create a forecast for distribution level DG generation post June 2018 (130 MW) using the EIA forecast for the exogenous variable growth.
- For the associated energy we used a uniform capacity factor of 20% for the projection period, which may be conservative as the efficiency of panels and equipment increases.

Distribution DG Forecast



Transmission DG Forecast Approach

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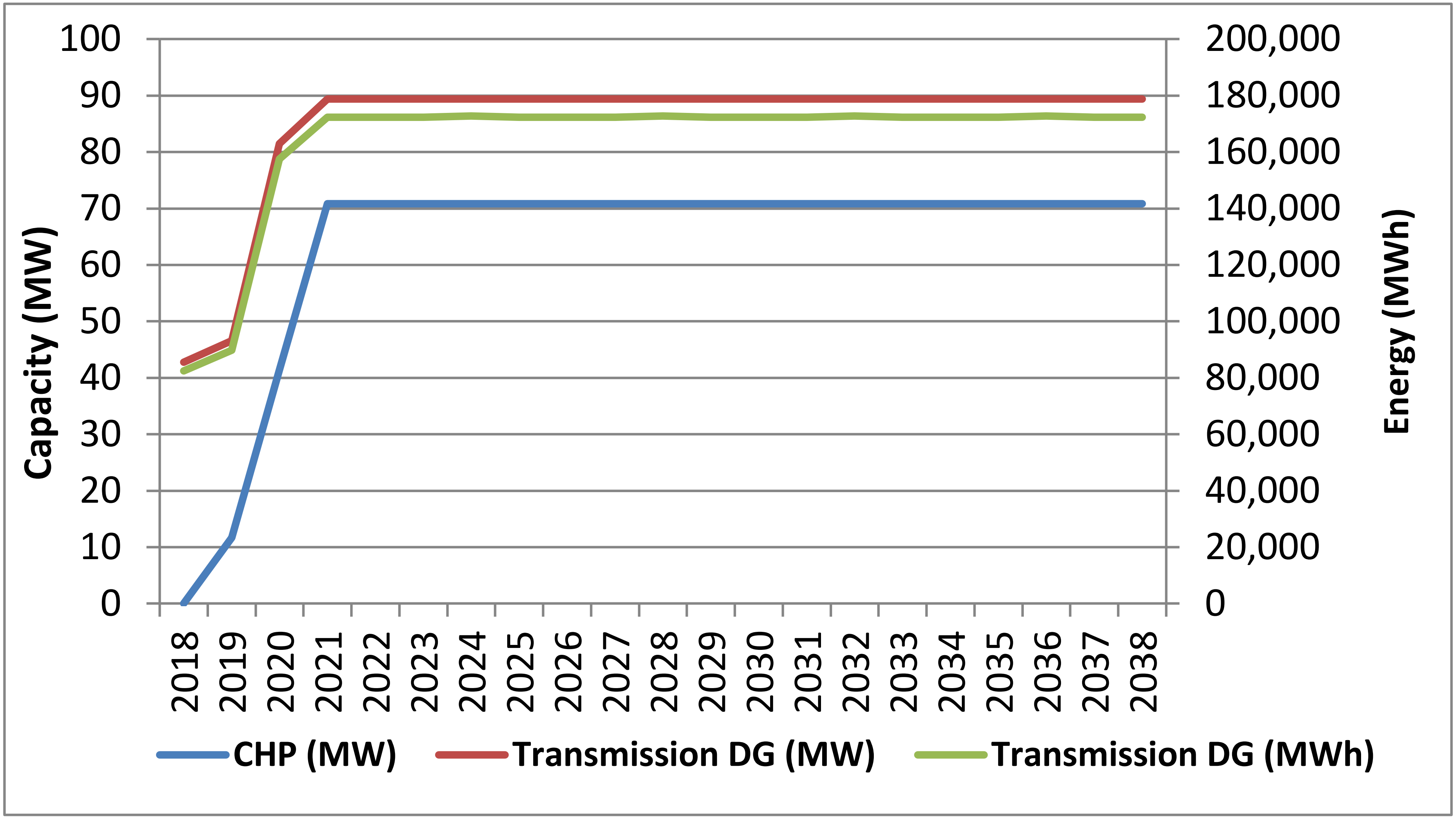
- The transmission Level DG and Cogen (CHP) based on the project status information provided by PREPA, assuming one-year lag time if the project status is "electric planes endorsed", two-year lag time to operation if the plant is under "evaluation" stage or three-year lag time if the project status is "incomplete information".
- Projections for transmission DG and Cogen, which peak by 2021. In reality, it is expected that the transmission level DG will continue. These larger scale projects are not embedded with the distribution load but rather connected at 38 kV and above, and play a role very similar to utility owned or contracted generation. Therefore, their increased penetration, beyond the one are modeled as taking part in supplying the local generation needs identified by the IRP.
- For transmission level DG a capacity factor of 22% of considered in line with the smaller utility scale generation.

Transmission DG Forecast



Availability and Cost of Capital

PREPA IRP

Capital Constraints

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- PREPA currently has no access to bond market and bank financing.
- Recent bill authorized PREPA to sell its generating assets to potential private buyers.
- Based on discussions with stakeholders, IRP will consider future builds to be financed by third parties, assuming PREPA obtain financial backing to contract as a credit-worthy counterparty if and as needed.
- The IRP also will take into account information on potential FEMA funding if such information is provided in a timely manner and as applicable.
- IRP does not have clear guidelines on capital constraints considerations. Such constraints could be incorporated as information becomes available.

Illustrative Weighted Average Cost of Capital for Generation

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Cost of Equity	
Asset Beta	0.70
Income Tax Rate	39.00%
Debt to Equity Ratio	0.90
Equity Beta	1.08
Risk-Free Rate	2.95%
Equity Risk Premium	5.50%
Company Specific Risk Premium	4.00%
Cost of Equity	12.91%
Cost of Debt	
Cost of Debt, Pre-tax	5.00%
Tax Rate	39.0%
Cost of Debt, After-tax	3.05%
Weighted Average Cost of Capital	
After-tax Cost of Debt	3.05%
Percent Debt	47%
Cost of Equity	12.91%
Percent Equity	53%
WACC	**8.25%**

Source: Siemens

- WACC for generation resources pending alignment with stakeholders.
- Higher or lower WACC could be incorporated in additional sensitivity.

Action Plan

PREPA IRP

Action Plan Covers Planned Acquisitions in First 5 Years

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- **The IRP is in the context of a transformation process and that process has both Puerto Rico and federal law processes and standards. The IRP needs to be an analysis and to some degree a plan but not directive and binding.**
- As a part of the IRP, the action plan during the first five years as a result of the Preferred Resource Plan will address potential acquisition of the following resources, if applicable.
  - Demand-side
  - Supply-side
  - Transmission
  - Distribution
  - Fuel infrastructure resources
  - Retirements and/or retrofits of existing generating resources
  - PPOAs
  - Other resource commitments

Action Plan Based on Preferred Resource Plan

- As a part of the IRP, implementation actions during the first five years as a result of the Preferred Resource Plan will be prepared to included the following elements:
  - Potential required studies
  - Potential procurement processes - RFPs
  - Potential permitting and/or regulatory requirements
  - Potential constructions
  - For any major expected resource acquisitions, retirements, retrofits or power purchase agreements, the action plan shall provide information on the cost of the option chosen.
- **The IRP will not address project-specific financing plans.**