



**Puerto Rico  
Electric Power  
Authority**

**DRAFT FOR DISCUSSION PURPOSES ONLY**

# **Puerto Rico Electric Power Authority**

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## **Generation Overview**

September 17, 2018

***Subject to Common Interest and Deliberative Process Privileges***

PRELIMINARY - Subject to Further Revisions and Modifications

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# Agenda

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Current Generation Fleet

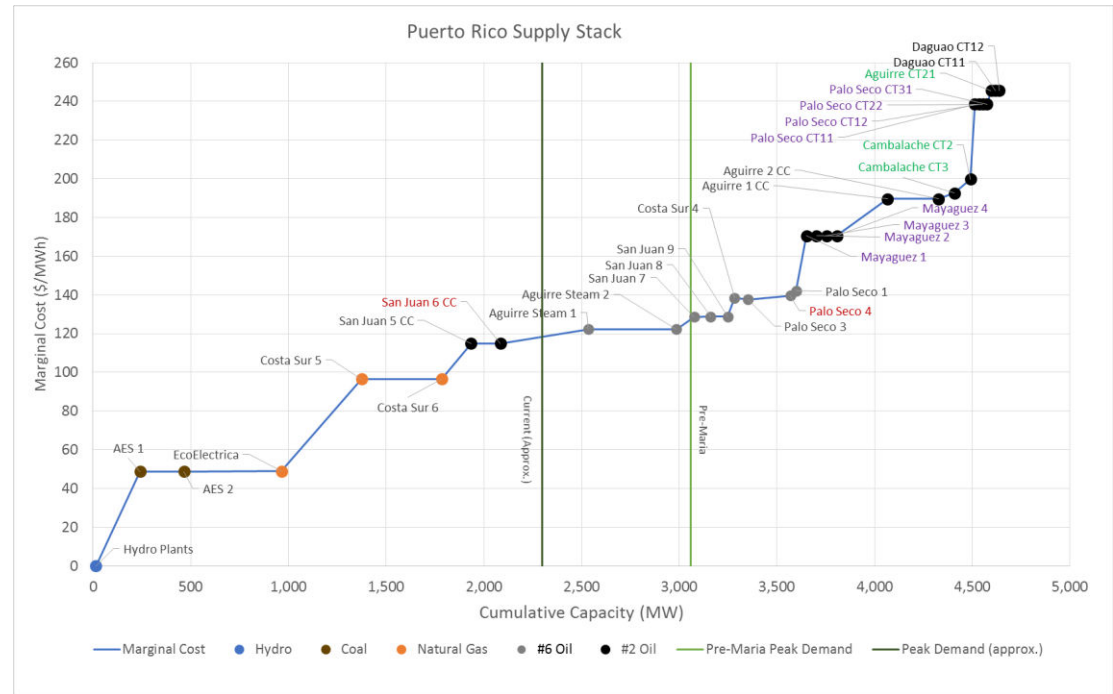
Future Plans for the Generation Fleet

# PREPA-Controlled Generating Capacity (Owned and Contracted)

Type	Number of Units/ Renewable Facilities	Total Capacity (MW)
Hydroelectric	11	105
Thermal Steam	14	2,892
Combined Cycle	10	1,056
Combustion Turbines	33	853
<b>Total Owned Generation</b>		<b>4,900</b>
Contracted Fossil	3	961
Contracted Renewables	11	254
<b>Total Contracted Generation</b>		<b>1,215</b>
<b>Total Controlled Generation</b>		<b>6,115</b>

Owned and contracted generation capacity of approximately 6,100 MW is comprised of natural gas, coal, diesel, residual fuel oil, hydroelectric, wind, solar, and landfill gas units

In an island system, all ancillary services (such as spinning reserve, voltage and frequency support, reserve margins, etc.) must also be provided. Thus, the actual dispatch and costs will vary significantly from that represented by the supply stack curve to meet these requirements.

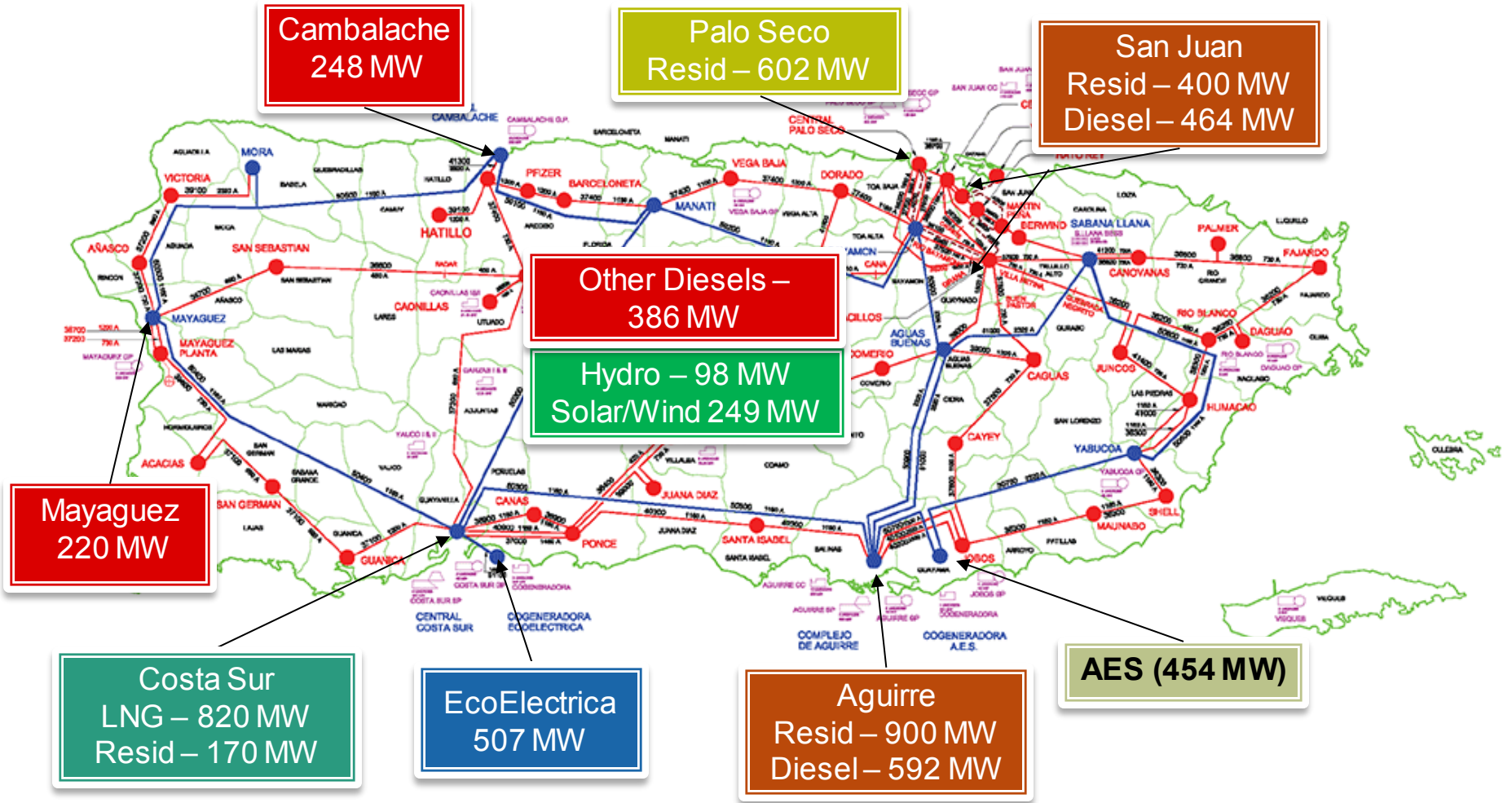


Based on full-load heat rate operations and full plant capacities

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# Current PREPA Generating Map



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# PREPA Contracted Generation

Under current contractual terms, PREPA has over 1,200 MWs of generation under contract

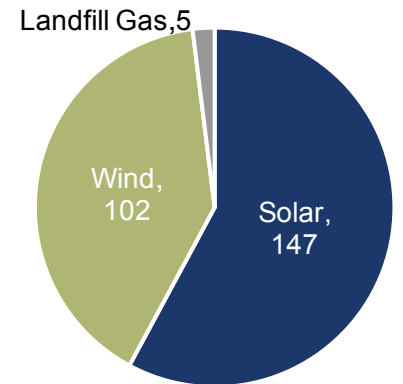
- AES contract expires in 2027
- EcoElectrica contract expires in 2022
- Various expiration dates on the renewable contracts

**REDACTED**

Resource	Capacity (MW)	Fuel Type	YTD Capacity Factor
AES 1	227	Coal	92%
AES 2	227	Coal	66%
EcoElectrica	507	Natural Gas (LNG)	57%*
Renewables	254	Solar, Wind & Landfill Gas	15%
<b>Total</b>	<b>1,215</b>		

\*Annual maintenance outage on one GT for ~ half of August

Renewable Capacity (MW)



# PREPA Owned Generation

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The generation assets that PREPA owns can be categorized into the following strategic classes when determining the current utility of the asset

- Viable mid- to long-term
  - Assets driven by an attractive fuel or operating profile
  - Will assist in meeting environmental guidelines
- Required for grid support
  - Stability of the PREPA power grid relies on having a geographically diverse set of quick start generating units that can be called to operate at the sign of any local or system-wide disruption
  - Low capacity factor and maintenance cost units
- Short-term standby as replacement options are deployed
  - Asset that are likely to be retired in the mid- to long-term, but maintain them while alternative strategic options are executed
- Mothball or retire
  - Costs to repair or maintain these assets exceed the functional value of the asset

The tables on the following pages outline the current stratification of the PREPA Owned generation into these strategic classes by resource

- As other opportunities are brought on-line, this stratification may materially change as the geography of the PREPA power grid is altered

# PREPA Owned Generation Review

## Viabile mid- to long-term

Resource	Capacity (MW)	Initial Operation	Fuel Type	Heat Rate (Btu/kWh)	YTD Capacity Factor
Costa Sur 5	410	1969	Residual Oil or Natural Gas (LNG)	11,000	70%
Costa Sur 6	410	1972	Residual Oil or Natural Gas (LNG)	11,000	57%
San Juan 5	232	2008	Diesel	8,300	75%
San Juan 6	232	2008	Diesel	8,300	79%
Hydro Units	98	1929 - 1953	River & Reservoir	n/a	3%
Total	1,382				

With the recent expansion of regasification facilities near Costa Sur, both units can now be fully fired at the same time by lower cost LNG, while maintaining the flexibility to run on residual oil if natural gas prices increase

The San Juan combined cycle plant has an attractive heat rate and could be converted to burn natural gas for a relatively modest investment of \$10 – \$30 million

# PREPA Owned Generation Review

## Required for grid support

Resource	Capacity (MW)	Initial Operation	Fuel Type	Heat Rate (Btu/kWh)	YTD Capacity Factor
Cambalache 2	82.5	1997	Diesel	12,000	2%
Cambalache 3	82.5	1998	Diesel	12,000	9%
Mayaguez 1	55	2009	Diesel	10,300	5%
Mayaguez 2	55	2009	Diesel	10,300	0%
Mayaguez 3	55	2009	Diesel	10,300	6%
Mayaguez 4	55	2009	Diesel	10,300	14%
Palo Seco 3	216	1967	Residual Oil	10,600	67%
Palo Seco 4	216	1968	Residual Oil	10,600	0%*
22 geographically diverse combustion turbines	386	1971 - 1973	Diesel	~13,500	6%
Total	1,203				

\* Unit on scheduled outage until December 2018

Certain combustion turbines may be retired as the costs of repair may exceed their economic value  
 This strata could be significantly influenced by future opportunities

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# PREPA Owned Generation Review

## Short-term standby as replacement options are deployed

Resource	Capacity (MW)	Initial Operation	Fuel Type	Heat Rate (Btu/kWh)	YTD Capacity Factor
Aguirre 1	450	1971	Residual Oil	10,600	62%
Aguirre 2	450	1971	Residual Oil	10,600	3%*
San Juan 7	100	1964	Residual Oil	11,400	0%
San Juan 8	100	1964	Residual Oil	11,400	0%
San Juan 9	100	1966	Residual Oil	11,400	39%
Total	1,200				

\* Unit on scheduled environmental outage most of August

If the Aguirre Gas Port becomes a reality, it is a high probability that Aguirre 1 and 2 would be placed in a more favorable category

- Key issue with Aguirre 1 and 2 is the size of the units
- Based on current expectations of future system peak load, it is challenging to derive a scenario where Costa Sur 5 and 6 and Aguirre 1 and 2 are coincidentally required on the system
  - A plausible scenario is one where either the AES or EcoElectrica plants are retired at the end of their respective contract terms

# PREPA Owned Generation Review

## Mothball or retire

Resource	Capacity (MW)	Initial Operation	Fuel Type	Heat Rate (Btu/kWh)	YTD Capacity Factor
Aguirre CC1	296	1976	Diesel	10,580	22%
Aguirre CC2	296	1975	Diesel	10,580	8%
Cambalache 1	82.5	1997	Diesel	12,000	0%
Costa Sur 3	85	1960	Residual Oil	13,000	0%
Costa Sur 4	85	1962	Residual Oil	13,000	0%
Palo Seco 1	85	1959	Residual Oil	11,200	8%
Palo Seco 2	85	1959	Residual Oil	11,200	0%
San Juan 10	100	1965	Residual Oil	11,400	0%
Total	1,115				

Even in the scenario where the Aguirre Gas Port is built, the Aguirre combined cycle facility would not be viable due to its outdated technology

# Agenda

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Current Generation Fleet

Future Plans for the Generation Fleet

# Future Generation Path

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## Baseline Assumptions

- Peak load will be approximately 2,500 MW following the restoration with no anticipated load growth in the next 5 years
  - Minimum load is 70% of daily peak load
- Approximately 250 – 350 MWs of new intermittent renewables will be added to the grid, resulting in total solar and wind capacity of 500 – 600 MWs
  - Quick payout investments will be made on any PREPA Owned hydroelectric units, thereby returning the entire approximately 100 MWs of company owned hydro generation to operational status

**REDACTED**

## New Construction & Modifications to Current Assets

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In addition to the new renewables that will be added, this plan considers the construction of the following:

- 500 +/- MW of “flex generation” will be added at multiple sites throughout the island
  - Depending on the site, these units may be natural gas, #6 fuel oil or diesel and would be internal combustion engines
  - **Solutions may be available to install temporary units within a few months until new, permanent units can be installed over the next several years**
- Battery storage will be added throughout the island
  - This storage will be used to operate as spinning reserve in order to provide a time window when the new flex generation will be started (5 to 10 minutes)
  - Storage will also be used to balance the intermittency of the renewable resources
  - Batteries are not intended for long term discharge/load supply but they will have some capability to do this for short periods

The San Juan 5 & 6 combined cycle plant will be converted from burning diesel fuel to natural gas

### Estimated Costs for these Initiatives

- New Flex Generation is \$1,342/kW - \$671 million (estimated cost from 2016 EIA)
- New battery cost about \$200/MW-hr.
- Modification of San Juan 5 & 6 to natural gas - \$10 million to \$30 million

## Expected Daily Operation

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### Minimum Load

• Hydroelectric resources	-	100 MW
• AES	-	454 MW
• EcoElectrica	-	507 MW
• San Juan 5 & 6	-	440 MW
• Costa Sur (Natural Gas)	-	<u>249 MW</u>
• TOTAL		1,750 MW

### Peak Load

• Hydroelectric resources	-	100 MW
• AES	-	454 MW
• EcoElectrica	-	507 MW
• San Juan 5 & 6	-	440 MW
• Costa Sur (Natural Gas)	-	510 MW
• Flex Generation	-	<u>489 MW</u>
• TOTAL		2,500 MW

- Calculations above are presented on an available capacity basis, therefore intermittent renewable resources like solar and wind are excluded
- After implementing the conversion of San Juan 5 & 6 to natural gas and assuming that natural gas is the fuel source for the majority of the flex generation, PREPA would achieve compliance under MATS and the island would be in a much more environment friendly position than it is today
- This result can be achieved with a minimum level of investment capital from either internal or external resources

# Options Under Consideration

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Construct additional new base-load combined cycle generation.

- Maximum size approximately 250 MW per shaft.
- Leverage on natural gas supply at Costa Sur short-term
- If San Juan natural gas delivery is established and increased, replace San Juan Units 7, 8, 9, and 10 with more efficient units.
- Additional battery and flex generation may be required throughout the island to support greater penetrations of intermittent renewable generation.
- If AES and EcoElectrica contracts are not renewed beyond the end of their respective terms, one or more of the above solutions could be implemented as a replacement

Current projects under consideration or in flight

- Issue an RFP to install and operate 40 MW of batteries in the North
  - Once established and operating, additional battery storage could be evaluated
- Issue an RFP to privatize the operation of the hydroelectric assets
  - This would include private investment and day-to-day operation to restore production capabilities to a full 100 MW
- Issue an RFP to install approximately 500 MW of interim temporary flexible generation in the North and East
- Issue an RFP to secure natural gas at the San Juan combined cycle units and convert the units to dual fuel capability (natural gas and diesel)
- Issue an RFP for new market-based renewable energy power purchase and operating agreements throughout the island

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