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PREPA IRP 2018
Preliminary Results of the Long Term Capacity Expansion Plan

October 31, 2018

Preliminary results subject to revision

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Introduction

- Siemens PTI is working with PREPA and multiple stakeholders in developing the 2018 IRP designed with the overarching goal of producing an economic, reliable and resilient system for Puerto Rico.
- To date the foundational elements of the IRP have been finalized, which include:
  - Load and Fuel Forecast
  - Fuel Infrastructure Analysis
  - Existing Resources Update
  - New Resources Definition and Cost Projection (Thermal, Storage, Renewables)
  - Energy Efficiency / Demand Response
  - DG / DER Forecast
  - Environmental Review
  - Formulation of Scenarios, Strategies and Sensitivities
  - Development of the Long Term Capacity Expansion in Aurora and Update in PROMOD
- Currently Siemens PTI is developing the long term capacity expansion plan (LTCE) for the key scenarios and strategies selected as well as working in the development of the electrical islands or minigrids into which the system is designed to separate under the occurrence of a major event.

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Introduction

- In this presentation we will cover the initial results of the LTCE for Scenarios 1, 2, 3 and 4 for Strategy 2 and 3.
- **Scenario 1** considers that there will be no new LNG terminals on the island.
- **Scenario 2** considers that one land based high capacity LNG terminal is developed at San Juan
- **Scenario 4** in addition considers that ship-based LNG terminals can be developed at Mayaguez and Yabucoa with base cost for renewable. **Scenario 3** has lower prices for renewables and storage.
- **Scenario 5** considers that there is gas as well at Aguirre through AOGP.

Scenario	New Gas				Renewable & Storage	
	AOGP	Land-based LNG at San Juan	Ship-based LNG at Yabucoa	Ship-based LNG at Mayaguez	Costs	Availability
1	No	No	No	No	Reference	Reference
2	No	Yes	No	No	Reference	Reference
3	No	Yes	Yes	Yes	Low	High
4	No	Yes	Yes	Yes	Reference	Reference
5	Yes	Yes	Yes	Yes	Reference	Reference

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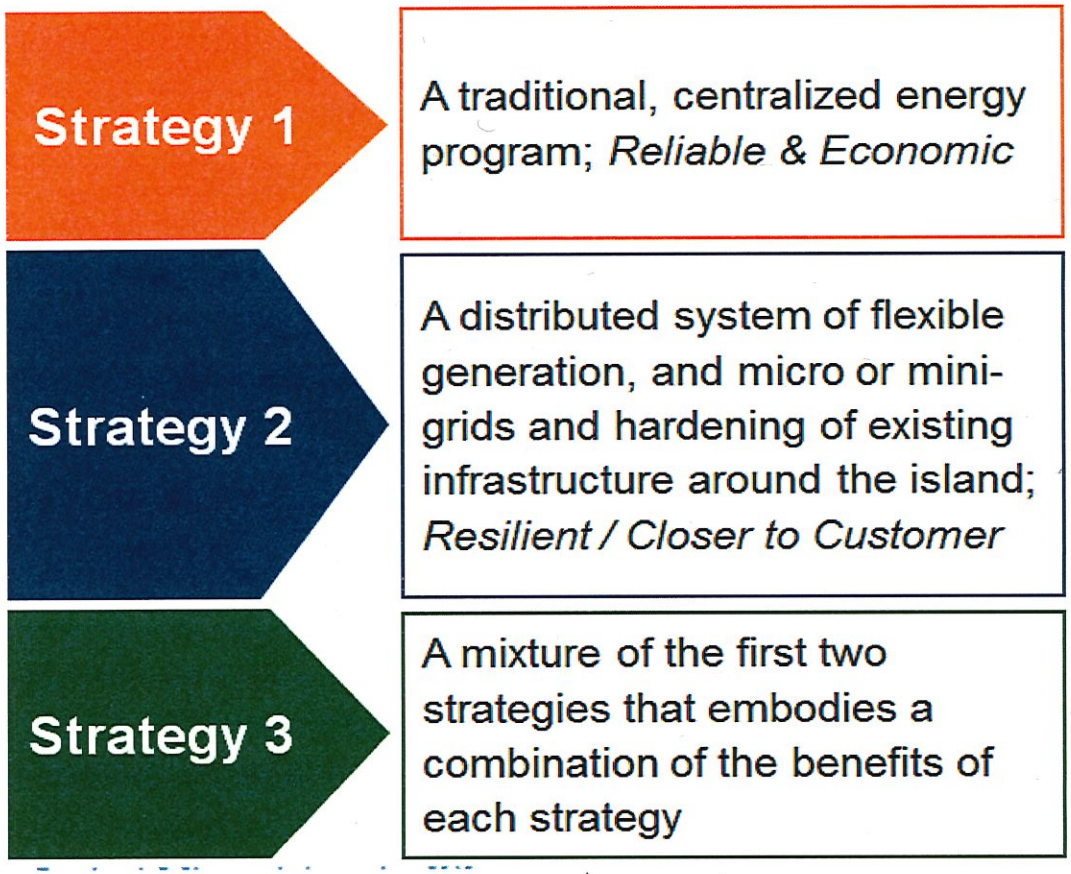
Introduction

- **Strategy 1** is fully centralized and there are no local resource requirements.
- **Strategy 2** is focused in distributed resources which translates into a requirement that at least 80% of the peak demand needs to be supplied locally.
- **Strategy 3** drops this requirement to 50%.
- Given the high levels of renewable and storage that the plan is building, initial results hint that the difference between the strategies is smaller than originally envisioned.



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Introduction

- 34 LTCEs will be developed considering the scenarios, strategies, sensitivities and 3 load forecast levels.
- We will cover the Base Load Forecast, which has declining load due to the combined effect of the expected load attrition and an energy efficiency program that considers 2% reduction per year for 10 years.
- The results will be presented for Scenario 2 (new gas at SJ), which has high likelihood of materializing, followed by Scenario 1 (no new gas), Scenario 4 (new gas at east, west and north), Scenario 3 (new gas at east, west and north, coupled with low costs for renewables and storage)
- ***It must be stressed that the results here are preliminary and subject to revisions***
- The results are presented in the following sequence:
  - LTCE additions
  - LTCE retirements
  - Economics and drivers of the results above
  - Effects on the energy supply of Puerto Rico
  - Cost of supply projections
  - RPS compliance & Minigrid considerations

Count	Case ID	Scenario	Strategy	Sensitivity	Load
1	S1S2B	1	2		Base
2	S1S2H	1	2		High
3	S1S2L	1	2		Low
4	S1S3B	1	3		Base
5	S1S3H	1	3		High
6	S1S3L	1	3		Low
7	S1S2S1B	1	2	1	Base
8	S1S2S1H	1	2	1	High
9	S1S2S1L	1	2	1	Low
10	S1S2S2B	1	2	2	Base
11	S1S2S3B	1	2	3	Base
12	S2S2B	2	2		Base
13	S2S2H	2	2		High
14	S2S2L	2	2		Low
15	S2S3B	2	3		Base
16	S2S3H	2	3		High
17	S2S3L	2	3		Low
18	S2S2S4B	2	2	4	Base
19	S3S2B	3	2		Base
20	S3S2H	3	2		High
21	S3S2L	3	2		Low
22	S3S3B	3	3		Base
23	S3S3H	3	3		High
24	S3S3L	3	3		Low
25	S4S2B	4	2		Base
26	S4S2H	4	2		High
27	S4S2L	4	2		Low
28	S4S3B	4	3		Base
29	S4S3H	4	3		High
30	S4S3L	4	3		Low
31	S4S2S3B	4	2	3	Base
32	S4S2S5B	4	2	5	Base
33	S5S1B	5	1		Base
34	S5S1S5B	5	1	5	Base

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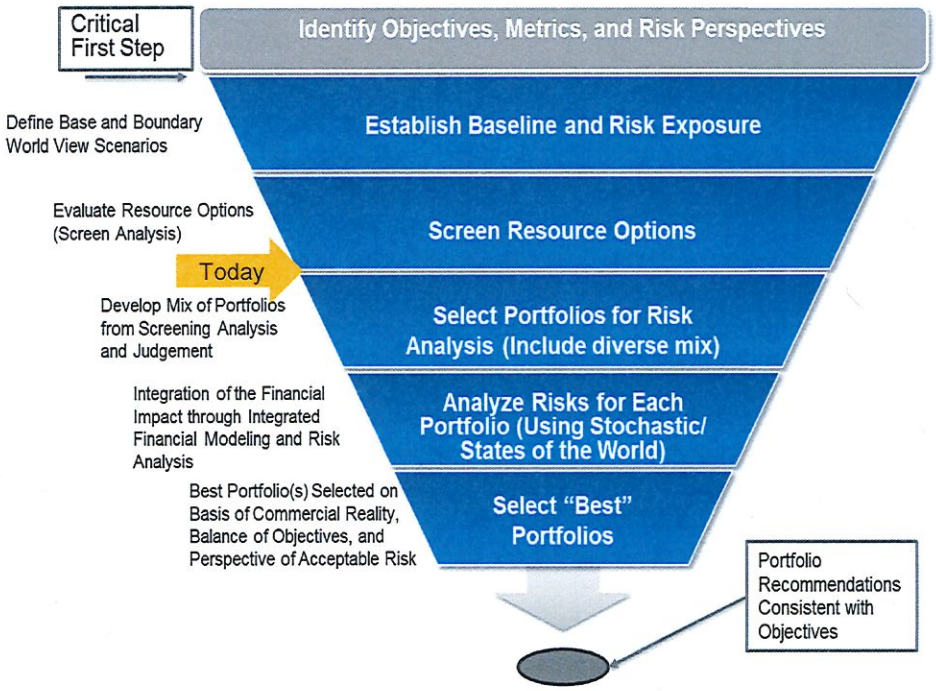
Caveats and Limitations

- The 21 LTCE plans presented here are work in progress, preliminary in nature, and are all subject to revisions.
- The LTCE plans are just the a first step in the analysis and formulation of the Portfolios and require further analysis and adjustments as will be evident from the discussion below.
- The results of the LTCE is not an executable Action Plan. The Action Plan, subject to Energy Bureau approval, will be delivered as part of the final IRP filing.
- The LTCE presented is an input to the next steps in the process and shows some common directional elements that are worthwhile sharing.



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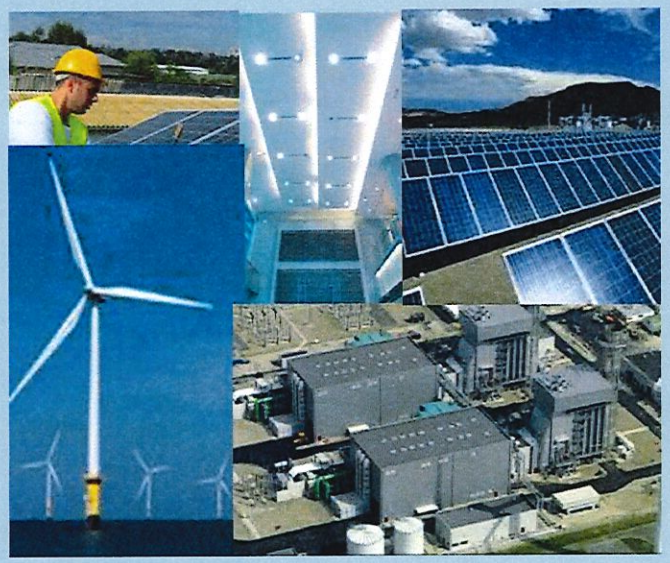

Scenario 2

Restricted

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Scenario 2 Under Base Load Forecast Generation Additions

Scenario 2 (Base Load)	Unit	Strategy 2	Strategy 3
Solar PV	MW	2,280	2,520
BESS	MW	1,580	1,240
Large CCGT	MW	1,120	1,053
Medium CCGT	MW	0	141
Small CCGT, Peaker, RICE	MW	685	548
Reserve Margin (2025 / 2038)	%	50% / 71%	45% / 53%
RPS (2025 / 2038)	%	36% / 53%	36% / 57%
System Cost (2025 / 2038) $ 2017	$/MWh	$93.5 / $90.4	$96.0 / $88.9

- The LTCE with Strategy 2 that has smaller amounts of PV achieves better costs in the short term with slightly higher cost in the long term.

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Scenario 2 Strategy 2 Under High, Base and Low Load

Scenario 2 Strategy 2	Unit	High Load	Base Load	Low Load
Solar PV	MW	3,240	2,280	2,640
BESS	MW	1,480	1,580	1,340
Large CCGT	MW	1,200	1,120	751
Medium CCGT	MW	141	0	144
GT Peaker, RICE	MW	609	685	605
Reserve Margin (2025/ 2038)	%	62% / 53%	50% / 71%	75% / 65%
RPS (2025/ 2038)	%	34% / 60%	36% / 53%	37% / 66%
System Cost (2025/ 2038)	$2017/MWh	$98.1 / $88.7	$93.5 / $90.4	$100.6 / $90.5

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Scenario 2 Strategy 3 Under High, Base and Low Load

Scenario 2 Strategy 3	Unit	High Load	Base Load	Low Load
Solar PV	MW	3,660	2,520	3,000
BESS	MW	2,240	1,240	1,340
Large CCGT	MW	898	1,053	751
Medium CCGT	MW	0	141	144
GT Peaker, RICE	MW	408	548	386
Planning Reserve Margin (2025 / 2038)	%	39% / 68%	45% / 53%	30% / 40%
RPS (2025 / 2038)	%	38% / 57%	36% / 57%	47% / 72%
System Cost (2025 / 2038)	$2017 /MWh	$92.3 / $89.2	$96.0 / $88.9	$97.1 / $88.5

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Scenario 2 Strategy 2 Under Base Load

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Scenario 2 Strategy 2 with Base Load Forecast Generation Additions

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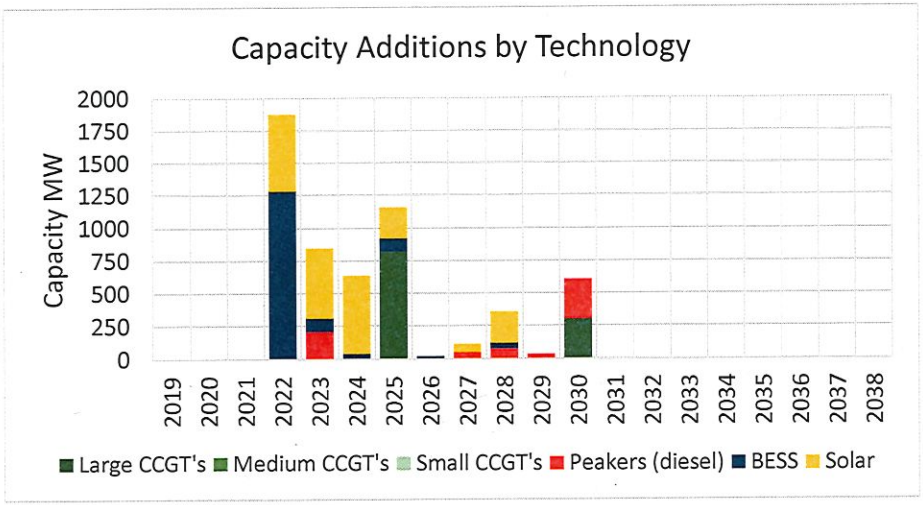

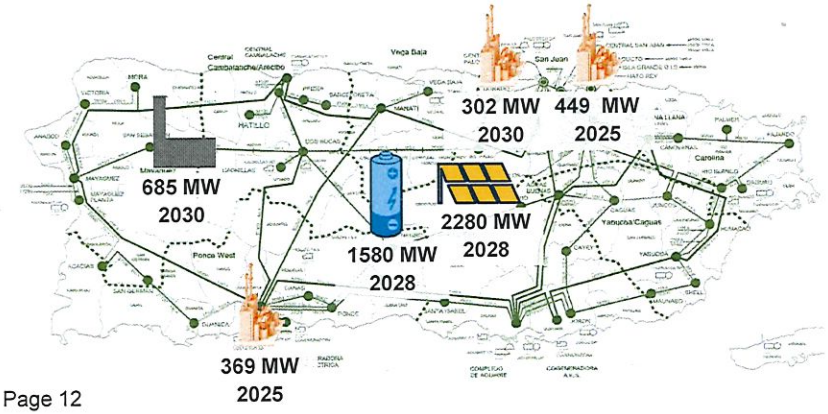

LTCE Additions

- 2,280 MW of utility scale PV are added starting on 2022 with a initial rate of 600 MW/yr.
- 1,580 MW of battery energy storage with a combination of 2, 4 and 6 hours. 1,280 MW installed in 2022.
- Three large CCGTs are installed, one H Class in Bayamon and one F-Class in Ponce West in 2025. Another smaller F Class is installed in 2030 in San Juan.
- SJ 5 & 6 converted to gas in 2023. One unit retired later economically by 2025 and the other by 2033.
- 685 MW of peaking generation distributed throughout the island.

Observations

- The plan combined with the retirements discussed next allows for incorporation large amounts of renewable generation with very small curtailment.
- After retirement of AES in 2027 a second large block of PV is added
- Plan is MATS compliant and reduces exposure to fuel volatility.

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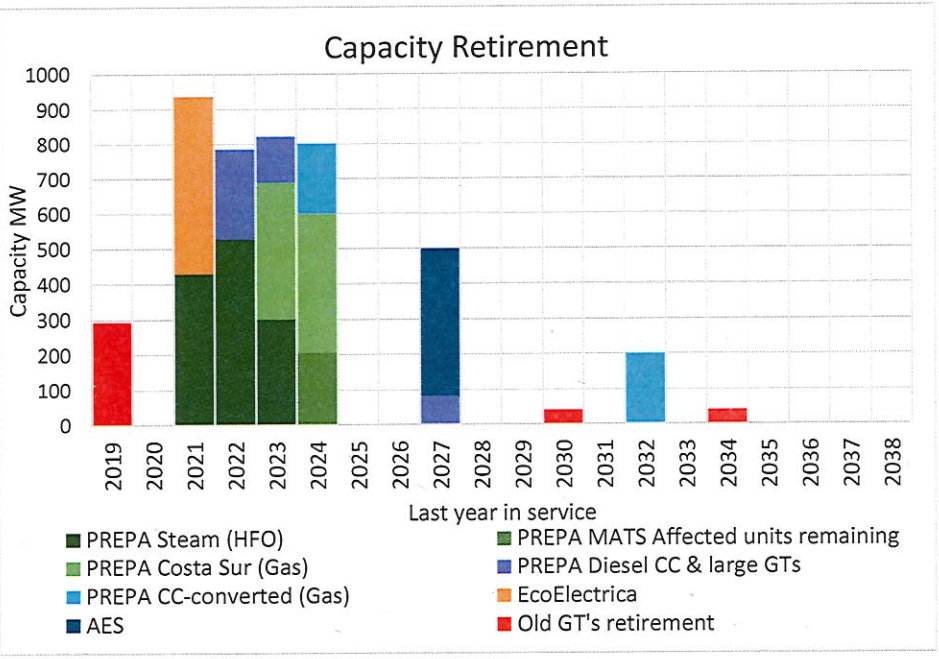
Scenario 2 Strategy 2 with Base Load Forecast Generation Retirements



LTCE Economic Retirements

- The installation of the PV and Storage in 2022 allows for the economic retirement of Aguirre ST 1 and 2 (2021 and 2022), Palo Seco ST 3 and 4 (2024 & 2023) and San Juan ST 7 & 8 in 2023 and 2022.
- EcoEléctrica is economically retired by 2022, as soon as the contract expires. No contract changes assumed.
- Costa Sur 5 & 6 last year in service are 2023 and 2024, respectively as in 2025 is replaced with the entry of the large CCGT F and H class.
- AES is retired by 2028, not economically but by model input
- The Aguirre CC 1 is retired by 2023, but the other is kept for reserves. Cambalache is retired by 2028 and Aero Mayaguez is maintained with only 50 MW retired by 2024
- The NG converted SJ 6 is retired by 2025 and SJ 5 by 2033.

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Scenario 2 Strategy 2 with Base Load Forecast Addition and Retirements Economics

Generator	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
AES_1	82	85	82	72	70	67	68	70	71			
AES_2	82	83	80	72	70	67	68	70	71			
AGUIRRE 1 CC	655	3,717	1,106									
AGUIRRE 2 CC	1,580	3,717	3,768		2,664	1,051	4,045	2,851	8,451	1,591		
AGUIRRE STEAM_1	124	128	134	128								
AGUIRRE STEAM_2	127	131	137									
COSTA SUR 5	107	102	107	102	107							
COSTA SUR 6	96	99	104	101	104	106						
EcoElectrica	86	95	106									
PALO SECO 3	125	131	135	127	129	130						
PALO SECO 4	126	132	135	128	131							
SAN JUAN 07	126	130	133	132	133							
SAN JUAN 08	127	130	133	132								
SAN JUAN 5 CC	251			902	249							
SAN JUAN 5 CC NG Conversion					89	92	97	99	101	100	101	105
SAN JUAN 6 CC	497				339							
SAN JUAN 6 CC NG COnversion					91	95						
Existing GT's4												
Cambalache	855					475	947		990			
Mayaguez	345					214	331	368		218	251	412
New Thermal Resources												
Generic_Recip_diesel					9,709	489	1,135	2,166	3,505	371	393	2,789
Generic Aero_LM6000_DLE_diesel									9,487	1,006	957	
Generic CC_F.04_gas												112
Generic CC_H.01_gas							97	97	99	98	98	101
Generic CC_F.05_gas							107	116	123	103	106	135
New Renewable + Storage												
Weighted Avg Costs	0	0	0	139	123	114	111	114	110	109	107	107
Metrics												
Total costs $/MWh (nominal)	**103.5**	**108.8**	**114.1**	**114.3**	**112.7**	**109.4**	**105.7**	**107.9**	**110.0**	**120.4**	**121.1**	**127.4**
Curtailment	**-0.4%**	**-9.8%**	**-12.9%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**

The model provides a view on the economics of the decisions on additions and retirements. The table shows the total costs in $/MWh for existing and new additions. For PV & Storage the combined costs per MWh of PV power is shown. Here we note that:

- The Steam Units with HFO have higher costs than those of the combination of PV + Storage and their inflexibly would create curtailment, hence are retired.
- EcoEléctrica is retired by the PV and storage by 2022. Also SJ 5&6 gas conversion support this.
- CS 5&6 is maintained but cannot compete with the efficient and flexible F-Class and H-Class CCGTs installed in 2025.

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Scenario 2 Strategy 2 with Base Load Forecast Addition and Retirements summary

- The table below provides an overview of the timing of the generation additions and retirements

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	Total
PREPA Steam (HFO)	0	0	429	527	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1257
PREPA MATS Affected units remaining						206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	206
PREPA Costa Sur (Gas)	0	0	0	0	388	393	0	0	0	0	0	0	0	0	0	0	0	0	0	0	782
PREPA Diesel CC & large GTs	0	0	0	257	132	0	0	0	82	0	0	0	0	0	0	0	0	0	0	0	472
PREPA CC-converted (Gas)	0	0	0	0	0	200	0	0	0	0	0	0	0	200	0	0	0	0	0	0	400
EcoElectrica	0	0	507	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	507
AES									416	0	0	0	0	0	0	0	0	0	0	0	416
Total Dependable Gen Retirement	**0**	**0**	**936**	**784**	**821**	**800**	**0**	**0**	**499**	**0**	**0**	**0**	**0**	**200**	**0**	**0**	**0**	**0**	**0**	**0**	**4040**
Note: For retirement last year in service shown																					
Old GT's retirement	294	0	0	0	0	0	0	0	0	0	0	42	0	0	0	42	0	0	0	0	378
Large CCGT's	0	0	0	0	0	0	818	0	0	0	0	302	0	0	0	0	0	0	0	0	1120
Medium CCGT's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small CCGT's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peakers (diesel)	0	0	0	0	208	0	0	0	55	78	39	305	0	0	0	0	0	0	0	0	685
BESS	0	0	0	1280	100	40	100	20	0	40	0	0	0	0	0	0	0	0	0	0	1580
Total Distchable Additions	**0**	**0**	**0**	**1280**	**308**	**40**	**918**	**20**	**55**	**118**	**39**	**607**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3385**
Solar	0	0	0	600	540	600	240	0	60	240	0	0	0	0	0	0	0	0	0	0	2280
Total Additions	**0**	**0**	**0**	**1,880**	**848**	**640**	**1,158**	**20**	**115**	**358**	**39**	**607**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5,457**

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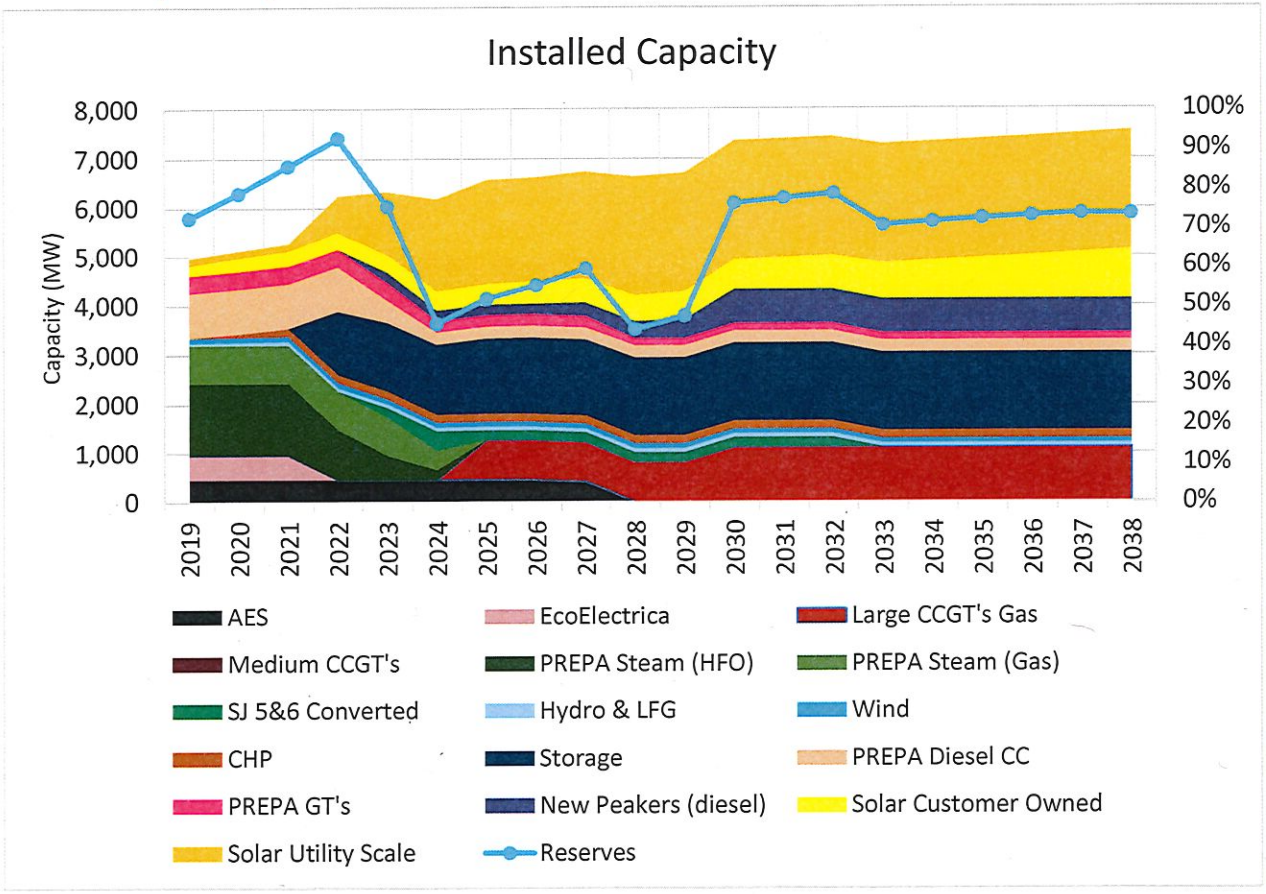
Scenario 2 Strategy 2 with Base Load Forecast Capacity & Reserves



Installed Capacity & Reserves

- As can be observed with this LTCE plan, the system transitions to one based on renewables. This can be observed considering that by 2038, 68% of the installed capacity in system consists of renewable generation or facilities in place for its integration (storage and peaking units).
- As PREPA's units and the thermal PPOA's are phased out the operating reserves are reduced reaching a minimum of 45% in 2024.
- The Planning Reserve Margin of 30% appears not to have been binding constraint on the LTCE plan formulation.

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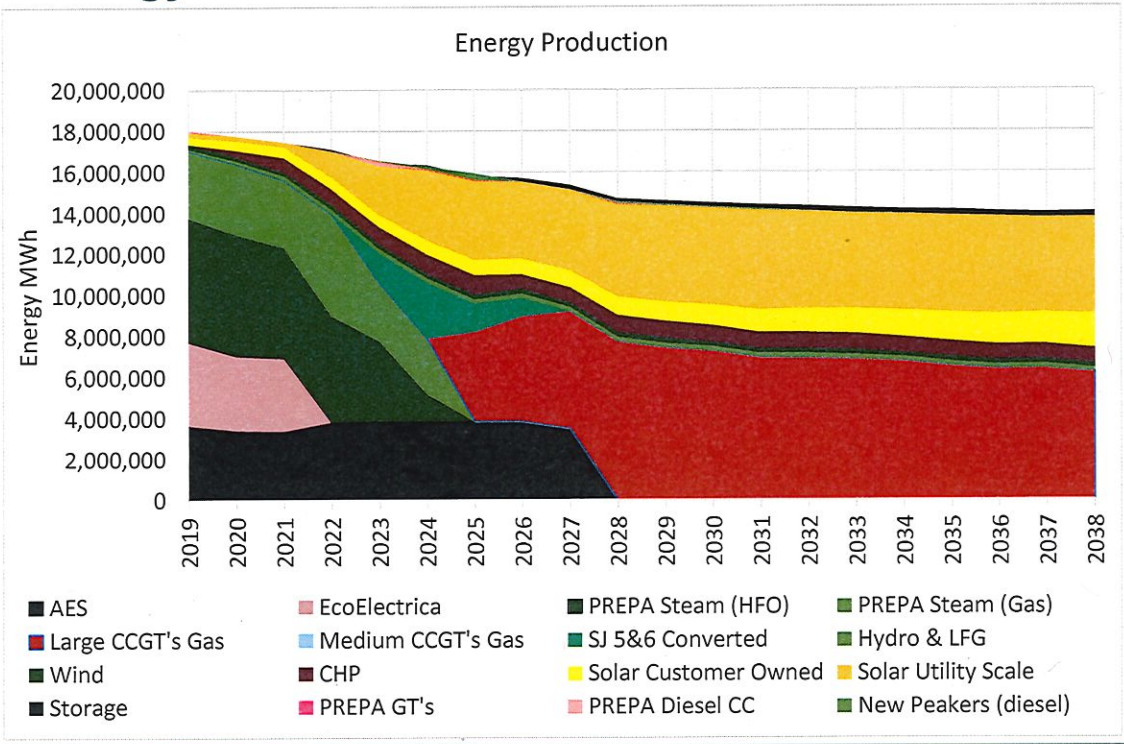
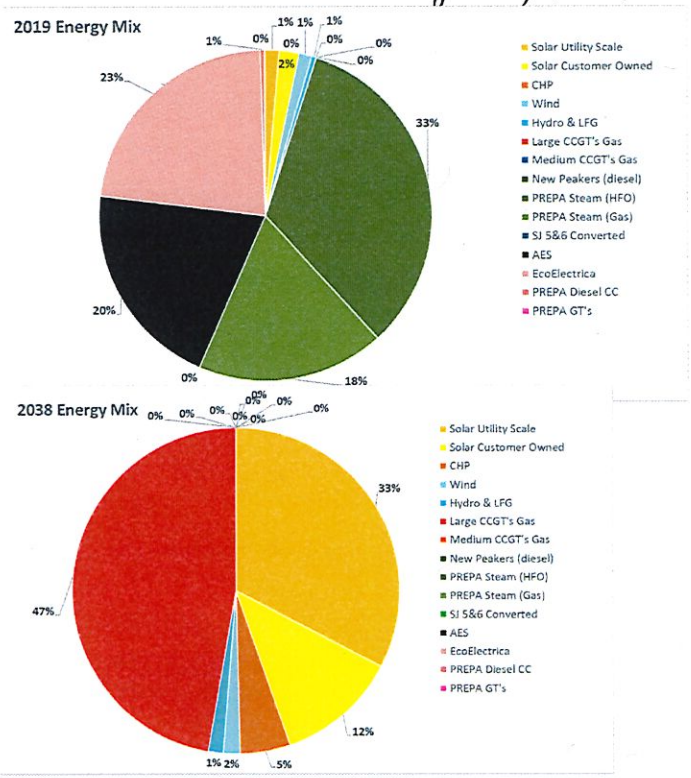
Scenario 2 Strategy 2 with Base Load Forecast Energy Mix





Installed Capacity & Reserves

- As can be observed the energy mix changes significantly over the life of the plan and by 2038 49% of the energy is from renewable generation, 48% from natural gas and 5% from CHP applications

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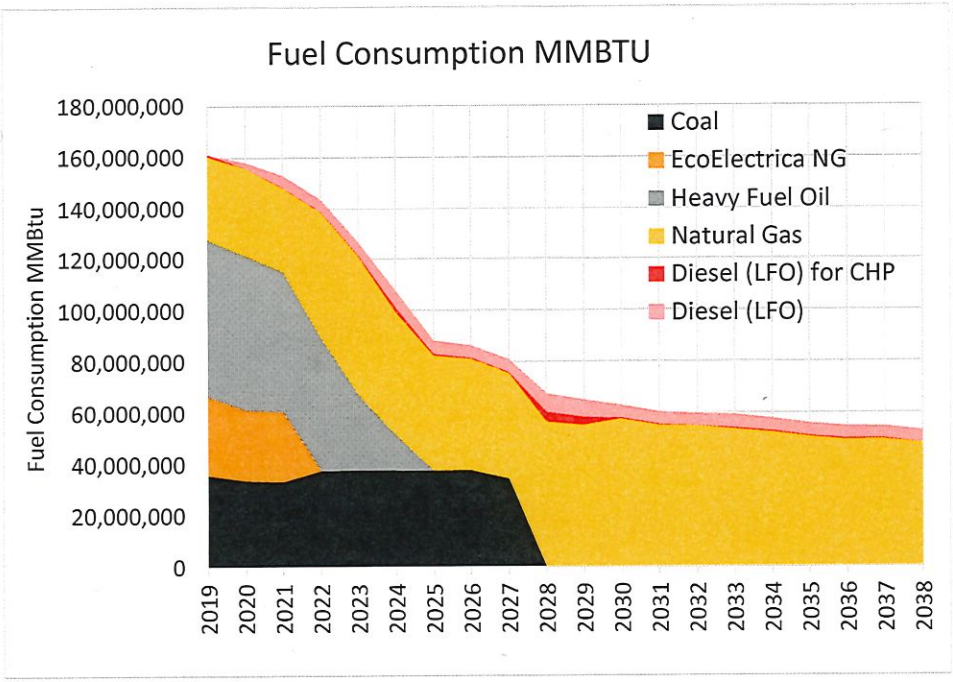
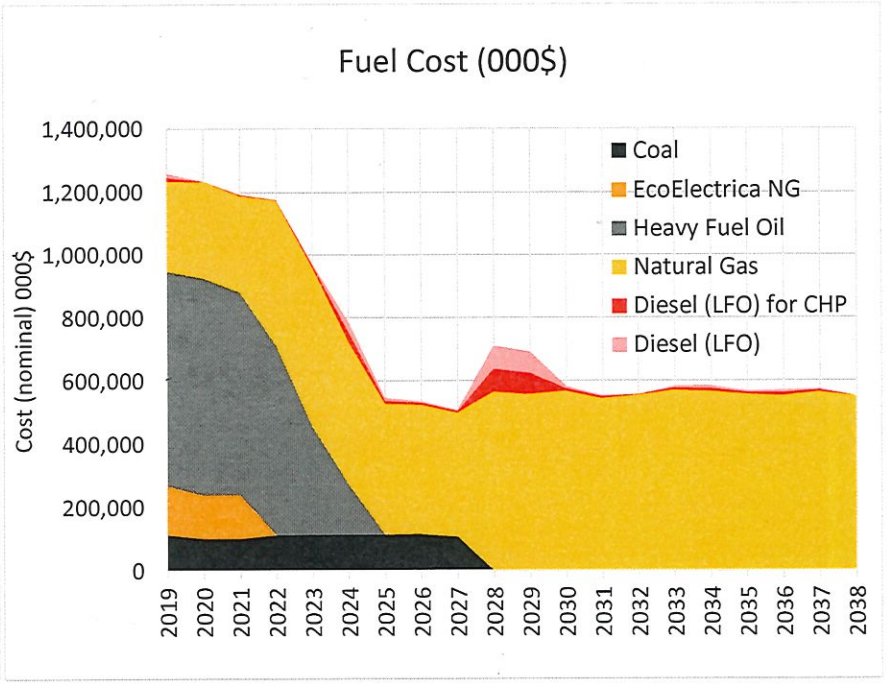
Scenario 2 Strategy 2 with Base Load Forecast Fuel Consumption





Fuel Consumption

- In line with the change in the energy supply matrix, there is a sharp drop in fuel consumption and associated costs with the implementation of the plan. The fuel consumption drops to 33% of the 2019 values.

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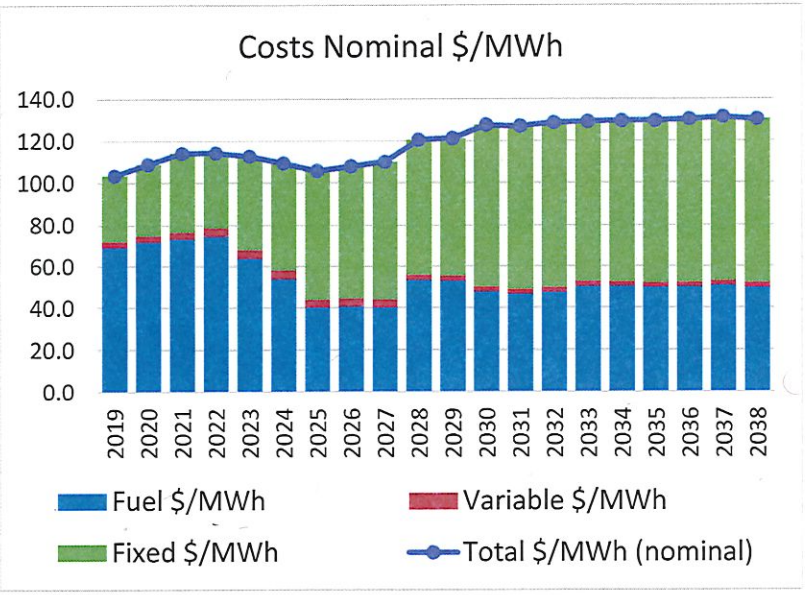
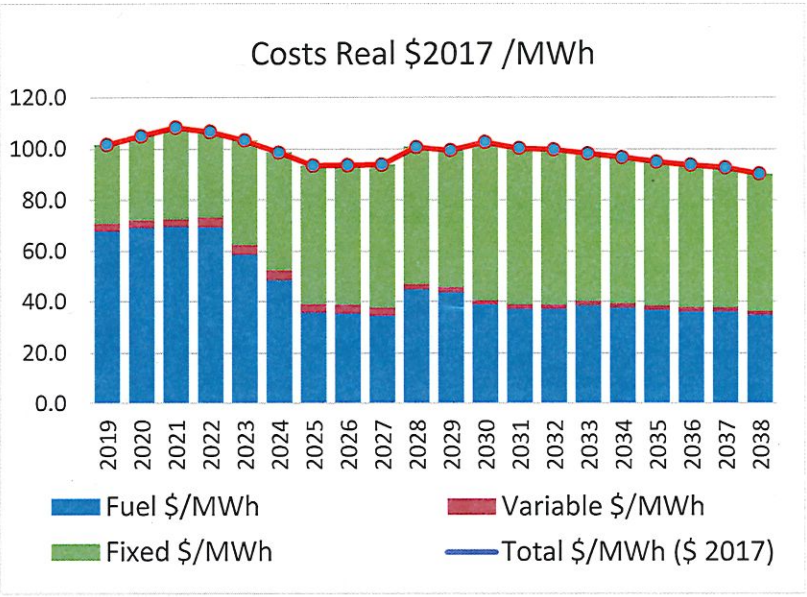
Scenario 2 Strategy 2 with Base Load Forecast
Total Cost of Supply





Total Cost of Supply

- The total cost of supply in real dollars including annualized capital costs, fuel costs and fixed and variable O&M is expected to decline with the implementation of the plan in 2022 onwards from 108/MWh in 2021 (real $2017) to $93.8/MWh by 2027, prior to AES Coal retirement in 2028. The costs increased in 2028 with AES retirement but declining reaching $90.3/MWh by 2038.

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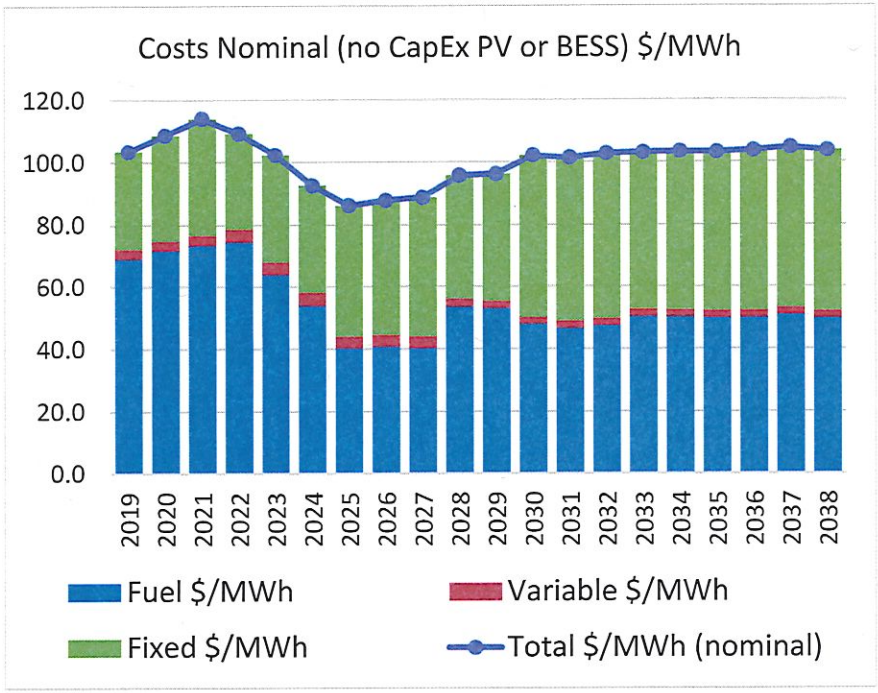
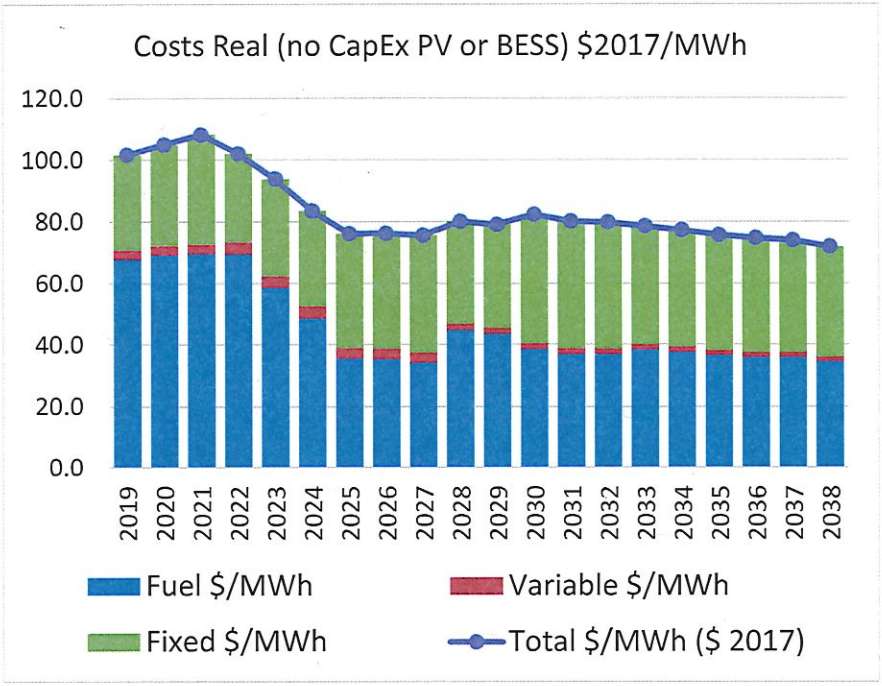
Scenario 2 Strategy 2 with Base Load Forecast
Total Cost of Supply / PV & BESS CapEx impact





PV & BESS CapEx impact

If the capital requirements for the PV and the energy storage are not taken into consideration, then there is a significant reduction on the costs, with total costs reaching $ 72.1 / MWh in 2038 (real $2017).

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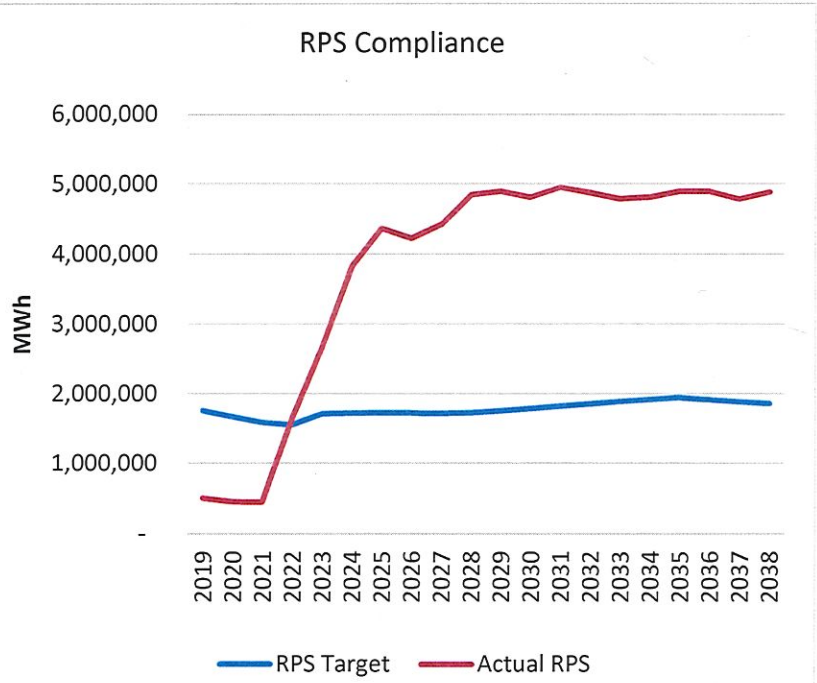
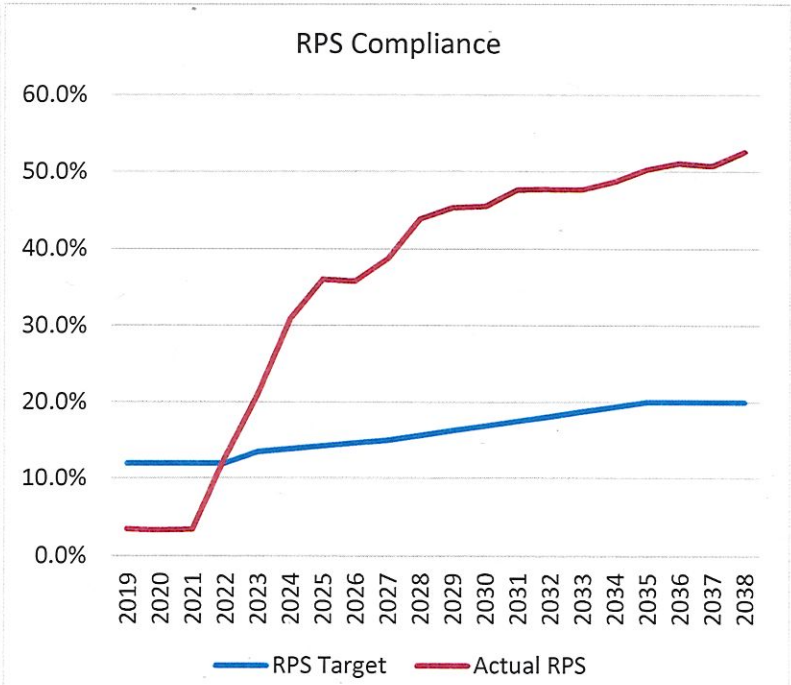
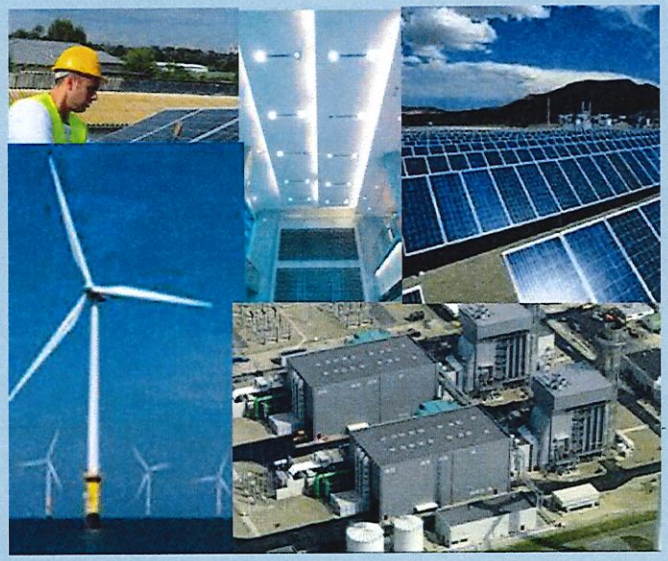
Scenario 2 Strategy 2 with Base Load Forecast
RPS Compliance





RPS Compliance

- By 2022 RPS compliance will be achieved with the expected 600 MW of PV expected for that year
- The RPS targets are almost tripled by the end of the forecast period (283%) with a compliance penetration of 53%.



Scenario 2 Strategy 3 Under Base Load

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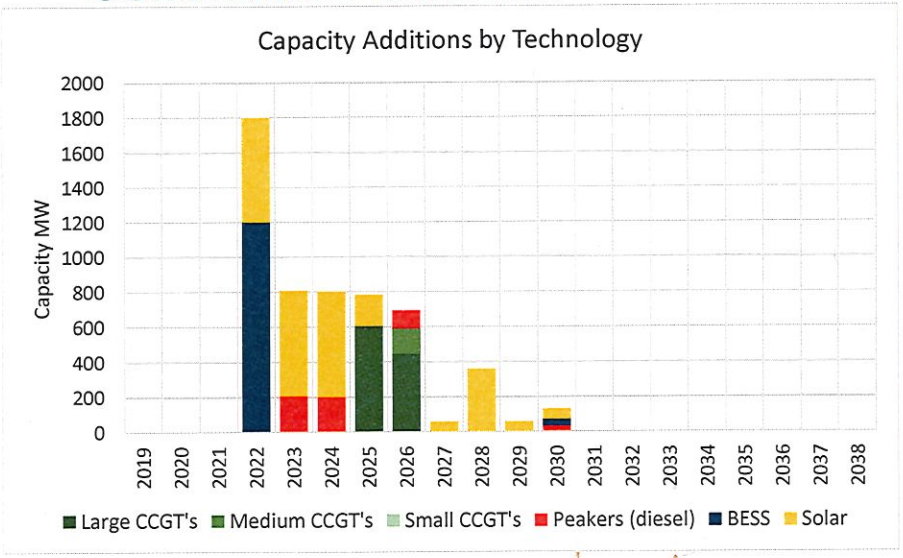
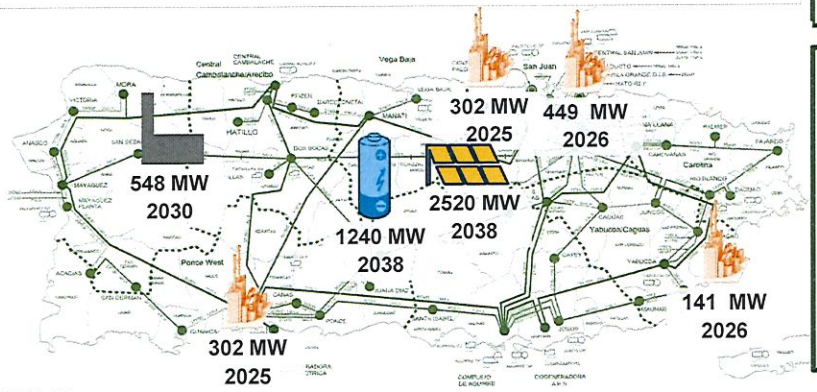
Scenario 2 Strategy 3 with Base Load Forecast
Generation Additions





LTCE Additions

- 2,520 MW of utility scale PV are added starting on 2022 with a initial rate of 600 MW/yr.
- 1,240 MW of battery energy storage with a combination of 2, 4 and 6 hours. 1,200 MW installed in 2022.
- Three large CCGTs are installed, two F class in Bayamon and Ponce West and one H class in San Juan. The F class are installed in 2025 and the H class in 2026.
- One medium CCGT 141 MW at Caguas in 2026.
- SJ 5 & 6 converted to gas in 2023. Both units are retired later economically in 2024 and 2026.
- 548 MW of peaking generation distributed throughout the island (368 MW in RICE, 117 MW in LM6000 and 63 MW LM 2500).

Observations

- The plan combined with the retirements discussed next allows for incorporation large amounts of renewable generation with very small curtailment.
- After retirement of AES in 2027 a second large block of PV is added
- Plan is MATS compliant and reduces exposure to fuel volatility.

Preliminary results subject to revision

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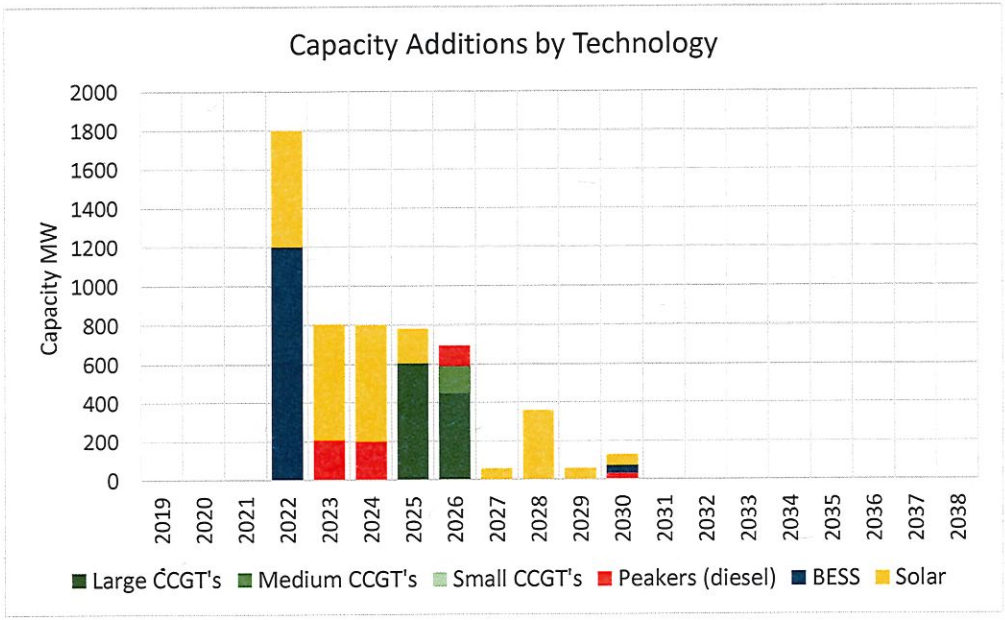
Scenario 2 Strategy 3 with Base Load Forecast Generation Retirements



LTCE Economic Retirements

- The installation of the PV and Storage in 2022 allows for the economic retirement of Aguirre ST 1 and 2 (2021 & 2022), Palo Seco ST 3 and 4 (2023 & 2024) and San Juan ST 7 & 8, both in 2023.
- EcoEléctrica is economically retired in 2022, as soon as the contract expires. No contract changes assumed.
- Costa Sur 5 & 6 last year in service are 2022 and 2024, respectively as in 2025 is replaced with the entry of two large CCGT F class.
- AES is retired by 2028, not economically but by model input
- The Aguirre CC 1 is retired in 2023, but the other is kept for reserves. The Cambalache and Aero Mayaguez are maintained with partial retirements after 2030
- The NG converted SJ 6 is retired by 2024 and SJ 5 by 2026.

Preliminary results subject to revision

Scenario 2 Strategy 3 with Base Load Forecast Addition and Retirements Economics

Generator	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
AES_1	82	85	82	72	70	68	69	70	71			
AES_2	82	83	80	72	70	68	68	70	71			
AGUIRRE 1 CC	726	3,715	1,636	7,462	939							
AGUIRRE 2 CC	1,367	3,719	1,655		1,678	754	597	1,093	797	515	761	792
AGUIRRE STEAM_1	124	128	134	128								
AGUIRRE STEAM_2	127	131	137									
COSTA SUR 5	107	102	107	102								
COSTA SUR 6	96	99	104	101	103	106						
EcoElectrica	86	95	106									
PALO SECO 3	125	131	135	127	127							
PALO SECO 4	126	132	135	129	128	130						
SAN JUAN 07	126	130	133	132	132							
SAN JUAN 08	127	130	133	132	132							
SAN JUAN 5 CC	241			1,675	163							
SAN JUAN 5 CC NG Conversion					89	92	95	110				
SAN JUAN 6 CC	497				158							
SAN JUAN 6 CC NG COnversion					91	95						
Existing GT's												
Cambalache							947			1,401		
Mayaguez	635				1,020	293	360		872	375		424
New Thermal Resources												
Generic CC_H.01_gas								102	101	100	101	102
Generic CC_F.04_gas							100	195	131	106	109	113
Generic Aero_LM6000_DLE_diesel						3,658	1,270		18,193	9,158		9,150
Generic Aero_GE LM2500_SAC_diesel												22,256
Generic CC_H100_diesel									2,314	263	302	340
Generic_Recip_diesel					3,794	719	369	29,338	9,899	1,546	1,687	3,228
New Renewable + Storage												
Weighted Avg Costs	0	0	0	134	115	108	103	105	101	99	96	97
Metrics												
Total costs $/MWh (nominal)	**103.6**	**109.1**	**114.4**	**114.3**	**113.7**	**110.9**	**108.5**	**115.5**	**115.1**	**122.4**	**122.5**	**125.2**
Curtailment	**-0.4%**	**-9.7%**	**-13.2%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**-0.1%**	**0.0%**	**-0.2%**

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The model provides a view on the economics of the decisions on additions and retirements. The table shows the total costs in $/MWh for existing and new additions. For PV & Storage the combined costs per MWh of PV power is shown. Here we note that:

- The Steam Units with HFO have costs above those of the combination of PV + Storage and their inflexibly would create curtailment, hence are retired.
- EcoEléctrica is retired by the PV and storage in 2022. Also SJ 5&6 conversion support this.
- CS 5&6 is maintained (depending on the dispatches can displace EcoEléctrica) but cannot compete with the efficient and flexible F-Class and H-Class CCGTs installed in 2025 / 2026.
- The CS F-Class at Costa Sur has low capacity factors in 2026 and 2027 when the H-Class at Palo Seco is committed.

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Scenario 2 Strategy 3 with Base Load Forecast Addition and Retirements summary

- The table below provides an overview of the timing of the generation additions and retirements.

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	Total
PREPA Steam (HFO)	0	0	429	432	395	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1257
PREPA MATS Affected units remaining						206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	206
PREPA Costa Sur (Gas)	0	0	0	388	0	393	0	0	0	0	0	0	0	0	0	0	0	0	0	0	782
PREPA Diesel CC & large GTs	0	0	0	0	257	0	0	100	0	0	0	215	0	0	0	0	0	0	0	0	572
PREPA CC-converted (Gas)	0	0	0	0	0	200	0	200	0	0	0	0	0	0	0	0	0	0	0	0	400
EcoElectrica	0	0	507	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	507
AES									416	0	0	0	0	0	0	0	0	0	0	0	416
Total Dependable Gen Retirement	**0**	**0**	**936**	**821**	**652**	**800**	**0**	**300**	**416**	**0**	**0**	**215**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4140**
Note: For retirement last year in service shown																					
Old GT's retirement	126	0	0	0	0	84	0	42	0	0	0	126	0	0	0	0	0	0	0	0	378
Large CCGT's	0	0	0	0	0	0	604	449	0	0	0	0	0	0	0	0	0	0	0	0	1053
Medium CCGT's	0	0	0	0	0	0	0	141	0	0	0	0	0	0	0	0	0	0	0	0	141
Small CCGT's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peakers (diesel)	0	0	0	0	208	202	0	106	0	0	0	32	0	0	0	0	0	0	0	0	548
BESS	0	0	0	1200	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	1240
Total Distchable Additions	**0**	**0**	**0**	**1200**	**208**	**202**	**604**	**696**	**0**	**0**	**0**	**72**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2982**
Solar	0	0	0	600	600	600	180	0	60	360	60	60	0	0	0	0	0	0	0	0	2520
Total Additions	**0**	**0**	**0**	**1,800**	**808**	**802**	**784**	**696**	**60**	**360**	**60**	**132**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5,502**

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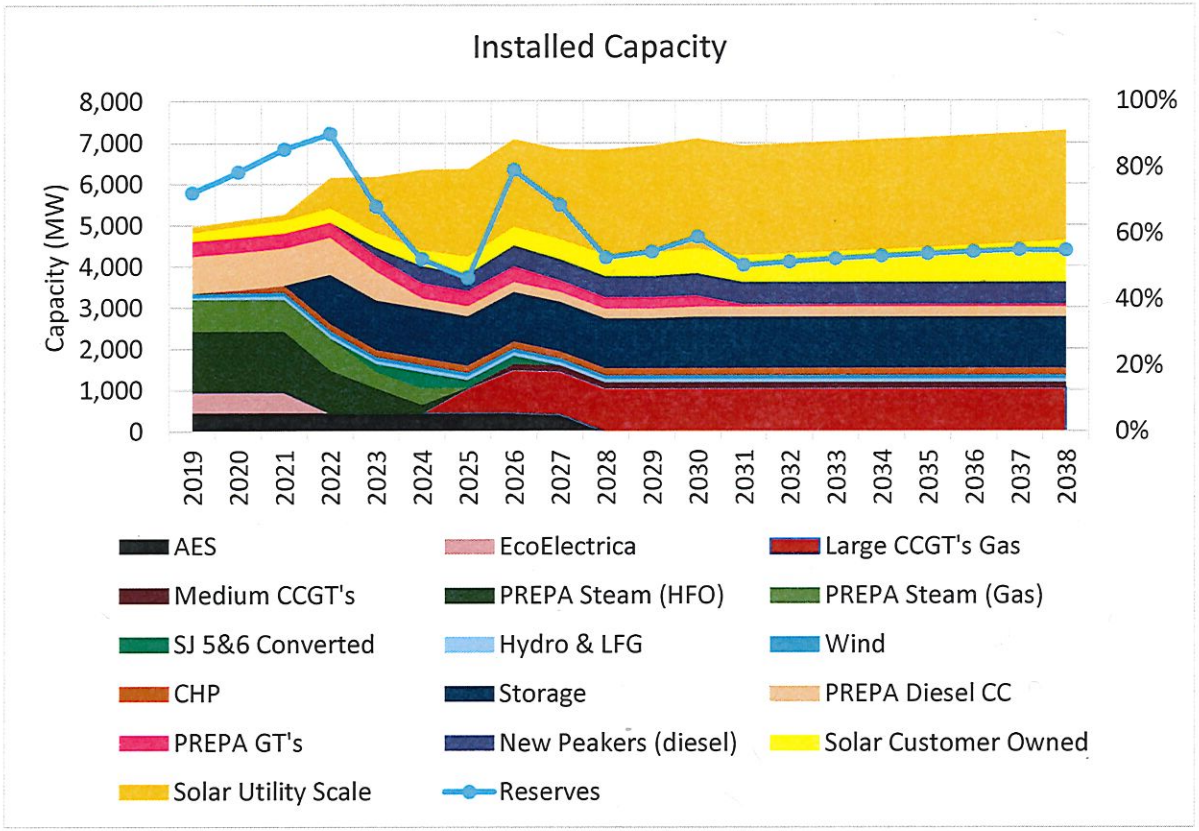
Scenario 2 Strategy 3 with Base Load Forecast Capacity & Reserves



Installed Capacity & Reserves

- As can be observed with this LTCE plan the system transitions to one based on renewables. This can be observed considering that by 2038, 69% of the installed capacity in system consists of renewable generation or facilities in place for its integration (storage and peaking units).
- As PREPA's units and the thermal PPOA's are phased out the operating reserves are reduced reaching a minimum of 45 % in 2025 and 48% in 2031, when they start increasing due to the reduction of the demand.
- The Planning Reserve Margin of 30% appears not to have been binding constraint on the LTCE plan formulation.

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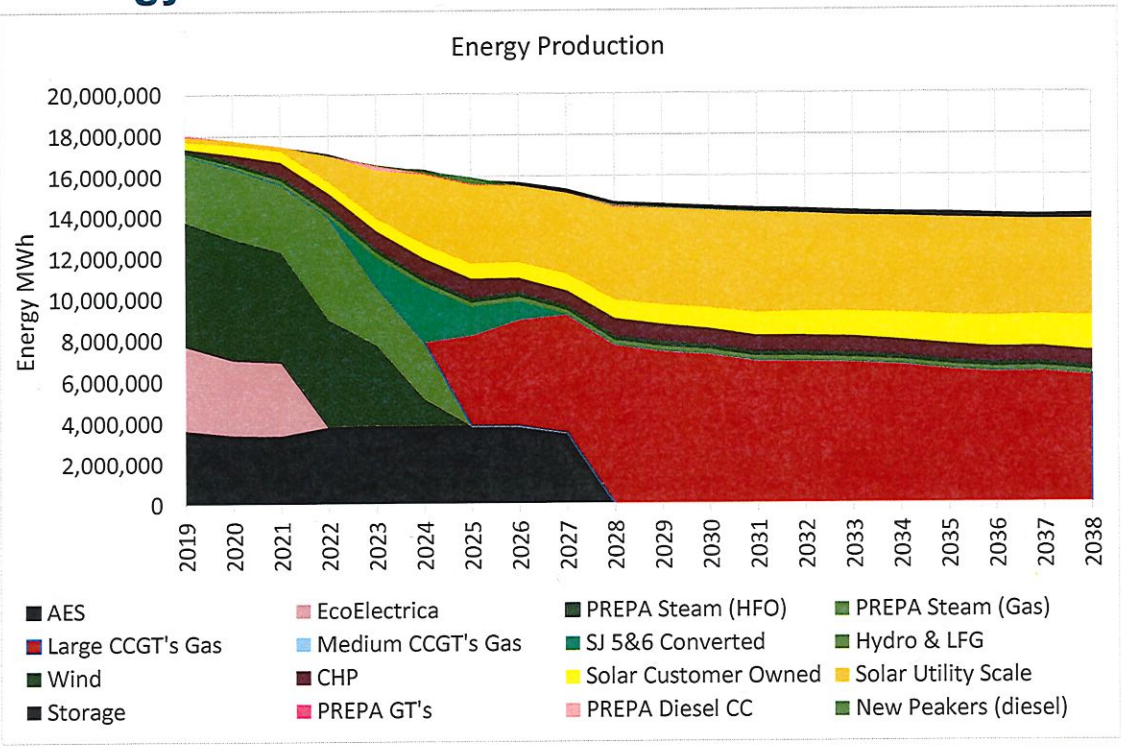
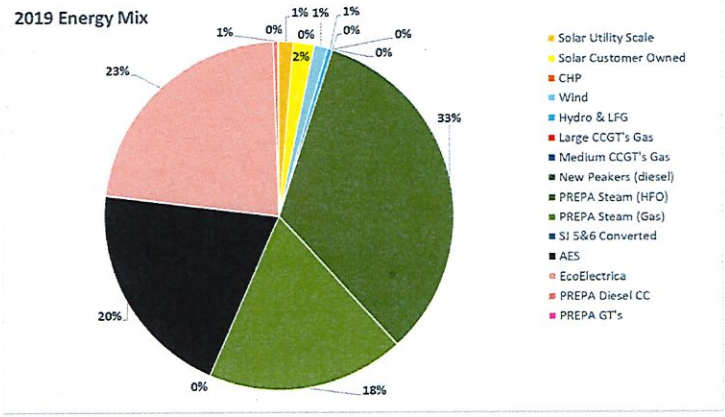
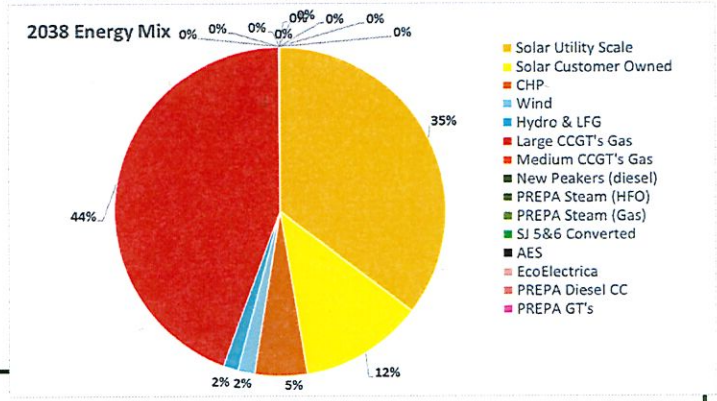
Scenario 2 Strategy 3 with Base Load Forecast Energy Mix







Installed Capacity & Reserves

- As can be observed the energy mix changes significantly over the life of the plan and by 2038 52% of the energy is from renewable generation, 45% from natural gas and 5% from CHP applications

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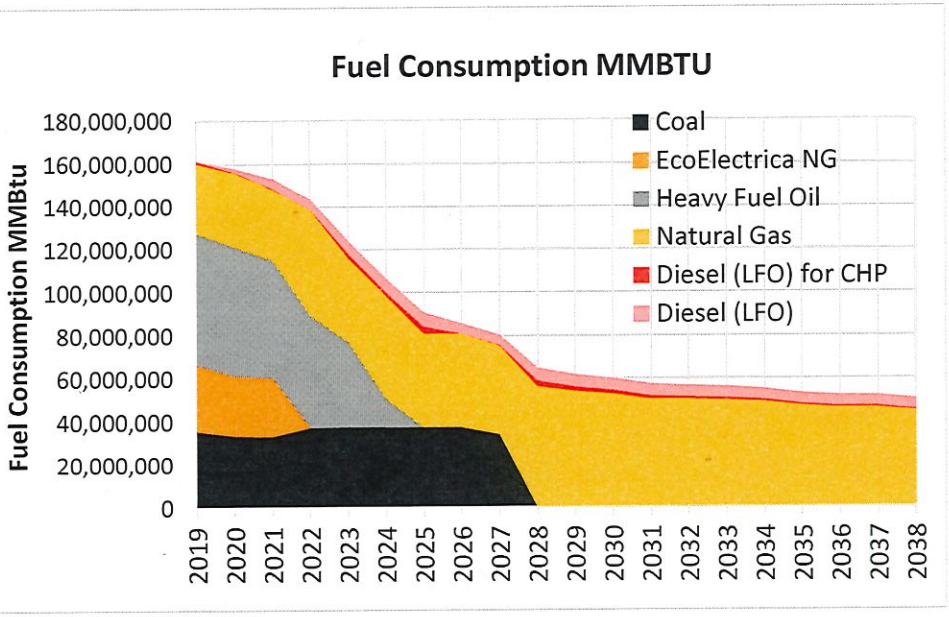
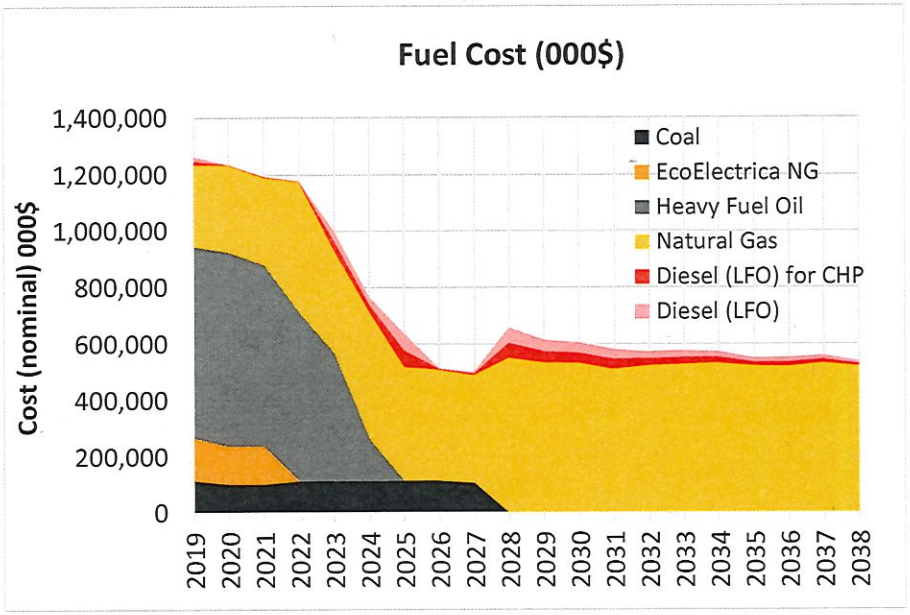
Scenario 2 Strategy 3 with Base Load Forecast
Fuel Consumption





Fuel Consumption

- In line with the change in the energy supply matrix, there is a sharp drop in fuel consumption and associated costs with the implementation of the plan. The fuel consumption drops to 31% of the 2019 values.

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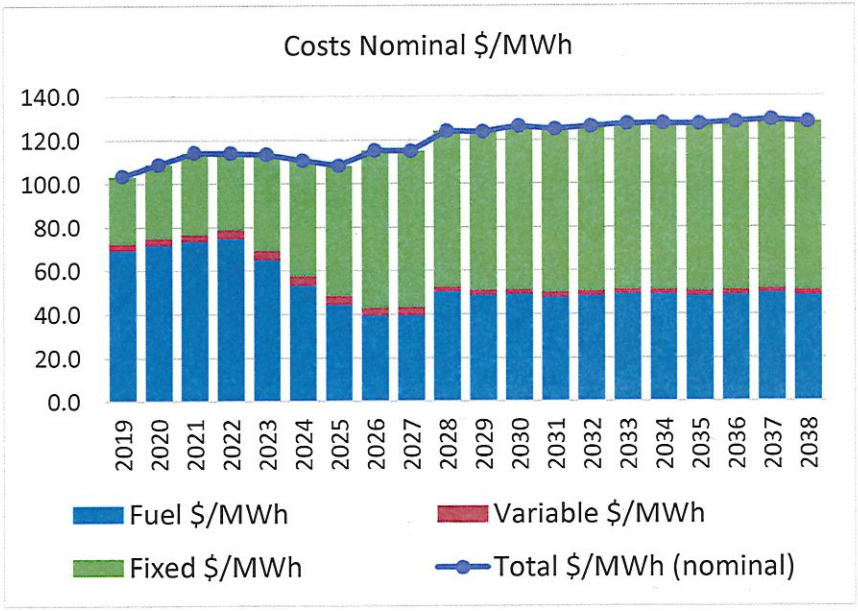
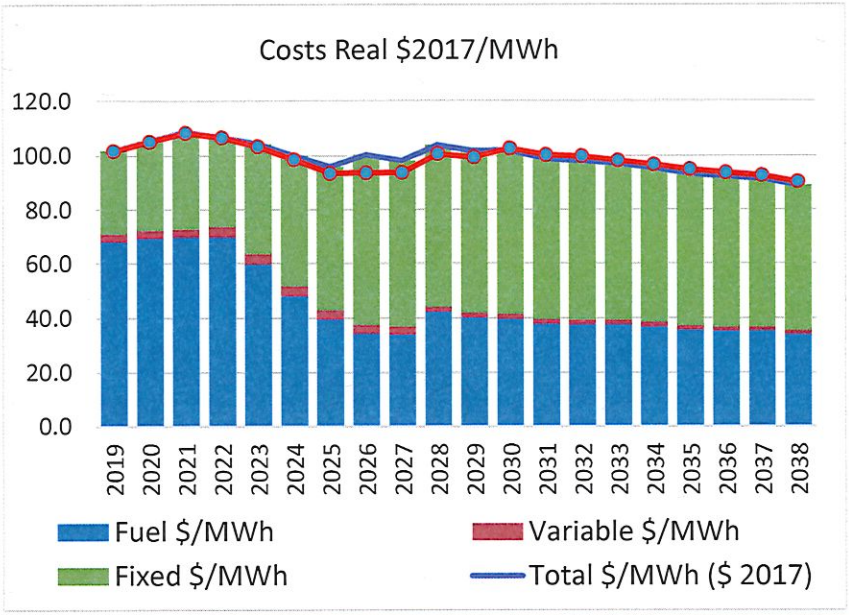
Scenario 2 Strategy 3 with Base Load Forecast
Total Cost of Supply





Total Cost of Supply

- The total cost of supply in real dollars including annualized capital costs, fuel costs, fixed and variable O&M is expected to decline with the implementation of the plan in 2022 onwards from $108/MWh in 2021 (real $2017) to $98/MWh by 2027, prior to AES Coal retirement in 2028. The costs increased in 2028 with AES retirement but declining to reach $89/MWh by 2038. We also observe that the Strategy 2 results in better costs for the period 2022 to 2030.

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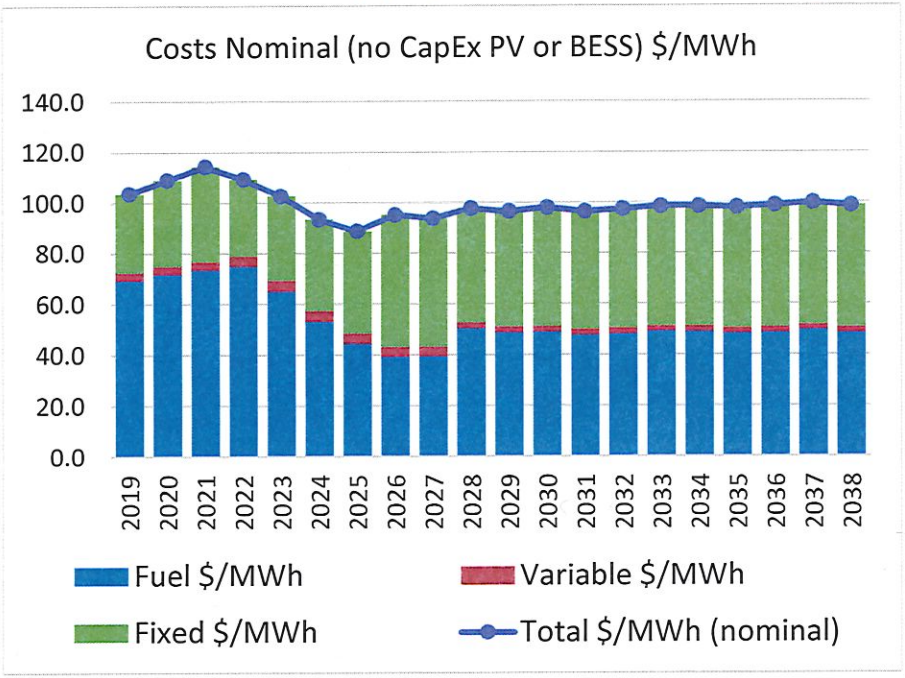
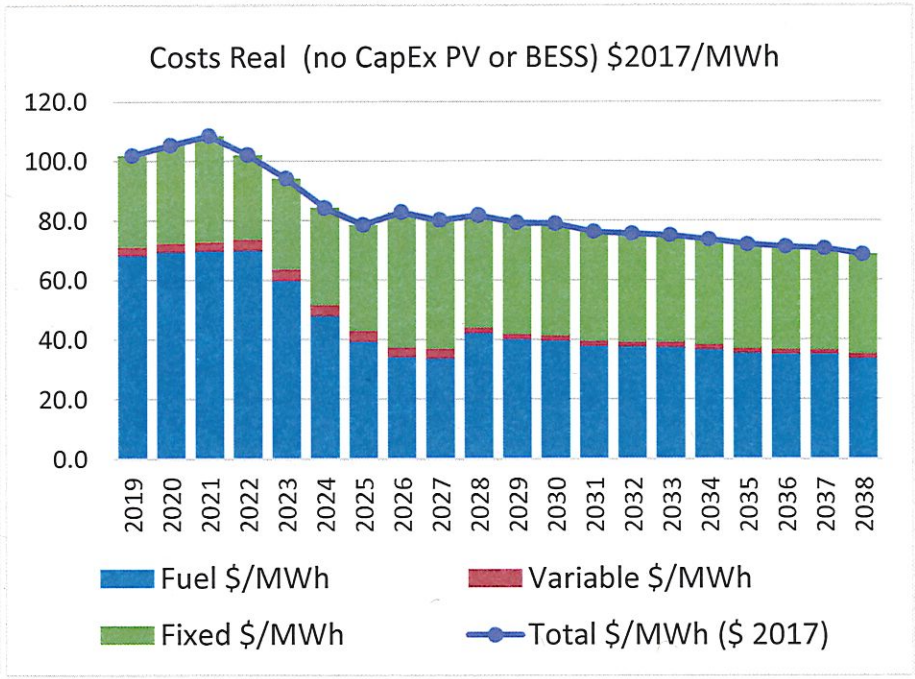
Scenario 2 Strategy 3 with Base Load Forecast
Total Cost of Supply / PV & BESS CapEx impact





PV & BESS CapEx impact

If the capital requirements for the PV and the energy storage are not taken into consideration, then there is a significant reduction on the costs, with total costs reaching $ 68.6 / MWh in 2038 (real $ 2017).

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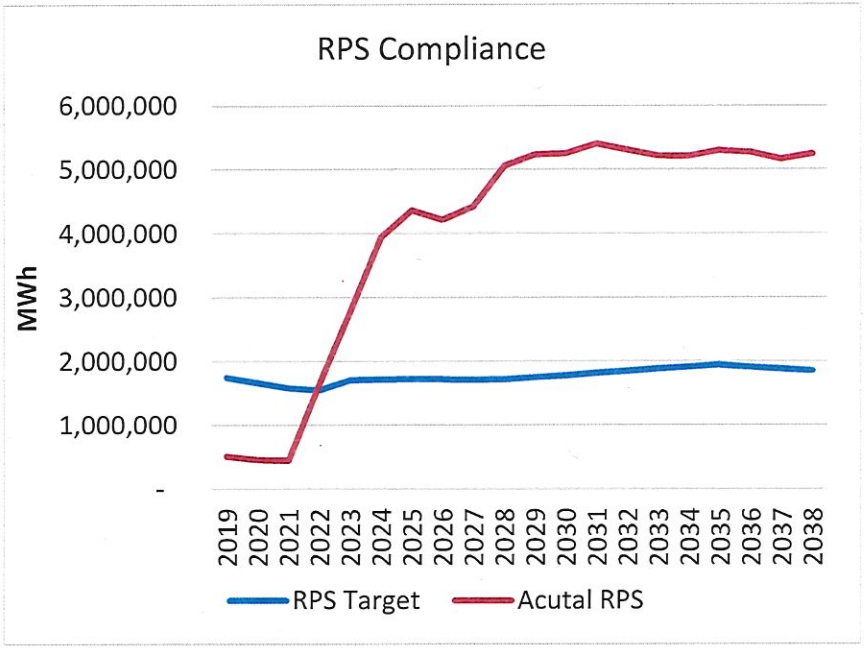
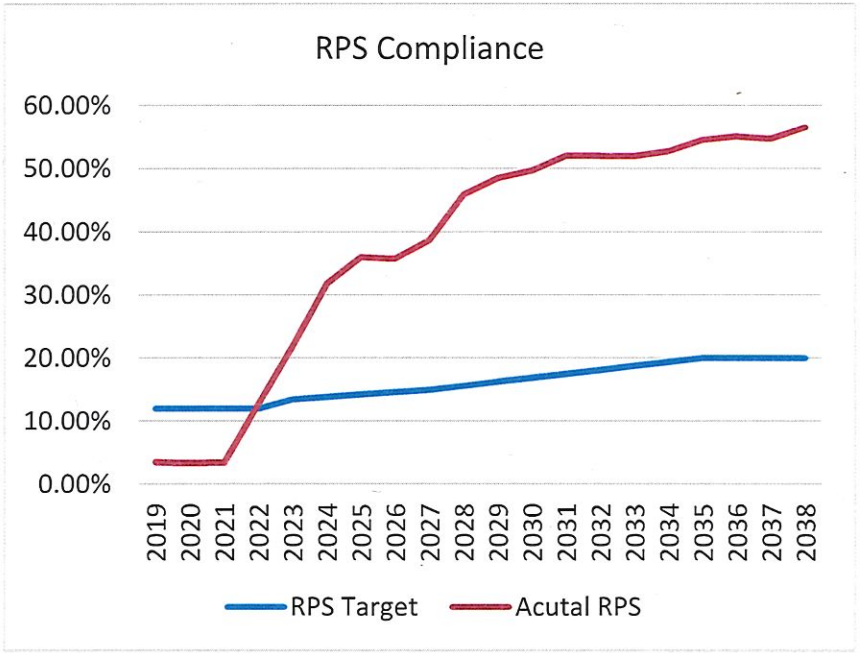
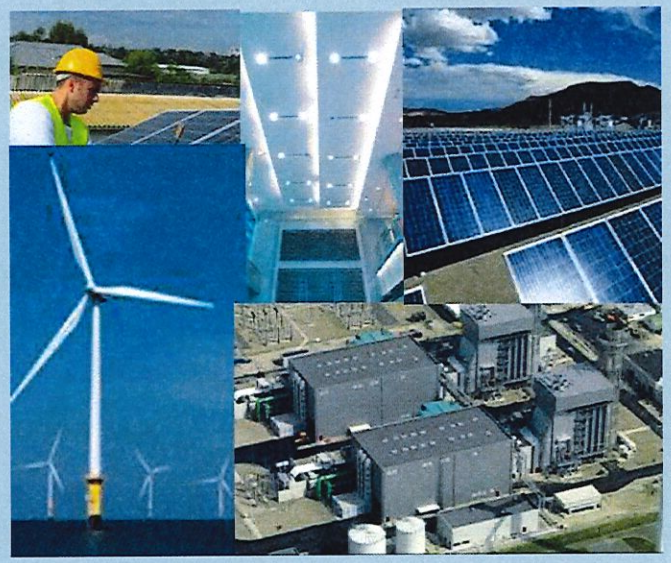
Scenario 2 Strategy 3 with Base Load Forecast
RPS Compliance





RPS Compliance

- By 2022 RPS compliance will be achieved with the expected 600 MW of PV expected for that year
- The RPS targets are almost tripled by the end of the forecast period (283%) or 57% compliance penetration.



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Scenario 1

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Scenario 1 Under Base Load Forecast
Generation Additions

Scenario 1 (Base Load)	Unit	Strategy 2	Strategy 3
Solar PV	MW	3,720	3,720
BESS	MW	1,900	1,600
Large CCGT	MW	898	898
Medium CCGT	MW	0	0
GT Peaker / RICE	MW	384	651
Reserve Margin (2025 / 2038)	%	59% / 65%	59% / 65%
RPS (2025 / 2038)	%	43% / 79%	43% / 76%
System Cost (2025 / 2038)	2017$/MWh	$96.0 / $89.2	$99.9 / $91.8

Scenario 2 (Base Load)	Unit	Strategy 2	Strategy 3
Solar PV	MW	2,280	2,520
BESS	MW	1,580	1,240
Large CCGT	MW	1,120	1,053
Medium CCGT	MW	0	141
Small CCGT, Peaker, RICE	MW	685	548
Reserve Margin (2025 / 2038)	%	50% / 71%	45% / 53%
RPS (2025 / 2038)	%	36% / 53%	36% / 57%
System Cost (2025 / 2038) $ 2017	$/MWh	$93.5 / $90.4	$96.0 / $88.9

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Scenario 1 Strategy 2 Under High, Base and Low Load

Scenario 1 Strategy 2	Unit	High Load	Base Load	Low Load
Solar PV	MW	4,380	3,720	2,220
BESS		2,120	1,900	1,820
Large CCGT	MW	1,194	898	449
Medium CCGT	MW	141	0	141
GT Peaker / RICE / Peaker	MW	602	384	316
Reserve Margin (2025/ 2038)	%	81% / 94%	59% / 65%	69% / 74%
RPS (2025/ 2038)	%	40% / 78%	43% / 79%	47% / 85%
System Cost (2025/ 2038)	$/MWh	$99.1 / $95.3	$96.0 / $89.2	$95.1 / $93.5

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Scenario 1 Strategy 3 Under High, Base and Low Load

Scenario 1 Strategy 3	Unit	High Load	Base Load	Low Load
Solar PV	MW	4,380	3,720	3,360
BESS	MW	2,140	1,600	2,260
Large CCGT	MW	1,336	898	745
Medium CCGT	MW	282	0	0
RICE / Peaker	MW	646	651	423
Planning Reserve Margin (2025/ 2038)	%	59% / 65%	59% / 65%	59% / 65%
RPS (2025/ 2038)	%	40% / 77%	43% / 76%	47% / 84%
System Cost (2025/ 2038)	$/MWh	$100.4 / $97.7	$99.9 / $91.8	$95.9 / $94.5

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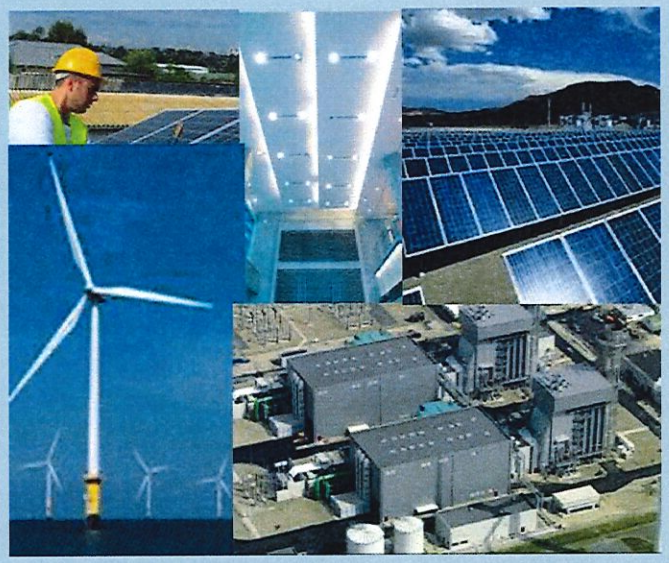

Scenario 1 Strategy 2 Under Base Load

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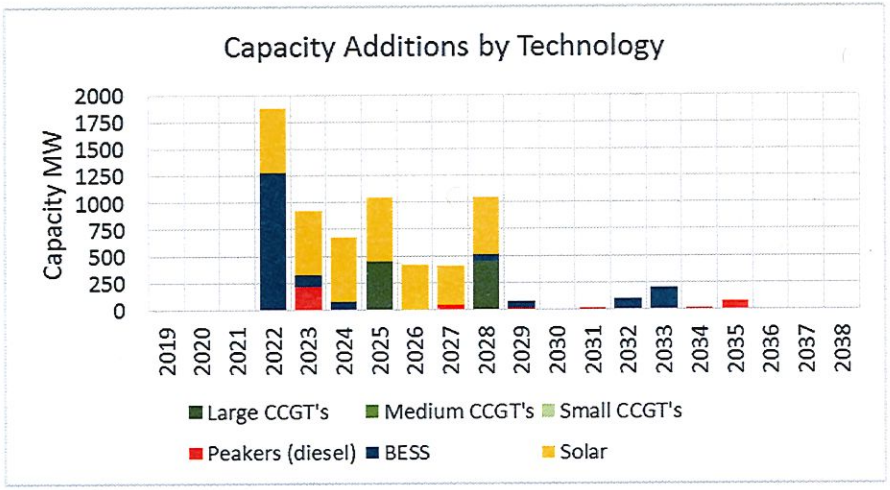
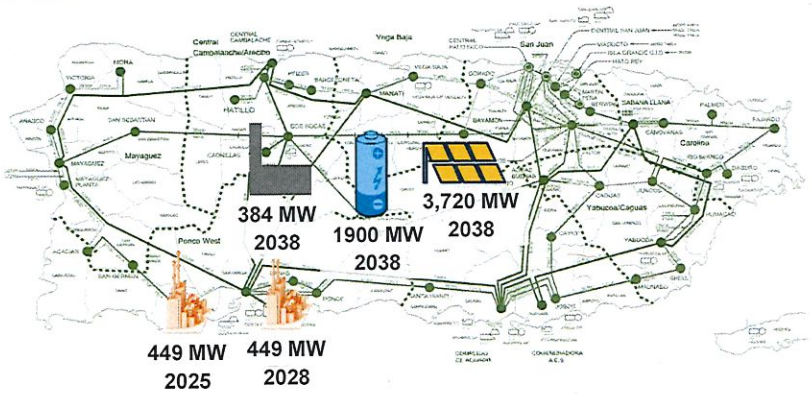
Scenario 1 Strategy 2 with Base Load Forecast Generation Additions





LTCE Additions

- 3,720 MW of utility scale PV are added starting on 2022 with a initial rate of 600 MW/yr.
- 1,900 MW of battery energy storage with a combination of 2, 4 and 6 hours. 1,280 MW installed in 2022.
- Two large H-Class CCGT (449 MW) are installed at Costa Sur, one in 2025 and the other in 2028.
- 384 MW of peaking generation distributed throughout the island.

Observations

- The plan combined with the retirements discussed next allows for incorporation large amounts of renewable generation with very small curtailment.
- Plan is MATS compliant and reduces exposure to fuel volatility.

Preliminary results subject to revision

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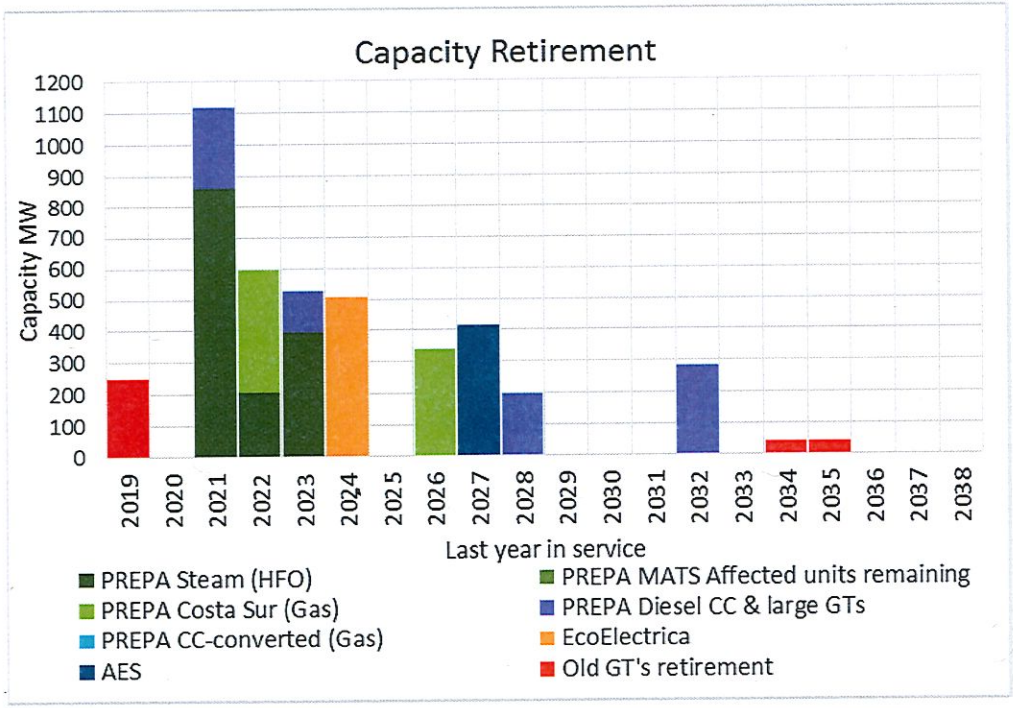
Scenario 1 Strategy 2 with Base Load Forecast Generation Retirements



LTCE Economic Retirements

- The installation of the PV and Storage in 2022 allows for the economic retirement of Aguirre 1 & 2 steam units and Aguirre CC 1 by 2021.
- Palo Seco 3 steam unit retires in 2022, while Palo Seco 4, San Juan 7 & 8 steam units retire in 2023.
- EcoEléctrica is economically retired in 2024 two years after contract expiration.
- Costa Sur 5 retires in 2022 as the entry of renewable + storage allows its economic retirement. Costa Sur 6 continues to operate and runs till 2026.
- AES is retired by 2028, not economically but by model input.
- Cambalache 3 retires in 2023 and 2 retires in 2032.

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Scenario 1 Strategy 2 with Base Load Forecast Addition and Retirements Economics

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
AES_1	81	81	78	72	71	68	68	70	72	0	0	0
AES_2	81	80	78	72	70	68	68	70	72	0	0	0
AGUIRRE 1 CC	470	908	625	0	0	0	0	0	0	0	0	0
AGUIRRE 2 CC	773	3,717	712	2,550	2,048	2,106	2,766	511	491	969	2,427	1,468
AGUIRRE STEAM_1	124	128	134	0	0	0	0	0	0	0	0	0
AGUIRRE STEAM_2	127	131	137	0	0	0	0	0	0	0	0	0
COSTA SUR 5	105	104	109	106	0	0	0	0	0	0	0	0
COSTA SUR 6	97	101	107	105	105	108	114	121	0	0	0	0
EcoElectrica	85	91	101	102	104	106	0	0	0	0	0	0
PALO SECO 3	123	128	132	130	0	0	0	0	0	0	0	0
PALO SECO 4	125	130	133	132	129	0	0	0	0	0	0	0
SAN JUAN 07	126	130	133	132	133	0	0	0	0	0	0	0
SAN JUAN 08	127	130	133	132	132	0	0	0	0	0	0	0
SAN JUAN 5 CC	146	175	154	249	152	145	155	171	164	182	181	190
SAN JUAN 6 CC	175	176	0	0	163	153	166	190	169	183	0	0
Existing GT's4												
Cambalache		1,770	2,324				581	402	392	457		812
Mayaguez	618	1,233	745	345		276	290	275	323	269	295	349
New Thermal Resources												
Generic_Recip_diesel					10,853	803	856	898	629	845	628	880
Generic CC_H.01_gas							90	94	99	101	104	107
New Renewable + Storage												
Weighted Avg Costs	0	0	0	141	125	117	109	110	108	108	107	108
Metrics												
Total costs $/MWh (nominal)	**104.0**	**107.9**	**113.1**	**112.7**	**115.6**	**113.0**	**108.5**	**110.7**	**115.3**	**121.7**	**121.7**	**123.7**
Curtailment	**-0.1%**	**-0.8%**	**-3.2%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**-0.6%**	**-3.0%**	**-3.7%**	**-3.1%**	**-3.6%**

The model provides a view on the economics of the decisions on additions and retirements. The table shows the total costs in $/MWh for existing and new additions. For PV & Storage the combined costs per MWh of PV power is shown. Here we note that:

- The Steam Units with HFO have costs above those of the combination of PV + Storage and their inflexibly would create curtailment, hence are retired.
- Costa Sur 6 is retired with the H Class in the same plant due to higher costs.

Preliminary results subject to revision

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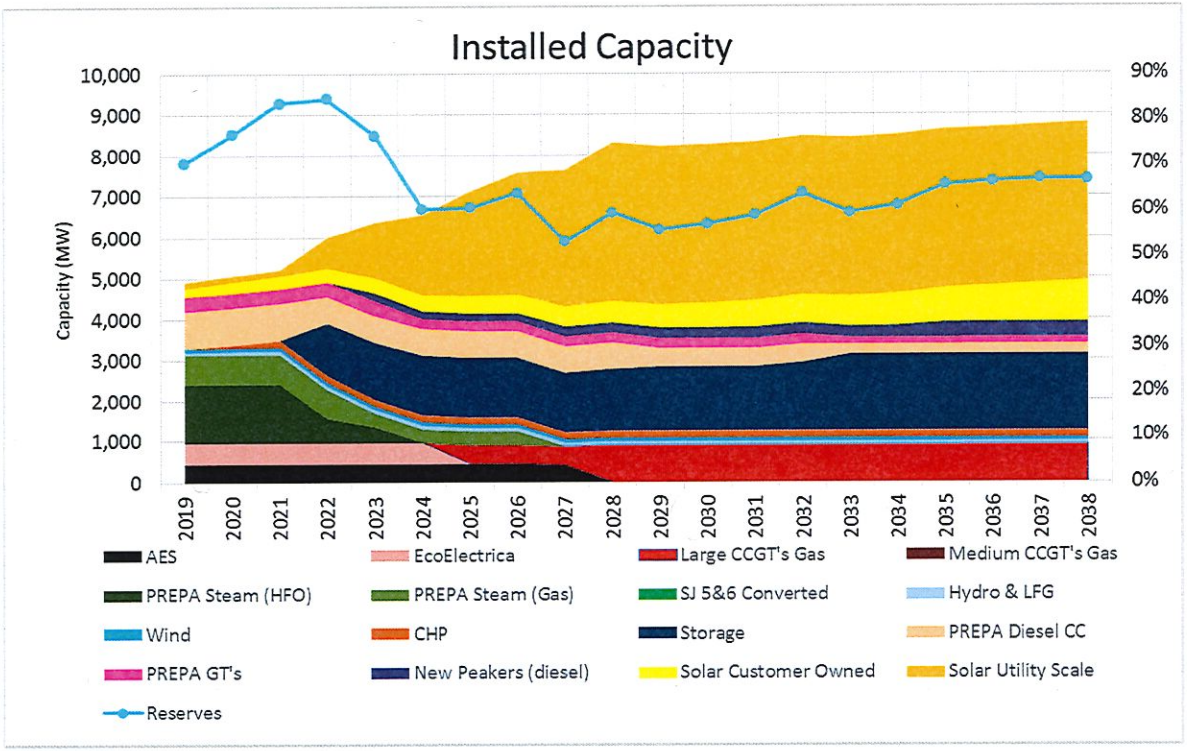
Scenario 1 Strategy 2 with Base Load Forecast Addition and Retirements summary

- The table below provides an overview of the timing of the generation additions and retirements.

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	Total
PREPA Steam (HFO)	0	0	862	206	395	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1463
PREPA MATS Affected units remaining						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PREPA Costa Sur (Gas)	0	0	0	388	0	0	0	339	0	0	0	0	0	0	0	0	0	0	0	0	728
PREPA Diesel CC & large GTs	0	0	257	0	132	0	0	0	0	200	0	0	0	282	0	0	0	0	0	0	872
PREPA CC-converted (Gas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EcoElectrica	0	0	0	0	0	507	0	0	0	0	0	0	0	0	0	0	0	0	0	0	507
AES									416	0	0	0	0	0	0	0	0	0	0	0	416
Total Dependable Gen Retirement	**0**	**0**	**1119**	**595**	**528**	**507**	**0**	**339**	**416**	**200**	**0**	**0**	**0**	**282**	**0**	**0**	**0**	**0**	**0**	**0**	**3986**
Note: For retirement last year in service shown																					
Old GT's retirement	252	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	42	0	0	0	336
Large CCGT's	0	0	0	0	0	0	449	0	0	449	0	0	0	0	0	0	0	0	0	0	898
Medium CCGT's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small CCGT's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peakers (diesel)	0	0	0	0	208	0	0	0	48	0	16	0	16	0	0	16	80	0	0	0	384
BESS	0	0	0	1280	120	80	0	0	0	60	60	0	0	100	200	0	0	0	0	0	1900
Total Distchable Additions	**0**	**0**	**0**	**1280**	**328**	**80**	**449**	**0**	**48**	**509**	**76**	**0**	**16**	**100**	**200**	**16**	**80**	**0**	**0**	**0**	**3182**
Solar	0	0	0	600	600	600	600	420	360	540	0	0	0	0	0	0	0	0	0	0	3720
Total Additions	**0**	**0**	**0**	**1,880**	**928**	**680**	**1,049**	**420**	**408**	**1,049**	**76**	**0**	**16**	**100**	**200**	**16**	**80**	**0**	**0**	**0**	**6,902**

Preliminary results subject to revision

Scenario 1 Strategy 2 with Base Load Forecast Capacity & Reserves



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Installed Capacity & Reserves

- As can be observed with this LTCE plan the system transitions to one based on renewables. 78% of the capacity is associated with renewables (includes peakers and storage).
- The reserves achieve a minimum 54% in 2027, from which time keeps increasing.
- The Planning Reserve Margin of 30% appears not to have been binding constraint on the LTCE plan formulation.

Preliminary results subject to revision

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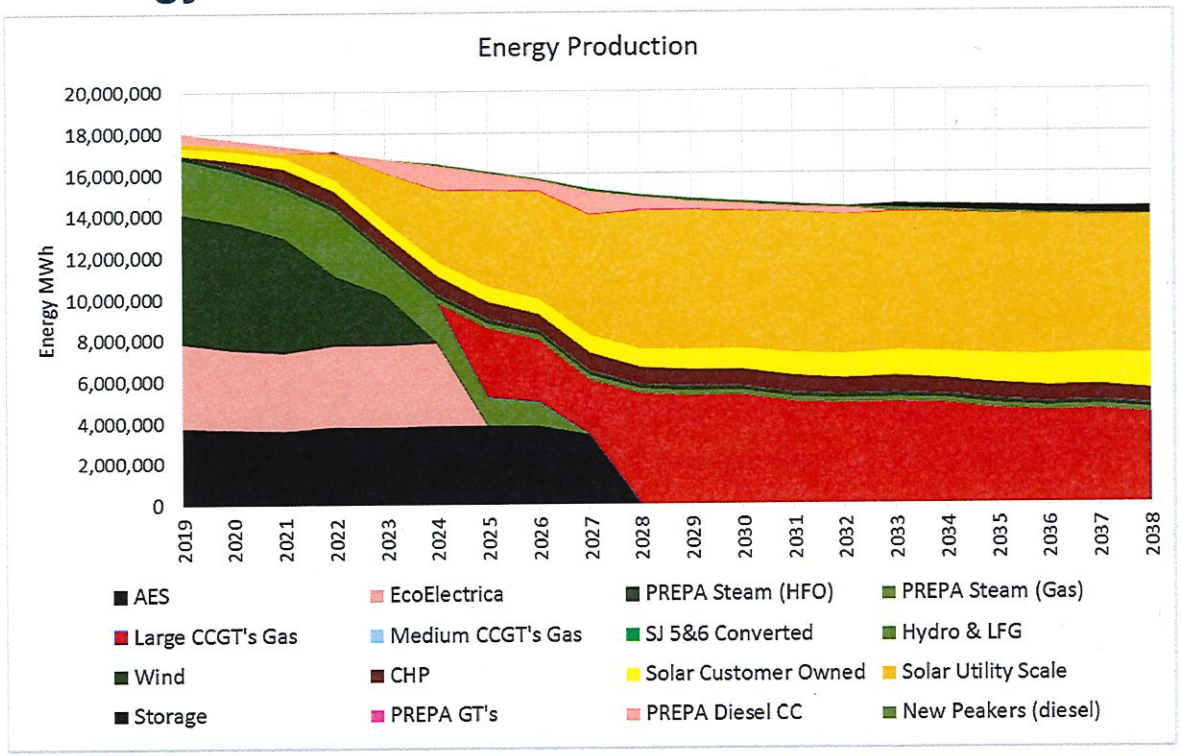
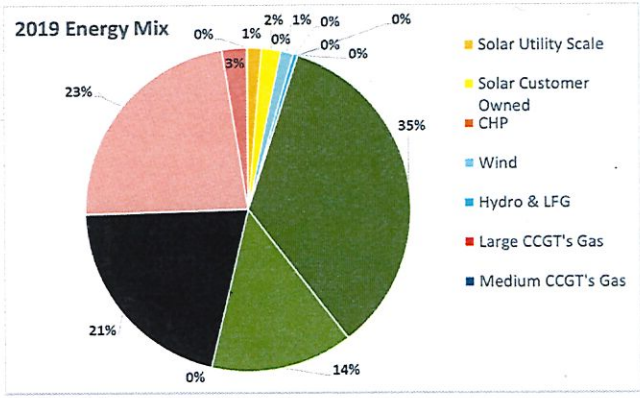
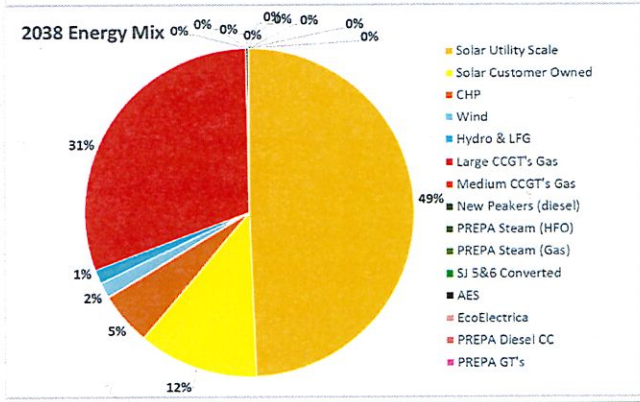
Scenario 1 Strategy 2 with Base Load Forecast Energy Mix







Installed Capacity & Reserves

- As can be observed the energy mix changes significantly over the life of the plan and by 2038, 65% of the energy is from renewable generation, 31% from natural gas and 5% from CHP applications

Preliminary results subject to revision

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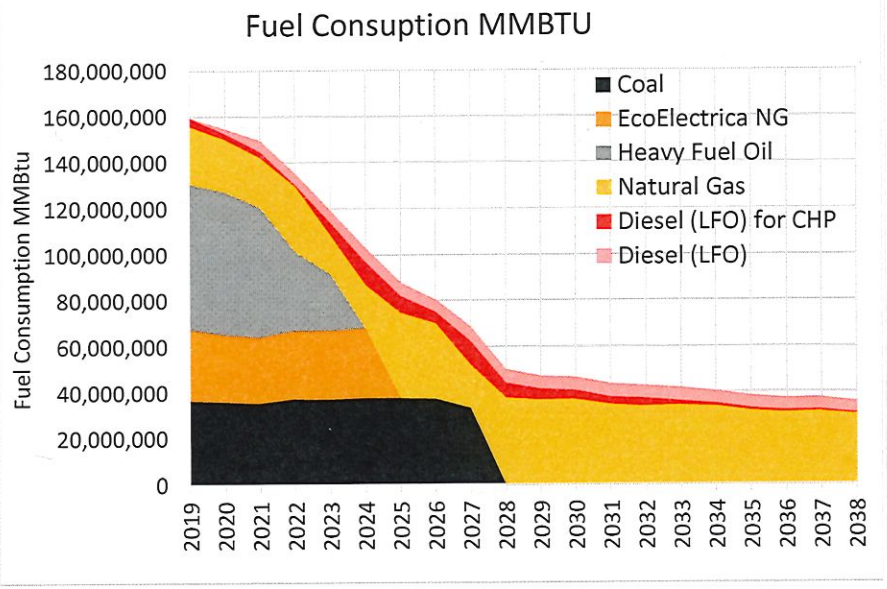
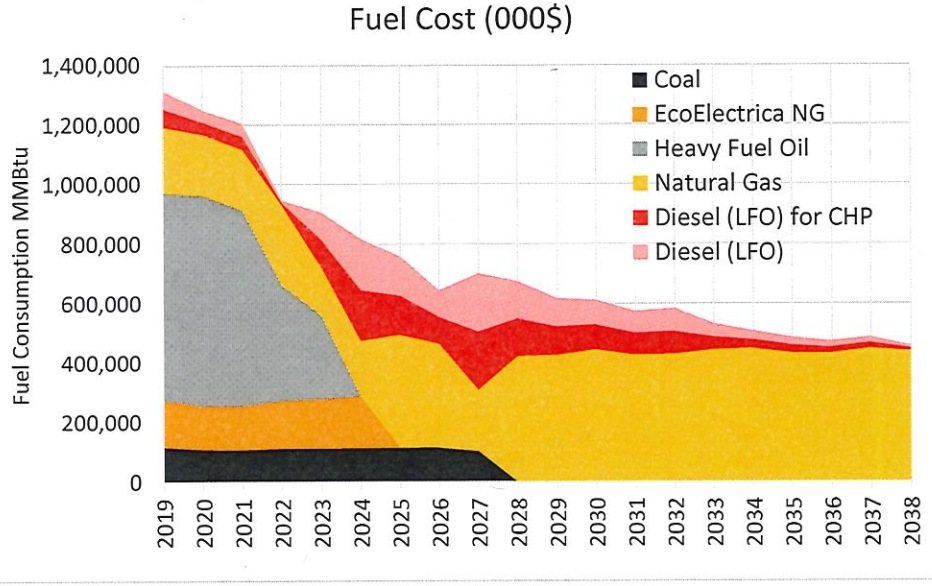
Scenario 1 Strategy 2 with Base Load Forecast
Fuel Consumption





Fuel Consumption

- In line with the change in the energy supply matrix, there is a sharp drop in fuel consumption and associated costs with the implementation of the plan. The fuel consumption drops to 23% of the 2019 values.

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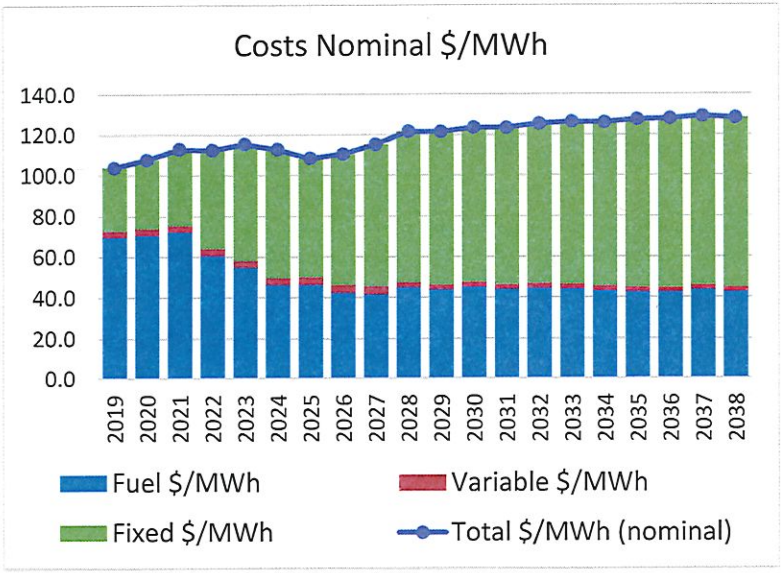
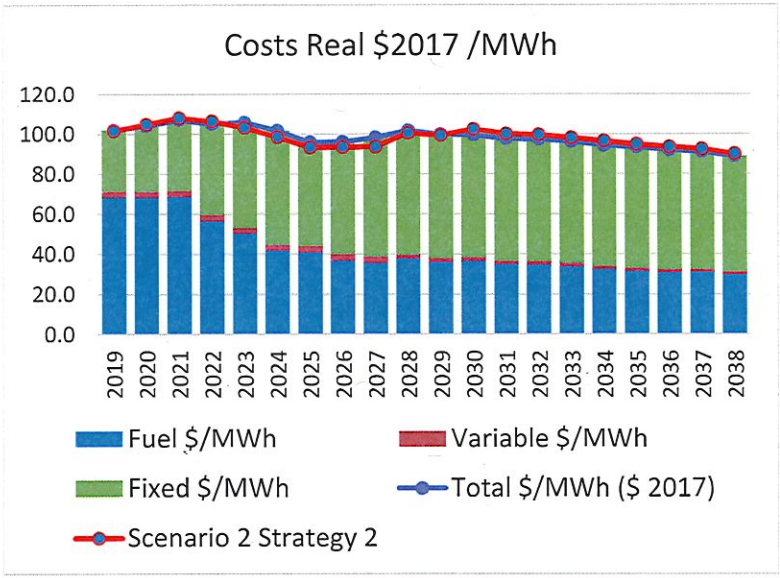
Scenario 1 Strategy 2 with Base Load Forecast
Total Cost of Supply





Total Cost of Supply

- The total cost of supply including annualized capital costs, fuel costs and fixed and variable O&M is expected to increase slightly until 2024, when there is a reduction due to the implementation of the H-Class at Costa Sur. There is a drop to $100/MWh and maintained till 2027 (real $2017), when the retirement of AES Coal increases the costs to $101.9/MWh in 2028. After this the cost continue declining reaching $89/MWh by 2038.
- The costs are higher than Scenario 2 Strategy 2 in the short term and lower in the long term

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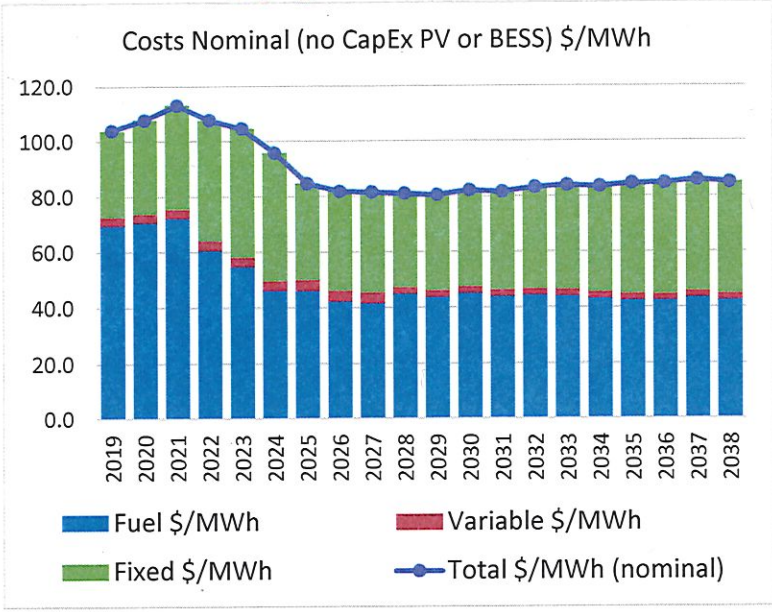
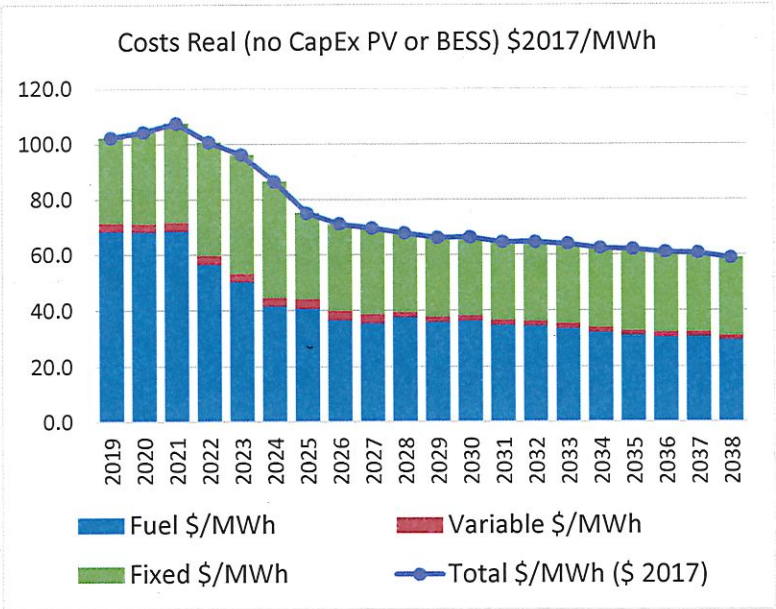
Scenario 1 Strategy 2 with Base Load Forecast
Total Cost of Supply / PV & BESS CapEx impact





PV & BESS CapEx impact

- If the capital requirements for the PV and the energy storage are not taken into consideration, then there is a significant reduction on the costs, which continue declining reaching $ 59/ MWh in 2038 (in $ 2017).
- By 2026 the costs are expected to reach $ 71.2/MWh that can be compared with $ 96.2/MWh for the case with the full CapEx considered.

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Scenario 1 Strategy 2 with Base Load Forecast
RPS Compliance

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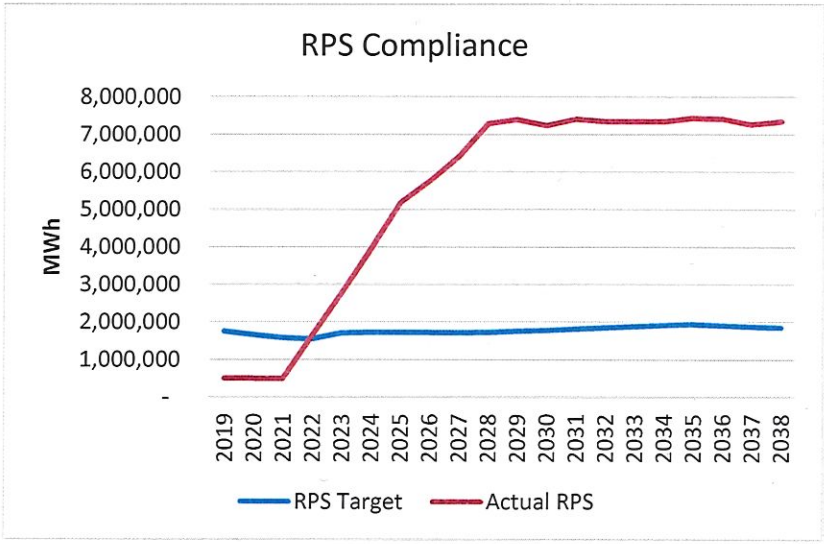

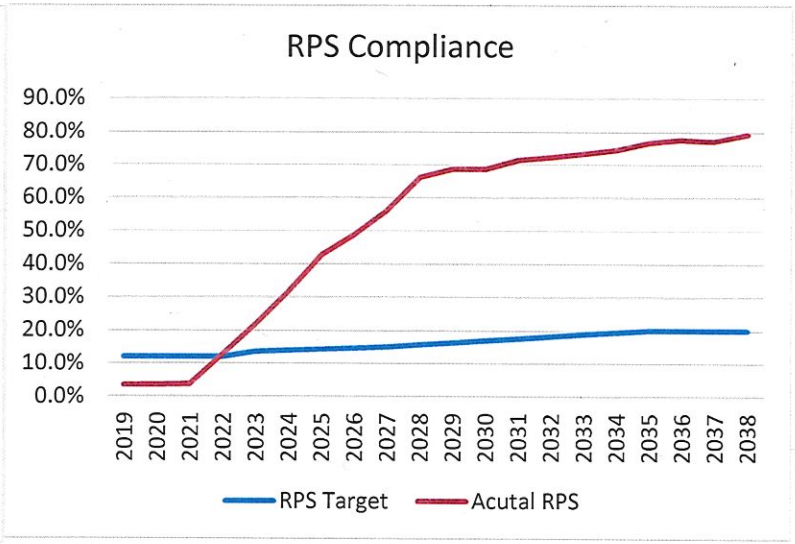

RPS Compliance

- By 2022 RPS compliance will be achieved with the expected 600 MW of PV expected for that year
- The RPS targets are almost tripled by the end of the forecast period (396%) with an actual RPS of 79%.

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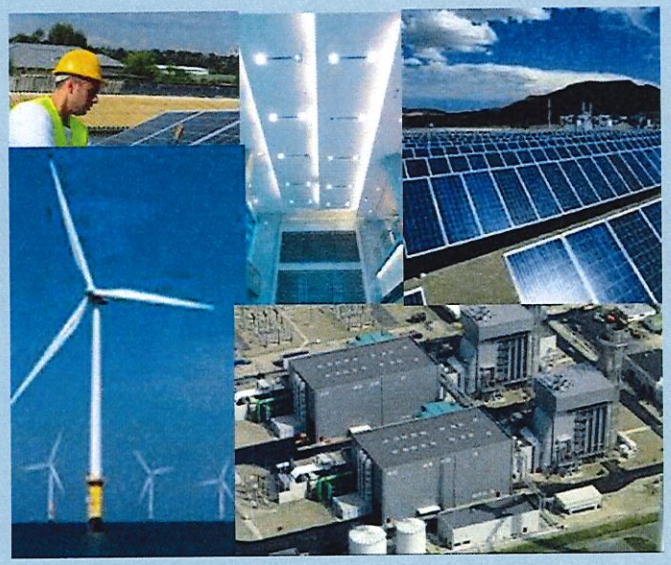

Scenario 1 Strategy 3 Under Base Load

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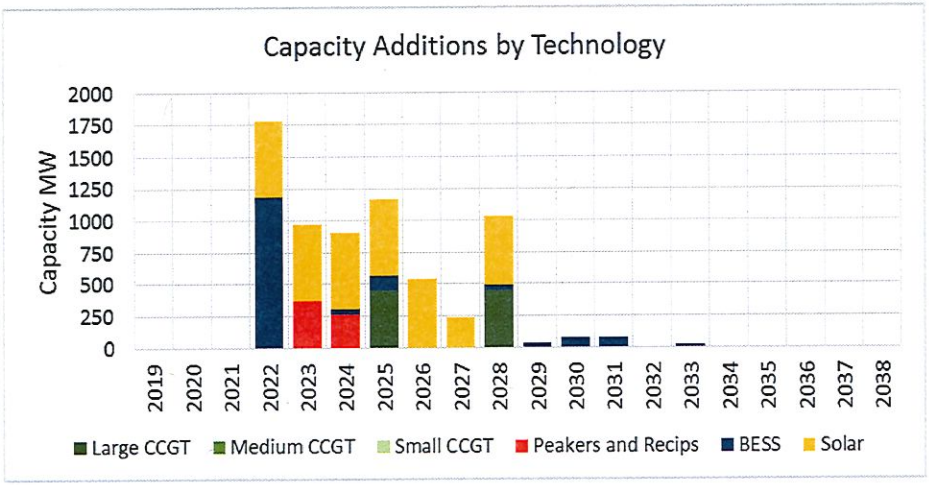
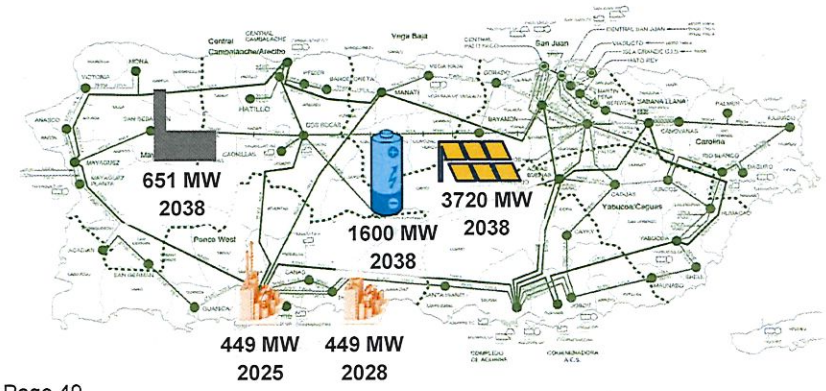
Scenario 1 Strategy 3 with Base Load Forecast Generation Additions





LTCE Additions

- 3,720 MW of utility scale PV are added starting on 2022 with a initial rate of 600 MW/yr.
- 1600 MW of battery energy storage with a combination of 2, 4 and 6 hours. 1,180 MW installed in 2022.
- Two large H-Class CCGT (449 MW) are installed at Cost Sur, one in 2025 and other in 2028.
- 651 MW of peaking generation distributed throughout the island (336 MW in RICE and 315 MW in LM6000, LM2500).

Observations

- The plan combined with the retirements discussed next allows for incorporation large amounts of renewable generation with very small curtailment.
- After retirement of AES in 2027 a second large block is added
- Plan is MATS compliant and reduces exposure to fuel volatility.

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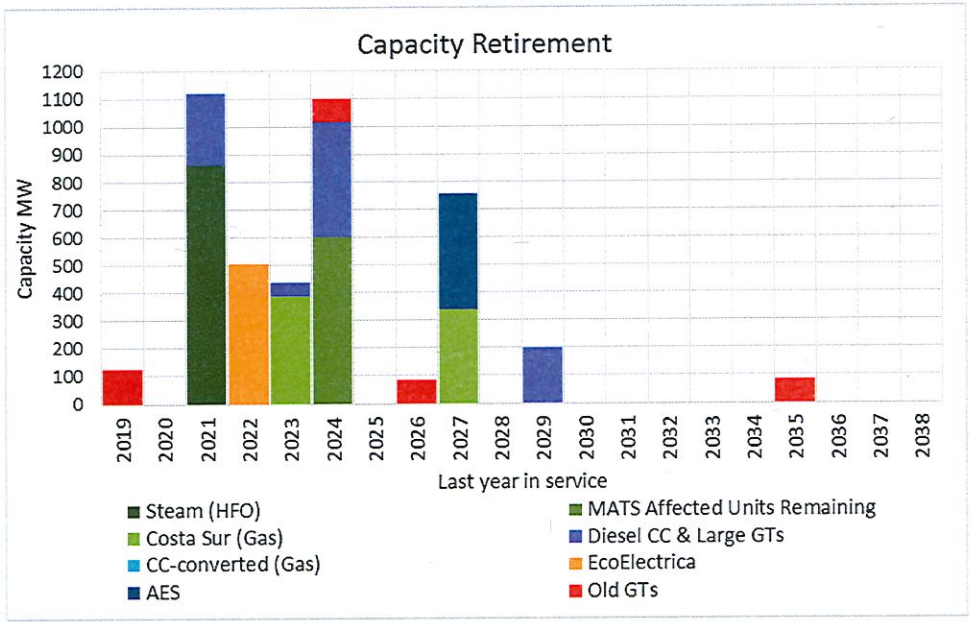
Scenario 1 Strategy 3 with Base Load Forecast Generation Retirements



LTCE Economic Retirements

- The installation of the PV and Storage in 2022 allows for the economic retirement of Aguirre 1 & 2 steam units by 2021. Aguirre CC 1 also retires by 2021. The steam units in the north are retired in 2024
- EcoEléctrica is economically retired in 2022, as soon as the contract expires. No contract changes assumed.
- Costa Sur 5 retires in 2023 as in 2024 the entry of the medium and small CCGT allows its economic retirement. Costa Sur 6 continues to operate and runs till 2027.
- AES is retired by 2028, not economically but by model input
- The Aguirre CC 1 is retired in 2021, but the other is kept for reserves. The Cambalache and Mayaguez are maintained with partial retirements after 2024.

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Scenario 1 Strategy 3 with Base Load Forecast Addition and Retirements Economics

Row Labels	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
AES_1	82	82	79	72	70	68	68	70	72			
AES_2	81	80	78	72	70	68	68	70	72			
AGUIRRE 1 CC	509	1,215	625									
AGUIRRE 2 CC	629	1,203	923		2,109	1,723	2,738	1,350	966	1,629	1,968	4,672
AGUIRRE STEAM_1	124	128	134									
AGUIRRE STEAM_2	127	131	137									
COSTA SUR 5	105	104	108	105	105							
COSTA SUR 6	98	101	108	105	103	106	113	119	123			
EcoElectrica	85	91	101	102								
PALO SECO 3	123	128	132	129	128	129						
PALO SECO 4	125	130	133	131	129	130						
SAN JUAN 07	126	130	133	132	133	135						
SAN JUAN 08	127	130	133	132	132	134						
SAN JUAN 5 CC	145	175	159		149	144	155	176	176	175	181	
SAN JUAN 6 CC	165	177	245		178	166						
Existing GT's												
Cambalache												
Mayaguez	413	914	1,293					1,375		270		381
New Thermal Resources												
Generic_Recip_diesel					10,247	7,719	1,014	1,107	1,365	585	778	589
Generic CC_H.01_gas							90	95	99	100	103	106
Generic Aero_LM6000_DLE_diesel						9,402	5,100	9,123	5,722	3,428	6,866	3,639
Generic Aero_GE LM2500_SAC_diesel						21,747		10,677	11,030	5,467		
New Renewable + Storage												
Weighted Avg Costs	0	0	0	135	115	109	106	108	107	107	106	107
Metrics												
Total costs $/MWh (nominal)	**104.2**	**108.1**	**113.2**	**112.3**	**117.1**	**121.9**	**112.1**	**115.0**	**117.9**	**125.4**	**126.2**	**127.6**
Curtailment	**-0.06%**	**-1.08%**	**-2.84%**	**0.00%**	**0.00%**	**-0.05%**	**-0.03%**	**-1.74%**	**-4.90%**	**-5.30%**	**-5.25%**	**-4.16%**

The model provides a view on the economics of the decisions on additions and retirements. The table shows the total costs in $/MWh for existing and new additions. For PV & Storage the combined costs per MWh of PV power is shown. Here we note that:

- The Steam Units with HFO have costs above those of the combination of PV + Storage and their inflexibly would create curtailment, hence are retired.
- CS 5&6 is maintained (depending on the dispatches can displace EcoEléctrica) but cannot compete with the efficient and flexible H-Class CCGTs installed in 2025.

Preliminary results subject to revision

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Scenario 1 Strategy 3 with Base Load Forecast Addition and Retirements summary

- The table below provides an overview of the timing of the generation additions and retirements.

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	Total
PREPA Steam (HFO)	0	0	862	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	862
PREPA MATS Affected units remaining						601	0	0	0	0	0	0	0	0	0	0	0	0	0	0	601
PREPA Costa Sur (Gas)	0	0	0	0	388	0	0	0	339	0	0	0	0	0	0	0	0	0	0	0	728
PREPA Diesel CC & large GTs	0	0	257	0	50	415	0	0	0	0	200	0	0	0	0	0	0	0	0	0	922
PREPA CC-converted (Gas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EcoElectrica	0	0	0	507	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	507
AES									416	0	0	0	0	0	0	0	0	0	0	0	416
Total Dependable Gen Retirement	**0**	**0**	**1119**	**507**	**438**	**1016**	**0**	**0**	**755**	**0**	**200**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4036**
Note: For retirement last year in service shown																					
Old GT's retirement	126	0	0	0	0	84	0	84	0	0	0	0	0	0	0	0	84	0	0	0	378
Large CCGT's	0	0	0	0	0	0	449	0	0	449	0	0	0	0	0	0	0	0	0	0	898
Medium CCGT's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small CCGT's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peakers (diesel)	0	0	0	0	165	262	0	0	0	0	0	0	0	0	0	0	0	0	0	0	427
BESS	0	0	0	1180	0	40	120	0	0	40	40	80	80	0	20	0	0	0	0	0	1600
Total Distchable Additions	**0**	**0**	**0**	**1180**	**165**	**302**	**569**	**0**	**0**	**489**	**40**	**80**	**80**	**0**	**20**	**0**	**0**	**0**	**0**	**0**	**2925**
Solar	0	0	0	600	600	600	600	540	240	540	0	0	0	0	0	0	0	0	0	0	3720
Total Additions	**0**	**0**	**0**	**1,780**	**765**	**902**	**1,169**	**540**	**240**	**1,029**	**40**	**80**	**80**	**0**	**20**	**0**	**0**	**0**	**0**	**0**	**6,645**

Preliminary results subject to revision

Scenario 1 Strategy 3 with Base Load Forecast Capacity & Reserves

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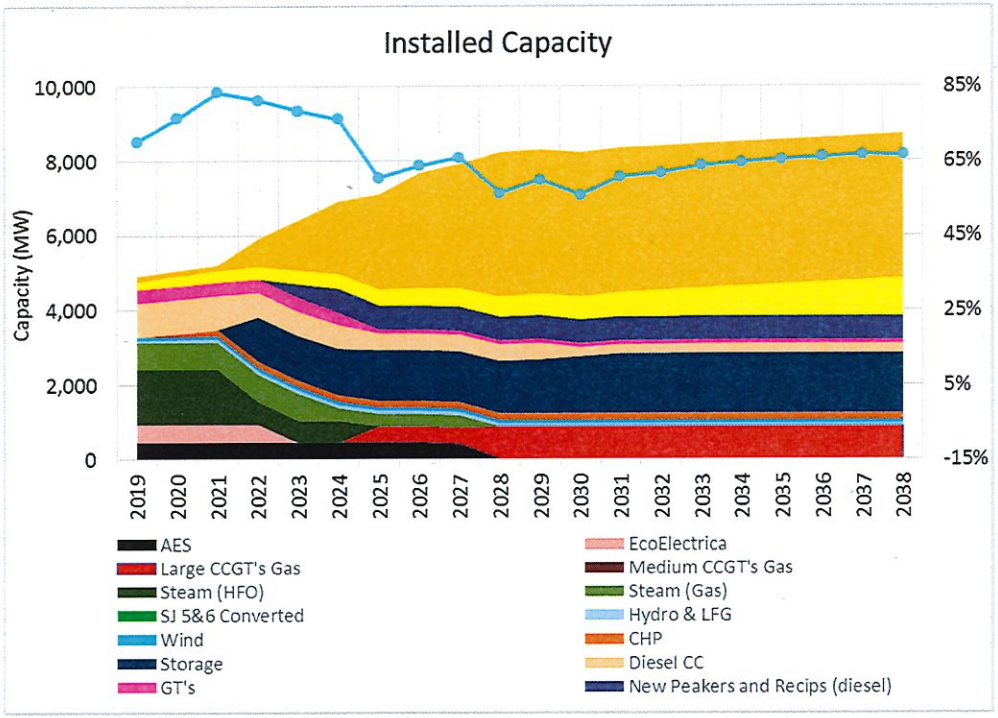

Installed Capacity & Reserves

- As can be observed with this LTCE plan the system transitions to one based on renewables. This can be observed considering that by 2038, 76% of the installed capacity in system consists of renewable generation or facilities in place for its integration (storage and peaking units).
- As PREPA's units and the thermal PPOA's are phased out the operating reserves are reduced reaching a minimum of 56 % in 2030, when they start increasing due to the reduction of the demand.
- The Planning Reserve Margin of 30% appears not to have been binding constraint on the LTCE plan formulation.

Preliminary results subject to revision

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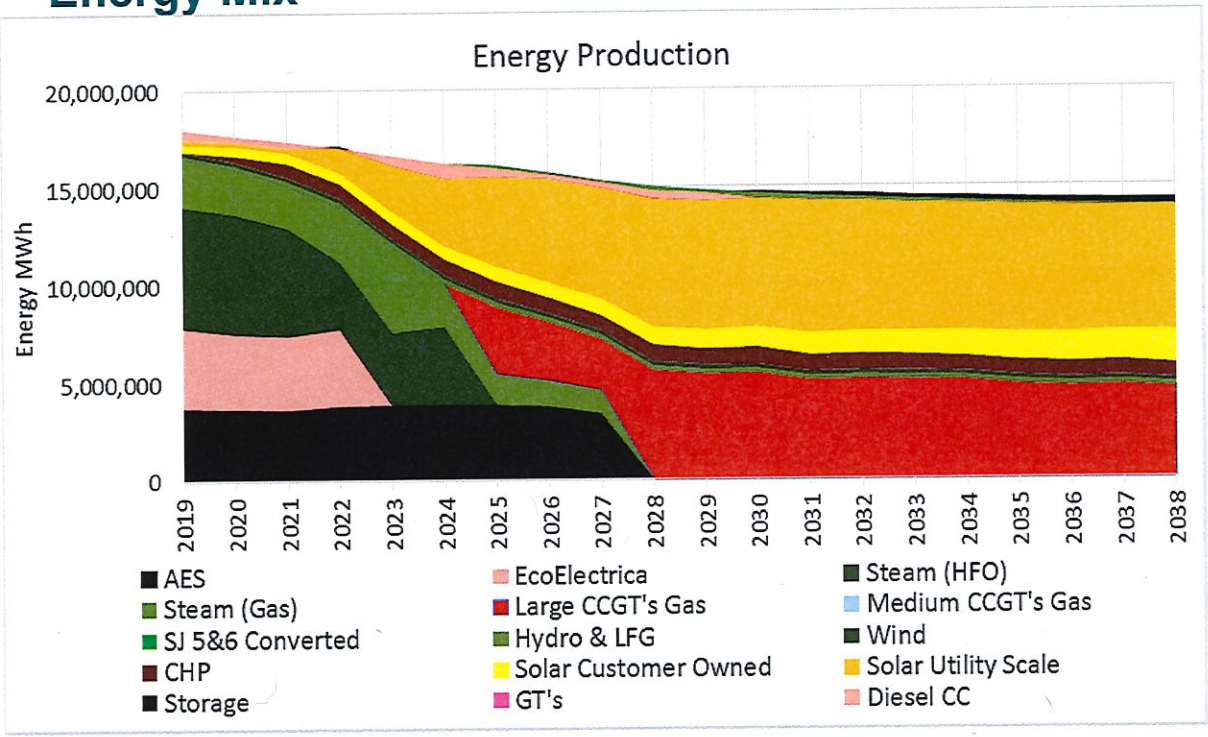
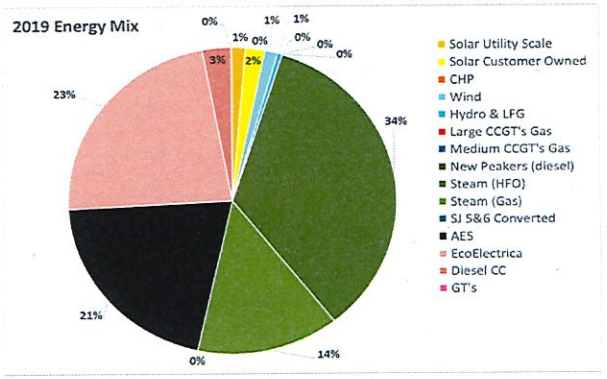
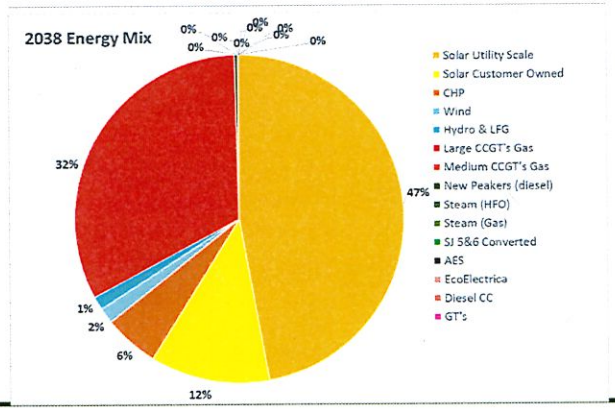
Scenario 1 Strategy 3 with Base Load Forecast Energy Mix







Installed Capacity & Reserves

- As can be observed the energy mix changes significantly over the life of the plan and by 2038, 64% of the energy is from renewable generation, 33% from natural gas and 6% from CHP applications.

Preliminary results subject to revision

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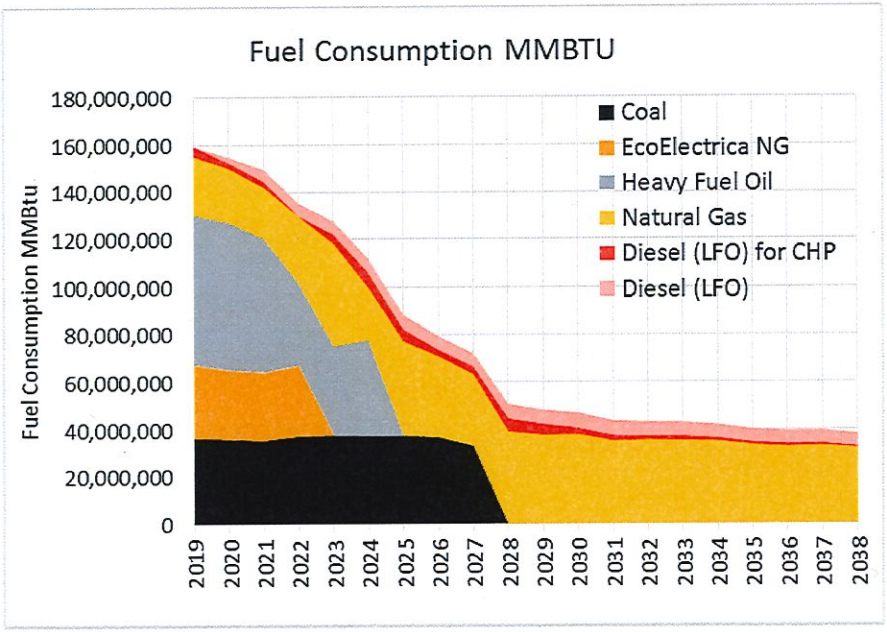
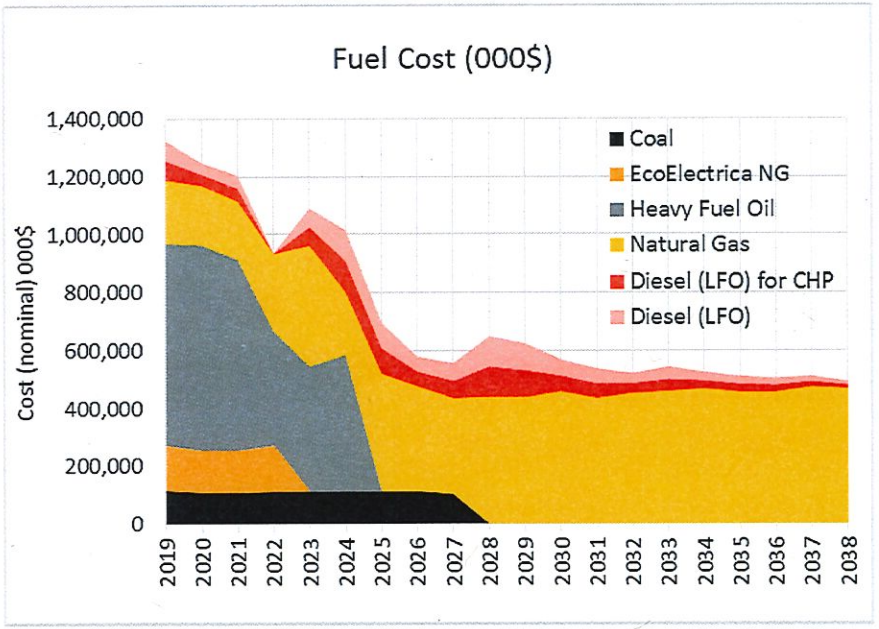
Scenario 1 Strategy 3 with Base Load Forecast Fuel Consumption





Fuel Consumption

- In line with the change in the energy supply matrix, there is a sharp drop in fuel consumption and associated costs with the implementation of the plan. The fuel consumption drops to 24% of the 2019 values.

Preliminary results subject to revision

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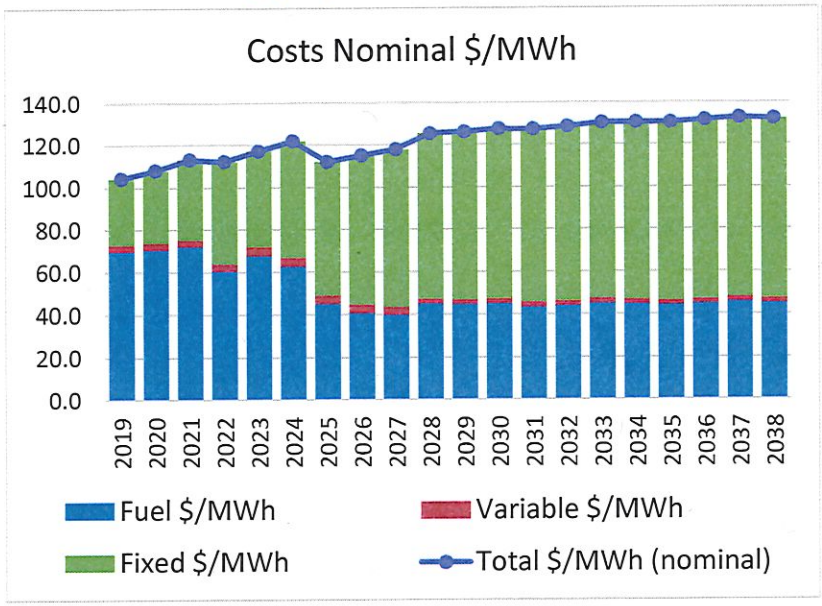
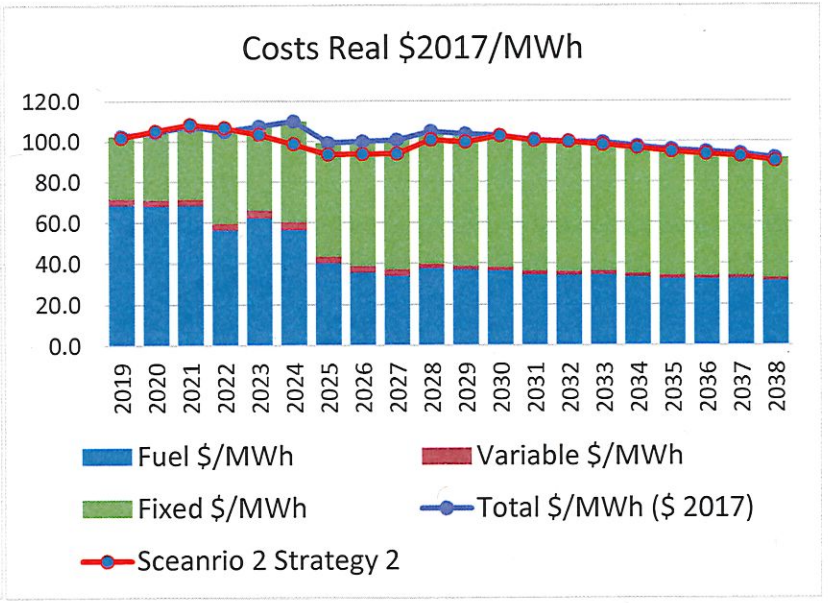
Scenario 1 Strategy 3 with Base Load Forecast
Total Cost of Supply





Total Cost of Supply

- The total cost of supply including annualized capital costs, fuel costs and fixed and variable O&M is expected to increase slightly until 2024, when there is a reduction due to the implementation of the H-Class at Costa Sur. There is a drop to $100/MWh and maintained till 2027 (real $2017), when the retirement of AES Coal increases the costs to $104.9/MWh in 2028. After this the cost continue declining reaching $91/MWh by 2038. As can be observed Scenario 2 Strategy 2 results in much lower costs for the period 2023 to 2030 and similar but lower costs to 2038.

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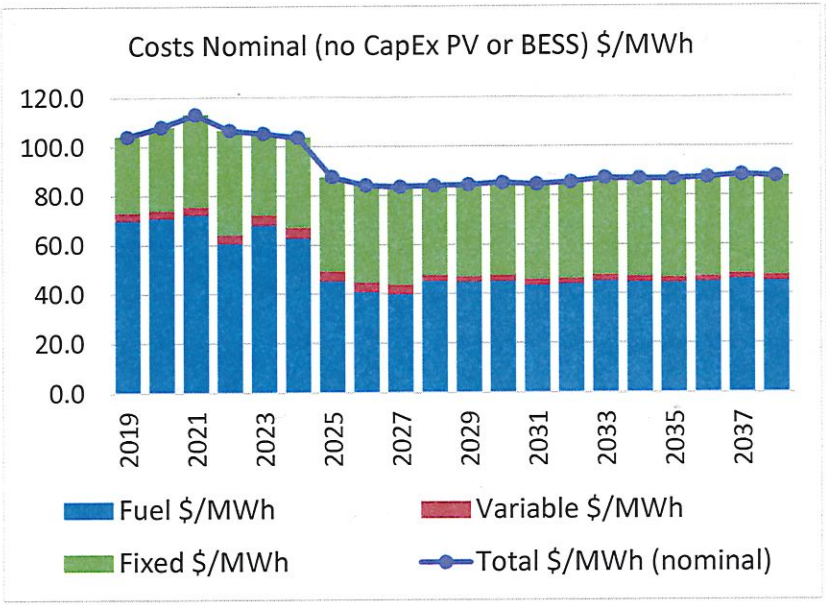
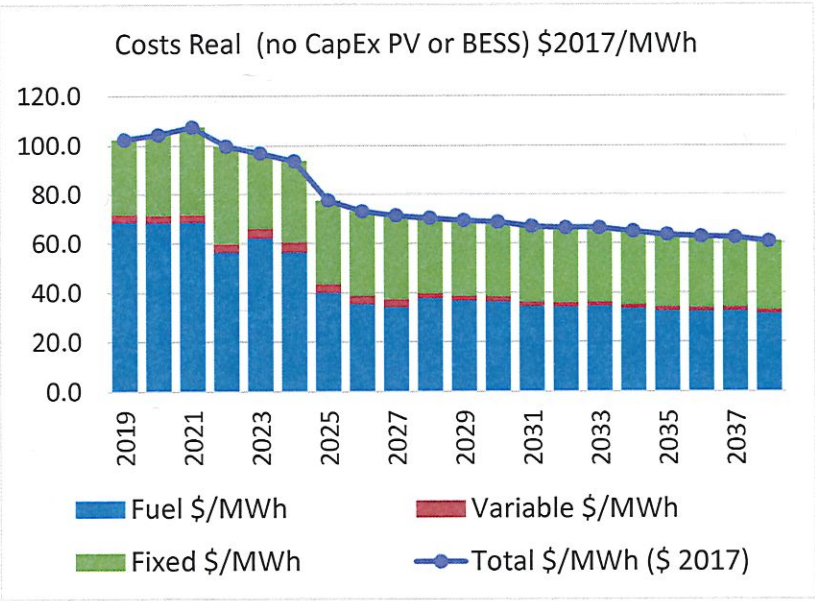
Scenario 1 Strategy 3 with Base Load Forecast
Total Cost of Supply / PV & BESS CapEx impact





PV & BESS CapEx impact

If the capital requirements for the PV and the energy storage are not taken into consideration, then there is a significant reduction on the costs, which continue declining reaching $ 61 / MWh in 2038 (in $ 2017). By 2025 the costs are expected to reach $ 78/MWh that can be compared with $ 99/MWh for the case with the full CapEx considered.

Preliminary results subject to revision

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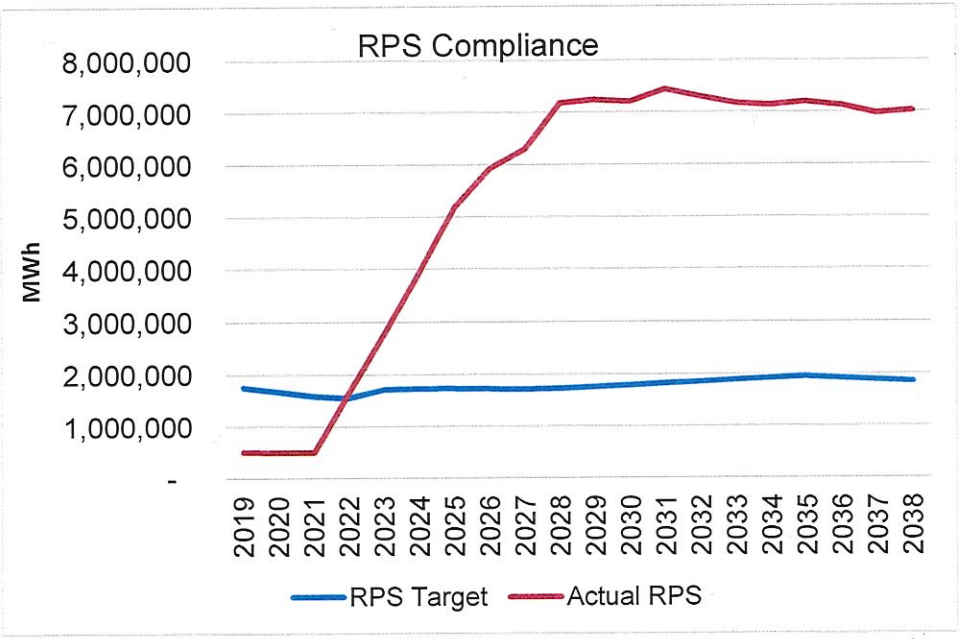
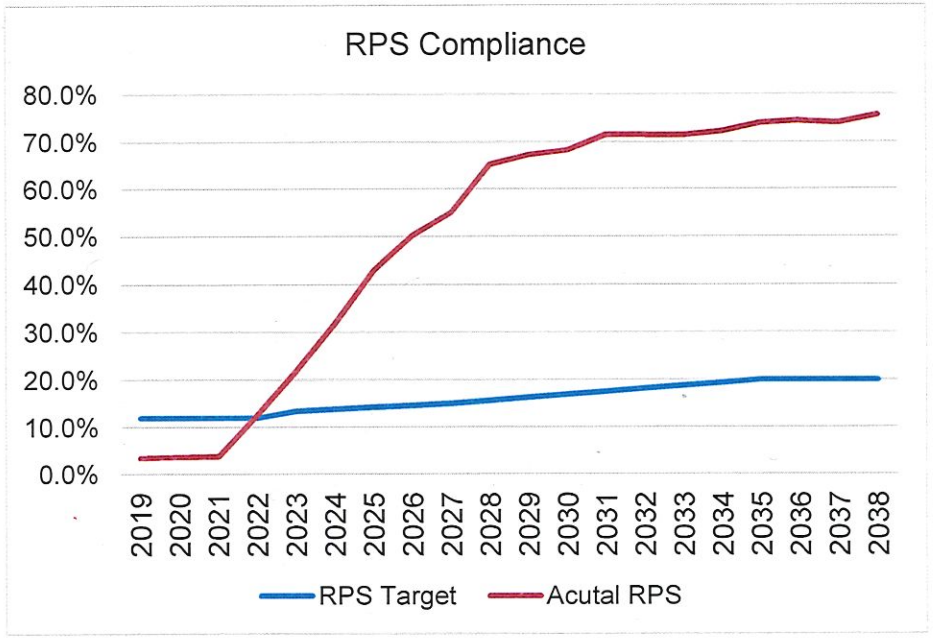
Scenario 1 Strategy 3 with Base Load Forecast
RPS Compliance





RPS Compliance

- By 2022 RPS compliance will be achieved with the expected 600 MW of PV expected for that year
- The RPS targets are almost tripled by the end of the forecast period (379%) with 76% actual RPS achieved.

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Scenario 4

Restricted

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Scenario 4 with Base Load Forecast Generation Additions

Scenario 4 (Base Load)	Unit	Strategy 2	Strategy 3
Solar PV	MW	3,000	3,420
BESS	MW	1,960	2,020
Large CCGT	MW	738	738
Medium CCGT	MW	0	0
Small CCGT, Peaker, RICE	MW	307	376
Planning Reserve Margin (2025/ 2038)	%	47% / 56%	39% / 56%
RPS (2025/ 2038)	%	42% / 67%	39% / 75%
System Cost (2025/ 2038)	$/MWh	$93.0 / $88.2	$91.96 / $88.5

Scenario 2 (Base Load)	Unit	Strategy 2	Strategy 3
Solar PV	MW	2,280	2,520
BESS	MW	1,580	1,240
Large CCGT	MW	1,120	1,053
Medium CCGT	MW	0	141
Small CCGT, Peaker, RICE	MW	685	548
Reserve Margin (2025 / 2038)	%	50% / 71%	45% / 53%
RPS (2025 / 2038)	%	36% / 53%	36% / 57%
System Cost (2025 / 2038) $ 2017	$/MWh	$93.5 / $90.4	$96.0 / $88.9

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Scenario 4 Strategy 2 Under High, Base and Low Load

Scenario 4 Strategy 2	Unit	High Load	Base Load	Low Load
Solar PV	MW	4,020	3,040	2,460
BESS	MW	1,800	1,960	1,620
Large CCGT	MW	1,107	738	738
Medium CCGT	MW	0	0	0
Small CCGT, Peaker, RICE	MW	492	307	414
Planning Reserve Margin (2025/ 2038)	%	41% / 52%	47% / 56%	44% / 48%
RPS (2025/ 2038)	%	40% / 71%	42% / 67%	31% / 64%
System Cost (2025/ 2038)	$2017/MWh	$94 / $88	$93 / $88	$92 / $88

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Scenario 4 Strategy 3 Under High, Base and Low Load

Scenario 4 Strategy 3	Unit	High Load	Base Load	Low Load
Solar PV	MW	3,960	3,420	2,580
BESS	MW	1,860	2,020	1,520
Large CCGT	MW	1,107	738	738
Medium CCGT	MW	0	0	0
Small CCGT, Peaker, RICE	MW	334	376	446
Planning Reserve Margin (2025/ 2038)	%	40% / 48%	39% / 56%	38% / 47%
RPS (2025/ 2038)	%	41% / 71%	39% / 75%	37% / 66%
System Cost (2025/ 2038)	$/MWh	$94 / $86	$92 / $88	$93 / $88

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Scenario 4 Strategy 3 Under Base Load

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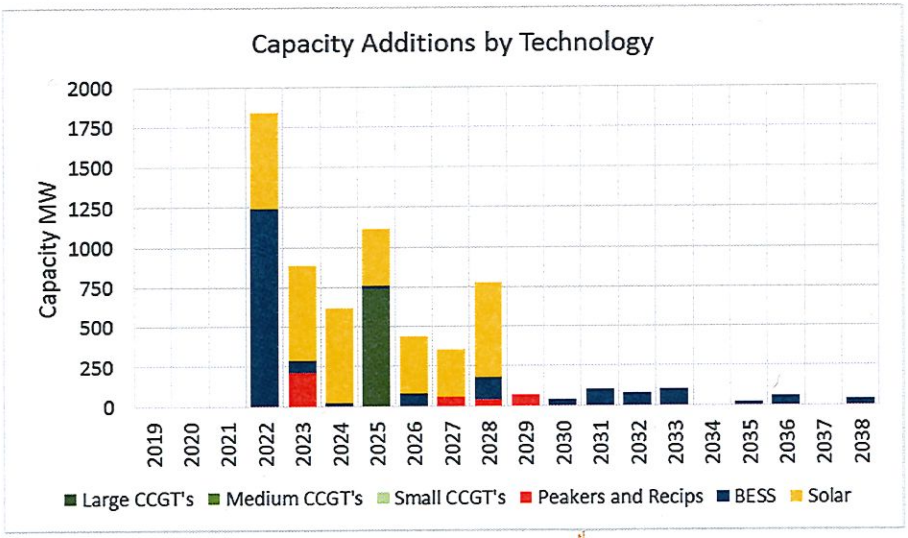
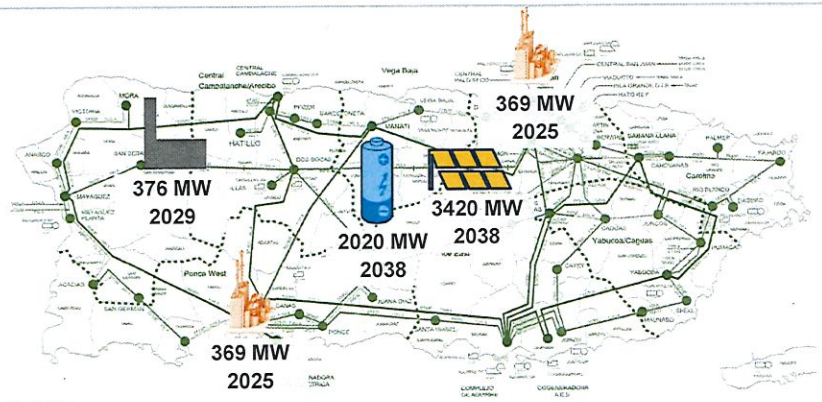
Scenario 4 Strategy 3 with Base Load Forecast Generation Additions





LTCE Additions

- 3,420 MW of utility scale PV are added starting on 2022 with a initial rate of 600 MW/yr.
- 2,020 MW of battery energy storage with a combination of 2, 4 and 6 hours. 1,240 MW installed in 2022.
- Two large F-Class CCGT (369 MW) are installed one in Bayamon and the second at Ponce OE, both in 2025.
- SJ 5 & 6 converted to gas in 2023
- 376 MW of peaking generation distributed throughout the island (120 MW in AERO and 256 MW in Recip).

Observations

- The plan combined with the retirements discussed next allows for incorporation large amounts of renewable generation with very small curtailment.
- After retirement of AES in 2027 a second large block is added
- Plan is MATS compliant and reduces exposure to fuel volatility.

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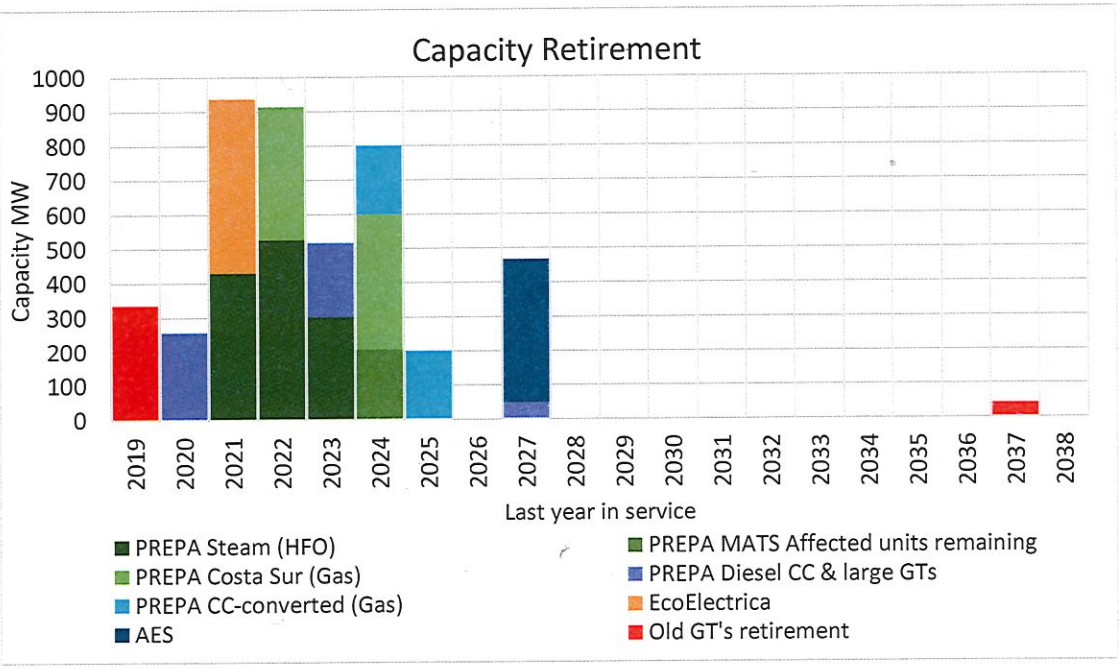
Scenario 4 Strategy 3 with Base Load Forecast Generation Retirements



LTCE Economic Retirements

- The installation of the PV and Storage in 2022 allows for the economic retirement of Aguirre CC 2 in 2019, Palo Seco 3 and San Juan 8. SJ 7 retires by 2023 and Palo Seco 4 by 2025.
- EcoEléctrica is economically retired in 2022, as soon as the contract expires. No contract changes assumed.
- Costa Sur 5 & 6 last year in service is 2022 and 2024 as in 2025 the entry of two large CCGT allows its economic retirement.
- AES is retired by 2028, not economically but by model input due to contract expiration.
- The NG converted to SJ 6 is retired by 2024 and SJ 5 by 2033.

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Scenario 4 Strategy 3 with Base Load Forecast Addition and Retirements Economics

Row Labels	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
AES_1	82	85	82	72	70	68	69	70	72			
AES_2	82	83	80	72	70	68	68	70	71			
AGUIRRE 1 CC	885	3,715										
AGUIRRE 2 CC	1,191		858		939	637	725	520	527	305	384	370
AGUIRRE STEAM_1	124	128	134	128								
AGUIRRE STEAM_2	127	131	137									
COSTA SUR 5	107	102	107	102								
COSTA SUR 6	96	99	104	101	103	106						
EcoElectrica	86	95	106									
PALO SECO 3	125	131	135	127	125							
PALO SECO 4	126	132	135	129	126	130						
SAN JUAN 07	126	130	133	132								
SAN JUAN 08	127	130	133	132	131							
SAN JUAN 5 CC	241			902	148							
SAN JUAN 5 CC NG Conversion					89	93	101					
SAN JUAN 6 CC	376				149							
SAN JUAN 6 CC NG COnversion					91	95						
Existing GT's4												
Cambalache	855			920	910							
Mayaguez	263				431	213	306	252	650	206	217	234
New Thermal Resources												
Generic CC_F.05_gas							96	97	103	99	101	103
Generic Aero_LM6000_DLE_diesel									1,747	335	448	491
Generic Aero_GE LM2500_SAC_diesel											1,040	1,005
Recip					1,498	542	721	483	675	272	300	330
New Renewable + Storage												
Weighted Avg Costs	0	0	0	136	121	112	106	109	107	105	104	106
Metrics												
Total costs $/MWh (nominal)	**103.5**	**108.8**	**113.7**	**113.7**	**113.3**	**108.7**	**103.9**	**106.9**	**109.5**	**123.2**	**124.0**	**125.7**
Curtailment	**-0.5%**	**-10.3%**	**-13.5%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**-0.6%**	**-1.4%**	**-1.4%**	**-1.3%**

The model provides a view on the economics of the decisions on additions and retirements. The table shows the total costs in $/MWh for existing and new additions. For PV & Storage the combined costs per MWh of PV power is shown. Here we note that:

- The Steam Units with HFO have costs above those of the combination of PV + Storage and their inflexibly would create curtailment, hence are retired.
- EcoEléctrica is retired by the entry of storage + renewable and SJ 5&6 converted to gas
- CS 5&6 is maintained but cannot compete with the efficient and flexible F-Class CCGTs installed in 2025.

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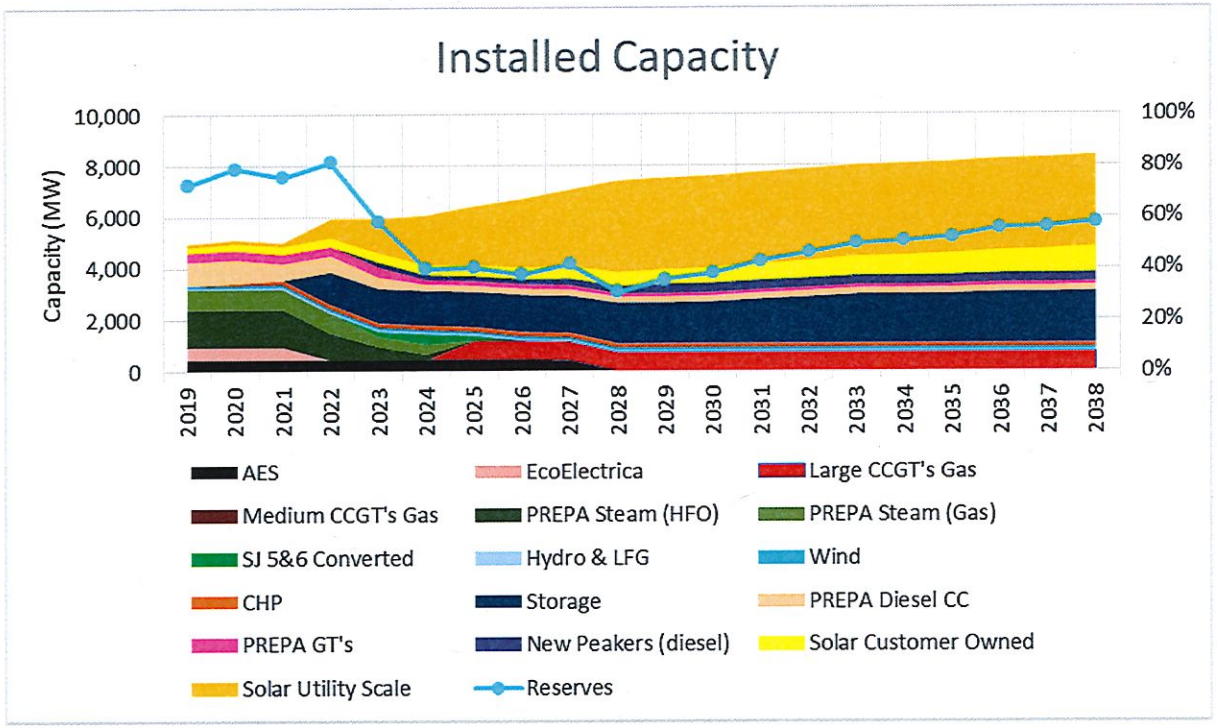
Scenario 4 Strategy 3 with Base Load Forecast Addition and Retirements summary

- The table below provides an overview of the timing of the generation additions and retirements.

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	Total
PREPA Steam (HFO)	0	0	429	526	301	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1257
PREPA MATS Affected units remaining						206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	206
PREPA Costa Sur (Gas)	0	0	0	388	0	393	0	0	0	0	0	0	0	0	0	0	0	0	0	0	782
PREPA Diesel CC & large GTs	0	257	0	0	215	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	522
PREPA CC-converted (Gas)	0	0	0	0	0	200	200	0	0	0	0	0	0	0	0	0	0	0	0	0	400
EcoElectrica	0	0	507	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	507
AES									416	0	0	0	0	0	0	0	0	0	0	0	416
Total Dependable Gen Retirement	**0**	**257**	**936**	**914**	**516**	**800**	**200**	**0**	**466**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**4090**
Note: For retirement last year in service shown																					
Old GT's retirement	336	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	378
Large CCGT's	0	0	0	0	0	0	738	0	0	0	0	0	0	0	0	0	0	0	0	0	738
Medium CCGT's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Small CCGT's	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peakers (diesel)	0	0	0	0	208	0	0	0	55	39	74	0	0	0	0	0	0	0	0	0	376
BESS	0	0	0	1240	80	20	20	80	0	140	0	40	100	80	100	0	20	60	0	40	2020
Total Distchable Additions	**0**	**0**	**0**	**1240**	**288**	**20**	**758**	**80**	**55**	**179**	**74**	**40**	**100**	**80**	**100**	**0**	**20**	**60**	**0**	**40**	**3134**
Solar	0	0	0	600	600	600	360	360	300	600	0	0	0	0	0	0	0	0	0	0	3420
Total Additions	**0**	**0**	**0**	**1,840**	**888**	**620**	**1,118**	**440**	**355**	**779**	**74**	**40**	**100**	**80**	**100**	**0**	**20**	**60**	**0**	**40**	**6,554**

Preliminary results subject to revision

Scenario 4 Strategy 3 with Base Load Forecast Capacity & Reserves



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Installed Capacity & Reserves

- As can be observed with this LTCE plan the system transitions to one based on renewables. This can be observed considering that by 2038, 85% of the installed capacity in system consists of renewable generation or facilities in place for its integration (storage and peaking units).
- As PREPA's units and the thermal PPOA's are phased out the operating reserves are reduced reaching a minimum of 31% in 2028, when they start increasing due to the reduction of the demand.
- The Planning Reserve Margin of 30% appears not to have been binding constraint on the LTCE plan formulation.

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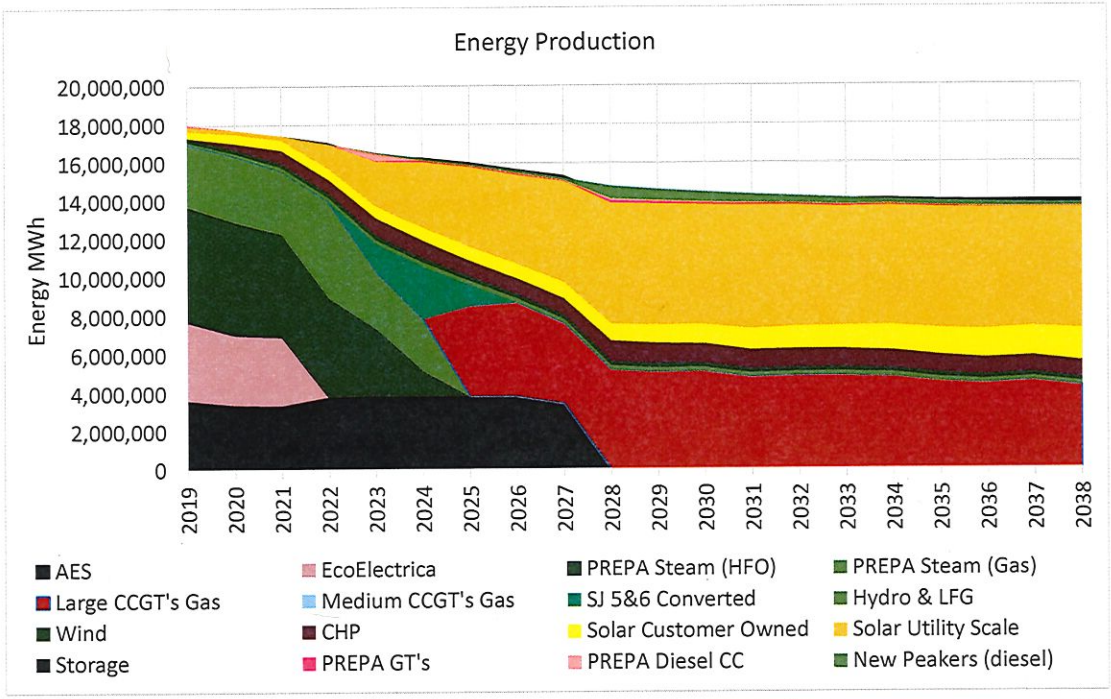
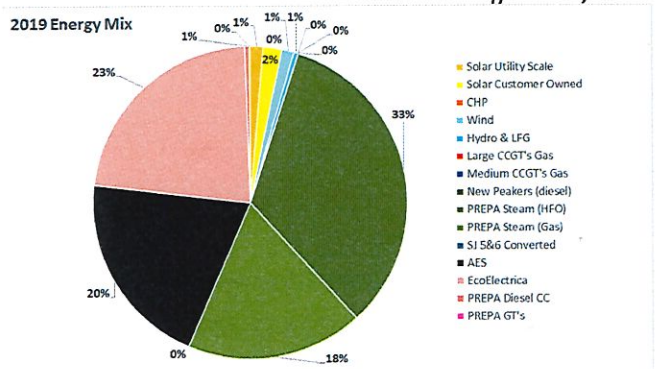
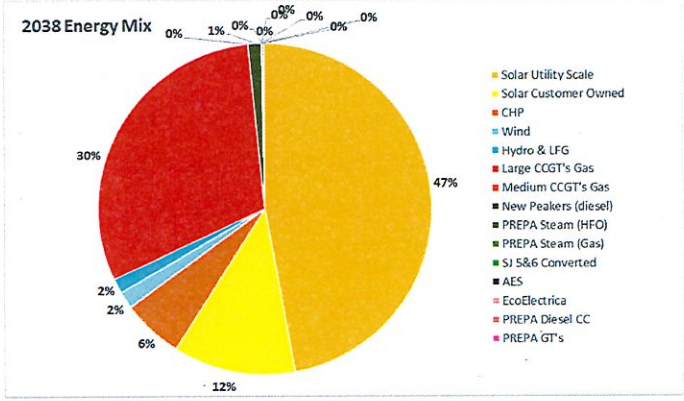
Scenario 4 Strategy 3 with Base Load Forecast Energy Mix







Installed Capacity & Reserves

- As can be observed the energy mix changes significantly over the life of the plan and by 2038 62% of the energy is from renewable generation, 30% from natural gas and 6% from CHP applications

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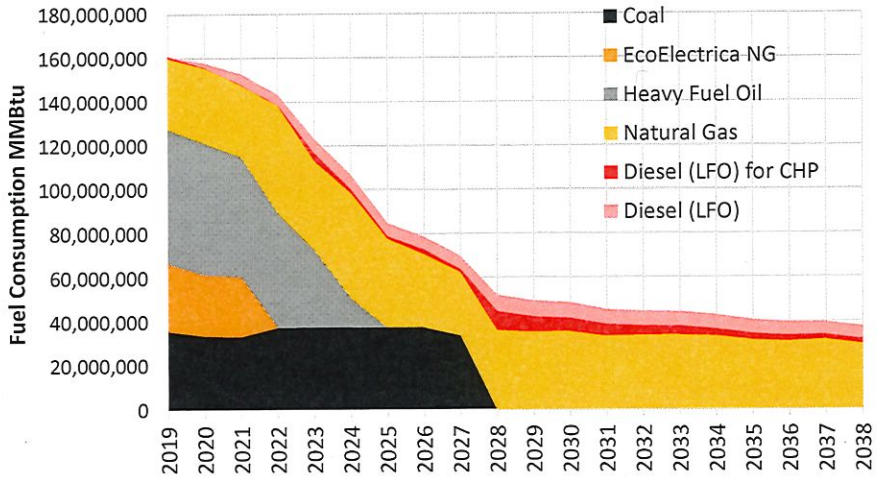
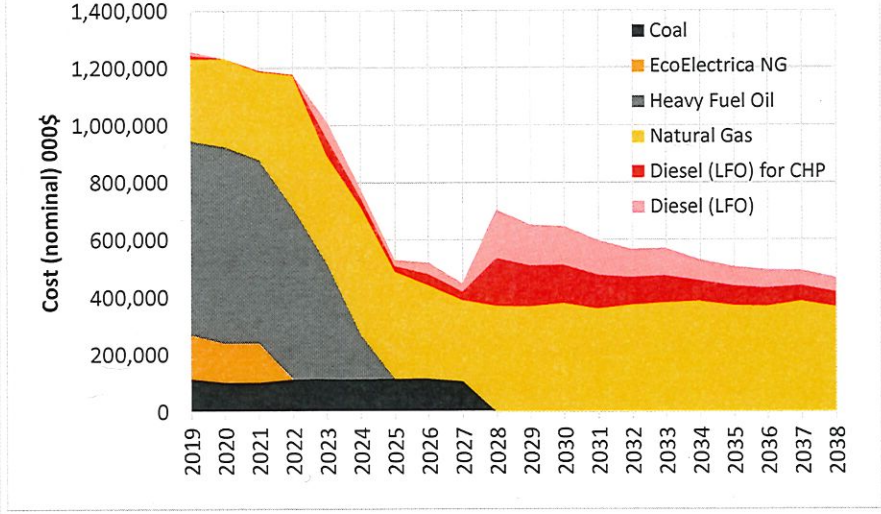
Scenario 4 Strategy 3 with Base Load Forecast Fuel Consumption





Fuel Consumption

- In line with the change in the energy supply matrix, there is a sharp drop in fuel consumption and associated costs with the implementation of the plan. The fuel consumption drops to 23% of the 2019 values.

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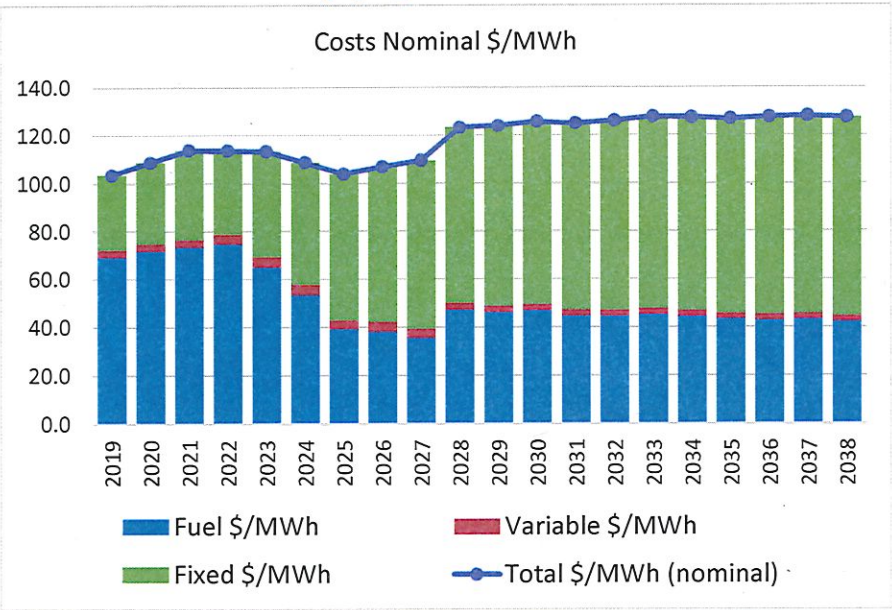
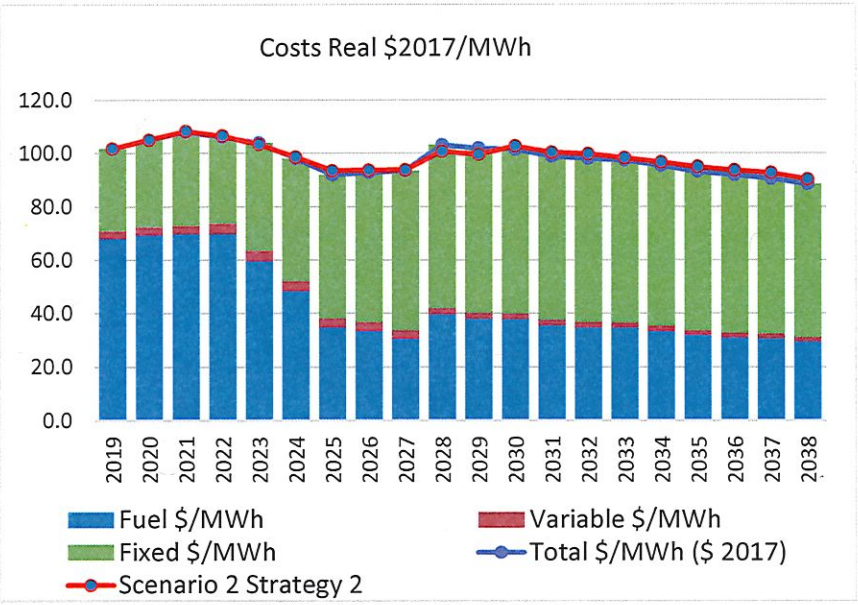
Scenario 4 Strategy 3 with Base Load Forecast
Total Cost of Supply





Total Cost of Supply

- The total cost of supply including annualized capital costs, fuel costs and fixed and variable O&M is expected to decline with the implementation of the plan in 2022 onwards from $108/MWh in 2021 to $93/MWh by 2027 (real $2017), when the retirement of AES Coal increases the costs to $103/MWh in 2028. After this the cost continue declining reaching $88.40/MWh by 2038. We also note above that the cost are very similar to those of Scenario 2 Strategy 2 (albeit lower to the end)

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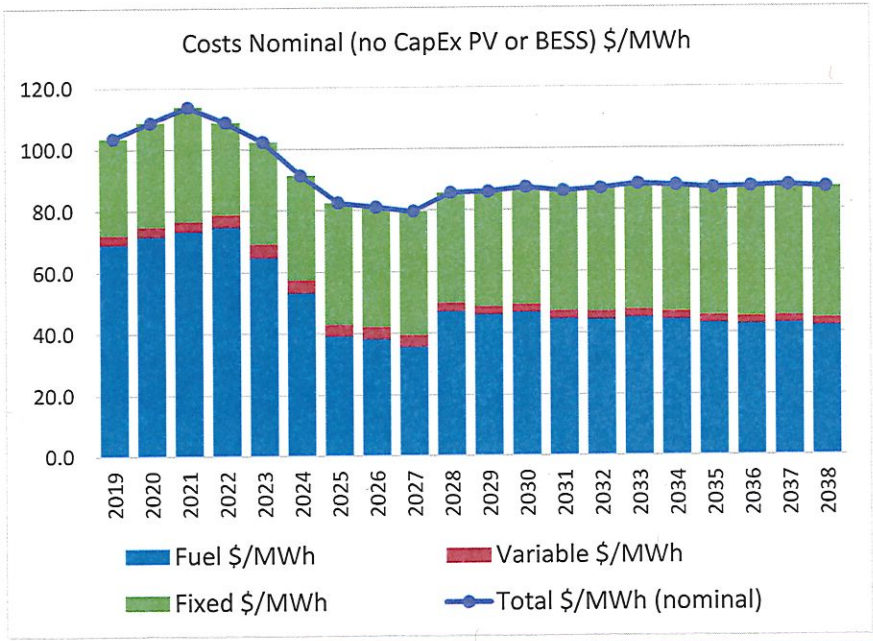
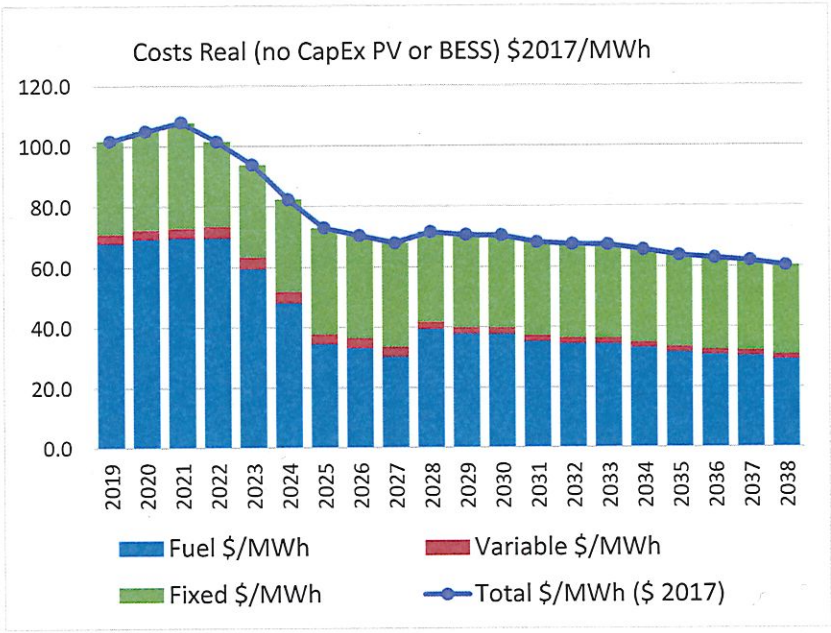
Scenario 4 Strategy 3 with Base Load Forecast
Total Cost of Supply / PV & BESS CapEx impact





PV & BESS CapEx impact

If the capital requirements for the PV and the energy storage are not taken into consideration, then there is a significant reduction on the costs, which continue declining reaching $61/MWh in 2038 (in $2017). By 2025 the costs are expected to reach $ 73/MWh that can be compared with $ 92/MWh for the case with the full CapEx considered.

Preliminary results subject to revision

Scenario 4 Strategy 3 with Base Load Forecast RPS Compliance

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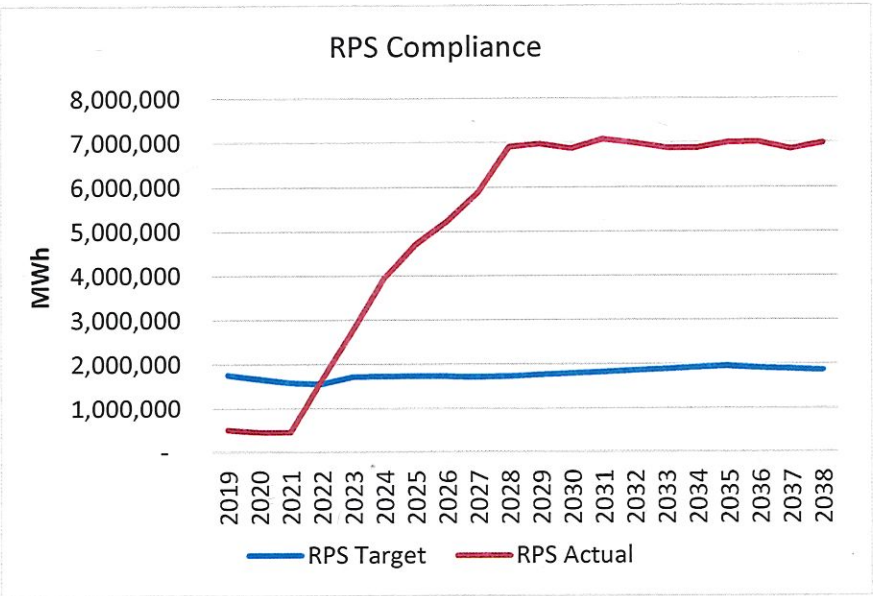

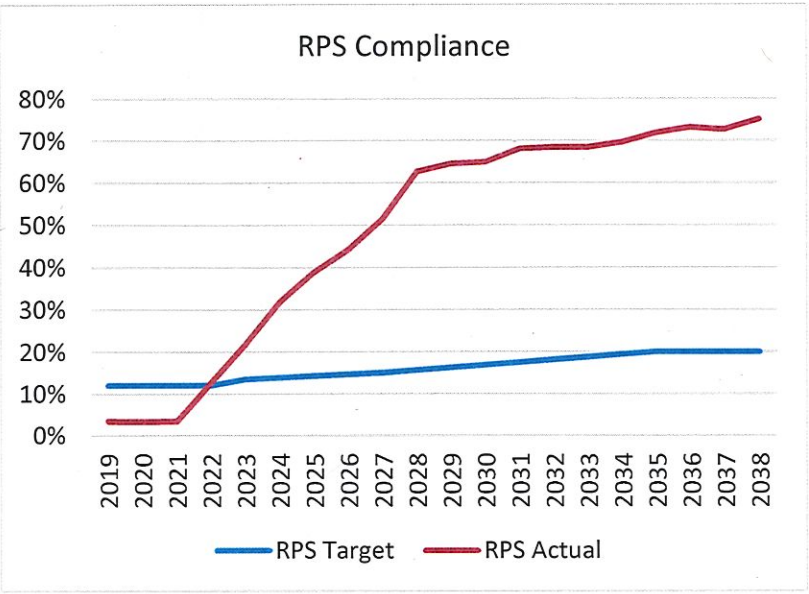

RPS Compliance

- By 2022 RPS compliance will be achieved with the expected 600 MW of PV expected for that year
- The RPS targets are almost quadrupled by the end of the forecast period (376%).

Preliminary results subject to revision

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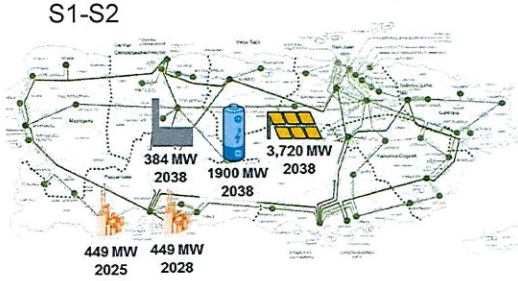
LTCE Summary

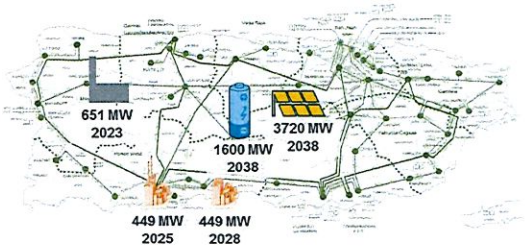
There are common trends observed under all Scenarios / Strategies

1. The Steam units burning heavy fuel oil are retired early in the plan starting with Aguirre 1 & 2 and displaced by renewable and storage and in those cases that is feasible the conversion of SJ 5&6
2. EcoEléctrica is economically retired as soon as the contract expires or shortly after.
3. There is always at least one large combined cycle installed in 2025 in the north (Palo Seco) and one in Costa Sur
4. There is large participation of PV and Storage and the curtailment is minimal.
5. There is an increase in costs when AES retires

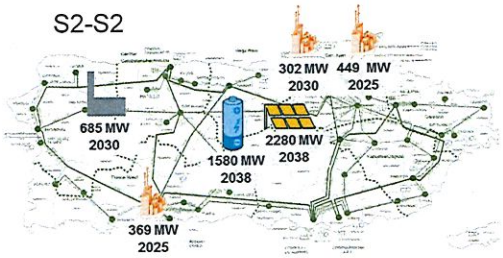
S1-S2



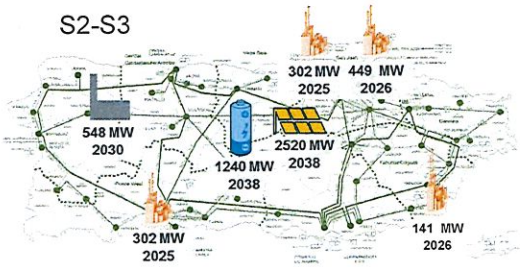
S1-S3



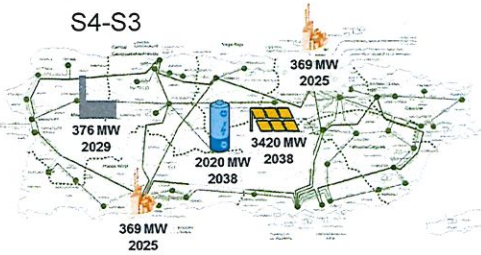
S2-S2



S2-S3



S4-S3



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Scenario 3 Strategy 2 Under Base Load

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Scenario 3 with Base Load Forecast Generation Additions

Scenario 3 (Base Load)	Unit	Strategy 2	Strategy 3
Solar PV	MW	3,780	3,720
BESS	MW	2,640	2,660
Large CCGT	MW	738	738
Medium CCGT	MW	0	0
Small CCGT, Peaker, RICE	MW	355	515
Planning Reserve Margin (2025/ 2038)	%	52% / 89%	40% / 89%
RPS (2025/ 2038)	%	51% / 83%	47% / 82%
System Cost (2025/ 2038)	$/MWh	$91 / $82	$91 / $83

Scenario 4 (Base Load)	Unit	Strategy 2	Strategy 3
Solar PV	MW	3,000	3,420
BESS	MW	1,960	2,020
Large CCGT	MW	738	738
Medium CCGT	MW	0	0
Small CCGT, Peaker, RICE	MW	307	376
Planning Reserve Margin (2025/ 2038)	%	47% / 56%	39% / 56%
RPS (2025/ 2038)	%	42% / 67%	39% / 75%
System Cost (2025/ 2038)	$/MWh	$93.0 / $88.2	$91.96 / $88.5

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Minigrids

Restricted

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Introduction

- In parallel with the generation expansion plan Siemens PTI evaluated PREPA's transmission system and determined the convenience of its separation into 8 electrical islands called MiniGrids for short, considering the geography of the system and the expected time to repair for the various overhead lines.
- The concept is that following (or even in preparation for) a major event the system can be segregated into autonomous areas that can operate separately from each other for extended periods of time including months.
- As presented earlier, the expansion plan is being designed so that there will be local resources to the MiniGrids and next we will present how this resources achieve balance with Critical, Priority and the total load. Also we will provide information to date on the identified investments necessary to consolidate the MiniGrids.
- Supplementary to the MiniGrids, microgrids as proposed for areas where there is difficulty of access and it would be impractical to harden the system to integrate them to the MiniGrid.

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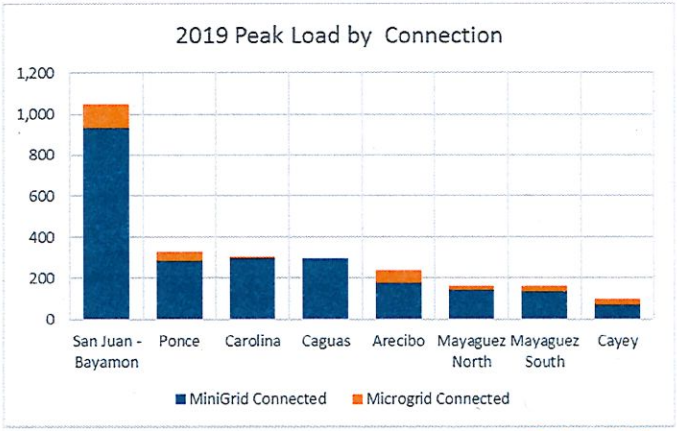
MiniGrids – Microgrids Loads

The load was catalogued into three categories:

- **Critical Loads:** these load include basic resources that should either ride through the storm or must be available short after. They are crucial for the restauration effort. Include hospitals, airports, shelters and town center, police, fire stations, storm water pumps, critical water supply/treatment AAA facilities and certain communication facilities.
- **Priority Loads:** these loads are those necessary to restore normalcy to each of the localities and include shopping centers and commercial establishments, gas stations, industries, higher density residential areas. These loads must be reconnected shortly after the Critical Loads. Some overhead lines may be to be inspected and repaired; no more than 10 days for the full connection.
- **Balance of the Loads:** these are the rest of the loads within the minigrid and the objective is to restore them also within 10 days of the event, but more overhead lines may be involved and 100% restauration may exceed 10 days.

	Peak Load MW (2019)						
	Total	Critical	Priority	Balance	% Critial	% Priority	% Balance
San Juan - Bayamon	1,049	316	113	620	30%	11%	59%
Ponce	331	105	66	160	32%	20%	48%
Carolina	307	88	23	195	29%	8%	64%
Caguas	298	82	52	164	28%	17%	55%
Arecibo	240	59	64	117	24%	27%	49%
Mayaguez North	164	72	1	91	44%	1%	56%
Mayaguez South	161	63	6	92	39%	4%	57%
Cayey	99	25	18	56	25%	18%	57%
Total	**2,649**	**810**	**342**	**1,497**	**31%**	**13%**	**57%**



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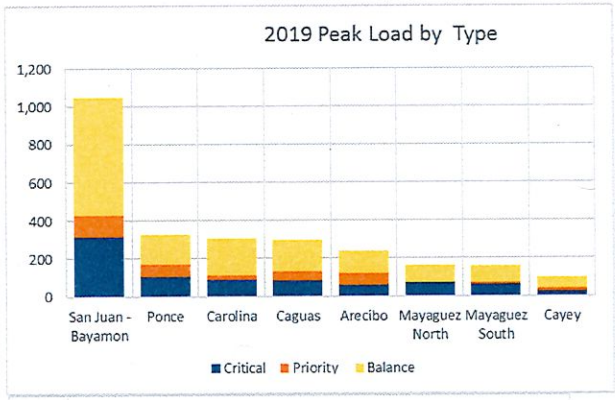
MiniGrids – Microgrids Loads

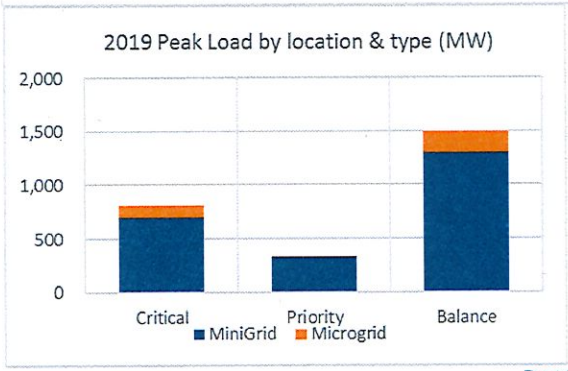
The load can be located in the MiniGrid or a Microgrid:

- 13 % of the critical loads and 4% of the priority loads are located in the microgrids that require similar restoration times.

	Peak Load MW (2019)				
	Total	MiniGrid Connected	Microgrid Connected	% MiniGrid	% Microgrid
San Juan - Bayamon	1,049	933	116	89%	11%
Ponce	331	284	47	86%	14%
Carolina	307	296	11	97%	3%
Caguas	298	298	0	100%	0%
Arecibo	240	176	64	73%	27%
Mayaguez North	164	142	22	87%	13%
Mayaguez South	161	132	29	82%	18%
Cayey	99	66	33	66%	34%
Total	**2,649**	**2,328**	**321**	**88%**	**12%**

	Peak Load MW (2019)						
	Total	Critical	Priority	Balance	% Critial	% Priority	% Balance
MiniGrid	2,328	701	328	1,299	30%	14%	56%
Microgrid	321	109	14	198	34%	5%	62%
Total	**2,649**	**810**	**342**	**1,497**	**31%**	**13%**	**57%**
MiniGrid	88%	87%	96%	87%			
Microgrid	12%	13%	4%	13%			





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MiniGrids Design

The Design of the MiniGrids (and microgrids) consist of two overarching activities:

Local Generation Resource Selection:

- The critical loads must be able to be served by thermal resources only; full coverage right after the event.
- Priority loads to be served by a combination of thermal resources and PV + Storage.
- Balance pf loads to be served by a combination of thermal resources and PV + Storage and on grid isolated mode some level of load shed is accepted.
- Microgrid ideally should be covered by reciprocating engines assigned by the LTCE to the region. PV + Storage can complement

We present next the results for Scenario 2 Strategy 3: -50% minimum reserves.

Transmission / Distribution design:

- Hardening / new underground facilities to create a MiniGrid backbone to which the generation is connected and loads are served from.
- Building underground facilities for interconnection of critical loads
- New underground reliable facilities for the Interconnection of MiniGrids and faster consolidation '
- Extension of the MiniGrid backbone to areas of high reliability and resiliency.
- Hardening of the existing infrastructure as complementary to the above.

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MiniGrids Design: Local Generation: *Carolina MiniGrid*

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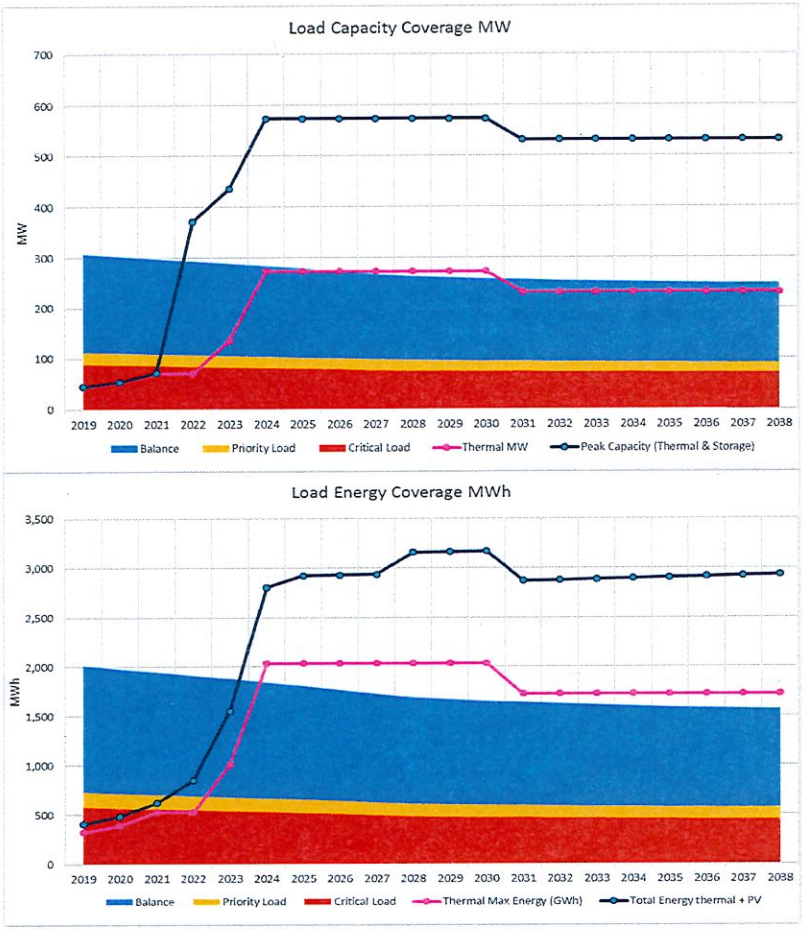

Resources

- The Carolina Area under Scenario 2 by 2026 is projected to have 273 MW of thermal (202 MW new peaker), 300 MW of Storage and 484 MW of PV (utility & customer owned)

Observations

- By 2023 the local thermal resources cover the critical load (red band) and by 2024 almost the entire load.
- Counting PV + Storage the entire local load can be served
- The peakers in the area are several times the microgrid load (10.8 MW 2019), so in the detail implementation some of these resources can be deployed to the microgrid using units of the right size; e.g. 3 x 5 MW RICE instead of a 16 MW RICE used in the LTCE.

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MiniGrids Design: Local Generation: *Caguas MiniGrid*

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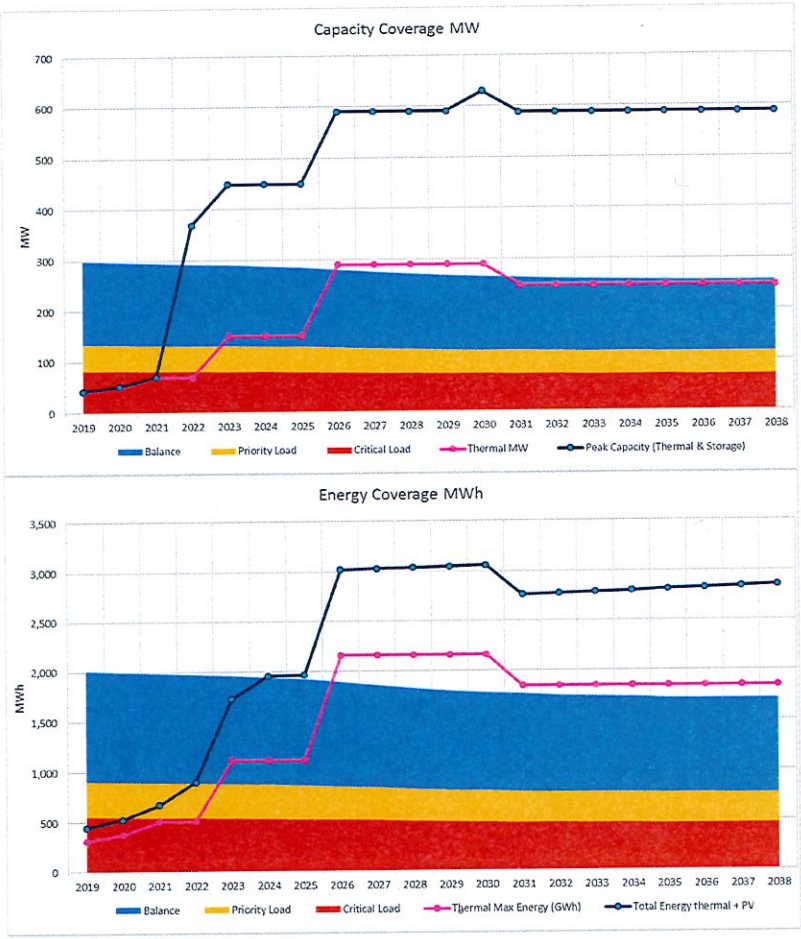

Resources

- The Caguas Area under Scenario 2 by 2026 is projected to have 290 MW of thermal (80 MW new peaker), 300 MW of Storage and 468 MW of PV (utility & customer owned)

Observations

- By 2023 the local thermal resources cover the critical load (red band) and by 2026 the entire load.
- Counting PV + Storage the entire local load can be served for the entire period
- There are currently no microgrids in the Caguas Area as the microgrids that could be assigned to it are associated with the Cayey MiniGrid and Carolina MiniGrid. However an microgrid in San Lorenzo may be required

Preliminary results subject to revision

MiniGrids Design: Local Generation: *Cayey MiniGrid*

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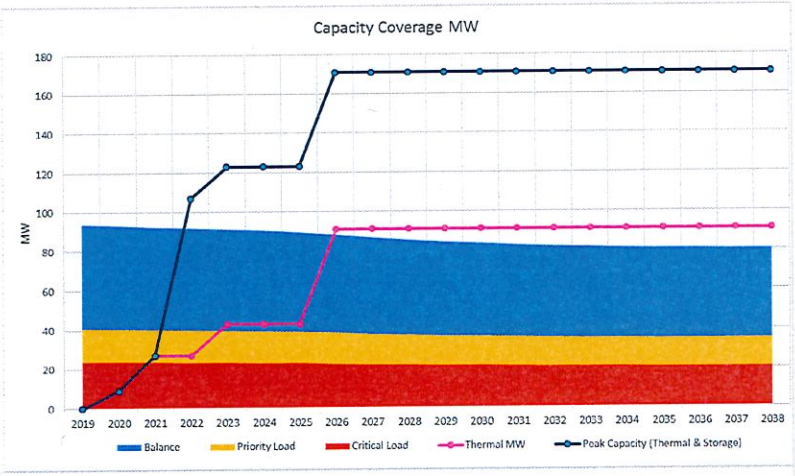

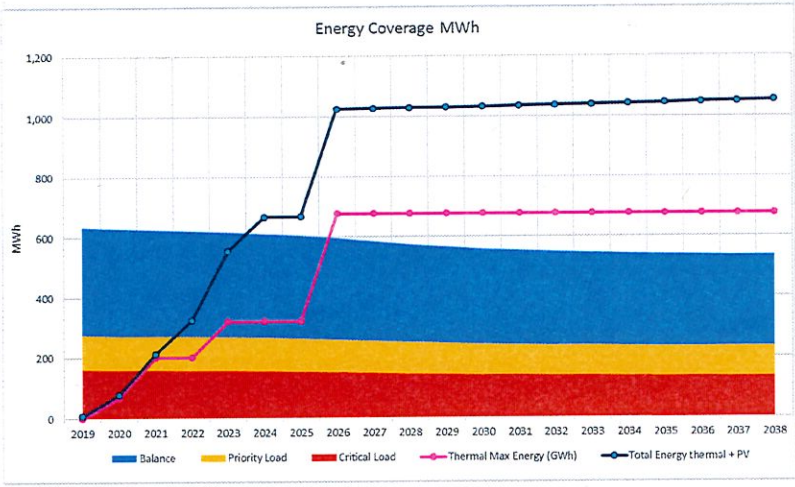

Resources

- The Cayey Area under Scenario 2 by 2026 is projected to have 91 MW of thermal (64 MW new peaker), 80 MW of Storage and 190 MW of PV (utility & customer owned)

Observations

- By 2021 the local thermal resources cover the critical load (red band) and by 2026 the entire load.
- 33.5% of the load in the footprint is under a potential microgrid. The new peakers in the area are several times the microgrid load (31.5 MW 2019), so in the detail implementation some of these resources can be deployed to the microgrid

Preliminary results subject to revision

MiniGrids Design: Local Generation: *Mayaguez North MG*

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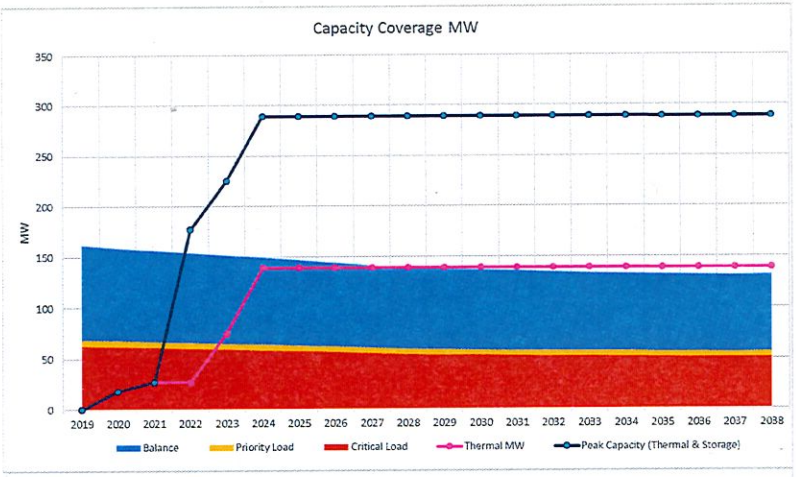

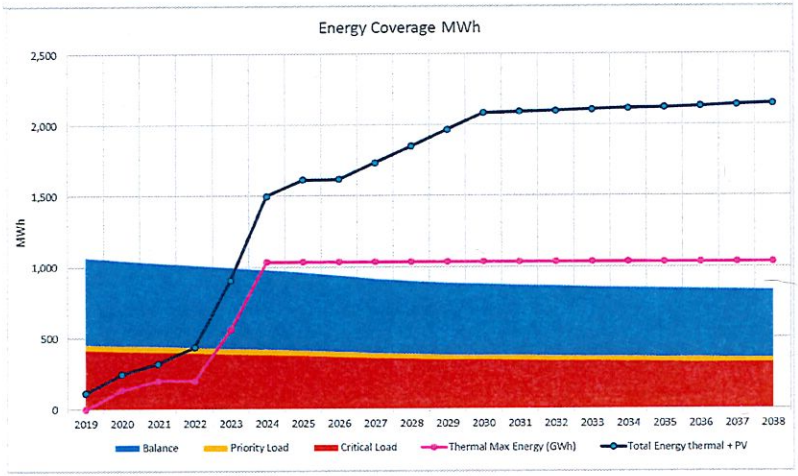

Resources

- The Mayaguez North Area under Scenario 2 by 2026 is projected to have 139 MW of thermal (112 MW new peaker), 150 MW of Storage and 318 MW of PV (utility & customer owned)

Observations

- By 2023 the local thermal resources cover the critical load (red band) and by 2024 almost the entire load.
- Counting PV + Storage the entire local load can be served
- The peakers in the area are several times the microgrid load (29.4 MW 2019), so in the detail implementation some of these resources can be deployed in the microgrid using units of the right size.

Preliminary results subject to revision

MiniGrids Design: Local Generation: *Mayaguez South MG*

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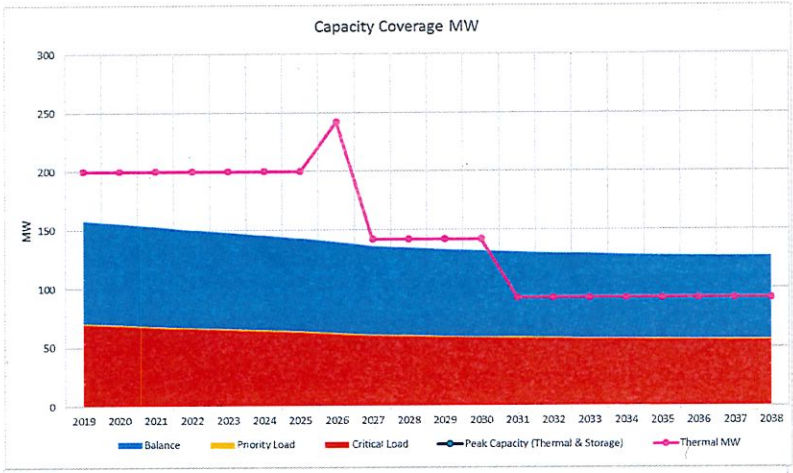

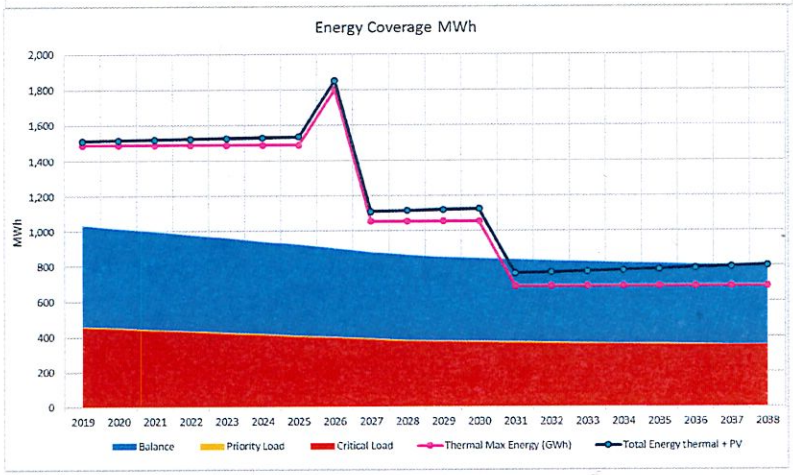

Resources

- The Mayaguez South Area under Scenario 2 by 2026 is projected to have 242 MW of thermal (42 MW new peaker), no Storage and 27 MW of PV (customer owned)

Observations

- From the onset the Aero Mayaguez covers the area load, however by 2031 there will be a deficit as this plant is retired under the LTCE. This is in line with Strategy 3 (the reserve drops to -30%), however this will be reassessed in the adjustment of the plan.
- The peakers in the area are twice the microgrid load (21MW 2019), so in the detail implementation some of these resources can be deployed in the microgrid using units of the right size. Additionally some storage may be reallocated to the microgrids.

Preliminary results subject to revision

MiniGrids Design: Local Generation: *Bayamon (SJ –Bay) MG*

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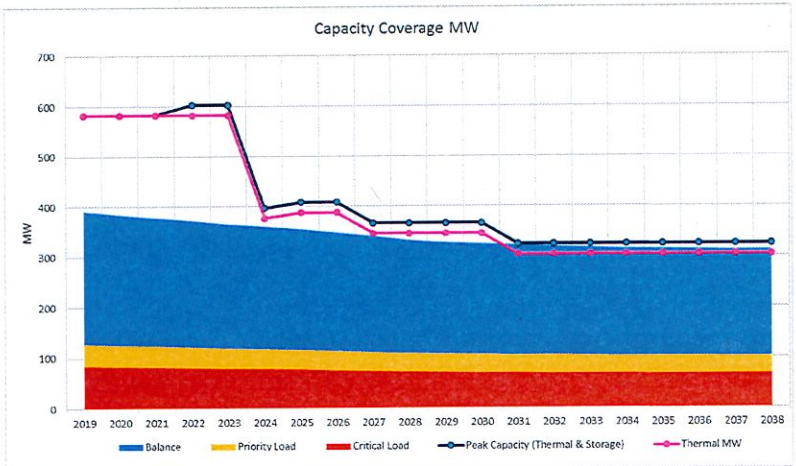

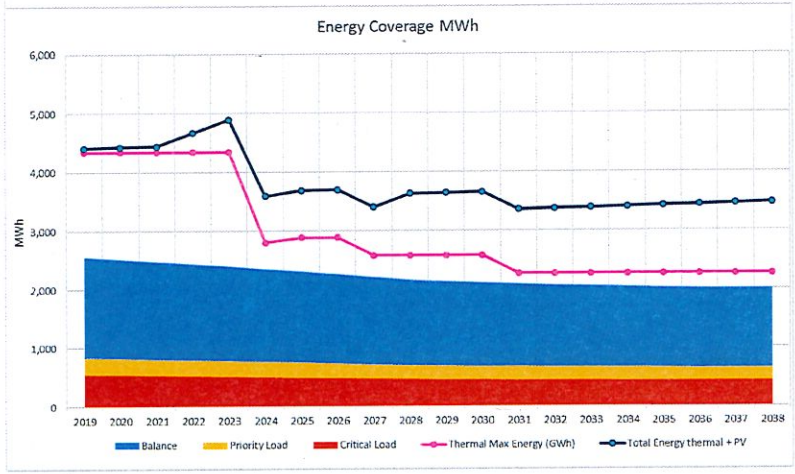

Resources

- Bayamon under Scenario 2 by 2026 is projected to have a new 388 MW of thermal (no new peaker and including a new CCGT at Palo Seco), 20 MW of Storage and 438 MW of PV (utility scale and customer owned)

Observations

- The load in Bayamon is expected to be covered for all the forecast period, even considering the retirements.
- No peakers were assigned to the area so some reallocation will be required to cover the microgrid load in the area (17.1 MW 2019).

Preliminary results subject to revision

MiniGrids Design: Local Generation: *San Juan (SJ –Bay) MG*

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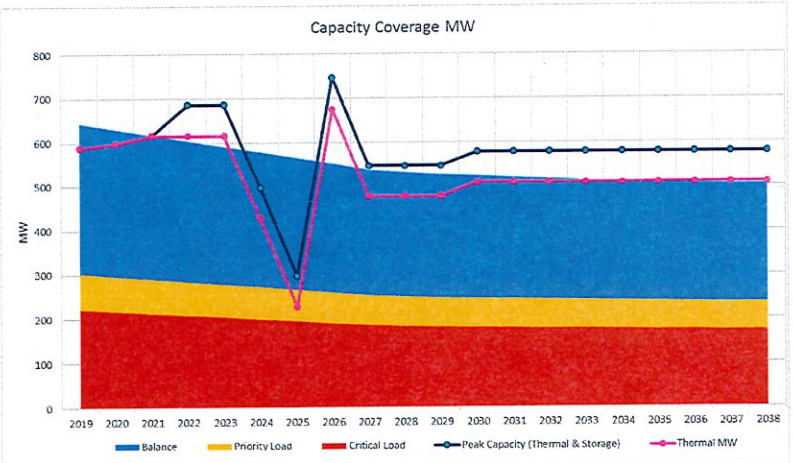

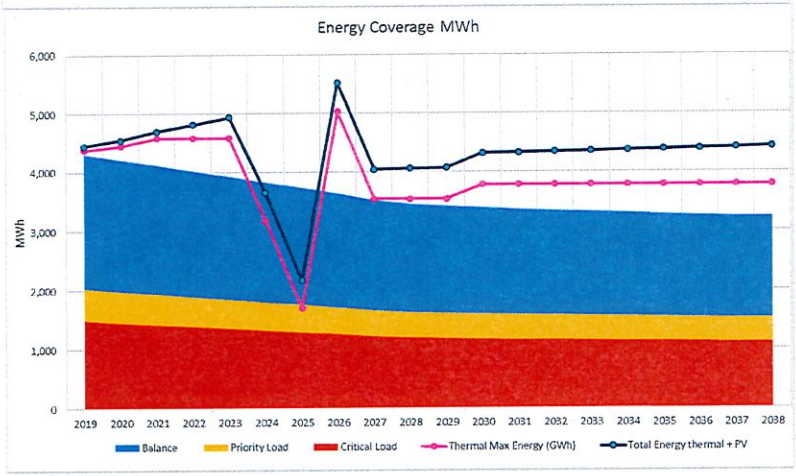

Resources

- San Juan under Scenario 2 by 2026 is projected to have 676 MW of thermal (32 MW of new peaker), 70 MW of Storage and 267 MW of PV (utility scale and customer owned)

Observations

- The LTCE retired all the steam generation in SJ and SJ 6 in 2025, but did not install the new CCGT unit until 2026, this creates a large drop in reserves (-47%). This will be fixed adjusting the LTCE **but it illustrates how the LTCE is just a tool for experts to work with**
- After 2026 there is full coverage of the load.
- The peakers assigned to the area are not enough so some reallocation will be required to cover the microgrid load in the area (92.3 MW 2019*)

* Caraizo, Villa Betina, Conquistador, Encantada & Q Negritos

Preliminary results subject to revision

MiniGrids Design: Local Generation: *Ponce*

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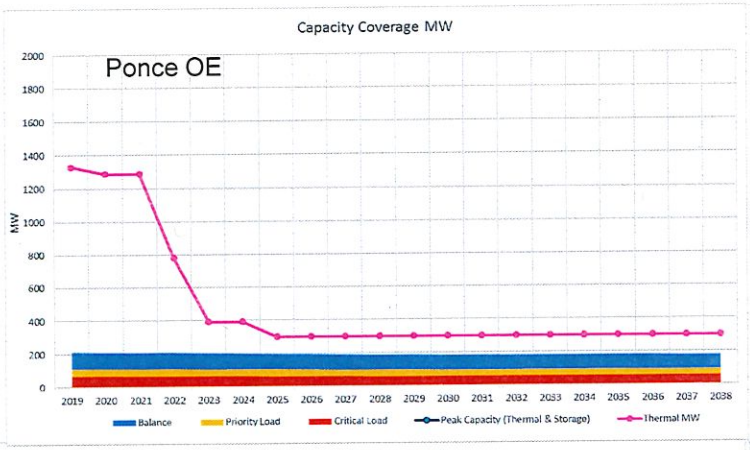

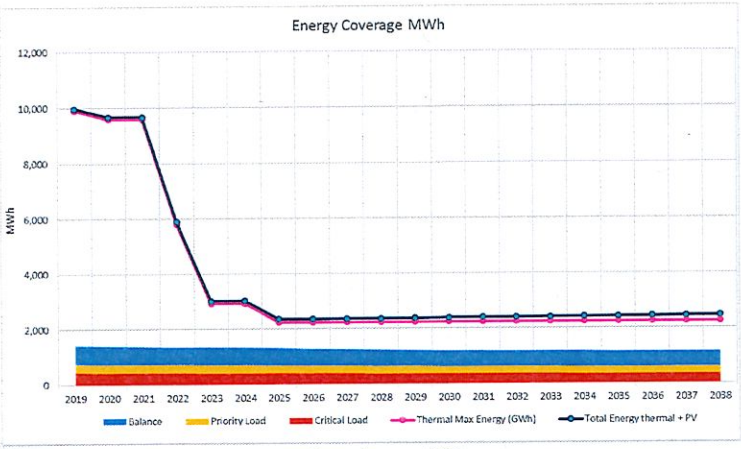

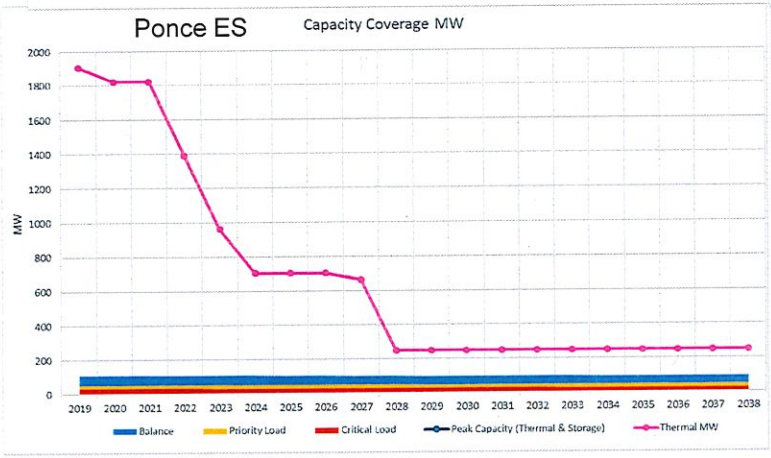

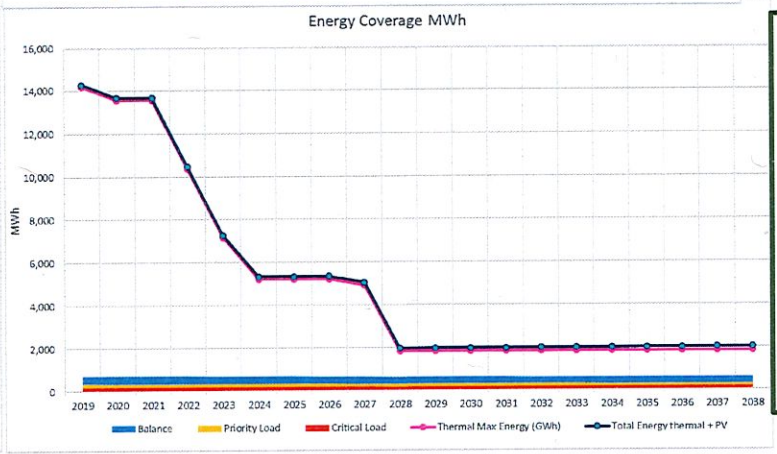

Resources

- Ponce ES under Scenario 2 by 2026 is projected to have 703 MW of thermal and Ponce OE 302 MW, no storage or utility scale PV

Observations

- Approximately 40 MW of microgrid load to be served from resources re-assigned to the area
- There is wide coverage of the existing load.

Preliminary results subject to revision

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MiniGrids Design: Transmission 115 kV

- There are 135 115 kV projects being analyzed in the context of the IRP and the MiniGrids under the different focus categories and encompasses activities ranging from reconstruction to new lines as highlighted below.

	Arecibo	Bayamón	Caguas	Carolina	Isla	Mayaguez	Ponce	San Juan	Total
Minigrid Main Backbone	6	10	13	13	3	11	6	10	**72**
Interconnection of Critical Loads	0	0	0	1	0	0	0	0	**1**
Interconnection of Minigrids	0	0	1	0	3	0	0	0	**4**
Minigrid Backbone Extensions to Cre	0	0	1	3	0	0	0	2	**6**
Existing Infrastructure Hardening for I	10	5	7	5	10	4	1	10	**52**
Total	**16**	**15**	**22**	**22**	**16**	**15**	**7**	**22**	**135**

Arecibo	**16**
Hardening/Switchyard Replacement	3
Line Hardening/Reconstruction	8
New Transmission Line	1
New Underground Construction	2
Switchyard Hardening/Reconstruction	2
Bayamón	**15**
Hardening/Switchyard Replacement	4
Line Hardening/Reconstruction	6
New Underground Construction	1
Switchyard Hardening/Reconstruction	4

Caguas	**22**
Hardening/Switchyard Replacement	7
Line Hardening/Reconstruction	8
New Transmission Line	1
New Underground Construction	5
Switchyard Hardening/Reconstruction	1
Carolina	**22**
Hardening/Switchyard Replacement	5
Line Hardening/Reconstruction	5
New Submarine Cable	3
New Switchyard	2
New Underground Construction	5
Switchyard Hardening/Reconstruction	2

Preliminary results subject to revision

MiniGrids Design: Transmission 115 kV

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- 135 115 kV projects continued...

	Arecibo	Bayamón	Caguas	Carolina	Isla	Mayaguez	Ponce	San Juan	Total
Minigrid Main Backbone	6	10	13	13	3	11	6	10	**72**
Interconnection of Critical Loads	0	0	0	1	0	0	0	0	**1**
Interconnection of Minigrids	0	0	1	0	3	0	0	0	**4**
Minigrid Backbone Extensions to Cre	0	0	1	3	0	0	0	2	**6**
Existing Infrastructure Hardening for I	10	5	7	5	10	4	1	10	**52**
Total	**16**	**15**	**22**	**22**	**16**	**15**	**7**	**22**	**135**

Mayaguez	**15**
Hardening/Switchyard Replacement	5
Line Hardening/Reconstruction	8
Switchyard Hardening/Reconstruction	2
Ponce	**7**
Hardening/Switchyard Replacement	2
Line Hardening/Reconstruction	4
Switchyard Hardening/Reconstruction	1

San Juan	**22**
Hardening/Switchyard Replacement	6
Line Hardening/Reconstruction	10
New Underground Construction	3
Other	1
Switchyard Hardening/Reconstruction	2

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MiniGrids Design: Transmission 115 kV

- One of the most important investments are those associated with new transmission lines / underground cables, which are presented below by Area and technical justification.

Project Description	Technical Justification
Arecibo	
New 115 kV Underground Circuit Cambalache TC – Barceloneta TC @2750 kcmil Cu XLPE	Backbone
New 115 kV Underground Circuit Vega Baja TC – Manati TC @2750 kcmil Cu XLPE	Backbone
Bayamón	
New 115 kV Underground Circuit Palo Seco Steam Plant – Dorado TC @2750 kcmil Cu XLPE	Backbone
Caguas	
Construction of 115 kV Line 37800 for Bairoa TC @ 1192.5 kcmil ACSR	Backbone
New 115 kV Underground Circuit Caguas TC/Bairoa TC – Monacillo TC @2750 kcmil Cu XLPE	Minigrid Interconnection
New 115 kV Underground Circuit Humacao TC - Juncos TC @ 2750 kcmil Cu XLPE	Backbone
New 115 kV Underground Circuit Juncos TC – Caguas TC/Bairoa TC @2750 kcmil Cu XLPE	Backbone
New Underground Line 115 kV Yabucoa TC- Humacao TC @ 2750 kcmil Cu XLPE	Backbone
Underground 115 kV Line Yabucoa TC - Sun Oil - Juan Martin Sect @ 2750 kcmil Cu	Backbone
Carolina	
New 115 kV Underground Circuit Canóvanas TC – Palmer TC@2750 kcmilCu XLPE	Backbone
New 115 kV Underground Line Fajardo TC - New Dos Marinas 115 kV Sect. GIS (to connect to r	Backbone
New 115 kV Underground Circuit Daguao TC – Fajardo TC@ 2750 kcmil Cu XLPE	Critical Load Connection
San Juan	
Line 40500 extension to Interconnect Venezuela TC GIS @2750 kcmil Cu XLPE	Backbone
New Underground 115 kV Line Martin Peña GIS - Berwind TC @ 2750 kcmil Cu XLPE	Backbone
New Underground 115 kV Line Sabana Llana TC- Berwind TC @ 2750 kcmil Cu XLPE	Minigrid Interconnection

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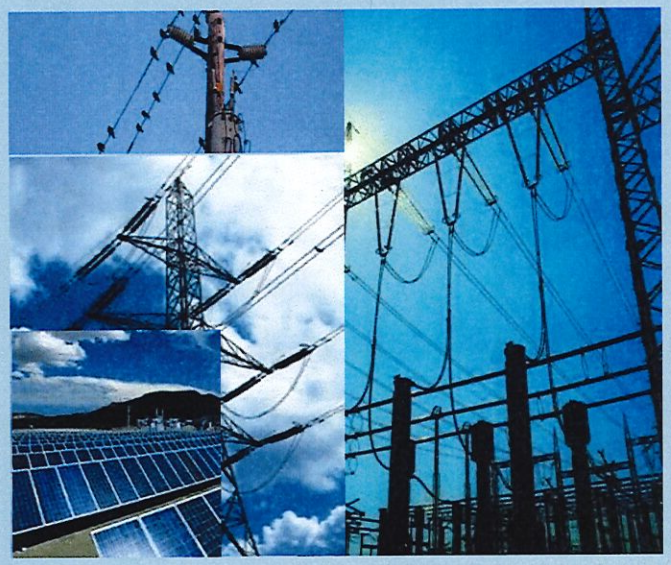

Thank You