

Draft Electric Resource Plan 2009 – 2018 Technical Workshop

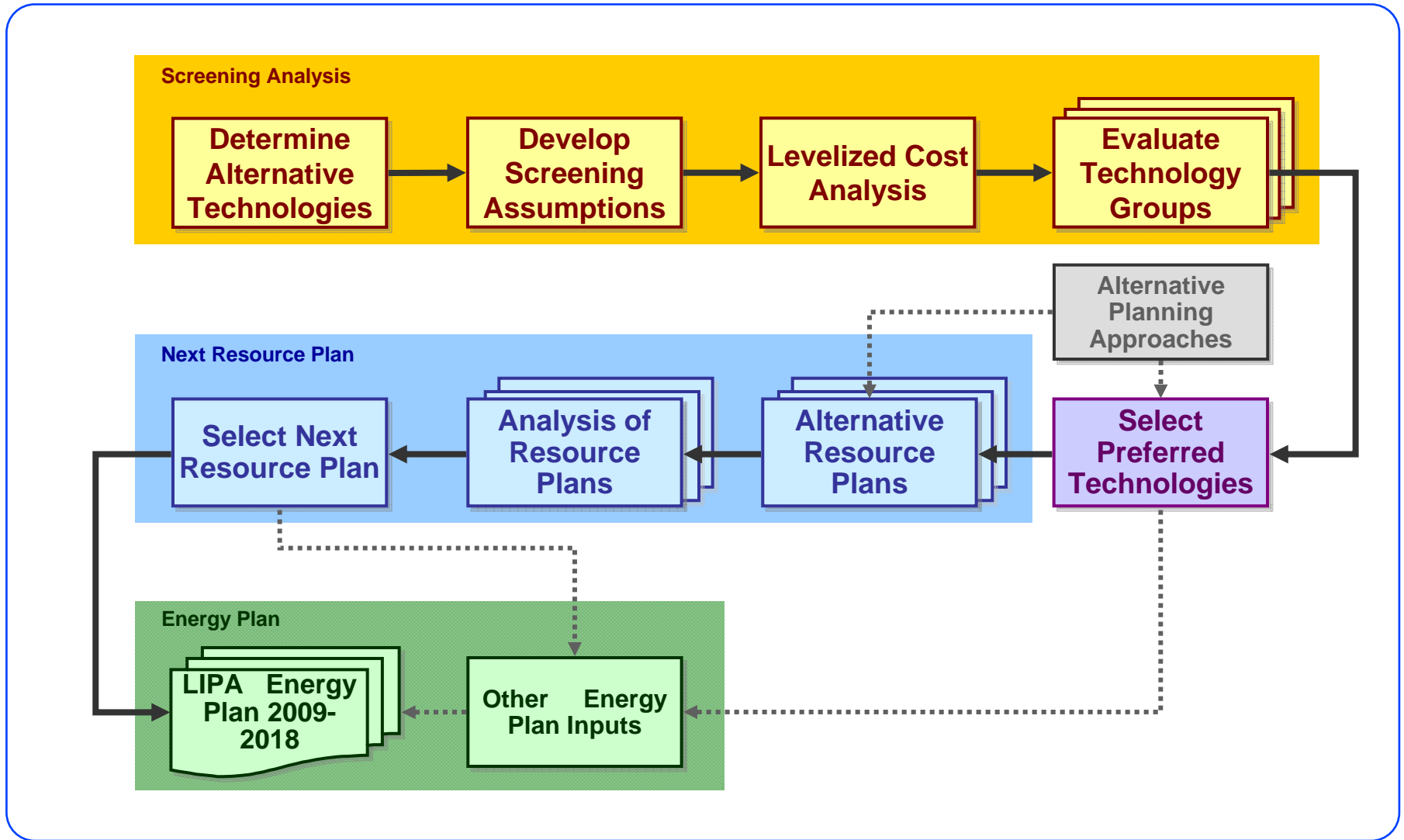


Alternative Plans Analysis

June 15, 2009

Resource Planning Process Overview

Process Methodology



Development of the Electric Resource Plan

Simulation Models



- Detailed computer simulation models are used to capture the costs and benefits of alternative plans.
 - ▶ **Capacity Market Model** – Models the need for new resources, determines the timing of new resources and projects the prices in the capacity markets.
 - ▶ **Production Simulation Model** – Models the detailed operation of the NYISO, ISO-NE and PJM Interconnection power systems including transmission constraints, individual plant operation, Location Based Marginal Pricing (LBMP) and Transmission Congestion Contracts (TCC). Data from this model is used to extract detailed information related to LIPA’s transactions in the ISO markets and the fuel consumptions and air emissions of each generating unit.
 - ▶ **Power Purchase Contract Model** – Simulates the finances of Independent Power Producers to project the price that LIPA might be charged for a contract for a specific type of generating unit.
 - ▶ **Financial Model** – Integrates the financial data from the above models to determine the projected integrated impacts on revenue requirements, average rates and average customer bills.

Development of the Electric Resource Plan

Evaluation Metrics

- In order to assess the benefits of each alternative planning option, LIPA has established a list of metrics or criteria that are important for designing a successful electric plan.

Exhibit 9-1 Evaluation Metrics

Economic
Net Present Value (NPV) total revenue requirements in 2009 dollars
Annual revenue requirements
Annual average electric rates
Production Efficiency
Average heat rate of LIPA contracted resources
Reliability Metrics
Surplus or deficit compared to probability weighted NYSRC Total Statewide Requirements for LIPA
Surplus or deficit compared to probability weighted NYISO Locational Requirement for
Environmental Metrics
Projected SO ₂ allowances compared to SO ₂ emissions from LIPA contracted units
Projected NO _x allowances compared to NO _x emissions from LIPA contracted units
Energy weighted share of statewide CO ₂ RGGI emissions allowances compared to CO ₂ emissions from LIPA contracted units
Total LIPA footprint of CO ₂ emissions from LIPA contracted units plus market purchases of energy at ISO/RTO incremental emissions per MWh
Assess alternative plans on \$/ton carbon reduced or increased from the Reference Plan

Development of the Electric Resource Plan

Reference Plan Description

- The Reference Plan is a hypothetical plan that establishes a benchmark for comparison against other plans. These alternative plans are developed to evaluate differing approaches to meeting the projected resource need.
- This Reference Plan does not represent LIPA's preferred plan, but is simply a means to measure the relative attractiveness of the alternative plans. Alternative plans are developed to test various strategies such as:
 - ▶ Relying upon specific types of resources such as energy efficiency, repowering, or renewables;
 - ▶ Achieving certain objectives such as reducing CO₂ emissions, minimizing rate impacts or reducing the impacts of fuel price volatility; or
 - ▶ Combining strategies based on the information gained from evaluating other strategies.

Development of the Electric Resource Plan

Reference Plan Description



Exhibit 9-2 Summary of Plans – Reference Plan

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
A	Reference Plan	None	None	None	None	None	8 501G Starting in 2014	None	None	None

Exhibit 9-3 Dashboard Results – Reference Plan

Plans	Reliability		Cost		Case (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions			
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req., NPV	Avg. of Ann. Rev Rate (Cents/kWh)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Net Cost (Savings) per Footprint Reduction (\$/ton)*
A) Reference Plan	3,191	20	115.7	66.9	22.7	24.7	30.5	9,013	8,099	20	20	6	0	191	295	-

Development of the Electric Resource Plan Analysis Groups

- The analysis groups are as follows
 - ▶ **Renewable Portfolio Standard Group** – This group evaluates the impact of using different Renewable Portfolio Standard Targets
 - ▶ **Energy Efficiency Group** – This group evaluates the impact of using different levels of energy efficiency
 - ▶ **Repowering Groups** – This consists of 5 groups of alternative plans that study the performance of repowering, repowering financing options, and technology options at the major sites.
 - ▶ **Retirement Options** – This examines the performance of plans that involve retiring power plants at various sites.
 - ▶ **Efficiency/Repowering Combinations** – Examines the interaction of repowering and energy efficiency.
 - ▶ **Alternative Strategies** – The above groups mostly focused on a single strategy like renewables, energy efficiency or repowering. The two Alternative Strategy groups examine how different strategies, including those that combine options from multiple groups compare with each other. Phase I group were performed first and then knowledge gained from the Phase I group was used to create the Phase II group.

- This analysis shows the worst case impact of RPS on customer costs and the best case on CO₂ reduction potential.
 - ▶ As is demonstrated in other Plan Groups, the costs of CO₂ reductions from RPS alone are higher than when RPS is combined with energy efficiency.
- Implementation of the 25% RPS is projected to increase average customer rates by an average of 0.3 cents or 1.3% over the study period and reduce CO₂ footprint tons by 30 million tons or 10.2%.
- Implementation of the 30% RPS is projected to increase average customer rates by an average of 0.5 cents or 2.2% over the study period and reduce CO₂ footprint tons by 42 million tons or 14.2%.
- The cost per ton of implementing RPS programs is higher than the CO₂ allowance cost per ton that is projected to result from proposed Climate Change Legislation.

Findings

Energy Efficiency Group

- The benefits of energy efficiency will be even greater if LIPA implements a program to reach the 30% RPS goal.
- Relative to the Reference Plan with 25% RPS, Energy Efficiency saves customers money and reduces average customer bills. However average rates increase.
- Taken in isolation, end use energy efficiency decreases Long Island Power production efficiency.
- Energy efficiency helps reduce the CO₂ emissions from LIPA contractual plants.
- Energy efficiency helps reduce LIPA's CO₂ footprint.

Findings

Repowering Group

- Repowering with conventional independent power producer financing increase costs to customers. The costs increases are smallest for Barrett, then Port Jefferson and then Northport (Section 9.4.1)
- The results of using 7FA, 7FB and 501G technologies are very close. This indicates that if LIPA issues a repowering RFP, the technology used for repowering should be left open to allow selection of the most cost effecting technology as part of the RFP (Sections 9.4.2, 9.4.4 and 9.4.5)
- Repowering two units instead of one during repowering tends to increase costs to consumers, improve power production efficiency and can have mixed results on CO₂ footprint emissions.(Sections 9.4.2 and 9.4.5)
- Using tax exempt financing for repowering saves customers money compared to taxable financing of repowering or taxable financing of new green field power plants. (Section 9.4.3)
- Once through cooling is economically preferable and can improve power production efficiency and in some cases reduce footprint CO₂ emissions. However, it is unclear whether environmental regulations will allow licensing of this technology. (Sections 9.4.4 and 9.4.5)

- Given the assumptions used for these scenarios, retirement increases costs and rates by a small percentage. However, if major environmental upgrades or costly repairs not captured in this analysis are required at a unit, retirement may be a breakeven or cost beneficial decision.
- Retirement of Far Rockaway is least costly to LIPA customers, followed by retirement of Glenwood 4&5 and then by the retirement of Barrett 1.
- Retirement has the benefit of improving production efficiency, and reducing Footprint CO₂ emissions.
- Retirement of Barrett 1 and Repowering of Barrett 1 with a 501 G combined cycle unit produce almost identical results, the only difference is due to costs specific to the site at which the 501 G plant is constructed (e.g., the repowered 501G at Barrett compared with a green field 501 G at another site located on Long Island).

- Increased energy efficiency delays the need for new units or repowering and thus defers the losses incurred by repowering. However it also defers the environmental benefits from repowering.
- Repowering increases the customer cost savings from increased energy efficiency, but also reduces the environmental benefits obtained from increased levels of energy efficiency programs.
- While repowering and increased energy efficiency have a tendency to reduce the benefits of the other activity, the combined strategy still produces savings for LIPA's customers while reducing the overall level of environmental emissions.

- The lowest total customer cost plans are the 15 x 15 Plan and the Market Access Focus Plan which both contain the 15 x 15 program. These plans also have the benefit of reducing CO₂ emissions while reducing customer costs.
- The Reference Plan has the lowest rate among all of the plans considered, but is about \$12 billion more expensive to consumers than the most cost effective plans. All other plans result in higher rate increases relative to the Reference Plan.
- The CEI + Repowering Focus Plan and Environmental Focus Plan have the best power production efficiency because of their reliance upon repowering.
- The best performing plans from a CO₂ emissions perspective rely heavily upon zero emission technologies such as renewable and nuclear power. However, these technologies are expensive and make these plans the most expensive evaluated in this group.

- A detailed study of the implications on reliability and costs should be considered before selecting a plan that bans the use of oil.
- All of the new Phase II plans are much more cost effective than the Environmental Focus Plan and the Reference Plan. However, rates are higher than the Reference Plan.
- All of the new Phase II plans are much more effective at reducing CO₂ footprint emissions than the 15 x 15 Plan. In aggregate, consumers save money for each ton of emissions reduced in each of these plans.
- The 15x15 Retirement Plan creates a long term supply surplus that would be difficult to justify.
- The greatest long term improvement in production efficiency comes from the Representative Plan and Representative Plan with Oil Ban.
 - ▶ With the exception of the Representative Plan with Oil Ban Plan, any of the alternative plans introduced in Phase II could justifiably be selected to be the Representative Plan.
 - ▶ The Representative Plan was selected because it provides the greatest CO₂ footprint reductions, the best power plant efficiency improvement while, relative to the Reference Plan saving customers money over the long term.

Development of the Electric Resource Plan

Representative Plan

Exhibit 9-27 Representative Plan

1. Energy Efficiency

- ? Endorse adoption of a LIPA 15 x 15 plan
 - End-use efficiency
 - ELI
 - Additional DSM to close remaining gap
 - Generation efficiency
 - T&D efficiency
 - Smart Meters
 - Efficient Electro-Technologies

2. Renewable Resources

- ? Endorse adoption of a LIPA RPS program that supports statewide goal of 30% renewables by 2015
- ? Off-Island Renewable RFP
- ? On-Island Resources
 - Wind (regional and backyard)
 - PV 50 MW RFP and successors
 - Net Metering Program
 - Expansion of Solar Rebate
- ? Utilize renewables to enhance fuel diversity

3. Upgrade Existing Fleet

- ? Repower older plants to address environmental and efficiency issues
- ? Competitive procurement of green field plants and repowering/retirement
- ? Retire some of older steam plants
- ? Study best site for Peaking Unit retirements
 - Issue RFP for new 10-minute reserve
 - Retire targeted units

4. Improve Interconnections & Reliability

- ? Proceed with NUSCO Upgrade
- ? Study to examine membership in NYISO, PJM, or ISO-NE
- ? Target new interconnections with best ISO System
- ? SmartGrid System

Legend:



Modeled in Representative Plan

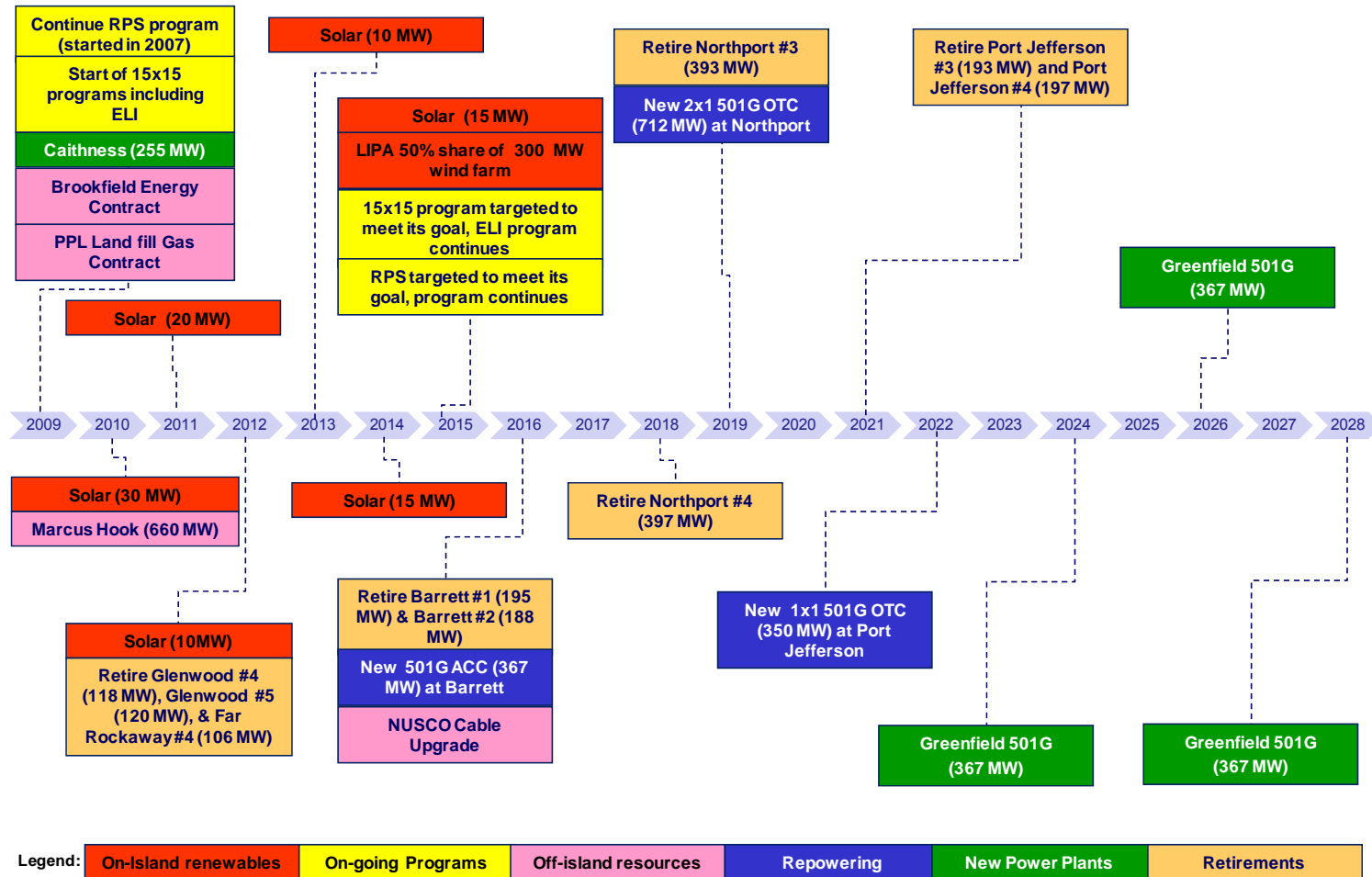


Not Modeled in Representative Plan

Development of the Electric Resource Plan

Representative Plan Timeline

Exhibit 9-28 Representative Plan Timeline



End of Presentation

Discussion

Target Completion Time **2:50 pm**

- Discussion on Alternative Plans Analysis
- Process Check

Next Up

- Opening Remarks
- Overview of Workshop Format
- Overview of Electric Resource Plan
- *Break*
- Review of Modeling System and Assumptions
- Energy Efficiency
- Need Analysis
- *Lunch*
- Technology Screening
- Alternative Plan Analysis
- *Break*
- **Action Plan**
- **Policy Input**
- **Input on Workshop Approach**

Summary of Plans

- Exhibit 9-5 shows the three alternative plans used to investigate the impacts of different levels of RPS programs. The scenarios are identical to the Reference Plan except that they have different levels of RPS programs. All three scenarios assume no energy efficiency programs, no repowering or retirement of existing units and no additional interconnections. Since the RPS program purchases RECs as well as renewable energy but not capacity, the expansion plans for all scenarios are identical.

Exhibit 9-5 Summary of Plans – RPS Group

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
A	Reference Plan	None	None	None	None	None	8 501G Starting in 2014	None	None	None
B	Reference Plan 25% RPS	None	25% x 2013	None	None	None	8 501G Starting in 2014	None	None	None
C	Reference Plan 30% RPS	None	30% x 2015	None	None	None	8 501G Starting in 2014	None	None	None

Results



- Exhibit 9-6 displays the dashboard results for the three alternative plans.
- The first line shows the absolute values for each metric of the Reference Plan. The second and third line shows the change between the Reference Plan and the alternative plans. These changes are calculated by subtracting the alternative plan from the Reference Plan. The compliance indicators (red, green or yellow boxes) are not subtracted since differences in these indicators are relatively easy to determine.

Exhibit 9-6 RPS Group – Results and Findings (2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met			CO ₂ Emissions			
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req. NPV	Avg. of Ann. Rev Rate (Cents/KW)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/KWh)	Avg. LI Sys Heat Rate, 2028 (BTU/KWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Net Cost (Savings) per Footprint Reduction (\$/ton)*
A) Reference Plan	3,191	20	115.7	66.9	22.7	24.7	30.5	9,013	8,099	20	18	6	0	191	295	-
B) Reference Plan 25% RPS	0	20	1.7	0.8	0.3	0.0	0.0	0	0	20	18	6	0	0	-30	57
C) Reference Plan 30% RPS	0	20	2.4	1.2	0.5	0.0	0.0	0	0	20	18	6	0	0	-42	57

Summary of Plans

- Exhibit 9-7 shows the four alternative plans used to investigate the impacts of different levels of Energy Efficiency programs. All four of the plans assume that LIPA continues to pursue implementation of the current 25% RPS program. Since energy efficiency reduces the amount of renewable energy needed to meet the RPS targets, the benefits of energy efficiency will be even greater if LIPA implements a program to reach the 30% RPS goal. None of the plans have any specific wind, fuel cell or solar PV projects. They also do not have any repowering, retirements or additional interconnections.

Exhibit 9-7 Summary of Plans – Efficiency Options

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
B	Reference Plan 25% RPS	None	25% x 2013	None	None	None	8 501G Starting in 2014	None	None	None
D	Continue CEI	CEI	25% x 2013	None	None	None	7 501G Starting in 2015	None	None	None
E	ELI	ELI	25% x 2013	None	None	None	5 501G Starting in 2016	None	None	None
F	15 x 15	15 x 15	25% x 2013	None	None	None	2 501G Starting in 2025	None	None	None

- Exhibit 9-8 displays the dashboard results for the alternative efficiency option plans, which is a similar dashboard to the one previously displayed. The first line of Exhibit 9-8 differs in that it shows the absolute values for the Reference Plan 25% RPS instead of the Reference Plan. Similar to the previously discussed dashboard, the remaining lines show the change between the alternative plans and the Reference Plan 25% RPS.

Exhibit 9-8 Efficiency Options - Results and Findings (2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions		
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req., NPV	Avg. of Ann. Rev Rate (Cents/kW)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Net Cost (Savings) per Footprint Reduction (\$/ton)*
B) Reference Plan 25% RPS	3,191	20	117.4	67.8	23.0	24.7	30.5	9,013	8,099	20	18	6	0	191	265	-
D) Continue CEI	-367	20	-2.1	-1.0	0.1	-0.7	-0.7	75	-30	20	16	6	0	-5	-4	-460
E) ELI	-1,101	20	-6.0	-2.8	0.1	-1.5	-1.9	294	171	20	16	7	0	-9	-6	-1,042
F) 15x15	-2,202	20	-13.2	-6.2	0.9	-4.0	-5.0	703	800	20	19	13	0	-47	-21	-631

Repowering Options - Summary of Plans

- The Repowering Options Group is designed to assess repowering of Barrett, Port Jefferson and Northport using combined cycle units with air cooled condensers (ACC). It is assumed that completely new plants are built at the plant location and an existing unit or units are retired.

Exhibit 9-9 Summary of Plans – Repowering Options

Plan ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
1	ELI	ELI	25% x 2013	None	None	None	5 501G Starting in 2016	None	None	None
2	ELI + Repower Barrett 1 with 2x1 7FA	ELI	25% x 2013	None	None	None	4 501G Starting in 2019	Barrett 1 2016	None	None
3	Port Jefferson 3 Repowering 7FB ACC	ELI	25% x 2013	None	None	None	5 501G Starting in 2017	Port Jefferson 2016	None	None
4	Northport 1 Repowering 3x1 7FB ACC	ELI	25% x 2013	None	None	None	4 501G Starting in 2020	Northport 2016	None	None

Repowering Options - Results

- Exhibit 9-10 displays the dashboard results for the Repowering Options plans. The first line of Exhibit 9-10 shows the absolute values for the ELI Plan. Similar to the previously discussed dashboard, the remaining lines show the change between the alternative plans and the ELI Plan.

Exhibit 9-10 Repowering Options – Results and Findings (2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions		
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req., NPV	Avg. of Ann. Rev Rate (Cents/kW)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mT ons)	Cum Footprint (mT ons)	Net Cost (Savings) per Footprint Reduction (\$/ton)*
E) ELI	2,090	20	111.5	65.0	23.1	23.2	28.6	9,307	8,269	20	16	7	0	172	259	-
G) ELI + Repower Barrett 1 with 2x1 7FA ACC	131	20	0.4	0.2	0.1	0.0	0.0	-198	-176	20	20	7	0	-3.4	-11	41
H) Port Jefferson 3 Repowering 7FB ACC	237	20	1.1	0.6	0.2	0.0	0.0	-280	-71	20	20	7	0	0.3	-4	292
I) Northport 1 Repowering 3x1 7FB ACC	368	20	1.3	0.7	0.3	0.0	0.0	-499	-271	20	20	7	0	0.1	-8	178

Repowering Options - Results

- In general, repowering to varying degrees has the effect of increasing the power output from the repowered stations deferring the need for new “greenfield” generation, increasing the revenue requirements from customers, increasing the rates of customers, improving the power production efficiency, and reducing the amount of CO₂ emissions.
- Compared to the ELI Plan, the repowering programs presented here result in improved power production efficiency and reduced CO₂ emissions.
- Total revenue required and the resulting electric rates increase in comparison the ELI Plan while sales remains the same.
- Compared to the ELI Plan, customers would incur additional costs totaling approximately \$0.4 billion under the Barrett 1 Repowering Plan, \$1.1 billion under the Port Jefferson 3 Repowering Plan, and \$1.3 billion under the Northport 1 Repowering Plan.

Barrett Alternatives Group - Summary of Plans

- Exhibit 9-11 shows three alternative plans used for the assessment of different repowering technologies at the Barrett power plant. All three scenarios are identical in having the ELI efficiency program and 25% RPS program, but differ by using different repowering technology configurations. Because the net change in power output at the stations varies from plan to plan, the timing of the expansion plan after the repowering may vary.

Exhibit 9-11 Summary of Plans – Barrett Repowering Technology Alternatives

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
G	ELI + Repower Barrett 1 with 2x1 7FA	ELI	25% x 2013	None	None	None	4 501G Starting in 2019	Barrett 1 2016	None	None
J	ELI + Repower Barrett 1 with 501G ACC	ELI	25% x 2013	None	None	None	4 501G Starting in 2018	Barrett 1 2016	None	None
K	ELI + Repower Barrett 1 & 2 with 2x1 7FA	ELI	25% x 2013	None	None	None	5 501G Starting in 2018	Barrett1& 2 2016	None	None

Barrett Alternatives Group - Results

- Exhibit 9-12 displays the dashboard results for the Barrett Repowering Technology Alternatives plans. The first line of Exhibit 9-12 shows the absolute values for the ELI + Repower Barrett 1 with 2x1 7FA - ACC plan the remaining lines show the change between the alternative plans and the ELI + Repower Barrett 1 with 2x1 7FA - ACC Plan.

Exhibit 9-12 Barrett Repowering Technology Alternatives – Results and Findings (2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions		
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req., NPV	Avg. of Ann. Rev Rate (Cents/kW)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Net Cost (Savings) per Footprint Reduction (\$/ton)*
G) ELI + Repower Barrett 1 with 2x1 7FA	2,221	20	111.9	65.2	23.2	23.2	28.6	9,109	8,093	20	20	7	0	169	248	-
J) ELI + Repower Barrett 1 with 501G ACC	-131	20	0.1	0.0	0.0	0.0	0.0	-146	25	20	19	7	0	1.0	6	-13
K) ELI + Repower Barrett 1 & 2 with 2x1 7FA	367	20	0.6	0.3	0.1	0.0	0.0	-286	-90	20	20	7	0	0.9	31	-18

Finance Alternatives Group - Summary of Plans

Exhibit 9-13 Summary of Plans – Repowering Finance Alternatives

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
J	ELI + Repower Barrett 1 with 501G ACC	ELI	25% x 2013	None	None	None	4 501G Starting in 2018	Barrett 1 2016	None	None
L	ELI + Tax Exempt Repower Barrett 1 with 501G	ELI	25% x 2013	None	None	None	5 501G Starting in 2016	Barrett 1 2016	None	None
G	ELI + Repower Barrett 1 with 2x1 7FA	ELI	25% x 2013	None	None	None	4 501G Starting in 2019	Barrett 1 2016	None	None
M	ELI + Tax Exempt Repower Barrett 1 with 2x1 7FA	ELI	25% x 2013	None	None	None	4 501G Starting in 2019	Barrett1&2 2016	None	None
K	ELI + Repower Barrett 1 & 2 with 2x1 7FA	ELI	25% x 2013	None	None	None	5 501G Starting in 2018	Barrett1&2 2016	None	None
N	ELI + Tax Exempt Repower Barrett 1 & 2 with 2x1 7FA	ELI	25% x 2013	None	None	None	5 501G Starting in 2018	Barrett1&2 2016	None	None

Finance Alternatives Group - Results

- Exhibit 9-14 displays the dashboard results for the Repowering Finance Alternatives plans.

Exhibit 9-14 Repowering Finance Alternatives – Results and Findings (2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions			
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req. NPV	Avg. of Ann. Rev Rate (Cents/kW)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Reduction (\$/ton)*	Net Cost (Savings) per Footprint
J) ELI + Repower Barrett 1 with 501G ACC	2,090	20	112.0	65.3	23.2	23.2	28.6	8,963	8,118	20	19	7	0	170	255		
L) ELI + Tax Exempt Repower Barrett 1 with 501G	0	20	-0.8	-0.4	-0.2	0.0	0.0	0	0	20	19	7	0	0.0	0		
G) ELI + Repower Barrett 1 with 2x1 7FA	2,221	20	111.9	65.2	23.2	23.2	28.6	9,109	8,093	20	20	7	0	169	248	-	
M) ELI + Tax Exempt Repower Barrett 1 with 2x1 7FA	0	20	-1.1	-0.5	-0.2	0.0	0.0	0	0	20	20	7	0	0.0	0	-	
K) ELI + Repower Barrett 1 & 2 with 2x1 7FA	2,588	20	112.5	65.5	23.3	23.2	28.6	8,823	8,003	20	20	7	0	170	279	-	
N) ELI + Tax Exempt Repower Barrett 1 & 2 with 2x1 7FA	0	20	-1.2	-0.6	-0.2	0.0	0.0	0	0	20	20	7	0	0.0	0	-	

Port Jefferson Alternatives Group – Summary of Plans

- Exhibit 9-15 shows two alternative plans used for the assessment of different repowering technologies at the Port Jefferson power plant. Both scenarios are identical in the fact that they incorporate the ELI efficiency program and 25% RPS program, but they differ by using different repowering and cooling technology configurations. Because the net change in power output at the stations varies from plan to plan, the timing of the expansion plan after the repowering may vary.

Exhibit 9-15 Summary of Plans – Port Jefferson Repowering Technology Alternatives

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
H	Port Jefferson 3 Repowering 7FB ACC	ELI	25% x 2013	None	None	None	5 501G Starting in 2017	Port Jefferson 2016	None	None
O	Port Jefferson 3 Repowering 501G OTC	ELI	25% x 2013	None	None	None	5 501G Starting in 2018	Port Jefferson 2016	None	None

Port Jefferson Alternatives Group – Results

- Exhibit 9-16 displays the dashboard results for the Port Jefferson Repowering Technology Alternatives plans. The first line of Exhibit 9-16 shows the absolute values for the ELI + Port Jefferson 3 Repowering 7FB ACC Plan. The second line shows the change between the alternative plan and this plan.

Exhibit 9-16 Port Jefferson Repowering Technology Alternatives – Results and Findings (2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions		
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req., NPV	Avg. of Ann. Rev Rate (Cents/kWh)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Net Cost (Savings) per Footprint Reduction (\$/ton)*
H) Port Jefferson 3 Repowering 7FB ACC	2,327	20	112.6	65.6	23.3	23.2	28.6	9,027	8,199	20	20	7	0	172	255	
O) Port Jefferson 3 Repowering 501G OTC	113	20	-0.9	-0.4	-0.2	0.0	0.0	-67	-89	20	19	7	0	-0.4	-1	-1,334

Northport Alternatives Group – Summary of Plans

- Exhibit 9-17 shows four alternative plans used for the assessment of different repowering technologies at the Northport power plant. All four scenarios are identical in having the ELI efficiency program and 25% RPS program, but differ by using different repowering technology configurations. Because the net change in power output at the stations varies from plan to plan, the timing of the expansion plan after the repowering may vary.

Exhibit 9-17 Summary of Plans – Northport Repowering Technology Alternatives

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
I	Northport 1 Repowering 3x1 7FB ACC	ELI	25% x 2013	None	None	None	4 501G Starting in 2020	Northport 2016	None	None
P	Northport 4 Repowering 2x1 501G OTC	ELI	25% x 2013	None	None	None	4 501G Starting in 2020	Northport 2016	None	None
Q	Northport 1&2 Repowering 3x1 7FB ACC	ELI	25% x 2013	None	None	None	5 501G Starting in 2016	Northport 2016	None	None
R	Northport 3&4 Repowering 2x1 501G OTC	ELI	25% x 2013	None	None	None	5 501G Starting in 2016	Northport 2016	None	None

Northport Alternatives Group - Results

- Exhibit 9-18 displays the dashboard results for the Northport Repowering Technology Alternatives plans. The first line of Exhibit 9-16 shows the absolute values for the ELI + Northport 1 Repowering 3x1 7FB ACC Plan. The remaining lines show the change between the alternative plans and this plan.

Exhibit 9-18 Northport Repowering Technology Alternatives – Results and Findings (2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions			
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req., NPV	Avg. of Ann. Rev Rate (Cents/kW)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Reduction (\$/ton)*	Net Cost (Savings) per Footprint
I) Northport 1 Repowering 3x1 7FB ACC	2,458	20	112.8	65.7	23.4	23.2	28.6	8,808	7,998	20	20	7	0	172	252	-	-
P) Northport 4 Repowering 2x1 501G OTC	-23	20	-1.1	-0.5	-0.2	0.0	0.0	-28	-21	20	20	7	0	-0.8	-1	-1,331	-1,331
Q) Northport 1&2 Repowering 3x1 7FB ACC	367	20	0.8	0.4	0.2	0.0	0.0	-400	-116	20	20	7	0	2.1	4	-231	-231
R) Northport 3&4 Repowering 2x1 501G OTC	344	20	-0.2	-0.1	0.0	0.0	0.0	-418	-150	20	20	7	0	3.1	-6	-30	-30

Summary of Plans

- Exhibit 9-19 shows five alternative plans used for the assessment of different retirement options. All five scenarios are identical in having the ELI efficiency program and 25% RPS program, but differ by using different retirement options. Because the power output of the retired units varies from plan to plan, the timing and number of the expansion units varies from plan to plan.

Exhibit 9-19 Summary of Plans –Retirement Options

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
E	ELI	ELI	25% x 2013	None	None	None	5 501G Starting in 2016	None	None	None
S	Retire Barrett 1	ELI	25% x 2013	None	None	None	5 501G Starting in 2016	None	Barrett1 2016	None
T	Retire Far Rockaway	ELI	25% x 2013	None	None	None	5 501G Starting in 2015	None	Far Rock 2010	None
U	Retire Glenwood 4&5	ELI	25% x 2013	None	None	None	6 501G Starting in 2014	None	Glenwood 2010	None
V	Retire Glenwood 4&5 and Far Rockaway	ELI	25% x 2013	None	None	None	6 501G Starting in 2013	None	Far Rock 2010; and Glenwood 2010	None

Results

- Exhibit 9-20 displays the dashboard results for the Retirement Options plans. The first line of this exhibit shows the absolute values for the ELI Plan. Subsequent lines add the individual retirement of Barrett 1, Far Rockaway, Glenwood 4&5 and lastly the combined retirement of Glenwood 4&5 and Far Rockaway.

Exhibit 9-20 Retirement Options – Results and Findings (2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions		
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req., NPV	Avg. of Ann. Rev Rate (Cents/kW)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Net Cost (Savings) per Footprint Reduction (\$/ton)*
E) ELI	2,090	20	111.5	65.0	23.1	23.2	28.6	9,307	8,269	20	16	7	0	172	259	-
S) Retire Barrett 1	0	20	0.5	0.3	0.1	0.0	0.0	-344	-151	20	19	7	0	-2.4	-5	101
T) Retire Far Rockaway	0	20	0.2	0.2	0.1	0.0	0.0	-5	-9	20	18	7	0	0.4	-1	201
U) Retire Glenwood 4&5	367	20	0.4	0.2	0.1	0.0	0.0	-361	-201	20	19	7	0	-0.7	-6	75
V) Retire Glenwood 4&5 and Far Rockaway	367	19	0.9	0.5	0.2	0.0	0.0	-467	-207	20	20	7	0	0.6	-7	125

Summary of Plans

- Exhibit 9-21 shows the four alternative plans used to investigate the interaction of Energy Efficiency programs and repowering. All four of the plans assume that LIPA continues to pursue implementation of the current 25% RPS program. Two levels of energy efficiency, ELI and 15x15 are examined against the repowering Barrett 1 with 2x1 7FA.

Exhibit 9-21 Summary of Plans – Repowering and Energy Efficiency Interaction

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
E	ELI	ELI	25% x 2013	None	None	None	5 501G Starting in 2016	None	None	None
G	ELI + Repower Barrett 1 with 2x1 7FA	ELI	25% x 2013	None	None	None	4 501G Starting in 2019	Barrett 1 2016	None	None
F	15 x 15	15 x 15	25% x 2013	None	None	None	2 501G Starting in 2025	None	None	None
W	15x15 + Repower Barrett 1 with 2X1 7FA	15 x 15	25% x 2013	None	None	None	1 501G Starting in 2027	Barrett1 2025	None	None

Results

- While, in combination, increasing energy efficiency and repowering tend to reduce the incremental benefits of each other, the combined strategies, when compared against pursuing neither option, are projected to still provide customer savings while increasing the total environmental and power production efficiency benefits.

Exhibit 9-22 Repowering and Energy Efficiency Interaction – Results and Findings 2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions		
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req. NPV	Avg. of Ann. Rev Rate (Cents/kWh)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Reduction (\$/ton)*
Effect of Energy Efficiency on Repowering																
E) ELI	2,090	20	111.5	65.0	23.1	23.2	28.6	9,307	8,269	20	16	7	0	172	259	-
K) ELI + Repower Barrett 1 & 2 with 2x1 7FA	498	20	1.0	0.5	0.2	0.0	0.0	-484	-266	20	20	7	0	-2.5	20	-52
F) 15 x 15	989	20	104.2	61.6	23.9	20.7	25.6	9,715	8,899	20	19	13	0	144	244	-
W) 15x15 + Repower Barrett 1 with 2X1 7FA	131	20	0.2	0.1	0.0	0.0	0.0	0	-134	20	19	13	0	-0.8	-1	221
Effect of Repowering on Energy Efficiency																
E) ELI	2,090	20	111.5	65.0	23.1	23.2	28.6	9,307	8,269	20	16	7	0	172	259	-
F) 15 x 15	-1,101	20	-7.3	-3.4	0.8	-2.5	-3.1	408	630	20	19	13	0	-28.0	-15	-477
K) ELI + Repower Barrett 1 & 2 with 2x1 7FA	2,588	20	112.5	65.5	23.3	23.2	28.6	8,823	8,003	20	20	7	0	170	279	-
W) 15x15 + Repower Barrett 1 with 2X1 7FA	-1,468	20	-8.1	-3.8	0.6	-2.5	-3.1	892	762	20	19	13	0	-26.4	-35	-225

Summary of Plans – Phase I

- Exhibit 9-23 shows seven alternative plans used for the Phase I assessment of Alternative Strategies. These scenarios vary greatly in all aspects of their design including different levels of energy efficiency, renewables, retirements, repowering and new transmission interconnections.

Exhibit 9-23 Summary of Plans – Alternative Strategies Phase I

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repower	Retire	
A	Reference Plan	None	None	None	None	None	8 501G Starting in 2014	None	None	None
D	Continue CEI	CEI	25% x 2013	None	None	None	7 501G Starting in 2015	None	None	None
X	CEI + Repowering Focus	CEI	25% x 2013	None	None	None	4 501G Starting in 2021	Barrett1 2015; Northport1 2017; and Port Jefferson3 2019	None	None
Y	Low Operating Cost Focus	CEI (and AMI)	25% x 2013	None	None	None	3 501G Starting in 2024	None	None	NUSCO Upgrade 2016; 1000 MW PJM w/ Nuclear 2017
F	15 x 15	15 x 15	25% x 2013	None	None	None	2 501G Starting in 2025	None	None	None
Z	Environmental Focus	15 x 15	30% x 2015	6 144 MW Starting in 2012	100 MW Fuel Cells beg. 2012	None	None	Barrett1 2014; Northport in 2016	Far Rock 12/31/2009; and Glenwood 12/31/2010	None

Results – Phase I

- Exhibit 9-24 displays the dashboard results for the Alternative Strategies Phase I plans. The first line of this exhibit shows the absolute values for the Reference Plan. Similar to the previously discussed dashboards, the remaining lines show the change between the alternative plans and the Reference Plan. The Reference Plan has the lowest average rates among the alternative plans considered in this section. This is partially driven by the absence of an RPS program and energy efficiency program, the repercussion of which is that the Reference Plan is one of the worst performing plans from a CO₂ emissions perspective.

Exhibit 9-24 Alternative Strategies Phase I – Results and Findings (2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions			
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req. NPV	Avg. of Ann. Rev Rate (Cents/kW)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Reduction (\$/ton)*	Net Cost (Savings) per Footprint
A) Reference Plan	3,191	20	115.7	66.9	22.7	24.7	30.5	9,013	8,099	20	18	6	0	191	295		
D) Continue CEI	-367	20	-0.4	-0.2	0.4	-0.7	-0.7	75	-30	20	16	6	0	-5.4	-34	-10	
X) CEI + Repowering Focus	386	20	2.4	1.2	0.9	-0.7	-0.7	-861	-443	20	20	7	0	-5.3	-47	53	
Y) Low Operating Cost Focus	-692	20	5.8	2.9	1.6	-0.7	-0.7	1,100	1,114	20	17	14	1	-43.8	-68	89	
F) 15 x 15	-2,202	20	-11.5	-5.3	1.2	-4.0	-5.0	703	800	20	19	13	0	-47.5	-50	-223	
Z) Environmental Focus	-730	20	3.2	2.6	4.6	-4.0	-5.0	-865	61	20	20	9	10	-48.6	-73	49	
AA) Market Access Focus	-1,793	20	-12.2	-5.6	1.1	-4.0	-5.0	703	1,908	20	19	16	0	-52.0	-35	-345	

Summary of Plans – Phase II

- Exhibit 9-25 shows seven alternative plans used for the Phase II assessment of Alternative Strategies. The first three plans were carried over from the Phase I assessment while the last four plans were developed from Phase I findings.

Exhibit 9-25 Summary of Plans – Alternative Strategies Phase II

ID	Plan Name	Energy Efficiency	Renewables				Upgrade Fleet			Inter-connection
			RPS	Wind	Fuel Cell	Solar	New	Repowerer	Retire	
A	Reference Plan	None	None	None	None	None	8 501G Starting in 2014	None	None	None
F	15 x 15	15 x 15	25% x 2013	None	None	None	2 501G Starting in 2025	None	None	None
Z	Environmental Focus	15 x 15	30% x 2015	6 144 MW Starting in 2012	100 MW Fuel Cells beg. 2012	None	None	Barrett1 2014; Northport in 2016	Far Rock 12/31/2009; and Glenwood 12/31/2010	None
BB	15 x15 Repowering Plan	15 x 15	30% x 2015	150 MW Starting in 2015	None	100 MW 2010-15	None	Barrett 1 2016; Northport 4 2019; Port Jefferson3 2022	Far Rock 2012; and Glenwood 2012	NUSCO Upgrade 2016
CC	15 x 15 Retirement Plan	15 x 15	30% x 2015	150 MW Starting in 2015	None	100 MW 2010-15	3 501G Starting in 2022	Barrett 1 2016	Far Rock 2012; and Glenwood 2012	NUSCO Upgrade 2016
DD	Representative Plan	15 x 15	30% x 2015	150 MW Starting in 2015	None	100 MW 2010-15	3 501G Starting in 2024	Barrett 1&2 2016; Northport 3&4 2019; Port Jefferson 3&4 2022	Far Rock 2012; and Glenwood 2012	NUSCO Upgrade 2016

Results – Phase II

- Exhibit 9-26 displays the dashboard results for the Alternative Strategies Phase II plans. Similar to the previous dashboard the first line of this exhibit shows the absolute values for the Reference Plan. The remaining lines show the change between the alternative plans and the Reference Plan. As a group these alternative plans offer the greatest opportunities for emission reductions and lower revenue requirements over the life of the study.

Exhibit 9-26 Alternative Strategies Phase II – Results and Findings (2009-2028)

Plan	Reliability		Cost			Plan (2018 / 2028)				Emissions Target Years Met				CO ₂ Emissions			
	New Generation (MW)	Capacity Criteria	Cum. Annual Rev. Req. (\$Bil)	Cum. Annual Rev. Req., NPV	Avg. of Ann. Rev Rate (Cents/kWh)	2018 Sales of Electricity (TWh)	2028 Sales of Electricity (TWh)	Avg. LI Sys Heat Rate, 2018 (BTU/kWh)	Avg. LI Sys Heat Rate, 2028 (BTU/kWh)	SO ₂	NO _x	CO ₂ Compliance	CO ₂ Footprint	Cum. Compliance (mTons)	Cum Footprint (mTons)	Reduction (\$/ton)*	Net Cost (Savings) per Footprint
A) Reference Plan	3,191	20	115.7	66.9	22.7	24.7	30.5	9,013	8,099	20	18	6	0	191	295	-	
F) 15 x 15	-2,202	20	-11.5	-5.3	1.2	-4.0	-5.0	703	800	20	19	13	0	-47.5	-50	-223	
Z) Environmental Focus	-730	20	3.2	2.6	4.6	-4.0	-5.0	-865	61	20	20	9	10	-48.6	-73	49	
BB) 15 x15 Repowering Plan	-1,380	20	-6.1	-2.5	2.4	-4.0	-5.0	33	-197	20	20	11	3	-49.3	-75	-77	
CC) 15 x 15 Retirement Plan	-1,341	20	-6.4	-2.7	2.4	-4.0	-5.0	33	-116	20	20	16	3	-54.2	-70	-86	
DD) Representative Plan	-279	20	-5.0	-2.1	2.7	-4.0	-5.0	-21	-696	20	20	15	3	-49.2	-78	-60	
EE) Representative Plan with Oil Ban	-279	20	-5.0	-2.0	2.7	-4.0	-5.0	-189	-780	20	20	16	9	-64.6	-86	-52	