APPENDIX R
London Economics Study of Repowering Village Power Plant
NYISO Model – Impact Study Results

prepared for the Village of Port Jefferson

Shawn Carraher, Ian Chow
November 29, 2012
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Repowering Port Jefferson in 2020 results in lower wholesale energy prices and capacity prices as compared to the base case

- LEI was asked to evaluate the energy market price impacts of a Repowered Port Jefferson (RPJ) on the Long Island (LI) market, specifically the impact on energy and capacity market benefits
- LEI has run an electricity and capacity market simulation model (2013 to 2022)
  - Model is calibrated to current natural gas prices, emissions, projected demand, and expected future supply conditions (retirements and new entry)
- In the Base Case representing “Business as Usual”, LEI modeled two new generation projects in Long Island over the modeling timeframe
  - 400 MW in 2016, assumed to be procured through the LIPA RFP process and given a long-term contract
  - 478 MW from Barrett repowering in 2019, given LI capacity need and stated preference for Barrett repowering over Port Jefferson in repowering studies and earlier repowering date in the New York Energy Highway Blueprint; (This study does not evaluate the merit of Barrett vs RPJ. Barrett repowering in Base Case could be a dummy for RPJ if Barrett does not go forward)
  - Retirements in the Base Case comprise 1,656 MW from 2013 to 2019
- To quantify impact of a Port Jefferson repowering, the base case was compared against an alternate case where Port Jefferson was repowered at 350 MW in 2020
  - 2020 was chosen as there was no need for additional capacity on LI prior to then and it would therefore be uneconomic from a private investor’s perspective
- Total average benefits on LI are $127 million per year between 2020 and 2022 (energy market benefits are $98 million and capacity market benefits are $29 million per year), which are greater than average annual all-in fixed costs for the modeled RPJ of $77 million. These benefits are short term and are expected to diminish over time
  - For the entire New York State, between 2020 and 2022, average annual energy market benefits are $270 million and average annual capacity market benefits are $236 million
- As a Base Case sensitivity we evaluated 706 MW new generation at Caithness for the LIPA RFP in 2016, instead of 400 MW. If 706 MW is selected for the RFP, then there would be no “capacity market need” for Port Jefferson repowering well beyond 2022
The New York Energy Highway Blueprint calls for 3,200 MW of new generation and transmission capacity with a focus on repowering and renewables

- Repowering seen to provide “system reliability, economic development, and environmental benefits” provided it does not impact rates negatively for customers
- Possible repowering of Barrett in 2019 and PJ (after retiring existing plant) in 2020

NYISO recently filed its compliance with FERC Order 1000 (ER13-102) which puts NY policymakers in the driver seat regarding having new transmission to meet any policy objectives

- “NYPSC ... is appropriately given the role of identifying needs and selecting among proposed solutions”
- This will lead to greater likelihood of projects going forward due to policy rather than economic justification -- more new entry means lower prices and therefore it becomes harder to justify economic benefits for additional investment down the road

On October 25, 2012, LIPA’s Board of Trustees gave LIPA management the green light to negotiate with two power plant developers (narrowed from 45 proposals), with the intention of picking one of them for a 20-year power purchase agreement

- J-Power, 377-MW natural gas-fired power plant in Shoreham
- Caithness, 706-MW natural gas-fired power plant in Yaphank next to existing Caithness facility. Environmental review required prior to authorizing any resulting PPA and is subject to approval of the NY state AG
- We modeled 400 MW as a base case which would make repowering Port Jefferson more likely and beneficial
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Key Assumptions

- In the base case, 1,656 MW of capacity was assumed to be retired in Long Island between 2013 and 2019 for economic reasons.
- As part of the economic retirements, Port Jefferson is retired in 2016 after three consecutive years of economic losses (defined as merchant market revenues less minimum going forward fixed costs).
  - We assumed plants that should retire based on economics do so even if they are under the renewed PSA.
- To meet reserve margins, LEI modeled one new 400 MW generation project in NYC in 2016, and two in East New York (ENY), in 2018 and 2019. In Long Island, we modeled the LIPA RFP and Barrett repowering. Repowering studies have indicated that Barrett repowering is preferable to PJ, hence why Barrett is assumed to be repowered first.
- Other known projects under development, such as CHPE, is not specifically modeled and LEI used generic new entry instead: in NYC, 400 MW of new entry is added in 2016 for economics.
  - NYC capacity is not needed for resource adequacy during the modeling time frame of 10 years.

Long Island prices under Base Case projected to increase from $56/MWh in 2013 to $85/MWh in 2022 in nominal dollar, demand weighted terms

- Nominal Compound Annual Growth Rate (CAGR) is 4.3%, consistent with nominal growth rate in gas prices.
- Historically, LI energy prices have been the highest in New York State. As modeled, LI prices dip below NYC in 2019, due to new entry.

LI capacity market prices increase over time due to assumed retirements and increasing demand, increasing from $3.6/kW-month in 2013 to levels consistent with cost of new entry of a peaker, $11/kW-month by 2022.
Long Island zone energy prices have historically been highest in New York State.
Long Island prices are expected to be the highest in New York State until 2019.

- **2013 prices are comparable to forward market, and are higher than 2012 due to higher natural gas prices.**
- **Prices in WNY depressed by significant new wind entry.**
- **LI prices converge to NYC prices due to RFP new entry.**
- **LI prices in 2019 depressed below NYC, by new entry.**
Separate capacity prices are calculated for New York City, Long Island, and the entire New York Control Area.
New York City capacity prices are significantly higher than those on Long Island and New York Control Area – consistent with historical trends.

- Reserve margins in NYC begin to fall, giving upward pressure.
- Prices depressed in 2019 due to new entry in ENY and LI.
- Retirements in NYCA and LI raise prices.

Base Case Results ► Capacity Prices
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In the Base Case modeling, LEI maintains reliability reserve requirements set by the NYISO

- Long Island has a requirement to procure capacity locally due to transmission constraints, known as the Long Island locational capacity requirement (LCR): 99%
- We assume the LCR stays constant over time. 99% is the lowest level in recent years, which results in the most conservative results

If both 706 MW Caithness plant and 478 MW Barrett repowering are assumed, Port Jefferson repowering is not needed based on reserve margin requirements until beyond the end of the forecasted period (2022)
- LI RFP new entry is expected by 2016, and Barrett repowering is assumed in 2019, as per New York Energy Highway Blueprint
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LEI then designed an alternative to the base case where Port Jefferson is also repowered, all other Base Case assumptions remained the same

▶ A Repowered Port Jefferson (RPJ) was modeled in 2020, as discussed in the New York Energy Highway Blueprint
  - The in service date was selected as it would likely yield better economic results than earlier repowering (for example, Fall 2018, per the PSA schedule)

▶ Port Jefferson is assumed to be repowered at 350 MW
  - Assumed “backyard” repowering, which uses new combined cycle units, rather than a hybrid approach which uses existing turbines
    - This approach was deemed to be most likely, although it is not a foregone conclusion and is contingent on various engineering studies
  - Natural gas fired with kerosene backup
  - Heat rate: 6,773 Btu/kWh (similar to what was assumed for Barrett in 2019)
  - Air cooled

▶ A comparison of the market prices under the base case and this repowering case can be used to identify impacts to the wholesale market
The addition of Repowered Port Jefferson (RPJ) results in wholesale energy price reductions in Long Island, ENY and WNY from 2020 to 2022

- LI achieves the largest price reductions (~$4/MWh), while NYC and ENY achieve price reductions of about $2/MWh on annual average (demand weighted) basis
  - WNY price changes are not statistically significant to a 95% confidence interval

- These price reductions result in New York State wholesale energy market savings of $270 million per year on average, of which $98 million is from Long Island
  - These wholesale market benefits are not permanent and would be expected to diminish over time
New York State wholesale energy market savings range from $302 million to $248 million
The addition of RPJ results in New York State capacity market savings of $236 million per year on average

- The addition of RPJ results in capacity price reductions Long Island and NYCA from 2020 to 2022

- LI achieves the largest price reductions (~$1/kW-month), while ROS (NYCA auction) achieves price reductions of about $0.8/kW-month
  - The NYC local capacity market is not impacted as RPJ is not within NYC

- These price reductions result in New York State capacity market savings of $236 million per year on average, of which $29 million is from Long Island
  - These wholesale capacity market benefits are not permanent and would be expected to diminish over time
New York State capacity market savings average $236 million per year, of which $29 million is from Long Island.
This is a short-term perspective. LEI’s all-in fixed cost model calculates debt costs over 18 years, and benefits will diminish in the medium-term. Additional analysis would be required to determine the benefit of RPJ over the life of the plant.

LEI has calculated wholesale market benefits, however, commercial arrangements can prevent benefits from reaching ratepayers. For example, if LIPA has entered into hedges on power prices, then its customers may not be exposed to wholesale market prices.
1. Executive Summary

2. Base Case Results

3. Base Case Sensitivity: LIPA RFP fulfilled with 706 MW Caithness

4. Repowering in 2020 Results

5. Appendix: Key Input Assumptions
NYISO energy prices are sensitive to natural gas prices and import assumptions

Forecast Natural Gas Prices

Estimated Imports

► New York gas forecast is based on a Henry Hub forecast, adjusted using historical price differentials between Henry Hub and New York hubs
  - Henry Hub forecast using current futures plus long term fundamentals forecast from EIA AEO 2012
  - Downstate gas is priced at Transco Zone 6; Upstate gas is priced at Tetco M3

► NYISO imports are calibrated to 2009-2012 YTD actual observed trends, with adjustment for certain future changes
  - New Hudson Transmission Partners transmission line in 2014 increases PJM imports
  - Ontario imports change as a result of evolving supply-demand conditions, specifically with respect to refurbishment and retirement of the nuclear fleet
Demand forecast is based on the NYISO 2012 Gold Book, which includes impacts of statewide energy efficiency programs

- Compound Annual Growth Rate (CAGR) of peak demand is 1.1% in NYC and 0.7% in LI over the modeling horizon. For energy consumption, CAGR is 0.9% in NYC and 0.8% in LI

- CO₂ emissions allowance prices based on over the counter (OTC) Regional Greenhouse Gas Initiative (RGGI) futures price, which grows at extrapolated rate to reach the equivalent, nominal price as Western Climate Initiative (WCI) by 2020 of $20/ton, and thereafter remains constant in nominal terms

- First 4 years of SO₂ and NOₓ allowance prices are based on OTC futures prices; in longer terms, allowance prices increase at 2% inflation
  - We assume 2013 CAIR emission rules, and CSAPR 2014 and onwards
LEI uses a three pronged approach to retirement
1. Incorporating announced and certain retirements
2. Environmental retirements
3. Economic retirements

LEI has retired plants across New York State which have announced retirement or requested mothballing
- Such retirements total 1,835 MW from 2012 to 2016
- Certain peakers in NYC have been assumed to return from their mothballed status, given the recovery in NYC capacity prices. An example of this type of activity includes Gowanus Barges 1 and 4 withdrawing mothballing plans (August 7, 2012)

LEI has assumed retirements of 1,529 MW of coal-fired plants in New York State, from 2014 to 2016
- Key reasons include: lack of equipment for \( \text{NO}_x \) reduction or \( \text{SO}_2 \) mitigation, or no current emission control for mercury to meet the EPA Mercury and Air Toxics Standards ("MATS") regulation
- MATS was signed in December 2011, and coal and oil-fired generating units have been given 4 years to comply

Significant economic retirement in LI, with 1,656 MW retired from 2013 to 2019 – much of the retirements are plants that do not run for energy

In the base case, Port Jefferson 3 and 4 are retired after 3 years of projected uneconomic operations

- Plants rarely run, with an average 3 year load factor of 3%, and thus make minimal revenue from energy market

Projected revenues in the energy and capacity market are compared with minimum going forward fixed costs

- Costs comprised of debt service costs and fixed operations and maintenance (FOM)
- LEI assumes 60% leverage, 8% interest rate on a notional market value to get to a debt payment

A total of 1,656 MW of Long Island capacity is forecast to be retired from 2013 to 2019

Original PSA has an annual capacity charge of $422.1 million, for a nameplate capacity of 3,975 MW, which is equivalent to $106/kW-year

- PSA payments include return on equity (ROE) and debt, however, retirement decisions won't include ROE as it is avoidable. This is why PSA payments are higher than minimum going forward fixed costs

### Long Island Retirements under base case

<table>
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<tr>
<th>Plant</th>
<th>Year Out</th>
<th>Capacity (MW)</th>
</tr>
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<tbody>
<tr>
<td>Far Rockaway GTs</td>
<td>2013</td>
<td>109</td>
</tr>
<tr>
<td>Barrett ST2</td>
<td>2013</td>
<td>196.5</td>
</tr>
<tr>
<td>EF Barrett 3-12, GT1 &amp; GT2</td>
<td>2014</td>
<td>361.4</td>
</tr>
<tr>
<td>Barrett ST1</td>
<td>2015</td>
<td>200.5</td>
</tr>
<tr>
<td>Port Jefferson 3,4</td>
<td>2016</td>
<td>393.9</td>
</tr>
<tr>
<td>Northport Unit 1</td>
<td>2019</td>
<td>394.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1655.8</strong></td>
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### Cost Assumptions

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Mover</th>
<th>Market value ($/kW)</th>
<th>Debt payment ($/kW/yr)</th>
<th>FOM ($/kW-yr)</th>
<th>Going Forward Fixed Cost ($/kW-yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas CC</td>
<td>Combined Cycle</td>
<td>640</td>
<td>57</td>
<td>13</td>
<td>70</td>
</tr>
<tr>
<td>Natural Gas ST</td>
<td>Steam Turbine</td>
<td>480</td>
<td>43</td>
<td>19</td>
<td>62</td>
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<tr>
<td>Natural Gas GT/IC</td>
<td>GT / IC</td>
<td>400</td>
<td>36</td>
<td>19</td>
<td>55</td>
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<tr>
<td>Distillate Fuel Oil</td>
<td></td>
<td>320</td>
<td>29</td>
<td>23</td>
<td>51</td>
</tr>
<tr>
<td>Residual Fuel Oil</td>
<td></td>
<td>280</td>
<td>25</td>
<td>22</td>
<td>47</td>
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</table>
New entry in Long Island is expected by 2016 as a result of LIPA announcements/policy as well as reserve margin requirements

- We maintain reliability reserve requirements set by the NYISO by adding generic new entry, assuming “just-in-time” capacity investment decisions that are timed to load growth. We assume this stays constant
  - New York Control Area installed reserve margin (IRM): 116%

- Long Island and NYC have requirements to procure capacity locally due to transmission constraints. We assume these stay constant
  - Long Island locational capacity requirement (LCR): 99%
  - New York City LCR: 83%

- LI RFP new entry is expected by 2016. LEI has assumed a 400 MW plant, rather than the 706 MW Caithness plant, given the amount of capacity required on LI given the LCR and the assumption of at least one repowered plant
  - Barrett repowering is assumed in 2019, as per New York Energy Highway Blueprint. This depresses prices and otherwise delays other ‘economic’ investment. Repowering studies have indicated that Barrett repowering is preferable to PJ, hence why Barrett is assumed to be repowered first
  - If both 706 MW Caithness plant and 478 MW Barrett repowering are assumed, Port Jefferson repowering is not needed based on reserve margin requirements until beyond the end of the forecasted period (2022)

- We assume Indian Point remains in service

- Certain mothballed NYC units return to service – this creates the “best” conditions under a base case for repowering

- New wind entry is based on NY RPS goals, moderated by feasibility analysis using the current NYISO interconnection queue
  - 2013: 532 MW
  - 2014: 900 MW
  - 2015: 700 MW
  - Maximum of 900 MW per year 2016 onwards

<table>
<thead>
<tr>
<th>LI New Entry</th>
<th>Details</th>
<th>Year of New Entry</th>
<th>Capacity (MW)</th>
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<tbody>
<tr>
<td>LI RFP</td>
<td></td>
<td>2016</td>
<td>400</td>
</tr>
<tr>
<td>Barrett repower</td>
<td></td>
<td>2019</td>
<td>478</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>New York State New Entry</th>
<th>Details</th>
<th>Year of New Entry</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York City</td>
<td></td>
<td>2016</td>
<td>400</td>
</tr>
<tr>
<td>East New York</td>
<td></td>
<td>2018</td>
<td>400</td>
</tr>
<tr>
<td>East New York</td>
<td></td>
<td>2019</td>
<td>400</td>
</tr>
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Over the long run, generic new entry is introduced to support resource adequacy and when it is economic (“just-in-time”).

From 2013 to 2022, LEI has assumed:

- 145 MW of mothballed assets in NYC return to service after market conditions improve over recent levels
- 2,087 MW of repowering and natural gas CCGT new entry, mostly in ENY
- 2,932 MW of wind new entry, all in West New York
Generic gas-fired CCGTs are generally economic in Base Case, with sufficient energy and capacity revenues to meet their levelized all-in fixed costs.

NYC 2016 Entry, 400 MW

ENY 2018 Entry, 400 MW

ENY 2019 Entry, 400 MW
LI RFP project is not economic on a standalone basis until 2022

Key All-In Fixed Cost Assumptions (2013)

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Value</th>
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<tbody>
<tr>
<td>Leverage</td>
<td>60%</td>
</tr>
<tr>
<td>Debt interest rate</td>
<td>8%</td>
</tr>
<tr>
<td>After-tax required equity return</td>
<td>15%</td>
</tr>
<tr>
<td>Corporate income tax rate</td>
<td>40%</td>
</tr>
<tr>
<td>Debt financing term</td>
<td>18</td>
</tr>
<tr>
<td>Average annual load factor</td>
<td>80%</td>
</tr>
<tr>
<td>Real capital cost, $/kW</td>
<td>$1,490</td>
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<tr>
<td>Inflation for capital cost</td>
<td>2%</td>
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<tr>
<td>Nominal capital cost</td>
<td>$1,520</td>
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At 2011 REC prices, generic new wind entry in 2013 reaches break-even on its all-in costs from market revenues (assuming PTCs) by 2018.

REC revenue assumption in chart above is based on the December 2011 New York State renewable RFP solicitation ($28.7/MWh)

- This is conservative, as REC prices in surrounding regions have increased significantly in 2012

REC revenues needs to be about $45/MWh in 2013-2015 timeframe to fully remunerate a generic windentrant (assuming PTC renewal)