WALDRON

Report for :

Big Six Towers
Energy Supply Alternatives Assessment
New York, NY

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Attachments

1 Executive Summary

On behalf of Big Six Towers, Inc. ("Big Six Towers"), Waldron Engineering of New York, P.C., ("Waldron") has completed an analysis of energy supply alternatives that could be implemented upon retirement of the existing engine generators in the power plant. Decommissioning of the existing engines is driven by Local Law 38, which requires stationary engines to meet Tier 4 emissions requirements for operating permit renewals after January of 2025.

Legal requirements aside, the existing engines are also roughly forty years old, at the end of their useful lives, and relatively inefficient compared to present technology. Additionally, three of the six engines operate on diesel fuel, which has been 2-3 times as expensive as natural gas in recent years. So converting Big Six Towers' electricity supply to grid power or to new natural gas fired engines would both realize significant cost reductions compared to the current value.

The decision-making space is complex, however, as legislation at the local and state level mandates significant overhauls to the types of energy used within the City and State respectively. The primary objective of these laws is to achieve large reductions in greenhouse gas emissions in their respective jurisdictions, primarily by accelerating the integration of renewable energy supplies. The impact these laws will have upon the future cost of delivered energy remains to be seen, but in Waldron's opinion it is prudent to consider a range of future scenarios in the decision-making process, including electricity cost increases and their potential impacts to Big Six Towers.

The conclusion to this report thus includes not only a recommendation, but a review of the possible outcomes that energy supply alternatives will have in a range of futures. Certain facts about the various alternatives are clear, such as which will cost more to construct, and which will have the greatest impact on annual operating costs, but the alternatives are relatively closely grouped in terms of overall life cycle costs so the decision for Big Six Towers becomes one of risk assessment and navigation.

1.1 Energy Supply Alternatives

Three basic categories of energy supply alternatives were explored in this analysis as described in the table on the following page. Multiple alternatives were initially evaluated in each category, and then the best in each was selected for review in this Executive Summary.

The first category of alternatives, termed "Grid Connection" (GR) herein, includes the establishment of an electrical interconnection to the Con Edison grid and retirement of on-site electrical power generation. All electrical power would be supplied by the grid. The key distinctions between energy supply alternatives in this category are the nature of the Con Edison service—Low Tension vs High Tension—and the manner in which building heating and cooling needs would be met in the future. For the latter, the primary alternatives were to continue with the existing boiler plant, the absorption chiller, and the tenants' space cooling system, or to incorporate alternate technologies such as liquid biofuel, geothermal heating/cooling, or electric boilers. These alternatives would provide reductions in greenhouse gas emissions as compared to continued operation of the boiler plant and were considered for this reason.

The second category of alternatives, termed "Power Plant Only" (PP) herein, is based on repowering the existing power plant with new electrical generators, and continuing to operate without an interconnection to Con Edison. For this category of alternatives, the boiler plant, absorption chiller and existing tenant cooling equipment were modeled to operate in accordance with their historical norms. The key variables were the size and quantity of natural gas fired reciprocating engines that were considered. Alternative electrical generation technologies such as fuel cells and gas turbines were excluded from consideration for reasons given in the body of the report (refer to Section 9).

The third category of alternatives, termed "Grid Parallel" (PA), is a hybrid category that includes a new electrical interconnection to the Con Edison grid plus continued operation of the Big Six Towers power plant with new natural gas reciprocating engines. The assumption regarding the community's heating and cooling systems was the same as that of the Power Plant (PP) alternatives, and the key variable for this category of alternatives was the quantity and size of engines included. Cases were considered that were able to cover 100% of the Big Six Towers forecasted loads, as well as cases with a lesser quantity of engines that only cover the base load.

A summary of the alternatives studied in each category, with identification of the best alternative in each, is provided in the table below.

High Level Category	Energy Supply Alternatives Studied
Grid Connection (GR)	Low Tension Interconnection, Existing Boiler Plant High Tension Interconnection, Existing Boiler Plant High Tension Interconnection, Geothermal Heating/Cooling High Tension Interconnection, Air Source Heat Pumps High Tension Interconnection, Liquid Biofuel Heating High Tension Interconnection, Electric Boiler Plant
	Best Alternative: High Tension, Existing Boiler Plant
Power Plant Only (PP)	6x 635 kW Engines 4x 1,200 kW Engines
	Best Alternative: 6x 635 kW Engines
Grid Parallel (PA) * All cases were evaluated with Low and High Tension interconnections.	1x 1,200 kW Engine 2x 1,200 kW Engines 1x 850 kW Engine 2x 850 kW Engines
	Best Alternative: 1x 1,200 kW Engine, High Tension

Figure A: Energy Supply Alternative

Unless noted otherwise, the figures presented in the remaining portions of the Executive Summary are based on the "Best Alternative" within each category. Figures B and C on the following page show cumulative operating costs for the twenty-year study period, from 2024 – 2043, as well as the cumulative life cycle cost (operating + capital amortization) for the same period. With the inclusion of capital amortization, the best alternatives in each category are very closely ranked in economic performance.

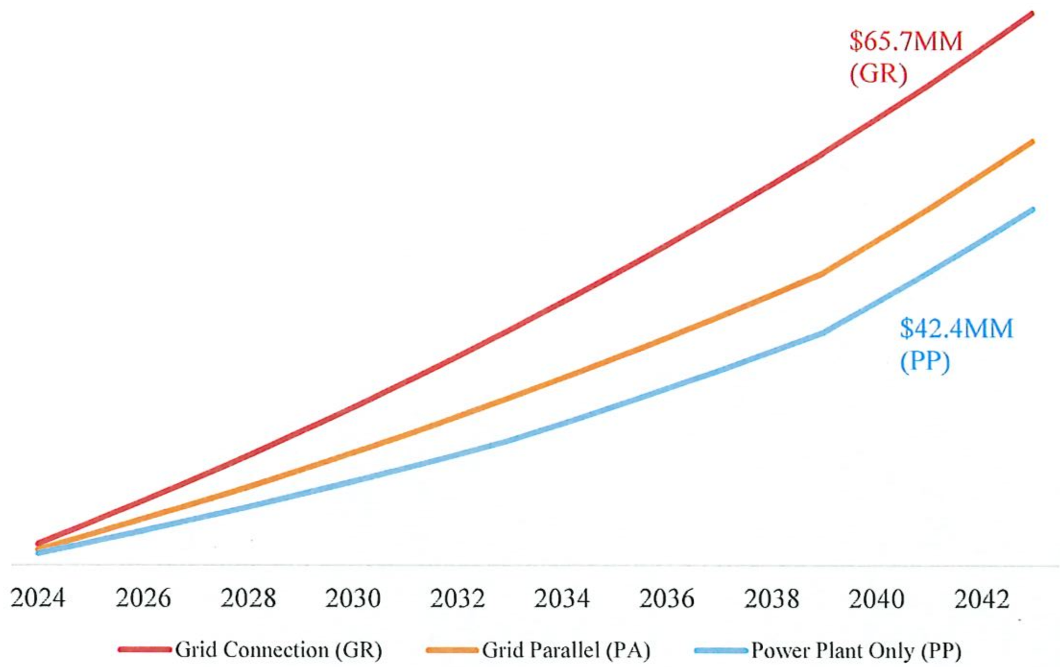

Figure B: Cumulative Operating Cost

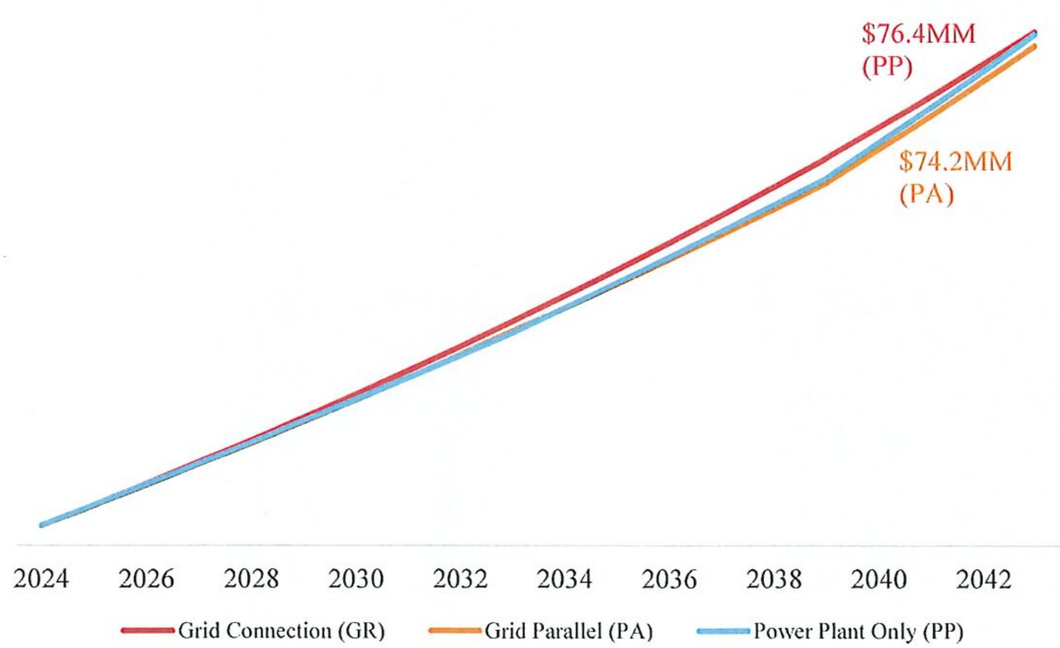

Figure C: Cumulative Life Cycle Cost (Operating Cost Plus Capital Amortization)

A summary of key project metrics is provided in the table below. The net present values and rates of return shown for the PP and PA alternatives are calculated against the incremental capital investment—above and beyond that required to construct the Grid Connection (GR) alternative—required to install them.

Energy Supply Alternative Parameter	GR	PP	PA
Capital Cost ($1,000's, 2023$)	$5,897	$18,509	$13,128
Cumulative Operating Cost (Then Current $)	$65.7	$42.4	$50.4
Cumulative Life Cycle Cost (includes capital)	$76.4	$76.0	$74.3
Net Present Value (6.5% discount rate)	-	$0.8	$1.40
Rate of Return	-	7.3%	8.9%

1.2 Climate Change Legislation and Greenhouse Gas Emissions Considerations

The Climate Leadership and Community Protection Act ("CLCPA"), was signed into law in 2019 by the New York State legislature. This legislation mandates 70% renewable energy in New York State by 2030 and 100% zero-emission electricity by 2040. The achievement of these targets will require extensive infrastructure upgrades in the form of transmission system upgrades, renewable electricity generation facilities, energy storage systems, and enhancements to the electrical grid for stability and control. Investments of this magnitude create uncertainty in future electricity pricing, and the impacts of various future electricity pricing scenarios on project economics was a key consideration of this analysis.

Within New York City, Local Law 97 establishes a greenhouse gas emissions threshold tied to energy use intensities for various building types, beyond which a penalty will be assessed beginning in Year 2024. Big Six Towers is exempt from the penalties through Year 2029 and is expected to remain exempt until Year 2034, at which time Waldron understands the Year 2024 thresholds would be applied. After this 10-yr grace period, Big Six Towers could face relatively high penalties for greenhouse gas emissions above the limits.

Key tasks of this analysis thus included a quantification of greenhouse gas emissions for the various alternatives studied, as well as a forecast of potential penalties that would be applicable to Big Six Towers in the future per Local Law 97. While the delay in applicability of the Local Law 97 penalties means they are not a significant driver of near-term project economics, it is important to understand their potential future value because different energy supply alternatives would expose Big Six Towers to varying degrees of penalty in future years, which could (in some alternatives) only be avoided through additional capital investments. Thus, the position in which Big Six Towers would find itself in twenty years, at the conclusion of the life cycle studied herein, will vary considerably for the alternatives studied.

Figure D on the following page shows the forecasted greenhouse gas emissions profile for the best energy supply alternative in each category, and Figure E provides forecasted Local Law 97 penalty costs for the same, in Year 2045. (Note that for the alternatives shown, the primary heating and cooling needs of the community are met in the same manner as they are currently, with the existing boiler plant and tenant space-cooling systems.)

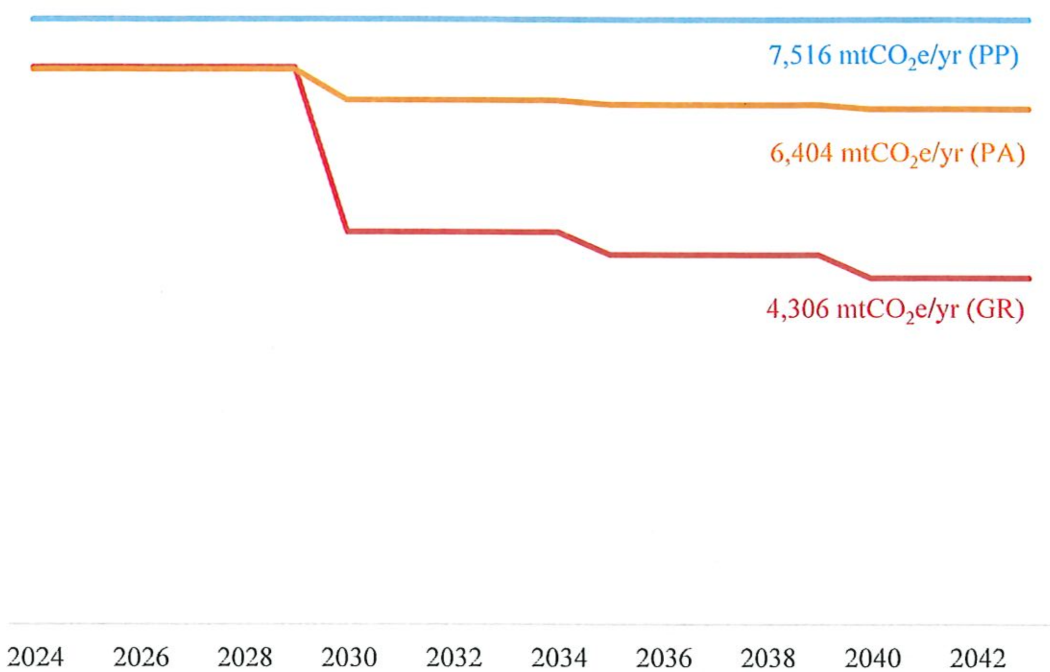

Figure D: Forecasted Annual GHG Emissions During Life Cycle Analysis Period

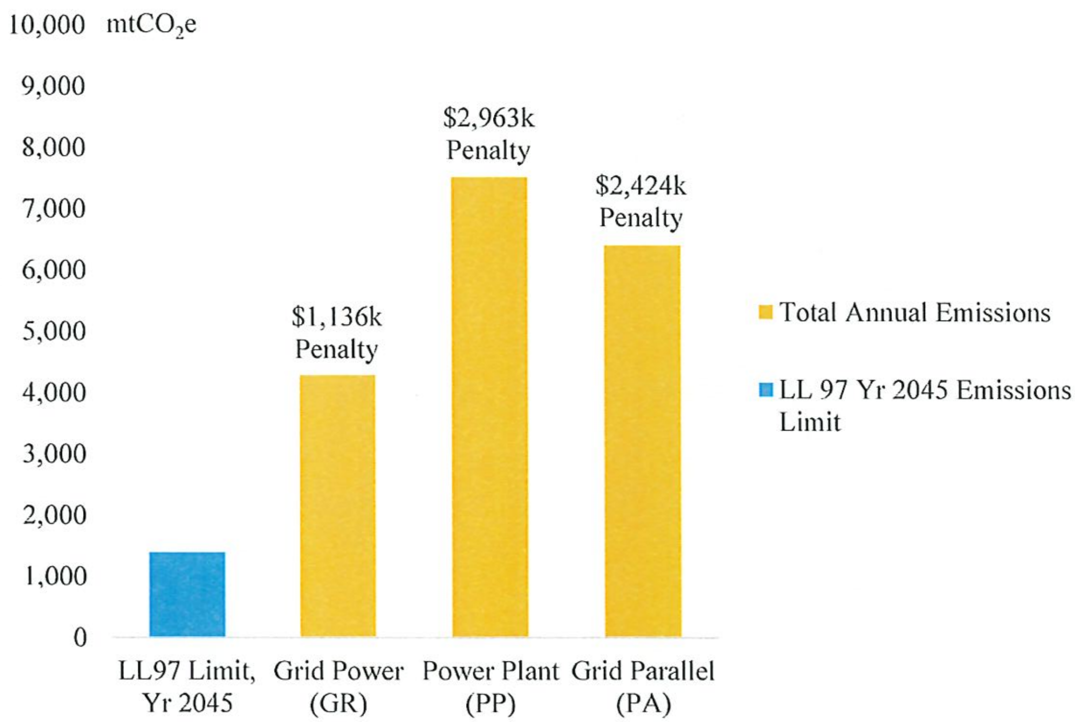

Figure E: Forecasted Yr 2045 GHG Emissions & Local Law 97 Penalty with 10-Yr Delay (TC$)

Because the capital cost of the engine installations would be paid for at the end of the life cycle studied, the engines in the Grid Parallel (PA) alternative could be shut down and used only as a resiliency asset to avoid roughly half of this penalty at no cost to Big Six Towers. In such a scenario, the penalty for the Grid Parallel (PA) alternative would be equal to the Grid Connection (GR) alternative. For the Power Plant (PP) alternative, this would not be an option, as a new Con Edison service with the associated capital costs would be required to supply electrical power to Big Six Towers in order to shut down the engines.

The residual penalties shown in Figure E are all based on zero emissions electricity from the grid and the continued operation of the Big Six Towers boiler plant on natural gas fuel. Although the grid electricity is carbon free, the emissions of operating the heating plant alone would still exceed the current limits contained in Local Law 97 using the metrics forecasted herein.

1.3 Low Carbon Alternatives

The previous section begs a question: how could the greenhouse gas emissions of the Big Six Towers community be reduced in order to avoid penalties in the future? This question was addressed at a screening level of analysis in this study because the financial necessity of implementing additional capital investment and/or incurring higher operating costs to reduce greenhouse gas emissions is not the most critical near-term factor in decision-making. Big Six Towers must secure an affordable energy supply alternative to its aging facility in the immediate future, and the carbon emission penalties noted above will not take effect (at the relatively high levels shown) for approximately two decades.

To assist in evaluating possible improvements to the facility that could reduce greenhouse gas emissions and avoid these penalties, Waldron considered multiple alternatives: the use of geothermal heating and cooling, the use of air-source heat pump heating and cooling, the use of a liquid biofuel for heating, and the electrification of the boiler plant. The capital and operating costs of these alternatives are shown in the figure below and are compared to the Grid Connection (GR). In essence, these are extensions of the Grid Connection case that require additional investment to reduce fossil fuel use in the existing boiler plant.

As Figure F on the following page shows, additional capital investment is required for each of the low carbon alternatives that was studied. The difficulty is that this capital investment does not yield operating cost reductions; in fact, with the exception of the geothermal alternative, the operating cost in each low-carbon alternative reviewed is forecasted to increase as well. The reason for this is that displacing natural gas fuel with electricity is predicted to result in an operating cost increase. Geothermal avoids this outcome because it has a higher efficiency than any other electrical option reviewed, but its applicability is limited.

The challenge with geothermal is the high construction cost associated with well-drilling, the associated collection piping systems, and the fact that the building systems themselves would have to be wholly retrofit to utilize geothermal hot water in lieu of steam. Also, the geothermal resource is limited by the size of the property. This analysis assumes all parking areas are utilized for well fields, and this is enough land area to shift just one of the seven towers from the boiler plant to geothermal heating and cooling.

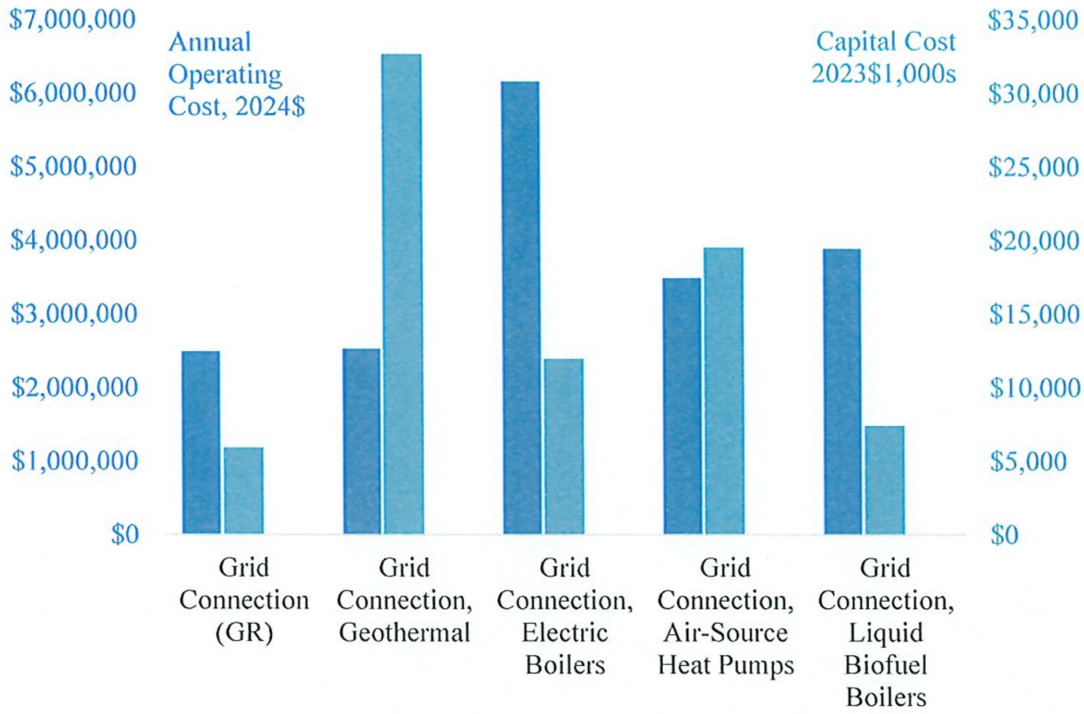

Figure F: Low Carbon Energy Supply Alternatives, Screening Level Assessment

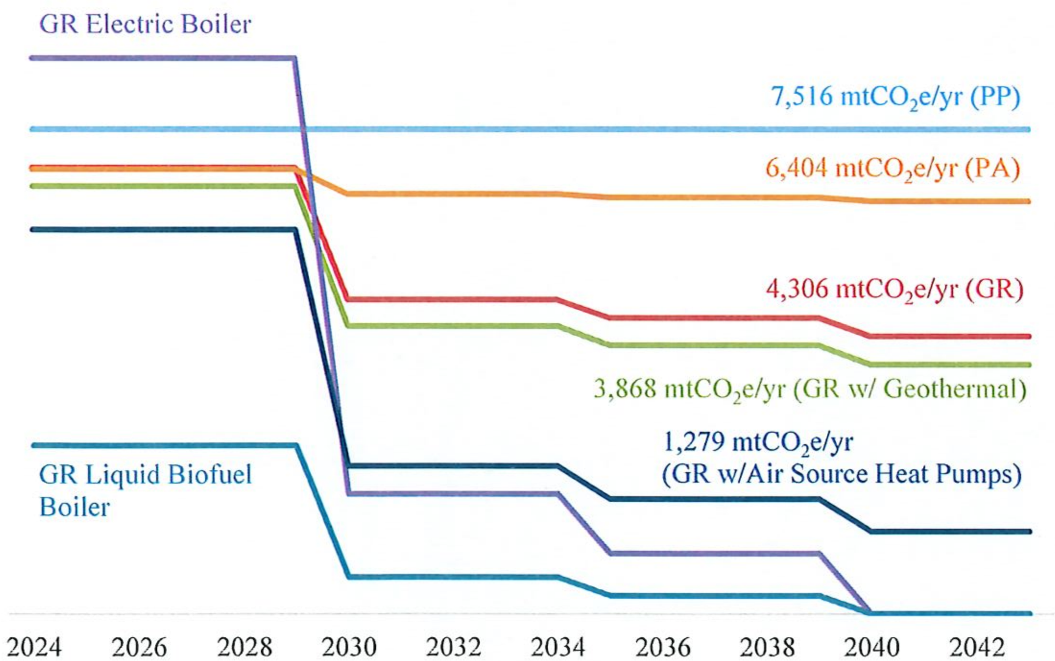

Figure G: Forecasted Annual GHG Emissions During Life Cycle Analysis Period

Figure G shows the annual greenhouse gas emissions for each of the low carbon alternatives studied, alongside of the conventional energy supply alternatives previously shown in Figure D. Based on information currently available, the low carbon alternative with the lowest unit cost of emissions reduction and the least impact on the existing infrastructure at Big Six Towers would be the use of a liquid biofuel in lieu of fossil fuels in the boiler plant. This would require modifications to both boiler fuel and fuel storage systems but would not require building modifications, so the capital investment is minimized. The tradeoff is the relatively high cost of the fuel.

There are various complexities to the entire greenhouse gas emissions analysis of this study that merit discussion, however. The figures above contain assumptions about the rate at which the electrical grid will be transformed to a zero-carbon electricity source for consumers. At present, the NYC/Westchester region of the electric grid is an area that forecasted to require dispatchable assets for the foreseeable future for grid stability. Those dispatchable assets presently include—and will likely include for the foreseeable future—natural-gas-fired power plants. Conventional wind and solar facilities are not dispatchable (without energy storage systems) because they depend on the environmental conditions. So there is uncertainty in this grid-transformation forecast. If the carbon intensity of the grid does not reduce as quickly as legislation requires, then the energy supply alternatives with on-site generation would perform closer to the Grid Connection (GR) case in terms of annual emissions.

Further, when the emissions of the PP and PA alternatives are compared to the emissions rates of the non-baseload, natural-gas-fired generators that are likely to be in use through much of the project life cycle for grid stability purposes, the alternatives studied are competitive in terms of greenhouse gas emissions.

1.4 Risk Assessment

The financial performance of the various alternatives is most sensitive to three primary parameters, in the order listed: electricity costs, capital costs and natural gas costs. The highest risk for Big Six Towers with regards to future energy costs is increasing electricity costs. In the Grid Connection (GR) alternative, for instance, purchased electricity accounts for roughly 75% of the annual operating cost. Because the other two alternatives generate savings proportional to those costs, the relative value of making the incremental investment to construct one of them is also most directly tied to future electricity prices.

Figures H through M on the following page depict the sensitivity of the economic performance of the various energy supply alternatives to these three parameters. In each set of figures, only one of the three parameters is varied in order to show how the life cycle cost and rate of return respond to those variations. The purpose of the graphics is to provide a sense of how sensitive the project economic outcomes are to these factors, and how changes to the values forecasted in the study models would impact the results.

As an example, Figure H on the following page shows that the life cycle cost for the alternatives with on-site generation decreases more slowly than the grid-connected alternative when electricity prices rise. Thus, the Grid Parallel (PA) alternative in particular works as a hedge against future increases in electricity costs: if electricity costs rise as compared to the baseline values modeled the overall life cycle cost exposure to Big Six Towers is lower than it would be for the Grid Connected (GR) alternative.

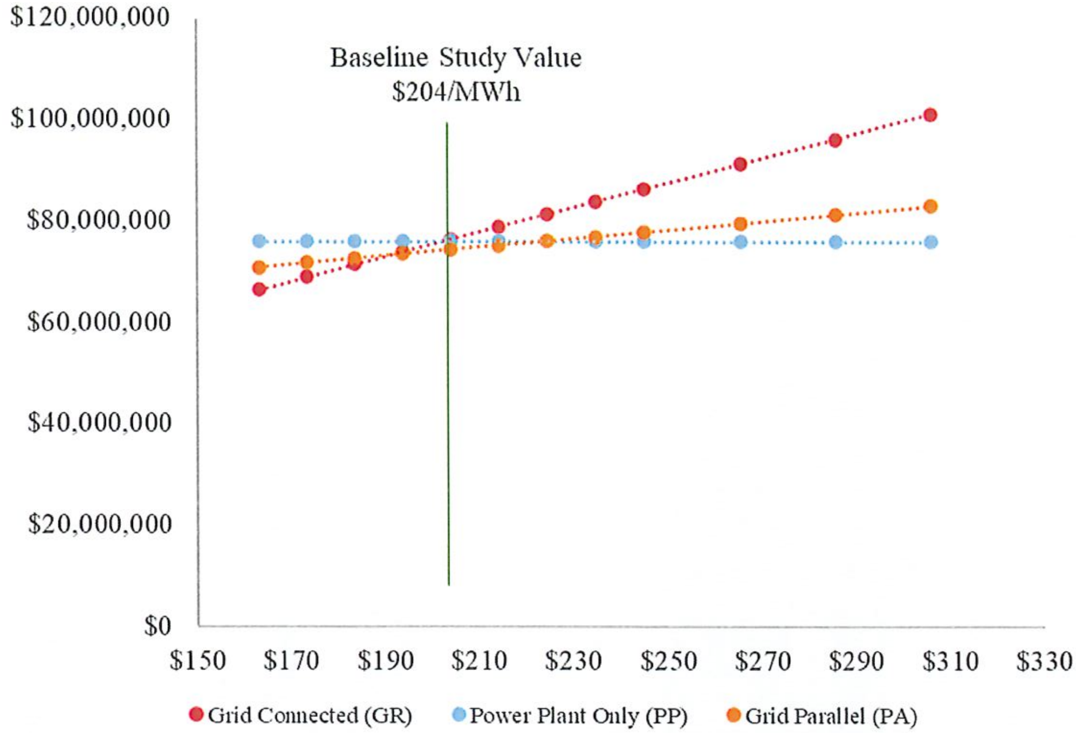

Figure H: Life Cycle Cost (TC$) as a Function of All-In Electricity Cost ($/MWh)

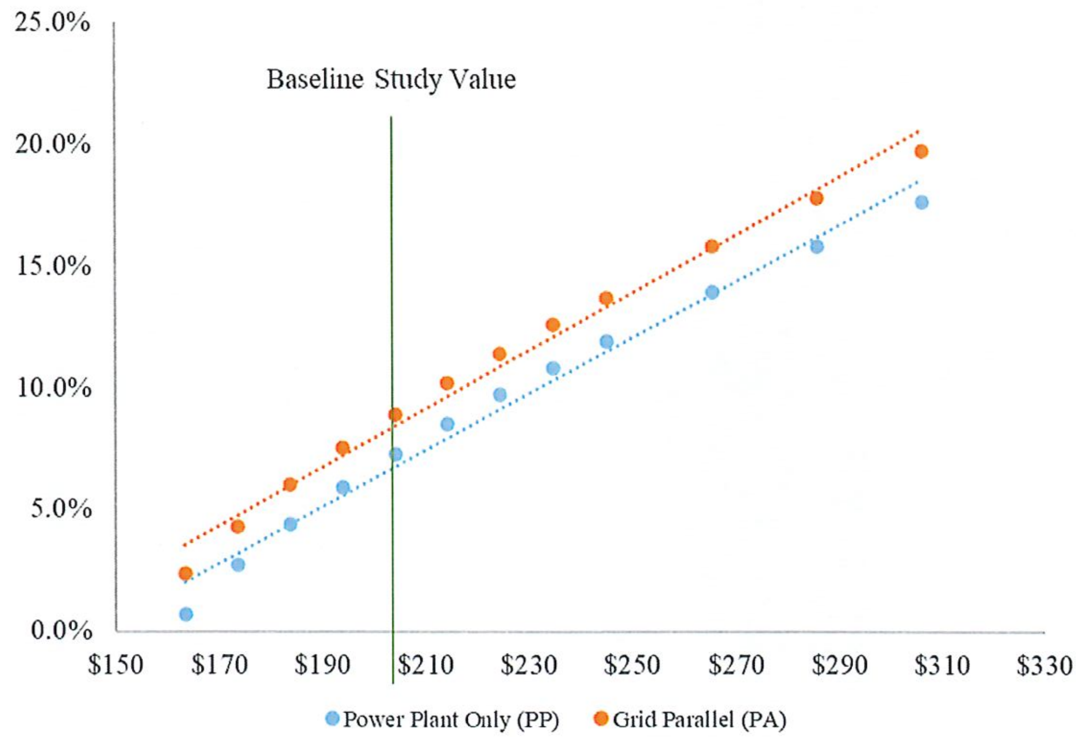

Figure I: Rate of Return as a Function of All-In Electricity Cost ($/MWh)

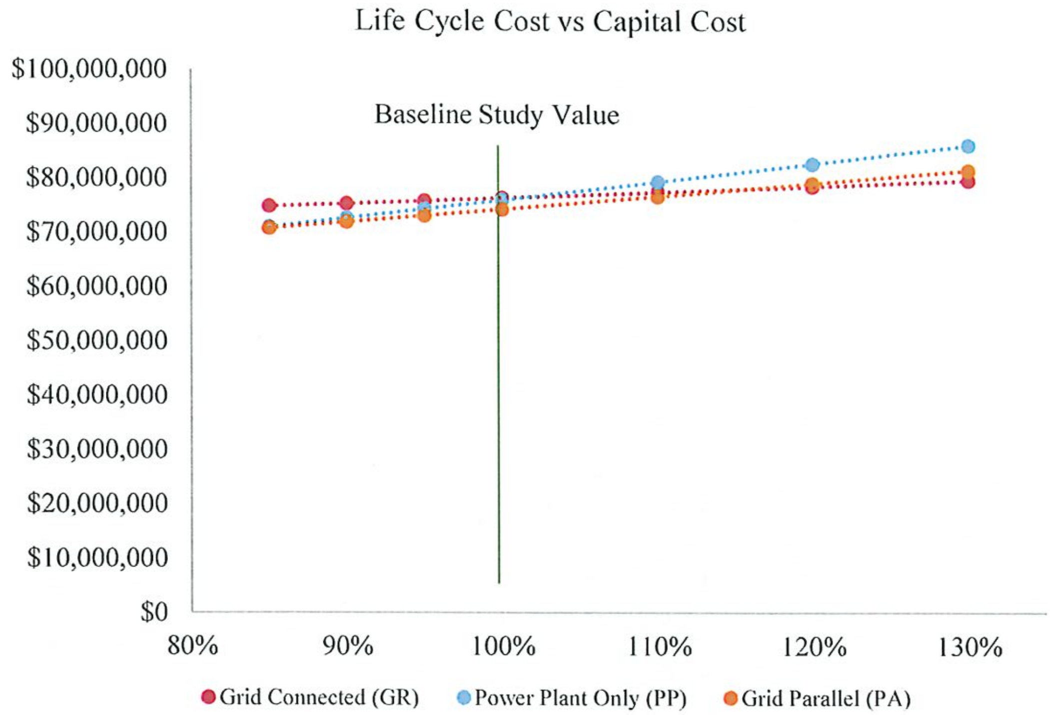

Figure J: Life Cycle Cost (TC$) as a Function of Capital Cost (% of Baseline)

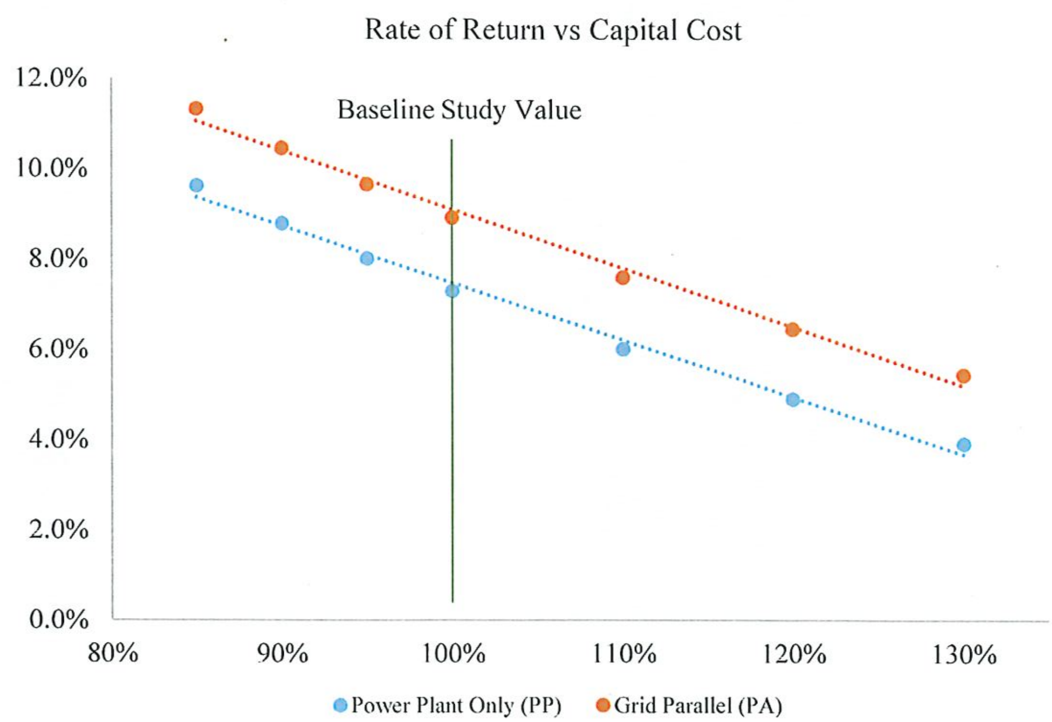

Figure K: Rate of Return as a Function of Capital Cost (% of Baseline)

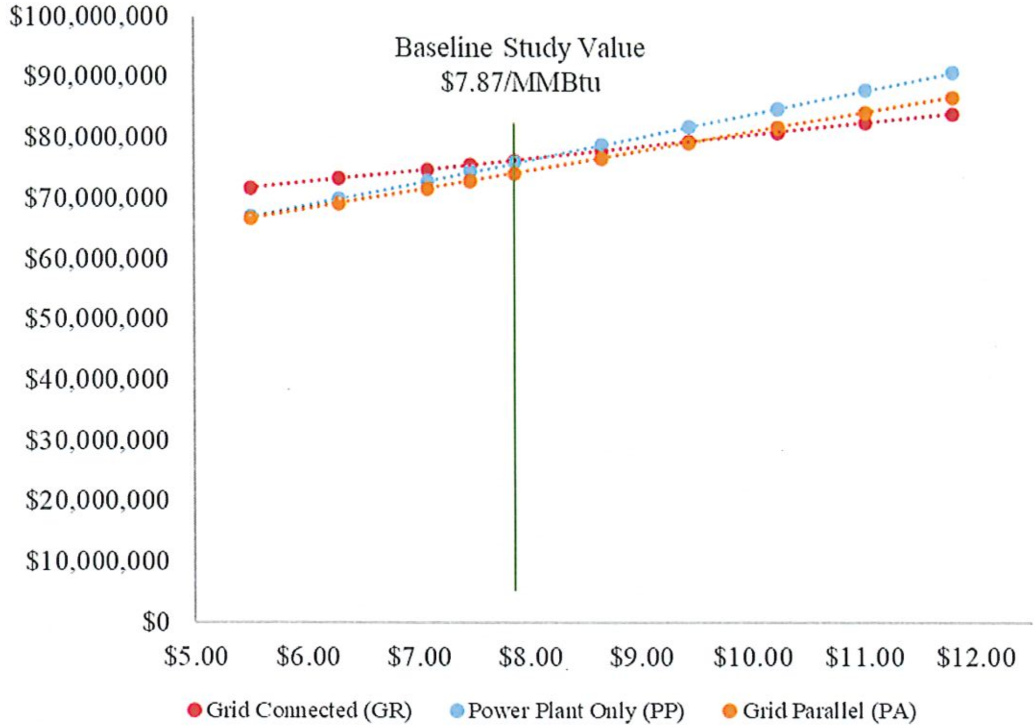

Figure L: Life Cycle Cost (TC$) as a Function of All-In Natural Gas Cost ($/MMBtu)

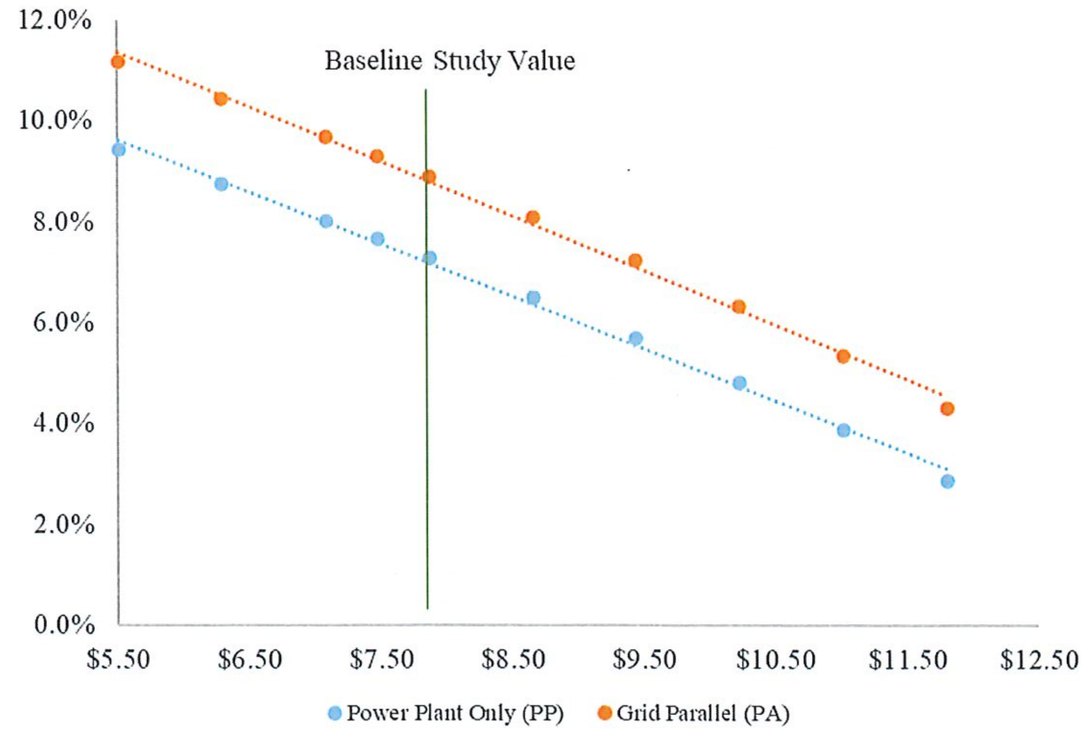

Figure M: Rate of Return as a Function of All-In Natural Gas Cost ($/MMBtu)

The graphics on the preceding pages depict project outcomes for cases when only a single parameter is varied at a time. The effects would compound for scenarios in which multiple parameters vary from the baseline assumptions. For instance, if electricity prices were to rise by 25%, capital costs to rise by 5%, and natural gas prices to rise by 5%, then the resulting rate of return for the grid parallel alternative (PA) would be 13.6%.

1.5 Recommendations and Next Steps

To make a decision on the energy supply alternative that is preferred for future development, Big Six Towers will need to weight the potential risks and benefits of the various alternatives. If minimizing capital investment is more important than mitigating risk exposure to future electricity prices, the grid-connected alternative (GR) would likely be the most attractive. On the other hand, if minimizing exposure to future year cost increases is paramount, given that future electricity prices are the most significant component of the operating budget as well as one of the most uncertain parameters of the analysis, then the grid parallel alternative (PA) would likely be the most attractive.

In Waldron's opinion, the Power Plant Only (PP) is the least attractive and could be removed from consideration. While the operating cost for this alternative is insensitive to the electricity markets, the higher capital cost results in a higher life cycle cost than the Grid Parallel (PA) alternative. Electricity prices would need to increase by roughly 30% in order for the life cycle cost of this alternative to equal the life cycle cost of the Grid Parallel (PA)alternative, and if electricity prices fall below the forecasted values the Power Plant (PP) alternative performs worst economically. It also exposes Big Six Towers to significant penalties at the conclusion of the life cycle period that could not be avoided without additional capital investments that the other options would not require.

Of the remaining two alternatives, assuming access to capital is not a hurdle, Waldron recommends the Grid Parallel (PA) case. The reason is that it provides a hedge against future electricity cost increases without a likely increase in life cycle cost, and if carbon emission penalties in the mid-2040's necessitate that the engines be curtailed in operation, the connection to the Con Edison grid would already be in place to provide a seamless transition. As low carbon technologies mature, the Grid Parallel (PA) case is flexible enough to accommodate either electrification or renewable fuel supply alternatives as may be required for roughly the same incremental cost as the Grid Connected (GR) alternative.

The recommended next steps will vary depending on the alternative that is most attractive to Big Six Towers. For the Grid Parallel (PA) option, Waldron would recommend the development of a conceptual engineering design suitable for use in creating a more detailed cost estimate of the work required. The purpose of this effort would be to scope out the project at a more refined level so that more accurate cost opinions could be developed. Further discussions with Con Edison, an environmental permitting consultant and the natural gas supplier, as well as possible commodity suppliers would also be recommended.

If the grid connected (GR) option is most attractive, the key step is continued engagement with Con Edison to define the scope of work and costs involved with establishing a grid connection for the supply of electricity.