Appendix B: Technical Benefit Cost Analysis

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Executive Summary

A total investment of $71 million ($20 million in Community Development Block Grant Disaster Recovery, CDBG-DR, funds via the Rebuild by Design program, $49.5 million in New York City capital funds, and $1.5 million in New York City Economic Development Corporation's funds) is dedicated to the "continued robust planning and study related to the future of the food market and a small pilot/demonstration project (to be selected by the City)" in Hunts Point. The Hunts Point Resiliency Project meets the project purpose and need by identifying an Energy Resiliency pilot project and providing a sustainable, reliable and resilient energy solution to the Hunts Point area through a combination of power generation solutions.

The original pilot project as defined in Action Plan Amendment 18 was a tri-generation facility with a microgrid for power distribution, solar photovoltaic (PV) with battery energy storage systems (BESSs), and mobile generators to provide a cumulative generating capacity of approximately 6.8 megawatts (MW). However, this pilot project encountered the following challenges during final design:

- elimination of an end user for the tri-generation facility (i.e., the Meat Market opted out of receiving hot water);
- potential Produce Market redevelopment that would replace all buildings and trailer refrigeration units (TRUs) with new construction;
- City and State policies and regulatory requirements to restrict local greenhouse gas emissions with penalties imposed; and
- cost saving strategies identified during conceptual design did not reduce total project costs to within available funding limits.

To address the combination of these factors, the tri-generation facility components of the original pilot project were evaluated and reconsidered. The amended energy resiliency pilot project will include the Fish Market given redevelopment of the Produce Market. The amended project scope still achieves the principal project objectives and supports subsequent project phases to achieve a larger vision of energy resiliency that is consistent with evolving City and State carbon neutrality goals. As such, the pilot project has been redefined to provide backup energy generation for the Fish Market with a solar PV generation and BESS facility, and one temporary, portable diesel generator to be brought in and deployed during extended emergency periods. In addition, one other Food Distribution Center (FDC) facility at 600 Food Center Drive will be backed up with a stationary diesel generator to be used during emergency periods. Community facilities (MS 424 and PS 48) on Hunts Point Peninsula will be provided solar PV plus BESSs for resiliency and sustainability similar to the original pilot project .

The cumulative energy capacity of the modified pilot project would generate up to approximately 7.3 MW for emergency conditions as needed. In addition, the pilot project will anchor a future microgrid with distributed energy resources (DERs) to achieve long-term sustainability and resiliency throughout the Hunts Point Peninsula.

The pilot project, as modified, consists of the following components:

Backup Generation for the Fish Market – This component of the pilot project involves a backup generation system that will supply electrical power to the Fish Market in the near term and anchor a future microgrid with DERs to achieve long-term sustainability and resiliency throughout the Hunts Point Peninsula. The backup generation system will consist of the 4 MW solar and a 2MW/5MWh battery energy storage system (BESS) to enable the "black start" of the facility and support load management at the Fish Market during emergency conditions. The backup generation system is primarily designed to operate in emergency conditions. In addition, EDC will pay for the service of a temporary, portable diesel generator to be deployed in emergency conditions to extend the reliability of the Fish Market electrical needs for up to 3 days if needed.

Community Facility Solar/Storage Installations – To provide sustainable and resilient power supply to some of the primary community facilities, the project will involve the installation of rooftop solar PV generation and a BESS for both the Middle School (MS) 424 and Primary School (PS) 48.

Emergency Backup Generation for Businesses – To provide resilient power supply to other buildings in the FDC, the project includes the purchase of a stationary diesel generator (0.5 MW) with the installation of connections to the electrical system at 600 Food Center Drive (Citarella/Sultana) for use during emergency periods.

The Benefit-Cost Analysis (BCA) of the pilot project was updated to reflect these project modifications and prepared in line with US Department of Housing and Urban Development (HUD) requirements, other federal guidelines, and industry best practices. The **analysis period of 20 years** reflects the average useful life of equipment, all values are estimated using **constant 2016 prices** (depicted as 2016$), **no general inflation** is used to escalate any values, and a **3.1 base discount rate** is used to bring all future values to a present value in 2016$.[1]

Overall, the **BCA shows positive outcomes with a $8.24 million net present value (NPV), 1.16 benefit-cost ratio (BCR), and an internal rate of return (4.4%)** that is above the 3.1% hurdle rate. The top monetized project impacts are summarized in Table 1 and described in detail throughout this appendix.

[1] All benefits are discounted at the 3.1% discount rate, except greenhouse gas emissions, which is discounted at 2%, in line with current guidance provided by United States Department of Transportation's Benefit-Cost Analysis Guidance as of December 2023. This follows the recent changes released in the Office of Management and Budget's Circular A-94 from November 2023.

Table 1: Table Describing BCA Costs and Benefits

Cost and Benefit by Category	Page # in Narrative Description	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative Assessment	Monetized Effect, NPV ($000s)	Uncer-tainty[2]
Life Cycle Costs					
Capital Costs	Pg. 9	Upfront one-time costs to implement the project and bring to operations.	Estimated by the Energy Resiliency Engineering Team based on costs of comparable recent project costs.	**($45,671)**	**2**
Incremental O&M Costs	Pg. 9	Costs required to operate and maintain the system in a state of good repair during its service life in excess of revenues earned from participation in demand response programs.	Estimated by the Energy Resiliency Engineering Team based on costs of comparable recent project costs.	**($4,821)**	**2**
Incremental Fuel Costs	Pg. 9	Cost of fuel (diesel or natural gas) consumed by power generating equipment in excess of revenues earned from participation in demand response programs.	Fuel consumption estimated by the Energy Resiliency Engineering Team. Fuel price forecasts from NY State Energy Plan and EIA 2017 Annual Energy Outlook.	**($927)**	**2**
Energy Cost Savings	Pg. 11	Reduction in demand for electricity from the grid.	Electricity price are based on Bronx location-based marginal price forecasts from the NYISO 2015 CARIS.	**$6,372**	**2**
Generation Capacity Cost Savings	Pg. 12	Avoided costs from deferring the need to invest in new bulk power generation.	Estimated reduction in demand for peaking capacity through demand response program participation and NYISO 2015 CARIS cost of generation.	**$4,767**	**2**
Resiliency Value					
Power Outage Reduction Benefits - Markets and Businesses	Pg. 13	Avoided revenue and inventory losses from shut down operations during a major power outage event.	Revenue loss and inventory loss estimated based on market data and interviews with market representatives.	**$43,422**	**4**
Power Outage Reduction Benefits - Direct Wages	Pg. 13	Reduced impacts on FDC businesses prevent the loss of wages of workers that would be out of work until the market could come back online.	Wage losses derived based on the number of employees obtained from NYCEDC Business Reporting and average employee wages – EMSI labor market data.	**$1,111 (excluded from BCA total)**	**4**
Power Outage Reduction Benefits - Indirect Impacts	Pg. 13	Indirect losses from impacts on FDC businesses' sales.	Direct revenue losses derived from the market impacts; Regional multipliers obtained from IMPLAN.	**$12,637 (excluded from BCA total)**	**4**
Power Outage Reduction Benefits - Community Facilities	Pg. 18	Energy packages enable community facilities to provide refuge to those in need during major weather and outage events, and other services to community members.	Estimated based on 1,200 person capacity and a value of $331 per person per day based on US General Services Administration guidelines for federal per diem reimbursable expenses.	**$731**	**4**
Reliability Improvements	Pg. 18	Avoided costs associated with the reduction in the frequency or duration of minor power outages.	Estimated annual cost of service interruption for each class of electricity customer with state-specific inputs using the US Department of Energy Interruption Cost Estimate Calculator.	**$117**	**2**
Environmental Values					
Greenhouse Gas (GHG) Emissions	Pg. 17	Change in environmental damages from GHG emissions, net impacts of avoided GHG emissions from bulk energy suppliers and local emissions offsets, and increased emissions from implemented energy solutions.	Emission allowance prices are based on the NYISO 2015 CARIS. CO_2 emission damage costs are based on the Interagency Working Group on Social Cost of Greenhouse Gases, Technical Update of the Social Cost of Carbon for Regulatory Impact. NY grid marginal emission rates derived from the New York Public Service Commission Case 15-E-0703, the USEPA National Emissions Inventory and the Commission for Environmental Cooperation (North American Power Plant Emissions).	**$2,723**	**2**
Social Values					
Health Impacts	Pg. 18	Net impacts of avoided criteria air pollutants causing mortality and respiratory issues from bulk energy suppliers and local emissions offsets, and increased pollution from implemented energy solutions.	Criteria air contaminant emission costs are estimated based on the USEPA Cost-Benefit Risk Assessment Screening Model.	**$1,199**	**2**
Food Supply	Pg. 20	Maintaining power to the markets would maintain food distribution to the region and avoid supply disruptions that could result in higher food prices.	+ (qualitative scale)	**n/a**	**4**

[2] Based on HUD guidelines – assessment of the certainty of the effect on a scale from 1 (very certain) to 5 (very uncertain).

Economic Revitalization					
Employment Opportunity	Pg. 20	The project will create temporary and permanent job opportunities during construction and operations.	+ (qualitative scale)	**30-40 people construction + 2 permanent & 3-4 on-call**	**2**

1 Introduction

This report presents the technical BCA of the Energy Resiliency pilot project for the Hunts Point Resiliency Project. This overall study process has been guided by a Sustainable Return on Investment (SROI) approach where several technology and project packages were developed, screened and evaluated. Ultimately, four project packages were formally evaluated using SROI, where preliminary BCA results for each package were reviewed, discussed and refined during a workshop session with the City, project team, and stakeholders. Based on this evaluation, one preferred pilot project was identified. The pilot project with changes based on further evaluation and refinement incorporated and BCA is summarized in the sections that follow.

2 BCA Overview and Approach

The BCA of the Energy Resiliency project is developed using a SROI process whereby the analysis and assumptions are developed and then reviewed and refined with key stakeholders in a workshop environment. Using this approach, effects that can be quantified and expressed in monetary terms are monetized. Other effects which are relevant but which cannot be expressed in monetary terms are discussed qualitatively.

The BCA methodology employed is consistent with the general principles outlined in Office of Management and Budget (OMB) Circular A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs" as well as National Disaster Resilience Competition (NDRC) and other BCA guidelines relevant to the energy generation sector.[3]

BCA is a conceptual framework that quantifies in monetary terms as many of the costs and benefits of a project as possible. Benefits are broadly defined. They represent the extent to which people impacted by the project are made better off. In other words, central to BCA is the idea that people are best able to judge what is "good" for them, or what improves their well-being or welfare.

BCA also adopts the view that a net increase in welfare (as measured by the summation of individual welfare changes) is a good thing, even if some parties benefit, while others do not. A project or proposal would be rated positively if the benefits to some are large enough to compensate the losses of others.

Finally, BCA is typically a forward-looking exercise, seeking to anticipate the welfare impacts of a project or proposal over its entire life cycle. Future welfare changes are weighted against today's changes through discounting, which is meant to reflect society's general preference for the present, as well as broader inter-generational concerns.

[3] This includes HUD BCA Guidelines, the New York Public Service Commission Order establishing the Benefit Cost Analysis Framework Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision (January 21, 2016) and the New York State Energy Research and Development Authority's Community Microgrid Benefit-Cost Analysis guide.

The specific methodology developed for this Energy Resiliency pilot project was developed using core BCA principles and is consistent with HUD guidelines. In particular, the methodology involves:

- Establishing existing and future conditions under the alternative (build) and base (no-build) scenarios;
- Assessing benefits with respect to each of the five long-term outcomes identified in HUD's requirements for Rebuild by Design projects[4] which are in line with NDRC BCA Guidance;
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using standard benefit value assumptions adopted by federal agencies (i.e., Federal Emergency Management Agency - FEMA, Department of Transportation - DOT, etc.) while relying on industry best practices for the valuation of other effects;
- Estimating benefits and costs over a project life cycle that includes the project development period plus 20 years of operations consistent with the expected useful life of project assets;
- Discounting future benefits and costs with the real discount rates recommended by OMB and US DOT (3.1%, and an alternative of 2% for greenhouse gas emissions based on latest federal guidance); and
- Engaging the City, technical experts and stakeholders in a workshop review to vet and refine project options, types of benefit and cost impacts, and key assumptions.

3 Project Description

The Hunts Point Resiliency Project meets the project purpose and need by reducing the peninsula's vulnerability to coastal flooding through a pilot project that provides a reliable and resilient energy solution to the Hunts Point area through a combination of power generation solutions. The pilot project incorporates rooftop solar PV generation, canopy solar PV generation and, BESS with other fossil fueled energy generation technologies for the supply of short-term, dispatchable energy resiliency during emergency conditions. In addition, the pilot project will anchor a future microgrid with DERs to achieve long-term sustainability and resiliency throughout the Hunts Point Peninsula. .

The pilot project outlined herein consists of the following components, all of which offer independent utility.

Backup Generation for the Fish Market – The backup generation system will consist of 4.0 MW of solar PV generation, as well as a 5 MWh BESS to enable the "black start" of the facility and support load management at the Fish Market during emergency conditions. The backup generation system is primarily designed to operate in emergency conditions. The backup generation facility will be located on the Fish Market Property and will be elevated above the 100-year floodplain to 19 feet NAVD88. The system will be interconnected with the existing Con Edison's infrastructure on site. Additionally, a portable diesel generator will be towed in and deployed to provide emergency backup generation in extended emergency conditions.

Community Facility Solar/Storage Installations – To provide sustainable and resilient power supply to two primary community facilities, the project will involve the installation of rooftop solar PV generation and a BESS for both the MS 424 and PS 48. The total supported installation is approximately 0.5 MW of solar

[4] US Department of Housing and Urban Development: CDBG-DR Rebuild by Design: Guidance regarding content and format of materials for approval of CDBG-DR Action Plan Amendments releasing funds for construction of Rebuild by Design projects, including guidance for Benefit-Cost Analysis, April 2016.

capacity with eight hours of energy storage capacity for facility critical loads. This level of power will enable the facilities to provide shelter, refuge, or gathering spaces in emergency situations.

Emergency Backup Generation for Businesses – To provide resilient power supply to other important citywide food distributors and employers in the FDC, the Energy Resiliency pilot project includes the purchase of one 500 kilowatt (kW) diesel generator with the installation of connections at 600 Food Center Drive (Citarella/Sultana) to provide electrical power for emergency conditions only. The generator will enable immediate energy resiliency with minimal capital construction costs for facilities that are critical to the city's food supply chain. Tier 4 diesel engines will be used to control and treat emissions. Emission rates will be specified as a condition of generator unit operating permits to be enforced by both NYSDEC and NYCDEP. Permit requirements will be specified to equipment suppliers and/or contractors and guaranteed by the equipment suppliers as a condition of facility installation. Ongoing compliance with these emissions rates and permitted hours of operation will be a condition of facility management.

The locations, capacities, and utilization of the various installations are summarized below in Table 2.

Table 2: Project Equipment Specifications

Project Location	Generation Type	Capacity (MW)	Purpose
Fish Market	Rooftop & Carport Solar PV Battery Storage	4 2	Fish Market Resiliency / Microgrid
MS 424	Rooftop Solar PV Battery Storage	0.45 0.13	Community Resiliency
PS 48	Rooftop Solar PV Battery Storage	0.07 0.13	Community Resiliency
600 Food Center Drive	Stationary Generator	0.50	Business Resiliency
Total Installed Capacity		**7.28**	

3.1 Base Case and Alternative

Base Case

The Base Case is defined as existing conditions and without the pilot project. The Hunts Point Resiliency study area as a whole faces its greatest threats from storm surge along areas of the coastline, building and system-level outages, and extreme heat. Economic resilience in the industrial area depends on physical resilience, i.e., staying in business, and the FDC businesses are part of a regional network of sellers and purchasers. Social resilience is directly dependent on the physical resiliency of community facilities and the ability of any new proposed project to address environmental justice concerns within the community.

Key points pertaining to the Base Case conditions include:

1. Building and system-level power outages are a significant and shared threat to residents and businesses in Hunts Point.
2. Due to considerable elevation change, the low-lying areas face significant threats from coastal flooding while the upland residential area does not.
3. Extreme rain/snow storms are not a major threat in Hunts Point.
4. The number of community organizations and history of organizing in Hunts Point can lay the foundation for strong social resiliency.

Several key economic centers including FDC facilities are vulnerable to a combination of building and system-level energy outages, storm surge, and extreme heat events. Food Center Drive, the main street to and from the FDC, would be underwater in a 100-year storm tide and 2050 sea level rise. Social services in the residential areas and, specifically, the schools that serve as community centers and emergency shelters (PS 48 and MS 424), are vulnerable to energy outages and extreme heat due to the potential displacement of schoolchildren and employees during an outage or if these facilities could not be used during an emergency because of a lack of power or air conditioning. The future threats and vulnerable critical facilities based on an assessment of the base case completed for the Hunts Point Resiliency Project are summarized in Figure 1.

Figure 1: Base Case Critical Facilities and Threats

Critical Facilities & Future Threats

Facility	Threat	
Hunts Point Recreational Center	*Outage, Heat*	**Community**
Pio Mendez Housing for the Elderly	*Outage*	
Primary School (PS) 48	*Outage, Heat*	
Middle School (MS) 424	*Outage, Heat*	
Produce Market	*Outage, Heat*	**Food Distribution Center**
Meat Market	*Outage, Surge, Heat*	
Fish Market	*Outage, Heat*	
600 Food Center Dr (Citarella/Sultana)	*Surge*	
Krasdale	*Surge*	
Hunts Point Wastewater Treatment Plant	*Surge*	**Infrastructure & Other Facilities**
Oak Point Railyard	*Surge*	
Vernon C. Bain Correctional Facility	*Surge, Heat*	
Certain Road Intersections	*Surge, Outage*	
Certain Electrical Transformers	*Surge, Outage*	

Alternative Case

The Alternative Case assumes that the Energy Resiliency pilot project is implemented as described above in the Introduction and Project Description.

3.2 Project Impacts

Implementation of the Energy Resiliency pilot project would have several impacts including life cycle costs, resiliency, environmental, social, and economic impacts. These are briefly summarized below (Table 3) and are explored in more detail in the following section.

Table 3: Project Impacts

Category	Cost and Benefit by Category	Description of Effect
Life Cycle Costs	Capital Costs	Upfront one-time costs to implement the Energy Resiliency pilot project and bring the project to operation.
Life Cycle Costs	Incremental O&M Costs	Costs required to operate and maintain the system in a state of good repair during its service.
Life Cycle Costs	Incremental Fuel Costs	Cost of fuel (diesel, natural gas, or electricity) consumed by power generating equipment in excess of revenues earned from participation in demand response programs.
Life Cycle Costs	Energy Cost Savings	Reduction in demand for electricity from the grid after pilot project implementation.
Life Cycle Costs	Generation Capacity Cost Savings	Avoided costs from deferring the need to invest in new bulk power generation after pilot project implementation.
Resiliency	Reliability Improvements	Avoided costs associated with the reduction in the frequency or duration of power outages after pilot project implementation.
Resiliency	Power Outage Reduction Benefits - Markets and Businesses	Avoided revenue and inventory losses from shut down operations during a major power outage event after pilot project implementation.
Resiliency	Power Outage Reduction Benefits - Direct Wages	Reduced impacts on FDC businesses prevent the loss of wages of workers that would be out of work until the market could come back online after pilot project implementation.
Resiliency	Power Outage Reduction Benefits - Indirect Impacts	Reduction in indirect losses from impacts on FDC businesses sales including avoided loss of economic activity by suppliers and consumers of the markets, as well as employee spending.
Resiliency	Power Outage Reduction Benefits - Community Facilities	Pilot project implementation enables the community facilities to provide refuge to those in need during major weather and outage events, and other services to community members.
Environmental	GHG Emissions	Change in environmental damages from GHG emissions.
Social	Health Impacts	Changes in criteria air pollutants causing mortality and respiratory issues.
Social	Food Supply	Maintaining power to the markets would maintain food distribution to the region and avoid supply disruptions that could result in higher food prices.
Economic Revitalization	Employment Opportunity	The project will create temporary and permanent job opportunities during construction and operations.

4 Benefits Measurement, Data, and Assumptions

The BCA was prepared in line with HUD requirements, other federal guidelines, and industry best practices. The **analysis period of 20 years** reflects the average useful life of equipment, all values are estimated using **constant 2016 prices** (depicted as 2016$), **no general inflation** is used to escalate any values, and a **3.1% base discount rate** is used to bring all future values to a present value in 2016$.[5]

[5] All benefits are discounted at the 3.1% discount rate, except greenhouse gas emissions, which is discounted at 2%, in line with current guidance provided by United States Department of Transportation's Benefit-Cost Analysis Guidance as of December 2023.

4.1 Life Cycle Costs

4.1.1 Capital Costs

The capital costs (Table 4) represent the full upfront one-time costs to implement the project and bring it to operations (regardless of ownership or funding structure). While all cost estimates are presented in 2016$, construction is not anticipated to begin until late 2022 with the bulk of spending spread across 2023 through 2025. Therefore, the estimated total expended capital cost value, accounting for escalation over the duration of the project execution, including previously incurred costs, is $77.1 million. The capital costs make up the far majority of the project costs. For the purposes of the BCA, the capital costs are presented exclusive of any financial credits or incentives for solar PV installations.

Table 4: Capital Costs

Capital Costs	$Millions
Total capital costs, excluding credits (2016$)	$62.94
Total capital costs, excluding credits (YOE$)	$77.13
Present Value (2016$)	$45.67
Equipment Life	20 years

4.1.2 Annual Costs

4.1.2.1 Operating & Maintenance Costs

The operating and maintenance (O&M) costs include both fixed and variable costs to operate and maintain the system in a state of good repair during its service life, including costs directly associated with power generation and excluding fuel. These costs will begin to be incurred once the project is operational in 2026 and through the final year of operation in 2045. The costs are assumed to escalate at the general level of inflation over the study period (and thus remain constant for the purposes of the BCA).

4.1.2.2 Fuel Costs

Fuel costs were estimated based on the expected fuel consumption according to the equipment efficiency, frequency of use, and capacity utilization. Price forecasts for delivered fuel to the region were based on information from the New York State Energy Plan and the latest US Energy Information Administration (EIA) 2017 Annual Energy Outlook price forecasts presented below in Figures 2 and 3.

Figure 2: Natural Gas Price Forecast

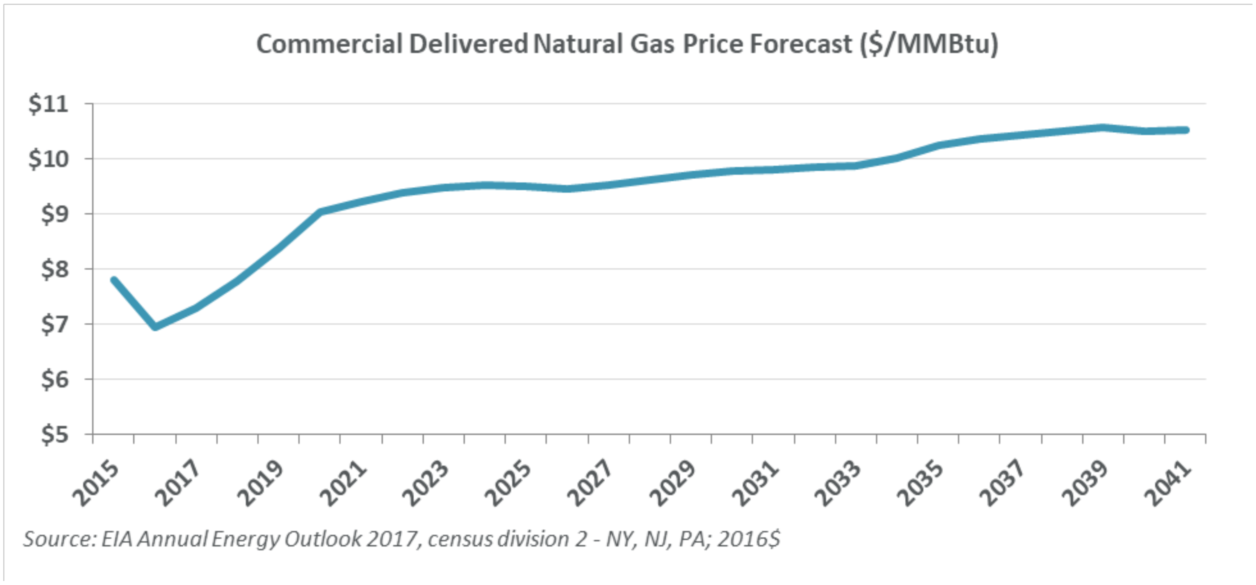
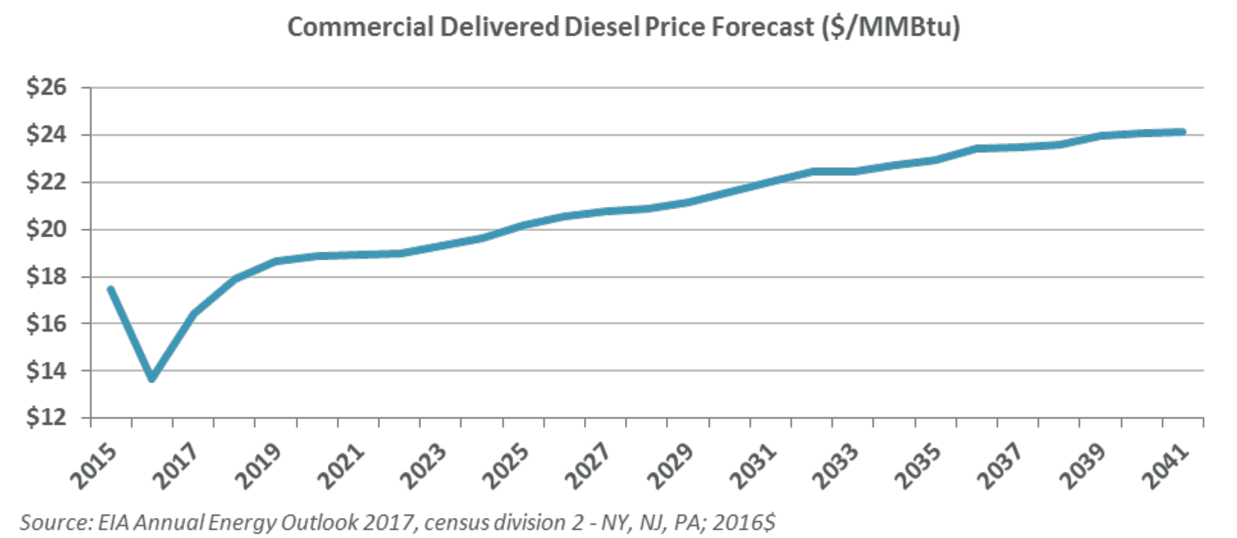


Figure 3: Diesel Price Forecast



The sum of O&M and fuel costs adds up to approximately $448 thousand per year assuming emergency operations of 150 hours per year.[6] Given the 2026 in service date and a 3.1% discount rate, the discounted costs over 20 years sum to a total of $5.8 million (Table 5). The costs to operate the Fish Market solar and battery storage is not modeled to be offset by participation in eligible demand response programs, even though there are programs including the Installed Capacity – Special Case Resource (SCR), Commercial System Relief Program (CSRP), Distribution Load Relief Program (DLRP), Peak Saver, Central Hudson Targeted Demand Response (TDR) program, and Demand-Side Ancillary Service Program (DSASP). Combined, participation in these programs could generate up to $1.54 million per year (2016$)[7], almost

[6] For costing purposes, the BCA relies on assumed actual hours of operation and not potential permitted hours of operation.

[7] Demand response opportunity analysis performed by Gotham Energy 360 LLC and evaluated a financial opportunity of $1.73 million in 2021$. Value was deflated to 2016$ using the BEA's Implicit Price Deflators for Gross Domestic Product, Table 1.1.9.

double the amount of O&M and fuel costs. To remain conservative, the benefit-cost analysis does not assume participation in demand response programs.

Table 5: Annual Costs

Millions 2016$	Present Value	Annual Average
O&M Costs	$4.82	$0.37
Fuel Costs	$0.93	$0.07
Total Annual Incremental Costs	**$5.75**	**$0.45**

4.1.3 Annual Savings

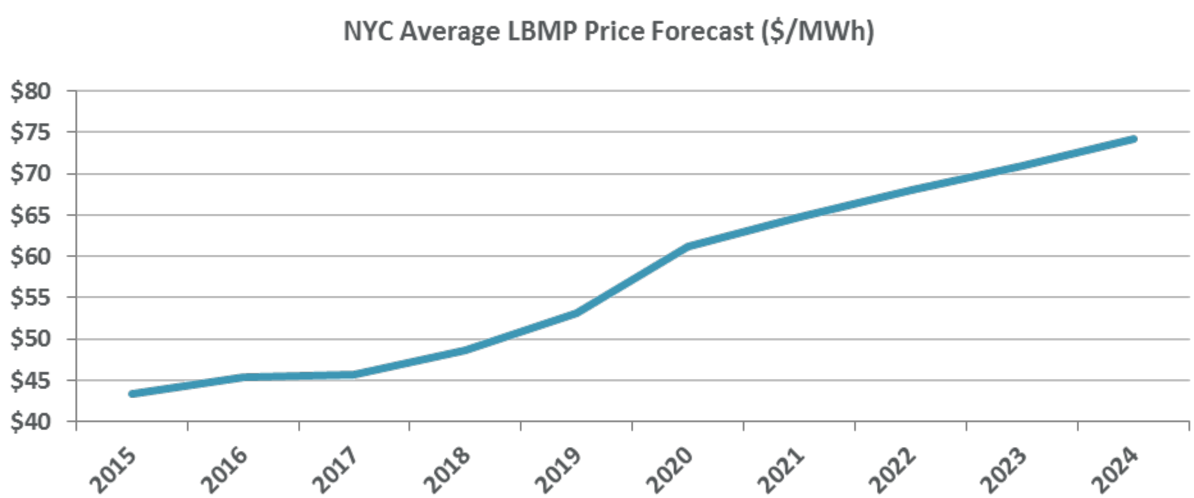
4.1.3.1 Energy Cost Savings

Energy cost savings represent the avoided cost of generating electricity on the grid and delivering it to Hunts Point. The project is anticipated to generate approximately over 4,940 megawatt hours (MWh) per year based on the solar PV installations.

In order to estimate the actual gross generation displaced from the grid, the annual generation is marked up by an average distribution loss factor of 3.5%[8] while it is assumed that transmission losses are internalized in the Location Based Marginal Prices (LBMP) which reflect the marginal cost of generating electricity at a given point in time.

The actual value of avoided electricity generation from the grid was estimated based on the 5-year real time average LBMP in the Bronx during the hours the equipment is expected to operate. The 5-year average spread between the LBMP at those times and the average New York City zonal LBMP was then applied to the NYC zonal forecast in the latest New York Independent System Operator (NYISO) 2015 Congestion Assessment and Resource Integration Study (CARIS). The average price forecast is presented through year 2024 in Figure 4. For subsequent years, the prices are escalated using the wholesale natural gas price forecast from the EIA since the majority of marginal generators at peak times are natural gas.

Figure 4: New York City Average LBMP Price Forecast



Source: NYISO, 2015 Congestion Assessment and Resource Integration Study; 2016$

[8] NYSERDA, Assessment of Transmission and Distribution Losses in New York.

4.1.3.2 Generation Capacity Cost Savings

In addition to avoided costs of generating electricity, it is possible for energy solutions to reduce load on the system during coincident peak periods, and as a result displace or defer future investments in generation or distribution capacity (e.g., the need to install new infrastructure required to meet peak system loads). Given substantial investments in local distribution infrastructure by Con Edison, it is not anticipated that distribution capacity cost savings could be reasonably attributed as a benefit.

The cost savings were calculated by multiplying the approximate 3,090 kW contribution from the solar and energy storage installations that may participate in demand response by the installed capacity price forecasts in line with NY DPS BCA Guidance[9] based on 2015 Gold Book with updates through January 2016 as presented in the charts above. The estimates account for the reserve margin that regulated utilities must maintain above anticipated peak load and are relatively small in comparison to the energy cost savings. See Figure 5 and Table 6 below.

Figure 5: Generation Capacity Cost Estimates

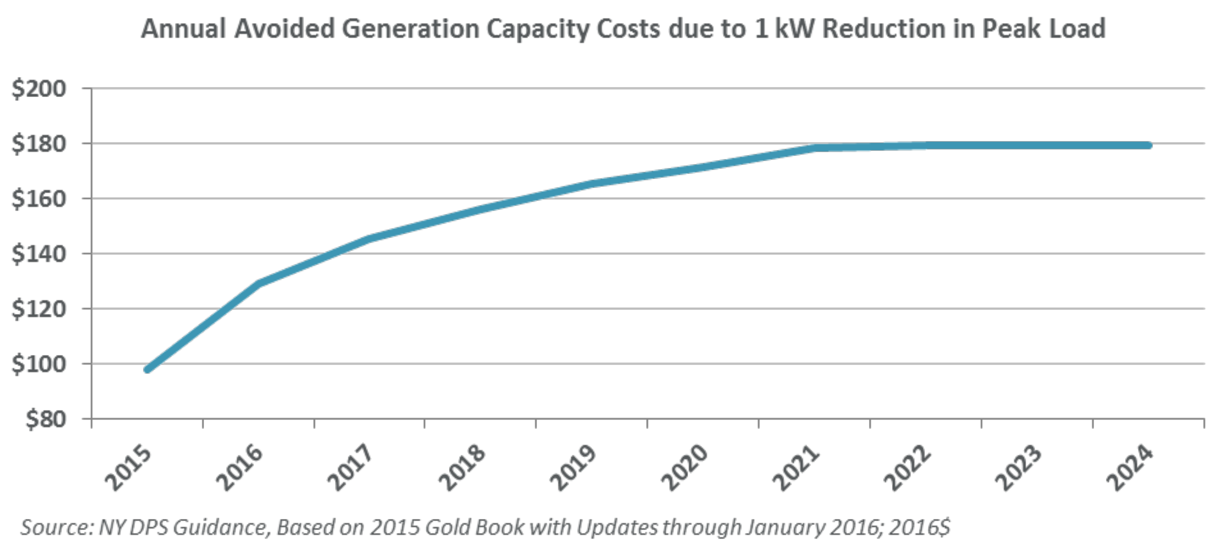


Table 6: Annual Savings

Millions 2016$	**Present Value**	**Annual Average**
Energy Cost Savings	$6.37	$0.50
Generation Capacity Cost Savings	$4.77	$0.37
Total Annual Savings	**$11.14**	**$0.87**

4.1.4 Life Cycle Costs Summary

Overall, the project is expected to cost $40.28 million over its life cycle from a societal perspective (without accounting for renewable energy financial incentives or customer electricity bill savings which are considered to be a transfer of wealth). Once operational, the project is expected to offset nearly all ongoing costs with energy and generation capacity cost savings (Table 7).

[9] New York Public Service Commission Case 14-M-0101 – Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, Order Establishing the Benefit Cost Analysis Framework.

Table 7: Life Cycle Costs Summary

Millions 2016$	Present Value	Annual Average
Capital Costs	($45.67)	
Annual Incremental Costs	($5.75)	($0.45)
Energy Cost Savings	$6.37	$0.50
Generation Capacity Cost Savings	$4.77	$0.37
Total Life Cycle Costs	**($40.28)**	**$0.42**

4.2 Resiliency Value

The project provides several resiliency benefit streams, some of which can reasonably be monetized. Specifically, new local generation will allow the local markets and businesses to continue operating, or at least maintain critical loads to prevent inventory losses, during a major power outage and provide shelter at community facilities. Installed permanent generation (like solar PV and the backup generation facility with microgrid) will further improve power reliability for those facilities in cases of minor power outages.

4.2.1 Methodology and Key Assumptions

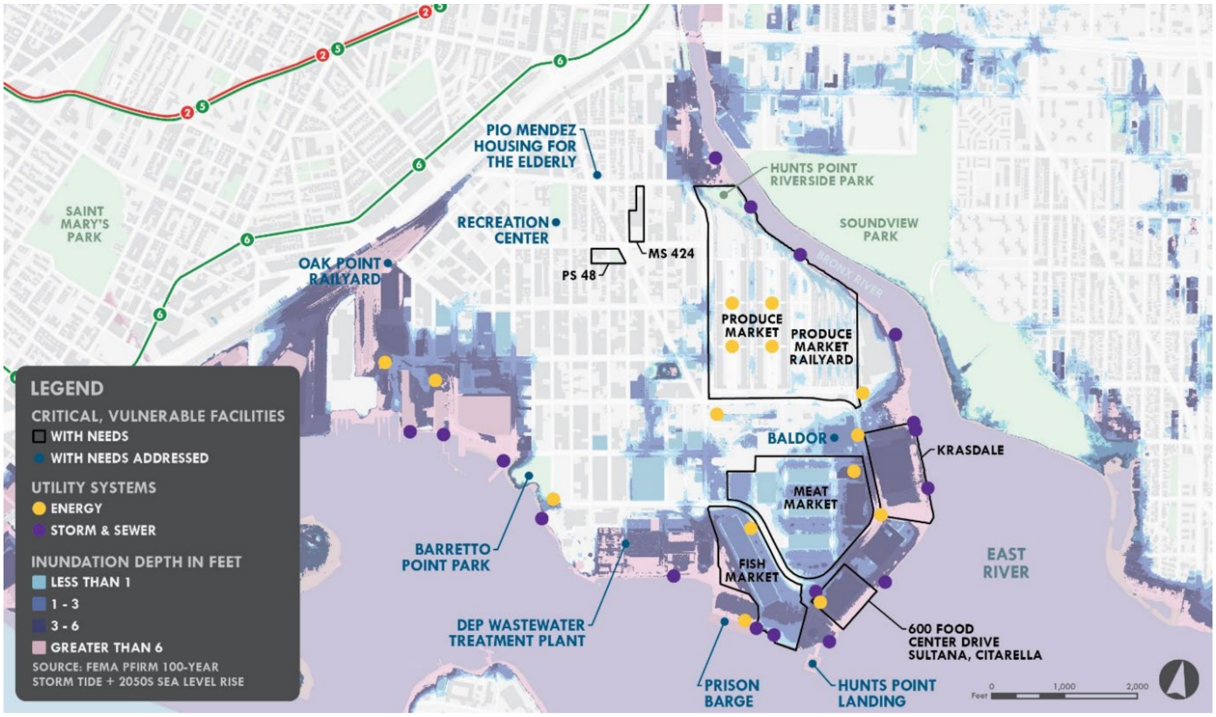
Major Outage Probability

The probability of a major power outage due to storm surge was estimated based on anticipated inundation rates of Con Edison transformers at Hunts Point and floodplain data for each transformer and the impacted facilities from FEMA Preliminary Flood Insurance Rate Maps. It was determined that and Citarella and Sultana could benefit most from generators during a major inundation event, which would allow them to preserve inventory for up to three days. In discussions with Con Edison, it was established that in the event of a major storm event power may be shut off a few of hours in advance as a preventative measure, and it could take as long as 48 hours to reinstate assuming that the transformer is not completely inundated (and would thus have to be replaced with an even longer outage time). Subsequently, storm surge durations of 6 to 24 hours are anticipated to result in a 2-3 day outage to the impacted facilities.

In addition to storm surge modeling estimates, it was assumed that a major outage event would occur once every 20 years (in other words with a 5% probability per year) and would cause a 3-day power outage to the peninsula. The event could range from a major Hurricane Sandy-like event to extreme heat, or anything else that causes a major system shut down. Based on historical data on the frequency and duration of outages, the assumption was deemed to be a reasonable representation of the project’s true resiliency benefits.

All power outage reduction benefits in this section are estimated based on these major outage probabilities, while reliability improvements are estimated based on Con Edison minor outage statistics for the Bronx.

Figure 6: Hunts Point Floodplain Map



Power Outage Reduction – Markets and Businesses

Preventing and reducing power outages to local markets and businesses is the overall biggest benefit to the project. Avoiding revenue and inventory losses from shutting down operations during a storm or other major outage event preserves the substantial economic activity generated by the facilities.

The impacts of major outages on specific FDC facilities were estimated in discrete blocks of outage time (12 hours, 24 hour, 36 hours, and 72 hours without power) based on certain assumptions that were derived from interviews with market representatives and subsequently vetted with stakeholders for reasonableness. The key assumptions included the share of inventory lost due to spoilage (based on the type of inventory, turnover rates, ability to use existing backup generators, etc.), and the days to return to business (influenced by facility lighting, cleanup of lost stock, ability to conduct offsite operations, etc.) which generated direct revenue and inventory loss estimates.

Only the direct revenue and inventory economic impacts were considered for the BCA as they represent the consumer willingness to pay for these goods and services. The direct impacts were subsequently used to derive other key economic impact metrics that are not additive benefits within the BCA as they serve to measure the impact on economic activity rather than social welfare. "Wage losses," a derived impact, was based on the number of employees from New York City Economic Development Corporation (NYCEDC) Business Reporting and average employee wages based on EMSI labor market data. The other derived is "regional economic benefits" based on the multiplier effect of reduced FDC business sales using IMPLAN economic multipliers.

Table 8: Estimated Economic Impacts of a Power Outage to the Markets and Businesses

	Fish Market	Sultana + Citarella	Fish Market	Sultana + Citarella	Fish Market	Sultana + Citarella	Fish Market	Sultana + Citarella
Power Outage Length	12 hours		24 hours		36 hours		72 hours	
Days Power Outage	0.5	0.5	1	1	1.5	1.5	3	3
Inventory Lost	0.5	0	1	0.25	1	0.5	1	0.5
Days to return to business	0.5	0.5	1.5	1	2	2	4	4

Assumptions on inventory lost and number of days to return to business based upon interviews with Market representatives. Number of days to return to business may be influenced by facility lighting (daylight versus all indoor lighting), cleanup of lost stock, or ability to conduct offsite operations.

Direct Damages

Building Damage								
Other Property Damage								
Inventory Loss	$1,260,000	$0	$3,780,000	$3,556,000	$5,460,000	$7,112,000	$8,400,000	$7,112,000
Revenue Loss	$2,800,000	$1,016,000	$5,600,000	$2,032,000	$8,400,000	$4,064,000	$16,800,000	$8,128,000
Wages Loss	$105,400	$11,000	$210,800	$22,000	$316,200	$44,000	$632,400	$88,000
Estimated Direct Damages	**$4,165,400**	**$1,016,000**	**$9,590,800**	**$5,588,000**	**$14,176,200**	**$11,176,000**	**$25,832,400**	**$15,240,000**

Lost wages are provided for reference and are not included in the total since wages paid are a component of Total Revenue.

Indirect Damages

Building Damage								
Other Property Damage								
Inventory Loss								
Revenue Loss	$1,414,884	$513,401	$2,829,769	$1,026,802	$4,244,653	$2,053,604	$8,489,307	$4,107,207
Impacts of Wages Lost	$26,404	$2,756	$52,809	$5,511	$79,213	$11,023	$158,426	$22,045
Estimated Indirect Damages	**$1,441,289**	**$513,401**	**$2,882,577**	**$1,026,802**	**$4,323,866**	**$2,053,604**	**$8,647,732**	**$4,107,207**

Lost wages are provided for reference and are not included in the total since wages paid are a component of Total Revenue.

Power Outage Reduction - Community Facilities

The rooftop solar PV and energy storage installations at MS 424 and PS 48 will add redundancy and allow the community facilities to ensure the provision of refuge to those in need during major weather and outage events, and other services to community members (cell phone charging, bathrooms, gathering point, information, etc.). Informed directly by NYC Emergency Management, the BCA accounted for at least 1,200 people to be accommodated at the schools in a major event. (Additional discussions with stakeholders indicated that the capacity could even accommodate more.) A monetary value of $331 per person per day was used based on U.S. General Services Administration guidelines for federal per diem reimbursable expenses (including an average of $257 for lodging and $74 for meals and incidentals in New York City).

Reliability Improvements

Reliability improvements were estimated using average annual frequency (SAIFI[10] of 16.56 outages per 1000 customers served) and duration (CAIDI[11] of 384.6 minutes) of minor outages based on Con Edison's 5 year historical performance statistics in the Bronx. The outage statistics along with other customer attributes were entered into the U.S. Department of Energy Interruption Cost Estimate (ICE) Calculator to generate the avoided annual cost of service interruptions.

The value of interruption costs is based on an econometric modeling of several surveys and studies of customer willingness-to-pay to avoid service unreliability or willingness to accept compensation for service interruptions.

4.2.2 Benefit Estimates

Overall, the power outage reduction benefits to the local markets and businesses are the biggest monetized resiliency benefit of the project, and collectively, resiliency benefits make up the majority of the total project benefits. See Table 9 and 10.

Table 9: Resiliency Value Impacts Summary

Millions 2016$	Present Value	Annual Average
Power Outage Reduction – Markets and Businesses	$43.42	$3.37
Power Outage Reduction - Community Facilities	$0.73	$0.06
Reliability Improvements	$0.12	$0.01
Total Resiliency Benefits	**$44.27**	**$3.44**

Table 10: Indirect Economic Impacts from Resiliency Improvements

Millions 2016$	Present Value	Annual Average
Avoidance of Wage Losses	$0.30	$0.04
Regional Economic Benefits	$5.95	$0.79

4.3 Environmental Value

The proposed project includes fossil fuel energy consumption and criteria pollutant and greenhouse gas (GHG) emissions compared to the base case primarily due to engine generators running during emergency operations and maintenance and testing periods. Fuel consumption and emissions will be limited by permit conditions. Regional emissions offsets are expected to occur from the solar PV installations associated with the Energy Resiliency pilot project.

[10] System Average Interruption Frequency Index.

[11] Customer Average Interruption Duration Index.

4.3.1 Methodology and Key Assumptions

GHG emissions were estimated based on technical specifications for the proposed generator units, as well as their operating characteristics, while emissions savings were estimated based on the equivalent amount of generation displaced from the grid (adjusted for transmission and distribution losses) for the solar PV installations. The emission rates for the grid were based on the probable types of fuel on the margin and the average emission rates of plants with the same primary fuel source in New York State. The emission rates were compiled and cross-examined primarily from the U.S. Environmental Protection Agency (EPA) National Emissions Inventory; Commission for Environmental Cooperation (North American Power Plant Emissions),[12] and net metering case documents from the New York State Public Service Commission published in December 2015.[13]

The value of net GHG emissions in CO_2-equivalent (CO_{2e}) tons was determined based on value per ton from the Interagency Working Group on Social Cost of Greenhouse Gases, Technical Update of the Social Cost of Carbon for Regulatory Impact using the widely recommended 3% discount rate.

In addition to the estimated social value of GHG emissions, utilities in New York are subject to certain emission allowance costs for CO_2, NOx, and SO_2 emissions which are internalized in LBMP prices. Consequently, while the approach to estimating the social value of changes in GHG emissions (as well as the social value or the health impacts of other pollutants in the next section) is appropriate, the benefits of avoided allowance costs are already captured as part of the LBMP in the "energy cost savings" impact category. As such, an adjustment is made to the overall BCA analysis results to deduct the overlap in benefits. A forecast for the actual values of allowances by pollutants were derived from the same NYISO 2015 Congestion Assessment and Resource Integration Study as the average LBMP price forecast.

Table 11 outlines the key inputs for estimating the environmental and social values of the project.

[12] Data last accessed and extracted January 2017.

[13] New York Public Service Commission Case 15-E-0703 – In the Matter of Performing a Study on the Economic and Environmental Benefits and Costs of Net Metering Pursuant to Public Service Law §66-n.

Table 11: Environmental and Social Value Key Inputs

Emission Factors (lb/MWh)	Grid	Engines/Generators
CO_2 Emissions	1,077	Varies by Equipment
NOx Emissions	0.5616	
SO_2 Emissions	0.5609	
$PM_{2.5}$ Emissions	0.0601	
VOC Emissions	0.0435	
Emission Damage Cost ($/ton)		
CO_2	$43.49	$43.49
NOx	$13,288	$49,661
SO_2	$58,254	$201,216
$PM_{2.5}$	$410,548	$1,973,626
VOC	$287	$1,843
Emission Allowance Prices ($/ton)		
CO_2 Emission Allowance per Ton	$6.53	n/a
NOx Emission Allowance per Ton	$154.64	n/a
SO_2 Emission Allowance per Ton	$0	n/a

4.3.2 Benefit Estimates

Unlike the impacts of criteria air contaminants which have more localized impacts, GHG emissions have a much broader impact on the Earth's atmosphere. The project is anticipated to decrease GHG emissions by 2,859 tons per year resulting in a total benefit of $2.72 million over the study period (Table 12).

Table 12: Environmental Value Impacts Summary

Net GHG Emissions Impacts	
Present Value (millions 2016$)	$2.72
Annual Average (thousand 2016$)	$180
Change in GHG Emissions (CO_{2e} tons/year)	(2,859)

4.4 Social Value

The project is anticipated to generate social value through resilient community development and emergency gathering locations, increased public awareness fostering energy savings, potential economic savings that could be passed on to low-moderate income residents and households in the area, preserving wages and maintaining business function and a secure food supply during major outages which could otherwise result in higher food prices throughout the study area– all of which are primarily qualitative considerations either due to the difficulty to defensibly monetize the impacts, or due to a lack of reliable and accurate data. The impacts on health from exposure to pollution are estimated for the purposes of the BCA. To account for existing air quality concerns in the Hunts Point community, the BCA took a conservative approach weighing negative health impacts in the local project area more heavily than the benefits for the greater regional area.

4.4.1 Methodology and Key Assumptions

Criteria air contaminant (CAC) emissions were derived using the same approach as the greenhouse gas emissions in the Environmental Value section above, and included NOx, SO_2, $PM_{2.5}$, and VOC emissions.

The social value of each pollutant per ton of emissions was estimated using EPA's Co-Benefit Risk Assessment Screening Model (COBRA). The model estimates the potential risk of health issues including asthma, heart or lung disease, and other respiratory issues associated with a change in levels of specific pollutants.

The BCA aimed to properly reflect differences of localized emissions in the more densely populated and environmental justice community of Hunts Point relative to offsetting emissions from the grid, which could impact utilities all across the State. Industry and federal BCA guidance typically uses a single average value of CAC emissions (which would have yielded a net health benefit). However, for this BCA, decreases in local emissions were estimated based on Bronx County values to account for existing air quality concerns in the Hunts Point community, while reduction in grid emissions were estimated based on New York State-wide values.

4.4.2 Benefit Estimates

An increase in net project emissions from emergency operations yields regional benefits in the form of a net increase in pollution. The overall health impacts of the project result in a net benefit of $1.19 million (Table 13).

Table 13: Social Value Impacts Summary

Net Health Impacts	
Present Value (millions 2016$)	$2.10
Annual Average (millions 2016$)	$0.16
Change in CAC Emissions (tons/year)	
NOx Emissions	(1.39)
SO_2 Emissions	(1.51)
PM Emissions	(0.16)
VOC Emissions	(0.08)

4.5 Economic Revitalization

The project will create both temporary and permanent job opportunities during construction and operations. These employment estimates are based on labor required for past comparable installation projects. The project construction duration varies from only 2 months for the community generators, to 6-18 months for solar PV and energy storage installations, and 20 months for the backup generation facility with microgrid resulting in an estimated average construction workforce of 30-40 people, as well as 2 permanent and 3 or 4 on-call employees going forward. These estimates assume staff required for individual installations and do not account for potential efficiencies between buildings where the same employees could service different equipment simultaneously.

In addition to direct employment, the project will provide training and development opportunities as well as serve to improve the competitive advantage of the Peninsula (Table 14).

Table 14: Employment

Construction Jobs	
Construction Workforce	30-40
Permanent Employment	2 permanent, 3-4 on-call

4.6 Other Non-monetized Impacts

There are other potential effects that have not been monetized in the analysis that provide value to the community. These include:

- The ability for MS 424 and PS 48 to support community and emergency functions in major power outages. This will enable the schools to either be used as emergency gathering locations for the community, or to maintain core administrative functions. The BCA does not anticipate that the schools will stay open for students in major power outage circumstances.
- The FDC provides food products throughout NYC. Maintaining business function in major power outages secures food supply to the region. Without a secure supply during major outages, there will be food shortages that potentially result in higher food prices throughout the study area.
- Establishes an anchor energy generation capacity for use in subsequent phases of Hunts Points energy master plan.

5 Project Risks and Implementation Challenges

5.1 Risks to Ongoing Project Benefits

The major ongoing benefit from the Energy Resiliency pilot project is maintaining business functions at the Fish Market in the FDC, including the preservation of existing inventories at the market and other commercial facilities.

One risk that could disrupt this benefit is a major flood or storm event that disrupts business activity at the markets such that one cannot access the markets for an extended period of time or an event that results in significant property damage at the facilities that requires operations to be shut down for repairs. In this situation, while power may be maintained from the Energy Resiliency pilot project which includes flood protections as part of conceptual design, there could still be a loss of business function. The inventory could still be maintained, but ongoing revenues may not be preserved.

5.2 Project Implementation Challenges

The screening of Energy Resiliency technologies and project packages considered constructability and implementation challenges as key criteria. Overall, the screening criteria were developed based on HUD funding requirements, the AWG's Implementation Principles (see Appendix A), and industry standards as referenced. The output of this screening process was a list of technologies with limited implementation challenges. In addition, only proven technologies were considered; project technologies were evaluated for their proven capability to provide the intended service.

From a constructability perspective, the following was considered:

- Available and Suitable Space: Project space requirements were evaluated against available useable space in the vicinity of the proposed application. Functionality was evaluated based on sufficient space, disposition (purchase, easement, or other agreement), geotechnical, hazardous waste, and underground utility constraints.
- Ease of Permitting: Projects were evaluated for regulatory and permitting considerations that may require more significant coordination, approvals, and/or schedules for implementation due to anticipated environmental impact or administrative considerations.
- Required Infrastructure: Projects were evaluated against the quantity and types of infrastructure improvements that would be required for the installation and operation of the facility. Availability of gas, water, structures, electrical interconnection, and other factors were considered.

From an implementation perspective, the following was considered:

- Potential to Leverage Public or Private Funds: Projects were evaluated for their potential to leverage public or private funds, with the identification of potential funding sources that have been successfully utilized for precedent projects/investments being evaluated more highly. Projects could also be evaluated highly for potential to capitalize upon avoided losses, such as lowered flood insurance premiums.
- Schedule (in years) to Plan, Design and Construct: Projects were evaluated on the estimated time to plan, design, permit, and construct from completion of evaluation in 2017. (The requirements of CDBG for funding spenddown has been extended to 2023 and NYCEDC and its project partners strive to reach key project milestones within this timeline.)

As such, only the most realistic and feasible Energy Resiliency technologies and project packages passed the screening process at the outset. Some key requirements or risks are outlined below.

- Con Edison Agreement: Con Edison is a key partner for the design, construction and operation of a first phase microgrid and solar plus storage project package. In addition, significant dependence upon utilization of the existing Con Edison infrastructure for the microgrid will require agreement on the terms and conditions of equipment utilization and system control, including different conditions under which Con Edison will de-energize its lines. A tidal surge, for example, could be such a condition when de-energizing occurs and back up generation might be needed. However, tidal surge is not expected to impact the proposed microgrid infrastructure as Con Edison assessed the vulnerability of this infrastructure to coastal flooding and hardened transformers that were determined to be potentially vulnerable (that is, infrastructure below the design flood elevation). The City and Con Edison have also been coordinating regularly to support successful design and implementation of the pilot project and plan to draft an agreement regarding the terms and conditions of the project.
- Regulatory: Implementation of the Hunts Point Resiliency Project will involve federal, state, and local permits and authorizations. Permits and authorizations cannot be obtained until the project design is further advanced. Coordination with federal, state, and city agencies that are potentially involved in the environmental review and regulatory permitting processes have already begun. Further coordination will continue after the identification of the pilot project to ensure that all required permits and authorizations will be obtained prior to groundbreaking.
- Fuel Access: The pilot project relies on solar PV generation and battery storage to provide multi-day resilience to the Fish Market. This fuel source does not require truck or other surface delivery infrastructure. At 600 Food Center Drive, the fuel source was selected since it is cost effective, reliable, not dependent on the weather, and does not require surface or truck delivery infrastructure.
- Stakeholder Buy-in: The City is conducting a robust stakeholder engagement process with design and facilitation support from the Interaction Institute for Social Change and additional outreach and engagement leadership from The Point Community Development Corporation. The City and community's engagement activities began in 2015 to inform the project scope before kickoff. Building upon efforts in 2015, engagement for the Hunts Point Resiliency Project now includes a multi-pronged approach designed to:
  - Disseminate information in order to educate the public;
  - Incorporate input directly into technical analyses; and

- Coordinate with other community-based resiliency efforts, leadership training, and workforce/ economic development opportunities.

The engagement process and structure for this project are viewed as contributing factors to resiliency in the Hunts Point community by ensuring transparency, robust information flows, social learning, skill development and relationship/trust building. The stakeholders will continue to be engaged throughout conceptual design and environmental review for the pilot project.

6 Summary of Findings and BCA Outcomes

Overall, the BCA shows positive outcomes with a $8.24 million NPV, 1.16 BCR, and a 4.4% internal rate of return that is above the 3.1% hurdle rate. Tables 15 and 16 as well as Figure 7 below summarize the results by monetized impact category.

Table 15: Summary of Monetized Impacts

All Monetized Impacts (Millions 2016$)	Undiscounted	NPV (3.1%)
Energy Cost Savings	$10.5	$6.37
Generation Capacity Cost Savings	$7.8	$4.77
Power Outage Reduction Benefits - Markets and Businesses	$70.8	$43.42
Power Outage Reduction Benefits - Community Facilities	$1.2	$0.73
Reliability Improvements	$0.0	$0.0
GHG Emissions	$0.0	$0.0
Health Impacts	$0.2	$0.117
Adjustment for Grid Emission Compliance Costs	$3.8	$2.72
Total Benefits	**$96.62**	**$59.66**
Capital Costs	($53.5)	($45.7)
Incremental O&M Costs	($7.9)	($4.8)
Fuel Costs	($1.5)	($0.9)
Total Costs	**($62.94)**	**($51.42)**
Net Impact	**$29.27**	**$8.24**

Table 16: BCA Results

Millions 2016$ - Discounted at 7%	
Present Value of Benefits	$59.66
Present Value of Costs	($51.42)
Net Present Value (NPV)	**$8.24**
Benefit-Cost Ratio (BCR)	1.16
Internal Rate of Return (IRR)	4.4%
Discounted Pay-back Period (years)	17.1

Figure 7: Summary of Monetized Costs and Benefits