Section 5.0 GREENHOUSE GAS ANALYSIS

5.0 GREENHOUSE GAS ANALYSIS

This section contains a revised GHG emissions analysis, discusses energy efficiency measures and tenant guidelines, and provides an update on GHG-related consultations.

5.1 Revised GHG Emissions Analysis

5.1.1 Introduction

A GHG emissions analysis was performed for the Project consistent with the "MEPA Greenhouse Gas Emissions Policy and Protocol" (May 5, 2010; the "Policy") and using the eQUEST energy model run in conformance with ASHRAE 90.1-2007 Appendix G. The Project involves construction of approximately 3.7 million square feet of new, mixed-use space in Quincy Center, of which approximately 3.1 million square feet will be net new space. In doing so, the Project will replace a significant mass of energy-inefficient commercial buildings in Quincy Center with new structures that embody the low-energy use design inherent to the Massachusetts Stretch Energy Code, thus substantially increasing energy efficiency. The proposed redevelopment Project adheres to, and is consistent with, all ten of the Commonwealth's Sustainable Development Principles.

Appendix G modeling was based on the Proponents' best estimate of building layouts and space usage allocation. It should be noted that none of the Project's redevelopment blocks have been progressed past an early conceptual level of design. Thus, the ability to realistically evaluate certain energy efficiency technologies does not exist at this time. For this reason, this analysis contains the Private Redeveloper's commitments to certain energy efficiency measures and identifies others that require further study at the stage of detailed building design. A full discussion of the energy efficiency measures is provided in Section 5.1.4 (Site Design), Section 5.1.5 (Building Design and Operation), and Section 5.1.6 (Transportation). The Proponents commit to the overall energy and carbon dioxide (CO_2) reductions presented in this section, but retain the flexibility to achieve these goals using energy efficiency measures that will be refined at the stage of detailed design. Specific mitigation commitments will be set forth in the self-certification process (see Section 7.6 and Table 7-1).

In some cases, the Proponents will build spaces equipped with full heating, ventilation, and air conditioning (HVAC) systems and lighting; in other cases, the Proponents will construct core and shell space in which individual tenants will fit-out the mechanical systems and lighting according to their needs. The Private Redeveloper will assist future building tenants in selecting energy efficiency measures for construction and interior fit-out to ensure all such tenant work complies with Stretch Code requirements. A draft outline for the Tenant Manual and Energy Efficiency Guide is provided in Section 5.3.

To provide a creative mix of energy mitigation, the Proponents have incorporated the following energy efficiency measures into the Project (see Section 5.1.5 for additional details):

- Cool roofs and green roof;
- Central chillers with better efficiency than ASHRAE 90.1-2007 energy code (the "Code");
- HVAC units with better efficiency than Code;
- Heating system efficiency better than Code;
- Demand Control Ventilation (DCV);
- Energy Recovery Ventilation (ERV)[1];
- Energy Management Systems (EMS);
- Building envelopes with roof, wall, and slab insulation better than Code;
- Window glass with insulating values well below Code;
- Low-emitting diode (LED) lights for all parking structures and surface parking lots;
- Light power density below Code;
- Occupancy controls for spaces not regularly occupied;
- Demand Control Exhaust Ventilation (DCEV) with variable-frequency drive (VFD) fans for underground parking structures;
- Supermarket refrigeration system design incorporating significant energy efficiencies;
- Energy-STAR appliances;
- Electric sub-metering;
- Water-conserving fixtures;
- Building commissioning in accordance with the Massachusetts Stretch Code; and

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1 Per guidance from the Massachusetts Department of Energy Resources (DOER), DCV and ERV are not assumed together in any building.

- Use of regional building materials with recycled content.

The Proponents have also identified a number of innovative energy efficiency measures that are more suitable for study and potential inclusion in the Project once the level of design progresses and specific tenants are identified. These additional energy efficiency measures include:

- Water-source or ground-source heat pumps for high-rise residential buildings;
- Exterior shading for building facades;
- Interior automatic shading devices;
- Daylighting controls for lights;
- Combined heat and power (CHP); and
- Third-party photovoltaic (PV) installation.

5.1.2 GHG Analysis Methodology

The Certificate on the Draft EIR requires the Proponents to quantify CO_2 emissions for two 2022 Full Build scenarios: (1) the Base Case corresponding to the Code; and (2) the Preferred Alternative, which includes proposed energy mitigation measures. The Preferred Alternative energy and emissions calculations were made for the Preferred Building Program. Results for the Alternative Building Program were estimated by scaling the Preferred Building Program results for a different mix of uses.

The Policy requires proponents to quantify CO_2 emissions and identify measures to avoid, minimize, or mitigate emissions, quantifying the effect of proposed mitigation in terms of emissions reduction and energy savings. According to the Policy, it is necessary to quantify GHG emissions from three sources: direct emissions from on-site stationary sources, indirect emissions from energy generated off-site (electricity), and project traffic. The Project's GHG emissions will include: (1) direct emissions of CO_2 from natural gas combustion for space heating, generating hot water, and cooking of food for sale; (2) indirect emissions of CO_2 from electricity generated off-site and used on-site for lighting, building cooling and ventilation, and refrigeration equipment; and (3) transportation emissions of CO_2 from Project-related traffic.

Appendix G modeling began by specifying the "baseline buildings" in each proposed redevelopment block. Most buildings have a residential component, and thus the HVAC systems per ASHRAE Table G-A will have heating provided by a hot-water fossil-fuel boiler and cooling provided by a package air conditioner unit and DX coils. For redevelopment blocks 8 through 11, which are non-residential and have more than 150,000 square feet, Table G-A specifies for the baseline building that heating will be provided by a hot-water fossil-fuel boiler and cooling will be provided by a central chiller, chilled water coils, and variable air volume (VAV) with hot-water reheat. Loads and schedules from ASHRAE Tables G-B, and G-E through G-O in Section G of the ASHRAE 90.1-2007 User's Manual, were employed; consistent with the requirements of a Stretch Code analysis, the Base Case assumed the ASHRAE 90.1-2007 energy code.

This building energy analysis was performed with the eQUEST energy design software (version 3.63b, July 2009), which incorporates the U.S. Department of Energy's DOE-2 building energy use model. The calculation of direct and indirect stationary source CO_2 emissions assumed emission rates of 120.6 lb/10^3 cubic feet of natural gas[2] and 829 lb/MWhr.[3] CO_2 emissions produced by Project-related motor vehicle trips were analyzed using the EPA MOBILE6 emissions factor of 550.4 grams/mile.[4] Building energy and GHG emissions for the Project are summarized in Table 5-1. The eQUEST model assumptions are summarized in Table 5-4, and eQUEST model output is provided in Attachment C; eQUEST model input files have been provided to Massachusetts Department of Energy Resource (DOER). Attachment C also contains supplemental calculations for the analyses of CHP and PV.

The transportation portion of the GHG analysis involved calculating CO_2 emissions for the air quality study area for three scenarios: 2022 No-Build; 2022 Build; and 2022 Build with Mitigation. The vehicle miles traveled (VMT) for each of the eight roadway segments in the traffic study area was calculated by multiplying the length of each road segment by the average daily traffic (ADT) volume on the segment. CO_2 emissions for each roadway segment were calculated by multiplying the daily VMT by the MOBILE6.2 predicted CO_2 emission factor of 550.4 grams per mile, which is approved by MEPA. Attachment C contains the transportation-related CO_2 emission calculations.

5.1.3 Summary of Results

Table 5-1 reveals that the energy mitigation measures proposed for the Project's Preferred Building Program will reduce direct energy use (natural gas) by 33.7% and indirect energy use (electricity) by 24.2%, resulting in an overall Project energy use reduction of 27.7% compared to the Base Case. This energy use reduction will thereby reduce total CO_2 emissions by 26.3%. Tables 5-2 and 5-3 extend the GHG emission results by adding in transportation emissions for the Preferred and Alternative Building Programs, respectively.

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2 U.S. Department of Energy, Energy Information Administration.

3 ISO New England Inc., 2010 New England Electric Generator Air Emissions Report, Annual Average Emission Rate, Table 5.3, March 2012.

4 MEPA, "Greenhouse Gas Emissions Policy and Protocol," May 5, 2010, page 9.

For the Preferred Building Program (Table 5-2), the Preferred Alternative will reduce total direct and indirect stationary source CO_2 emissions by 4,955.9 tons/year, or 26.3% compared to the Base Case. The Project's mitigation measures for motor vehicle emissions will include a number of TDM strategies and roadway improvements (see Section 4.0). These measures will reduce Project-related motor vehicle CO_2 emissions by 117.3 tons/year, or 6.1% compared to the Base Case. Cumulatively, the net reduction in the Project's total CO_2 emissions (stationary source plus transportation) will be 5,073.2 tons/year, or 24.4% compared to the Base Case.

For the Alternative Building Program (Table 5-3), the Preferred Alternative will reduce total direct and indirect stationary source CO_2 emissions by 4,969.7 tons/year, or 26.1% compared to the Base Case. TDM strategies and Project-related roadway improvements will reduce Project-related motor vehicle CO_2 emissions by 125.2 tons/year, or 6.0% compared to the Base Case. Cumulatively, the net reduction in the Project's total CO_2 emissions (stationary source plus transportation) will be 5,094.9 tons/year, or 24.1% compared to the Base Case.

Relative to the Preferred Building Program, the Alternative Building Program would have higher electricity and gas use as well as slightly higher transportation-related emissions. As a consequence, total CO_2 emissions for the Alternative Building Program would be 355.7 tons/year higher than the Preferred Building Program emissions.

Table 5-1 Building Energy and GHG Emissions for the Project

Category	*Base Case*	*Preferred Alternative*	*Differential*
Indirect – Electricity (1,000 kWh)			
Space Cooling	3,499.8	2,244.9	-35.9%
Cooling Tower Heat Rejection	202.1	157.0	-22.3%
Ventilation and Fans	5,863.7	4,580.4	-21.9%
Pumps and Auxilary	1,690.3	1,367.3	-19.1%
Misc. Equipment	7,592.7	6,884.0	-9.3%
Area Lighting	9,046.0	8,453.6	-6.5%
Refrigeration Equipment	2,695.0	2,022.0	-25.0%
Parking Lighting	1,216.6	373.1	-69.3%
Underground Parking Fans	3,323.9	553.9	-83.3%
Subtotal	35,130.1	26,636.1	-24.2%
Direct – Gas (1,000,000 Btu)			
Space Heating	64,594.0	40,805.9	-36.8%
Domestic Hot Water	5,213.1	3,732.5	-28.4%
Misc. Equipment	910.0	2,380.0	161.5%
Subtotal	70,717.1	46,918.4	-33.7%
Total Energy Use (10^9 Btu)	**190,581.1**	**137,800.6**	**-27.7%**
CO_2 Emissions (tons/year)			
Direct	4,264.2	2,829.2	-33.7%
Indirect	14,561.4	11,040.6	-24.2%
Total CO_2 Emissions	**18,825.7**	**13,869.8**	**-26.3%**

Table 5-2 Carbon Dioxide Emissions Summary for the Preferred Building Program (tons/year)

Source	*Base Case*	*Preferred Alternative*	*Percent Reduction in GHG Emissions*
Direct Emissions	4,264.2	2,829.2	33.7%
Indirect Emissions	14,561.4	11,040.6	24.2%
Subtotal Direct and Indirect Emissions	18,825.7	13,869.8	26.3%
Transportation Emissions	1,919.2	1,801.9	6.1%
Total CO_2 Emissions	20,744.9	15,671.7	24.4%

Table 5-3 Carbon Dioxide Emissions Summary for the Alternative Building Program (tons/year)

Source	*Base Case*	*Preferred Alternative*	*Percent Reduction in GHG Emissions*
Direct Emissions	4,468.9	3,007.4	32.7%
Indirect Emissions	14,564.3	11,056.1	24.1%
Subtotal Direct and Indirect Emissions	19,033.2	14,063.5	26.1%
Transportation Emissions	2,089.1	1,963.9	6.0%
Total CO_2 Emissions	21,122.3	16,027.4	24.1%

Table 5-4 Summary of eQUEST Model Assumptions

Energy Efficiency Measure	*Base Case (Code)*[1]	*Preferred Alternative*
Cool Roof	No	Yes, all buildings
Green Roof	No	Yes, Building 5B: 40,000 SF
Blocks 1 thru 7 HVAC Cooling Efficiency for Typical 20-ton Unit	EER 10.0	EER 11.0 (10% above Code) Energy STAR units
Blocks 8 thru 11 Water-Cooled Centrifugal Chiller Efficiency	0.576 kW/ton	0.490 kW/ton (15% better than Code)
Heating System Efficiency	80%	90%
Demand Control Ventilation (DCV)	No	Yes, Blocks 8 thru 11
Energy Recovery Ventilation (ERV)	No	Yes, Buildings 1C, 3A, 5A, 5B, 6B,6C
Cool/Heat Setpoints occupied, unoccupied	76°/ 70°, 82°/ 64° eQUEST defaults	Same
Roof Insulation (Installed Above Deck)	R-20	R-25
Wall Insulation	R13+R7.5ci	R13+R10ci (10% above Code)
Slab Insulation	None	R-15

[1] ASHRAE 90.1-2007.

Table 5-4 Summary of eQUEST Model Assumptions (continued)

Energy Efficiency Measure	*Base Case (Code)*[1]	*Preferred Alternative*
Windows Glazing Type	Double Pane, U=0.55, DOE Type 2000	Double Pane, Low-e, U=0.29, SHGC=0.37, VT=0.67 DOE Type 2664
Daylighting Controls	No	Design building envelope for deep natural light penetration. Encourage tenants to use daylighting controls to dim lights
Parking Structure and Surface Lot Lighting	150 W/1,000 SF	LED 46 W/1,000 SF
Supermarket Refrigeration System Designed to Reduce Electrical Consumption	No	Yes, by 25% Buildings 7A, 8A
Light Power Density (Whole Building Method)	Retail 1.5 W/SF Restaurant 1.6 W/SF Office 1.0 W/SF Residential 0.7 W/SF Hotel 1.0 W/SF Health Club 1.0 W/SF Movie Theater 1.2 W/SF	Retail 1.3 W/SF Office 0.9 W/SF Public areas of all buildings at least 10% below Code. Encourage tenants to design for LPD 10% below Code.
Occupancy Controls for Lighting	No	Yes, for all spaces not regularly occupied
Parking Garage Ventilation DCEV with VFD Fans	No	Yes
Energy STAR Appliances for Residential Units and Kitchens in Offices	No	Yes

[1] ASHRAE 90.1-2007.

5.1.4 Site Design Mitigation Measures

The Project will incorporate all reasonable and feasible site design mitigation measures. The Proponents have committed to the following site design mitigation measures:

- *Sustainable Development Principles:* The Project will preserve open space by redeveloping an existing urban area into a high-density, transit-oriented Project that will achieve LEED-ND Silver;
- *Minimize Building Footprints:* The Project has been designed with taller buildings to allow for well-designed public spaces and parks with landscaping and trees;
- *Minimize Energy Use through Building Orientation:* The 14 buildings that will comprise the Project will have south-facing façades that minimize energy use;

- ***Provide Pedestrian Connections to Other Commercial Establishments:*** Well-designed sidewalks and public squares will connect the Project to the surrounding Quincy Center urban area and nearby commercial establishments;

- ***Design Water-Efficient Landscaping:*** Water-efficient landscaping will be installed to minimize water use, and drought-resistant and native plants will be used in conjunction with Smart Irrigation technology (e.g., irrigation controllers to avoid over-watering); and

- ***BMPs for Stormwater Design:*** The Project's stormwater management system will utilize BMPs to collect and treat runoff from impervious surfaces, and will comply with MassDEP's Stormwater Management regulations and the City's NPDES General Permit (see Section 2.2). LID techniques will be employed throughout the Project area where conditions allow.

5.1.5 Energy Mitigation Measures for Building Design and Operation

Consistent with sustainable development principles, the proposed redevelopment will provide significant energy efficiencies in its design. The Project will achieve LEED-ND Silver, and all buildings will be LEED-certifiable. The Private Redeveloper will adopt all reasonable and feasible building design and operational mitigation measures.

As described in Section 5.1.1, it is not feasible to evaluate certain energy efficiency technologies at this time given the Project's conceptual level of design. For this reason, the Proponent has committed to certain energy efficiency measures while also planning to study other energy efficiency measures at the stage of detailed building design (see Section 5.2). Table 5-4 lists the building design mitigation measures that were quantified through eQUEST modeling, and the following list describes energy efficiency measures that will be incorporated into the Project and those that the Private Redeveloper will encourage in the Tenant Manual:

- ***Cool Roofs and Green Roof:*** A reflective cool roof will be installed on all buildings to minimize the urban heat island effect, and a 40,000-square-foot green roof will be installed on Building 5B, the parking structure proposed in Block 5;

- ***Centralized Chiller for Large Office Buildings:*** Blocks 8 through 11 will have a central chilled water plant with a Coefficient of Performance (COP) 15% better than Code;

- ***High-Efficiency HVAC Systems:*** Energy-STAR rated HVAC units will be used in Blocks 1 through 7, and Energy Efficiency Ratios (EER) will be 10% above Code;

- ***High-Efficiency Heating:*** Heating systems will be 10% more efficient than Code;

- ***DCV:*** Blocks 8 through 11 will have DCV controls;

- ***ERV:*** Buildings 1C, 3A, 5A, 5C, 6B, 6C will have ERV;

- ***Seal, Test, and Insulate HVAC Supply Ducts:*** HVAC supply ducts will be sealed, leak-tested, and insulated to reduce energy losses;

- ***Energy Management Systems:*** The Project will employ EMS to monitor and control the heating, air conditioning, refrigeration and lighting systems for all buildings. Base Case and Preferred alternative temperatures are identical and equal to eQUEST default values.

- ***Energy-Efficient Windows and Building Envelope:*** Building envelope insulation will exceed Code for the roof, walls, slab, and fenestration. Roof insulation will be R-25, wall insulation will be 10% higher than Code, and slab insulation will be R-15 with two-foot depth. Window type and design will carefully balance Solar Heat Gain Coefficient (SHGC) with Visible Transmittance (VT) to reduce solar gain while admitting natural light. Windows will be double-pane, low-e glass with a U value no higher than 0.29. Window area and design will allow deep penetration of natural light into buildings, and tenants will be encouraged to install daylighting controls;

- ***LED Lighting for Parking:*** Exterior Light Power Density (LPD) will be at least 60% below Code through the use of LED lighting for all structured and surface lot parking covering over 1.8 million square feet;

- ***Energy-Efficient Interior Lighting:*** Interior LPD will be at least 10% below Code for the retail, office, and public spaces in all buildings, and through a Tenant Manual the Private Redeveloper will encourage tenants to design for LPD 10% below Code;

- ***Occupancy Sensors for Lighting:*** Occupancy sensors will be used for all spaces not regularly occupied;

- ***DCEV with VFD Fans:*** Underground parking garages will have DCEV with VFD fans to reduce electricity used for ventilation;

- ***High-Efficiency Refrigeration System:*** The food markets in Buildings 7A and 8A will have a refrigeration system design that achieves an overall 25% energy savings compared to standard refrigeration design without such energy efficiency features. While grocery tenants have not yet been identified, most modern supermarkets use some or all of the following design features: (1) high-efficiency compressor rack and condenser fans; (2) vertical doors on refrigerated and freezer food cases; (3) LED lights on case doors and occupancy sensors in aisles; and (4) anti-sweat heater controls. For the 14,060-square-foot grocery store proposed in Building 7A, a high-efficiency design will lower electrical usage from 965 megawatt hours (MWH)/year to 724 MWH/year. For the 40,155-square-foot supermarket proposed in Building 8A, a high-efficiency design will lower electrical usage from 1,730 MWH/year to 1,298 MWH/year;

- *Energy STAR Equipment:* Energy STAR appliances will be used in residential units, associated laundry rooms, and kitchens in office spaces to reduce plug load, and tenants will be encouraged to use Energy STAR-rated computers and other equipment;

- *Electric Sub-Metering:* Sub-metering will be installed for each major tenant;

- *Daylighting Controls:* Building envelopes will be designed for deep natural light penetration, and the Private Redeveloper will encourage tenants to use daylighting controls to dim electric lights;

- *Use Water Conserving Fixtures:* Restrooms will use low-flow faucets in wash sinks that will be activated by motion sensors, and low-flow toilets and urinals (1.3 gpf and 1 pint per flush, respectively) will have designs less than Code;

- *Building Commissioning:* Each building's mechanical systems will undergo commissioning in accordance with the Massachusetts Stretch Code Section 503.2.9;

- *Provide for Storage and Collection of Recyclables in Building Design:* The Project will provide adequate space for tenants to recycle materials;

- *Use Building Materials with Recycled Content and Use Low-VOC Content:* Whenever possible, the Project will include environmentally-friendly building materials including materials with recycled content and low volatile organic compounds (VOC); and

- *Operations Waste Management Program:* Through a Tenant Manual, the Private Redeveloper will encourage tenants to recycle materials such as bottles, cans, office paper, cardboard, and pallets, and to properly dispose of hazardous materials such as fluorescent bulbs.

Other building design and operation mitigation measures were considered for the Project but were rejected because they are either technically or financially infeasible or inappropriate for the Project:

- *Reduce Energy Demand by Using Peak Shaving or Load Shifting Strategies:* These measures are not appropriate for office, retail, supermarket, and other tenant spaces that must use power during peak periods.

5.1.6 Transportation Mitigation Measures

The Project is conveniently located within walking distance of the Quincy Center MBTA Station that provides commuter rail, subway, and bus service, and the Private Redeveloper is committed to a number of TDM strategies to reduce employee and customer vehicle trips. TDM measures are designed to reduce peak hour and daily vehicle trips by shifting the mode of transportation from single occupancy vehicles to transit, increasing vehicle occupancy rates, the transferring demand from the peak hour. The TDM measures identified and described in the Draft EIR and supplemented by Section 4.6 of this Final EIR are expected to reduce transportation emissions related to the aggregate of employee, customer, and Project-resident trips by 6%. Predicted CO_2 emissions for the three study scenarios are provided in Table 5-5.

- ***Locate New Buildings Near Transit*** – The Project is located within walking distance of Quincy Center Station that provides commuter rail, subway, and bus service.
- ***Develop Multi-Use Paths To and Through Site*** – The Project will provide sidewalks, marked crosswalks, pedestrian traffic signals, lighting, and landscaping, to encourage pedestrian travel to and from the site.
- ***Size Parking Capacity to Meet, Not Exceed, Local Parking Requirements*** – The Project's parking capacity is sized to be the minimum amount to meet typical parking requirements for an urban, mixed-use redevelopment project and is not excessive. The planned parking assumes shared parking savings between multiple uses.
- ***Provide On-Site Food Service*** – The Project will provide a wide variety of restaurant and food service options for employees and customers.
- ***Provide Bicycle Storage*** – The Project will provide secure bicycle storage racks throughout the Project area.
- ***TC*** – A Transportation Coordinator will be provided to manage the TDM program and reach out to residents, business owners, and employees. The TC will provide transit, subway, and bus schedules, and will assist employees and residents in finding carpool/vanpool matches.
- ***Transit Passes and Subsidies*** – The Private Developer, through the TC, will offer transit subsidies for employees and will include transit passes in the rent for residents to encourage transit use.
- ***Roadway and Signalization Improvements to Improve Traffic Flow*** – The Project includes significant roadway and traffic signal improvements (see Section 4.0).

- ***Preferential Parking*** – The Project will provide preferential parking spaces for vanpools and carpools.

- ***Electric Vehicle Charging Stations*** – The Private Redeveloper will provide electric vehicle charging stations throughout the Project area.

- ***Tenant Manual*** – Through a Tenant Manual, the Private Redeveloper shall require tenants to notify their employees of all available benefits which qualify as TDM measures that are offered by the tenant, including but not limited to: transit subsidies for commuting or a commuter tax benefit program; flexible work schedules; direct deposit of paychecks; shower facilities for employees to encourage bicycle commuting; and a guaranteed ride home for employees who carpool or use transit.

- ***No-Idling Truck Zones*** – Signs will be posted to require no-idling for trucks parked for more than five minutes.

Although the Project includes a variety of TDM measures, the Private Redeveloper will not maintain an exclusive fleet of vehicles for the Project, and therefore the potential mitigation measure of purchasing alternative fuel or a fuel-efficient fleet of vehicles was considered but found to be inappropriate for the Project.

Table 5-5 Motor Vehicle Carbon Dioxide Air Quality Emissions Summary

Study Scenario	*Total CO_2 (kg/day)*	*Total CO_2 (tons/year)*	*Project CO_2 (kg/day)*	*Project CO_2 (tons/year)*
2022 No-Build	32,067	12,890	0	0
2022 Build for the Preferred Building Program	36,841	14,809	4,774.3	1,919.2
2022 Build With Mitigation for the Preferred Building Program	36,549	14,692	4,482.6	1,801.9
2022 Build for the Alternative Building Program	37,264	14,979	5,197.1	2,089.1
2022 Build With Mitigation for the Alternative Building Program	36,952	14,854	4,885.5	1,963.9

5.2 Building Energy Efficiency Measures Requiring Further Study

This section identifies other energy efficiency measures that will be studied further at the stage of detailed building design.

5.2.1 *Water and Ground Source Heat Pumps*

The high-rise residential buildings in the Project may be suitable for water-source or ground-source heat pumps. However, due to the amount of utility infrastructure buried beneath the Project site, it may not be practical to excavate the large and deep area needed for a ground-source heat pump system. At a minimum, water-source heat pumps will be considered in the detailed mechanical design for the high-rise residential buildings.

5.2.2 *Shading Devices and Daylighting Controls*

During detailed building design, the Proponents will consider exterior shading for west- and south-facing building facades to shield excess solar insolation during the summer months while still allowing light penetration. During the tenant build-out process, the Private Redeveloper will recommend that tenants install daylighting controls to take advantage of natural light penetration into structures, and that tenants consider automatic interior shading devices for south-facing windows.

5.2.3 *Combined Heat and Power*

The most likely candidate for CHP in the first phase (Step 1) of the Project is the large office tower (Building 11A), which will have a conditioned floor area of 541,221 square feet. A detailed cogeneration analysis is presented below, assuming 800 kW of microturbines with heat recovery to provide heat and hot water needs for the office building. The next most likely application for CHP would be in the hotel planned in Building 6A as part of the second phase (Step 2) of the Project. The Proponents will study CHP in conjunction with potential hotel tenants at Step 2 of Project development. A CHP strategy involving more than one building, or buildings built in different phases, is not financially feasible for the Project, since with multiple tenants and co-developers, the Proponents would not have financial guarantees from potential customers at the point in time when capital would be needed for construction of a multi-building CHP, and banks would not offer financing without iron-clad guarantees.

CHP requires a host for the constant and substantial steam load (waste heat) generated as part of the process. For this reason, CHP is typically found: (1) in heavy manufacturing plants that require substantial process heat; (2) in larger hotels where there is a demand for heat in laundry, domestic hot water for guest rooms and kitchens, and space heating; or (3) in colleges and universities. For the proposed Project, energy use is expected to be primarily electricity used for lighting, ventilation, air conditioning, and appliances.

For the feasibility analysis of CHP in Building 11A, the peak and monthly average electrical loads of the office building were calculated by eQUEST as 1,290 kW and 504 kW, respectively, assuming all energy mitigation measures. To achieve optimal design in terms of electrical and heating loads, an 800-kW cogeneration plant was analyzed that at 60% load would provide 480 kW, or close to the monthly average electric load. Annual electric use for space cooling is projected by eQUEST to be only 8.6% of total electric consumption, and thus absorption cooling is not economical for this installation since absorption chillers have a capital cost double of that for electric chillers and the office building's cooling load is relatively low due to the excellent insulation in the building envelope.

The CHP feasibility analysis considered the annual income from Alternative Energy Certificates (AECs) under the State's Alternative Energy Portfolio Standard (APS), as calculated using DOER's APS calculator.[5] Due to the very low heat demand of the building, the energy recovery from the cogeneration system's waste heat would be too low for the Project to qualify for AECs.

National Grid may provide a purchase subsidy for a cogeneration plant depending on specifics of the design. Tech Environmental, on behalf of the Proponents, spoke with Joseph Dolengo and Dinesh Patel at National Grid and provided information on the size of equipment and the heating and electrical demands of the building, and requested a subsidy analysis. Despite several requests, National Grid has not provided an answer regarding whether the cogeneration plant would qualify for a purchase subsidy. As a result, none was assumed for this feasibility analysis. The cost of the microturbine installation was calculated as $1,100 per kW for equipment, $350 per kW for heat recovery, and $798 per kW for engineering and installation, yielding a total installed cost of $2,248 per kW.[6] With a federal tax credit of $40,000, the cogeneration plant installed cost would be $1,758,400 with maintenance costing $0.016 per kW-hour. The typical useful life of a commercially available machine ranges from 40,000 to 80,000 hours, or up to 10 years with proper overhaul.[7] Since the microturbines would run at less than full load much of the time and equivalent full-load run-time would be 5,759 hours per year per turbine (4,607 MWh per year divided by the capacity of 0.8 MW), the feasibility analysis optimistically assumed a 14-year life for the cogeneration plant.

The CHP feasibility analysis was performed using the RETScreen-4 energy model from Natural Resources Canada.[8] Inputs to RETScreen-4 include electricity and heating demands for the building, obtained from the eQUEST model simulation of the office building, and

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5 The APS calculator output is included in Attachment C. DOER has increased the Maximum $/Credit from $20 to $21 since this calculator was provided. Using the higher figure would not change the conclusions from the APS calculator that the Project would not qualify for AECs.

6 http://www.wbdg.org/resources/microturbines.php

7 "The Market for Microturbine Electric Power Generation," August 2010, Forecast International, http://www.forecastinternational.com/samples/F647_CompleteSample.pdf

8 http://www.retscreen.net/ang/home.php

current electric and gas utility rates for commercial customers in Massachusetts.[9] Compared to the rest of the country, natural gas and electric rates in Massachusetts are high. The RETScreen-4 model output along with the DOER Alternative Energy Certificate calculation is provided in Attachment C.

Results from this analysis reveal that total annual cogeneration plant costs ($830,690) would exceed the total annual cost without the cogeneration plant ($689,038). Thus, the CHP system would never pay for itself and would not be economically feasible in Building 11A. The primary reasons for these results are: (1) the relatively high cost of natural gas in Massachusetts; and (2) the relatively low heat demand of the building after applying energy mitigation measures. The Proponents will study CHP in conjunction with potential hotel tenants at Step 2.

5.2.4 On-Site Renewable Energy

The Proponents will set aside space on the roofs of buildings in Blocks 4 through 11 for a possible third-party PV installation. The PV cost feasibility analysis presented below estimates the cost of a 200-kW system installed in a single block on a commercial building roof. To obtain the most accurate installed cost for a commercial-size PV system, data were obtained from the most recent installed cost report on the Massachusetts Clean Energy Center (MassCEC) website for commercial solar installations of 100 or more MW over the last two reporting years (application years 2010 and 2009).[10] The data, provided in Attachment C, were sorted by Owner-Installed and Third-Party-Installed projects and then by year within those categories. The results are as follows.

- For Owner-Installed Commercial PV, the average cost actually increased for the more recent projects: costs for 2009 projects ranged from $4.34 to $6.66 per Watt, averaging $5.60 per Watt, while costs for 2010 projects ranged from $4.95 to $7.23 per Watt, averaging $5.96 per Watt. The overall two-year average for 23 Owner-Installed Commercial PV projects was $5.74 per Watt.

- For Third-Party-Installation Commercial PV, similarly, the average cost increased for the more recent projects: costs for 2009 projects ranged from $4.79 to $8.21 per Watt, averaging $5.65 per Watt, while costs for 2010 projects ranged from $4.68 to $9.60 per Watt, averaging $6.44 per Watt. The overall two-year average for 21

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9 U.S. Energy Information Administration, Average Price of Electricity to Commercial Customers in Massachusetts (May 2012) is 13.84 cents per kWh and adding in a demand charge of 0.72 cents per kWh yields a total of 14.56 cents per kWh, Average Price of Natural Gas to Commercial Customers in Massachusetts (March 2012) is $11.08 per million Btu, or $0.41/m^3.

10 MassCEC, "PV Installers Costs," May 30, 2012. The two most recent years of data in the report are "dates of Application" in 2009 and 2010. Public projects were not included because costs often do not reflect the market cost for a Commercial installation.

Third-Party-Installation Commercial PV projects was $5.99 per Watt. The Third-Party installation projects were 4.4% more expensive than Owner-Installed projects, consistent with the fact the Third-Party Installer charges a fee for its work.

For this PV cost analysis, two scenarios were examined: (1) an Owner-Installed 200-kW system with a cost of $5.74 per Watt; and (2) a Third-Party-Installation 200-kW system with a cost of $5.99 per Watt. The following facts were obtained from DOER: (1) Solar Renewable Energy Certificates (SRECs) are market-based incentives and should sell today between $300 and $550 per MWh, less broker fees; (2) an owner can place excess SRECs into an auction account and receive $285 per MWh ($300 minus 5% fee); (3) the Alternative Compliance Payment (ACP) cap that is $550 today will decline to only $365 in the future on a schedule set by DOER. Since there are no firm estimates of the future value of SRECs, this analysis assumed the guaranteed floor price of $285, the most realistic assumption.

A 200-kW system was assumed for the alternative analysis, which is generally considered the minimum size for a financially feasible third-party vendor Power Purchase Agreement (PPA).[11] In Massachusetts, a flat-mounted 200 kW PV system is projected to generate 206,528 kWh per year,[12] which equates to 85.5 tons per year[13] in GHG emissions reductions. A 200 kW PV system would reduce the annual Preferred Alternative CO_2 emissions (Table 5-1) by 0.6% ((85.6/13,869.8) * 100).

The economics of a PV installation were calculated using the DOER Commercial Solar Financial Model updated to reflect the above assumptions. Model output is provided in Attachment C. The cost calculator inputs are as follows:

- PV system size of 200 kW;
- System cost of $5.74 per Watt (Owner Installed) or $5.99 per Watt (Third-Party Installation);
- Annual capacity factor of 11.8% (flush mounted on roof)[14];
- SREC value of $285 per MWh and revenue term 10 years;

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11 Personal communication, Dave Hebert, Gloria Spire Solar, March 3, 2009.

12 Personal communication, Natalie Howlett, Renewable Energy Project Coordinator, Massachusetts DOER, December 18, 2008. This figure is 4 times 51,632 kWh/year for a 50 kW system.

13 Annual PV system electrical generation is 206.5 MWh. Multiplying by the ISO New England emission factor of 829 lb CO2 per MWh and dividing by 2,000 lb/ton yields an annual CO2 emission reduction of 85.6 tons/year.

14 Personal communication, Natalie Howlett, Renewable Energy Project Coordinator, Massachusetts DOER, December 18, 2008.

- An inverter replacement frequency of once every 10 years[15]; and
- Customer discount rate of 7%.

The default customer discount rate in the CS Financial Model is 3%, which is incorrect. The customer discount rate is defined as the interest rate of return that could be earned in an investment in the financial markets with similar risk. At present, a 20-year U.S. Treasury bond pays just below 3%, which is the lowest risk investment possible and is not comparable to the risk of investing in a PV system. Corporate bond rates are 4% to 8%, depending on their investment grade. This analysis assumed a reasonable customer discount rate of 7%. The calculations assume all current financial incentives: federal tax credits, State tax deductions, and SREC values.

For the 200-kW system, the calculated Net Present Value of the PV system is -$33,681 (Owner-Installation) and -$52,812 (Third-Party Installation). The internal rates of return (IRR) are 6.0% (Owner Installation) and 5.5% (Third-Party Installation). The Simple Payback Period is eight years for each scenario.

Based on market research, almost 90 percent of strong prospects would consider a payback of four years, but acceptance begins to drop rapidly once paybacks reach five years.[16] The Simple Payback also has serious limitations as a measure of cost feasibility and is not used in making business decisions because it ignores inflation, the time value of money, and investment risk.

Net Present Value (NPV) is the standard financial method for using the time value of money to appraise long-term projects. Used for capital budgeting and throughout economics, NPV measures the excess or shortfall of cash flows, in present value terms, once financing charges are met. If the NPV is positive, an investment may be accepted since it would add value to a project over the long-term. If the NPV is negative, as is the case here, the investment should be rejected. The IRR is the annualized effective compound return rate that can be earned on the invested capital (i.e. the yield on the investment). A project is a good investment if its IRR is greater than the rate of return that could be earned by alternate investments of equal risk; in this case, the alternate rate of return is the 7% discount rate in the financial model.

Given the negative NPV and longer-than-acceptable payback period, a PV system is not financially feasible for the Project at this time. The Proponents will set aside space on the roofs of the two large flat-roofed buildings so they can be "solar ready" to accommodate flat-mounted PV systems for a possible 3rd-party provider PV installation in the future. In

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15 Personal communication, Dave Hebert, Gloria Spire Solar, March 3, 2009.

16 *Assessment of California CHP Market and Policy Options for Increased Penetration*, Final Report, Cosponsors Public Interest Energy Research Program (PIER) and California Energy Commission, July 2005.

addition, the Proponents will set aside roof space in Blocks 4 through 11 as "solar ready" with sufficient structural support to accommodate flat-mounted PV systems for possible third-party provider PV installations in the future.

5.3 Draft Outline for the Tenant Manual and Energy Efficiency Guide

As part of the design phase of the Project, the Private Redeveloper will implement a set of tenant guidelines in the Project Tenant Manual and accompanying Energy Efficiency Guide which either mandate or encourage specific sustainable measures (by providing assistance and/or information for consideration), where applicable, reasonable, and feasible for specific users. Each tenant and their design team shall be provided a copy of the Tenant Manual and Energy Efficiency Guide upon executing a lease. With respect to the various energy efficiency commitments made within the Tenant Manual, it is assumed at this preliminary stage that the Private Redeveloper will be responsible for constructing the building core and shell and individual tenants responsible for the fit-out of interior spaces. The Energy Efficiency Guide will provide tenants with additional building information and guidance.

5.3.1 Tenant Manual

The Tenant Manual includes the following requirements that tenants or the Private Redeveloper must comply with:

- As allowed by Massachusetts Building and Electrical Code, future building tenants shall be required to fit-out electrical wiring to be compatible with a building's EMS and occupancy controls for lighting;

- In collaboration with tenants, the Private Redeveloper shall identify the potential need for electric plug-in stations in the proposed garages, and the Private Redeveloper shall allocate areas in those garages for such use;

- The Private Redeveloper shall provide for individualized tenant control and metering of electricity and natural gas, to the extent practicable and feasible, to help promote increased efficiency;

- Where HVAC units are not provided by the Private Redeveloper, the tenant shall be required to use HVAC units with EER values 10% above the Code assumed in this EIR, and any heating systems will be required to achieve an efficiency 10% above the Code;

- Future tenants shall be required to use Energy-STAR rated appliances, as readily available and economically viable, in residential units and office break-room kitchens;

- The Private Redeveloper shall provide future tenants with a list of amenities (e.g., ATMs, convenience retail stores, restaurants, and food retailers) within walking distance that tenants will be required to pass on to their employees;

- The Private Redeveloper shall provide future building tenants with a list of incentives and facilities to promote alternative transportation to the site and reduce single-occupancy vehicle use (e.g., bicycle storage, preferential parking spaces) that tenants will be required to pass on to their employees;

- The Private Redeveloper shall require tenants to notify their employees of TDM measures adopted by the tenant, including transit subsidies for commuting or a commuter tax benefit program, flexible work schedules, direct deposit of paychecks, shower facilities for employees to encourage bicycle commuting, and a guaranteed ride home for employees who carpool or use transit; and

- The Private Redeveloper shall, in coordination with the MBTA, create a web site that provides a central resource for tenants and their employees of all local maps, schedules, and station locations with regard to public transit.

5.3.2 Energy Efficiency Guide

In addition to requirements in the Tenant Manual, the Private Redeveloper shall proactively assist future building tenants in selecting energy reduction measures as part of interior construction and fit-out to ensure all such tenant work fully complies with the Code. To accomplish this, at the time a lease is executed, in addition to the Tenant Manual, the Private Redeveloper shall provide tenants with an Energy Efficiency Guide (the "Guide") that details specific additional design measures that the tenant can take to obtain LEED-equivalent or otherwise more energy-efficient space. The Guide will explain the energy efficiency features already built into the building by the Private Redeveloper as well as construction options available to further reduce energy use in the tenant-controlled space. By providing specific energy efficiency information and recommendations in this Guide, tenants will be encouraged to use environmentally-friendly building materials in the fit-out of their space, and to implement materials recycling in their leased space.

The following are examples of items that will be included in the Guide to encourage tenants to include additional energy-efficient design features within their spaces:

- Design information regarding interior lighting systems with an LPD at least 10% below Code. The Private Redeveloper shall encourage tenants to meet the 10%-below-Code goal for other building uses by providing example fixtures and lighting systems with a very high efficiency.

- Design information relating to interior space with daylighting controls to automatically dim electric lights and automatic shading controls on south-facing windows, taking advantage of the natural light provided through the building's shell. The Guide shall describe specific examples of successful daylighting designs from other developments and will provide a list of products and vendors that tenants can use to achieve these daylighting goals.

- Design information relating to ERV or DCV systems as it may relate to any tenant build-out HVAC system design. The Guide shall include a list of HVAC products that have ERV and DCV integrated into their design.

- Resources regarding Energy STAR-rated computers and other equipment. The Guide shall include a list of or resources that detail typical office equipment that is Energy STAR rated.

5.4 Consultations with MEPA, MassDEP, and MassDOER

The Proponents and their consultants met with MEPA, MassDEP, and DOER staff on August 20, 2012 to discuss the scope of the revised GHG analysis. Tech Environmental, Inc. presented the assumptions to be used in the Appendix G energy modeling of the Project for the Final EIR. Agency staff offered suggested changes, all of which have been incorporated into the GHG study presented above.