

727 Massachusetts Avenue



June 30, 2020

WSP

Sustainability Narrative



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I. PROJECT DESCRIPTION

727 Mass Ave is slated to provide New Construction office space and a boutique hotel above ground floor retail and renovation of the existing Bank of America in the Central Square neighborhood. This project is meeting the Special Permit application requirement with a minimum LEED v4 Gold Certification for New Construction and Major Renovation. The project is currently tracking 62 points.

II. AFFIDAVIT

I, Maeve Donohue, do hereby affirm that I have thoroughly reviewed the supporting documents for LEED v4 New Construction, and confirm that 727 Mass Ave meets the requirement for Gold with 62 points. 727 Mass Ave Cambridge, MA has been designed to meet the green building requirement under Article 22.20 of the Cambridge Zoning Ordinance.

	<p>GREEN BUSINESS CERTIFICATION INC. CERTIFIES THAT</p>
	<p>Maeve Donohue</p>
	<p>HAS ATTAINED THE DESIGNATION OF</p>
	<p>LEED AP[®] Building Design + Construction</p>
	<p>by demonstrating the knowledge and understanding of green building practices and principles needed to support the use of the LEED green building program.</p>
<p>11204746-AP-BD+C CREDENTIAL ID</p> <p>27 FEB 2019 ISSUED</p> <p>26 FEB 2021 VALID THROUGH</p>	 <p>MAHESH RAMANUJAN PRESIDENT & CEO, U.S. GREEN BUILDING COUNCIL PRESIDENT & CEO, GREEN BUSINESS CERTIFICATION INC.</p>



III. LEED VERSION 4 FOR NEW CONSTRUCTION CHECKLIST

A. Please see attached LEED v4 checklist.

B. The project meets the Gold certification requirement achieving 62 points.

Location and Transportation	[13 points]
Sustainable Sites	[6 points]
Water Efficiency	[5 points]
Energy and Atmosphere	[19 points]
Materials and Resources	[9 points]
Indoor Environmental Quality	[4 points]
Innovation and Design Process	[4 points]
Regional Priority	[2 points]

Total Points [62 points]

IV. NARRATIVE FOR LEED CREDITS

The 727 Mass Ave Project fulfills all the prerequisites for all categories.

A. LOCATION AND TRANSPORTATION

LTC1: Sensitive Land Protection [1 point]

The project site is located on land that has been previously developed and does not currently qualify as sensitive land.

LTC3: Surrounding Density and Diverse Uses [5 points]

The project is located in the heart of Central Square, which includes a variety of necessary amenities, such as grocery stores, restaurants, pharmacies, and places of worship.

LTC4: Access to Quality Transit [5 points]

The site is located within ¼ mile of the Central Square Red Line Massachusetts Bay Transit Authority subway stop. It's also within a close walk of several bus lines providing access to surrounding neighborhoods and downtown Boston.

LTC5: Bicycle Facilities [1 point]

727 Mass Ave will include ample covered, secure bicycle spaces within the building. The number of bike spaces exceeds the minimum requirement of 5% of building occupants. The project also provides shower and changing facilities accessible to all full-time employees.

LTC6: Reduced Parking Footprint [1 point]

The project will not provide any parking spaces on site.



B. SUSTAINABLE SITES

SSP1: Construction Activity Pollution Prevention [Required]

727 Mass Ave design documents include an erosion and sedimentation plan that complies with both local code and the EPA Construction General Permit that addresses all construction activities associated with the project.

SSC1: Site Assessment [1 point]

The project team conducted a site assessment that focuses on environmental features of the site to help them identify opportunities for sustainable site development.

SSC2: Site Development – Protect or Restore Habitat [1 point]

Chevron Partners will provide financial support to a local land conservation trust to fulfill the requirements of Option 2.

SSC4: Rainwater Management [3 points]

The 90th percentile of local rainfall events is retained on site for this zero lot line project. The 90th percentile rainfall event is 1.19 inches, yielding a 1,043 cubic foot requirement for the 10,516 square foot site. The provided onsite retention is 1,320 cubic feet of storage in the proposed onsite subsurface infiltration system.

SSC6: Light Pollution Reduction [1 point]

The project will ensure that all exterior lighting complies with the limitations of the uplight-backlight-glare method to reduce the amount of disrupting, ambient light in the area.

C. WATER EFFICIENCY

WEP1: Outdoor Water Use Reduction [Required]

727 Mass Ave will implement an irrigation system that utilizes efficient technology and planting strategy to reduce the amount of outdoor, potable water use by a minimum of 30%.

WEP2: Indoor Water Use Reduction [Required]

727 Mass Ave will utilize high efficiency fixtures to reduce indoor water by at least 20%.

WEP3: Building-Level Water Metering [Required]

Permanent, building-level water meters will be installed in the project to encourage more sustainable water management strategies. Ownership will commit to sharing usage data collected from the water meters to USGBC to be tracked and analyzed.

WEC1: Outdoor Water Use Reduction [1 point]



In addition to the required minimum of a 30% reduction, 727 Mass Ave will utilize native, tolerant planting species to reduce the need for potable irrigation by 50% from the baseline.

WEC2: Indoor Water Use Reduction [3 points]

The project will pursue a 35% reduction in indoor water use from the calculated baseline by utilizing low flow showers, water closets, and faucets in all resident spaces.

WEC4: Advanced Water Metering [1 point]

727 Mass Ave will install at least two permanent water meters on the domestic hot water and irrigation subsystems to further improve indoor water use management on-site.

D. ENERGY AND ATMOSPHERE

EAP1: Fundamental Commissioning [Required]

The project team has engaged a commissioning agent to review and oversee the commissioning process activities including HVAC systems, refrigeration systems and controls, lighting, and domestic hot water systems.

EAP2: Minimum Energy Performance [Required]

The project meets the minimum requirements of ASHRAE 90.1-2010 for major building components as well as achieves a minimum of a 5% improvement in the proposed building performance rating compared with the baseline building performance rating.

EAP3: Building-Level Energy Metering [Required]

The project team will install building-level energy meters to measure total energy use of the project and encourage the project to monitor and improve on energy saving strategies. The Owner will commit to sharing usage data with USGBC for at least 5 years.

EAP4: Fundamental Refrigerant Management [Required]

The project will ensure that no chlorofluorocarbon based refrigerants will be used.

EAC1: Enhanced Commissioning [5 points]

In order to further support the design, construction, and operations of the project, both enhanced systems commissioning and envelope commissioning are being pursued.

EAC2: Optimize Energy Performance [12 points]

The project team has worked to go beyond the energy requirements outlined in the prerequisite and has achieved a total savings of 29.7% using the Alternative Energy Performance Metrics. Calculations are shown below.



LEED v4 Savings Calculation Using Alternative Energy Performance Metrics

	Annual Site Energy Use		Energy Cost	Source MMBTU	CO2 Emiss. kg
	kWh	therms			
ASHRAE 90.1-2013 Baseline	513,047	18,957	\$101,952	6,892	231,865
Proposed Design	552,764	3,406	\$90,630	5,639	159,429
% Savings vs. ASHRAE 90.1-2013			11.1%	18.2%	31.2%
% Savings Adjustment for ASHRAE 90.1-2010			5%	5%	5%
% Savings vs. ASHRAE 90.1-2010			16.1%	23.2%	36.2%
Avg. % Savings of 2 Highest Metrics (LEED Savings)			29.7%		

MA Utility Rates from EIA.gov data

Electricity	\$0.1570 \$/kWh
Natural Gas	\$1.13 \$/therm

EnergyStar Source-to-Site Factors

Electricity	2.8
Natural Gas	1.05

EnergyStar Greenhouse Gas Emission Rates (New England)

Electricity	74.94 kg/MMBTU
Natural Gas	53.11 kg/MMBTU

EAC7: Green Power and Carbon Offsets

[2 points]

Chevron Partners will engage in a contract that specifies the provision of 100% of the project's energy from green power, carbon offsets, or renewable energy certificates over the course of at least 5 years.

E. MATERIALS AND RESOURCES

MRP1: Storage and Collection of Recyclables

[Required]

727 Mass Ave will include a designated location for the storage and collection of recyclables on-site. Recyclable materials will include at least mixed paper, corrugated cardboard, glass, plastics, and metals. The project will also provide a location for building users to recycle batteries and electronic waste.

MRP2: Construction and Demolition Waste Management Planning

[Required]

The project team will develop a Construction and Demolition Waste Management plan that works to reduce waste disposed of in landfills. The plan will identify at least 5 materials to be diverted and provide details on storage, collection, and processing of these materials.

MRC1: Building Life-Cycle Impact Reduction

[5 points]

727 Mass Ave will achieve Option 1 under this credit for reusing a historic building.

MRC2: BPDO – Environmental Product Declarations

[1 point]

The project will specify at least 20 products that have an Environmental Product Declaration to help encourage transparency within the materials sector of the industry.



MRC4: BPDO – Material Ingredients

[1 point]

The project will specify at least 20 products that have a Health Product Declaration, Cradle to Cradle certificate, or USGBC-approved material ingredient reporting program.

MRC5: Construction and Demolition Waste Management

[2 points]

The project will develop a construction and demolition waste management plan that will divert at least 75% by weight or volume of total material from at least 4 waste streams.

F. INDOOR ENVIRONMENTAL QUALITY

IEQP1: Minimum Indoor Air Quality Performance

[Required]

The project’s mechanical ventilation systems will meet the requirements of ASHRAE 62.1-2010 sections 4-7 in order to provide a comfortable and healthy environment for all building occupants.

IEQP2: Environmental Tobacco Smoke Control

[Required]

727 Mass Ave will prohibit smoking inside and within 25 feet of building entrances to minimize the negative impacts of tobacco smoke on occupants’ health, indoor surfaces, and ventilation systems.

IEQC1: Enhanced Indoor Air Quality Strategies

[1 point]

The project will incorporate walk-off mats, MERV 13 filters, and will exhaust all housekeeping areas. This will promote a healthy, comfortable, and productive indoor environment for building occupants.

IEQC2: Low-Emitting Materials

[2 points]

727 Mass Ave will achieve 2 points for this credit by utilizing at least 4 materials of different categories that comply with emissions and content standards. Utilizing low-emitting materials will create a healthier, lower impact indoor space, as volatile organic compounds (VOCs) can be harmful to air quality, human health and the environment.

IEQC3: Construction Indoor Air Quality Management Plan

[1 point]

The general contractor will develop an IAQ Management Plan to promote wellness during construction.

G. INNOVATION IN DESIGN

[4 points]

The project team is investigating which three Innovation in Design credits will be most beneficial in reducing the environmental impacts of the building and improve the occupant experience. An additional point is awarded for having a LEED Accredited Professional as part of the project team.



H. REGIONAL PRIORITY

RPC1: Regional Priority

[2 points]

The project has achieved the Regional Priority thresholds for the Rainwater Management and Optimize Energy Performance credits.



LEED v4 for BD+C: New Construction and Major Renovation

Project Checklist

Project Name: 727 Mass Ave
6/30/2020

Y ? N

1	0	1	Credit 1	Integrative Process	1
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13	0	3	Location and Transportation		16
			Credit	LEED for Neighborhood Development Location	16
1			Credit 1	Sensitive Land Protection	1
		2	Credit 2	High Priority Site	2
5			Credit 3	Surrounding Density and Diverse Uses	5
5			Credit 4	Access to Quality Transit	5
1			Credit 5	Bicycle Facilities	1
1			Credit 6	Reduced Parking Footprint	1
		1	Credit 7	Green Vehicles	1

6	0	4	Sustainable Sites		10
Y			Prereq 1	Construction Activity Pollution Prevention	Required
1			Credit 1	Site Assessment	1
1		1	Credit 2	Site Development - Protect or Restore Habitat	2
		1	Credit 3	Open Space	1
3			Credit 4	Rainwater Management	3
		2	Credit 5	Heat Island Reduction	2
1			Credit 6	Light Pollution Reduction	1

5	0	6	Water Efficiency		11
Y			Prereq 1	Outdoor Water Use Reduction	Required
Y			Prereq 1	Indoor Water Use Reduction	Required
Y			Prereq 1	Building-Level Water Metering	Required
1		1	Credit 1	Outdoor Water Use Reduction	2
3		3	Credit 2	Indoor Water Use Reduction	6
		2	Credit 3	Cooling Tower Water Use	2
1			Credit 4	Water Metering	1

19	0	14	Energy and Atmosphere		33
Y			Prereq 1	Fundamental Commissioning and Verification	Required
Y			Prereq 2	Minimum Energy Performance	Required
Y			Prereq 3	Building-Level Energy Metering	Required
Y			Prereq 4	Fundamental Refrigerant Management	Required
5		1	Credit 1	Enhanced Commissioning	6
12		6	Credit 2	Optimize Energy Performance	18
		1	Credit 3	Advanced Energy Metering	1
		2	Credit 4	Demand Response	2
		3	Credit 5	Renewable Energy Production	3
		1	Credit 6	Enhanced Refrigerant Management	1
2			Credit 7	Green Power and Carbon Offsets	2

9	0	4	Materials and Resources		13
Y			Prereq 1	Storage and Collection of Recyclables	Required
Y			Prereq 2	Construction and Demolition Waste Management Planning	Required
5			Credit 1	Building Life-Cycle Impact Reduction	5
1		1	Credit 2	Building Product Disclosure and Optimization - Environmental Product Declarations	2
		2	Credit 3	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
1		1	Credit 4	Building Product Disclosure and Optimization - Material Ingredients	2
2			Credit 5	Construction and Demolition Waste Management	2

4	0	12	Indoor Environmental Quality		16
Y			Prereq 1	Minimum Indoor Air Quality Performance	Required
Y			Prereq 2	Environmental Tobacco Smoke Control	Required
1		1	Credit 1	Enhanced Indoor Air Quality Strategies	2
2		1	Credit 2	Low-Emitting Materials	3
1			Credit 3	Construction Indoor Air Quality Management Plan	1
		2	Credit 4	Indoor Air Quality Assessment	2
		1	Credit 5	Thermal Comfort	1
		2	Credit 6	Interior Lighting	2
		3	Credit 7	Daylight	3
		1	Credit 8	Quality Views	1
		1	Credit 9	Acoustic Performance	1

4	0	2	Innovation		6
3		2	Credit 1-5	Innovation	5
1			Credit 6	LEED Accredited Professional	1

2	0	2	Regional Priority		4
1			Credit 1	Optimize Energy Performance (Threshold: 8)	1
		1	Credit 2	High Priority Site	1
1			Credit 3	Rainwater Management (Threshold 2)	1
		1	Credit 4	Indoor Water Use Reduction (Threshold: 4)	1

62	0	48	TOTALS	Possible Points: 110
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Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110



Finegold Alexander Architects

727 MASSACHUSETTS AVENUE

ZERO CARBON BUILDING ASSESSMENT

5.5.2020
WSP Built Ecology



Zero Carbon Building Assessment

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Executive Summary

Project Overview

This project is a 42,000 SF mixed use renovation and addition to the former Gas Light Building at 727 Mass Ave in Cambridge. It will feature retail and restaurant spaces on the basement and ground level and office spaces on the second and third floor of the existing building. The new addition on floors three through six will add approximately 37 boutique hotel rooms and an amenity roof. It should be noted that the ground floor of the existing building that houses the Bank of America space is not in contract for this project.

Proposed Design

The Proponent has performed extensive restoration to the existing façade of the former Gas Light Building in preparation for the new addition. Significant upgrades were made to the thermal resistance of the vision glass, spandrel, and opaque wall assemblies. The Proposed Design features a vertical facade average R-value of 5.6, which is a 15% improvement compared to the code baseline. The Proposed Design's facade has a low Window to Wall Ratio (WWR) at 26%. The mechanical system is a VRF system that takes advantage of variable refrigerant flow to simultaneously heat and cool the building by shifting heat from places in need of cooling to areas where heating is needed. A gas fired ERU conditions incoming fresh air. Domestic hot water (DHW) will be provided by condensing gas water heaters. Overall, the Proposed Design shows 36% site energy savings and 27% GHG savings against the LEEDv4 ASHRAE 90.1-2010 baseline. Figures 1-3 on the page 7 summarize the savings of the Proposed Design

Future Low Carbon Design

For the Low Carbon Design, an all-electric scenario was modeled. The building will be served by a VRF system for heating and cooling with an electric heat pump ERV. DHW was modeled using electric resistance water heaters. Any remaining gas loads (eg. kitchen equipment, laundry) were converted to all electric equipment. The Low Carbon Design showed a total of 49% site energy savings and 37% GHG savings against code. See graphs on page 8 and 9 for details.

On Site Solar PV

A comprehensive Solar PV feasibility study of the building's roof area was conducted. Open space currently programmed for the amenity deck on the south facing roof was analyzed and showed a potential total capacity of

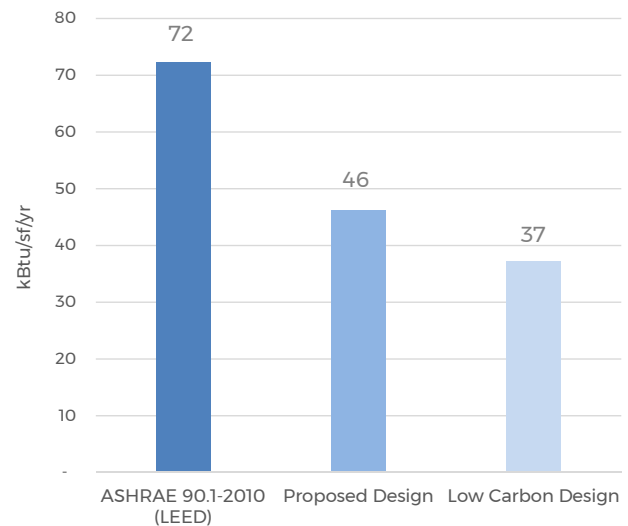
14 kW. This would offset 2.2% of the Proposed Design's annual site energy use. It is assumed that all 1,085 sf will be available for a future PV canopy with remaining areas reserved for rooftop mechanical equipment. See Figure 8 on page 11 for a rooftop plan of the PV arrays.

Off Site Clean Energy & Carbon Offsets

In order to arrive at net zero carbon, any site energy not generated by on site PV will need to be offset by off site clean and renewable energy. Renewable Energy Credits (RECs) and carbon offsets may be purchased to accomplish this. The Proposed Design can arrive at net zero carbon with \$2,068 for Green-e Certified RECs and \$62 for carbon offsets annually. The all electric Low Carbon Design would need to purchase \$2,039 worth of RECs annually to run on clean energy.

Conclusion

The Proposed Design demonstrates significant savings against the LEEDv4 baseline with a high performance facade and VRF mechanical system. This analysis shows several paths for the Proposed Design to arrive at net zero carbon in the future through on site solar PV and the purchase of off site clean and renewable energy. At minimum, the project will be solar ready. The project has set a goal of being LEEDv4 Silver certifiable. As part of this commitment, the Proponent is holding the Green Power credit (RECs and carbon offsets) for 100% of the building's site energy use. 727 Mass Ave will operate as a carbon neutral building for a minimum of 5 years.



Building EUI Comparison

Overview



Zero Carbon Building Assessment



Energy Analysis



**Clean and Renewable
Energy Analysis**



Financial Analysis



Life Cycle Cost Analysis

Introduction

This assessment explores the Carbon Neutral Design for 727 Mass Ave with respect to the lowest possible site energy usage, on site solar PV generation, and off site clean energy mitigation.

In the first phase of this assessment, an Energy Analysis of three scenarios — LEED Baseline, Proposed Design, and Future Low Carbon Design — was performed. Passive building envelope optimizations and a suite of HVAC options were simulated to identify the best features for the low carbon design.

The Clean and Renewable Energy Analysis demonstrates how the design could arrive at carbon neutral. Carbon accounting unpacks how the site energy efficiency could be offset by on site PV and off site clean energy mitigation to arrive at net zero carbon.

A Financial Analysis for off site green power and carbon offset purchasing was conducted to show the financial expenditure needed to achieve this.

A Life Cycle Cost Analysis (LCCA) was conducted for potential rooftop PV arrays. First cost is weighed against avoided cost, incentives and operational energy cost savings to summarize the net value and cost savings of producing clean energy on site.



Project Overview

727 Mass Ave is designed to be a 42,000 SF mixed use development on the corner of Mass Ave and Temple Street in Cambridge. The project will feature retail and restaurant spaces on the basement and ground level and office spaces on the second and third floor of the former Gas Light Building. The new addition on floors three through six will add approximately 37 boutique hotel rooms and an amenity roof.

It has been a key objective throughout the design process to address both human and environmental health through mitigating and adapting to the impacts of climate change while maximizing occupant well-being and comfort. The design team has analyzed a suite of scenarios for the project from envelope packages to HVAC system options to identify the best course towards a Future Low Carbon Design.

The project has committed to partially electrifying the HVAC system using a high performance VRF system and a DOAS system with an 82% efficient gas furnace and 64% efficient ERV. Domestic hot water is produced using a 95% efficient gas condensing boiler. A 10% lighting power density reduction over the baseline has also been incorporated. This Proposed Design will result in 27% greenhouse gas (GHG) emissions savings compared to the LEEDv4 baseline.

Furthermore, 727 Mass Ave is planning to be LEEDv4 NC Silver certifiable to display a commitment of the owner and project team to meet resiliency and GHG reduction goals. The project will not be adding any new parking to support mobile-source GHG emissions reductions by reducing vehicle trips.

The Proposed Design has been optimized for a total of 36% site energy savings against the LEEDv4 ASHRAE 90.1-2010 baseline and incorporates all feasible sustainability measures. This report highlights how the design features of the Proposed Design can reach carbon neutrality in its current state and outlines what strategies a Future Low Carbon Design can take to further reduce operational carbon towards reaching net zero carbon.

Approach

Preliminary building energy modeling was performed by DMI under the building design engineer, WB Engineers. Modeling was conducted for LEEDv4 following the design guidelines of ASHRAE 90.1 - 2010 Appendix G.

The following sections outline the Proposed Design's exceptional energy performance, explain the reasoning behind design decisions and demonstrate how 727 Mass Ave can arrive at carbon neutrality.



727 MASS AVE

Energy Conservation Measures

The Proposed Design features for carbon neutral design:

- Tune the building's passive thermal performance
- Optimize the building's mechanical systems for performance efficiency
- Fully electrify HVAC system to allow for further carbon reductions with clean and renewable energy

Passive Thermal Performance

The passive thermal envelope of 727 Mass Ave has undergone extensive analysis for performance as part of this study. It should be noted that the historical portion of the buildings on floors 1 and 2 has undergone extensive restoration. The Proponent has left the first floor storefront windows and existing 2' mass wall in its existing condition due to structural concerns with existing mullions and moisture concerns respectively. The Proposed Design features a vertical facade average U-value at 0.18, which is a 15% improvement compared to a typical ASHRAE 90.1-2013 code compliant envelope. Glazing is typically the weakest portion of the thermal envelope. The Proposed Design's facade has a low Window to Wall Ratio (WWR) at 26%. For the Future Low Carbon Design, significant upgrades were made to the thermal resistance of the vision glass

and opaque wall assemblies. Figure 1 on the next page summarizes the thermal envelope improvements and savings of the Proposed Design and Low Carbon Design.

Mechanical Systems

A suite of mechanical design options were modeled to identify the mechanical system that best fit the constraints of the program while also considering the city's goal of building electrification. The hotel program has a high demand for heating and cooling as well as high domestic hot water (DHW) demand due to the dense hotel room layout. The two system options that were evaluated were:

1. VRF system with gas-fired DOAS and 64% efficient ERU & gas condensing water heater (Proposed Design)
2. VRF system with electric heat pump DOAS & electric storage water heater (Low Carbon Design)

A rigorous comparative analysis of all both system options was performed. The Proposed Design's Variable Refrigerant Flow (VRF) system with gas fired dedicated outdoor air supply (DOAS) has the potential to earn the project up to 36% site energy savings. For domestic hot water, the Proposed Design's gas condensing water heater

*Note: GHG Emission rates used to calculate savings were 682 lb/MWh Electricity, 117 lb/MMBtu Gas (ISO NE Emissions Report, 2017)

Energy Analysis Results

Mechanical Systems (cont'd)

showed higher GHG savings* based on the current emissions of the electric grid than the Low Carbon Design's electric resistance heater. However, these DHW GHG losses in the Low Carbon Design were offset by the dramatic savings that the electric heat pump DOAS system provided. Additional savings taken into account for the Low Carbon Design included 20% reduction for interior lighting due to future advances in technology, as well as a 20% reduction in plug loads for energy star appliances. See Figures 2 and 3 for site energy savings and GHG savings of both design options.

Electrification

The project team has set electrification goals in its Proposed Design for the HVAC system using VRF. A future opportunity to fully electrify the DOAS system using electric heat pumps shows 15 MT of GHG savings versus the gas fired alternative. Due to roof space concerns, the project team did not consider this upgrade feasible at this time. The domestic hot water was not electrified due lack of market availability of commercial Air Source Heat Pump water heaters. Electric resistance water heaters are not considered feasible at this time due to the high operational cost for the hotel DHW demand.

Measure	Code Baseline	Proposed Design	Low Carbon Design
Roof	R-30 (U = 0.033)	R-36 (U = 0.028)	R-37 (U = 0.027)
Existing Opaque Wall	R-18 (U = 0.055)	R-3.9 (U = 0.258)	R-16 (U = 0.063)
New Opaque Wall	R-18 (U = 0.055)	R-23.3 (U = 0.043)	R-30 (U = 0.033)
Glazing	R-2.4 (U = 0.42)	R-2.3 (U = 0.43)	R-2.6 (U = 0.38)
WWR	30%	26%	26%
Vertical Facade Average	R-5 (U = 0.20)	R-5.6 (U = 0.18)	R-8.4 (U = 0.12)
Energy Savings Above Code	—	15%	24%

Figure 1: Thermal Envelope Design Comparison

Measure	LEED Baseline	Proposed Design	Low Carbon Design
Electricity (kWh)	630,641	602,720	665,672
Natural Gas (therm)	18,133	4,130	—
Site Energy (MBTU)	3,964	2,533	2,039
EUI (kBtu/sf/yr)	72	46	37
Site Energy Savings (%)	—	36%	48%

Figure 2: Mechanical System Energy Comparison

Measure	LEED Baseline	Proposed Design	Low Carbon Design
Electricity (tons)	215	207	204
Natural Gas (tons)	106	27	—
Total (tons)	321	234	204
GHG Savings (%)	—	27%	37%

Figure 3: GHG Savings*

Energy Analysis Results

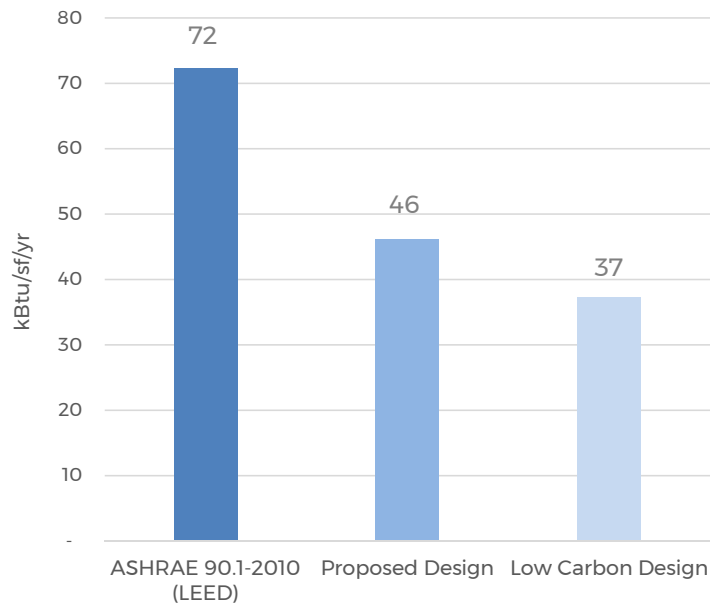


Figure 4: Building EUI Comparison

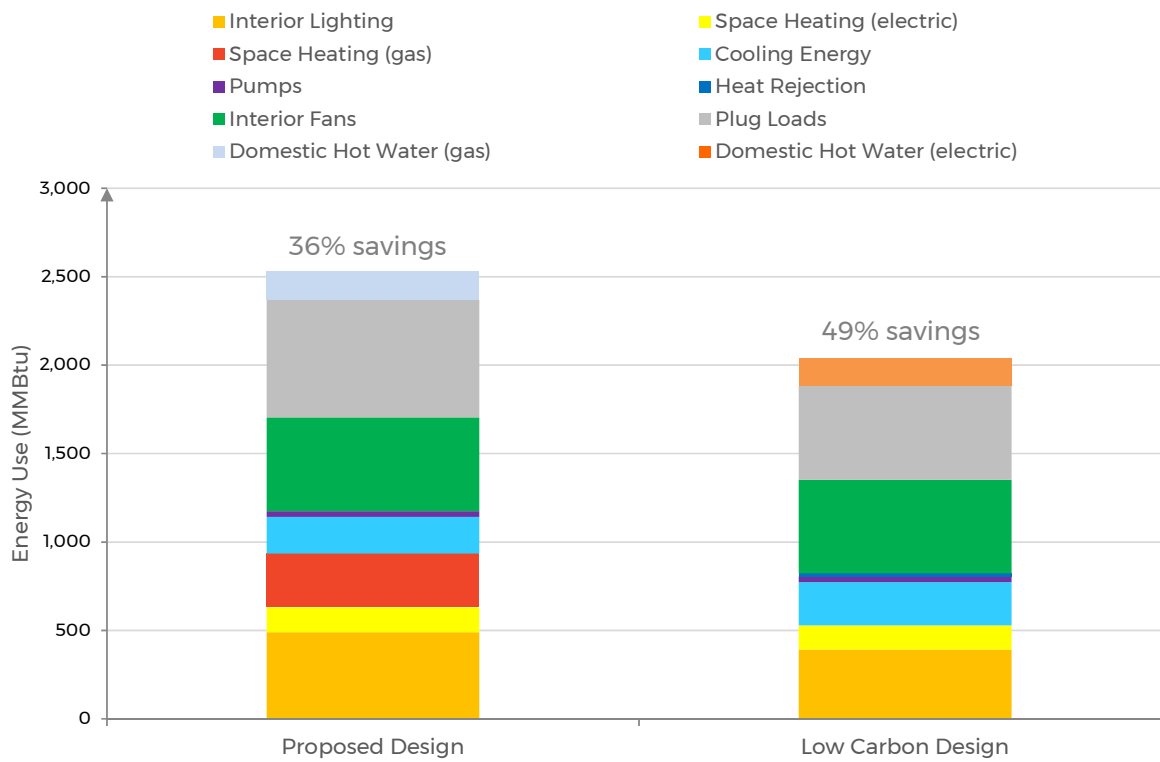


Figure 5: Energy End Use Breakdown

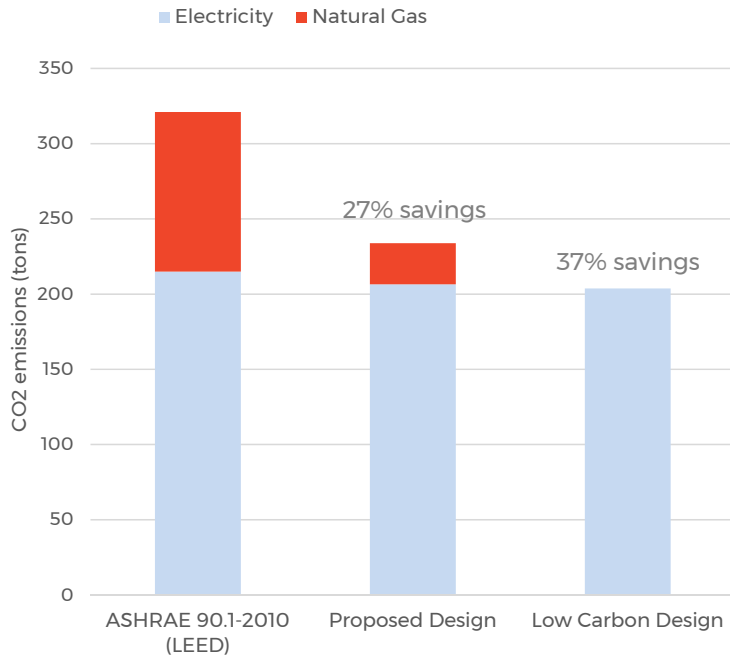


Figure 6: GHG Savings Comparison

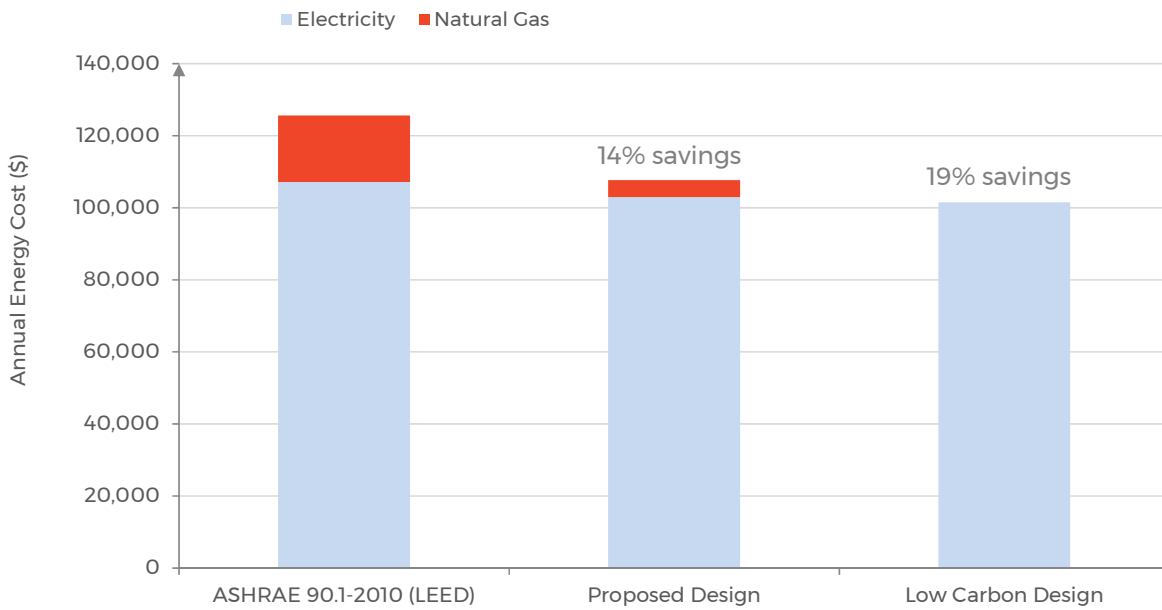
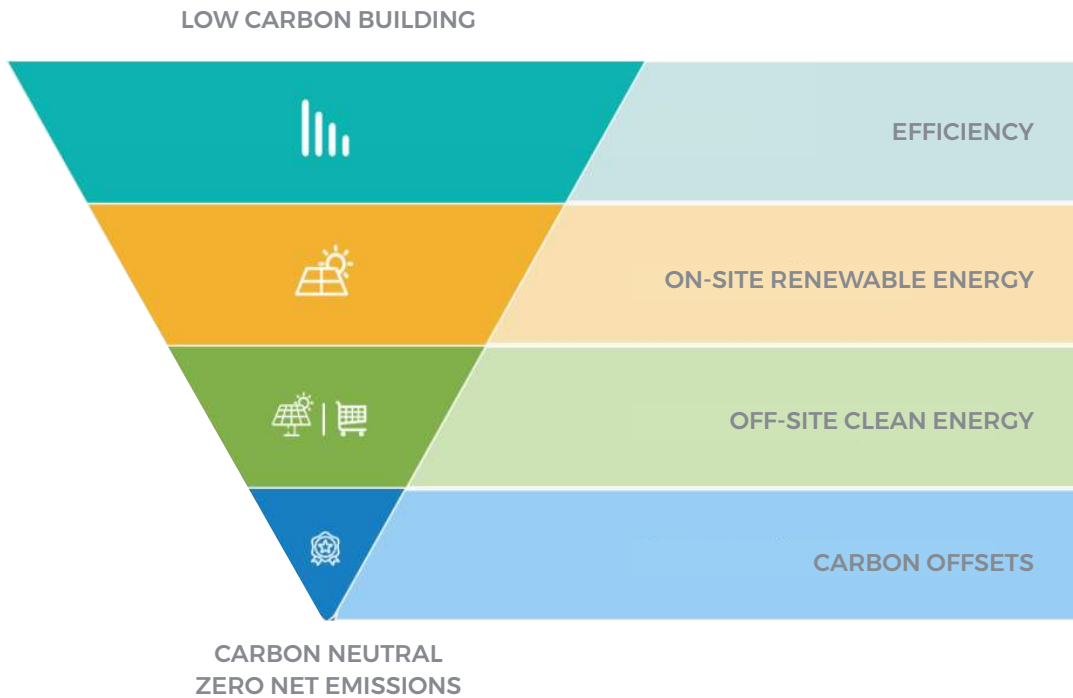


Figure 7: Annual Energy Cost Comparison

Clean and Renewable Energy Analysis



Getting to Zero

In order to arrive at Zero Carbon, the Proposed Design's energy efficiency needs to be offset by on site and off site clean and renewable energy and mitigated through the purchase of carbon offsets.

The diagram at the top of this page shows the typical carbon management hierarchy.

The Proposed Design scenario can arrive at Zero Carbon by using On Site Solar for 2.2% of its annual energy use and purchasing Renewable Energy Certificates and Carbon Offsets for the remaining 97.8%. The cost of this proposed Zero Carbon mitigation plan is shown in the financial analysis following this section.

On Site Clean Energy

The project has a feasible photovoltaic array location on the Level 6 roof (1,085 SF). Shading studies have indicated that the rooftop will receive direct sunlight from the southwest, making it suitable for PV. It is assumed that the entire roof area identified for solar would be available for a future PV canopy above the amenity deck, with the remaining roof area reserved for mechanical equipment and setbacks from the roof edge.

Rooftop PV

A preliminary shading analysis was completed for the rooftop canopy PV array using the architectural roof plan issued in the construction documentation phase. The analysis indicates that a third of the roof area, or up to 14 kW solar photovoltaic capacity could be installed. The system would generate an estimated cost savings of \$2,900 and an offset of approximately 2.2% of annual building energy use. This preliminary capacity estimate will continue to evolve as the roof plan is finalized throughout the design process. Currently, the space studied for the PV canopy is programmed for the amenity roof deck. The proponent will at minimum explore providing for this area to be pv ready for a future PV array.

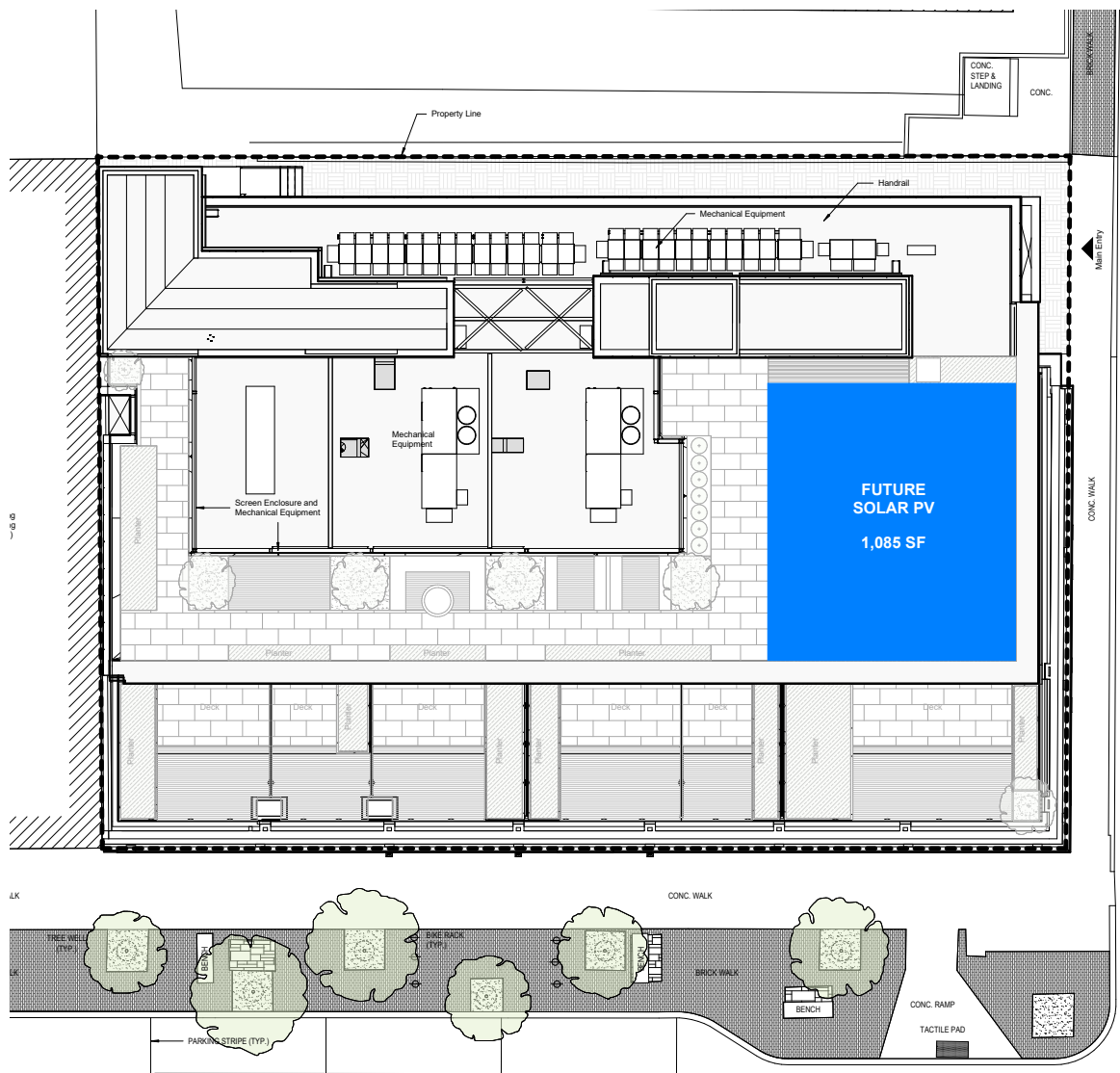


Figure 8: Rooftop Solar PV Plan

Financial Analysis

Design Option	Energy Consumption Natural Gas (MBtu)	Annual MT of CO2 Emissions	Carbon Offset Price (per MT CO2e)	Annual Carbon Offset Price
Proposed Design	465	25	\$ 2.50	\$ 62
Future Low Carbon Design	–	–	–	–

Figure 9: Annual Carbon Offset Estimate

Design Option	REC Type	Quantity (MWh)	Price Per Unit	Annual REC Price
Proposed Design	Green-e certified Massachusetts RECs	2,068	\$30	\$62,040
Proposed Design	Green-e certified Clean Source RECs (non-MA)	2,068	\$1	\$2,068
Future Low Carbon Design	Green-e certified Massachusetts RECs	2,039	\$30	\$61,160
Future Low Carbon Design	Green-e certified Clean Source RECs (non-MA)	2,039	\$1	\$2,039

Figure 10: Annual Renewable Energy Certificate Estimate

Carbon Offsets

Projects may offset their greenhouse gas emissions from natural gas or fossil fuel generated electricity through the purchase of carbon offsets. Carbon offsets are financial contributions to projects that help reduce GHG emissions or increase the storage of carbon.

The price of carbon offset varies greatly. Carbon offsets are purchased in units of metric tons of carbon dioxide emissions (MT CO2e). The chart above demonstrates the cost of carbon offsetting the Proposed Design’s natural gas use of 465 MBtu annually. The cost of \$2.50 per metric ton of carbon dioxide equivalent (MT CO2e) is based on data collected from recent projects pursuing carbon offsets in Boston.

The Future Low Carbon Design would not need to purchase carbon offsets since it is all electric. The Proposed Design has 465 MBTU natural gas usage due to reheating outdoor air with the gas fired dedicated outdoor air system and due to the gas condensing water heater for domestic hot water. Based on the current energy model information, the Proposed Design for 727 Mass Ave could offset its carbon emissions for \$62 annually.

Off Site Clean Energy

In order to achieve carbon neutrality, projects can use renewable energy certificates (RECs), which represent one megawatt-hour (MWh) of electricity that is generated and delivered to the electricity grid from a renewable energy source. These certificates allow projects to use renewable energy, even if they don’t have on site generation. RECs are not limited by geographic location and can be purchased in deregulated and regulated states.

RECs can widely vary in terms of pricing. It is estimated that Green-e Certified Massachusetts RECs are currently priced at \$30 per REC, while Green-e Certified Clean Source RECs are a little under \$1 per REC.

The table above demonstrates a path for 727 Mass Ave to run on clean electricity through the purchase of Green-e certified RECs.

Life Cycle Cost Analysis

PV System Simple Payback Summary	
	727 Mass Ave
PV Capacity (kW)	14
PV Production (kWh/yr)	16,362
Electricity Cost Saved per Year	\$2,900
Total Installed Cost of PV	\$42,300
Federal Investment Tax Credit (22%)	\$9,306
MACRS Depreciation Deductions (27%)	\$11,504
SMART Incentive	\$818
Owner/Landlord Energy Use (kWh/yr)	2.2%
Simple Payback (yrs)	6

Figure 11: PV System Life Cycle Cost Analysis

PV System Life Cycle Cost

The installed cost of the on-site 14 kW Solar PV system for 727 Mass Ave would be approximately \$42,300. It has the capacity to generate around 16,362 kWh per year which equates to \$2,900 in electricity cost savings. The solar array would qualify for the SMART incentive with an annual payback of \$818, a one time Federal Investment Tax Credit of \$9,306 and MACRS Depreciation deduction of around \$11,504. The system will payback after 6 years. This array would offset 2.2% of the Proposed Design's annual building energy use with clean and renewable energy.

Conclusion

The project design team will investigate including both the structural and electrical infrastructure to allow future integration of PV into the building electrical system.

The proponent has committed under LEEDv4 to the purchase of renewable energy certificates and carbon offsets to offset 100% of the building's annual energy efficiency for five years. This commitment of purchasing off site clean power and offsetting operational carbon brings 727 Mass Ave to net zero carbon.