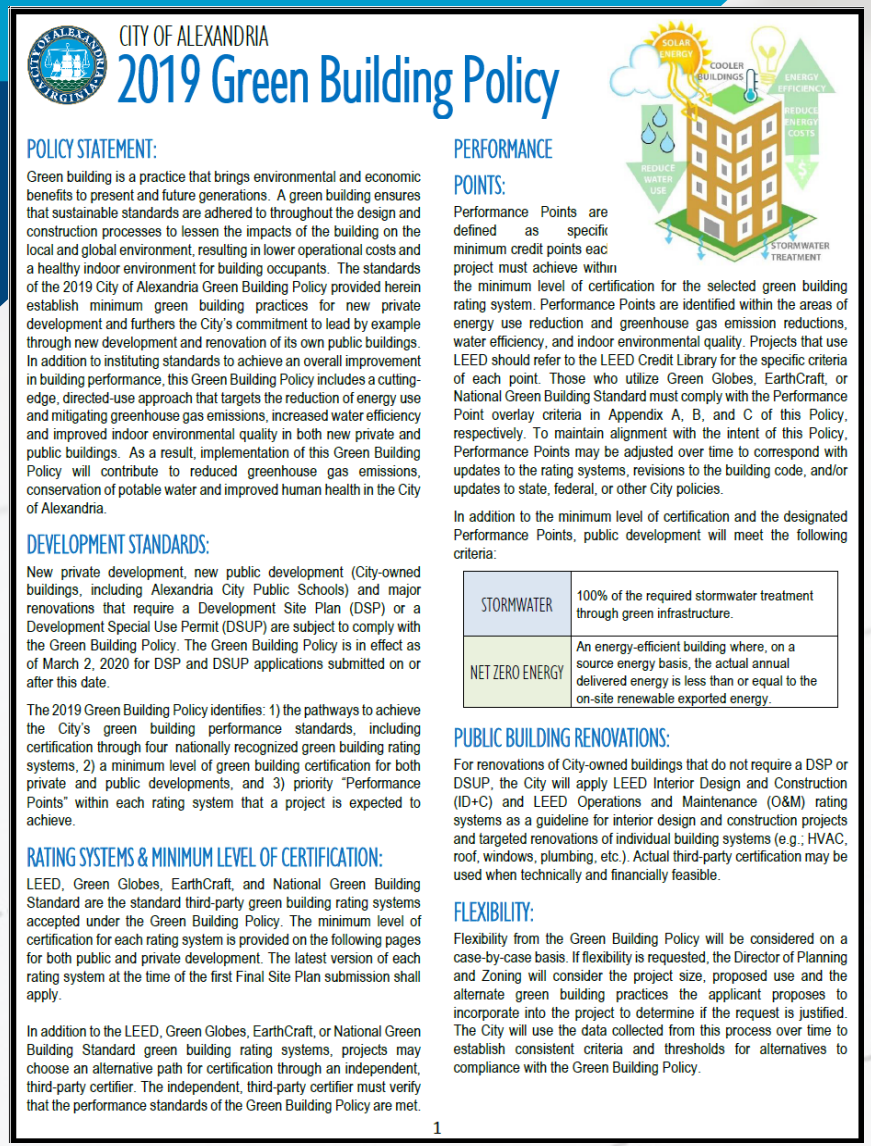
CITY OF ALEXANDRIA

2025 Green Building Policy Update

April 4, 2025

Agenda



CITY OF ALEXANDRIA

2019 Green Building Policy

POLICY STATEMENT:

Green building is a practice that brings environmental and economic benefits to present and future generations. A green building ensures that sustainable standards are adhered to throughout the design and construction processes to lessen the impacts of the building on the local and global environment, resulting in lower operational costs and a healthy indoor environment for building occupants. The standards of the 2019 City of Alexandria Green Building Policy provided herein establish minimum green building practices for new private development and furthers the City's commitment to lead by example through new development and renovation of its own public buildings. In addition to instituting standards to achieve an overall improvement in building performance, this Green Building Policy includes a cutting-edge, directed-use approach that targets the reduction of energy use and mitigating greenhouse gas emissions, increased water efficiency and improved indoor environmental quality in both new private and public buildings. As a result, implementation of this Green Building Policy will contribute to reduced greenhouse gas emissions, conservation of potable water and improved human health in the City of Alexandria.

DEVELOPMENT STANDARDS:

New private development, new public development (City-owned buildings, including Alexandria City Public Schools) and major renovations that require a Development Site Plan (DSP) or a Development Special Use Permit (DSUP) are subject to comply with the Green Building Policy. The Green Building Policy is in effect as of March 2, 2020 for DSP and DSUP applications submitted on or after this date.

The 2019 Green Building Policy identifies: 1) the pathways to achieve the City's green building performance standards, including certification through four nationally recognized green building rating systems, 2) a minimum level of green building certification for both private and public developments, and 3) priority "Performance Points" within each rating system that a project is expected to achieve.

RATING SYSTEMS & MINIMUM LEVEL OF CERTIFICATION:

LEED, Green Globes, EarthCraft, and National Green Building Standard are the standard third-party green building rating systems accepted under the Green Building Policy. The minimum level of certification for each rating system is provided on the following pages for both public and private development. The latest version of each rating system at the time of the first Final Site Plan submission shall apply.

In addition to the LEED, Green Globes, EarthCraft, or National Green Building Standard green building rating systems, projects may choose an alternative path for certification through an independent, third-party certifier. The independent, third-party certifier must verify that the performance standards of the Green Building Policy are met.

PERFORMANCE POINTS:

Performance Points are defined as specific minimum credit points each project must achieve within the minimum level of certification for the selected green building rating system. Performance Points are identified within the areas of energy use reduction and greenhouse gas emission reductions, water efficiency, and indoor environmental quality. Projects that use LEED should refer to the LEED Credit Library for the specific criteria of each point. Those who utilize Green Globes, EarthCraft, or National Green Building Standard must comply with the Performance Point overlay criteria in Appendix A, B, and C of this Policy, respectively. To maintain alignment with the intent of this Policy, Performance Points may be adjusted over time to correspond with updates to the rating systems, revisions to the building code, and/or updates to state, federal, or other City policies.

In addition to the minimum level of certification and the designated Performance Points, public development will meet the following criteria:

STORMWATER	100% of the required stormwater treatment through green infrastructure.
NET ZERO ENERGY	An energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.

PUBLIC BUILDING RENOVATIONS:

For renovations of City-owned buildings that do not require a DSP or DSUP, the City will apply LEED Interior Design and Construction (ID+C) and LEED Operations and Maintenance (O&M) rating systems as a guideline for interior design and construction projects and targeted renovations of individual building systems (e.g.; HVAC, roof, windows, plumbing, etc.). Actual third-party certification may be used when technically and financially feasible.

FLEXIBILITY:

Flexibility from the Green Building Policy will be considered on a case-by-case basis. If flexibility is requested, the Director of Planning and Zoning will consider the project size, proposed use and the alternate green building practices the applicant proposes to incorporate into the project to determine if the request is justified. The City will use the data collected from this process over time to establish consistent criteria and thresholds for alternatives to compliance with the Green Building Policy.

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1. **Context**
2. **Recommendation Overview**
3. **Initial Recommendation** (EUI, Renewable Energy, and Electrification)
4. **Certification**
5. **Affordable Housing Projects**
6. **Flexibility Requests**
7. **Public Buildings**
8. **Next Steps**
9. **Questions**

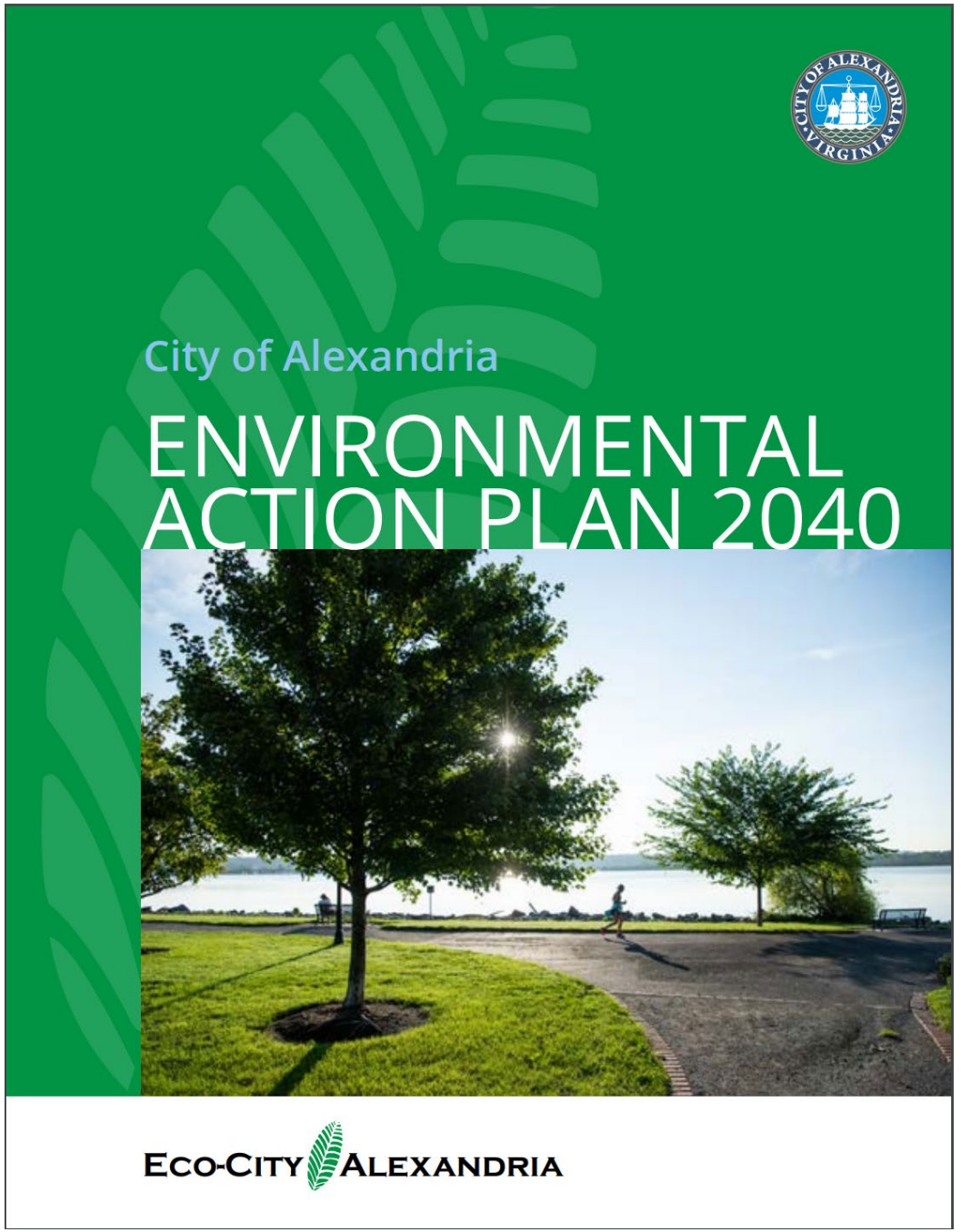
Context

Why an Update?

- Simplicity & Clarity
- Focus on What Matters

Current Market – Very Different World

- Tariffs, Employment Market, Federal Offices
- Return to Office
- Housing Shortage
- Skilled Labor Shortage
- Interest Rates



Recommendation Overview

1. Initial Recommendation

- **Building Use-Specific Energy Use Intensity (EUI) Targets**
- **Onsite Renewable Energy**
- **Electrification**
- Building Level Meters
- Potable Water Conservation
- Energy-Efficient Appliances
- EV Charging Infrastructure
- Low Emitting Materials
- Pre-Occupancy Building Flush or Air Quality Testing

2. Certification

3. Affordable Housing Projects

4. Flexibility Requests

- Adaptive Reuse
- Interim Uses, Residential Projects with 4 or Fewer Units, or <25k GFA (Meet Achievable Prescriptive Measures)
- General Flexibility

5. Public Buildings

Initial Recommendation

- **Building Energy Performance**
  - Building Use-Specific Energy Use Intensity (EUI) Targets
  - Onsite Renewable Energy
  - Electrification

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- **Key Certification Components**
  - Building Level Meters
  - Potable Water Conservation
  - Energy-Efficient Appliances
  - EV Charging Infrastructure
  - Low Emitting Materials
  - Pre-Occupancy Building Flush or Air Quality Testing

Initial Recommendation: Energy Use Intensity
(EUI = Energy Use/Square Foot)

Total Energy Consumption for 365 Days (Predicted or Measured)

Space Heating

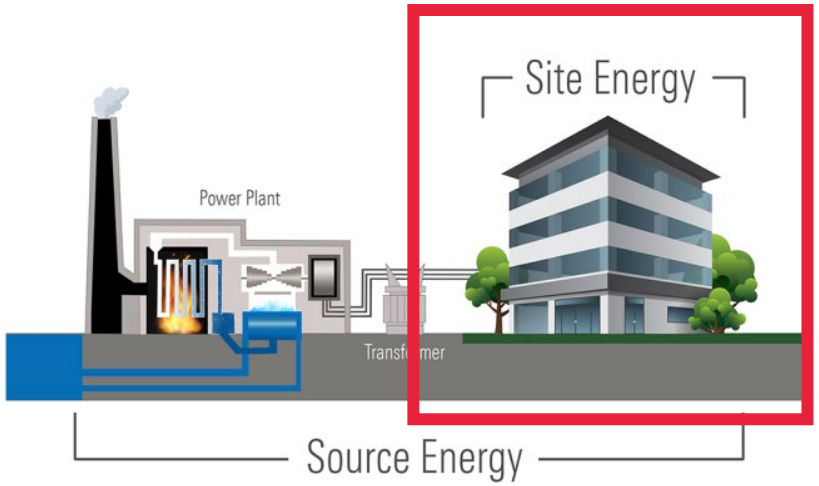
Pumps/Fans

Space Cooking

Lighting

Hot Water

Plug/Process Loads



Floor Area (Sq Ft)

Initial Recommendation: Energy Use Intensity (EUI = Energy Use/Square Foot)

- Baseline construction cost estimate for multi unit residential: $350 per square foot

Less Energy Consumed Per Square Foot

Multi Unit Residential Packages	**EUI** (Lower = Less Energy)	**Percent Reduction** from Baseline	**Cost Estimate of Measure Package: $/ sq ft** (Percentage Cost Increase over Baseline)
Baseline	**42.00**	0%	- *
Good	**38.50**	8%	*$3.37* ***(1%)***
Better	**35.70**	15%	$12.68 **(3.6%)**
Best	**30.98**	26%	$14.96 **(4.27%)**

Contextual References

- Baseline construction cost estimate for multi unit residential: $350 per square foot
- National Definition of Zero Emissions Building: https://www.energy.gov/eere/buildings/articles/national-definition-zero-emissions-building

Initial Recommendation: Energy Use Intensity
(EUI = Energy Use/Square Foot)

Less Energy Consumed Per Square Foot →

Property Use Type	ALX Baseline	2025 Recommendation	Zero Energy-Ready Building Target
Single Unit Residential	35[2]	31	20
Multi Unit Residential	42[2]	38	25[3]
Commercial Office	47[4]	40	22[3]
Hotel	92[2]	83	36[3]
Retail	45[2]	40	25[3]
Restaurants	305[2]	289	
Other		Demonstrate a 15% reduction from the median EUI of local benchmarking data	

- **Contextual References**
  - 1: IECC 2021 Table CC 103.1
  - 2: Modeled Baseline EUI from Cadmus
  - 3: New Building Institute's Zero Energy Commercial Building Targets: https://newbuildings.org/wp-content/uploads/2019/09/ZeroEnergyCommercialBuildingTargets.pdf
  - 4. Local Benchmarking Data from Pacific Northwest National Laboratory
  - 5. Montgomery County Regulation on Building Energy Performance Standards: https://www.montgomerycountymd.gov/DEP/Resources/Files/energy/commercial/BEPS_Modified_Reg_Clean%201_21.pdf
  - 6. U.S. Energy Use Intensity by Property Type – National Median: https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf
  - 7. Architecture 2030's Zero Tool: https://www.zerotool.org/

Initial Recommendation: Renewable Energy

Number of Solar Arrays in Northern Virginia 2009 to 2023

Year of Year

Locality	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Alexandria	2	12	17	22	25	30	35	46	58	74	100	172	222	304	390
Arlington	14	43	49	60	67	78	114	162	223	288	372	532	712	923	1,140
City of Fairfax	0	3	5	6	6	10	13	28	35	44	79	114	148	212	227
City of Falls Church	2	2	3	4	6	9	18	23	28	39	47	58	65	91	107
City of Manassas	1	2	2	2	5	7	10	16	17	38	60	75	169	209	547
City of Manassas Park	1	1	1	1	1	1	2	2	2	4	5	7	19	26	81
Fairfax County	19	76	105	127	162	188	255	323	481	844	1,380	1,910	2,559	3,618	4,753
Loudoun County	10	37	50	63	95	123	160	207	260	362	576	815	1,240	1,762	2,886
Prince William County	2	7	9	9	39	40	51	61	66	139	332	430	741	1,026	2,143
Grand Total	51	183	241	294	406	486	658	868	1,170	1,832	2,951	4,113	5,875	8,171	12,274

- **Reference: Northern Virginia Regional Commission – NOVA Region Dashboard**
  https://public.tableau.com/app/profile/nvrc/viz/CumulativekWofSolarinNorthernVirginia2009to2020/Dashboard1

Arrays Per Capita (2023)	
Alexandria	0.3%
Arlington	0.5%
City of Fairfax	0.9%
City of Falls Church	0.7%
City of Manassas	1.3%
City of Manassas Park	0.5%
Fairfax County	0.4%
Loudoun County	0.7%
Prince William County	0.4%

2019 Policy Renewable Energy: Benchmark Senior Living

- 143 bed/117 unit Continuum of Care Facility
- LEED Silver Certification
- RE Cost/Unit: Appx $90

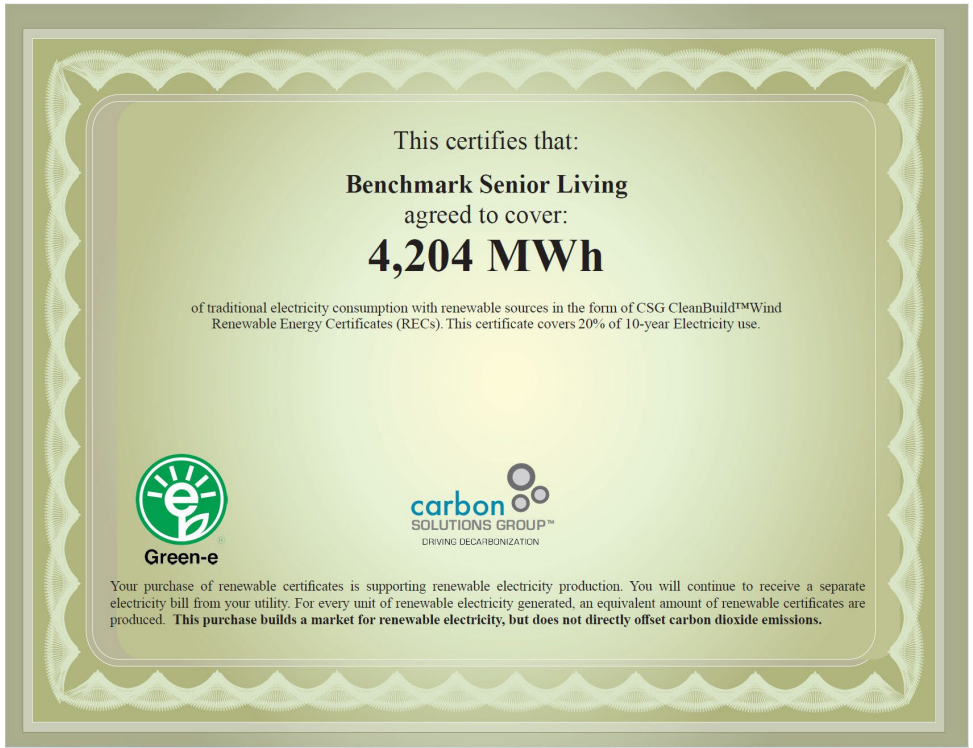
LEED Quote - Version 4.1 Tier II

12/4/23

Dear Laura Eubanks,

Thank you for requesting a quote from Carbon Solutions Group for your BSLA LEED project. We appreciate the opportunity to work with you. The attached quotes fulfill the v4.1 EA Credit: Renewable Energy based on annual electricity use of 1,087,043 kWh and total site energy use of 2,101,599 kWh. We will provide Green-e-certified RECs for US projects or Green-e-equivalent RECs for international projects from new facilities operational for a maximum of five years.

LEED v4.1 EA Credit: Renewable Energy, Tier II	Quantity (MWh)	Cost/MWh	Total Cost
1 EA Point - 10% of 10-year total site energy	2,102	$2.49	$5,230.56
2 EA Points - 20% of 10-year total site energy	4,204	$2.48	$10,419.08
3 EA Points - 30% of 10-year total site energy	6,305	$2.47	$15,563.09
4 EA Points - 40% of 10-year total site energy	8,407	$2.46	$20,667.53



This certifies that:

Benchmark Senior Living
agreed to cover:

4,204 MWh

of traditional electricity consumption with renewable sources in the form of CSG CleanBuild™Wind Renewable Energy Certificates (RECs). This certificate covers 20% of 10-year Electricity use.

Green-e

carbon SOLUTIONS GROUP™
DRIVING DECARBONIZATION

Your purchase of renewable certificates is supporting renewable electricity production. You will continue to receive a separate electricity bill from your utility. For every unit of renewable electricity generated, an equivalent amount of renewable certificates are produced. **This purchase builds a market for renewable electricity, but does not directly offset carbon dioxide emissions.**

2019 Policy Renewable Energy: Landmark Blocks L&M

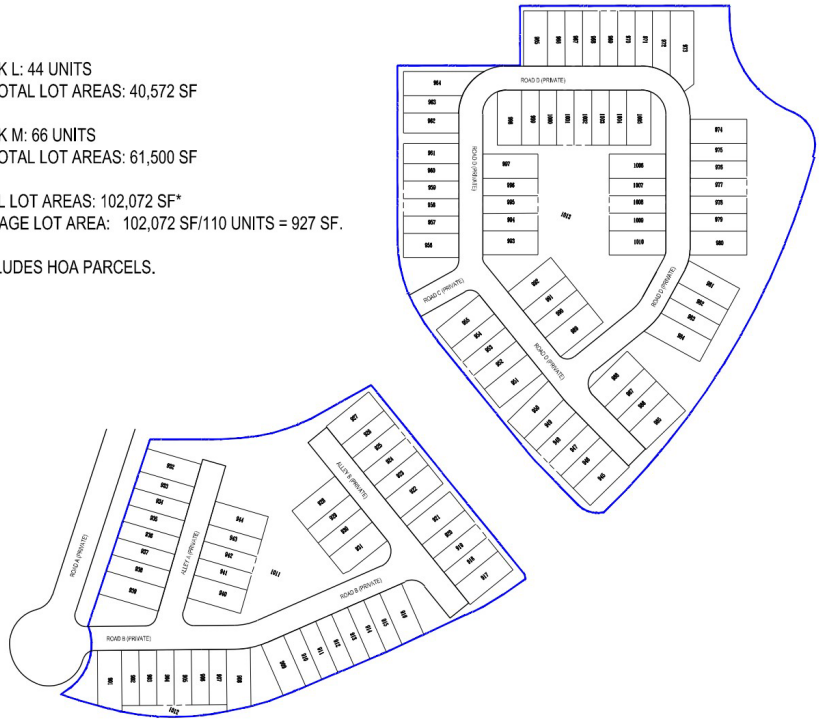
- 110 Townhomes by Van Metre Homes
- NGBS Silver Certification
- RE Cost/Unit: Appx $1100

BLOCK L: 44 UNITS
SUBTOTAL LOT AREAS: 40,572 SF

BLOCK M: 66 UNITS
SUBTOTAL LOT AREAS: 61,500 SF

TOTAL LOT AREAS: 102,072 SF*
AVERAGE LOT AREA: 102,072 SF/110 UNITS = 927 SF.

*EXCLUDES HOA PARCELS.



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February 22, 2024

Green Building Narrative for:

Townhouses at Landmark by Van Metre Homes

The following narrative is in support of the Completeness submission for the project referenced above.

General Approach

The 2020 National Green Building Standard (NGBS; ICC-700), verified at the Silver level with sufficient Performance Points achieved per the 2019 City of Alexandria Green Building Policy, is proposed for green building compliance.

Energy

- Dwelling-unit-specific energy models are being completed to ensure all involved building components contribute to achieving sufficient Performance Points for project energy use. These incorporate passive solar heating design elements by including in energy calculations all orientations, areas, and solar heat gain coefficients (SHGC's) of exterior fenestrations.
- Building envelopes will utilize light residential construction with 2x6 wood frame walls assembled with advanced framing techniques to save materials and enhance performance.
- 100% LED lighting will be used inside and on the exterior of all homes in this community.
- All equipment and appliances will be ENERGY STAR labeled or equivalent and included as installed in energy modeling to confirm adequate overall energy performance impacts.
- Renewable energy production is projected for a selection of homes to be net-zero-energy such that, relative to the total-site energy consumption of all the homes, 5% will be supplied by onsite solar photovoltaics. The NGBS scorecard provided is reflective of a home in projected worst-case configuration without any associated onsite generation. Energy report documentation is provided for the home projected to have the largest electricity demand and the home with the smallest projected electricity demand, both without any associated onsite generation.

Initial Recommendation: Renewable Energy

Renewable Energy Options	
1: Onsite - % of Annual Energy Offset	3%
2: Clean Energy Fund Contribution	90% of Option 1 Cost
3: Combination of Options 1 & 2	

Estimated Average Install Cost per Use Type	3% Energy Offset Target
Multi Unit Residential & Commercial Office	$22k (10 kW)
Single Unit Residential	$15k (8 kW)
Hotel	$155k (75 kW)
Retail	$16k (7.5 kW)
Restaurants	$23k (11 kW)

Assumptions for Cost Estimates:

- **System Cost Estimate: $1.80 – $2.34 per Watt**
- **Renewable Energy Cost/Unit: Appx $570**

Initial Recommendation: Electrification

Building Type	Current Frequent Flexibility Requests	Policy Update: Prohibited Combustion Uses
Multi Unit Residential	Ventilation (DOAS)	DOAS Untimed/Uncontrolled Amenities (Fireplaces or grills)
Single Unit Residential	Gas cooktops	Gas cooktops Fireplaces
Hotels	Ventilation (DOAS) Centralized Domestic Hot Water Commercial Laundry	DOAS Untimed/Uncontrolled Amenities (Fireplaces or grills)

- **Current Standard Conditions:**
  - Building is electric with flexibility for amenity uses (grills, fireplaces, etc.) with timers
  - Retail and generator uses permitted
- **Note: Update would permit commercial kitchens and emergency generators**

Recommendation Overview

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2. Certification

3. Affordable Housing Projects

4. Flexibility Requests

- Adaptive Reuse
- Interim Uses, Residential Projects with 4 or Fewer Units, or <25k GFA (Meet Achievable Prescriptive Measures)
- General Flexibility

5. Public Buildings

Certification

- Passive House Institute US (PHIUS) Certification
- Passive House Institute (PHI) Certification
- Living Building Challenge Certification
- U.S DOE Zero Energy Ready Home (Section 45L)
- U.S. DOE Zero Emissions Building

ZERO ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

LIVING BUILDING CHALLENGE

phius

Certified Passive House
Passive House Institute

	Single Family	Manufactured	Multifamily No Prevailing Wages	Multifamily Prevailing Wages Met
ENERGY STAR	$2,500	$2,500	$500	$2,500
ZERO ENERGY READY HOME	$5,000	$5,000	$1,000	$5,000

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Affordable Housing Projects

- **Virginia Housing Development Authority Low Income Housing Tax Credits OR City of Alexandria's Housing Opportunities Fund**
  - Baseline energy performance requirement: HERS Rating or Energy Star Compliance
  - Additional green certification: LEED, EarthCraft, National Green Building Standard or Enterprise

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Flexibility Requests

- **Flexibility for Adaptive Reuse**
  - The City strongly supports the conversion or "adaptive reuse" of existing buildings to achieve significant environmental benefit over the construction of new buildings.
  - Proposals including adaptive reuse of existing buildings may seek waivers or reductions of the required EUI and renewable energy targets of the Green Building Policy. Waivers will be approved by the Director of Planning & Zoning and the Climate Action Officer.
- **Interim Uses, Residential Projects with 4 or Fewer Units, or <25k GFA (Meet Achievable Prescriptive Measures)**
- **General Flexibility**

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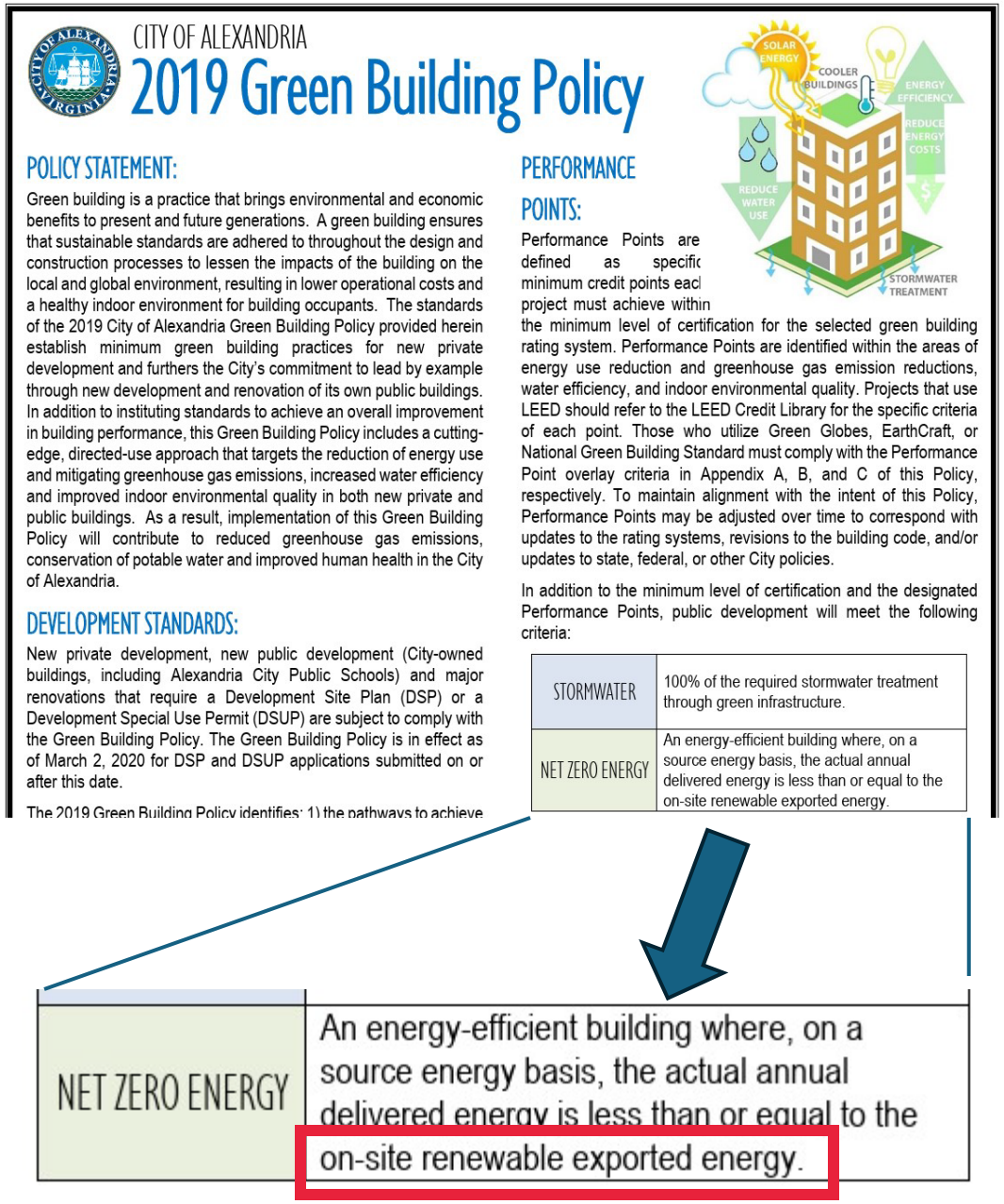
Public Buildings

- Utility Interconnection (>250 kW)
- Flexibility for Net Zero Energy through **Offsite Renewable Energy**



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Ongoing Education

Material & Design Forums

- Passive House Techniques/Challenges
- All Electric Buildings
- Heat Pumps
- Indoor Air Quality
- And Others

Next Steps

- **Advisory Group: April 4, 2025**
- **Public Comment Period (30 days): April 7 – May 7, 2025**
- **Staff Respond to Public Comments** – appx 2 weeks
- **City Council**
  - Legislative Meeting: June 10, 2025
  - Public Hearing: June 14, 2025

Next Steps: Public Comment

- **Public Comment Period (30 days): April 7 – May 7, 2025**
- www.AlexandriaVA.gov/GreenBuilding

Questions

Appendices

- Appendix 1: EUI Context
- Appendix 2: Construction Cost Estimates in Alexandria
- Appendix 3: Single Unit Residential Modeling Assumptions
- Appendix 4: Multi Unit Residential Modeling Assumptions
- Appendix 5: Hotel Modeling Assumptions
- Appendix 6: Retail Modeling Assumptions
- Appendix 7: Restaurant Modeling Assumptions
- Appendix 8: Additional Modeling Assumptions
- Appendix 9: Renewable Energy Estimates

Appendix 1: EUI Context

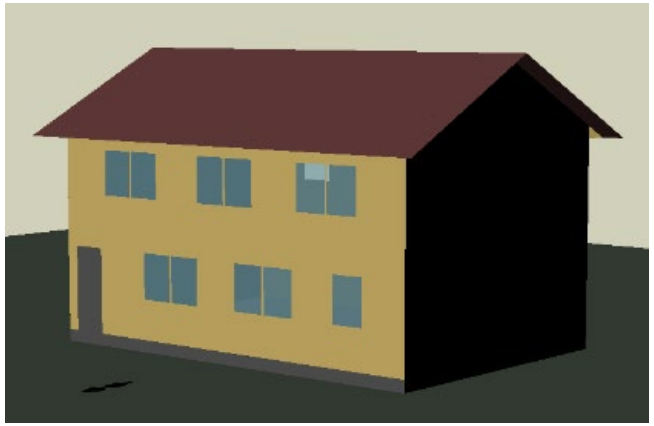
- **2024 Virginia Energy Conservation Code Baseline:** 42
- **PRGS:** 45 (Multi Unit Residential)
- **Samuel Madden**
  - North Bldg (Affordable): 29
  - South Bldg (Market Rate): 45
- **Robinson Terminal North:** 34 (Multi Unit Residential, Average for Both Buildings)
  - East Building & West Building

Appendix 2: Construction Cost Estimates in Alexandria

Building Type	Average Cost ($/SF)
Single Unit Residential	$420
Multi Unit Residential	$350
Hotel	$320
Commercial Office	$250
Restaurant	$600
Retail	$400

Appendix 3: Single Unit Residential Modeling Assumptions

- Overall, electrification incremental costs have a wide range depending on technology and property type. For simplicity, $5.50/sf was used as an estimate for the air source heat pump (ASHP) upgrade, and $0.95/sf was used for the heat pump water heater (HPWH) upgrades.
- Lighting Fixtures – RS Means
  - 10” diameter, 36W LED = 503.09
  - Fluorescent, interior, 32W and 40W = 242.11
  - Baseline is 40% LED
    - 503.09(0.4) + 242.11(0.6) = 346.50
    - 503.09-346.5 = $156.59 / 1680 = $0.09/sf

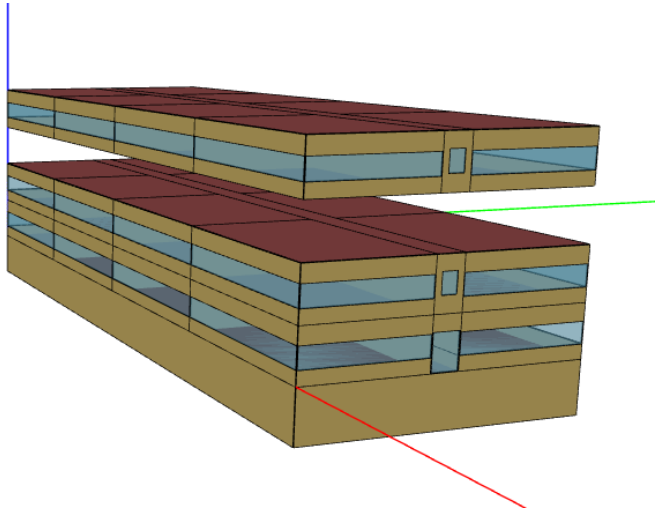


- Insulation and Heat pumps - NREL Energy Efficiency Tool - https://remdb.nrel.gov/
  - Insulation – Cost per square foot of wall area = $1.20 with 3,500 sq ft of wall and 1680 sq ft of floor area.
  - Heat pumps – basic heat pump cost is $3,400 per installation compared to $1,800 for basic furnace, so that is approximately $1.00 per square foot in incremental cost
- Wall sheathing – costs for OSB and R-12 polyiso board vary by less than $0.02
- Heat pumps for heating and domestica hot water – BuildingDecarbCostStudy.pdf
  - “Cost Study of the Building Decarbonization Code.” New Buildings Institute, Apr. 2022, newbuildings.org/wp-content/uploads/2022/04/BuildingDecarbCostStudy.pdf.

Appendix 4: Multi Unit Residential Modeling Assumptions

Overall, electrification incremental costs have a wide range depending on technology and property type. For simplicity, $5.50/sf was used as an estimate for the air source heat pump (ASHP) upgrade, and $0.95/sf was used for the heat pump water heater (HPWH) upgrades.

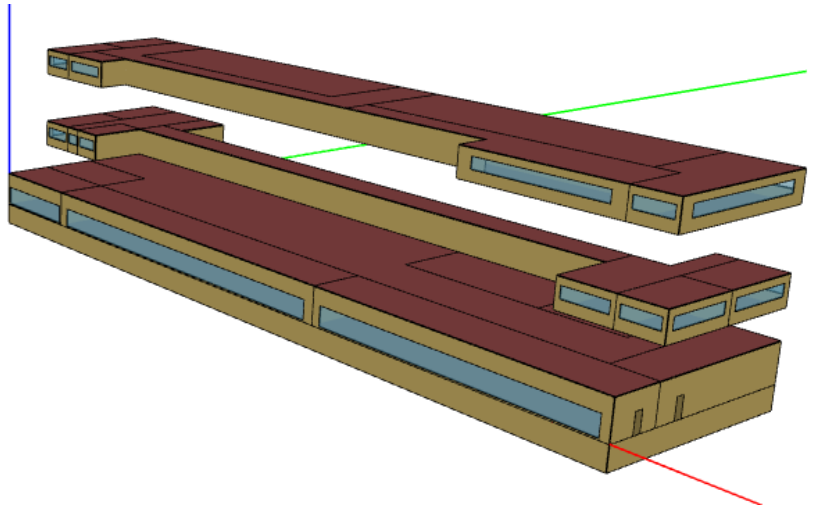
- Incremental Costs
  - Assume upgrades are made in all 24 Zones, representing each space type
    - 884.73 * 24 = 21233.52 (/ 33740 = $0.63 / sq ft)
- Microsoft PowerPoint - NEEA_Partner_Webinar-20170720
  - “Building Innovation - Multifamily.” New Buildings Institute, 16 Mar. 2016, newbuildings.org/wp-content/uploads/2017/08/NEEA_Partner_Webinar-20170720.pdf.
  - Incremental cost of installing cold climate heat pump in Boston was $6.80
- Guide to Energy-Efficient Windows
  - “Guide to Energy-Efficient Windows.” U.S. Department of Energy, Oct. 2010, www.energy.gov/sites/prod/files/guide_to_energy_efficient_windows.pdf.
- NREL Energy Efficiency - EE Measures Database: https://remdb.nrel.gov/
- NYSERDA’s Building of Excellence program data: https://www.nyserda.ny.gov/All-Programs/Multifamily-Buildings-of-Excellence/Winners/Resources
  - Incremental costs before incentives for all-electric HVAC range from $0.03 to $17.19 per sq ft, the median was $1.05 and the average was $3.56
  - Incremental costs before incentives for all-electric DHW systems range from even to $7.76 per sq ft, the median was $0.00 and the average was $0.95
- Motor and Belt Efficiencies
  - Baseline 5 HP motor = $368.64
  - Drip proof, premium efficiency 5 heat pump motor = $1,253.37
    - 1253-368= $884.73 / motor
- Elevator Improvement
  - Average cost for standard elevator = $97,500
  - Average cost of efficient elevator = $110,500
    - Difference of $13,000 = Incremental cost of $0.39/sf
- Daylight Sensors
  - 16 sensors, 4 per corridor on 4 floors @ ~$100 each
  - $1,600 total gives and incremental cost of $0.05/sf



Appendix 5: Hotel Modeling Assumptions

Overall, electrification incremental costs have a wide range depending on technology and property type. For simplicity, $5.50/sf was used as an estimate for the air source heat pump (ASHP) upgrade, and $0.95/sf was used for the heat pump water heater (HPWH) upgrades.

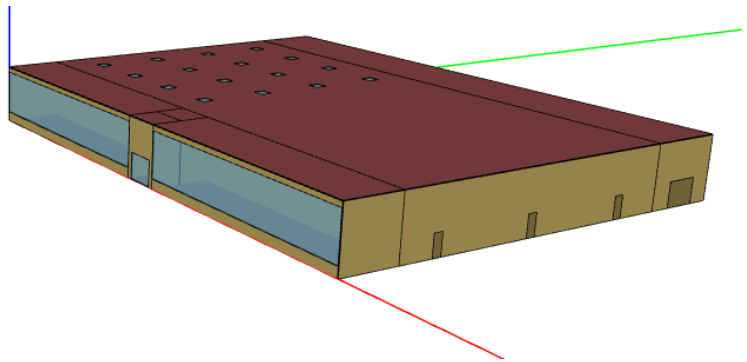
- Incremental Costs
  - Assume (1) chiller, (1) boiler, and (2) fan motors are upgraded
  - $884.73 * 2 = 1769.46 (/ 122120 = $0.01 / sq ft)
  - 51 * 2 = 102 (/ 122120 = $0.00 / sq ft)
- Heat pump for space heat - BuildingDecarbCostStudy.pdf
  - "Cost Study of the Building Decarbonization Code." New Buildings Institute, Apr. 2022, newbuildings.org/wp-content/uploads/2022/04/BuildingDecarbCostStudy.pdf.
- Insulation – RS Means
- Blanket insulation for walls R13, 11" wide
  - (2.5" thick R10.9 fiberglass = 4.30/sf)
- Motor and Belt Efficiencies
  - Baseline 5 HP motor = $368.64
  - Drip proof, premium efficiency 5 HP motor = $1,253.37
    - 1253-368= $884.73 / 122120 = $0.007244/sf
- Heating and Cooling Efficiencies
  - 3 T air cooled = $6,007.38
  - 3 T water cooled = $6,057.88
    - $50.50 per unit
- NYSERDA's Building of Excellence program data: https://www.nyserda.ny.gov/All-Programs/Multifamily-Buildings-of-Excellence/Winners/Resources
- Incremental costs before incentives for all-electric DHW systems range from even to $7.76 per sq ft, the median was $0.00 and the average was $0.95



Appendix 6: Retail Modeling Assumptions

Overall, electrification incremental costs have a wide range depending on technology and property type. For simplicity, $5.50/sf was used as an estimate for the air source heat pump (ASHP) upgrade, and $0.95/sf was used for the heat pump water heater (HPWH) upgrades.

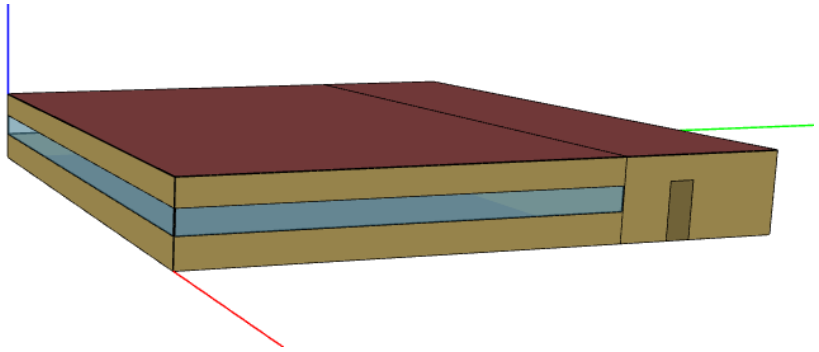
- Incremental Costs
  - Assume upgrades are made in all 4 Zones
    - 884.73 * 4 = 3538.92 (/ 24692 = $0.14 / sq ft)
    - 51 * 4 = 204 (/ 24692 = $0.01 / sq ft)
- Heat pump for space heat - BuildingDecarbCostStudy.pdf
  - "Cost Study of the Building Decarbonization Code." New Buildings Institute, Apr. 2022, newbuildings.org/wp-content/uploads/2022/04/BuildingDecarbCostStudy.pdf.
- RS Means
  - Blanket insulation for walls R13, 11" wide
    - (2.5" thick R10.9 fiberglass = 4.30/sq ft)
  - Occupancy sensor, passive infrared = 177.62 ea
  - Motor and Belt Efficiencies
    - Baseline 5 HP motor = $368.64
    - Drip proof, premium efficiency 5 HP motor = $1,253.37
      - 1253-368= $884.73 / 24692 = $0.358/sf
  - Heating and Cooling Efficiencies
    - 3 T air cooled = $6,007.38
    - 3 T water cooled = $6,057.88
      - $50.50 per unit
- DHW Electrification NYSERDA's Building of Excellence program data: https://www.nyserda.ny.gov/All-Programs/Multifamily-Buildings-of-Excellence/Winners/Resources
  - Incremental costs before incentives for all-electric DHW systems range from even to $7.76 per sq ft, the median was $0.00 and the average was $0.95



Appendix 7: Restaurant Modeling Assumptions

Overall, electrification incremental costs have a wide range depending on technology and property type. For simplicity, $5.50/sf was used as an estimate for the air source heat pump (ASHP) upgrade, and $0.95/sf was used for the heat pump water heater (HPWH) upgrades.

- Incremental Costs
  - Assume upgrades are made in both the Kitchen and Dining Zones
    - 884.73 * 2 = 1769.46 (/ 5502 = $0.32 / sq ft)
    - 51 * 2 = 102 (/ 5502 = $0.02 / sq ft)
- RS Means
  - Blanket insulation for walls R13, 11" wide
    - (2.5" thick R10.9 fiberglass = 4.30/sf)
  - Daylight sensors, manual control = $278 per sensor
  - Motor and Belt Efficiencies
    - Baseline 5 HP motor = $368.64
    - Drip proof, premium efficiency 5 HP motor = $1,253.37
      - 1253-368= $884.73 / 5502 = $0.16/sf
  - Hot water boiler
    - 85 MBH (84%) = 3814.63
    - 94 MBH (95%) = 6052.78
      - 2238.15 / 5502 = $0.4067
  - Heating and Cooling Efficiencies
    - 3 T air cooled = $6,007.38
    - 3 T water cooled = $6,057.88
      - $50.50 per unit
- NYSERDA's Building of Excellence program data: https://www.nyserda.ny.gov/All-Programs/Multifamily-Buildings-of-Excellence/Winners/Resources
  - Incremental costs before incentives for all-electric HVAC range from $0.03 to $17.19 per sq ft, the median was $1.05 and the average was $3.56
- Incremental costs before incentives for all-electric DHW systems range from even to $7.76 per sq ft, the median was $0.00 and the average was $0.95



Appendix 8: Additional Modeling Assumptions

Type Index	1	2	3	4	5
Building Type	Single Unit Residential	Multi Unit Residential	Hotel	Retail	Restaurants
Baseline Code	IECC 2021/ASHRAE 90.1 2019				
Vintage	New Construction				
Weather File (CZ4)	Washington-DC-Reagan-AP VA USA TMY3				
Number of floors (Above Grade)	2	4	4	1	1
Spaces	3 Bedrooms, 2 Bathrooms	39 Units, 1 Office	183 Guest rooms, Retail, Dinning, Office	Retail Space, Point of Sale	Kitchen, Dinning
Total Building Sq. Ft.	1,680	33,740	122,120	24,692	5,502
HVAC	Central AC and Gas-fired furnace	Split AC (with gas heating)	VAV with Reheat plus DOAS with ERV in guest rooms (Includes Economizer)	Unitary AC with gas heating coil	Unitary AC with gas heating coil
Hot water (DHW)	Storage Water Heater, Gas	Electric Water Heater	Storage Water Heater, Gas	Storage Water Heater, Gas	Storage Water Heater, Gas
Heating Efficiency (AFUE)	0.8	0.8	0.8	0.8	0.8
Cooling System Efficiency (SEER/EER/COP)	SEER 14	SEER 14	SEER 14	SEER 14	SEER 14
Heating Set Point (F)	70	70	70	70	70
Cooling Set Point (F)	73	73	73	73	73
Wall Construction (exterior)	Insulated Wood Framed(R-20)	Insulated Wood Framed(R-20)	Insulated Metal Building Wall (R-13.89)	Insulated Exterior Mass Wall (R-9.62)	Insulated Steel Framed (R-15.63)
Roof Construction	Insulated Attic (R-60)	IEAD Roof (R-31.25)	IEAD Roof (R-31.25)	IEAD Roof (R-31.25)	IEAD Roof (R-31.25)
Foundation Construction	Unconditioned Basement (Whole Wall- R10)	Unconditioned Basement (Whole Wall- R10)	Unconditioned Basement	Slab on Grade (F-Factor 0.52 Btu/hr.ft.R)	Slab on Grade (F-Factor 0.52 Btu/hr.ft.R)
Model Window to wall ratio	20%	40%	27%	20%	18%
Window (U-Factor / SHGC)	0.3U / 0.4 SHGC	0.36U / 0.36 SHGC	0.36U / 0.36 SHGC	0.36U / 0.36 SHGC	0.36U / 0.36 SHGC

Appendix 9: Renewable Energy Estimates

Building Type	Offset Target	System Size DC (kW)	System Area (sq ft)	Total Available Roof Space (sq ft)	Roof area available for HVAC (sq ft)	Annual Electricity Production (kWh)	Estimated Module Count	Estimated Install Cost (Low: $1.8/W)	Estimated Install Cost (High: $2.34/W)
Single Unit Residential	3%	0.4	21	469	448	530	2	$720	$936
Single Unit Residential (full system)	61%	8.0	411	469	58	10,576	24	$14,400	$18,720
Multi Unit Residential	3%	10.0	513	8,435	7,922	13,321	30	$18,000	$23,400
Hotel	3%	75.0	3,845	13,790	9,945	99,911	218	$135,000	$175,500
Retail	3%	7.5	385	12,345	11,960	9,991	22	$13,500	$17,550
Restaurant	3%	11.0	564	5,500	4,936	14,654	32	$19,800	$25,740