NYStretch Energy Code–2020

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The NYStretch Energy Code–2020 (NYStretch) is a voluntary, readily adoptable energy code that calls for higher efficiency standards in new and renovated building construction projects.

When buildings are built above and beyond the minimum code requirements of the 2020 Energy Conservation Construction Code of New York State (ECCCNYS), they can make meaningful strides in mitigating climate change. The efforts pay off—buildings that are built to NYStretch requirements save **10–12%** in energy costs over those built to the 2020 ECCCNYS. Those energy cost savings will pay back the additional cost of construction in less than 10 years.

NYStretch Energy Code–2020

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What are the benefits?

- **Save money and energy:** Use less energy and reduce living and operational costs for your constituents with lower utility bills and better building envelopes.
- **Help the environment:** Reduce your greenhouse gas emissions and reliance on fossil fuels.
- **Boost the local economy:** Develop your existing workforce, build expertise in newer technologies, and create more green jobs.
- **Improve community growth:** Increase community attractiveness and property values as more home and business owners are looking for green and energy-efficient buildings.
- **Increase property values:** Encourage the use of NYStretch locally so future occupants (renters, tenants, and owners) of new and renovated buildings that meet this code will benefit from the long-term energy and cost savings.

Where does NYStretch go beyond the 2020 ECCCNYS?

- **Building envelope:** Improved insulation and window performance, air barrier commissioning, air leakage testing, and mandatory mechanical ventilation
- **Lighting:** Reduced interior and exterior lighting power and lighting controls
- **Electrical:** Whole-building energy monitoring
- **Compatibility:** Renewable and electric vehicle readiness

What resources are available?

- **Code Manual:** NYSERDA provides a single-volume code manual that aids in consistent interpretation among code officials and offers reliable standards.
- **Template Legislation:** A NYStretch Adoption Guide with a resolution/legislation template is available to help facilitate local adoption of NYStretch.
- **NYStretch Training for Code Officials, Architects, and Builders**
- **Updated RESCheck™ and COMCheck™ tools**
- **FAQs Document**

For assistance with adoption, contact NYSERDA's outreach coordinators at nyserda.ny.gov/cec-coordinators.

Learn more and access resources at nyserda.ny.gov/stretchenergy2020.

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2020 NYStretch Energy Code Commercial Cost Effectiveness Analysis

Final Report | Report Number 19-34 | July 2019

NEW YORK
STATE OF
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NYSERDA

NYSERDA's Promise to New Yorkers:

NYSERDA provides resources, expertise, and objective information so New Yorkers can make confident, informed energy decisions.

Mission Statement:

Advance innovative energy solutions in ways that improve New York's economy and environment.

Vision Statement:

Serve as a catalyst – advancing energy innovation, technology, and investment; transforming New York's economy; and empowering people to choose clean and efficient energy as part of their everyday lives.

2020 NYStretch Energy Code Commercial Cost Effectiveness Analysis

Final Report

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Notice

Abstract

This report summarizes the energy savings and cost-effectiveness analysis of the commercial provisions of the 2020 NYStretch Energy Code of New York State. For this study, cost effectiveness means comparing the annual energy cost and first costs of complying with NYStretch versus the commercial provisions of the 2020 ECCC NYS to determine the incremental cost of design and construction as compared to the annual energy cost savings. NYStretch includes overlays of both the 2018 IECC and ASHRAE 90.1-2016. This analysis is limited to the overlay of ASHRAE 90.1-2016. The report includes the methodology used in the analysis, assumptions, and results at the applicable climate design zones for New York State.

Keywords

Energy code, stretch energy code, cost effectiveness, NYSERDA

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Definitions

Climate Zones: The three climate zones of New York State: 4A, 5A, and 6A. For purposes of these analyses, the weather files used are New York City (CZ 4A), Buffalo (CZ 5A), and Watertown (CZ 6A).

Prototypes: Prototypes developed by the Department of Energy for modeling purposes for the following building types: Large Office, Stand-alone Retail, Secondary School, Large Hotel, Full-Service Restaurant, Outpatient Healthcare, Warehouse, 10-Story High-Rise Apartment, and 20-Story High-Rise Apartment. The 10- and 20-Story High-Rise Apartment prototypes were developed by PNNL based on New York City building permit data for multifamily buildings for use in the NYStretch Code analysis.

2020 Energy Conservation Construction Code of New York State (2020 ECCC NYS): An energy code based on the *2018 International Energy Conservation Code*, published by the International Code Council and subsequently modified by New York State.

Summary

With guidance from a 25-member advisory group composed of public and private stakeholders, the New York State Energy Research and Development Authority (NYSERDA) developed the NYStretch Energy Code-2020 (draft dated January 2019) (NYStretch) as a voluntary, locally adoptable stretch energy code. It is intended that NYStretch will overlay the 2020 Energy Conservation Construction Code of New York State (2020 ECCC NYS) resulting in an energy code that is roughly 7% more efficient than the commercial provisions of ASHRAE 90.1-2016.

To assist communities in adopting NYStretch, NYSERDA contracted Vidaris to provide a cost-effectiveness analysis of the commercial provisions of NYStretch. For this study, cost effectiveness means comparing the annual energy cost and first costs of complying with NYStretch versus the 2020 ECCC NYS to determine the incremental cost of design and construction as compared to the annual energy cost savings. NYStretch includes overlays of both the 2018 IECC and ASHRAE 90.1-2016. The analysis presented in this report is limited to the overlay of ASHRAE 90.1-2016.

The NYStretch overlay for 90.1-2016 includes a new requirement for choosing an additional set of increased efficiency requirements. For this analysis, the option for reduced lighting power was included for all buildings. A summary of results is presented in Tables ES-1 through ES-6.

The differences between ASHRAE 90.1-2016 and NYStretch vary by building type and climate zone with site energy savings ranging from 2.3 to 14%, source energy savings ranging from 3.0 to 15.3%, and energy cost savings ranging from 3.0 to 16.4%. Incremental costs range from \$0.28 to \$5.59 per square foot and simple payback ranges from 3.0 to 18.4 years.

In aggregate, this analysis indicates that versus ASHRAE 90.1-2016, the NYStretch yields savings statewide for each building in each climate zone with site energy savings of 5.4%, source energy savings of 6.7%, and energy cost savings of 7.1%. These savings are achieved with an average additional cost of \$1.14 per square foot with a 10.5-year simple payback.

Table ES-1. Aggregate Summary of Results

Prototype	Construction Weight [%]	Site Energy [kBtu/ft2/yr]			Source Energy [kBtu/ft2/yr]			Energy Cost [$/ft2]			Incremental First Cost	Simple Payback
		90.1-2016	NYStretch	% Savings	90.1-2016	NYStretch	% Savings	90.1-2016	NYStretch	% Savings	$/ft2	years
Large Office	8.8%	60.5	58.5	3.4%	179.5	172.4	4.0%	$ 2.26	$ 2.16	4.1%	$ 0.31	3.27
Standalone Retail	14.6%	46.2	40.9	11.6%	130.7	111.2	14.9%	$ 1.62	$ 1.36	15.8%	$ 3.39	13.25
Secondary School	9.8%	37.4	34.3	8.3%	102.7	94.3	8.2%	$ 1.26	$ 1.16	8.1%	$ 0.55	5.36
Large Hotel	7.8%	83.1	77.4	6.9%	185.6	170.4	8.2%	$ 2.13	$ 1.94	8.7%	$ 1.64	8.84
Full-Service Restaurant	0.5%	414.9	378.2	8.8%	741.0	659.6	11.0%	$ 7.65	$ 6.72	12.1%	$ 4.29	4.60
Outpatient Healthcare	5.4%	113.0	108.2	4.3%	313.2	295.2	5.7%	$ 3.86	$ 3.62	6.1%	$ 2.85	12.03
Warehouse	7.5%	21.5	18.6	13.7%	41.8	36.3	13.2%	$ 0.45	$ 0.39	12.9%	$ 0.77	13.26
10-Story High-Rise Apartment	21.9%	48.4	47.1	2.8%	96.0	93.1	3.0%	$ 1.04	$ 1.01	3.0%	$ 0.43	11.45
20-Story High-Rise Apartment	23.7%	48.5	47.4	2.4%	106.4	103.2	3.1%	$ 1.21	$ 1.17	3.4%	$ 0.47	13.50
Weighted Average	**100.0%**	**54.1**	**51.2**	**5.4%**	**129.4**	**120.7**	**6.7%**	**$ 1.52**	**$ 1.41**	**7.1%**	**$ 1.14**	**10.50**

Table ES-2. Summary of Results for Climate Zone 4A

Prototype	Construction Weight	Site Energy [kBtu/ft2/yr]			Source Energy [kBtu/ft2/yr]			Energy Cost [$/ft2]			Inc. First Cost	Simple Payback
		90.1-2016	NYStretch	% Savings	90.1-2016	NYStretch	% Savings	90.1-2016	NYStretch	% Savings	$/ft2	years
Large Office	7.5%	60.0	58.0	3.4%	179.3	172.2	3.9%	$ 2.26	$ 2.16	4.1%	$ 0.28	3.1
Standalone Retail	4.9%	44.5	39.1	12.1%	130.1	111.0	14.7%	$ 1.63	$ 1.38	15.4%	$ 3.89	15.6
Secondary School	5.0%	37.0	33.9	8.5%	104.0	95.6	8.1%	$ 1.29	$ 1.18	8.0%	$ 0.61	6.0
Large Hotel	3.5%	81.7	75.9	7.1%	187.4	172.2	8.1%	$ 2.17	$ 1.99	8.5%	$ 1.77	9.6
Full-Service Restaurant	0.1%	380.3	341.6	10.2%	717.1	629.0	12.3%	$ 7.62	$ 6.60	13.3%	$ 5.59	5.5
Outpatient Healthcare	2.0%	111.7	106.7	4.5%	314.6	296.5	5.8%	$ 3.90	$ 3.66	6.2%	$ 3.10	12.9
Warehouse	2.5%	17.7	15.2	14.0%	37.4	32.4	13.5%	$ 0.42	$ 0.36	13.3%	$ 1.03	18.4
10-Story High-Rise Apartment	21.9%	48.4	47.1	2.8%	96.0	93.1	3.0%	$ 1.04	$ 1.01	3.0%	$ 0.43	13.5
20-Story High-Rise Apartment	23.5%	48.4	47.3	2.4%	106.4	103.1	3.1%	$ 1.21	$ 1.17	3.4%	$ 0.47	11.5
Weighted Average (CLIMATE ZONE 4A)	**70.9%**	**51.4**	**49.2**	**4.2%**	**120.6**	**114.5**	**5.1%**	**$ 1.41**	**$ 1.33**	**5.5%**	**$ 0.85**	**11.0**

Table ES-3. Summary of Results for Climate Zone 5A

Prototype	Construction Weight	Site Energy [kBtu/ft2/yr] 90.1-2016	Site Energy NYStretch	Site Energy % Savings	Source Energy [kBtu/ft2/yr] 90.1-2016	Source Energy NYStretch	Source Energy % Savings	Energy Cost 90.1-2016	Energy Cost NYStretch	Energy Cost % Savings	Inc. First Cost $/ft2	Simple Payback years
Large Office	1.0%	63.4	61.2	3.4%	180.6	173.1	4.1%	$ 2.24	$ 2.15	4.3%	$ 0.47	4.8
Standalone Retail	7.1%	46.5	41.2	11.6%	129.9	110.0	15.3%	$ 1.60	$ 1.34	16.4%	$ 3.08	11.7
Secondary School	3.7%	37.7	34.6	8.1%	101.2	92.9	8.2%	$ 1.24	$ 1.13	8.3%	$ 0.43	4.3
Large Hotel	2.5%	83.3	77.7	6.8%	183.4	168.1	8.4%	$ 2.09	$ 1.90	9.0%	$ 1.55	8.3
Full-Service Restaurant	0.3%	418.0	381.9	8.6%	741.4	661.8	10.7%	$ 7.63	$ 6.72	11.9%	$ 3.90	4.3
Outpatient Healthcare	2.4%	112.9	108.2	4.2%	310.6	292.8	5.7%	$ 3.82	$ 3.58	6.2%	$ 2.70	11.5
Warehouse	3.8%	23.9	20.6	13.8%	43.9	38.2	13.0%	$ 0.46	$ 0.40	12.6%	$ 0.60	10.4
10-Story High-Rise Apartment	0.0%	54.5	52.5	3.6%	99.8	96.3	3.5%	$ 1.04	$ 1.01	3.5%	$ 0.38	10.5
20-Story High-Rise Apartment	0.1%	54.4	53.2	2.3%	112.2	103.1	8.1%	$ 1.24	$ 1.17	6.0%	$ 0.43	10.3
Weighted Average (CLIMATE ZONE 5A)	**20.9%**	**59.1**	**54.2**	**8.2%**	**147.5**	**132.8**	**10.0%**	**$ 1.76**	**$ 1.57**	**10.5%**	**$ 1.81**	**9.8**

Table ES-4. Summary of Results for Climate Zone 6A

Prototype	Construction Weight	Site Energy [kBtu/ft2/yr]			Source Energy [kBtu/ft2/yr]			Energy Cost			Inc. First Cost	Simple Payback
		90.1-2016	NYStretch*	% Savings	90.1-2016	NYStretch*	% Savings	90.1-2016	NYStretch*	% Savings	$/ft2	years
Large Office	0.3%	64.4	62.1	3.5%	181.7	174.1	4.2%	$ 2.25	$ 2.15	4.4%	$ 0.30	3.0
Standalone Retail	2.6%	48.6	43.4	10.7%	133.9	115.0	14.1%	$ 1.65	$ 1.40	15.1%	$ 3.27	13.2
Secondary School	1.1%	38.2	35.0	8.3%	101.8	93.3	8.3%	$ 1.24	$ 1.14	8.3%	$ 0.65	6.3
Large Hotel	1.8%	85.4	79.9	6.5%	185.1	170.0	8.2%	$ 2.09	$ 1.91	8.8%	$ 1.49	8.1
Full-Service Restaurant	0.1%	439.9	403.5	8.3%	763.7	683.6	10.5%	$ 7.76	$ 6.85	11.7%	$ 4.18	4.6
Outpatient Healthcare	1.0%	116.0	111.3	4.0%	316.4	298.6	5.6%	$ 3.88	$ 3.64	6.1%	$ 2.71	11.5
Warehouse	1.2%	22.0	19.1	13.2%	44.2	38.3	13.4%	$ 0.48	$ 0.42	13.5%	$ 0.75	11.6
10-Story High-Rise Apartment	0.0%	54.5	52.6	3.6%	99.8	96.2	3.5%	$ 1.04	$ 1.01	3.5%	$ 0.42	11.6
20-Story High-Rise Apartment	0.1%	55.1	53.3	3.3%	113.0	108.7	3.8%	$ 1.25	$ 1.20	4.0%	$ 0.40	8.1
Weighted Average (CLIMATE ZONE 6A)	**8.2%**	**65.0**	**60.2**	**7.4%**	**159.1**	**144.3**	**9.3%**	**$ 1.88**	**$ 1.70**	**9.9%**	**$ 1.96**	**10.5**

Life-cycle cost savings were calculated based on a 10- and 30-year period. The results for these analyses are in Tables ES-5 and ES- 6. Over the 10-year period, the present value of the energy savings are more than the incremental costs of $0.85/sq.ft., $1.81/ sq.ft., and $1.96/ sq.ft. for climate zones 4A, 5A, and 6A, respectively. Net energy savings over 10 years are $0.18/sf in aggregate statewide.

Over the 30-year period, the net present value of the energy savings also accounts for replacement and residual value, and yields savings of $0.52/sq.ft., $1.57/ sq.ft., and $1.38/ sq.ft. for climate zones 4A, 5A, and 6A, respectively. Net energy savings over 30 years are $0.81/sf in aggregate statewide.

Table ES-5. Summary of 10-year Life-Cycle Cost Analysis

Prototype	Construction Weight [%]	Annual Energy Cost		10 Year Life Cycle Energy Cost			Incremental First Cost	Residual Value at 10yrs	Net Savings over 10 Years	
		90.1-2016	NYStretch	90.1-2016	NYStretch	Savings			Total	$/sf
4A Totals	70.9%	$ 253,616	$ 242,215	$ 2,365,240	$ 2,259,659	$ 105,581	$ 83,955	$ 25,162	$ 46,788	$ 0.11
5A Totals	20.9%	$ 167,142	$ 154,337	$ 1,556,783	$ 1,438,147	$ 118,636	$ 1,558,123	$ 24,902	$ 781,498.62	$ 0.37
6A Totals	8.2%	$ 170,912	$ 157,469	$ 1,595,414	$ 1,470,838	$ 124,576	$ 1,252,578	$ 30,782	$ 617,704	$ 0.30
AGGREGATE VALUES	100.0%	$ 228,761	216,899	$ 2,133,146	$ 2,023,280	$ 109,867	$ 88,326	$ 25,568	$ 47,109	$ 0.18

Table ES-6. Summary of 30-year Life-Cycle Cost Analysis

Prototype	Construction Weights	CZ	First Cost	Replacement Costs	Maintenance	Residual Value	Energy Cost Savings	30 Year Net Present Value of Savings	
								$	$/sf
4A Totals	70.9%	4A	$83,955	$40,133	$0	$1,671	$260,157	$137,741	$0.52
5A Totals	20.9%	5A	$94,765	$41,112	$0	($107)	$292,323	$156,339	$1.57
6A Totals	8.2%	6A	$109,714	$50,027	$0	$1,211	$305,970	$147,441	$1.38
AGGREGATE VALUES			**$88,326**	**$41,149**	**$0**	**$1,262**	**$270,636**	**$142,423**	**$0.81**

1 Cost Effectiveness Study

1.1 Background

The PNNL report *Final Energy Savings Analysis of the Proposed NYStretch-Energy Code 2018*, February 2019 (*PNNL-ACT-10073 Rev. 1*) presents the energy and energy cost savings for nine prototype buildings, which represent more than 73% of the projected new construction by floor-space accounted for in the full suite of 16 DOE prototypes. *PNNL-ACT-10073 Rev. 1* identifies 15 Energy Efficiency Measures (EEMS) required by the NYStretch. The PNNL analysis and report compare the provisions of the NYStretch against ASHRAE Standard 90.1-2013 to determine savings.

To determine the cost effectiveness of NYStretch relative to ASHRAE 90.1-2016, Vidaris quantified the difference in annual energy performance between NYStretch and ASHRAE 90.1-2016 using Energy Plus models for nine prototype buildings in three New York cities representing the climates zones shown in Table 1.

Table 1. Prototypes and New York Climate Zones

<table>
<tr><th>DOE Prototype</th><th>Climate Zone: City
(Weather file)</th></tr>
<tr><td>Large Office Building</td><td rowspan="9">CZ 4A: New York
(USA_NY_New.York-J.F.Kennedy.Intl.AP.744860_TMY3.epw)

CZ 5A: Buffalo
(USA_NY_Buffalo-Greater.Buffalo.Intl.AP.725280_TMY3.epw)

CZ 6A: Watertown
(USA_NY_Watertown.AP.726227_TMY3.epw)</td></tr>
<tr><td>Stand-alone Retail</td></tr>
<tr><td>Secondary School</td></tr>
<tr><td>Large Hotel</td></tr>
<tr><td>Full-service Restaurant</td></tr>
<tr><td>Outpatient Healthcare</td></tr>
<tr><td>Warehouse</td></tr>
<tr><td>10-Story High-rise Apartment</td></tr>
<tr><td>20-Story High-rise Apartment</td></tr>
</table>

The cities selected for CZs 4A and 5A are the same cities used by PNNL in its most recent national analysis of ASHRAE 90.1-2016: Energy Savings Analysis: ANSI/ASHRAE/IES Standard 90.1-2016, October 2017 (PNNL 2017); namely, New York City and Buffalo, NY.

Changes to the climate zone map in ASHRAE 90.1-2016 reclassified some cities in CZ 6A to CZ 5A, including Buffalo, NY. Consequently, for CZ 5A Buffalo supplanted Albany, which had been used in previous State-specific analyses for CZ 5A. Moving Buffalo meant selecting another city for CZ 6A as PNNL 2017 used Rochester, MN to represent CZ 6A in the national analysis. Based on consultation with NYSERDA, Watertown, NY was selected to represent CZ 6A for this analysis. Weather files were downloaded directly from the DOE's EERE website for this analysis.[1]

Note that the cities used for this analysis are the same cities used in support of the New York State Department of State rulemaking process for adopting the 2020 ECCC NYS.

1.2 Energy Analysis Results

PNNL developed the EnergyPlus prototype models specifically for the NYStretch analysis done for NYSERDA. NYSERDA provided PNNL's nine prototype building types to be used by Vidaris in this analysis. Vidaris started with the NYStretch models and modified them as necessary to create the ASHRAE 90.1-2016 baseline models for each prototype appropriate to each climate zone. A list of the differences between the NYStretch and 90.1-2016 models is provided in Appendix A.

To determine the statewide savings that the NYStretch offers beyond ASHREA 90.1-2016, weighting factors for each result were applied to determine the aggregate savings. The weighting factors used in this analysis were developed by PNNL based on construction volume by building type and climate zone and are presented in *PNNL-ACT-10073 Rev. 1.*

Vidaris used the same energy prices used for the 2020 ECCC NYS cost-effectiveness and are shown in Table 4. These rates are based on commercial energy price information available from the U.S. Energy Information Administration (EIA) for the 2017 calendar year.[2]

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1 www.energycodes.gov/development/commercial/90.1_models

2 The year 2017 was the most current year for which complete data for electricity and natural gas rates and heat content for natural gas was available as of January 2019 when the 2020 NYS ECC cost-effectiveness analysis was started.

Vidaris used EnergyPlus v8.0.0 and generated the results for each prototype under both codes and for each climate zone. Based on the prototype buildings, 2020 NYStretch has been shown to be 7.1% more efficient than ASHRAE 90.1-2016 on a cost per square foot basis. With respect to site and source energy, NYStretch yields savings of 5.4% and 6.7%, respectively. The aggregated results by code and by climate zone are presented in Table 2 (See Appendix B for more detailed results by building type.)

Table 2. Aggregated Differences in Annual Energy Use and Annual Energy Cost between ASHRAE 90.1-2016 and 2020 NYStretch

		Total (kBtu)		NYS Energy Cost		Energy Cost	EUI (kBtu/sf)		ECI	Weighting Factors
		Site	Source	Electricity	Gas	Total	Site	Source	$/sf	
Aggregate Values	ASHRAE 90.1-2016	65,273,116	156,127,787	$ 1,655,039	$ 179,661	$ 1,834,701	54.2	129.6	$ 1.52	
	NYStretch	61,721,089	145,682,605	$ 1,528,231	$ 175,543	$ 1,703,773	51.2	120.9	$ 1.41	
	Savings	**3,552,026**	**10,445,183**	**$ 126,809**	**$ 4,118**	**$ 130,927**	**2.9**	**8.7**	**$ 0.11**	
		5.44%	**6.69%**	**7.66%**	**2.29%**	**7.14%**	**5.44%**	**6.69%**	**7.14%**	
Savings by CZ	4A	2,618,314	7,452,920	$ 88,826	$ 3,752	$ 92,578	2.2	6.2	$ 0.0768	70.8%
	5A	5,815,539	17,673,722	$ 218,408	$ 5,081	$ 223,490	4.8	14.7	$ 0.1855	21.0%
	6A	5,828,422	17,805,195	$ 220,633	$ 4,824	$ 225,457	4.8	14.8	$ 0.1871	8.2%
	Combined	**3,552,026**	**10,445,183**	**$ 126,809**	**$ 4,118**	**$ 130,927**	**2.9**	**8.7**	**$ 0.11**	100.0%

1.3 Cost-Effectiveness Analysis

As part of its analysis, Vidaris included statewide-average utility rates available from the EIA. Additionally, Vidaris modified the cost data to reflect city-specific cost factors from RS Means. For consistency, the EIA rate data and RS Means cost factors were selected from 2017, the most recent year for which complete annual average utility data was available from the EIA.

Cost-effectiveness analysis was not included in *PNNL-ACT-10073 Rev. 1*. Consequently, Vidaris developed incremental cost data based predominantly on the following sources:

- 2018 Building Construction Costs with RSMeans Data (RSMeans 2018),
- *2018 Mechanical Costs with RSMeans Data (RSMeans 2018),* and
- cost data used by PNNL in their national cost-effectiveness analysis of ASHRAE 90.1-2016

Where these sources were insufficient, Vidaris obtained estimates based on data from the internet (e.g., electric vehicle charging stations), or its own experience supplemented as needed with conversations with other practitioners (e.g., infiltration testing, lighting).

The life of energy efficiency measures was determined from NYSERDA's *Whole Building Incentive Calculator* and are summarized in Table 3. Detailed cost estimates by building type and climate zone are included in Appendix D.

Table 3. Measure Life Assumptions

Measure Description	Life (years)
Energy Star Kitchen Equipment	7
Lighting System	15
Motor/drives	15
Gas fired DHW	15
HVAC- Air handlers	15
Building Shell/Glazing-Windows	20
HVAC - Electric chillers	20
HVAC - Boilers	20
Building Shell/Roof, Wall, Slab	30

Regarding the life-cycle costing, PNNL's latest analysis of ASHRAE 90.1-2016 is based upon Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis published by the National Institute of Standards and Technology (NIST). NIST data for 2017 was selected to be consistent with the other cost data being used. NIST identifies the real discount rate for non-energy related expenses (i.e., maintenance and replacement costs) and delineates Uniform Present Value Factors (UPV Factors) to be used for life-cycle periods from one to 30 years, by energy type, for Census Region 1 (which includes New York State) and based on a real DOE discount rate of 3.0%. The UPV Factor is multiplied by the annual energy cost to determine the life-cycle value of energy cost over the life-cycle period. The city cost factors, utility cost data, and life-cycle parameters used in the analysis are presented in Table 4.

Table 4. Life-Cycle Cost Analysis Parameters

		Value		Source
NYS Energy - 2017	Electricity	0.1475	$/kWh	U.S. Energy Information Administration
	Natural Gas	6.87	$/1000 cf	
	Heat Content of Natural Gas	1,032	Btu/cf	
Energy Price Escalation	Uniform Present Value Factors: Commercial			Table Ba.1: Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis – 2017, (Lavappa, et.al.)
		10 yr	30 yr	
	Electricity	9.22	22.72	
	Natural Gas	10.57	26.00	
Discount Rate (Real)		3.00%		Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis – 2017, (Lavappa, et.al.)
City Code Index	4A. New York	1.346		RS Means Building Construction Cost Data (2017)
	5A.Buffalo	1.057		
	6A. Watertown	0.995		

The life of a measure does not necessarily equal the life-cycle study period. Measures may have longer or shorter lives than the 10- and 30-year periods used for this analysis, as detailed in Table 3. Consequently, a residual value of the measures was included in the analysis to account for the value of the measure associated with the remaining life of the materials installed as part of the measure. The residual values used are based on straight line depreciation of the present value of the measure over the life of the measure. For example, if a measure has a 20-year life, then at the end of 10 years it has a residual value equal to 50% of the first cost to install the measure.

Economic analysis results based on annual energy savings and simple payback are presented in Tables 5 and 6. The payback period varies from 3.0 years for Large Office in CZ6A to 18.4 years for Warehouse in CZ4A. In aggregate, the statewide area weighted payback period is 10.5 years.

Table 5. Energy Savings and Simple Payback for By Building Type and Climate Zone

Prototype	CZ	Construction Weight [%]	Site Energy [kBtu/ft2/yr]			Source Energy [kBtu/ft2/yr]			Energy Cost			Incremental First Cost	Simple Payback
			90.1-2016	NYStretch	% Savings	90.1-2016	NYStretch	% Savings	90.1-2016	NYStretch	% Savings	$/ft2	years
Large Office	4A	7.5%	60.0	58.0	3.4%	179.3	172.2	3.9%	$ 2.26	$ 2.16	4.1%	$ 0.28	3.1
	5A	1.0%	63.4	61.2	3.4%	180.6	173.1	4.1%	$ 2.24	$ 2.15	4.3%	$ 0.47	4.8
	6A	0.3%	64.4	62.1	3.5%	181.7	174.1	4.2%	$ 2.25	$ 2.15	4.4%	$ 0.30	3.0
Standalone Retail	4A	4.9%	44.5	39.1	12.1%	130.1	111.0	14.7%	$ 1.63	$ 1.38	15.4%	$ 3.89	15.6
	5A	7.1%	46.5	41.2	11.6%	129.9	110.0	15.3%	$ 1.60	$ 1.34	16.4%	$ 3.08	11.7
	6A	2.6%	48.6	43.4	10.7%	133.9	115.0	14.1%	$ 1.65	$ 1.40	15.1%	$ 3.27	13.2
Secondary School	4A	5.0%	37.0	33.9	8.5%	104.0	95.6	8.1%	$ 1.29	$ 1.18	8.0%	$ 0.61	6.0
	5A	3.7%	37.7	34.6	8.1%	101.2	92.9	8.2%	$ 1.24	$ 1.13	8.3%	$ 0.43	4.3
	6A	1.1%	38.2	35.0	8.3%	101.8	93.3	8.3%	$ 1.24	$ 1.14	8.3%	$ 0.65	6.3
Large Hotel	4A	3.5%	81.7	75.9	7.1%	187.4	172.2	8.1%	$ 2.17	$ 1.99	8.5%	$ 1.77	9.6
	5A	2.5%	83.3	77.7	6.8%	183.4	168.1	8.4%	$ 2.09	$ 1.90	9.0%	$ 1.55	8.3
	6A	1.8%	85.4	79.9	6.5%	185.1	170.0	8.2%	$ 2.09	$ 1.91	8.8%	$ 1.49	8.1
Full-Service Restaurant	4A	0.1%	380.3	341.6	10.2%	717.1	629.0	12.3%	$ 7.62	$ 6.60	13.3%	$ 5.59	5.5
	5A	0.3%	418.0	381.9	8.6%	741.4	661.8	10.7%	$ 7.63	$ 6.72	11.9%	$ 3.90	4.3
	6A	0.1%	439.9	403.5	8.3%	763.7	683.6	10.5%	$ 7.76	$ 6.85	11.7%	$ 4.18	4.6
Outpatient Healthcare	4A	2.0%	111.7	106.7	4.5%	314.6	296.5	5.8%	$ 3.90	$ 3.66	6.2%	$ 3.10	12.9
	5A	2.4%	112.9	108.2	4.2%	310.6	292.8	5.7%	$ 3.82	$ 3.58	6.2%	$ 2.70	11.5
	6A	1.0%	116.0	111.3	4.0%	316.4	298.6	5.6%	$ 3.88	$ 3.64	6.1%	$ 2.71	11.5
Warehouse	4A	2.5%	17.7	15.2	14.0%	37.4	32.4	13.5%	$ 0.42	$ 0.36	13.3%	$ 1.03	18.4
	5A	3.8%	23.9	20.6	13.8%	43.9	38.2	13.0%	$ 0.46	$ 0.40	12.6%	$ 0.60	10.4
	6A	1.2%	22.0	19.1	13.2%	44.2	38.3	13.4%	$ 0.48	$ 0.42	13.5%	$ 0.75	11.6
10-Story High-Rise Apartment	4A	21.9%	48.4	47.1	2.8%	96.0	93.1	3.0%	$ 1.04	$ 1.01	3.0%	$ 0.43	13.5
	5A	0.0%	54.5	52.5	3.6%	99.8	96.3	3.5%	$ 1.04	$ 1.01	3.5%	$ 0.38	10.5
	6A	0.0%	54.5	52.6	3.6%	99.8	96.2	3.5%	$ 1.04	$ 1.01	3.5%	$ 0.42	11.6
20-Story High-Rise Apartment	4A	23.5%	48.4	47.3	2.4%	106.4	103.1	3.1%	$ 1.21	$ 1.17	3.4%	$ 0.47	11.5
	5A	0.1%	54.4	53.2	2.3%	112.2	103.1	8.1%	$ 1.24	$ 1.17	6.0%	$ 0.43	10.3
	6A	0.1%	55.1	53.3	3.3%	113.0	108.7	3.8%	$ 1.25	$ 1.20	4.0%	$ 0.40	8.1
4A Totals	4A	70.9%	51.4	49.2	4.2%	120.6	114.5	5.1%	$ 1.41	$ 1.33	5.5%	$ 0.85	11.0
5A Totals	5A	20.9%	59.1	54.2	8.2%	147.5	132.8	10.0%	$ 1.76	$ 1.57	10.5%	$ 1.81	9.8
6A Totals	6A	8.2%	65.0	60.2	7.4%	159.1	144.3	9.3%	$ 1.88	$ 1.70	9.9%	$ 1.96	10.5
AGGREGATE VALUES		**100.0%**	**54.1**	**51.2**	**5.4%**	**129.4**	**120.7**	**6.7%**	**$ 1.52**	**$ 1.41**	**7.1%**	**$ 1.14**	**10.5**

Table 6. Energy Savings and Simple Payback by Building Type

Prototype	Construction Weight [%]	Site Energy [kBtu/ft2/yr]			Source Energy [kBtu/ft2/yr]			Energy Cost [$/ft2]			Incremental First Cost	Simple Payback
		90.1-2016	NYStretch	% Savings	90.1-2016	NYStretch	% Savings	90.1-2016	NYStretch	% Savings	$/ft2	years
Large Office	8.8%	60.5	58.5	3.4%	179.5	172.4	4.0%	$ 2.26	$ 2.16	4.1%	$ 0.31	3.27
Standalone Retail	14.6%	46.2	40.9	11.6%	130.7	111.2	14.9%	$ 1.62	$ 1.36	15.8%	$ 3.39	13.25
Secondary School	9.8%	37.4	34.3	8.3%	102.7	94.3	8.2%	$ 1.26	$ 1.16	8.1%	$ 0.55	5.36
Large Hotel	7.8%	83.1	77.4	6.9%	185.6	170.4	8.2%	$ 2.13	$ 1.94	8.7%	$ 1.64	8.84
Full-Service Restaurant	0.5%	414.9	378.2	8.8%	741.0	659.6	11.0%	$ 7.65	$ 6.72	12.1%	$ 4.29	4.60
Outpatient Healthcare	5.4%	113.0	108.2	4.3%	313.2	295.2	5.7%	$ 3.86	$ 3.62	6.1%	$ 2.85	12.03
Warehouse	7.5%	21.5	18.6	13.7%	41.8	36.3	13.2%	$ 0.45	$ 0.39	12.9%	$ 0.77	13.26
10-Story High-Rise Apartment	21.9%	48.4	47.1	2.8%	96.0	93.1	3.0%	$ 1.04	$ 1.01	3.0%	$ 0.43	11.45
20-Story High-Rise Apartment	23.7%	48.5	47.4	2.4%	106.4	103.2	3.1%	$ 1.21	$ 1.17	3.4%	$ 0.47	13.50
Weighted Average	100.0%	54.1	51.2	5.4%	129.4	120.7	6.7%	$ 1.52	$ 1.41	7.1%	$ 1.14	10.50

Additionally, the results of the 10- and 30-year life-cycle analyses are presented in Tables 7 and 8, respectively. The results show that the 10-year present value of energy savings between NYStretch and ASHRAE 90.1-2016 is greater than the installed cost of materials for most building types in each of the climate zones examined with the exception of Standalone Retail, Outpatient Healthcare and Warehouse in CZ4A. The net savings are aggregated based on the floor space-based weighting factors. The resulting aggregated energy cost savings, for all climate zones and prototypes, is greater than the installed cost of materials to achieve the savings of $0.18/sf over the 10-year period.

Table 7. 10-Year Present Values of Energy Cost Savings between ASHRAE 90.1-2016 and NYStretch

Prototype	Area	CZ	Construction Weight [%]	Annual Energy Cost		10 Year Life Cycle Energy Cost			Incremental First Cost	Residual Value at 10 years	Net Savings over 10 Years	
				90.1-2016	NYStretch	90.1-2016	NYStretch	Savings			Total	$/sf
Large Office	497,337	4A	7.5%	$ 1,122,721	$ 1,076,703	$ 10,392,669	$ 9,968,956	$ 423,714	$ 141,187	$ 37,036	$319,563	$0.64
		5A	1.0%	$ 1,115,954	$ 1,067,460	$ 10,349,779	$ 9,903,163	$ 446,616	$ 234,656	$ 40,924	$252,884	$0.51
		6A	0.3%	$ 1,119,808	$ 1,070,785	$ 10,389,609	$ 9,937,763	$ 451,846	$ 148,621	$ 23,746	$326,971	$0.66
Standalone Retail	24,630	4A	4.9%	$ 40,095	$ 33,936	$ 371,457	$ 314,777	$ 56,679	$ 95,821	$ 25,882	($13,259)	($0.54)
		5A	7.1%	$ 39,525	$ 33,042	$ 366,882	$ 307,296	$ 59,586	$ 75,788	$ 18,591	$2,389	$0.10
		6A	2.6%	$ 40,555	$ 34,425	$ 376,676	$ 320,293	$ 56,383	$ 80,645	$ 21,594	($2,668)	($0.11)
Secondary School	210,357	4A	5.0%	$ 270,675	$ 249,133	$ 2,511,847	$ 2,311,520	$ 200,327	$ 128,629	$ 54,590	$126,288	$0.60
		5A	3.7%	$ 260,020	$ 238,559	$ 2,417,702	$ 2,218,244	$ 199,458	$ 91,266	$ 35,287	$143,479	$0.68
		6A	1.1%	$ 260,845	$ 239,071	$ 2,426,145	$ 2,223,689	$ 202,456	$ 137,223	$ 55,849	$121,082	$0.58
Large Hotel	121,813	4A	3.5%	$ 264,267	$ 241,853	$ 2,477,276	$ 2,268,602	$ 208,673	$ 215,819	$ 58,057	$50,912	$0.42
		5A	2.5%	$ 254,323	$ 231,509	$ 2,390,220	$ 2,178,138	$ 212,083	$ 189,061	$ 46,283	$69,305	$0.57
		6A	1.8%	$ 255,157	$ 232,605	$ 2,400,350	$ 2,190,813	$ 209,537	$ 182,079	$ 45,577	$73,035	$0.60
Full-Service Restaurant	5,488	4A	0.1%	$ 41,811	$ 36,233	$ 397,393	$ 345,075	$ 52,318	$ 30,670	$ 9,805	$31,453	$5.73
		5A	0.3%	$ 41,857	$ 36,882	$ 400,005	$ 353,253	$ 46,751	$ 21,387	$ 7,721	$33,085	$6.03
		6A	0.1%	$ 42,607	$ 37,601	$ 408,012	$ 360,965	$ 47,046	$ 22,967	$ 8,675	$32,754	$5.97
Outpatient Healthcare	40,843	4A	2.0%	$ 159,158	$ 149,351	$ 1,476,791	$ 1,386,620	$ 90,171	$ 126,695	$ 30,589	($5,934)	($0.15)
		5A	2.4%	$ 155,998	$ 146,402	$ 1,448,966	$ 1,360,775	$ 88,191	$ 110,444	$ 24,158	$1,905	$0.05
		6A	1.0%	$ 158,498	$ 148,849	$ 1,472,744	$ 1,384,110	$ 88,634	$ 110,741	$ 25,228	$3,121	$0.08
Warehouse	51,914	4A	2.5%	$ 21,760	$ 18,870	$ 205,049	$ 177,741	$ 27,308	$ 53,254	$ 14,315	($11,631)	($0.22)
		5A	3.8%	$ 23,926	$ 20,919	$ 227,895	$ 199,092	$ 28,803	$ 31,272	$ 10,203	$7,734	$0.15
		6A	1.2%	$ 25,092	$ 21,707	$ 237,340	$ 205,358	$ 31,982	$ 39,118	$ 14,592	$7,455	$0.14
10-Story High-Rise Apartment	84,140	4A	21.9%	$ 87,838	$ 85,168	$ 831,581	$ 806,423	$ 25,157	$ 36,040	$ 12,192	$1,310	$0.02
		5A	0.0%	$ 87,886	$ 84,824	$ 837,400	$ 808,170	$ 29,230	$ 32,095	$ 11,372	$8,507	$0.10
		6A	0.0%	$ 87,795	$ 84,762	$ 836,627	$ 807,645	$ 28,982	$ 35,330	$ 13,443	$7,094	$0.08
20-Story High-Rise Apartment	168,279	4A	23.5%	$ 203,645	$ 196,793	$ 1,914,173	$ 1,850,628	$ 63,545	$ 78,578	$ 22,905	$7,872	$0.05
		5A	0.1%	$ 209,293	$ 202,329	$ 1,975,537	$ 1,910,836	$ 64,701	$ 71,908	$ 21,836	$14,629	$0.09
		6A	0.1%	$ 210,112	$ 201,789	$ 1,984,121	$ 1,906,196	$ 77,926	$ 67,193	$ 20,681	$31,414	$0.19
4A Totals		4A	70.9%	$ 253,616	$ 242,215	$ 2,365,240	$ 2,259,659	$ 105,581	$ 83,955	$ 25,162	$46,788	$0.11
5A Totals		5A	20.9%	$ 167,142	$ 154,337	$ 1,556,783	$ 1,438,147	$ 118,636	$ 1,558,123	$ 24,902	$781,499	$0.37
6A Totals		6A	8.2%	$ 170,912	$ 157,469	$ 1,595,414	$ 1,470,838	$ 124,576	$ 1,252,578	$ 30,782	$617,704	$0.30
AGGREGATE VALUES			**100.0%**	**$ 228,761**	**216,899**	**$ 2,133,146**	**$ 2,023,280**	**$ 109,867**	**$ 88,326**	**$ 25,568**	**$47,109**	**$0.18**

Table 8 shows that over 30 years, the present value of the energy savings is worth more than the first, maintenance and replacement costs for each of the buildings in each of the climate zones examined, with the exception of Standalone Retail in CZ4A. The resulting aggregated energy cost savings, for all climate zones and prototypes, is greater than the installed cost of materials to achieve the savings of $0.81/sf over the 30-year period.

Table 8. 30-Year Present Values of Energy Cost Savings between ASHRAE 90.1-2016 and NYStretch

Prototype	CZ	Construction Weights	Incremental First Cost	Replacement Costs	Maintenance Costs	Residual Value	Energy Cost Savings	30 Year Net Present Value of Savings	
								Total	$/sf
Large Office	4A	7.5%	$141,187	$72,568	$0	($5,456)	$1,044,138	$824,927	$1.66
	5A	1.0%	$234,656	$90,142	$0	($6,118)	$1,100,573	$769,657	$1.55
	6A	0.3%	$148,621	$35,951	$0	($3,995)	$1,113,447	$924,879	$1.86
Standalone Retail	4A	4.9%	$95,821	$49,532	$0	($458)	$139,674	($6,138)	($0.25)
	5A	7.1%	$75,788	$36,331	$0	($1,298)	$146,839	$33,422	$1.36
	6A	2.6%	$80,645	$38,657	$0	($420)	$138,944	$19,222	$0.78
Secondary School	4A	5.0%	$128,629	$54,294	$0	$6,911	$493,589	$317,577	$1.51
	5A	3.7%	$91,266	$31,305	$0	$1,169	$491,451	$370,049	$1.76
	6A	1.1%	$137,223	$44,735	$0	$6,162	$491,451	$315,656	$1.50
Large Hotel	4A	3.5%	$215,819	$135,226	$0	$2,880	$514,145	$165,980	$1.36
	5A	2.5%	$189,061	$107,301	$0	$2,495	$522,556	$228,690	$1.88
	6A	1.8%	$182,079	$107,446	$0	$2,407	$516,287	$229,169	$1.88
Full Service Restaurant	4A	0.1%	$30,670	$31,248	$0	$3,649	$128,892	$70,624	$12.87
	5A	0.3%	$21,387	$24,554	$0	$2,871	$115,174	$72,105	$13.14
	6A	0.1%	$22,967	$24,552	$0	$2,703	$115,901	$71,084	$12.95
Outpatient Healthcare	4A	2.0%	$126,695	$62,998	$0	$519	$222,209	$33,035	$0.81
	5A	2.4%	$110,444	$49,572	$0	$452	$217,331	$57,766	$1.41
	6A	1.0%	$110,741	$51,869	$0	$395	$218,424	$56,209	$1.38
Warehouse	4A	2.5%	$53,254	($2,443)	$0	$28	$67,271	$16,487	$0.32
	5A	3.8%	$31,272	($781)	$0	$22	$70,939	$40,470	$0.78
	6A	1.2%	$39,118	($1,274)	$0	$21	$78,783	$40,960	$0.79
10 Story Highrise Apartment	4A	21.9%	$36,040	$11,036	$0	$1,015	$61,974	$15,914	$0.19
	5A	0.0%	$32,095	$9,033	$0	$937	$71,995	$31,805	$0.38
	6A	0.0%	$35,330	$8,116	$0	$551	$71,382	$28,488	$0.34
20 Story Highrise Apartment	4A	23.5%	$78,578	$40,382	$0	$3,972	$156,575	$41,587	$0.25
	5A	0.1%	$71,908	$36,963	$0	$5,132	$159,420	$55,681	$0.33
	6A	0.1%	$67,193	$35,250	$0	$4,213	$191,984	$93,754	$0.56
4A Totals	4A	70.9%	$83,955	$40,133	$0	$1,671	$260,157	$137,741	$0.52
5A Totals	5A	20.9%	$94,765	$41,112	$0	($107)	$292,323	$156,339	$1.57
6A Totals	6A	8.2%	$109,714	$50,027	$0	$1,211	$305,970	$147,441	$1.38
AGGREGATE VALUES			$88,326	$41,149	$0	$1,262	$270,636	$142,423	$0.81

Appendix A.

Differences between 2020 NYStretch Energy Code and ASHRAE 90.1-2016

by DOE Prototype and Climate Zone

Note: This appendix adopts the EEM numbering convention used in the PNNL report, Final Energy Savings Analysis of the Proposed NYStretch-Energy Code 2018, February 2019 (PNNL-ACT-10073, Rev. 1).

The following EEMs were not included in Vidaris' analysis as they are not considered stretch measures with respect to ASHRAE 90.1-2016:

- EEM 5 Occupancy Sensors and Automatic Lighting Controls
- EEM 6 Exterior Lighting Controls
- EEM 8 Hotel Guestroom HVAC Vacancy Control
- EEM 14 ERV for Apartment Makeup Air Units

The following EEMs were not included in the final version of the 2020 NYStretch Energy Code:

- EEM 9 High-efficiency SHW (Refer to Appendix C for further discussion)
- EEM 15 Demand-based Controls for Recirculated SHW systems

EEM 1 Enhanced Insulation for Roofs and Walls

This measure amends Table C402.1.4 with more stringent U-factors for opaque thermal envelope assemblies. The ASHRAE compliance path is required to comply with this revision per section C401.2.1.a of NYStretch.

Cost data for this measure was developed by determining an insulation cost per R-value from RSMeans and applying this to the additional insulation required to achieve the improved U-values specified in table C402.1.4. It was assumed that continuous mineral fiber would be used to meet the required thermal performance for walls; additional extruded polystyrene was used to meet the increased performance for roofs. This requirement applies to each of the building prototypes as follows.

OPAQUE THERMAL ENVELOPE (U-factor)	NYStretch	ASHRAE 90.1 -2016
Large office, Stand-alone retail		
CLIMATE ZONE 4		
Roofs: insulation entirely above deck	0.030	0.032
Walls, above grade: mass (non-res)	0.099	0.104
CLIMATE ZONE 5		
Roofs: insulation entirely above deck	0.030	0.032
Walls, above grade: mass (non-res)	0.086	0.090
CLIMATE ZONE 6		
Roofs: insulation entirely above deck	0.029	0.032
Walls, above grade: mass (non-res)	0.076	0.080
Full-Service Restaurant[3]		
CLIMATE ZONE 4		
Roofs: attic and other	0.020	0.021
Walls, above grade: steel framed (non-res)	0.061	0.064
CLIMATE ZONE 5		
Roofs: attic and other	0.020	0.021
Walls, above grade: steel framed (non-res)	0.052	0.055
CLIMATE ZONE 6		
Roofs: attic and other	0.019	0.021
Walls, above grade: steel framed (non-res)	0.047	0.049
Secondary School, Outpatient Healthcare		
CLIMATE ZONE 4		
Roofs: insulation entirely above deck	0.030	0.032
Walls, above grade: steel framed (non-res)	0.061	0.064
CLIMATE ZONE 5		
Roofs: insulation entirely above deck	0.030	0.032
Walls, above grade: steel framed (non-res)	0.052	0.055
CLIMATE ZONE 6		
Roofs: insulation entirely above deck	0.029	0.032
Walls, above grade: steel framed (non-res)	0.047	0.049

3 U-factor for attic roof in the NYStretch model was revised to reflect updated draft requirements

OPAQUE THERMAL ENVELOPE (U-factor)	NYStretch	ASHRAE 90.1 -2016
Large Hotel		
CLIMATE ZONE 4		
Roofs: insulation entirely above deck	0.030	0.032
Walls, above grade: mass (residential)	0.086	0.090
CLIMATE ZONE 5		
Roofs: insulation entirely above deck	0.030	0.032
Walls, above grade: mass (residential)	0.076	0.080
CLIMATE ZONE 6		
Roofs: insulation entirely above deck	0.029	0.032
Walls, above grade: mass (residential)	0.067	0.071
Warehouse [4]		
CLIMATE ZONE 4		
Roofs: metal building	0.035	0.037
Walls, above grade: metal building	0.048	0.060
CLIMATE ZONE 5		
Roofs: metal building	0.035	0.037
Walls, above grade: metal building	0.048	0.050
CLIMATE ZONE 6		
Roofs: metal building	0.028	0.031
Walls, above grade: metal building	0.048	0.050
10-Story Apartment, 20-Story Apartment		
CLIMATE ZONE 4		
Roofs: insulation entirely above deck	0.030	0.032
Walls, above grade: steel framed (residential)	0.061	0.064
CLIMATE ZONE 5		
Roofs: insulation entirely above deck	0.030	0.032
Walls, above grade: steel framed (residential)	0.052	0.055
CLIMATE ZONE 6		
Roofs: insulation entirely above deck	0.029	0.032
Walls, above grade: steel framed (residential)	0.044	0.049

4 U-factor for metal building walls and roof in the NYStretch model were revised to reflect updated 2020 NYStretch requirements.

EEM 2 Enhanced Fenestration

This measure amends Table C402.2.4 with more stringent U-factors and SHGCs for building envelope fenestration assemblies. The ASHRAE compliance path is required to comply with this revision per section C401.2.1.b of NYStretch. Currently under the 2020 NYS ECCC, there is a proposed revision to 2018 IECC such that north-facing vertical fenestration will be required to meet the SHGC requirements applicable to south, east and west facing fenestration. Consequently, this analysis assumes all orientations will meet the SHGC requirements for the south, east, and west orientations. Window performance in the energy models is based on weighting factors provided by PNNL for fixed, operable, and non-metal framing for each of the building prototypes. This requirement applies to all the building prototypes. Vidaris revised the U-factors in the PNNL NYStretch models to reflect the current NYStretch requirements.

Cost data for this measure was developed based on the incremental costs between windows with respect to decreased U-factor in PNNL's national cost effectiveness analysis.

VERTICAL FENESTRATION (U-Factor)	NYStretch	ASHRAE 90.1-2016
Large Office, Stand-alone Retail, Secondary School, Large Hotel, Full-Service Restaurant, Outpatient Healthcare, Warehouse, 10-Story High-Rise Apartment, and 20-Story High-Rise Apartment		
CLIMATE ZONE 4		
Fixed fenestration (metal)	0.36	0.38
Operable fenestration (metal)	0.43	0.46
Non-metal	0.30	0.31
SHGC	0.36	0.36
Skylight U	0.48	0.50
Skylight SHGC	0.38	0.40
CLIMATE ZONE 5		
Fixed fenestration (metal)	0.36	0.38
Operable fenestration (metal)	0.43	0.46
Non-metal	0.27	0.31
SHGC	0.38	0.38
Skylight U	0.48	0.50
Skylight SHGC	0.38	0.40
CLIMATE ZONE 6		
Fixed fenestration (metal)	0.34	0.36
Operable fenestration (metal)	0.41	0.45
Non-metal	0.27	0.30
SHGC	0.40	0.40
Skylight U	0.48	0.50
Skylight SHGC	0.38	0.40

EEM 3 Air Leakage Testing for Mid-sized Buildings

This measure amends section 5.4.3.1.3 to add a requirement for buildings 25,000 to 50,000 square feet and less than or equal to 75 feet in height to comply with whole building pressurization testing and air barrier requirements. Previously, testing was not required.

For this analysis, the new testing requirement applied only to the Outpatient Healthcare and Warehouse prototypes. The difference between 90.1-2016 and NYStretch are as follows:

AIR LEAKAGE [cfm/sf]	NYStretch	90.1-2016
Outpatient Healthcare	0.40	1.00
Warehouse	0.40	1.00

Infiltration testing was assumed to be done once to confirm compliance. Any additional testing would be optional since it would not necessarily be required for compliance but would be an aid during construction. Costing for this measure was based on Vidaris experience with this work and feedback from industry professionals. For CZ 5A and 6A the size of the Outpatient Healthcare allows for a cost of $3,200, and $8,500 for climate CZ 4A due to complexity related testing in locations like New York City.

The Warehouse was considered more complex due to the volume and height of a typical warehouse with greater cost of testing equipment and more effort to do the work. Ultimately, the cost was judged to be twice that of the Outpatient Healthcare, or about $17,000 for CZ 4A and $6,400 for CZs 5A and 6A.

EEM 4 Reduced LPD for Interior Lighting

This measure amends Tables C405.3.2(1) and C405.3.2(2) with reduced lighting power densities (LPD). The ASHRAE compliance path is required to comply with this revision per section C401.2.1.c of NYStretch. The ASHRAE compliance path is also directed to follow the requirements of section C406—Additional Efficiency Package Options. Per direction from NYSERDA, the analysis is based on Option 2—reduced lighting power in accordance with section C406.3, which specifies an additional 10% reduction in connected lighting power. This requirement applies to all the building prototypes.

Previous cost estimates from PNNL associate a lower first cost for buildings with lower LPD; based on feedback from lighting design professionals, it is anticipated there will be no cost associated with this measure. LPDs are based on the space-by-space method unless indicated otherwise.

INTERIOR LIGHTING POWER DENSITY (W/ft^2)	NYStretch	NYStretch less 10%	90.1-2016
Large Office			
Office (building area method)	0.69	0.62	0.79
Stand-Alone Retail			
BOH (area weighted average)	0.50	0.45	
Sales Area	1.06	0.95	1.22
Lobby [5]	0.90	0.81	1.00
Display lighting - type 1,2,3 (area weighted average)	0.32	0.29	
Secondary School			
Classroom	0.74	0.67	0.92
Corridor	0.58	0.52	0.66
Lobby [5]	0.90	0.81	1.00
Mechanical [5]	0.39	0.35	0.43
Restroom	0.75	0.68	0.85
Office	0.85	0.77	0.93
Gymnasium/exercise area [5]	0.50	0.45	0.50
Kitchen/Food Preparation Area	0.92	0.83	1.06
Cafeteria/Dining	0.53	0.48	0.63
Library/reading area (Building Area Method)	0.78	0.70	0.82
Audience seating area – auditorium [5]	0.63	0.57	0.63
Large Hotel			
Office (Building Area Method)	0.69	0.62	0.79
Retail (Building Area Method)	0.91	0.82	1.06
Mechanical rooms [5]	0.39	0.35	0.43
Storage	0.43	0.39	0.46
Laundry Room	0.43	0.39	0.43
Dining Area - family dining [5]	0.54	0.49	0.71
Lobby – hotel	0.68	0.61	1.06
Guest rooms	0.75	0.68	0.77
Corridor	0.58	0.52	0.66
Kitchen/Food Preparation Area	0.92	0.83	1.06
10-story Apartment			
Office - enclosed [5]	0.85	0.77	0.93
Corridor	0.58	0.52	0.792
Stairwell	0.50	0.45	0.58
Mechanical rooms [5]	0.39	0.35	0.43

5 LPDs in PNNL's NYStretch model were revised to reflect current NYStretch code requirements.

INTERIOR LIGHTING POWER DENSITY (W/ft2)	NYStretch	NYStretch less 10%	90.1-2016
20-story Apartment			
Office - enclosed[6]	0.85	0.77	0.93
Corridor	0.58	0.52	0.792
Stairwell	0.50	0.45	0.58
Mechanical rooms[7]	0.39	0.35	0.43
Sales Area[7]	1.06	0.954	1.22
Display lighting - retail type 3[7] (weighted average)	1.05	0.945	1.05
Display lighting - retail type 2[7] (weighted average)	0.45	0.405	0.45
Display lighting - retail type 1[7] (weighted average)	0.45	0.405	0.45
Additional retail allowance [Watts] [7]	1,000	900	1,000
Outpatient Healthcare			
Conference/Meeting/Multipurpose	0.93	0.84	1.07
Corridor	0.58	0.52	0.792
Dining Area - cafeteria/fastfood	0.53	0.48	0.63
Healthcare Facility - nurse station	0.75	0.68	0.81
Healthcare Facility - patient room	0.45	0.41	0.62
Healthcare Facility - physical therapy	0.84	0.76	0.84
Healthcare Facility - recovery room	0.89	0.80	1.03
Healthcare Facility - exam/treatment	1.16	1.04	1.68
Healthcare Facility - imaging room	0.98	0.88	1.06
Healthcare Facility - operating room	1.87	1.68	2.17
Lobby - all other[7]	0.90	0.81	1.00
Lounge/breakroom – healthcare[7]	0.53	0.48	0.78
Office - enclosed >250 sf[7]	0.85	0.77	0.93
Restroom[7]	0.75	0.68	0.85
Storage room, 50-100 sf	0.43	0.39	0.46
Full-service Restaurant			
Dining Area - family dining	0.54	0.49	0.71
Kitchen/Food Preparation Area	0.92	0.83	1.06
Warehouse			
Office (Building Area Method)	0.69	0.62	0.79
Warehouse - storage- medium to bulky	0.27	0.24	0.35
Warehouse - storage - small hand carried items	0.65	0.59	0.69

6 LPDs in PNNL's NYStretch model were revised to reflect current NYStretch draft code requirements

EEM 7 Reduced Fan Power Allowances

This measure found in Tables C403.8.1(1) and 6.5.3.1-1 limits the fan energy used by heating, ventilation, and air-conditioning (HVAC) equipment. It requires that variable air volume (VAV) systems use no more than 0.0010 bhp/cfm and constant air volume (CAV) systems use no more than 0.00088 bhp/cfm for fan power. These limits only apply to fan motors larger than 5 nameplate horsepower; smaller fan sizes are not regulated in either code. This requirement applies to the large office, standalone retail, secondary school, large hotel, and outpatient healthcare building prototypes. Vidaris revised the PNNL NYStretch models to reflect current NYStretch code requirements for these fan systems.

Costing for this measure was based on increased system capacities for larger air handling equipment that would result in increased cross-sectional areas of the unit and components (e.g., coils, filters, ducts, unit housings, etc.) that would reduce the static pressure, and thus the brake horsepower, for the affected systems. For constant volume fans, this required an increased capacity of 3.2%; variable volume systems required a 13.4% increase in capacity.

Fan Power Allowance	NYStretch	90.1-2016
Large Office, Standalone Retail, Secondary School, Large Hotel, and Outpatient Healthcare		
CV (bhp/cfm)	0.00088	0.00094
VAV (bhp/cfm)	0.00100	0.00130

EEM 10 High-efficiency Commercial Kitchen Equipment

EEM10 reduces plug load energy usage. This measure upgrades major commercial kitchen appliances to ENERGY STAR®.

Costing for this measure was based on equipment lists from previous projects and the incremental costs from the Savings Calculator for ENERGY STAR® Commercial Kitchen Equipment developed by the U.S. EPA and DOE.[7] To account for the variation of kitchen sizes in the affected prototypes, an incremental cost per square foot was used.

Affected prototypes: secondary school, full-service restaurant, and large hotel.

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7 The Savings Calculator for Energy Commercial Kitchen Equipment is available at https://www.energystar.gov/sites/.../commercial_kitchen_equipment_calculator.xlsx

EEM 11 Thermal Bridging Reduction

EEM11 addresses the mandatory provision in NYStretch to include a minimum R-3 thermal break at penetrations, including parapet walls and balcony projections. None of the prototypes include balconies. Each building with a flat roof is assumed to have a parapet that is 42 in. high and follows the perimeter of the roof.

This analysis assumes that each prototype meets prescriptive requirements of the code. This measure simply requires that elements of the envelope that are noncompliant have an R-value no less than R-3, which is itself less than code compliant. Consequently, the remainder of the envelope systems would have to be improved to reach overall code compliance.

Consequently, this measure does not result in any energy savings. Additional insulation is included in the lifecycle cost analysis to address the additional cost of meeting the prescriptive requirements for opaque envelope assemblies.

Costing for this measure was based on the assumption of additional mineral wool insulation at the parapet to eliminate thermal bridging. It was assumed that this will require 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck = 9 ft of total insulation of R-4.2/in for entire perimeter of roof.

Affected prototypes: large office, standalone retail, secondary school, large hotel, outpatient healthcare, 10-story high-rise apartment, and 20-story high-rise apartment.

EEM 12 Exterior Lighting Power Reduction

This measure modifies Table C405.4.2(2) with reduced exterior lighting power allowances. As allowances vary by lighting zone, the model uses an average of lighting zones for each protype building; these averages were developed by PNNL for the national analysis of ASHRAE 90.1-2016. Following the methodology used by PNNL's analysis of NYStretch, it is assumed there are no parking lots for prototypes in climate zone 4A. PNNL also excluded exterior lighting for 10-story and 20-story apartment prototypes as the majority of these buildings are in climate zone 4A and have no or limited exterior lighting.

At the time of this analysis, this measure is only included in the IECC overlay of the NYStretch draft. Vidaris included this measure in the analysis at NYSERDA's direction as the final version of the code is anticipated to include it in the ASHRAE path as well.

Based on an analysis of typical parking lot lighting, it was determined that standard metal halide lamps could be used to achieve the LPD limits for NYStretch. As there is only a minimal reduction in façade and entryway lighting, it was assumed there is no incremental cost for this measure.

	Façade W/sf]		Doors [W/lf]		Parking lot [W/sf] *	
Lighting Zone	NYStretch	90.1-2016	NYStretch	2016	NYStretch	2016
1	0.000	0.000	12.6	14.0	0.03	0.03
2	0.075	0.100	12.6	14.0	0.04	0.04
3	0.113	0.150	20.0	21.0	0.05	0.06
4	0.150	0.200	20.0	21.0	0.05	0.08

*Parking lot lighting is only included in climate zones 5A and 6A

Lighting Zone	Prototype	Façade W/sf]		Doors [W/lf]		Parking lot [W/sf] *	
		NYStretch	90.1-2016	NYStretch	2016	NYStretch	2016
4	Large Office	0.150	0.200	20.0	21.0	0.050	0.080
2,3	Stand-alone Retail	0.094	0.125	16.3	17.5	0.045	0.050
2,3	Secondary School	0.094	0.125	16.3	17.5	0.045	0.050
3,4	Large Hotel	0.132	0.175	20.0	21.0	0.050	0.070
2,3,4	Full-service Restaurant	0.113	0.150	17.5	18.7	0.050	0.060
2,3	Outpatient Healthcare	0.094	0.125	16.3	17.5	0.045	0.050
2,3	Warehouse	0.094	0.125	16.3	17.5	0.045	0.050
3,4	10 Story Mid-Rise Apt.	n/a		n/a		n/a	
3,4	20 Story High-Rise Apt.	n/a		n/a		n/a	

* Parking lot lighting is only included in climate zones 5A and 6A

EEM 13 Efficient Elevator, Regenerative Drives

This measure requires regenerative drives for elevator motors with a rise of 75 feet or greater. The PNNL NYStretch models included this as a 5% power reduction for the elevator motors.

Costing for this measure was based on data from previous projects.

Prototype Building	NYStretch [W, total]	90.1-2016 [W, total]
LARGE OFFICE – (12) 30hp motors	232,222	244,444
10-STORY APARTMENT – (1) 30hp motor	19,352	20,371
20-STORY APARTMENT – (2) 30hp motors	19,352	20,371

Appendix B

Differences in Energy Performance, and Annual Energy Cost between 2020 NYStretch Energy Code and ASHRAE 90.1-2016

by Climate Zone and Building Type

TABLE B1: Differences in Energy Performance, and Annual Energy Cost between ASHRAE 90.1-2016 and 2020 NYStretch by Climate Zone and Building Type (Part A)

		Energy Usage		Total (kBtu)		Energy Cost			EUI (kBtu/sf)		ECI ($/sf)			Weighting Factors
		kWh	therms	Site	Source	Electricity	Gas	Total	Site	Source	Electricity	Gas	Total	
Large Office		497,337	square feet											
4A	ASHRAE 90.1-2016	7,404,873	45,821	29,847,478	89,183,930	1,092,219	30,503	1,122,721	60.01	179.32	2.196	0.061	$ 2.26	
4A	NYStretch	7,090,011	46,458	28,836,870	85,662,437	1,045,777	30,927	1,076,703	57.98	172.24	2.103	0.062	$ 2.16	
4A	Savings	314,861	(637)	1,010,608	3,521,492	46,442	(424)	46,018	2.03	7.08	0.093	(0.001)	$ 0.09	7.5%
5A	ASHRAE 90.1-2016	7,261,025	67,527	31,527,310	89,817,293	1,071,001	44,953	1,115,954	63.39	180.60	2.153	0.090	$ 2.24	
5A	NYStretch	6,929,778	68,076	30,452,005	86,099,862	1,022,142	45,318	1,067,460	61.23	173.12	2.055	0.091	$ 2.15	
5A	Savings	331,247	(549)	1,075,306	3,717,431	48,859	(366)	48,493	2.16	7.47	0.098	(0.001)	$ 0.10	1.0%
6A	ASHRAE 90.1-2016	7,265,584	72,306	32,020,810	90,369,650	1,071,674	48,134	1,119,808	64.38	181.71	2.155	0.097	$ 2.25	
6A	NYStretch	6,932,525	72,462	30,900,009	86,590,416	1,022,547	48,238	1,070,785	62.13	174.11	2.056	0.097	$ 2.15	
6A	Savings	333,059	(156)	1,120,801	3,779,234	49,126	(104)	49,022	2.25	7.60	0.099	(0.000)	$ 0.10	0.3%
Standalone Retail		24,630	square feet											
4A	ASHRAE 90.1-2016	262,889	1,981	1,095,100	3,203,339	38,776	1,319	40,095	44.46	130.06	1.574	0.054	$ 1.63	
4A	NYStretch	220,589	2,102	962,803	2,733,881	32,537	1,399	33,936	39.09	111.00	1.321	0.057	$ 1.38	
4A	Savings	42,300	(120)	132,297	469,458	6,239	(80)	6,159	5.37	19.06	0.253	(0.003)	$ 0.25	4.9%
5A	ASHRAE 90.1-2016	255,586	2,742	1,146,310	3,199,822	37,699	1,826	39,525	46.54	129.91	1.531	0.074	$ 1.60	
5A	NYStretch	210,720	2,946	1,013,551	2,709,799	31,081	1,961	33,042	41.15	110.02	1.262	0.080	$ 1.34	
5A	Savings	44,867	(203)	132,759	490,023	6,618	(135)	6,483	5.39	19.90	0.269	(0.005)	$ 0.26	7.1%
6A	ASHRAE 90.1-2016	261,103	3,068	1,197,708	3,296,796	38,513	2,043	40,555	48.63	133.85	1.564	0.083	$ 1.65	
6A	NYStretch	218,834	3,225	1,069,137	2,831,477	32,278	2,147	34,425	43.41	114.96	1.310	0.087	$ 1.40	
6A	Savings	42,269	(157)	128,571	465,319	6,235	(104)	6,131	5.22	18.89	0.253	(0.004)	$ 0.25	2.6%
Secondary School		210,357	square feet											
4A	ASHRAE 90.1-2016	1,753,599	18,055	7,788,751	21,874,479	258,656	12,019	270,675	37.03	103.99	1.230	0.057	$ 1.29	
4A	NYStretch	1,616,146	16,151	7,129,347	20,108,691	238,381	10,751	249,133	33.89	95.59	1.133	0.051	$ 1.18	
4A	Savings	137,453	1,904	659,404	1,765,788	20,274	1,268	21,542	3.13	8.39	0.096	0.006	$ 0.10	5.0%
5A	ASHRAE 90.1-2016	1,660,790	22,612	7,927,850	21,294,010	244,967	15,053	260,020	37.69	101.23	1.165	0.072	$ 1.24	
5A	NYStretch	1,523,268	20,845	7,281,909	19,541,774	224,682	13,877	238,559	34.62	92.90	1.068	0.066	$ 1.13	
5A	Savings	137,522	1,767	645,941	1,752,236	20,285	1,176	21,461	3.07	8.33	0.096	0.006	$ 0.10	3.7%
6A	ASHRAE 90.1-2016	1,662,210	23,538	8,025,261	21,407,104	245,176	15,669	260,845	38.15	101.77	1.166	0.074	$ 1.24	
6A	NYStretch	1,523,135	21,645	7,361,422	19,623,981	224,662	14,409	239,071	34.99	93.29	1.068	0.068	$ 1.14	
6A	Savings	139,075	1,893	663,839	1,783,124	20,514	1,260	21,774	3.16	8.48	0.098	0.006	$ 0.10	1.1%

* **Negative Savings** indicate that NYStretch results in higher energy use or cost relative to ASHRAE 90.1 - 2016

TABLE B1: Differences in Energy Performance, and Annual Energy Cost between ASHRAE 90.1-2016 and 2020 NYStretch by Climate Zone and Building Type (Part B)

		Energy Usage		Total (kBtu)		Energy Cost			EUI (kBtu/sf)		ECI ($/sf)			Weighting
		kWh	therms	Site	Source	Electricity	Gas	Total	Site	Source	Electricity	Gas	Total	Factors
Large Hotel		121,813	square feet											
4A	ASHRAE 90.1-2016	1,587,057	45,330	9,947,992	22,832,229	234,091	30,176	264,267	81.67	187.44	1.922	0.248	$ 2.17	
4A	NYStretch	1,445,229	43,085	9,239,607	20,980,929	213,171	28,681	241,853	75.85	172.24	1.750	0.235	$ 1.99	
4A	Savings	141,828	2,245	708,385	1,851,300	20,920	1,494	22,414	5.82	15.20	0.172	0.012	$ 0.18	3.5%
5A	ASHRAE 90.1-2016	1,496,437	50,472	10,153,016	22,337,909	220,725	33,599	254,323	83.35	183.38	1.812	0.276	$ 2.09	
5A	NYStretch	1,350,487	48,539	9,461,786	20,472,318	199,197	32,312	231,509	77.67	168.06	1.635	0.265	$ 1.90	
5A	Savings	145,950	1,932	691,231	1,865,591	21,528	1,286	22,814	5.67	15.32	0.177	0.011	$ 0.19	2.5%
6A	ASHRAE 90.1-2016	1,489,832	53,188	10,402,112	22,547,031	219,750	35,407	255,157	85.39	185.10	1.804	0.291	$ 2.09	
6A	NYStretch	1,345,009	51,399	9,729,110	20,709,350	198,389	34,216	232,605	79.87	170.01	1.629	0.281	$ 1.91	
6A	Savings	144,822	1,789	673,001	1,837,681	21,361	1,191	22,552	5.52	15.09	0.175	0.010	$ 0.19	1.8%
Full Service Restaurant		5,488	square feet											
4A	ASHRAE 90.1-2016	223,706	13,240	2,087,321	3,935,635	32,997	8,814	41,811	380.33	717.11	6.012	1.606	$ 7.62	
4A	NYStretch	190,350	12,252	1,874,650	3,452,004	28,077	8,156	36,233	341.58	628.99	5.116	1.486	$ 6.60	
4A	Savings	33,356	989	212,671	483,631	4,920	658	5,578	38.75	88.12	0.896	0.120	$ 1.02	0.1%
5A	ASHRAE 90.1-2016	213,031	15,675	2,294,327	4,068,852	31,422	10,435	41,857	418.05	741.39	5.725	1.901	$ 7.63	
5A	NYStretch	183,745	14,691	2,096,005	3,632,083	27,102	9,780	36,882	381.91	661.80	4.938	1.782	$ 6.72	
5A	Savings	29,286	984	198,322	436,769	4,320	655	4,975	36.14	79.58	0.787	0.119	$ 0.91	0.3%
6A	ASHRAE 90.1-2016	212,659	16,885	2,414,046	4,191,286	31,367	11,240	42,607	439.86	763.70	5.715	2.048	$ 7.76	
6A	NYStretch	183,195	15,893	2,214,359	3,751,697	27,021	10,580	37,601	403.48	683.60	4.924	1.928	$ 6.85	
6A	Savings	29,464	992	199,687	439,589	4,346	660	5,006	36.38	80.10	0.792	0.120	$ 0.91	0.1%
Outpatient Healthcare		40,843	square feet											
4A	ASHRAE 90.1-2016	1,032,065	10,408	4,562,204	12,851,209	152,230	6,929	159,158	111.70	314.65	3.727	0.170	$ 3.90	
4A	NYStretch	964,334	10,684	4,358,667	12,108,201	142,239	7,112	149,351	106.72	296.46	3.483	0.174	$ 3.66	
4A	Savings	67,731	(276)	203,537	743,009	9,990	(183)	9,807	4.98	18.19	0.245	(0.004)	$ 0.24	2.0%
5A	ASHRAE 90.1-2016	1,004,067	11,865	4,612,345	12,684,663	148,100	7,898	155,998	112.93	310.57	3.626	0.193	$ 3.82	
5A	NYStretch	937,570	12,183	4,417,320	11,960,217	138,292	8,110	146,402	108.15	292.83	3.386	0.199	$ 3.58	
5A	Savings	66,497	(319)	195,025	724,447	9,808	(212)	9,596	4.77	17.74	0.240	(0.005)	$ 0.23	2.5%
6A	ASHRAE 90.1-2016	1,017,373	12,672	4,738,507	12,920,854	150,063	8,436	158,498	116.02	316.35	3.674	0.207	$ 3.88	
6A	NYStretch	950,276	13,044	4,546,734	12,195,118	140,166	8,683	148,849	111.32	298.58	3.432	0.213	$ 3.64	
6A	Savings	67,097	(372)	191,773	725,736	9,897	(247)	9,649	4.70	17.77	0.242	(0.006)	$ 0.24	1.0%

* **Negative Savings** indicate that NYStretch results in higher energy use or cost relative to ASHRAE 90.1 - 2016

TABLE B1: Differences in Energy Performance, and Annual Energy Cost between ASHRAE 90.1-2016 and 2020 NYStretch by Climate Zone and Building Type (Part C)

		Energy Usage		Total (kBtu)		Energy Cost			EUI (kBtu/sf)		ECI ($/sf)			Weighting Factors
		kWh	therms	Site	Source	Electricity	Gas	Total	Site	Source	Electricity	Gas	Total	
Warehouse		51,914	square feet											
4A	ASHRAE 90.1-2016	125,317	4,921	919,663	1,943,329	18,484	3,276	21,760	17.72	37.43	0.356	0.063	$ 0.42	
4A	NYStretch	109,025	4,189	790,848	1,681,000	16,081	2,788	18,870	15.23	32.38	0.310	0.054	$ 0.36	
4A	Savings	16,292	732	128,814	262,330	2,403	487	2,890	2.48	5.05	0.046	0.009	$ 0.06	2.5%
5A	ASHRAE 90.1-2016	125,589	8,115	1,240,006	2,280,859	18,524	5,402	23,926	23.89	43.94	0.357	0.104	$ 0.46	
5A	NYStretch	110,586	6,921	1,069,439	1,984,898	16,311	4,607	20,919	20.60	38.23	0.314	0.089	$ 0.40	
5A	Savings	15,003	1,194	170,567	295,961	2,213	795	3,008	3.29	5.70	0.043	0.015	$ 0.06	3.8%
6A	ASHRAE 90.1-2016	140,039	6,664	1,144,259	2,293,664	20,656	4,437	25,092	22.04	44.18	0.398	0.085	$ 0.48	
6A	NYStretch	120,967	5,805	993,282	1,986,376	17,843	3,865	21,707	19.13	38.26	0.344	0.074	$ 0.42	
6A	Savings	19,072	859	150,977	307,288	2,813	572	3,385	2.91	5.92	0.054	0.011	$ 0.07	1.2%
10 Story Highrise Apt.		84,140	square feet											
4A	ASHRAE 90.1-2016	486,453	24,164	4,076,188	8,073,640	71,752	16,086	87,838	48.45	95.96	0.853	0.191	$ 1.04	
4A	NYStretch	471,098	23,557	3,963,044	7,835,041	69,487	15,682	85,168	47.10	93.12	0.826	0.186	$ 1.01	
4A	Savings	15,356	608	113,144	238,599	2,265	404	2,669	1.34	2.84	0.027	0.005	$ 0.03	21.9%
5A	ASHRAE 90.1-2016	459,795	30,143	4,583,161	8,395,873	67,820	20,066	87,886	54.47	99.79	0.806	0.238	$ 1.04	
5A	NYStretch	444,061	29,030	4,418,150	8,100,014	65,499	19,325	84,824	52.51	96.27	0.778	0.230	$ 1.01	
5A	Savings	15,733	1,113	165,011	295,860	2,321	741	3,062	1.96	3.52	0.028	0.009	$ 0.04	0.0%
6A	ASHRAE 90.1-2016	458,814	30,223	4,587,788	8,393,046	67,675	20,119	87,795	54.53	99.75	0.804	0.239	$ 1.04	
6A	NYStretch	443,359	29,091	4,421,886	8,098,427	65,395	19,366	84,762	52.55	96.25	0.777	0.230	$ 1.01	
6A	Savings	15,456	1,132	165,902	294,620	2,280	753	3,033	1.97	3.50	0.027	0.009	$ 0.04	0.0%
20 Story Highrise Apt		168,279	square feet											
4A	ASHRAE 90.1-2016	1,197,004	40,689	8,153,111	17,901,324	176,558	27,087	203,645	48.45	106.38	1.049	0.161	$ 1.21	
4A	NYStretch	1,152,409	40,277	7,959,762	17,349,994	169,980	26,813	196,793	47.30	103.10	1.010	0.159	$ 1.17	
4A	Savings	44,594	412	193,349	551,331	6,578	274	6,852	1.15	3.28	0.039	0.002	$ 0.04	23.5%
5A	ASHRAE 90.1-2016	1,188,626	51,029	9,158,537	18,888,461	175,322	33,970	209,293	54.42	112.24	1.042	0.202	$ 1.24	
5A	NYStretch	1,143,904	50,478	8,950,788	18,321,053	168,726	33,603	202,329	53.19	108.87	1.003	0.200	$ 1.20	
5A	Savings	44,722	552	207,749	567,408	6,597	367	6,964	1.23	3.37	0.039	0.002	$ 0.04	0.1%
6A	ASHRAE 90.1-2016	1,188,990	52,179	9,274,748	19,012,980	175,376	34,736	210,112	55.12	112.98	1.042	0.206	$ 1.25	
6A	NYStretch	1,138,529	50,857	8,970,389	18,299,523	167,933	33,856	201,789	53.31	108.75	0.998	0.201	$ 1.20	
6A	Savings	50,461	1,322	304,359	713,458	7,443	880	8,323	1.81	4.24	0.044	0.005	$ 0.05	0.1%

* **Negative Savings** indicate that NYStretch results in higher energy use or cost relative to ASHRAE 90.1 - 2016

TABLE B2: Payback Period of Incremental First Cost between ASHRAE 90.1-2016 and 2020 NYStretch by CZ and Building Type (Part A)

Climate Zone	ASHRAE Standard	Energy Usage kWh	Energy Usage therms	Annual NYS Energy Cost Electricity	Annual NYS Energy Cost Gas	Annual NYS Energy Cost Total	Annual Savings Total	Annual Savings ($/sf)	Incremental First Cost Total	Incremental First Cost ($/sf)	Payback Period (Years)	Weighting Factors
Large Office		497,337 square feet										
4A	90.1-2016	7,404,873	45,821	$ 1,092,219	$ 30,503	$ 1,122,721						
4A	NYStretch	7,090,011	46,458	$ 1,045,777	$ 30,927	$ 1,076,703	$ 46,018	$ 0.093	$ 141,187	$ 0.284	3.1	7.5%
5A	90.1-2016	7,261,025	67,527	$ 1,071,001	$ 44,953	$ 1,115,954						
5A	NYStretch	6,929,778	68,076	$ 1,022,142	$ 45,318	$ 1,067,460	$ 48,493	$ 0.098	$ 234,656	$ 0.472	4.8	1.0%
6A	90.1-2016	7,265,584	72,306	$ 1,071,674	$ 48,134	$ 1,119,808						
6A	NYStretch	6,932,525	72,462	$ 1,022,547	$ 48,238	$ 1,070,785	$ 49,022	$ 0.099	$ 148,621	$ 0.299	3.0	0.3%
Standalone Retail		24,630 square feet										
4A	90.1-2016	262,889	1,981	$ 38,776	$ 1,319	$ 40,095						
4A	NYStretch	220,589	2,102	$ 32,537	$ 1,399	$ 33,936	$ 6,159	$ 0.250	$ 95,821	$ 3.890	15.6	4.9%
5A	90.1-2016	255,586	2,742	$ 37,699	$ 1,826	$ 39,525						
5A	NYStretch	210,720	2,946	$ 31,081	$ 1,961	$ 33,042	$ 6,483	$ 0.263	$ 75,788	$ 3.077	11.7	7.1%
6A	90.1-2016	261,103	3,068	$ 38,513	$ 2,043	$ 40,555						
6A	NYStretch	218,834	3,225	$ 32,278	$ 2,147	$ 34,425	$ 6,131	$ 0.249	$ 80,645	$ 3.274	13.2	2.6%
Secondary School		210,357 square feet										
4A	90.1-2016	1,753,599	18,055	$ 258,656	$ 12,019	$ 270,675						
4A	NYStretch	1,616,146	16,151	$ 238,381	$ 10,751	$ 249,133	$ 21,542	$ 0.102	$ 128,629	$ 0.611	6.0	5.0%
5A	90.1-2016	1,660,790	22,612	$ 244,967	$ 15,053	$ 260,020						
5A	NYStretch	1,523,268	20,845	$ 224,682	$ 13,877	$ 238,559	$ 21,461	$ 0.102	$ 91,266	$ 0.434	4.3	3.7%
6A	90.1-2016	1,662,210	23,538	$ 245,176	$ 15,669	$ 260,845						
6A	NYStretch	1,523,135	21,645	$ 224,662	$ 14,409	$ 239,071	$ 21,774	$ 0.104	$ 137,223	$ 0.652	6.3	1.1%
Large Hotel		121,813 square feet										
4A	90.1-2016	1,587,057	45,330	$ 234,091	$ 30,176	$ 264,267						
4A	NYStretch	1,445,229	43,085	$ 213,171	$ 28,681	$ 241,853	$ 22,414	$ 0.184	$ 215,819	$ 1.772	9.6	3.5%
5A	90.1-2016	1,496,437	50,472	$ 220,725	$ 33,599	$ 254,323						
5A	NYStretch	1,350,487	48,539	$ 199,197	$ 32,312	$ 231,509	$ 22,814	$ 0.187	$ 189,061	$ 1.552	8.3	2.5%
6A	90.1-2016	1,489,832	53,188	$ 219,750	$ 35,407	$ 255,157						
6A	NYStretch	1,345,009	51,399	$ 198,389	$ 34,216	$ 232,605	$ 22,552	$ 0.185	$ 182,079	$ 1.495	8.1	1.8%
Full Service Restaurant		5,488 square feet										
4A	90.1-2016	223,706	13,240	$ 32,997	$ 8,814	$ 41,811						
4A	NYStretch	190,350	12,252	$ 28,077	$ 8,156	$ 36,233	$ 5,578	$ 1.016	$ 30,670	$ 5.588	5.5	0.1%
5A	90.1-2016	213,031	15,675	$ 31,422	$ 10,435	$ 41,857						
5A	NYStretch	183,745	14,691	$ 27,102	$ 9,780	$ 36,882	$ 4,975	$ 0.906	$ 21,387	$ 3.897	4.3	0.3%
6A	90.1-2016	212,659	16,885	$ 31,367	$ 11,240	$ 42,607						
6A	NYStretch	183,195	15,893	$ 27,021	$ 10,580	$ 37,601	$ 5,006	$ 0.912	$ 22,967	$ 4.185	4.6	0.1%

TABLE B2: Payback Period of Incremental First Cost between ASHRAE 90.1-2016 and 2020 NYStretch by CZ and Building Type (Part B)

Climate Zone	ASHRAE Standard	Energy Usage kWh	Energy Usage therms	Annual NYS Energy Cost Electricity	Annual NYS Energy Cost Gas	Annual NYS Energy Cost Total	Annual Savings Total	Annual Savings ($/sf)	Incremental First Cost Total	Incremental First Cost ($/sf)	Payback Period (Years)	Weighting Factors
Outpatient Healthcare		40,843 square feet										
4A	90.1-2016	1,032,065	10,408	$ 152,230	$ 6,929	$ 159,158						
4A	NYStretch	964,334	10,684	$ 142,239	$ 7,112	$ 149,351	$ 9,807	$ 0.240	$ 126,695	$ 3.102	12.9	2.0%
5A	90.1-2016	1,004,067	11,865	$ 148,100	$ 7,898	$ 155,998						
5A	NYStretch	937,570	12,183	$ 138,292	$ 8,110	$ 146,402	$ 9,596	$ 0.235	$ 110,444	$ 2.704	11.5	2.4%
6A	90.1-2016	1,017,373	12,672	$ 150,063	$ 8,436	$ 158,498						
6A	NYStretch	950,276	13,044	$ 140,166	$ 8,683	$ 148,849	$ 9,649	$ 0.236	$ 110,741	$ 2.711	11.5	1.0%
Warehouse		51,914 square feet										
4A	90.1-2016	125,317	4,921	$ 18,484	$ 3,276	$ 21,760						
4A	NYStretch	109,025	4,189	$ 16,081	$ 2,788	$ 18,870	$ 2,890	$ 0.056	$ 53,254	$ 1.026	18.4	2.5%
5A	90.1-2016	125,589	8,115	$ 18,524	$ 5,402	$ 23,926						
5A	NYStretch	110,586	6,921	$ 16,311	$ 4,607	$ 20,919	$ 3,008	$ 0.058	$ 31,272	$ 0.602	10.4	3.8%
6A	90.1-2016	140,039	6,664	$ 20,656	$ 4,437	$ 25,092						
6A	NYStretch	120,967	5,805	$ 17,843	$ 3,865	$ 21,707	$ 3,385	$ 0.065	$ 39,118	$ 0.754	11.6	1.2%
10 Story Highrise Apt.		84,140 square feet										
4A	90.1-2016	486,453	24,164	$ 71,752	$ 16,086	$ 87,838						
4A	NYStretch	471,098	23,557	$ 69,487	$ 15,682	$ 85,168	$ 2,669	$ 0.032	$ 36,040	$ 0.428	13.5	21.9%
5A	90.1-2016	459,795	30,143	$ 67,820	$ 20,066	$ 87,886						
5A	NYStretch	444,061	29,030	$ 65,499	$ 19,325	$ 84,824	$ 3,062	$ 0.036	$ 32,095	$ 0.381	10.5	0.0%
6A	90.1-2016	458,814	30,223	$ 67,675	$ 20,119	$ 87,795						
6A	NYStretch	443,359	29,091	$ 65,395	$ 19,366	$ 84,762	$ 3,033	$ 0.036	$ 35,330	$ 0.420	11.6	0.0%
20 Story Highrise Apt		168,279 square feet										
4A	90.1-2016	1,197,004	40,689	$ 176,558	$ 27,087	$ 203,645						
4A	NYStretch	1,152,409	40,277	$ 169,980	$ 26,813	$ 196,793	$ 6,852	$ 0.041	$ 78,578	$ 0.467	11.5	23.5%
5A	90.1-2016	1,188,626	51,029	$ 175,322	$ 33,970	$ 209,293						
5A	NYStretch	1,143,904	50,478	$ 168,726	$ 33,603	$ 202,329	$ 6,964	$ 0.041	$ 71,908	$ 0.427	10.3	0.1%
6A	90.1-2016	1,188,990	52,179	$ 175,376	$ 34,736	$ 210,112						
6A	NYStretch	1,138,529	50,857	$ 167,933	$ 33,856	$ 201,789	$ 8,323	$ 0.049	$ 67,193	$ 0.399	8.1	0.1%
				Weighted Averages by Climate Zone			**4A**	**$ 0.077**		**$ 0.848**	**11.04**	**70.9%**
							5A	**$ 0.185**		**$ 1.808**	**9.76**	**20.9%**
							6A	**$ 0.187**		**$ 1.962**	**10.48**	**8.2%**
							Combined	**$ 0.109**		**$ 1.140**	**10.50**	**100.0%**

TABLE B3: 10 Year Present value of differences in Annual Energy Performance, Energy Cost and First Cost between ASHRAE 90.1-2016 and 2020 NYStretch by CZ and Building Type (Part A)

Climate Zone	ASHRAE Standard	Energy Usage kWh	Energy Usage therms	Energy Cost Total	10 yr Life Cycle Energy Cost Electricity	10 yr Life Cycle Energy Cost Gas	10 yr Life Cycle Energy Cost Total	10 yr Life Cycle Energy Cost Savings	Incremental First Cost	Residual Value At 10 Years	Net Savings over 10 yr Total	Net Savings over 10 yr Cost Index ($/sf)	Weighting Factors
Large Office		497,337 square feet											
4A	90.1-2016	7,404,873	45,821	$ 1,122,721	$ 10,070,256	$ 322,413	$ 10,392,669						
4A	NYStretch	7,090,011	46,458	$ 1,076,703	$ 9,642,061	$ 326,895	$ 9,968,956	$ 423,714	$ 141,187	$ 37,036	$319,563	$0.64	7.5%
5A	90.1-2016	7,261,025	67,527	$ 1,115,954	$ 9,874,631	$ 475,148	$ 10,349,779						
5A	NYStretch	6,929,778	68,076	$ 1,067,460	$ 9,424,151	$ 479,012	$ 9,903,163	$ 446,616	$ 234,656	$ 40,924	$252,884	$0.51	1.0%
6A	90.1-2016	7,265,584	72,306	$ 1,119,808	$ 9,880,830	$ 508,778	$ 10,389,609						
6A	NYStretch	6,932,525	72,462	$ 1,070,785	$ 9,427,887	$ 509,876	$ 9,937,763	$ 451,846	$ 148,621	$ 23,746	$326,971	$0.66	0.3%
Standalone Retail		24,630 square feet											
4A	90.1-2016	262,889	1,981	$ 40,095	$ 357,516	$ 13,941	$ 371,457						
4A	NYStretch	220,589	2,102	$ 33,936	$ 299,990	$ 14,787	$ 314,777	$ 56,679	$ 95,821	$ 25,882	($13,259)	($0.54)	4.9%
5A	90.1-2016	255,586	2,742	$ 39,525	$ 347,585	$ 19,297	$ 366,882						
5A	NYStretch	210,720	2,946	$ 33,042	$ 286,568	$ 20,728	$ 307,296	$ 59,586	$ 75,788	$ 18,591	$2,389	$0.10	7.1%
6A	90.1-2016	261,103	3,068	$ 40,555	$ 355,087	$ 21,589	$ 376,676						
6A	NYStretch	218,834	3,225	$ 34,425	$ 297,603	$ 22,691	$ 320,293	$ 56,383	$ 80,645	$ 21,594	($2,668)	($0.11)	2.6%
Secondary School		210,357 square feet											
4A	90.1-2016	1,753,599	18,055	$ 270,675	$ 2,384,806	$ 127,041	$ 2,511,847						
4A	NYStretch	1,616,146	16,151	$ 249,133	$ 2,197,877	$ 113,642	$ 2,311,520	$ 200,327	$ 128,629	$ 54,590	$126,288	$0.60	5.0%
5A	90.1-2016	1,660,790	22,612	$ 260,020	$ 2,258,592	$ 159,110	$ 2,417,702						
5A	NYStretch	1,523,268	20,845	$ 238,559	$ 2,071,568	$ 146,676	$ 2,218,244	$ 199,458	$ 91,266	$ 35,287	$143,479	$0.68	3.7%
6A	90.1-2016	1,662,210	23,538	$ 260,845	$ 2,260,522	$ 165,623	$ 2,426,145						
6A	NYStretch	1,523,135	21,645	$ 239,071	$ 2,071,387	$ 152,302	$ 2,223,689	$ 202,456	$ 137,223	$ 55,849	$121,082	$0.58	1.1%
Large Hotel		121,813 square feet											
4A	90.1-2016	1,587,057	45,330	$ 264,267	$ 2,158,318	$ 318,958	$ 2,477,276						
4A	NYStretch	1,445,229	43,085	$ 241,853	$ 1,965,439	$ 303,163	$ 2,268,602	$ 208,673	$ 215,819	$ 58,057	$50,912	$0.42	3.5%
5A	90.1-2016	1,496,437	50,472	$ 254,323	$ 2,035,080	$ 355,140	$ 2,390,220						
5A	NYStretch	1,350,487	48,539	$ 231,509	$ 1,836,595	$ 341,543	$ 2,178,138	$ 212,083	$ 189,061	$ 46,283	$69,305	$0.57	2.5%
6A	90.1-2016	1,489,832	53,188	$ 255,157	$ 2,026,097	$ 374,254	$ 2,400,350						
6A	NYStretch	1,345,009	51,399	$ 232,605	$ 1,829,146	$ 361,668	$ 2,190,813	$ 209,537	$ 182,079	$ 45,577	$73,035	$0.60	1.8%
Full Service Restaurant		5,488 square feet											
4A	90.1-2016	223,706	13,240	$ 41,811	$ 304,229	$ 93,165	$ 397,393						
4A	NYStretch	190,350	12,252	$ 36,233	$ 258,867	$ 86,209	$ 345,075	$ 52,318	$ 30,670	$ 9,805	$31,453	$5.73	0.1%
5A	90.1-2016	213,031	15,675	$ 41,857	$ 289,711	$ 110,294	$ 400,005						
5A	NYStretch	183,745	14,691	$ 36,882	$ 249,883	$ 103,370	$ 353,253	$ 46,751	$ 21,387	$ 7,721	$33,085	$6.03	0.3%
6A	90.1-2016	212,659	16,885	$ 42,607	$ 289,205	$ 118,807	$ 408,012						
6A	NYStretch	183,195	15,893	$ 37,601	$ 249,135	$ 111,830	$ 360,965	$ 47,046	$ 22,967	$ 8,675	$32,754	$5.97	0.1%

* **Negative Savings** indicate that NYStretch results in higher energy use or cost relative to ASHRAE 90.1-2016

TABLE B3: 10 Year Present value of differences in Annual Energy Performance, Energy Cost and First Cost between ASHRAE 90.1-2016 and 2020 NYStretch by CZ and Building Type (Part B)

Climate Zone	ASHRAE Standard	Energy Usage kWh	Energy Usage therms	Energy Cost Total	10 yr Life Cycle Energy Cost Electricity	10 yr Life Cycle Energy Cost Gas	10 yr Life Cycle Energy Cost Total	10 yr Life Cycle Energy Cost Savings	Incremental First Cost	Residual Value At 10 Years	Net Savings over 10 yr Total	Net Savings over 10 yr Cost Index ($/sf)	Weighting Factors*
Outpatient Healthcare		40,843 square feet											
4A	90.1-2016	1,032,065	10,408	$ 159,158	$ 1,403,556	$ 73,235	$ 1,476,791						
4A	NYStretch	964,334	10,684	$ 149,351	$ 1,311,446	$ 75,174	$ 1,386,620	$ 90,171	$ 126,695	$ 30,589	($5,934)	($0.15)	2.0%
5A	90.1-2016	1,004,067	11,865	$ 155,998	$ 1,365,482	$ 83,485	$ 1,448,966						
5A	NYStretch	937,570	12,183	$ 146,402	$ 1,275,049	$ 85,727	$ 1,360,775	$ 88,191	$ 110,444	$ 24,158	$1,905	$0.05	2.4%
6A	90.1-2016	1,017,373	12,672	$ 158,498	$ 1,383,576	$ 89,168	$ 1,472,744						
6A	NYStretch	950,276	13,044	$ 148,849	$ 1,292,328	$ 91,783	$ 1,384,110	$ 88,634	$ 110,741	$ 25,228	$3,121	$0.08	1.0%
Warehouse		51,914 square feet											
4A	90.1-2016	125,317	4,921	$ 21,760	$ 170,425	$ 34,625	$ 205,049						
4A	NYStretch	109,025	4,189	$ 18,870	$ 148,269	$ 29,472	$ 177,741	$ 27,308	$ 53,254	$ 14,315	($11,631)	($0.22)	2.5%
5A	90.1-2016	125,589	8,115	$ 23,926	$ 170,795	$ 57,100	$ 227,895						
5A	NYStretch	110,586	6,921	$ 20,919	$ 150,392	$ 48,700	$ 199,092	$ 28,803	$ 31,272	$ 10,203	$7,734	$0.15	3.8%
6A	90.1-2016	140,039	6,664	$ 25,092	$ 190,446	$ 46,894	$ 237,340						
6A	NYStretch	120,967	5,805	$ 21,707	$ 164,509	$ 40,850	$ 205,358	$ 31,982	$ 39,118	$ 14,592	$7,455	$0.14	1.2%
10 Story Highrise Apt.		84,140 square feet											
4A	90.1-2016	486,453	24,164	$ 87,838	$ 661,552	$ 170,029	$ 831,581						
4A	NYStretch	471,098	23,557	$ 85,168	$ 640,669	$ 165,754	$ 806,423	$ 25,157	$ 36,040	$ 12,192	$1,310	$0.02	21.9%
5A	90.1-2016	459,795	30,143	$ 87,886	$ 625,298	$ 212,102	$ 837,400						
5A	NYStretch	444,061	29,030	$ 84,824	$ 603,901	$ 204,268	$ 808,170	$ 29,230	$ 32,095	$ 11,372	$8,507	$0.10	0.0%
6A	90.1-2016	458,814	30,223	$ 87,795	$ 623,964	$ 212,663	$ 836,627						
6A	NYStretch	443,359	29,091	$ 84,762	$ 602,946	$ 204,700	$ 807,645	$ 28,982	$ 35,330	$ 13,443	$7,094	$0.08	0.0%
20 Story Highrise Apt		168,279 square feet											
4A	90.1-2016	1,197,004	40,689	$ 203,645	$ 1,627,865	$ 286,307	$ 1,914,173						
4A	NYStretch	1,152,409	40,277	$ 196,793	$ 1,567,219	$ 283,409	$ 1,850,628	$ 63,545	$ 78,578	$ 22,905	$7,872	$0.05	23.5%
5A	90.1-2016	1,188,626	51,029	$ 209,293	$ 1,616,472	$ 359,065	$ 1,975,537						
5A	NYStretch	1,143,904	50,478	$ 202,329	$ 1,555,652	$ 355,184	$ 1,910,836	$ 64,701	$ 71,908	$ 21,836	$14,629	$0.09	0.1%
6A	90.1-2016	1,188,990	52,179	$ 210,112	$ 1,616,967	$ 367,155	$ 1,984,121						
6A	NYStretch	1,138,529	50,857	$ 201,789	$ 1,548,342	$ 357,853	$ 1,906,196	$ 77,926	$ 67,193	$ 20,681	$31,414	$0.19	0.1%

Weighted Average Savings by Climate Zone			
	4A	$0.11	70.9%
	5A	$0.37	20.9%
	6A	$0.30	8.2%
	Combined	**$0.18**	**100.0%**

* **Negative Savings** indicate that NYStretch results in higher energy use or cost relative to ASHRAE 90.1-2016

Appendix C

EEM 9 High-efficiency SHW

Based on concerns over possible preemption of this measure, the requirement was subsequently removed from NYStretch. The analysis of the impact of the measure is included to memorialize the findings.

This measure required a high-efficiency service water heating (SWH) system. A service water heating system with large input size for either individual water heater or aggregate capacity of all water heaters would be required to have minimum thermal efficiency (Et) of 94%. This requirement only applied to buildings with water heating equipment with an individual or aggregate input rating of 1,000,000 Btu/h or greater.

PNNL's analysis for this measure originally showed savings associated with the prototypes for large hotel, full-service restaurant, outpatient healthcare, 10-story apartments and 20-story apartments.

Upon review, Vidaris found only 20-story apartment building prototype had a SHW system meeting the 1,000,000 Btu/h threshold. Costing for this measure was based on the price differential for three 400 MBH boilers with the efficiencies in the following table.

	2020 NYStretch	**ASHRAE 90.1-2016**
20-Story Apartment	High efficiency hot water heaters with 94% Et 1,200 MBH total capacity	Hot water heaters with 90% Et 1,200 MBH total capacity

Based on Vidaris' analysis, savings and payback for this measure varies by climate zone as shown in the following table. Annual energy cost savings are between $563 and $633, and payback is between 8.58 and 5.65 years for CZs 4A and 6A, respectively.

20 Story Highrise Apt **168,279 square feet**

CZ	Description	Energy Usage kWh	Energy Usage therms	Annual NYS Energy Cost Electricity	Annual NYS Energy Cost Gas	Annual NYS Energy Cost Total	Annual Savings Total	Incremental First Cost Total	Payback Period (Years)
4A	SHW 90% Eff.	1,152,409	40,277	$169,980	$26,813	$196,793			
4A	SHW 94% Eff.	1,152,409	39,432	$169,980	$26,250	$196,230	**$563**	**$4,833**	**8.58**
5A	SHW 90% Eff.	1,143,904	50,478	$168,726	$33,603	$202,329			
5A	SHW 94% Eff.	1,143,904	49,577	$168,726	$33,003	$201,729	**$600**	**$3,795**	**6.33**
6A	SHW 90% Eff.	1,138,529	50,857	$167,933	$33,856	$201,789			
6A	SHW 94% Eff.	1,138,529	49,907	$167,933	$33,223	$201,156	**$633**	**$3,572**	**5.65**

Based on the limited savings for the measure and concerns regarding potential federal preemption of this section, NYSERDA elected not to include the SHW requirements in the final version of the 2020 NYStretch Energy Code.

Appendix D.

Cost Estimates

2020 NYStretch
LARGE OFFICE - 4A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 16,034	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		38,353	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential mass wall)* *4A: U-0.104; R-7.62*		74,849	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 4A: U-0.030; R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	38,353	Area	$ 0.3881	$ 14,884		
EEM	Enhanced wall insulation (nonresidential mass wall) 4A: U-0.099; R-8.30 (+ R-0.48)	RSMeans 07 21 13.10	74,849	Area	$ 0.0154	$ 1,150		
EEM 2	**Enhanced fenestration**						$ 25,904	
Standard	*Standard windows, U-0.38*		49,899	Area	$ -	$ -		
EEM	Enhanced windows, U-0.36	PNNL CE ANALYSIS	49,899	Area	$ 0.52	$ 25,904		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		392,896	watts	$ 6.75	$ -		No cost assumed for this building type
EEM	Reduced LPDs, ~20% more efficient	HBL	308,846	watts	$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-		$ -	$ -		
EEM	n/a - IECC only		-		$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-		$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-		$ -	$ -		
EEM 7	**Reduce fan power allowances (based on improved fan efficiencies)**						$ 116,592	
Standard	*CV fans: 0.00094 bhp/cfm*					$ -		
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		
EEM	CV fans: 0.00088 bhp/cfm	RSMeans 23 74 33.10	4.98	tons	$ 1,031	$ 5,137		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	31,262	cfm	$ 3.565	$ 111,456		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 2,448	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck, 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	7,200	Area	$ 0.3400	$ 2,448		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	RSMeans 26 51 13.55	17,406	watts	$ -	$ -		No cost; parking lot can be met with MH
EEM	Reduced LPDs, ~32% more efficient	RSMeans 26 51 13.55			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ 120,000	
Standard	*Standard elevator motors, 30hp*		-	each		$ -		
EEM	Elevator motors with regenerative drives, 30 hp	Previous projects	12	each	$ 10,000	$ 120,000		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-		$ -	$ -		
EEM	n/a - applies to IECC path only		-		$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (32,749)	
Standard	*Watercooled chiller, 701 tons*	*RSMeans 23 64 13.10*	2	units	$ 318,147	$ 636,295		
Standard	*Cooling tower, 1602 tons*	*RSMeans 23 65 13.10*	2	units	$ 184,539	$ 369,079		
EEM	Watercooled chiller, 676 tons	RSMeans 23 64 13.10	2	units	$ 308,568	$ 617,136		
EEM	Cooling tower, 1543 tons	RSMeans 23 65 13.10	2	units	$ 177,744	$ 355,488		
ACA 2	**Reduced capacity for heating equipment**						$ (12,832)	
Standard	*Hot water boiler, gas fired, 8877 MBH*	*RSMeans D3020 130*	1	units	$ 261,867	$ 261,867		
EEM	*Hot water boiler, gas fired, 8419 MBH*	RSMeans D3020 130	1	units	$ 249,034	$ 249,034		
ACA 3	**Reduced capacity for air handling equipment**						$ (133,102)	
Standard	*VAV with Reheat, 274885 cfm*	*RSMeans D3040 134*	1	units	$ 2,727,871	$ 2,727,871		
EEM	*VAV with Reheat, 261451 cfm*	RSMeans D3040 134	1	units	$ 2,594,768	$ 2,594,768		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard	*No charging stations, 325,080sf parking lot, 300sf per parking spot*		-		$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-		$ -	$ -		No Cost
EEM			-		$ -	$ -		
						Total	***$ 104,894***	

2020 NYStretch
LARGE OFFICE - 5A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-19

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 16,130	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		38,353	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential mass wall)* *5A: U-0.090; R-9.31*		74,849	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 5A: U-0.030; R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	38,353	Area	$ 0.3881	$ 14,884		
EEM	Enhanced wall insulation (nonresidential mass wall) 5A: U-0.086; R-9.83 (+ R-0.52)	RSMeans 07 21 13.10	74,849	Area	$ 0.0166	$ 1,245		
EEM 2	**Enhanced fenestration**						$ 26,344	
Standard	*Standard windows, U-0.38*		49,899	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.36	PNNL CE ANALYSIS	49,899	Area	$ 0.53	$ 26,344		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		392,896	watts	$ 6.75	$ -		No cost assumed for this buidling type
EEM	Reduced LPDs, ~20% more efficiant	HBL	308,846	watts	$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-		$ -	$ -		
EEM	n/a - IECC only		-		$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-		$ -	$ -		
EEM	n/a - IECC only, already included in NYS amendments to 90.1-2016		-		$ -	$ -		
EEM 7	**Reduce fan power allowances (based on improved fan efficiencies)**						$ 120,025	
Standard	*CV fans: 0.00094 bhp/cfm*					$ -		
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		
EEM	CV fans: 0.00088 bhp/cfm	RSMeans 23 74 33.10	5.09	tons	$ 1,031	$ 5,250		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	32,193	cfm	$ 3.565	$ 114,775		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 2,448	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	7,200	Area	$ 0.3400	$ 2,448		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	RSMeans 26 51 13.55	43,412	watts	$ -	$ -		
EEM	Reduced LPDs, ~32% more efficient	RSMeans 26 51 13.55			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ 120,000	
Standard	*Standard elevator motors, 30hp*		-	each	$ -	$ -		
EEM	Elevator motors with regenerative drives, 30 hp	Previous projects	12	each	$ 10,000	$ 120,000		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-		$ -	$ -		
EEM	n/a - applies to IECC path only		-		$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (10,238)	
Standard	*Watercooled chiller, 683 tons*	RSMeans 23 64 13.10	2	*units*	$ 311,297	$ 622,594		
Standard	*Cooling tower, 1560 tons*	RSMeans 23 65 13.10	2	*units*	$ 179,680	$ 359,360		
EEM	Watercooled chiller, 675 tons	RSMeans 23 64 13.10	2	*units*	$ 308,303	$ 616,605		
EEM	Cooling tower, 1542 tons	RSMeans 23 65 13.10	2	*units*	$ 177,556	$ 355,112		
ACA 2	**Reduced capacity for heating equipment**						$ (44,204)	
Standard	*Hot water boiler, gas fired, 9963 MBH*	RSMeans D3020 130	1	*units*	$ 292,309	$ 292,309		
EEM	*Hot water boiler, gas fired, 8386 MBH*	RSMeans D3020 130	1	units	$ 248,105	$ 248,105		
ACA 3	**Reduced capacity for air handling equipment**						$ (78,938)	
Standard	*VAV with Reheat, 276750 cfm*	RSMeans D3040 134	1	*units*	$ 2,746,345	$ 2,746,345		
EEM	*VAV with Reheat, 268782 cfm*	RSMeans D3040 134	1	units	$ 2,667,408	$ 2,667,408		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*			units		$ -		
EEM	n/a - does not apply to this building type			units		$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 70,434	
Standard	*No charging stations, 325,080sf parking lot, 300sf per parking spot*		-		$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	54	outlets	$ 1,300	$ 70,434		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-		$ -	$ -		
EEM			-		$ -	$ -		
						Total	***$ 222,002***	

2020 NYStretch
LARGE OFFICE - 6A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-19

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 24,583	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		38,353	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential mass wall) 6A: U-0.080; R-10.70*		74,849	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 6A: U-0.029; R-33.4 (+ R-3.4)	RSMeans 07 22 16.10	38,353	Area	$ 0.5998	$ 23,003		
EEM	Enhanced wall insulation (nonresidential mass wall) 6A: U-0.076; R-11.36 (+ R-0.66)	RSMeans 07 21 13.10	74,849	Area	$ 0.0211	$ 1,581		
EEM 2	**Enhanced fenestration**						$ 26,137	
Standard	*Standard windows, U-0.36*		49,899	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.34	PNNL CE ANALYSIS	49,899	Area	$ 0.52	$ 26,137		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling unit**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		392,896	watts	$ -	$ -		No cost assumed for this building type
EEM	Reduced LPDs, ~20% more efficient	HBL	308,846	watts	$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lightin**						$ -	
Standard	*n/a - IECC only*		-		$ -	$ -		
EEM	n/a - IECC only		-		$ -	$ -		
EEM 6	**Exterior lighting contro**						$ -	
Standard	*n/a*		-		$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-		$ -	$ -		
EEM 7	**Reduce fan power allowances (based on improved fan efficiencies)**						$ 115,148	
Standard	*CV fans: 0.00094 bhp/cfm*					$ -		
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		
EEM	CV fans: 0.00088 bhp/cfm	RSMeans 23 74 33.10	4.95	tons	$ 1,031	$ 5,107		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	30,865	cfm	$ 3.565	$ 110,041		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 2,448	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	7,200	Area	$ 0.3400	$ 2,448		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	RSMeans 26 51 13.55	*43,412*	watts	$ -	$ -		
EEM	Reduced LPDs, ~11% more efficient	RSMeans 26 51 13.55	-		$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ 120,000	
Standard	*Standard elevator motors, 30hp*		-	each	$ -	$ -		
EEM	Elevator motors with regenerative drives, 30 hp	Previous projects	12	each	$ 10,000	$ 120,000		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-		$ -	$ -		
EEM	n/a - applies to IECC path only		-		$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (31,001)	
Standard	*Watercooled chiller, 633 tons*	RSMeans 23 64 13.10	2	*units*	$ 292,639	$ 585,278		
Standard	*Cooling tower, 1445 tons*	RSMeans 23 65 13.10	2	*units*	$ 166,445	$ 332,890		
EEM	Watercooled chiller, 607 tons	RSMeans 23 64 13.10	2	units	$ 283,243	$ 566,486		
EEM	Cooling tower, 1392 tons	RSMeans 23 65 13.10	2	units	$ 160,340	$ 320,680		
ACA 2	**Reduced capacity for heating equipment**						$ (14,628)	
Standard	*Hot water boiler, gas fired, 9870 MBH*	RSMeans D3020 130	1	units	$ 289,692	$ 289,692		
EEM	*Hot water boiler, gas fired, 9348 MBH*	RSMeans D3020 130	1	units	$ 275,064	$ 275,064		
ACA 3	**Reduced capacity for air handling equipment**						$ (163,754)	
Standard	*VAV with Reheat, 275076 cfm*	RSMeans D3040 134	1	units	$ 2,729,760	$ 2,729,760		
EEM	*VAV with Reheat, 258548 cfm*	RSMeans D3040 134	1	units	$ 2,566,006	$ 2,566,006		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 70,434	
Standard	*No charging stations, 325,080sf parking lot, 300sf per parking spot*		-		$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	54	outlets	$ 1,300	$ 70,434		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-		$ -	$ -		
EEM			-		$ -	$ -		
						Total	***$ 149,368***	

2020 NYStretch
STANDALONE RETAIL - 4A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 9,763	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		24,692	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential mass wall)* *4A: U-0.104; R-7.82*		11,768	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 4A: U-0.030; R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	24,692	Area	$ 0.3881	$ 9,583		
EEM	Enhanced wall insulation (nonresidential mass wall) 4A: U-0.099; R-8.30 (+ R-0.48)	RSMeans 07 21 13.10	11,766	Area	$ 0.0154	$ 181		
EEM 2	**Enhanced fenestration**						$ 447	
Standard	*Standard windows, U-0.37*		904	Area	$ -	$ -		
EEM	Enhanced windows, U-0.35	PNNL CE ANALYSIS	904	Area	$ 0.50	$ 447		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 59,518	
Standard	*Lighting per ASHRAE 90.1-2016*		35,787	watts	$ 6.75	$ 241,565		Cost assumed to be proportional to increased efficiency
EEM	Reduced LPDs, ~25% more efficient	HBL	26,970	watts	$ -	$ 301,083.28		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ 960	
Standard	*CV fans: 0.00094 bhp/cfm*			tons		$ -		Costed as increased system size for reduction in static pressure
EEM	CV fans: 0.00088 bhp/cfm	RSMeans 23 74 33.10	0.93	tons	$ 1,031	$ 960		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	Area	$ 0	$ -		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	1,702	watts	$ -	$ -		
EEM	Reduced LPDs, ~11% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (2,100)	
Standard	*Packaged single-zone AC, 56 tons*	*RSMeans 23 74 33.10*	1	units	$ 72,373	$ 72,373		
EEM	Packaged single-zone AC, 53 tons	RSMeans 23 74 33.10	1	units	$ 70,273	$ 70,273		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 71,189***	

2020 NYStretch
STANDALONE RETAIL - 5A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 9,778	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		24,692	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential mass wall) 5A: U-0.090; R-9.31*		11,766	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 5A: U-0.030, R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	24,692	Area	$ 0.3881	$ 9,583		
EEM	Enhanced wall insulation (nonresidential mass wall) 5A: U-0.086, R-9.83 (+ R-0.52)	RSMeans 07 21 13.10	11,766	Area	$ 0.0166	$ 196		
EEM 2	**Enhanced fenestration**						$ 517	
Standard	*Standard windows, U-0.37*		904	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.35	PNNL CE ANALYSIS	904	Area	$ 0.57	$ 517		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 59,518	
Standard	*Lighting per ASHRAE 90.1-2016*		*35,787*	*watts*	$ 6.75	$ *241,565*		Cost assumed to be proportional to increased efficiency
EEM	Reduced LPDs, ~20% more efficient	HBL	26,970	watts	$ -	$ 301,083		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only, already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ 780	
Standard	*CV fans: 0.00094 bhp/cfm*			tons		$ -		Costed as increased system size for reduction in static pressure
EEM	CV fans: 0.00088 bhp/cfm	RSMeans 23 74 33.10	0.76	tons	$ 1,031	$ 780		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	Area	$ 0	$ -		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*3,453*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~11% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (6,479)	
Standard	*Packaged single-zone AC, 53 tons*	*RSMeans 23 74 33.10*	*1*	units	$ 69,354	$ 69,354		
EEM	Packaged single-zone AC, 46 tons	RSMeans 23 74 33.10	1	units	$ 62,875	$ 62,875		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	*units*	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 7,586	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	6	outlets	$ 1,300	$ 7,586		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 71,701***	

2020 NYStretch
STANDALONE RETAIL - 6A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 15,058	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		24,692	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential mass wall)* *6A: U-0.080; R-10.70*		11,766	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 6A: U-0.029; R-33.4 (+ R-3.4)	RSMeans 07 22 16.10	24,692	Area	$ 0.5998	$ 14,809		
EEM	Enhanced wall insulation (nonresidential mass wall) 6A: U-0.076; R-11.36 (+ R-0.66)	RSMeans 07 21 13.10	11,766	Area	$ 0.0211	$ 248		
EEM 2	**Enhanced fenestration**						$ 496	
Standard	*Standard windows, U-0.35*		904	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.33	PNNL CE ANALYSIS	904	Area	$ 0.55	$ 496		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 59,518	
Standard	*Lighting per ASHRAE 90.1-2016*		*35,787*	watts	$ 6.75	$ *241,565*		Cost assumed to be proportional to increased efficiency
EEM	Reduced LPDs, ~20% more efficient	HBL	28,870	watts	$ -	$ 301,083		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only, already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ 936	
Standard	*CV fans: 0.00094 bhp/cfm*			tons		$ -		Costed as increased system size for reduction in static pressure
EEM	CV fans: 0.00088 bhp/cfm	RSMeans 23 74 33.10	0.91	tons	$ 1,031	$ 936		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	Area	$ 0	$ -		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*3,453*	watts	$ -	$ -		
EEM	Reduced LPDs, ~11% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (2,543)	
Standard	*Packaged single-zone AC, 50 tons*	*RSMeans 23 74 33.10*	*1*	units	$ 66,677	$ *66,677*		
EEM	Packaged single-zone AC, 48 tons	RSMeans 23 74 33.10	1	units	$ 64,134	$ 64,134		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 7,586	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	6	outlets	$ 1,300	$ 7,586		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 81,051***	

2020 NYStretch
SECONDARY SCHOOL - 4A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 50,747	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		128,112	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential steel-frame wall) 4A: U-0.064; R-13.4*		41,755	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 4A: U-0.030; R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	128,112	Area	$ 0.3881	$ 49,718		
EEM	Enhanced wall insulation (nonresidential steel-frame wall) 4A: U-0.061; R-14.2 (+ R-0.77)	RSMeans 07 21 13.10	41,755	Area	$ 0.0246	$ 1,029		
EEM 2	**Enhanced fenestration**						$ 12,004	
Standard	*Standard windows, U-0.39*		22,484	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.37	PNNL CE ANALYSIS	22,484	Area	$ 0.53	$ 12,004		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		*157,768*	watts	$ 6.75	$ -		No cost assumed for this building type
EEM	Reduced LPDs, ~20% more efficient	HBL	127,266	watts	$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances (based on improved fan efficiencies)**						$ 36,643	
Standard	*CV fans: 0.00094 bhp/cfm*					$ -		
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		
EEM	CV fans: 0.00088 bhp/cfm	RSMeans 23 74 33.10	1.97	tons	$ 1,031	$ 2,032		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	9,708	cfm	$ 3.565	$ 34,611		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ 14,280	
Standard	*Standard efficiency fryers, dishwashers, ovens, and holding cabinets*		-	0	$ -	$ -		
EEM	Enegy Star fryers, dishwashers, ovens, and holding cabinets	Energy Star Savings Calculator	2,318	Area	$ 6.16	$ 14,280		
EEM 11	**Thermal bridging reduction**						$ 7,344	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	21,600	Area	$ 0.3400	$ 7,344		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*3,549*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~10% more efficient	RSMeans 26 51 13.55			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (5,166)	
Standard	*Air-cooled chiller, 308 tons*	*RSMeans 23 64 19.10*	*1*	units	$ 206,960	$ 206,960		
EEM	Air-cooled chiller, 300 tons	RSMeans 23 64 19.10	1	units	$ 201,794	$ 201,794		
ACA 2	**Reduced capacity for heating equipment**						$ (2,314)	
Standard	*Hot water boiler, gas fired, 3237 MBH*	RSMeans D3020 130	*1*	units	$ 103,770	$ 103,770		
EEM	Hot water boiler, gas fired, 3155 MBH	RSMeans D3020 130	1	units	$ 101,456	$ 101,456		
ACA 3	**Reduced capacity for air handling equipment**						$ (20,574)	
Standard	*VAV with Reheat, 64817 cfm*	RSMeans D3040 134	*1*	*units*	$ 646,519	$ 646,519		
EEM	VAV with Reheat, 62741 cfm	RSMeans D3040 134	1	units	$ 625,945	$ 625,945		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 95,564***	

2020 NYStretch
SECONDARY SCHOOL - 5A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 51,121	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		128,112	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential steel-frame wall) 5A: U-0.055, R-16.0*		41,755	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 5A: U-0.030, R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	128,112	Area	$ 0.3881	$ 49,718		
EEM	Enhanced wall insulation (nonresidential steel-frame wall) 5A: U-0.052, R-17.1 (+ R-1.05)	RSMeans 07 21 13.10	41,755	Area	$ 0.0336	$ 1,403		
EEM 2	**Enhanced fenestration**						$ 15,786	
Standard	*Standard windows, U-0.39*		22,484	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.35	PNNL CE ANALYSIS	22,484	Area	$ 0.70	$ 15,786		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		*157,768*	watts	$ 6.75	$ -		No cost assumed for this building type
EEM	Reduced LPDs, ~20% more efficient	HBL	127,268	watts	$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only, already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances (based on improved fan efficiencies)**						$ 37,359	
Standard	*CV fans: 0.00094 bhp/cfm*					*$ -*		
Standard	*VAV fans: 0.00130 bhp/cfm*					*$ -*		
EEM	CV fans: 0.00088 bhp/cfm	RSMeans 23 74 33.10	2.01	tons	$ 1,031	$ 2,070		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	9,898	cfm	$ 3.565	$ 35,289		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ 14,280	
Standard	*Standard efficiency fryers, dishwashers, ovens, and holding cabinets*		-	0	$ -	$ -		
EEM	Enegy Star fryers, dishwashers, ovens, and holding cabinets	Energy Star Savings Calculator	2,319	Area	$ 6.16	$ 14,280		
EEM 11	**Thermal bridging reduction**						$ 7,344	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation. Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	21,600	Area	$ 0.3400	$ 7,344		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*6,525*	watts	$ -	$ -		
EEM	Reduced LPDs, ~10% more efficient	RSMeans 26 51 13.55			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (30,626)	
Standard	*Air-cooled chiller, 295 tons*	*RSMeans 23 64 19.10*	*1*	units	$ 198,755	*$ 198,755*		
EEM	Air-cooled chiller, 243 tons	RSMeans 23 64 19.10	1	units	$ 168,129	$ 168,129		
ACA 2	**Reduced capacity for heating equipment**						$ (192)	
Standard	*Hot water boiler, gas fired, 3420 MBH*	RSMeans D3020 130	*1*	units	$ 108,879	*$ 108,879*		
EEM	Hot water boiler, gas fired, 3413 MBH	RSMeans D3020 130	1	units	$ 108,687	$ 108,687		
ACA 3	**Reduced capacity for air handling equipment**						$ (21,624)	
Standard	*VAV with Reheat, 66152 cfm*	RSMeans D3040 134	*1*	*units*	$ 659,746	*$ 659,746*		
EEM	*VAV with Reheat, 63970 cfm*	RSMeans D3040 134	1	units	$ 638,122	$ 638,122		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 12,896	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	10	outlets	$ 1,300	$ 12,896		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 86,344***	

2020 NYStretch
SECONDARY SCHOOL - 6A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 78,907	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		128,112	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential steel-frame wall) 6A: U-0.049; R-17.5*		41,755	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 6A: U-0.029, R-33.4 (+ R-3.4)	RSMeans 07 22 16.10	128,112	Area	$ 0.5998	$ 76,836		
EEM	Enhanced wall insulation (nonresidential steel-frame wall) 6A: U-0.047; R-19.1 (+ R-1.55)	RSMeans 07 21 13.10	41,755	Area	$ 0.0496	$ 2,071		
EEM 2	**Enhanced fenestration**						$ 16,119	
Standard	*Standard windows, U-0.37*		22,484	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.34	PNNL CE ANALYSIS	22,484	Area	$ 0.72	$ 16,119		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		*157,768*	watts	$ 6.75	$ -		No cost assumed for this buidling type
EEM	Reduced LPDs, ~20% more efficient	HBL	127,266	watts	$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only, already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances (based on improved fan efficiencies)**						$ 36,864	
Standard	*CV fans: 0.00094 bhp/cfm*					$ -		
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		
EEM	CV fans: 0.00088 bhp/cfm	RSMeans 23 74 33.10	1.99	tons	$ 1,031	$ 2,054		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	9,764	cfm	$ 3.565	$ 34,810		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ 14,280	
Standard	*Standard efficiency fryers, dishwashers, ovens, and holding cabinets*		-	0	$ -	$ -		
EEM	Enegy Star fryers, dishwashers, ovens, and holding cabinets	Energy Star Savings Calculator	2,319	Area	$ 6.16	$ 14,280		
EEM 11	**Thermal bridging reduction**						$ 7,344	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	21,600	Area	$ 0.3400	$ 7,344		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*6,525*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~10% more efficient	RSMeans 26 51 13.55			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (3,519)	
Standard	*Air-cooled chiller, 230 tons*	*RSMeans 23 64 19.10*	1	units	$ 159,995	$ 159,995		
EEM	Air-cooled chiller, 224 tons	RSMeans 23 64 19.10	1	units	$ 156,476	$ 156,476		
ACA 2	**Reduced capacity for heating equipment**						$ (2,935)	
Standard	*Hot water boiler, gas fired, 2438 MBH*	RSMeans D3020 130	*1*	units	$ 81,357	$ *81,357*		
EEM	Hot water boiler, gas fired, 2333 MBH	RSMeans D3020 130	1	units	$ 78,423	$ 78,423		
ACA 3	**Reduced capacity for air handling equipment**						$ (22,044)	
Standard	*VAV with Reheat, 65326 cfm*	RSMeans D3040 134	*1*	*units*	$ 651,558	$ *651,558*		
EEM	*VAV with Reheat, 63101 cfm*	RSMeans D3040 134	1	units	$ 629,514	$ 629,514		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 12,896	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	10	outlets	$ 1,300	$ 12,896		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 137,912***	

2020 NYStretch
LARGE HOTEL - 4A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 8,770	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		21,300	Area	$ -	$ -		
Standard	*Standard wall insulation (residential mass wall)* *4A: U-0.090; R-9.31*		30,285	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 4A: U-0.030, R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	21,300	Area	$ 0.3881	$ 8,266		
EEM	Enhanced wall insulation (residential mass wall) 4A: U-0.086, R-9.83 (+ R-0.52)	RSMeans 07 21 13.10	30,285	Area	$ 0.0166	$ 504		
EEM 2	**Enhanced fenestration**						$ 7,042	
Standard	*Standard windows, U-0.39*		13,068	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.37	PNNL CE ANALYSIS	13,068	Area	$ 0.54	$ 7,042		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 138,136	
Standard	*Lighting per ASHRAE 90.1-2016*		*95,014*	watts	$ 6.75	$ *641,345*		
EEM	Reduced LPDs, ~20% more efficient	HBL	74,550	watts	$ -	$ 779,481		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only, already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ 21,952	
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	6,157.34	cfm	$ 3.565	$ 21,952		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ 6,810	
Standard	*Standard efficiency fryers, dishwashers, ovens, and holding cabinets*		-	0	$ -	$ -		
EEM	Enegy Star fryers, dishwashers, ovens, and holding cabinets	Energy Star Savings Calculator	1,106	Area	$ 6.16	$ 6,810		
EEM 11	**Thermal bridging reduction**						$ 2,197	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	6,462	Area	$ 0.3400	$ 2,197		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*12,951*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~24% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (3,703)	
Standard	*Air-cooled chiller, 255 tons*	*RSMeans 23 64 19.10*	*1*	units	$ 175,162	$ *175,162*		
EEM	Air-cooled chiller, 249 tons	*RSMeans 23 64 19.10*	1	0	$ 171,459	$ 171,459		
ACA 2	**Reduced capacity for heating equipment**						$ (2,677)	
Standard	*Hot water boiler, gas fired, 2197 MBH*	*RSMeans D3020 130*	*1*	units	$ 74,604	$ *74,604*		
EEM	Hot water boiler, gas fired, 2101 MBH	*RSMeans D3020 130*	1	0	$ 71,926	$ 71,926		
ACA 3	**Reduced capacity for air handling equipment**						$ (20,784)	
Standard	*VAV w/reheat, 41891 cfm*	*RSMeans D3040 134*	*1*	*units*	$ 419,384	$ *419,384*		
EEM	*VAV w/reheat, 39793 cfm*	RSMeans D3040 134	1	units	$ 398,580	$ 398,580		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 160,341***	

2020 NYStretch
LARGE HOTEL - 5A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 8,905	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		21,300	Area	$ -	$ -		
Standard	*Standard wall insulation (residential mass wall) 5A: U-0.080, R-10.70*		30,265	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 5A: U-0.030, R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	21,300	Area	$ 0.3881	$ 8,266		
EEM	Enhanced wall insulation (residential mass wall) 5A: U-0.076, R-11.3 (+ R-0.66)	RSMeans 07 21 13.10	30,265	Area	$ 0.0211	$ 639		
EEM 2	**Enhanced fenestration**						$ 8,212	
Standard	*Standard windows, U-0.39*		13,068	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.36	PNNL CE ANALYSIS	13,068	Area	$ 0.63	$ 8,212		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 138,136	
Standard	*Lighting per ASHRAE 90.1-2016*		95,014	watts	$ 6.75	$ 641,345		
EEM	Reduced LPDs, ~20% more efficient	HBL	74,550	watts	$ -	$ 779,481		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ 22,502	
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	6,311.43	cfm	$ 3.565	$ 22,502		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ 6,810	
Standard	*Standard efficiency fryers, dishwashers, ovens, and holding cabinets*		-	0	$ -	$ -		
EEM	Enegy Star fryers, dishwashers, ovens, and holding cabinets	Energy Star Savings Calculator	1,106	Area	$ 6.16	$ 6,810		
EEM 11	**Thermal bridging reduction**						$ 2,197	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	6,462	Area	$ 0.3400	$ 2,197		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*12,951*	watts	$ -	$ -		
EEM	Reduced LPDs, ~11% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (3,555)	
Standard	*Air-cooled chiller, 249 tons*	*RSMeans 23 64 19.10*	*1*	units	$ 171,684	$ *171,684*		
EEM	Air-cooled chiller, 243 tons	*RSMeans 23 64 19.10*	1	0	$ 168,129	$ 168,129		
ACA 2	**Reduced capacity for heating equipment**						$ (2,925)	
Standard	*Hot water boiler, gas fired, 2484 MBH*	*RSMeans D3020 130*	*1*	units	$ 82,642	$ *82,642*		
EEM	Hot water boiler, gas fired, 2379 MBH	*RSMeans D3020 130*	1	0	$ 79,717	$ 79,717		
ACA 3	**Reduced capacity for air handling equipment**						$ (20,574)	
Standard	*VAV w/reheat, 42865 cfm*	*RSMeans D3040 134*	*1*	*units*	$ 429,021	$ *429,021*		
EEM	*VAV w/reheat, 40789 cfm*	RSMeans D3040 134	1	units	$ 408,447	$ 408,447		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 19,158	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	15	outlets	$ 1,300	$ 19,158		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 178,865***	

2020 NYStretch
LARGE HOTEL - 6A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 12,775	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		21,300	Area	$ -	$ -		
Standard	*Standard wall insulation (residential mass wall)* *6A: U-0.071; R-12.3*		30,265	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 6A: U-0.029, R-33.4 (+ R-3.4)	RSMeans 07 22 16.10	21,300	Area	$ 0.5998	$ 12,775		
EEM	Enhanced wall insulation (residential mass wall) 6A: U-0.067; R-13.1 (+ R-0.84)	RSMeans 07 21 13.10	30,265	Area	$ 0.0269	$ 814		
EEM 2	**Enhanced fenestration**						$ 8,470	
Standard	*Standard windows, U-0.37*		13,068	Area	$ -	$ -		
EEM	Enhanced windows, U-0.35	PNNL CE ANALYSIS	13,068	Area	$ 0.65	$ 8,470		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 138,136	
Standard	*Lighting per ASHRAE 90.1-2016*		*95,014*	watts	$ 6.75	$ *641,345*		
EEM	Reduced LPDs, ~20% more efficient	HBL	74,550	watts	$ -	$ 779,481		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only, already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ 22,057	Costed as increased system size for reduction in static pressure
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	6,186.85	cfm	$ 3.565	$ 22,057		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ 6,810	
Standard	*Standard efficiency fryers, dishwashers, ovens, and holding cabinets*		-	0	$ -	$ -		
EEM	Enegy Star fryers, dishwashers, ovens, and holding cabinets	Energy Star Savings Calculator	1,106	Area	$ 6.16	$ 6,810		
EEM 11	**Thermal bridging reduction**						$ 2,197	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	6,462	Area	$ 0.3400	$ 2,197		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*12,951*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~11% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (3,519)	
Standard	*Air-cooled chiller, 230 tons*	*RSMeans 23 64 19.10*	1	units	$ 159,995	$ 159,995		
EEM	Air-cooled chiller, 224 tons	*RSMeans 23 64 19.10*	1	0	$ 156,476	$ 156,476		
ACA 2	**Reduced capacity for heating equipment**						$ (2,935)	
Standard	*Hot water boiler, gas fired, 2438 MBH*	*RSMeans D3020 130*	1	units	$ 81,357	$ *81,357*		
EEM	Hot water boiler, gas fired, 2333 MBH	*RSMeans D3020 130*	1	0	$ 78,423	$ 78,423		
ACA 3	**Reduced capacity for air handling equipment**						$ (20,164)	
Standard	*VAV w/reheat, 42018 cfm*	*RSMeans D3040 134*	1	*units*	$ 420,623	$ *420,623*		
EEM	VAV w/reheat, 39984 cfm	RSMeans D3040 134	1	units	$ 400,459	$ 400,459		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 19,158	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	15	outlets	$ 1,300	$ 19,158		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 182,994***	

2020 NYStretch
FULL-SERVICE RESTAURANT - 4A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 2,602	
Standard	*Standard U-0.021, R-49 roof insulation (attic roof)*		6,130	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential steel-frame wall)* *4A: U-0.064; R-13.4*		2,460	Area	$ -	$ -		
EEM	Enhanced roof insulation (attic roof) 4A: U-0.020; R-51.4 (+ R-2.35)	RSMeans 07 22 16.10	6,130	Area	$ 0.4145	$ 2,541		
EEM	Enhanced wall insulation (nonresidential steel-frame wall) 4A: U-0.061; R-14.2 (+ R-0.77)	RSMeans 07 21 13.10	2,460	Area	$ 0.0246	$ 61		
EEM 2	**Enhanced fenestration**						$ 251	
Standard	*Standard windows, U-0.37*		508	Area	$ -	$ -		
EEM	Enhanced windows, U-0.35	PNNL CE ANALYSIS	508	Area	$ 0.50	$ 251		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 8,372	
Standard	*Lighting per ASHRAE 90.1-2016*		4,418	watts	$ 6.75	$ 29,820		
EEM	Reduced LPDs, ~20% more efficient	HBL	3,176	watts	$ -	$ 38,192		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*n/a - does not apply to this building type*			tons	$ 1,031	$ -		
EEM	n/a - does not apply to this building type			cfm	$ 4	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ 9,216	
Standard	*Standard efficiency fryers, dishwashers, ovens, and holding cabinets*		-	0	$ -	$ -		
EEM	Enegy Star fryers, dishwashers, ovens, and holding cabinets	Energy Star Savings Calculator	1,497	Area	$ 6.16	$ 9,216		
EEM 11	**Thermal bridging reduction**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	Area	$ 0	$ -		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	1,433	watts	$ -	$ -		
EEM	Reduced LPDs, ~9% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (255)	
Standard	*Packaged single-zone AC, 26.2 tons*	*RSMeans 23 74 33.10*	1	units	$ 31,039	$ 31,039		
EEM	Packaged single-zone AC, 26 tons	*RSMeans 23 74 33.10*	1	units	$ 30,784	$ 30,784		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 22,786***	

2020 NYStretch
FULL SERVICE RESTAURANT - 5A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 2,624	
Standard	*Standard U-0.021, R-49 roof insulation (attic roof)*		6,130	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential steel-frame wall)* *5A: U-0.055; R-16.0*		2,460	Area	$ -	$ -		
EEM	Enhanced roof insulation (attic roof) 5A: U-0.020; R-51.4 (+ R-2.35)	RSMeans 07 22 16.10	6,130	Area	$ 0.4145	$ 2,541		
EEM	Enhanced wall insulation (nonresidential steel-frame wall) 5A: U-0.052; R-17.1 (+ R-1.05)	RSMeans 07 21 13.10	2,460	Area	$ 0.0336	$ 83		
EEM 2	**Enhanced fenestration**						$ 291	
Standard	*Standard windows, U-0.37*		508	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.35	PNNL CE ANALYSIS	508	Area	$ 0.57	$ 291		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 8,372	
Standard	*Lighting per ASHRAE 90.1-2016*		*4,416*	watts	$ 6.75	$ 29,820		
EEM	Reduced LPDs, ~20% more efficient	HBL	3,178	watts	$ -	$ 38,192		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only, already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*n/a - does not apply to this building type*			tons	$ 1,031	$ -		
EEM	n/a - does not apply to this building type			cfm	$ 4	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ 9,216	
Standard	*Standard efficiency fryers, dishwashers, ovens, and holding cabinets*		-	0	$ -	$ -		
EEM	Enegy Star fryers, dishwashers, ovens, and holding cabinets	Energy Star Savings Calculator	1,497	Area	$ 6.16	$ 9,216		
EEM 11	**Thermal bridging reduction**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	Area	$ 0	$ -		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*1,433*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~9% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (266)	
Standard	*Packaged single-zone AC, 26.3 tons*	*RSMeans 23 74 33.10*	*1*	units	$ 31,156	$ *31,156*		
EEM	Packaged single-zone AC, 26.1 tons	*RSMeans 23 74 33.10*	1	units	$ 30,887	$ 30,887		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	*units*	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ -	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	-	outlets	$ 1,300	$ -		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 20,234***	

2020 NYStretch
FULL SERVICE RESTAURANT - 6A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 5,475	
Standard	*Standard U-0.021, R-49 roof insulation (attic roof)*		6,130	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential steel-frame wall) 6A: U-0.049; R-17.5*		2,460	Area	$ -	$ -		
EEM	Enhanced roof insulation (attic roof) 6A: U-0.019; R-53.9 (+ R-4.95)	RSMeans 07 22 16.10	6,130	Area	$ 0.8732	$ 5,353		
EEM	Enhanced wall insulation (nonresidential steel-frame wall) 6A: U-0.047; R-19.1 (+ R-1.55)	RSMeans 07 21 13.10	2,460	Area	$ 0.0496	$ 122		
EEM 2	**Enhanced fenestration**						$ 278	
Standard	*Standard windows, U-0.35*		508	Area	$ -	$ -		
EEM	Enhanced windows, U-0.33	PNNL CE ANALYSIS	508	Area	$ 0.55	$ 278		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 8,372	
Standard	*Lighting per ASHRAE 90.1-2016*		*4,418*	watts	$ 6.75	$ *29,820*		
EEM	Reduced LPDs, ~20% more efficient	HBL	3,178	watts	$ -	$ 38,192		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only, already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*n/a - does not apply to this building type*			tons	$ 1,031	$ -		
EEM	n/a - does not apply to this building type			cfm	$ 4	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ 9,216	
Standard	*Standard efficiency fryers, dishwashers, ovens, and holding cabinets*		-	0	$ -	$ -		
EEM	Enegy Star fryers, dishwashers, ovens, and holding cabinets	Energy Star Savings Calculator	1,497	Area	$ 6.16	$ 9,216		
EEM 11	**Thermal bridging reduction**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	Area	$ 0	$ -		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*1,433*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~9% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (258)	
Standard	*Packaged single-zone AC, 25.3 tons*	*RSMeans 23 74 33.10*	*1*	units	$ 30,079	$ *30,079*		
EEM	Packaged single-zone AC, 25.1 tons	*RSMeans 23 74 33.10*	1	units	$ 29,821	$ 29,821		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	*units*	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ -	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	-	outlets	$ 1,300	$ -		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 23,083***	

2020 NYStretch
OUTPATIENT HEALTHCARE - 4A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 6,067	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		14,782	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential steel-frame wall)* *4A: U-0.064; R-13.4*		13,402	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 4A: U-0.030; R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	14,782	Area	$ 0.3881	$ 5,737		
EEM	Enhanced wall insulation (nonresidential steel-frame wall) 4A: U-0.061; R-14.2 (+ R-0.77)	RSMeans 07 21 13.10	13,402	Area	$ 0.0246	$ 330		
EEM 2	**Enhanced fenestration**						$ 1,740	
Standard	*Standard windows, U-0.38*		3,318	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.36	PNNL CE ANALYSIS	3,318	Area	$ 0.52	$ 1,740		
EEM 3	**Air leakage testing for mid-sized buildings**						$ 8,500	
Standard	*Not Required*		-	units	$ -	$ -		
EEM	Testing required	BET, LLC	1	units	$ 8,500	$ 8,500		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 71,679	
Standard	*Lighting per ASHRAE 90.1-2016*		*39,536*	watts	$ 6.75	$ *266,868*		
EEM	Reduced LPDs, ~20% more efficient	HBL	28,917	watts	$ -	$ 338,548		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ 17,767	
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	4,983.57	cfm	$ 3.565	$ 17,767		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 1,596	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	4,694	Area	$ 0.3400	$ 1,596		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	RSMeans 26 51 13.55	*1,619*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~9% more efficient	RSMeans 26 51 13.55			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ -	
Standard	*INCLUDED WITH AHU IN ACA 3*		-	units	$ -	$ -		
EEM			-	units	$ 177,744	$ -		
ACA 2	**Reduced capacity for heating equipment**						$ 133	
Standard	*Hot water boiler, gas fired, 302 MBH*	RSMeans D3020 130	*1*	units	$ 21,475	$ *21,475*		
EEM	Hot water boiler, gas fired, 306 MBH	RSMeans D3020 130	1	0	$ 21,608	$ 21,608		
ACA 3	**Reduced capacity for air handling equipment**						$ (15,955)	
Standard	*VAV AHU, 33818 cfm*	RSMeans D3040 134	*1*	*units*	$ 339,376	$ *339,376*		
EEM	*VAV AHU, 32207 cfm*	RSMeans D3040 134	1	units	$ 323,421	$ 323,421		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 94,127***	

2020 NYStretch
OUTPATIENT HEALTHCARE - 5A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 6,187	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		14,782	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential steel-frame wall)* *5A: U-0.055; R-16.0*		13,402	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 5A: U-0.030; R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	14,782	Area	$ 0.3881	$ 5,737		
EEM	Enhanced wall insulation (nonresidential steel-frame wall) 5A: U-0.052, R-17.1 (+ R-1.05)	RSMeans 07 21 13.10	13,402	Area	$ 0.0336	$ 450		
EEM 2	**Enhanced fenestration**						$ 1,972	
Standard	*Standard windows, U-0.38*		3,318	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.36	PNNL CE ANALYSIS	3,318	Area	$ 0.59	$ 1,972		
EEM 3	**Air leakage testing for mid-sized buildings**						$ 3,200	
Standard	*Not Required*		-	units	$ -	$ -		
EEM	Testing required	BET, LLC	1	units	$ 3,200	$ 3,200		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 71,679	
Standard	*Lighting per ASHRAE 90.1-2016*		*39,536*	watts	$ 6.75	$ *266,868*		
EEM	Reduced LPDs, ~20% more efficient	HBL	28,917	watts	$ -	$ 338,548		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ 18,375	
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	5,154.07	cfm	$ 3.565	$ 18,375		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 1,596	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	4,694	Area	$ 0.3400	$ 1,596		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	RSMeans 26 51 13.55	*5,764*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~10% more efficient	RSMeans 26 51 13.55			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ -	
Standard	*INCLUDED WITH AHU IN ACA 3*		-	units	$ -	$ -		
EEM			-	units	$ 177,744	$ -		
ACA 2	**Reduced capacity for heating equipment**						$ 102	
Standard	*Hot water boiler, gas fired, 364 MBH*	RSMeans D3020 130	*1*	units	$ 23,223	$ 23,223		
EEM	Hot water boiler, gas fired, 368 MBH	RSMeans D3020 130	1	0	$ 23,325	$ 23,325		
ACA 3	**Reduced capacity for air handling equipment**						$ (16,585)	
Standard	*VAV AHU, 34983 cfm*	RSMeans D3040 134	*1*	*units*	$ 350,923	$ *350,923*		
EEM	*VAV AHU, 33309 cfm*	RSMeans D3040 134	1	units	$ 334,338	$ 334,338		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 17,962	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	14	outlets	$ 1,300	$ 17,962		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 104,489***	

2020 NYStretch
OUTPATIENT HEALTHCARE - 6A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 9,530	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		14,782	Area	$ -	$ -		
Standard	*Standard wall insulation (nonresidential steel-frame wall) 6A: U-0.049, R-17.5*		13,402	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 6A: U-0.029, R-33.4 (+ R-3.4)	RSMeans 07 22 16.10	14,782	Area	$ 0.5998	$ 8,866		
EEM	Enhanced wall insulation (nonresidential steel-frame wall) 6A: U-0.047, R-19.1 (+ R-1.55)	RSMeans 07 21 13.10	13,402	Area	$ 0.0496	$ 665		
EEM 2	**Enhanced fenestration**						$ 1,831	
Standard	*Standard windows, U-0.36*		3,318	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.34	PNNL CE ANALYSIS	3,318	Area	$ 0.55	$ 1,831		
EEM 3	**Air leakage testing for mid-sized buildings**						$ 3,200	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type	BET, LLC	1	0	$ 3,200	$ 3,200		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling unit**						$ 71,679	
Standard	*Lighting per ASHRAE 90.1-2016*		39,536	watts	$ 6.75	$ 266,868		
EEM	Reduced LPDs, ~20% more efficient	HBL	28,917	watts	$ -	$ 338,548		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lightin**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting contro**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ 18,212	
Standard	*VAV fans: 0.00130 bhp/cfm*					$ -		Costed as increased system size for reduction in static pressure
EEM	VAV fans: 0.00100 bhp/cfm	RSMeans D3040 134	5,108.16	cfm	$ 3.565	$ 18,212		
EEM 8	**Hotel guestroom HVAC vacancy contro**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipmen**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 1,596	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	4,694	Area	$ 0.3400	$ 1,596		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	RSMeans 26 51 13.55	5,764	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~10% more efficient	RSMeans 26 51 13.55			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipmen**						$ -	
Standard	*INCLUDED WITH AHU IN ACA 3*		-	units	$ -	$ -		
EEM			-	units	$ 177,744	$ -		
ACA 2	**Reduced capacity for heating equipmen**						$ 94	
Standard	*Hot water boiler, gas fired, 366 MBH*	RSMeans D3020 130	1	units	$ 23,274	$ 23,274		
EEM	Hot water boiler, gas fired, 369 MBH	RSMeans D3020 130	1	0	$ 23,368	$ 23,368		
ACA 3	**Reduced capacity for air handling equipmen**						$ (12,806)	
Standard	*VAV AHU, 34305 cfm*	RSMeans D3040 134	1	*units*	$ 344,205	$ 344,205		
EEM	VAV AHU, 33012 cfm	RSMeans D3040 134	1	units	$ 331,399	$ 331,399		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirement**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of space**						$ 17,962	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	14	outlets	$ 1,300	$ 17,962		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 111,298***	

2020 NYStretch
WAREHOUSE - 4A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 22,863	
Standard	*Standard U-0.032, R-30 roof insulation (metal building)* *4A: U-0.037; R-32.2 (+ R-2.2)*		49,495	Area	$ -	$ -		
Standard	*Standard wall insulation (metal building)* *4A: U-0.060; R-15.3*		26,687	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 4A: U-0.035; R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	49,495	Area	$ 0.3881	$ 19,208		
EEM	Enhanced wall insulation (nonresidential mass wall) 4A: U-0.048; R-19.5 (+ R-4.28)	RSMeans 07 21 13.10	26,687	Area	$ 0.1370	$ 3,655		
EEM 2	**Enhanced fenestration**						$ 100	
Standard	*Standard windows, U-0.38*		190	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.36	PNNL CE ANALYSIS	190	Area	$ 0.53	$ 100		
EEM 3	**Air leakage testing for mid-sized buildings**						$ 17,000	
Standard	*Not Required*		-	units	$ -	$ -		
EEM	Testing required	Vidaris	1	units	$ 17,000	$ 17,000		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		*24,400*	watts	$ 6.75	$ -		No cost assumed for this building type
EEM	Reduced LPDs, ~20% more efficient	HBL	18,686	watts	$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-		$ -	$ -		
EEM	n/a - IECC only		-		$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-		$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-		$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*n/a - does not apply to this building type*				$ 1,031	$ -		
EEM	n/a - does not apply to this building type				$ 4	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-	Area	$ 0	$ -		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*4,100*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~8% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-		$ -	$ -		
EEM	n/a - applies to IECC path only		-		$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ -	
Standard	*INCLUDED WITH AHU IN ACA 3*		-	units	$ -	$ -		
EEM			-	units		$ -		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*INCLUDED WITH AHU IN ACA 3*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ (2,999)	
Standard	*PSZ AHU, CAV, 3390 cfm*	*RSMeans 23 74 33.10*	*1*	*units*	$ 16,691	$ *16,691*		
EEM	*PSZ AHU, CAV, 2543 cfm*	RSMeans 23 74 33.10	1	units	$ 13,692	$ 13,692		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-		$ -	$ -		
EEM			-		$ -	$ -		
						Total	***$ 39,565***	

2020 NYStretch
WAREHOUSE - 5A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 20,019	
Standard	*Standard U-0.032, R-30 roof insulation (metal building)* *5A: U-0.037; R-32.2 (+ R-2.2)*		49,495	Area	$ -	$ -		
Standard	*Standard wall insulation (metal building)* *5A: U-0.050; R-18.8*		26,687	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 5A: U-0.035; R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	49,495	Area	$ 0.3881	$ 19,208		
EEM	Enhanced wall insulation (nonresidential mass wall) 5A: U-0.048; R-19.5 (+ R-0.95)	RSMeans 07 21 13.10	26,687	Area	$ 0.0304	$ 811		
EEM 2	**Enhanced fenestration**						$ 103	
Standard	*Standard windows, U-0.36*		190	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.36	PNNL CE ANALYSIS	190	Area	$ 0.54	$ 103		
EEM 3	**Air leakage testing for mid-sized buildings**						$ 6,400	
Standard	*Not Required*		-	*units*	$ -	$ -		
EEM	Testing required	Vidaris	1	units	$ 6,400	$ 6,400		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		24,400	*watts*	$ 6.75	$ -		No cost assumed for this building type
EEM	Reduced LPDs, ~20% more efficient	HBL	18,689		$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-		$ -	$ -		
EEM	n/a - IECC only		-		$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-		$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-		$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*CV fans: 0.00094 bhp/cfm* *VAV fans: 0.00130 bhp/cfm*				$ 1,031	$ -		
EEM	CV fans: 0.00088 bhp/cfm VAV fans: 0.00100 bhp/cfm				$ 4	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ 0	$ -		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*5,101*	*watts*	$ -	$ -		
EEM	Reduced LPDs, ~8% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ -	
Standard	*INCLUDED WITH AHU IN ACA 3*		-	units	$ -	$ -		
EEM			-	units	$ 177,744	$ -		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*INCLUDED WITH AHU IN ACA 3*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ (1,274)	
Standard	*PSZ AHU, CAV, 2755 cfm*	*RSMeans 23 74 33.10*	*1*	*units*	$ 14,442	$ 14,442		
EEM	*PSZ AHU, CAV, 2394 cfm*	RSMeans 23 74 33.10	1	units	$ 13,167	$ 13,167		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 4,338	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	3	outlets	$ 1,300	$ 4,338		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 29,586***	

2020 NYStretch
WAREHOUSE - 6A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 30,496	
Standard	*Standard U-0.032, R-30 roof insulation (metal building)* *6A: U-0.031; R-33.4 (+ R-3.4)*		49,495	Area	$ -	$ -		
Standard	*Standard wall insulation (metal building)* *6A: U-0.050; R-18.6*		26,667	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 6A: U-0.028; R-33.4 (+ R-3.4)	RSMeans 07 22 16.10	49,495	Area	$ 0.5998	$ 29,685		
EEM	Enhanced wall insulation (nonresidential mass wall) 6A: U-0.048; R-19.5 (+ R-0.95)	RSMeans 07 21 13.10	26,667	Area	$ 0.0304	$ 811		
EEM 2	**Enhanced fenestration**						$ 105	
Standard	*Standard windows, U-0.36*		190	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.34	PNNL CE ANALYSIS	190	Area	$ 0.55	$ 105		
EEM 3	**Air leakage testing for mid-sized buildings**						$ 6,400	
Standard	*Not Required*		1	*units*	$ -	$ -		
EEM	Testing required	Vidaris	1	units	$ 6,400	$ 6,400		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		24,400	watts	$ 6.75	$ -		No cost assumed for this building type
EEM	Reduced LPDs, ~20% more efficient	HBL	18,689		$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-		$ -	$ -		
EEM	n/a - IECC only		-		$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-		$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-		$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*CV fans: 0.00094 bhp/cfm* *VAV fans: 0.00130 bhp/cfm*				$ 1,031	$ -		
EEM	CV fans: 0.00088 bhp/cfm VAV fans: 0.00100 bhp/cfm				$ 4	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ 0	$ -		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*	*RSMeans 26 51 13.55*	*5,101*	watts	$ -	$ -		
EEM	Reduced LPDs, ~8% more efficient	*RSMeans 26 51 13.55*			$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ -	
Standard	*n/a - does not apply to this building type*		-	each	$ -	$ -		
EEM	n/a - does not apply to this building type		-	each	$ -	$ -		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ -	
Standard	*INCLUDED WITH AHU IN ACA 3*		-	units	$ -	$ -		
EEM			-	units	$ 177,744	$ -		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*INCLUDED WITH AHU IN ACA 3*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ (2,024)	
Standard	*PSZ AHU, CAV, 2882 cfm*	*RSMeans 23 74 33.10*	*1*	units	$ 14,891	$ 14,891		
EEM	PSZ AHU, CAV, 2310 cfm	RSMeans 23 74 33.10	1	units	$ 12,867	$ 12,867		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 4,338	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	3	outlets	$ 1,300	$ 4,338		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 39,315***	

2020 NYStretch
10 STORY HIGH-RISE APARTMENT - 4A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 3,991	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		8,435	Area	$ -	$ -		
Standard	*Standard wall insulation (residential steel-frame wall)* *4A: U-0.064; R-13.4*		29,112	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 4A: U-0.030; R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	8,435	Area	$ 0.3881	$ 3,274		
EEM	Enhanced wall insulation (residential steel-frame wall) 4A: U-0.061; R-14.2 (+ R-0.77)	RSMeans 07 21 13.10	29,112	Area	$ 0.0246	$ 717		
EEM 2	**Enhanced fenestration**						$ 6,679	
Standard	*Standard windows, U-0.39*		12,383	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.37	PNNL CE ANALYSIS	12,383	Area	$ 0.54	$ 6,679		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		*60,160*	watts	$ -	$ -		No cost assumed for this buidling type
EEM	Reduced LPDs, ~20% more efficient	HBL	57,804	watts	$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*n/a - does not apply to this building type*				$ -	$ -		
EEM	n/a - does not apply to this building type				$ -	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*Hot water boiler with 80% thermal efficiency*		-		$ -	$ -		
EEM	Hot water boiler with 94% thermal efficiency		-		$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 1,270	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	3,735	Area	$ 0.3400	$ 1,270		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*n/a - not modeled for this building type*	*RSMeans 26 51 13.55*	-		$ -	$ -		
EEM	*n/a - not modeled for this building type*	*RSMeans 26 51 13.55*	-		$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ 10,000	
Standard	*Standard elevator motors, 30hp*		-	each	$ -	$ -		
EEM	Elevator motors with regenerative drives, 30 hp	Previous projects	1	each	$ 10,000	$ 10,000		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (2,551)	
Standard	*PTAC, 105 tons*	*RSMeans D3050 255*	1	units	$ 179,837	$ *179,837*		
EEM	PTAC, 104 tons	*RSMeans D3050 255*	1	units	$ 177,287	$ 177,287		
ACA 2	**Reduced capacity for heating equipment**						$ (469)	
Standard	*Hot water boiler, gas fired, 1076 MBH*	*RSMeans D3020 130*	1	units	$ 43,188	$ *43,188*		
EEM	Hot water boiler, gas fired, 1059 MBH	*RSMeans D3020 130*	1	0	$ 42,719	$ 42,719		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	*units*	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ 5,255	
Standard	*Opaque wall with U-0.061*		-	0	$ -	$ -		
EEM	Opaque wall with U-0.045, R-22.2 (+R-5.85)	RSMeans 07 21 13.10	28,086	0	$ 0.1871	$ 5,255		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 26,775***	

2020 NYStretch
10 STORY HIGH-RISE APARTMENT - 5A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 4,252	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		8,435	Area	$ -	$ -		
Standard	*Standard wall insulation (residential steel-frame wall) 5A: U-0.055; R-16.0*		29,112	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 5A: U-0.030, R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	8,435	Area	$ 0.3881	$ 3,274		
EEM	Enhanced wall insulation (residential steel-frame wall) 5A: U-0.052; R-17.1 (+ R-1.05)	RSMeans 07 21 13.10	29,112	Area	$ 0.0336	$ 978		
EEM 2	**Enhanced fenestration**						$ 9,755	
Standard	*Standard windows, U-0.39*		12,383	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.36	PNNL CE ANALYSIS	12,383	Area	$ 0.79	$ 9,755		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		*60,150*	watts	$ -	$ -		No cost assumed for this buidling type
EEM	Reduced LPDs, ~20% more efficient	HBL	57,604	watts	$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*n/a - does not apply to this building type*				$ -	$ -		
EEM	n/a - does not apply to this building type				$ -	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 1,270	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	3,735	Area	$ 0.3400	$ 1,270		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*n/a - not modeled for this building type*	*RSMeans 26 51 13.55*	-		$ -	$ -		
EEM	*n/a - not modeled for this building type*	*RSMeans 26 51 13.55*	-		$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ 10,000	
Standard	*Standard elevator motors, 30hp*		-	each	$ -	$ -		
EEM	Elevator motors with regenerative drives, 30 hp	Previous projects	1	each	$ 10,000	$ 10,000		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (4,679)	
Standard	*PTAC, 106 tons*	*RSMeans D3050 255*	1	units	$ 180,632	$ *180,632*		
EEM	PTAC, 103.2 tons	*RSMeans D3050 255*	1	units	$ 175,954	$ 175,954		
ACA 2	**Reduced capacity for heating equipment**						$ (771)	
Standard	*Hot water boiler, gas fired, 1073 MBH*	*RSMeans D3020 130*	1	units	$ 43,089	$ 43,089		
EEM	Hot water boiler, gas fired, 1045 MBH	*RSMeans D3020 130*	1	0	$ 42,318	$ 42,318		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	*units*	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ 7,938	
Standard	*Opaque wall with U-0.052*		-	0	$ -	$ -		
EEM	Opaque wall with U-0.036, R-28.1 (+R-8.83)	RSMeans 07 21 13.10	28,086	0	$ 0.2826	$ 7,938		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 30,364***	

2020 NYStretch
10 STORY HIGH-RISE APARTMENT - 6A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 6,503	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		8,435	Area	$ -	$ -		
Standard	*Standard wall insulation (residential steel-frame wall)* *6A: U-0.049; R-17.5*		29,112	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 6A: U-0.029; R-33.4 (+ R-3.4)	RSMeans 07 22 16.10	8,435	Area	$ 0.5998	$ 5,059		
EEM	Enhanced wall insulation (residential steel-frame wall) 6A: U-0.044; R-19.1 (+ R-1.55)	RSMeans 07 21 13.10	29,112	Area	$ 0.0496	$ 1,444		
EEM 2	**Enhanced fenestration**						$ 10,005	
Standard	*Standard windows, U-0.38*		12,383	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.35	PNNL CE ANALYSIS	12,383	Area	$ 0.81	$ 10,005		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ -	
Standard	*Lighting per ASHRAE 90.1-2016*		*60,160*	watts	$ 6.75	$ -		No cost assumed for this building type
EEM	Reduced LPDs, ~20% more efficient	HBL	57,804	watts	$ -	$ -		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*n/a - does not apply to this building type*				$ -	$ -		
EEM	n/a - does not apply to this building type				$ -	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 1,270	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	3,736	Area	$ **0.3400**	$ 1,270		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*n/a - not modeled for this building type*	*RSMeans 26 51 13.55*	-		$ -	$ -		
EEM	*n/a - not modeled for this building type*	*RSMeans 26 51 13.55*	-		$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ 10,000	
Standard	*Standard elevator motors, 30hp*		-	each	$ -	$ -		
EEM	Elevator motors with regenerative drives, 30 hp	Previous projects	1	each	$ 10,000	$ 10,000		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (6,309)	
Standard	*PTAC, 108 tons*	*RSMeans D3050 255*	*1*	units	$ 183,620	$ *183,620*		
EEM	PTAC, 104 tons	*RSMeans D3050 255*	1	units	$ 177,311	$ 177,311		
ACA 2	**Reduced capacity for heating equipment**						$ (1,006)	
Standard	*Hot water boiler, gas fired, 1112 MBH*	*RSMeans D3020 130*	*1*	units	$ 44,195	$ *44,195*		
EEM	Hot water boiler, gas fired, 1076 MBH	*RSMeans D3020 130*	1	0	$ 43,189	$ 43,189		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUDED W/PACKAGED UNITS IN ACA 1)*		-	*units*	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ 12,444	
Standard	*Opaque wall with U-0.044*		-	0	$ -	$ -		
EEM	Opaque wall with U-0.027, R-36.57 (+R-13.9)	RSMeans 07 21 13.10	28,086	0	$ 0.4431	$ 12,444		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 35,508***	

2020 NYStretch
20 STORY HIGH-RISE APARTMENT - 4A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 4,397	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		8,435	Area	$ -	$ -		
Standard	*Standard wall insulation (residential steel-frame wall)* *4A: U-0.064; R-13.4*		45,603	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 4A: U-0.030; R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	8,435	Area	$ 0.3881	$ 3,274		
EEM	Enhanced wall insulation (residential steel-frame wall) 4A: U-0.061; R-14.2 (+ R-0.77)	RSMeans 07 21 13.10	45,603	Area	$ 0.0246	$ 1,124		
EEM 2	**Enhanced fenestration**						$ 20,166	
Standard	*Standard windows, U-0.39*		37,387	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.37	PNNL CE ANALYSIS	37,387	Area	$ 0.54	$ 20,165		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 15,786	
Standard	*Lighting per ASHRAE 90.1-2016*		13,812	watts	$ 6.75	$ 93,229		Cost for retail area only
EEM	Reduced LPDs, ~20% more efficient	HBL	11,473	watts	$ -	$ 109,015.58		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*n/a - does not apply to this building type*				$ -	$ -		
EEM	n/a - does not apply to this building type				$ -	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*Natural gas water heaters, 1200 MBH, 90% thermal efficiency (as (3) 400MBH units)*		3	*each*	$ -	$ -		
EEM	Natural gas water heaters, 1200 MBH, 94% thermal efficiency(as (3) 400MBH units)		3	each	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 1,270	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	3,735	Area	$ 0.3400	$ 1,270		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*n/a - not modeled for this building type*	RSMeans 26 51 13.55	-		$ -	$ -		
EEM	*n/a - not modeled for this building type*	RSMeans 26 51 13.55	-		$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ 20,000	
Standard	*Standard elevator motors, 30hp*		-	each	$ -	$ -		
EEM	Elevator motors with regenerative drives, 30 hp	Previous projects	2	each	$ 10,000	$ 20,000		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (5,840)	
Standard	*WSHP, 174 tons*	RSMeans D3050 240	1	units	$ 492,590	$ 492,590		
Standard	*Closed circuit cooling tower, 140 tons*	RSMeans 23 65 133.10	1	units	$ 109,749	$ 109,749		
EEM	WSHP, 172 tons	RSMeans D3050 240	1	units	$ 487,823	$ 487,823		
EEM	Closed circuit cooling tower, 138.2 tons	RSMeans 23 65 133.10	1	units	$ 108,676	$ 108,676		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*(INCLUDED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	*units*	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 58,379***	

2020 NYStretch
20 STORY HIGH-RISE APARTMENT - 5A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 4,806	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		8,435	Area	$ -	$ -		
Standard	*Standard wall insulation (residential steel-frame wall)* *5A: U-0.055, R-16.0*		45,603	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 5A: U-0.030, R-32.2 (+ R-2.2)	RSMeans 07 22 16.10	8,435	Area	$ 0.3881	$ 3,274		
EEM	Enhanced wall insulation (residential steel-frame wall) 5A: U-0.052, R-17.1 (+ R-1.05)	RSMeans 07 21 13.10	45,603	Area	$ 0.0336	$ 1,532		
EEM 2	**Enhanced fenestration**						$ 29,452	
Standard	*Standard windows, U-0.39*		37,387	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.36	PNNL CE ANALYSIS	37,387	Area	$ 0.79	$ 29,452		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 15,786	
Standard	*Lighting per ASHRAE 90.1-2016*		13,812	watts	$ 6.75	$ 93,229		Cost for retail area only
EEM	Reduced LPDs, ~20% more efficient	HBL	11,473	watts	$ -	$ 109,016		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only, already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*n/a - does not apply to this building type*				$ -	$ -		
EEM	n/a - does not apply to this building type				$ -	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		3	*each*	$ -	$ -		
EEM	n/a - does not apply to this building type		3	each	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 1,270	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	3,735	Area	$ 0.3400	$ 1,270		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*n/a - not modeled for this building type*	RSMeans 26 51 13.55	-		$ -	$ -		
EEM	*n/a - not modeled for this building type*	RSMeans 26 51 13.55	-		$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ 20,000	
Standard	*Standard elevator motors, 30hp*		-	each	$ -	$ -		
EEM	Elevator motors with regenerative drives, 30 hp	Previous projects	2	each	$ 10,000	$ 20,000		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (5,884)	
Standard	*WSHP, 172 tons*	RSMeans D3050 240	1	units	$ 486,559	$ 486,559		
Standard	*Closed circuit cooling tower, 138 tons*	RSMeans 23 65 133.10	1	units	$ 108,392	$ 108,392		
EEM	WSHP, 169.8 tons	RSMeans D3050 240	1	units	$ 481,756	$ 481,756		
EEM	Closed circuit cooling tower, 136.5 tons	RSMeans 23 65 133.10	1	units	$ 107,311	$ 107,311		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*(INCLUDED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	*units*	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 68,030***	

2020 NYStretch
20 STORY HIGH-RISE APARTMENT - 6A
EEM Incremental Cost Worksheet
Prepared by Vidaris Inc.
19-Jun-2019

EEM	Description	Source of Item Cost	Number of EEM Units	Unit	Cost / Unit	Total Item Cost	Total Incremental Cost	Notes / Comments
EEM 1	**Enhanced insulation for roofs and walls**						$ 7,321	
Standard	*Standard U-0.032, R-30 roof insulation (insulation entirely above deck)*		8,435	Area	$ -	$ -		
Standard	*Standard wall insulation (residential steel-frame wall) 6A: U-0.049; R-17.5*		45,603	Area	$ -	$ -		
EEM	Enhanced roof insulation (insulation entirely above deck) 6A: U-0.029; R-33.4 (+ R-3.4)	RSMeans 07 22 16.10	8,435	Area	$ 0.5998	$ 5,059		
EEM	Enhanced wall insulation (residential steel-frame wall) 6A: U-0.044; R-19.1 (+ R-1.55)	RSMeans 07 21 13.10	45,603	Area	$ 0.0496	$ 2,262		
EEM 2	**Enhanced fenestration**						$ 30,209	
Standard	*Standard windows, U-0.38*		37,387	*Area*	$ -	$ -		
EEM	Enhanced windows, U-0.35	PNNL CE ANALYSIS	37,387	Area	$ 0.81	$ 30,209		
EEM 3	**Air leakage testing for mid-sized buildings**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
EEM 4	**Reduced LPD for interior lighting; high efficacy lights in dwelling units**						$ 15,786	
Standard	*Lighting per ASHRAE 90.1-2016*		***13,812***	watts	$ 6.75	*$ 93,229*		Cost for retail area only
EEM	Reduced LPDs, ~20% more efficient	HBL	11,473	watts	$ -	$ 109,016		
EEM 5	**Occupancy sensors and automatic lighting controls including egress lighting**						$ -	
Standard	*n/a - IECC only*		-	0	$ -	$ -		
EEM	n/a - IECC only		-	0	$ -	$ -		
EEM 6	**Exterior lighting control**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - IECC only; already included in NYS amendments to 90.1-2016		-	0	$ -	$ -		
EEM 7	**Reduce fan power allowances**						$ -	
Standard	*n/a - does not apply to this building type*				$ -	$ -		
EEM	n/a - does not apply to this building type				$ -	$ -		
EEM 8	**Hotel guestroom HVAC vacancy control**						$ -	
Standard	*n/a - already included in 90.1-2016*		-		$ -	$ -		
EEM	n/a - already included in 90.1-2016		-		$ -	$ -		
EEM 9	**High-efficiency SHW**						$ -	
Standard	*n/a - does not apply to this building type*		3	*each*	$ -	$ -		
EEM	n/a - does not apply to this building type		3	each	$ -	$ -		
EEM 10	**High-efficiency commercial kitchen equipment**						$ -	
Standard	*n/a - does not apply to this building type*		-		$ -	$ -		
EEM	n/a - does not apply to this building type		-		$ -	$ -		
EEM 11	**Thermal bridging reduction**						$ 1,270	
Standard	*Standard wall insulation*		-		$ -	$ -		
EEM	Additional Parapet Insulation: Assume 12in at wall + 42in of parapet height + 12in wide parapet + 42in of parapet height to roof deck. 9 ft of total insulation of R-4.2/in for entire perimeter of roof.	RSMeans 07 22 16.10	3,735	Area	$ 0.3400	$ 1,270		
EEM 12	**Exterior lighting power reduction**						$ -	
Standard	*n/a - not modeled for this building type*	RSMeans 26 51 13.55	-		$ -	$ -		
EEM	*n/a - not modeled for this building type*	RSMeans 26 51 13.55	-		$ -	$ -		
EEM 13	**Efficient elevator, regenerative drives**						$ 20,000	
Standard	*Standard elevator motors, 30hp*		-	each	$ -	$ -		
EEM	Elevator motors with regenerative drives, 30 hp	Previous projects	2	each	$ 10,000	$ 20,000		
EEM 14	**ERV for apartment makeup air units**						$ -	
Standard	*n/a - already included in 90.1-2016*		-	0	$ -	$ -		
EEM	n/a - already included in 90.1-2016		-	0	$ -	$ -		
EEM 15	**Demand-based recirculated SHW controls**						$ -	
Standard	*n/a*		-	0	$ -	$ -		
EEM	n/a - applies to IECC path only		-	0	$ -	$ -		
ADDITIONAL COST ADJUSTMENTS								
ACA 1	**Reduced capacity for cooling equipment**						$ (8,656)	
Standard	*WSHP, 166 tons*	RSMeans D3050 240	*1*	units	$ 471,779	*$ 471,779*		
Standard	*Closed circuit cooling tower, 134 tons*	RSMeans 23 65 133.10	*1*	units	$ 105,066	*$ 105,066*		
EEM	WSHP, 163.5 tons	RSMeans D3050 240	1	units	$ 463,897	$ 463,897		
EEM	Closed circuit cooling tower, 131.3 tons	RSMeans 23 65 133.10	1	units	$ 103,292	$ 103,292		
ACA 2	**Reduced capacity for heating equipment**						$ -	
Standard	*(INCLUDED W/PACKAGED UNITS IN ACA 1)*		-	units	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 3	**Reduced capacity for air handling equipment**						$ -	
Standard	*(INCLUCED W/PACKAGED UNITS IN ACA 1)*		-	*units*	$ -	$ -		
EEM			-	units	$ -	$ -		
ACA 4	**Increased insulation to account for PTAC openings, thermal bridging requirements**						$ -	
Standard	*n/a - does not apply to this building type*		-	0	$ -	$ -		
EEM	n/a - does not apply to this building type		-	0	$ -	$ -		
ACA 5	**Electric vehicle charging station capable parking lots for 5% of spaces**						$ 2,600	
Standard			-	0	$ -	$ -		
EEM	208/240V 40 amp outlets (zones 5A and 6A only)	chargehub.com	2	outlets	$ 1,300	$ 2,600		
ACA 6	**Solar-ready zone per Appendix CA of 2018 IECC**						$ -	
Standard			-	0	$ -	$ -		
EEM			-	0	$ -	$ -		
						Total	***$ 67,531***	

NYSERDA, a public benefit corporation, offers objective information and analysis, innovative programs, technical expertise, and support to help New Yorkers increase energy efficiency, save money, use renewable energy, and reduce reliance on fossil fuels. NYSERDA professionals work to protect the environment and create clean-energy jobs. NYSERDA has been developing partnerships to advance innovative energy solutions in New York State since 1975.

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NYStretch Energy Code — 2020

An Overlay of the 2018 International Energy Conservation Code and ASHRAE Standard 90.1-2016

Version 1.0 | July 2019

NEW YORK STATE OF OPPORTUNITY | NYSERDA

PREFACE

The NYStretch Energy Code 2020 project was undertaken by NYSERDA to develop a pivotal tool for New York jurisdictions to support the State's energy and climate goals by accelerating the savings obtained through their local building energy codes. Authorities having jurisdiction have the legal ability to voluntarily adopt NYStretch-Energy.

The NYStretch Code was developed as a statewide model code to save more energy than New York's minimum code and to be readily adopted as a more stringent local standard to the ECCCNYS. It was developed with the following goals:

- Technically sound
- Thoroughly reviewed by stakeholders
- Written in code enforceable language
- Fully consistent with the 2018 IECC, ASHRAE 90.1-2016, and uniform codes

For communities that adopt it, the NYStretch Code will provide greater savings over the ECCCNYS for both residential and commercial buildings.

Marginal Markings

Solid vertical lines in the margins of Parts 1, 2, and 3 indicate a technical change from the requirements of 2018 IECC and ASHRAE 90.1-2016. Black, right-facing arrows in the left-hand margin indicate a deletion from the requirements.

Unaffected Provisions

The chapters, sections, tables, and other provisions in the 2018 IECC and ASHRAE 90.1-2016 not amended by NYStretch Code shall continue in full force and effect. Nothing in the NYStretch Code shall be construed as deleting all or part of any unaffected provision.

Severability

If any portion of the NYStretch Energy Code 2020, the 2018 IECC or ASHRAE 90.1-2016 is held by a court of a competent jurisdiction to be illegal or void, such holding shall not affect the validity of any other portion of the NYStretch Code, the 2018 IECC or ASHRAE 90.1-2016

Implied license / Use of NYStretch

While a jurisdiction may adopt one or both of the Commercial and Residential provisions, it is NYSERDA's desire, but not a rule, that the NYStretch be adopted as written. Changes to or deletions of the provisions contained herein may affect energy savings, cost savings, and enforceability. Jurisdictions are encouraged to contact NYSERDA codes@nyserda.ny.gov before considering any changes to the NYStretch.

DISCLAIMER

Version 1 of NYStretch Energy Code-2020 (NYStretch) is an overlay of the 2018 International Energy Conservation Code (2018 IECC) and ASHRAE Standard 90.1-2016 (ASHRAE). It does not reflect changes the New York State Fire Prevention and Code Council may adopt for the 2020 New York State Energy Conservation Construction Code (2020 NYS ECCC). Visit https://www.dos.ny.gov/DCEA/CodeUpdate.html for updates on the 2020 NYS ECCC.

Furthermore this version of NYStretch does not contain changes to it that New York City may adopt for the 2020 Energy Conservation Code of New York City (2020 ECC NYC). Visit https://www1.nyc.gov/site/buildings/codes/energy-conservation-code.page for updates on the 2020 ECC NYC.

It is NYSERDA's intent to release a version of NYStretch that will overlay the 2020 NYS ECCC upon release of that code by New York State Department of State.

Stringency of NYStretch

NYSERDA recognizes that there are differentials between the requirements of the IECC and ASHRAE paths in NYStretch. It is NYSERDA's intent to create two separate inclusive code books, one for the IECC paths and another for the ASHRAE paths and find and correct the differentials between those code provisions such that they are consistent with the intent and stringency of NYStretch. Until that time, where there is a differential between the paths, the more stringent of the requirements will prevail.

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International Code Council, Inc.

American Society of Heating, Refrigerating and Air-Conditioning Engineers

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PART 1

1 Amendments to 2018 International Energy Conservation Construction Code Commercial Provisions

1.1 Amendments to Section C401.2 Application

C401.2 Application. *Commercial buildings* shall comply with one of the following compliance paths:

1. ASHRAE Compliance Path (prescriptive): The requirements of ASHRAE 90.1-2016 (as amended) Section 4.2.1.1(a). The building shall also comply with the following:
   a. The *building thermal envelope* opaque assembly requirements of Section C402.1.4.
      EXCEPTION: *Semi-heated spaces* in compliance with ASHRAE 90.1-2016 (as amended) are not required to comply with Section C402.1.4.
   b. The *fenestration* requirements of Section C402.4.
      EXCEPTION: Semi-heated spaces in compliance with ASHRAE 90.1-2016 (as amended) are not required to comply with Section C402.4.3.
   c. The interior and exterior lighting power allowance requirements of Section C405.3.2 and Section C405.4.2, respectively.
   d. The requirements of Section C406 and tenant spaces shall comply with the requirements of Section C406.1.1.
   e. The requirements of Section C408 (note: in lieu of Section C408.4, the requirements of 5.9.2 prevail) and, if mandated by local ordinance, Appendix CC.
2. ASHRAE Compliance Path (Section 11): The requirements of ASHRAE 90.1-2016 (as amended) Section 4.2.1.1(b). The building shall also comply with Section C408 (note: in lieu of Section C408.4, the requirements of 5.9.2 prevail) and, if mandated by local ordinance, Appendix CC.
3. ASHRAE Compliance Path (Appendix G): The requirements of ASHRAE 90.1-2016 (as amended) 4.2.2.1(c). The building shall also comply with Section C408 (note: in lieu of Section C408.4, the requirements of 5.9.2 prevail) and, if mandated by local ordinance, Appendix CC.
4. Prescriptive Compliance Path: The requirements of Sections C402 through C406 and C408, and, if mandated by local ordinance, Appendix CC.

1.2 Amendments to Section C402.1 General (Prescriptive)

C402.1 General (Prescriptive). Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 4 of Section C401.2, shall comply with the following:

1. The opaque portions of the building thermal envelope shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of the *U-, C- and F-factor*-based method of Section C402.1.4, or the component performance alternative of section C402.1.5.
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. Fenestration in building envelope assemblies shall comply with Section C402.4.
4. Air leakage of building envelope assemblies shall comply with Section C402.5.

Alternatively, where buildings have a *vertical fenestration* area or skylight area exceeding that allowed in Section C402.4, the building and building thermal envelope shall comply with Section C401.2, Item 1 or Section C401.2, Item 2 or Section C401.2, Item 3.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.10.1 or C403.10.2.

1.3 Replace Section C402.1.3 Insulation Component R-Value-Based Method

C402.1.3 (Reserved for jurisdictions choosing to allow the provisions of Appendix CB)

1.4 Amendments to Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements: U-Factor Method

Table C402.1.4
Opaque Thermal Envelope Assembly Maximum Requirements, U-Factor Method[a,b]

CLIMATE ZONE	4		5		6	
	All other	Group R	All other	Group R	All other	Group R
Roofs						
Insulation Entirely above roof deck	U-0.030	U-0.030	U-0.030	U-0.030	U-0.029	U-0.029
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.028	U-0.026
Attic and other	U-0.020	U-0.020	U-0.020	U-0.020	U-0.019	U-0.019
Walls, above grade						
Mass[e]	U-0.099	U-0.086	U-0.086	U-0.076	U-0.076	U-0.067
Metal building	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048	U-0.048
Metal framed	U-0.061	U-0.061	U-0.052	U-0.052	U-0.047	U-0.044
Wood framed and other[c]	U-0.061	U-0.061	U-0.048	U-0.048	U-0.048	U-0.046
Walls, below grade						
Below-grade wall[c]	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063
Floors						
Mass[d]	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051
Joist/framing	U-0.033	U-0.033	U-0.033	U-0.033	U-0.027[f]	U-0.027[f]
Slab-on-grade floors						
Unheated slabs	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434
Heated slabs	F-0.63	F-0.63	F-0.63	F-0.63	F-0.63	F-0.63
Opaque doors						
Swinging	U-0.50	U-0.50	U-0.37	U-0.37	U-0.37	U-0.37
Garage door <14% glazing	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.
ci = Continuous insulation, NR = No Requirement, LS = Liner System.

a. Where assembly U-factors, C-factors, and F-factors are established in ANSI/ASHRAE/IESNA 90.1 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/ISNEA 90.1 Appendix A.
b. Where U-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The R-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design.
c. Where heated slabs are below grade, below-grade walls shall comply with the U-factor requirements for above-grade mass walls.
d. "Mass floors" shall be in accordance with Section C402.2.3.
e. "Mass walls" shall be in accordance with Section C402.2.2.

1.5 Addition of New Section C402.1.4.2 Thermal Resistance of Mechanical Equipment Penetrations (Mandatory)

C402.1.4.2 Thermal resistance of mechanical equipment penetrations (Mandatory). When the total area of penetrations from mechanical equipment listed in Table C403.2.3(3) exceeds 1 percent of the opaque above-grade wall area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a default U-factor of 0.5.

> **Exception:** Where mechanical equipment has been tested in accordance with testing standards approved by the authority having jurisdiction, the mechanical equipment penetration area may be calculated as a separate wall assembly with the U-factor as determined by such test.

1.6 Amendments to Section C402.2 Specific Building Thermal Envelope Insulation Requirements (Prescriptive)

C402.2 Specific building thermal envelope insulation requirements (Prescriptive). Insulation in building thermal envelope opaque assemblies shall comply with Sections C402.2.1 through C402.2.8 and Table C402.1.4.

1.7 Addition of New Section C402.2.8 Continuous Insulation (Mandatory)

C402.2.8 Continuous insulation (Mandatory). In new construction, structural elements of balconies and parapets that penetrate the *building thermal envelope*, shall comply with one of the following:

1. Structural elements penetrating the *building thermal envelope* shall be insulated with *continuous insulation* having a minimum thermal resistance of R-3.
2. Structural elements of penetrations of the *building thermal envelope* shall incorporate a minimum R-3 thermal break where the structural element penetrates the *building thermal envelope*.

1.8 Amendments to Section C402.4 Fenestration (Prescriptive)

C402.4 Fenestration (Prescriptive). Fenestration shall comply with Sections C402.4.1 through C402.4.5 and Table C402.4. Daylight responsive controls shall comply with this section and Section C405.2.3.

1.9 Amendments to Table C402.4 Building Envelope Fenestration Maximum U-Factor and SHGC Requirements

Table C402.4
Building Envelope Fenestration Maximum U-Factor and SHGC Requirements

CLIMATE ZONE	**4**	**5**	**6**
Vertical Fenestration			
U-Factor			
Fixed fenestration	0.36	0.36	0.34
Operable fenestration	0.43	0.43	0.41
All other vertical fenestration			
All fenestration	0.30	0.27	0.27
Entrance doors	0.77	0.77	0.77
SHGC			
PF < 0.2	0.36	0.38	0.40
0.2 ≤ PF < 0.5	0.43	0.46	0.48
PF ≥ 0.5	0.58	0.61	0.64
Skylights			
U-Factor	0.48	0.48	0.48
SHGC	0.38	0.38	0.38

PF = Projection Factor.
a. U-factor and SHGC shall be rated in accordance with NFRC 100.

1.10 Amendments to Section C402.5 Air Leakage--Thermal Envelope (Mandatory)

C402.5 Air leakage--thermal envelope (Mandatory). The *thermal envelope* of buildings shall comply with Section C402.5.9 or shall comply with Sections C402.5.1 through C402.5.8 and C408.4. New buildings not less than 25,000 square feet and not greater than 50,000 square feet, and less than or equal to 75 feet in height, shall show compliance through testing in accordance with Section C402.5.9.

1.11 Addition of New Section C402.5.9. Air Barrier Testing

C402.5.9 Air Barrier Testing. The *building thermal envelope* shall be tested in accordance with ASTM E779 at a pressure differential of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official and shall be deemed to comply with the provisions of this section when the tested air leakage rate of the building thermal envelope is not greater than 0.40 cfm/ft^2 (2.0 L/s * m^2). Where the compliance is based on such testing, the building shall also comply with Sections C402.5.5, C402.5.6, and C402.5.7. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

1.12 Amendments to Section C403.7.4 Energy Recovery Ventilation Systems (Mandatory)

C403.7.4 Energy recovery ventilation systems (Mandatory). Where the supply airflow rate of a fan system exceeds the values specified in Tables C403.7.4(1) and C403.7.4(2), the system shall include an energy recovery ventilation system. The energy recovery ventilation system shall be configured to provide a change in the enthalpy of the outdoor air supply of not less than 50 percent of the difference between the outdoor air and return air enthalpies, at design conditions. Where an air economizer is required, the energy recovery ventilation system shall include a bypass or controls that permit operation of the economizer as required by Section C403.5.

Exception: An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by the *International Mechanical Code*.
2. Laboratory fume hood systems that include not fewer than one of the following features:
   - 2.1 Variable-air-volume hood exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values.
   - 2.2 Direct makeup (auxiliary) air supply equal to or greater than 75 percent of the exhaust rate, heated not warmer than 2°F (1.1°C) above room setpoint, cooled to not cooler than 3°F (1.7°C) below room setpoint, with no humidification added, and no simultaneous heating and cooling used for dehumidification control.
3. Systems serving spaces that are heated to less than 60°F (15.5°C) and that are not cooled.
4. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site-solar energy.
5. Heating energy recovery in Climate Zones 1 and 2.
6. Cooling energy recovery in Climate Zones 3C, 4C, 5B, 5C, 6B, 7, and 8.
7. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
8. Where the largest source of air exhausted at a single location at the building exterior is less than 75 percent of the design ventilation outdoor air flow rate. Multiple exhaust fans or outlets located within a 30-foot radius from the *outdoor air* supply unit shall be considered a single exhaust location.
9. Systems expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table C403.7.4(1).
10. Systems exhausting toxic, flammable, paint or corrosive fumes, or dust.
11. Commercial kitchen hoods used for collecting and removing grease vapors and smoke.

1.13 Amendments to Section C403.8.1 Allowable Fan Horsepower

C403.8.1 Allowable fan horsepower (Mandatory). Each HVAC system having a total fan system motor nameplate horsepower exceeding 5 hp (3.7 kW) at fan system design conditions shall not exceed the allowable *fan system motor nameplate hp* (Option 1) or *fan system bhp* (Option 2) shown in Table C403.8.1(1). This includes supply fans, exhaust fans, return/relief fans, and fan-powered terminal units associated with systems providing heating or cooling capability. Single-zone variable air volume systems shall comply with the constant volume fan power limitation.

Exceptions:

1. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall be permitted to use variable volume fan power limitation.
2. Individual exhaust fans with motor nameplate horsepower of 1 hp (0.746 kW) or less are exempt from the allowable fan horsepower requirement.
3. Fans supplying air to active chilled beams.

1.14 Amendments to Table C403.8.1(1) Fan Power Limitation

Table C403.8.1(1)
Fan Power Limitation

	Limit	Constant volume	Variable volume
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	hp $\leq CFM_s$*0.0009	hp $\leq CFM_s$* 0.0011
Option 2: Fan system bhp	Allowable fan system bhp	bhp ≤ CFM_s X 0.00088 + A	bhp ≤ CFM_s X 0.0010 + A

For SI: 1 bhp = 735.5 W, 1 hp = 745.5 W, 1 cfm = 0.4719 L/S
Where:
CFM_s = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute.
hp = The maximum combined motor nameplate horsepower.
bhp = The maximum combined fan brake horsepower.
A = Sum of [PD X CFM_D/4131]
Where:
PD = Each applicable pressure drop adjustment from Table C403.8.1 (2) in. w.c.
CFM_D = The design airflow through each applicable device from Table C403.8.1(2) in cubic feet per minute.

1.15 Amendments to Section C405.2.1 Occupant Sensor Controls

C405.2.1 Occupant sensor controls. Occupant *sensor controls* shall be installed to control lights in the following space types:

1. Classrooms/lecture/training rooms.
2. Conference/meeting/multipurpose rooms.

3. Copy/print rooms.
4. Corridor/transition areas.
5. Dining areas.
6. Lounges/breakrooms.
7. Enclosed offices.
8. Open plan office areas.
9. Restrooms.
10. Storage rooms.
11. Locker rooms.
12. Other spaces 300 square feet (28 m^2) or less that are enclosed by floor-to-ceiling height partitions.
13. Warehouse storage areas.

1.16 Addition of New Section C405.2.1.4 Occupant Sensor Control Function for Egress Illumination

C405.2.1.4 Occupant sensor control function for egress illumination. In new buildings, luminaires serving the exit access and providing means of egress illumination required by Section 1008.1 of the *International Building Code*, including luminaires that function as both normal and emergency means of egress illumination shall be controlled by a combination of listed emergency relay and occupancy sensors, or signal from another building control system that automatically reduces the lighting power by 50 percent when unoccupied for longer than 15 minutes.

Exceptions:

1. Means of egress illumination serving the exit access that does not exceed 0.02 watts per square foot of building area is exempt from this requirement.
2. Emergency lighting designated to meet Section 1008.3 of the *International Building Code.*

1.17 Amendments to Section C405.2.3 Daylight Responsive Controls

C405.2.3 Daylight responsive controls. *Daylight-responsive controls* complying with Section C405.2.3.1 shall be provided to control the electric lights within *daylight zones* in the following spaces:

1. Spaces with a total of more than 100 watts of general lighting within sidelit zones complying with Section C405.2.3.2. General lighting does not include lighting that is required to have specific application control in accordance with Section C405.2.4.
2. Spaces with a total of more than 100 watts of general lighting within toplit zones complying with Section C405.2.3.3.

Exceptions: Daylight responsive controls are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.

2. Lighting that is required to have specific application control in accordance with Section C405.2.4.
3. Sidelit zones on the first floor above grade in Group A-2 and Group M occupancies.
4. New buildings where the total connected lighting power calculated in accordance with Section C405.3.1 is not greater than the adjusted interior lighting power allowance (LPA_{adj}) calculated in accordance with Equation 4-9:

$$LPA_{adj} = [LPA_{norm} \times (1.0 - 0.4 \times UDZFA / TBFA)]$$ **(Equation 4-9)**

Where:

LPA_{adj} = Adjusted building interior lighting power allowance in watts.

LPA_{norm} = Normal building lighting power allowance in watts calculated in accordance with Section C405.3.2 and reduced in accordance with Section C406.3 where Option 2 of Section C406.1 is used to comply with the requirements of Section C406.

UDZFA = Uncontrolled daylight zone floor area is the sum of all sidelit and toplit zones, calculated in accordance with Sections C405.2.3.2 and C405.2.3.3, that do not have daylight responsive controls.

TBFA = Total building floor area is the sum of all floor areas included in the lighting power allowance calculation in Section C405.3.2.

1.18 Amendments to Section C405.2.3.2 Sidelit Zone

C405.2.3.2 Sidelit zone. The sidelit zone is the floor area adjacent to vertical *fenestration* that complies with all of the following:

1. Where the fenestration is located in a wall, the sidelit zone shall extend laterally to the nearest full-height wall, or up to 1.0 times the height from the floor to the top of the fenestration, and longitudinally from the edge of the fenestration to the nearest full-height wall, or up to 2 feet (610 mm), whichever is less, as indicated in Figure C405.2.3.2.
2. The area of the fenestration is not less than 24 square feet (2.23 m^2).
3. The distance from the fenestration to any building or geological formation that would block *access* to daylight is no greater than one-half of the height from the bottom of the fenestration to the top of the building or geologic formation.
4. The visible transmittance of the fenestration is not less than 0.20.

1.19 Amendments to Section C405.2.6 Exterior Lighting Controls

C405.2.6 Exterior lighting controls. Exterior lighting systems shall be provided with controls that comply with Sections C405.2.6.1 through C405.2.6.5. Decorative lighting systems shall comply with Sections C405.2.6.1, C405.2.6.2, and C405.2.6.4.

Exceptions:

1. Lighting for covered vehicle entrances and exits from buildings and parking structures where required for eye adaptation.
2. Lighting controlled from within dwelling units.

C405.2.6.1 (Daylight shutoff) is unchanged.

C405.2.6.2 (Decorative lighting shutoff) is unchanged.

C405.2.6.3 Lighting setback. Lighting not controlled in accordance with Section C405.2.6.2 shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at one of the following times:

1. From not later than midnight to not earlier than 6 a.m.
2. From not later than one hour after business closing to not earlier than one hour before business opening.
3. During any time where activity has not been detected for 15 minutes or more.

C405.2.6.4 (Exterior time-switch control function) is unchanged.

1.20 Addition of New Section C405.2.6.5 Outdoor parking area lighting control

C405.2.6.5 Outdoor parking area lighting control. Outdoor parking area luminaires mounted 24' or less above the ground shall be controlled to automatically reduce the power of each luminaire by a minimum of 50 percent when no activity has been detected for at least 15 minutes. No more than 1500 W of lighting power shall be controlled together.

Exception: Outdoor parking areas with less than 1,000 watts of lighting.

1.21 Amendments to Table C405.3.2(1) Interior Lighting Power Allowances: Building Area Method

TABLE C405.3.2(1)
Interior Lighting Power Allowances: Building Area Method

BUILDING AREA TYPE	LPD (w/ft^2)
Automotive facility	0.64
Convention center	0.70
Courthouse	0.74
Dining: bar lounge/leisure	0.69
Dining: cafeteria/fast food	0.66
Dining: family	0.61
Dormitory [a, b]	0.52
Exercise center	0.65
Fire station [a]	0.50
Gymnasium	0.67
Health care clinic	0.68
Hospital [a]	0.86
Hotel/motel [a, b]	0.70
Library	0.78
Manufacturing facility	0.60
Motion picture theater	0.62
Multifamily [c]	0.49
Museum	0.68
Office	0.69
Parking garage	0.12
Penitentiary	0.67
Performing arts theater	0.85
Police station	0.68
Post office	0.62
Religious building	0.72
Retail	0.91
School/university	0.67
Sports arena	0.76
Town hall	0.72
Transportation	0.51

TABLE C405.3.2(1)

Interior Lighting Power Allowances: Building Area Method (continued)

BUILDING AREA TYPE	LPD (w/ft²)
Warehouse	0.41
Workshop	0.83

a. Where sleeping units are excluded from lighting power calculations by application of Section R405.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.
b. Where dwelling units are excluded from lighting power calculations by application of R405.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.
c. Dwelling units are excluded. Neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

1.22 Amendments to Table C405.3.2(2) Interior Lighting Power Allowances: Space-By-Space Method

Table C405.3.2(2)
Interior Lighting Power Allowances: Space-by-Space Method

COMMON SPACE TYPES [a]	LPD (w/ft^2)
Atrium	
Less than 40 feet in height	0.023 per foot in total height
Greater than 40 feet in height	0.40 + 0.02 per foot in total height
Audience seating area	
In an auditorium	0.63
In a convention center	0.65
In a gymnasium	0.43
In a motion picture theater	0.64
In a penitentiary	0.28
In a performing arts theater	1.34
In a religious building	0.98
In a sports arena	0.42
Otherwise	0.40
Banking activity area	0.79
Breakroom (See Lounge/Breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	1.06
Otherwise	0.74
Computer room	1.16
Conference/meeting/multipurpose room	0.93
Confinement cells	0.52
Copy/print room	0.50
Corridor	
In a facility for the visually impaired (and not used primarily by the staff) [b]	0.81
In a hospital	0.81
In a manufacturing facility	0.28
In a primary or secondary school (and not used primarily by the staff)	0.74
Otherwise	0.58
Courtroom	1.06

COMMON SPACE TYPES [a]	LPD (w/ft^2)
Dining area	
In bar/lounge or leisure dining	0.62
In cafeteria or fast food dining	0.53
In a facility for the visually impaired (and not used primarily by the staff) [b]	1.48
In family dining	0.54
In a penitentiary	0.72
Otherwise	0.53
Electrical/mechanical room	0.39
Emergency vehicle garage	0.41
Food preparation area	0.92
Guestroom [c, d]	0.75
Laboratory	
In or as a classroom	1.04
Otherwise	1.32
Laundry/washing area	0.43
Loading dock, interior	0.51
Lobby	
For an elevator	0.52
In a facility for the visually impaired (and not used primarily by the staff) [b]	2.03
In a hotel	0.68
In a motion picture theater	0.38
In a performing arts theater	0.82
Otherwise	0.9
Locker room	0.45
Lounge/breakroom	
In a healthcare facility	0.53
Otherwise	0.44
Office	
Enclosed	0.85
Open plan	0.78
Parking area, interior [i]	0.11
Pharmacy area	1.23
Restroom	
In a facility for the visually impaired (and not used primarily by the staff) [b]	0.81

COMMON SPACE TYPES [a]	LPD (w/ft^2)
Otherwise	0.75
Sales area	1.06
Seating area, general	0.38
Stairway (See space containing stairway)	
Stairwell	0.50
Storage room	0.43
Vehicular maintenance area	0.53
Workshop	1.09

BUILDING TYPE SPECIFIC SPACE TYPES [a]	LPD (w/ft^2)
Automotive (See Vehicular Maintenance Area above)	
Convention Center—exhibit space	0.69
Dormitory—living quarters [c, d]	0.46
Facility for the visually impaired [b]	
In a chapel (and not used primarily by the staff)	0.89
In a recreation room (and not used primarily by the staff)	1.53
Fire Station—sleeping quarters [c]	0.19
Gymnasium/fitness center	
In an exercise area	0.50
In a playing area	0.75
Healthcare facility	
In an exam/treatment room	1.16
In an imaging room	0.98
In a medical supply room	0.54
In a nursery	0.94
In a nurse's station	0.75
In an operating room	1.87
In a patient room [c]	0.45
In a physical therapy room	0.84
In a recovery room	0.89
Library	
In a reading area	0.77
In the stacks	1.20

BUILDING TYPE SPECIFIC SPACE TYPES [a]	LPD (w/ft²)
Manufacturing facility	
In a detailed manufacturing area	0.86
In an equipment room	0.61
In an extra-high-bay area (greater than 50' floor-to-ceiling height)	0.73
In a high-bay area (25-50' floor-to-ceiling height)	0.58
In a low-bay area (less than 25' floor-to-ceiling height)	0.61
Museum	
In a general exhibition area	0.61
In a restoration room	0.77
Performing arts theater—dressing room	0.35
Post Office—Sorting Area	0.66
Religious buildings	
In a fellowship hall	0.54
In a worship/pulpit/choir area	0.98
Retail facilities	
In a dressing/fitting room	0.49
In a mall concourse	0.79
Sports arena—playing area	
For a Class I facility [e]	2.26
For a Class II facility [f]	1.45
For a Class III facility [g,j]	1.08
For a Class IV facility [h,j]	0.72
Transportation facility	
In a baggage/carousel area	0.40
In an airport concourse	0.31
At a terminal ticket counter	0.48
Warehouse—storage area	
For medium to bulky, palletized items	0.27
For smaller, hand-carried items	0.65

a. In cases where both a common space type and a building area specific space are listed, the building area specific space type shall apply.

b. A 'Facility for the Visually Impaired' is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

c. Where sleeping units are excluded from lighting power calculations by application of Section R405.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

BUILDING TYPE SPECIFIC SPACE TYPES [a]	LPD (w/ft^2)
d. Where dwelling units are excluded from lighting power calculations by application of Section R405.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted. e. Class I facilities consist of Professional facilities; and Semi-professional, Collegiate, or Club facilities with seating for 5,000 or more spectators. f. Class II facilities consist of Collegiate and Semi-professional facilities with seating for fewer than 5,000 spectators; Club facilities with seating for between 2,000 and 5,000 spectators; and Amateur League and High School facilities with seating for more than 2,000 spectators. g. Class III facilities consist of Club, Amateur League, and High School facilities with seating for 2,000 or fewer spectators. h. Class IV facilities consist of Elementary School and Recreational facilities, and Amateur League and High School facilities without provisions for spectators. i. The wattage of lighting in daylight transition zones and ramps without parking is excluded. j. Pool surfaces are excluded. Neither the surface area of the swimming or spa pool nor the wattage of the lighting serving them shall be counted.	

1.23 Amendments to Table C405.4.2(2)
Lighting power allowances for building exteriors

Table C405.4.2(2)
Lighting Power Allowances for Building Exteriors

	LIGHTING ZONES			
	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
Base Site Allowance	350 W	400 W	500 W	900 W
Uncovered Parking Areas				
Parking areas and drives	0.03 W/ft^2	0.04 W/ft^2	0.05 W/ft^2	0.05 W/ft^2
Building Grounds				
Walkways and ramps less than 10 feet wide	0.5 W/linear foot	0.5 W/linear foot	0.6 W/linear foot	0.7 W/linear foot
Walkways and ramps 10 feet wide or greater, plaza areas special feature areas	0.10 W/ft^2	0.10 W/ft^2	0.11 W/ft^2	0.14 W/ft^2
Dining areas	0.65 W/ft^2	0.65 W/ft^2	0.75 W/ft^2	0.95 W/ft^2
Stairways	0.6 W/ft^2	0.7 W/ft^2	0.7 W/ft^2	0.7 W/ft^2
Pedestrian tunnels	0.12 W/ft^2	0.12 W/ft^2	0.14 W/ft^2	0.21 W/ft^2
Landscaping	0.03 W/ft^2	0.04 W/ft^2	0.04 W/ft^2	0.04 W/ft^2
Building Entrances and Exits				
Pedestrian and vehicular entrances and exits	12.6 W/linear foot of opening width	12.6 W/linear foot of opening width	20 W/linear foot of opening width	20 W/linear foot of opening width
Entry canopies	0.20 W/ft^2	0.25 W/ft^2	0.4 W/ft^2	0.4 W/ft^2
Loading docks	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2	0.35 W/ft^2
Sales Canopies				
Free-standing and attached	0.40 W/ft^2	0.40 W/ft^2	0.6 W/ft^2	0.7 W/ft^2
Outdoor Sales				
Open areas (including vehicle sales lots)	0.20 W/ft^2	0.20 W/ft^2	0.35 W/ft^2	0.50 W/ft^2
Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	7 W/linear foot	7 W/linear foot	21 W/linear foot

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 1 W/0.0929 m^2.
W = watts

1.24 Addition of New Section C405.8.1.1 Power conversion system

C405.8.1.1 Power conversion system. New traction elevators with a rise of 75 feet or more in new buildings shall have a power conversion system that complies with Sections 405.8.1.1.1 through 405.8.1.1.3.

C405.8.1.1.1 Motor. Induction motors with a Class IE2 efficiency ratings, as defined by IEC EN 60034-30, or alternative technologies, such as permanent magnet synchronous motors that have equal or better efficiency, shall be used.

C405.8.1.1.2 Transmission. Transmissions shall not reduce the efficiency of the combined motor/transmission below that shown for the Class IE2 motor for elevators with capacities below 4,000 lbs. Gearless machines shall be assumed to have a 100 percent transmission efficiency.

C405.8.1.1.3 Drive. Potential energy released during motion shall be recovered with a regenerative drive that supplies electrical energy to the building electrical system.

1.25 Addition of New Section C405.9 Commercial Kitchen Equipment

C405.9 Commercial Kitchen Equipment. Commercial kitchen equipment shall comply with the minimum efficiency requirements of Tables C405.9(1) through table C405.9(5).

Table C405.9(1)
Minimum Efficiency Requirements: Commercial Fryers

	Heavy-Load Cooking Energy Efficiency	Idle Energy Rate	Test Procedure
Standard Open Deep-Fat Gas Fryers	≥ 50%	≤ 9,000 Btu/hr	ASTM Standard F1361-17
Standard Open Deep-Fat Electric Fryers	≥ 83%	≤ 800 watts	
Large Vat Open Deep-Fat Gas Fryers	≥ 50%	≤ 12,000 Btu/hr	ASTM Standard F2144-17
Large Vat Open Deep-Fat Electric Fryers	≥ 80%	≤ 1,100 watts	

Table C405.9(2)
Minimum Efficiency Requirements: Commercial Hot Food Holding Cabinets

Product Interior Volume (Cubic Feet)	Maximum Idle Energy Consumption Rate (Watts)	Test Procedure
0 < V < 13	≤ 21.5 V	ASTM Standard F2140-11
13 ≤ V < 28	≤ 2.0 V + 254.0	
28 ≤ V	≤ 3.8 V + 203.5	

Table C405.9(3)
Minimum Efficiency Requirements: Commercial Steam Cookers

Fuel Type	Pan Capacity	Cooking Energy Efficiency[a]	Idle Rate	Test Procedure
Electric Steam	3-pan	50%	400 watts	ASTM Standard F1484-18
	4-pan	50%	530 watts	
	5-pan	50%	670 watts	
	6-pan and larger	50%	800 watts	
Gas Steam	3-pan	38%	6,250 Btu/h	
	4-pan	38%	8,350 Btu/h	
	5-pan	38%	10,400 Btu/h	
	6-pan and larger	38%	12,500 Btu/h	

a. Cooking Energy Efficiency is based on heavy load (potato) cooking capacity

Table C405.9(4)
Minimum Efficiency Requirements: Commercial Dishwashers

Machine Type	High Temp Efficiency Requirements		Low Temp Efficiency Requirements		Test Procedure
	Idle Energy Rate[a]	Water Consumption[b]	Idle Energy Rate[a]	Water Consumption[b]	
Under Counter	≤ 0.50 kW	≤ 0.86 GPR	≤ 0.50 kW	≤ 1.19 GPR	ASTM Standard F1696-18 ASTM Standard F1920-15
Stationary Single Tank Door	≤ 0.70 kW	≤ 0.89 GPR	≤ 0.60 kW	≤ 1.18 GPR	
Pot, Pan, and Utensil	≤ 1.20 kW	≤ 0.58 GPSF	≤ 1.00 kW	≤ 0.58 GPSF	
Single Tank Conveyor	≤ 1.50 kW	≤ 0.70 GPR	≤ 1.50 kW	≤ 0.79 GPR	
Multiple Tank Conveyor	≤ 2.25 kW	≤ 0.54 GPR	≤ 2.00 kW	≤ 0.54 GPR	
Single Tank Flight Type	Reported	GPH ≤ 2.975x + 55.00	Reported	GPH ≤ 2.975x + 55.00	
Multiple Tank Flight Type	Reported	GPH ≤ 4.96x + 17.00	Reported	GPH ≤ 4.96x + 17.00	

a. Idle results shall be measured with the door closed and represent the total idle energy consumed by the machine including all tank heater(s) and controls. Booster heater (internal or external) energy consumption should not be part of this measurement unless it cannot be separately monitored per US EPA Energy Star Commercial Dishwasher Specification Version 2.0.

b. GPR = gallons per rack; GPSF = gallons per square foot of rack; GPH = gallons per hour; x = sf of conveyor belt (i.e., W*L)/min (maximum conveyor speed).

Table C405.9(5)
Minimum Efficiency Requirements: Commercial Ovens

Fuel Type	Classification	Idle Rate	Cooking-Energy Efficiency, %	Test Procedure
Convection Ovens				
Gas	Full-Size	≤ 12,000 Btu/h	≥ 46	ASTM F1496 - 13
Electric	Half-Size	≤ 1.0 Btu/h	≥ 71	
	Full-Size	≤ 1.60 Btu/h		
Combination Ovens				
Gas	Steam Mode	≤ 200P[a]+6,511 Btu/h	≥ 41	ASTM F2861 - 17
	Convection Mode	≤ 150P[a]+5,425 Btu/h	≥ 56	
Electric	Steam Mode	≤ 0.133P[a]+0.6400 kW	≥ 55	
	Convection Mode	≤ 0.080P[a]+0.4989 kW	≥ 76	
Rack Ovens				
Gas	Single	≤ 25,000 Btu/h	≥ 48	ASTM F2093 - 18
	Double	≤ 30,000 Btu/h	≥ 52	

a. P = Pan Capacity: The number of steam table pans the combination oven is able to accommodate as per the ASTM F – 1495 – 05 standard specification.

1.26 Addition of New Section C405.10 Electric Vehicle Charging Station Capable

C405.10 Electric vehicle charging station capable. New parking garages and new parking lots powered by the energy services for a building, and with 10 or greater parking spaces, shall provide either:

1. Panel capacity and conduit for the future installation of minimum 208/240V 40-amp outlets for 5 percent of the total parking spaces and not less than two parking spaces; or
2. Minimum 208/240V 40-amp outlets for 5 percent of the total parking spaces and not less than two parking spaces.

1.27 Addition of New Section C405.11 Solar-Ready Zone

C405.11 Solar-ready zone (Mandatory). New *buildings* shall comply with the provisions of Appendix CA.

1.28 Addition of Section C405.12 Whole Building Energy Monitoring

C405.12 Whole building energy monitoring. Measurement devices shall be installed in new buildings to individually monitor energy use of each of the following types of energy supplied by a utility, energy provider, or plant that is not within the building:

1. Natural gas
2. Fuel oil
3. Propane
4. Steam
5. Chilled Water
6. Hot Water

Exceptions:

1. Buildings less than 25,000 square feet (2,325 m^2).
2. Group R buildings with less than 10,000 square feet of common area (930 m^2).
3. Fuel use for on-site emergency equipment.

1.29 Addition of Section C405.13 Whole Building Electrical Monitoring

C405.13 Whole building electrical monitoring. Each new building shall have a measurement device capable of recording electrical energy use every 60 minutes and the capability to report use on an hourly, daily, monthly, and annual basis. The measurement device shall be capable of retaining the recorded data for 36 months.

Exceptions:

1. Buildings less than 25,000 square feet (2,325 m^2).
2. *Group R* buildings with less than 10,000 square feet of common area (930 m^2).
3. Fuel use for on-site emergency equipment.

1.30 Replacement of Section C406.1 Requirements

C406.1 Requirements. Buildings shall comply with at least one of the following Sections.

1. More efficient HVAC equipment in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced digital lighting controls in accordance with Section C406.4.
4. Dedicated outdoor air systems with energy recovery ventilation in accordance with Section C406.5.
5. Enhanced envelope performance in accordance with Section C406.6.
6. Reduced air infiltration in accordance with Section C406.7.

1.31 Amendment to Section C406.1.1 Tenant Spaces

C406.1.1. Tenant spaces. Tenant spaces shall comply with Section C406.2, C406.3, C406.4 or C406.7. Alternatively, tenant spaces shall be in compliance with Section C406.5 or C406.6 where the entire building is in compliance.

> **Exception:** Previously occupied tenant spaces that comply with this code using Section C501.

1.32 Replacement and Renaming of Section C406.5 On-Site Renewable Energy

C406.5 Dedicated outdoor air system. Buildings containing equipment or systems regulated by Section C403.3.4, C403.4.3, C403.4.4, C403.4.5, C403.6, C403.8.4, C403.8.5, C403.8.5.1, C403.9.1, C403.9.2, C403.9.3 or C403.9.4 shall be equipped with an independent ventilation system designed to provide not less than the minimum 100-percent outdoor air to each individual occupied space, as specified by the International Mechanical Code. The ventilation system shall be equipped with an energy recovery system meeting the requirements of Section C403.7.4, without exception (Note: C406.5 cannot be selected where ERV is prohibited by the *International Mechanical Code* or otherwise prohibited.) The HVAC system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.

1.33 Replacement and Renaming of Section C406.6 Dedicated Outdoor Air System

C406.6 Enhanced envelope performance. The thermal performance of the envelope shall demonstrate a 15 percent improvement compared to the requirements of Section C402.1.5.

1.34 Replacement and Renaming of Section C406.7 Reduced Energy Use in Service Water Heating

C406.7 Reduced air infiltration. Air infiltration shall be verified by whole building pressurization testing conducted in accordance with Section C402.5.9. The measured air leakage rate of the building envelope shall not exceed 0.25 cfm/ft^2 (2.0 L/s x m^2) under a pressure differential of 0.3 in. water (75 Pa), with the calculated surface area being the sum of the above and below grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

> **Exception:** For buildings with more than 250,000 square feet (25 000 m^2) of conditioned floor area, air leakage testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.

1.35 Replacement of Section C407 Total Building Performance

Section C407
Total Building Performance

C407.1 Scope. This section establishes criteria for compliance using total building performance. Buildings following the total building performance path must comply with ASHRAE 90.1-2016 (as amended), demonstrating compliance under Section 11 or Appendix G of such standard.

1.36 Amendments to Section C408.2 Mechanical Systems and Service Water-Heating Systems Commissioning and Completion Requirements

C408.2 Mechanical, renewable energy, and service water heating systems commissioning and completion requirements. This section is required when one of the following conditions is met:

1. The *building* is not less than 25,000 square feet (2,325 m^2).
2. The total mechanical equipment capacity being installed is greater than 480,000 Btu/h (140.7 kW) cooling capacity.
3. The combined *service water-heating* and space-heating capacity is greater than 600,000 Btu/h (175.8 kW).

Prior to passing the final mechanical and plumbing inspections, the *registered design professional or approved agency* shall provide evidence of systems *commissioning* and completion in accordance with the provisions of this section.

Construction document notes shall clearly indicate provisions for *commissioning* and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner or owner's authorized agent and made available to the *code official* upon request in accordance with Sections C408.2.4 and C408.2.5.

Mechanical systems, renewable energy, and *service water heating* systems shall include, at a minimum, the following systems (mechanical and/or passive) and associated controls:

1. Heating, cooling, air handling and distribution, ventilation, and exhaust systems, and their related air quality monitoring systems.
2. Air, water, and other energy recovery systems.
3. Manual or automatic controls, whether local or remote, on energy using systems including but not limited to temperature controls, setback sequences, and occupancy-based control, including energy management functions of the building management system.
4. Plumbing, including insulation of piping and associated valves, domestic and process water pumping, and mixing systems.
5. Mechanical heating systems and service water heating systems.
6. Refrigeration systems.

7. Renewable energy and energy storage systems where installed generating capacity is not less than 25kW.
8. Other systems, equipment and components that are used for heating, cooling or ventilation, and affect energy use.

C408.2.1 Commissioning Plan is unchanged.

1.37 Amendments to Section C408.2.2 Systems Adjusting and Balancing

C408.2.2 Systems adjusting and balancing. HVAC systems shall be balanced in accordance with ANSI/ASHRAE 111, "Testing, Adjusting, and Balancing of Building HVAC Systems" or other approved engineering standards.

C408.2.2.1 Air systems balancing is unchanged.

C408.2.2.2 Hydronic systems balancing is unchanged.

1.38 Addition of New Section C408.4 Air Barrier Commissioning

C408.4 Air barrier commissioning. Prior to passing final inspection, the registered design professional or approved agent shall provide evidence of air barrier commissioning and substantial completion in accordance with the provisions of sections C408.4.1 through C408.4.3.

C408.4.1 Documentation. Construction documents shall include documentation of the continuous air barrier components included in the design and a field inspection checklist that includes all requirements necessary for maintaining air barrier continuity and durability in accordance with Section C402.5.1.

C408.4.2 Field inspections. Reports from field inspections during project construction showing compliance with continuous air barrier requirements including proper material handling and storage, use of approved materials and material substitutes, proper material and surface preparation, and air barrier continuity shall be provided to the owner and, upon request, to the code official. Air barrier continuity shall be determined by testing or inspecting each type of unique air barrier joint or seam in the building envelope for continuity and defects.

C408.4.3 Report. A final commissioning report indicating compliance with the continuous air barrier requirements shall be provided to the building owner and, upon request, to the code official.

1.39 Addition of New Section C502.2.3.1 Commissioning

C502.2.3.1 Commissioning. New heating, cooling, and duct system components that are part of the addition and the controls that serve them shall comply with Sections C408.2.2, C408.2.3 and C408.2.5.

Exception: Mechanical systems in additions where the total mechanical equipment capacity of the building is less than 480,000 Btu/h (140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW) combined service water heating and space heating capacity.

1.40 Addition of New Section C502.2.4.1 Commissioning

C502.2.4.1 Commissioning. New service hot water system components that are part of the addition and the controls that serve them shall comply with Sections C408.2.2, C408.2.3, and C408.2.5.

Exception: Service hot water systems in additions where the combined service water heating and space heating capacity of the building is less than 600,000 Btu/h (175.8 kW).

1.41 Addition of New Section C502.3 Air Barriers

C502.3 Air barriers. The thermal envelope of additions shall comply with Sections C402.5.1 through C402.5.8.

1.42 Addition of New Section C503.3.4 Air Barriers

C503.3.4 Air barriers. The thermal envelope of alterations shall comply with Sections C402.5.1 through C402.5.8.

1.43 Addition of New Section C503.4.2 Commissioning

C503.4.2 Commissioning. New heating, cooling and duct system components that are part of the alteration and the controls that serve them shall comply with Sections C408.2.2, C408.2.3, and C408.2.5.

Exceptions: Mechanical systems in alterations where the total mechanical equipment capacity of the building is less than 480,000 Btu/h (140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW) combined service water heating and space heating capacity.

1.44 Addition of New Section C503.5.1 Commissioning

C503.5.1 Commissioning. New service hot water system components that are part of the alteration and the controls that serve them shall comply with Sections C408.2.2, C408.2.3, and C408.2.5.

> **Exception:** Service hot water systems in alterations where the combined service water heating and space heating capacity of the building is less than 600,000 Btu/h (175.8 kW).

1.45 Addition of New Appendix CB
Rated R-value of Insulation—Commercial

Appendix CB
Rated *R*-Value of Insulation – Commercial

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

Section CB101
Scope

CB101.1 General. These provisions shall be applicable for new construction where an Insulation R-value based method is required.

Section CB102
Insulation Component *R*-Value-Based Method

CB102.1 General. The opaque portions of the building thermal envelope shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of the R-value-based method of Section CB102.2.

CB102.2 Insulation component *R*-value-based method. *Building thermal envelope* opaque assemblies shall comply with the requirements of Sections C402.2 and C402.4 based on the *climate zone* specified in Chapter 3. For opaque portions of the *building thermal envelope* intended to comply on an insulation component *R-value* basis, the *R*-values for insulation shall be not less than that specified in Table CB102.2. Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the R values from the "*Group R*" column of Table CB102.2. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *R*-values from the "All other" column of Table CB102.2.

Table CB102.2

Opaque Thermal Envelope Insulation Component Minimum Requirements, R-Value Method[a, h]

CLIMATE ZONE	4 EXCEPT MARINE		5 AND MARINE 4		6	
	All other	Group R	All other	Group R	All other	Group R
Roofs						
Insulation Entirely above roof deck	R-33ci	R-33ci	R-33ci	R-33ci	R-33ci	R-33ci
Metal buildings[b]	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS
Attic and other	R-53	R-53	R-53	R-53	R-53	R-53
Walls, above grade						
Mass[f]	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci
Metal building	R-13 + R-13ci	R-13+ R-19.5ci	R-13+ R-19.5ci	R-13+ R-19.5ci	R-13+ R-19.5ci	R-13+ R-19.5ci

Metal framed	R-13 + R-8.5ci	R-13 + R-8.5ci	R-13 + R-11ci	R-13 + R-11ci	R-13+ R13.5ci	R-13+ R14.5ci
Wood framed and other	R-13 + R-4.5ci or R-19 + R-1.5ci	R-13 + R-4.5ci or R-19 + R-1.5ci	R-13 + R-9ci or R-19 + R-5ci	R-13 + R-9ci or R-19 + R-5ci	R-13 + R-9ci or R-19 + R-5ci	R-13 + R-9.5ci or R-19 + R-6ci
Walls, below grade						
Below-grade wall[c]	R-7.5ci	R-10ci	R-7.5ci	R-10ci	R-10ci	R-15ci
Floors						
Mass[d]	R-15ci	R-16.7ci	R-15ci	R-16.7ci	R-16.7ci	R-16.7ci
Joist/framing	R-30	R-30[e]	R-30[e]	R-30[e]	R-38	R-38
Slab-on-grade floors						
Unheated slabs	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below	R-15 for 24" below
Heated slabs[g]	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab	R-20 for 48" below + R-5 full slab
Opaque doors						
Non-Swinging	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/ m^2, 1 pound per cubic foot = 16 kg/m^3.
ci = Continuous insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A.

b. Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.4.

c. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

d. "Mass floors" shall be in accordance with Section C402.2.3.

e. Steel floor joist systems shall be insulated to R-38.

f. "Mass walls" shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

h. Not applicable to garage doors. See Table C402.1.4.

1.46 Addition of New Appendix CC
Additional Power Distribution System Packages—Commercial

Appendix CC
Additional power distribution system packages – Commercial

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.

Section CC101
Scope

CC101.1 General. These provisions shall be applicable for new construction where additional power distribution system packages are required.

Section CC102
Additional Power Distribution System Packages

CC102.1 General (Mandatory). New buildings shall comply with at least one of the following:

1. Additional *on-site renewable energy* in accordance with Section CC102.2.
2. Electrical energy monitoring in accordance with Section CC102.3.
3. Interoperable automated demand-response (AutoDR) infrastructure in accordance with Section CC102.4.
4. Electric vehicle charging stations in accordance with Section CC102.5.
5. Automatic receptacle controls in accordance with CC102.6.

CC102.2 On-site renewable energy. The total minimum rating of *on-site renewable energy* systems shall be one of the following:

1. Not less than 1.71 Btu/hr/ft^2 (5.4 w/m^2) or 0.50 w/ft^2 of conditioned floor area.
2. Not less than 3 percent of energy use within the building for mechanical, service hot water heating, and lighting regulated in Chapter 4 [CE].

CC102.3 Electrical energy monitoring. Buildings shall comply with Sections CC102.3.1 through CC102.3.4. Buildings shall be equipped to measure, monitor, record, and report electricity consumption data for each end-use category listed in Table CC102.3.1. For buildings with tenants, the end-uses in Table CC102.3.1 shall be separately monitored for the total building load and (excluding shared systems) for each individual tenant.

Exception:

1. Up to 10 percent of the load for each of the end uses shall be allowed to be from other electrical loads.
2. Individual tenant spaces that have their own utility services and meters and have less than 5,000 square feet (465 m^2) of conditioned floor area.

CC102.3.1 End-use metering categories. Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category specified in Table CC102.3.1. These meters shall have the capability to collect energy consumption data for the whole building or for each separately metered portion of the building. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all the energy used by that category. Not more than 5 percent of the measured load for each end-use category specified in Table CC102.3.1 shall be from a load not within that category.

TABLE CC102.3.1
ENERGY USE CATEGORIES

LOAD CATEGORY
HVAC systems
Interior lighting
Exterior lighting
Receptacle circuits
Total electrical energy

CC102.3.2 Meters. Meters and other measurement devices required by this Section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section CC102.3.3. Source meters shall be any digital-type meter. Lighting, HVAC, and other building systems that can monitor their energy consumption shall not require meters. Current sensors are an alternative to meters, provided they have a tested accuracy of +/-2 percent. Required metering systems and equipment shall be able to provide not less than hourly data that is fully integrated into the data acquisition system and produce a graphical energy report in accordance with Sections CC102.3.3 and CC102.3.4.

CC102.3.3 Data acquisition systems. A data acquisition system shall have the capability to store data from the required meters and other sensing devices for not less than 36 months. The data acquisition system shall be able to store real-time energy consumption data and provide hourly, daily, monthly, and yearly logged data for each end-use category required by Table CC102.3.1.

CC102.3.4 Graphical energy report. A permanent reporting mechanism shall be provided in the building that can be accessed by building operation and management personnel. The reporting mechanism shall be able to graphically provide the energy consumption data for each end-use category required by Table CC102.3.1 for not less than every hour, day, month and year for the previous 36 months.

CC102.4 Interoperable automated demand-response (AutoDR) infrastructure. The building controls shall be designed with automated demand-response (Auto-DR) infrastructure capable of receiving demand-response requests from the utility, electrical system operator, or third-party DR program provider, and of automatically implementing load adjustments to the HVAC and lighting-systems.

Buildings shall comply with the following:

1. HVAC systems shall be programmed to allow automatic centralized demand reduction in response to a signal from a centralized contact or software point.
2. HVAC equipment with variable speed control shall be programmed to allow automatic adjustment of the maximum speed of the equipment.
3. Lighting systems with central control shall be programmed to allow automatic reduction of total connected lighting power.

CC102.5 Electric vehicle charging stations. Not less than two electric vehicle charging stations at minimum 208/240V 40 amp shall be provided on the *building site*.

CC102.6 Automatic receptacle controls. The following receptacles shall be automatically controlled in accordance with Section CC102.6.1:

1. At least 50 percent of all 125 V, 15- and 20-amp receptacles in all private offices, conference rooms, rooms used primarily for printing and/or copying functions, break rooms, classrooms, and individual workstations.
2. At least 25 percent of branch circuit feeders installed for modular furniture not shown on the construction documents.

All controlled receptacles shall be permanently marked to visually differentiate them from uncontrolled receptacles and are to be uniformly distributed throughout the space. Plug-in devices shall not be used to comply with Section CC102.6.1.

Exceptions:

1. Receptacles specifically designated for equipment intended for continuous operation (24 hours/day, 365 days/year).
2. Spaces where an automatic shutoff would endanger occupant safety or security.

CC102.6.1 Automatic receptacle control function. Automatic receptacle controls shall comply with one of the following:

1. Automatically turn receptacles off at specific programmed times, and the occupant shall be able to manually override the control device for up to two hours. An independent program schedule shall be provided for controlled areas of not more than 5000 square feet and not more than one floor.
2. Be an occupant sensor to automatically turn receptacles off within 20 minutes of all occupants leaving a space.
3. Be an automated signal from another control or alarm system to automatically turn receptacles off within 20 minutes of all occupants leaving a space.

PART 2

2 Amendments to ASHRAE 90.1-2016

2.1 Addition to Section 3.2 Definitions

Baseline building source energy: the annual *source energy* use in units of BTU for a *building* design intended for use as a baseline for rating above-standard design or when using the *performance rating method* as an alternative path for minimum standard compliance in accordance with Section 4.2.1.1.

On-site electricity generation systems: systems located at the *building* site that generate electricity, including but not limited to generators, combined heat and power systems, fuel cells, and *on-site renewable energy* systems.

Proposed building source energy: the annual *source energy* use in units of BTU for a *proposed design.*

Site Energy: The amount of fuel that is consumed on-site to operate a building.

Source Energy: the total amount of primary fuel that is required to operate a building incorporating transmission, delivery, and production losses. Source Energy is calculated by multiplying site energy of each fuel type by the conversion factors in Table 4.2.1.2.

2.2 Amendments to Section 4.2.1.1 New Buildings

4.2.1.1 New Buildings

New *buildings* shall comply with either the provisions of

a. Section 5, "*Building Envelope*"; Section 6, "Heating, Ventilating, and Air Conditioning"; Section 7, "*Service Water Heating*"; Section 8, "Power"; Section 9, "Lighting"; and Section 10, "*Other Equipment*," or
b. Section 11, "*Energy Cost Budget* Method,", or
c. Appendix G, "*Performance Rating Method*", using <u>one</u> of the following methods:

   1. **Performance Cost Index Method**. When using Appendix G, the Performance Cost Index (PCI) shall be less than or equal to the Performance Cost Index Target (PCIt) when calculated in accordance with the following:

$$PCIt = [BBUEC + (BPF_{cost} \times BBREC)]/BBP$$

Where

PCI = Performance Cost Index calculated in accordance with Section G1.2.

BBUEC = Baseline *Building* Unregulated *Energy* Cost, the portion of the annual *energy* cost of a *Baseline building design* that is due to *unregulated energy use*.

BBREC = Baseline *Building* Regulated *Energy* Cost, the portion of the annual *energy* cost of a *Baseline building design* that is due to *regulated energy use*.

BPF_{cost} = *Building* Performance Factor from Table 4.2.1.1. For *building* area types not listed in Table 4.2.1.1 use "All others." Where a *building* has multiple *building* area types, the required BPF_{cost} shall be equal to the area-weighted average of the *building* area types.

BBP = *Baseline Building Performance*.

Regulated *energy* cost shall be calculated by multiplying the total *energy* cost by the ratio of *regulated energy* use to total *energy* use for each *fuel* type. Unregulated *energy* cost shall be calculated by subtracting regulated *energy* cost from total *energy* cost.

2. **Performance Source Energy Index Method.** When using Appendix G, the Performance *Source Energy* Index (PSEI) shall be less than or equal to the Performance Source Energy Index Target (PSEIt) when calculated in accordance with the following:

$$PSEIt = [BBUSE + (BPF_{source} \times BBRSE)]/BBSE$$

Where

PSEI = Performance Source Energy Index calculated in accordance with Section G1.2

BBUSE = Baseline building unregulated source energy use in units of BTU, the portion of the annual site energy of a baseline building design that is due to unregulated energy use multiplied by the site to source conversion ratios in Table 4.2.1.2 for each fuel type.

BBRSE = Baseline building regulated source energy use in units of BTU, the portion of the annual site energy of a baseline building design that is due to regulated energy use multiplied by the site to source conversion ratios in Table 4.2.1.2 for each fuel type.

BPF_{source} = Building Performance Factor from Table 4.2.1.3. For building area types not listed in Table 4.2.1.3 use "All others." Where a building has multiple building area types, the required BPF_{source} shall be equal to the area-weighted average of the building area types.

BBSE = *Baseline building source energy*.

2.3 Replacement of Table 4.2.1.1 *Building* Performance Factor

Table 4.2.1.1 *Building* Performance Factor (Cost) (BPF_{cost})

Building Area Type	4A	5A	6A
Office	.54	.54	.55
Retail	.45	.42	.44
School	.45	.46	.46
Hotel/motel	.62	.56	.56
Multifamily	.67	.67	.64
Healthcare/hospital	.54	.54	.51
Restaurant	.56	.55	.55
Warehouse	.42	.42	.46
All others	.53	.52	.52

2.4 Addition of Table 4.2.1.2 Site to Source Energy Conversion Ratios

Table 4.2.1.2 Site to Source Energy Conversion Ratios

Energy Type	New York Ratio
Electricity (Grid Purchase)	2.55
Electricity (*On-site Renewable Energy* Installation)	1.00
Natural Gas	1.05
Fuel Oil	1.01
Propane & Liquid Propane	1.01
Steam	1.20
Hot Water	1.20
Chilled Water, Coal, Wood, Other	1.00

2.5 Addition of Table 4.2.1.3 Building Performance Factor (Source) (BPF_{source})

Table 4.2.1.3 Building Performance Factor (BPF_{source})

Building Area Type	4A	5A	6A
Office	.55	.55	.56
Retail	.45	.42	.43
School	.45	.45	.45
Hotel/motel	.62	.56	.54
Multifamily	.68	.68	.65
Healthcare/hospital	.56	.56	.54
Restaurant	.63	.64	.63
Warehouse	.44	.46	.49
All others	.55	.54	.54

2.6 Addition of New Section 5.2.3 Additional Requirements to Comply with Section 11 and Appendix G

5.2.3 Additional Requirements to Comply with Section 11 and Appendix G

The *building* envelope in new buildings 50,000 square feet and greater shall comply with either:

1. Section 5.5, "Prescriptive Building Envelope Option," or
2. An envelope performance factor shall be calculated in accordance with 90.1 Appendix C, and buildings shall comply with one of the following:

    i. For multifamily, hotel/motel and dormitory building area types, the margin by which the *proposed envelope performance factor* exceeds the *base envelope performance factor* shall not be greater than 15 percent. For compliance with this requirement, the *base envelope performance factor* shall be calculated using metal framing operable windows. In *buildings* with window area accounting for 40 percent or more of the *gross wall* area, the SHGC of the *vertical fenestration* on east and west oriented façade may be reduced by the following multiplier to account for the permanent site shading from existing buildings or infrastructure.

    $M_{West} = 0.18 + 0.33/WWR$

    $M_{East} = 0.35 + 0.26/WWR$

    Where:

    M_{West} = SHGC multiplier for the West façade

    M_{East} = SHGC multiplier for the East façade

    WWR = the ratio of the proposed *vertical fenestration* area to the *gross wall* area in consistent units.

    The multiplier may be applied to the rated SHGC of the *vertical fenestration* which has at least 50 percent of the area located directly opposite of the shading surfaces and no higher from the street level than the difference between the shading surface height and the shading surface distance from the façade. *Orientation* must be determined following Section 5.5.4.5, Fenestration Orientation.

    ii. For all other *building* area types, the margin by which the proposed *envelope performance factor* exceeds the *base envelope performance factor* shall be not greater than 7 percent. For compliance with this requirement, the *base envelope performance factor* shall be calculated using metal framing fixed windows.

    iii. For mixed-use *buildings* the margin shall be calculated as the *gross wall area*-weighted average of i and ii.

2.7 Addition of New Section 5.4.1.1 Continuous Insulation

5.4.1.1 Continuous Insulation

In new construction, structural elements of balconies and parapets that penetrate the *building envelope*, shall comply with one of the following:

1. Structural elements penetrating the *building* thermal *envelope* shall be insulated with *continuous insulation* having a minimum thermal resistance of R-3.
2. Structural elements of penetrations of the *building* thermal *envelope* shall incorporate a minimum R-3 thermal break where the structural element penetrates the *building* thermal *envelope*.

2.8 Amendments to Section 5.4.3.1.3 Testing, Acceptable Materials, and Assemblies

5.4.3.1.3 Testing, Acceptable Materials, and Assemblies

The *building* shall comply with whole-*building* pressurization testing in accordance with Section 5.4.3.1.3(a) or with the *continuous air barrier* requirements in Section 5.4.3.1.3(b) or 5.4.3.1.3(c). New *buildings* not less than 25,000 square feet and not greater than 50,000 square feet, and less than or equal to 75 feet in height, must show compliance through testing in accordance with Section 5.4.3.1.3(a).

The remainder of 5.4.3.1.3 is unchanged.

2.9 Amendments to Section 5.5.3 Opaque Areas

5.5.3 Opaque Areas.

For all *opaque* surfaces except *doors*, compliance shall be demonstrated by one of the following two methods:

a. Minimum rated *R-value* of insulation for the *thermal resistance* of the added insulation in framing cavities and *continuous insulation* only. Specifications listed in Normative Appendix A for each *class of construction* shall be used to determine compliance.
b. Maximum *U-factor, C-factor, or F-factor* for the entire assembly. The values for typical *construction* assemblies listed in Normative Appendix A shall be used to determine compliance.

Exceptions to 5.5.3

1. For assemblies significantly different than those in Appendix A, calculations shall be performed in accordance with the procedures required in Appendix A.

2. For multiple assemblies within a single *class of construction* for a single *space-conditioning category*, compliance shall be shown for either (a) the most restrictive requirement or (b) an area-weighted average *U-factor, C-factor, or F-factor*.
3. When the total area of penetrations from mechanical equipment listed in Table 6.8.1-4 exceeds 1 percent of the *opaque above-grade wall* area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a default *U-factor* of 0.5, and compliance shall be shown with method b. Where mechanical equipment has been tested in accordance with testing standards, approved by the *authority having jurisdiction*, the mechanical equipment penetration area may be calculated as a separate wall assembly with the *U-factor* as determined by such test.

2.10 Amendments to Section 5.6.1.1 Subsection to 5.6 Building Envelope Trade-Off Option

5.6.1.1

All components of the *building envelope* shown on architectural drawings or installed in *existing buildings* shall be modeled in the *proposed design*. The *simulation program* model *fenestration* and *opaque building* envelope types and area shall be consistent with the *construction documents*. Any *building envelope* assembly that covers less than 5 percent of the total area of that assembly type (e.g., *exterior walls*) need not be separately described, provided it is similar to an assembly being modeled. If not separately described, the area of a *building envelope* assembly shall be added to the area of an assembly of that same type with the same *orientation* and thermal properties. When the total area of penetrations from mechanical equipment listed in Table 6.8.1-4 exceeds 1 percent of the *opaque above-grade wall* area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a default *U-factor* of 0.5.

Exception to 5.6.1.1

Where mechanical equipment has been tested in accordance with testing standards approved by the *authority having jurisdiction*, the mechanical equipment penetration area may be calculated as a separate wall assembly with the *U-factor* as determined by such test.

2.11 Amendments to Section 6.5.3.1.1 Allowable Fan Horsepower

6.5.3.1.1 Allowable Fan Horsepower.

Each *HVAC system* having a total *fan system motor nameplate horsepower* exceeding 5 hp at *fan system design conditions* shall not exceed the allowable *fan system motor nameplate horsepower* (Option 1) or fan *system* bhp (Option 2) as shown in Table 6.5.3.1-1. This includes supply fans, return/relief fans, exhaust fans, and fan-powered *terminal* units associated with *systems* providing heating or cooling capability that operate at *fan system design conditions*. Single-zone *VAV systems* shall comply with the constant-volume fan power limitation.

Exceptions to 6.5.3.1.1

1. Hospital, vivarium, and laboratory *systems* that use flow *control devices* on exhaust and/or return to maintain *space* pressure relationships necessary for occupant health and safety or environmental *control* may use variable-volume fan power limitation.
2. Individual exhaust fans with motor *nameplate horsepower* of 1 hp or less.
3. Fans supplying air to active chilled beams.

2.12 Amendments to Table 6.5.3.1-1 Fan Power Limitation

Table 6.5.3.1-1 Fan Power Limitation

	Limit	Constant volume	Variable volume
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	hp ≤ CFM_S*0.0009	hp ≤ CFM_S* 0.0011
Option 2: Fan system bhp	Allowable fan system bhp	bhp ≤ CFM_S X 0.00088 + A	bhp ≤ CFM_S X 0.0010 + A

For SI: 1 bhp = 735.5 W, 1 hp = 745.5 W, 1 cfm = 0.4719 L/S
Where:
CFM_S = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute.
hp = The maximum combined motor nameplate horsepower.
Bhp = The maximum combined fan brake horsepower.
A = Sum of [PD X CFM_D/4131]
Where:
PD = Each applicable pressure drop adjustment from Table 6.5.3.1-2 in in. of water
CFM_D = The design airflow through each applicable device from Table 6.5.3.1-2 in cubic feet per minute.

2.13 Amendments to Section 6.5.6.1 Exhaust Air Energy Recovery

6.5.6.1 Exhaust Air Energy Recovery.

Each fan *system* shall have an *energy* recovery *system* when the design supply fan airflow rate exceeds the value listed in Tables 6.5.6.1-1 and 6.5.6.1-2, based on the climate zone and percentage of *outdoor air* at design airflow conditions. Table 6.5.6.1-1 shall be used for all *ventilation systems* that operate less than 8,000 hours per year, and Table 6.5.6.1-2 shall be used for all ventilation systems that operate 8,000 or more hours per year.

Energy recovery *systems* required by this section shall result in an *enthalpy recovery ratio* of at least 50 percent. A 50 percent *enthalpy recovery ratio* shall mean a change in the enthalpy of the *outdoor air* supply equal to 50 percent of the difference between the *outdoor air* and entering exhaust air enthalpies at *design conditions*. Provision shall be made to bypass or *control* the *energy* recovery *system* to permit *air economizer* operation as required by Section 6.5.1.1.

Exceptions

1. Laboratory *systems* meeting Section 6.5.7.3.
2. *Systems* serving *spaces* that are not cooled and that are heated to less than 60°F.

3. Where more than 60 percent of the *outdoor air* heating *energy* is provided from *site-recovered energy* or *site-solar energy.*
4. Heating *energy* recovery in Climate Zones 0, 1, and 2.
5. Cooling *energy* recovery in Climate Zones 3C, 4C, 5B, 5C, 6B, 7, and 8.
6. Where the largest source of air exhausted at a single location at the building exterior is less than 75 percent of the design ventilation outdoor air flow rate, multiple exhaust fans or outlets located within a 30-foot radius from the outdoor air supply unit shall be considered a single exhaust location.
7. *Systems* requiring dehumidification that employ *energy* recovery in series with the cooling coil.
8. *Systems* expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table 6.5.6.1-1.

2.14 Addition of New Section 10.4.3.5 Power Conversion System

10.4.3.5 Power Conversion System

New traction elevators with a rise of 75 feet or more in new buildings shall have a power conversion system that complies with Sections 10.4.3.5.1 through 10.4.3.5.3.

10.4.3.5.1 Motor

Induction motors with a Class IE2 efficiency ratings, as defined by IEC EN 60034-30, or alternative technologies, such as permanent magnet synchronous motors that have equal or better efficiency, shall be used.

10.4.3.5.2 Transmission

Transmissions shall not reduce the efficiency of the combined motor/transmission for the Class IE2 motor for elevators with capacities below 4,000 lbs. Gearless machines shall be assumed to have a 100 percent transmission efficiency.

10.4.3.5.3 Drive

Potential energy released during motion shall be recovered with a regenerative drive that supplies electrical energy to the building electrical system.

2.15 Addition of New Section 10.4.6 Commercial Kitchen Equipment

10.4.6 Commercial Kitchen Equipment

Commercial kitchen equipment shall comply with the minimum efficiency requirements of Tables 10.4.6-1 through Table 10.4.6-5.

Table 10.4.6-1: Minimum Efficiency Requirements: Commercial Fryers

	Heavy-Load Cooking Energy Efficiency	Idle Energy Rate	Test Procedure
Standard Open Deep-Fat Gas Fryers	≥50%	≤ 9,000 Btu/hr	ASTM Standard F1361-17
Large Vat Open Deep-Fat Gas Fryers	≥ 50%	≤ 12,000 Btu/hr	
Standard Open Deep-Fat Electric Fryers	≥ 83%	≤ 800 watts	ASTM Standard F2144-17
Large Vat Open Deep-Fat Electric Fryers	≥ 80%	≤ 1,100 watts	

Table 10.4.6-2: Minimum Efficiency Requirements: Commercial Hot Food Holding Cabinets

Product Interior Volume (Cubic Feet)	Maximum Idle Energy Consumption Rate (Watts)	Test Procedure
0 < V < 13	≤ 21.5 V	ASTM Standard F2140-11
13 ≤ V < 28	≤ 2.0 V + 254.0	
28 ≤ V	≤ 3.8 V + 203.5	

Table 10.4.6-3: Minimum Efficiency Requirements: Commercial Steam Cookers

Fuel Type	Pan Capacity	Cooking Energy Efficiency[a]	Idle Rate	Test Procedure
Electric Steam	3-pan	50%	400 watts	ASTM Standard F1484-18
	4-pan	50%	530 watts	
	5-pan	50%	670 watts	
	6-pan and larger	50%	800 watts	
Gas Steam	3-pan	38%	6,250 Btu/h	
	4-pan	38%	8,350 Btu/h	
	5-pan	38%	10,400 Btu/h	
	6-pan and larger	38%	12,500 Btu/h	

a. Cooking Energy Efficiency is based on heavy load (potato) cooking capacity

Table 10.4.6-4: Minimum Efficiency Requirements: Commercial Dishwashers

Machine Type	High Temp Efficiency Requirements		Low Temp Efficiency Requirements		Test Procedure
	Idle Energy Rate[a]	Water Consumption[b]	Idle Energy Rate[a]	Water Consumption[b]	
Under Counter	≤ 0.50 kW	≤ 0.86 GPR	≤ 0.50 kW	≤ 1.19 GPR	ASTM Standard F1696-18 ASTM Standard F1920-15
Stationary Single Tank Door	≤ 0.70 kW	≤ 0.89 GPR	≤ 0.60 kW	≤ 1.18 GPR	
Pot, Pan, and Utensil	≤ 1.20 kW	≤ 0.58 GPSF	≤ 1.00 kW	≤ 0.58 GPSF	
Single Tank Conveyor	≤ 1.50 kW	≤ 0.70 GPR	≤ 1.50 kW	≤ 0.79 GPR	
Multiple Tank Conveyor	≤ 2.25 kW	≤ 0.54 GPR	≤ 2.00 kW	≤ 0.54 GPR	
Single Tank Flight Type	Reported	GPH ≤ 2.975x + 55.00	Reported	GPH ≤ 2.975x + 55.00	
Multiple Tank Flight Type	Reported	GPH ≤ 4.96x + 17.00	Reported	GPH ≤ 4.96x + 17.00	

a. Idle results shall be measured with the door closed and represent the total idle energy consumed by the machine including all tank heater(s) and controls. Booster heater (internal or external) energy consumption should not be part of this measurement unless it cannot be separately monitored per US EPA Energy Star Commercial Dishwasher Specification Version 2.0

b. GPR = gallons per rack; GPSF = gallons per square foot of rack; GPH = gallons per hour; x = sf of conveyor belt (i.e., W*L)/min (maximum conveyor speed).

Table 10.4.6-5: Minimum Efficiency Requirements: Commercial Ovens

Fuel Type	Classification	Idle Rate	Cooking-Energy Efficiency, %	Test Procedure
Convection Ovens				
Gas	Full-Size	≤ 12,000 Btu/h	≥ 46	ASTM F1496 - 13
Electric	Half-Size	≤ 1.0 Btu/h	≥ 71	
	Full-Size	≤ 1.60 Btu/h		
Combination Ovens				
Gas	Steam Mode	≤ 200P[a] +6,511 Btu/h	≥ 41	ASTM F2861 - 17
	Convection Mode	≤ 150P[a] +5,425 Btu/h	≥ 56	
Electric	Steam Mode	≤ 0.133P[a] +0.6400 kW	≥ 55	
	Convection Mode	≤ 0.080P[a] +0.4989 kW	≥ 76	
Rack Ovens				
Gas	Single	≤ 25,000 Btu/h	≥ 48	ASTM F2093 - 18
	Double	≤ 30,000 Btu/h	≥ 52	

a. P = Pan Capacity: The number of steam table pans the combination oven is able to accommodate as per the ASTM F – 1495 – 05 standard specification.

2.16 Addition of New Section 10.4.7 Electric Vehicle Charging Station Capable

10.4.7 Electric vehicle charging station capable.

New parking garages and new parking lots powered by the energy services for a building, and with 10 or more parking spaces, shall provide either:

1. Panel capacity and conduit for the future installation of minimum 208/240V 40-amp outlets for 5 percent of the total parking spaces and not less than two parking spaces; or
2. Minimum 208/240V 40-amp outlets for 5 percent of the total parking spaces and not less than two parking spaces.

2.17 Addition of New Section 10.4.8 Solar-Ready Zone

10.4.8 Solar-ready zone (Mandatory)

Comply with the provisions of Appendix CA of 2018 IECC (as amended).

2.18 Amendments to Section 11.2 Compliance

11.2 Compliance.

Compliance with Section 11 will be achieved if

a. All requirements of Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4, and Section C408 and Appendix CC (if mandated by local ordinance) of the 2018 IECC (as amended) are met;
b. The *design energy cost*, as calculated in Section 11.5, does not exceed the building *energy use budget,* as calculated by the *simulation program* described in Section 11.4, and
c. The *energy efficiency* level of components specified in the *building* design meet or exceed the *efficiency* levels used to calculate the design energy cost; and
d. In new buildings 50,000 square feet and greater, an envelope performance factor shall be calculated in accordance with 90.1 Appendix C, and buildings shall comply with one of the following:

    i. For multifamily, hotel/motel and dormitory building area types, the margin by which the *proposed envelope performance factor* exceeds the *base envelope performance factor* shall not be greater than 15 percent. For compliance with this requirement, the *base envelope performance factor* shall be calculated using metal framing operable windows. In buildings with window area accounting for 40 percent or more of the wall area, the SHGC of the *vertical fenestration* on east and west oriented façade may be reduced by the following multiplier to account for the permanent site shading from existing buildings or infrastructure.

$M_{West} = 0.18 + 0.33/WWR$
$M_{East} = 0.35 + 0.26/WWR$
Where:
M_{West} = SHGC multiplier for the West facade
M_{East} = SHGC multiplier for the East facade
WWR = the ratio of the proposed *vertical fenestration* area to the *gross wall area* in consistent units.

The multiplier may be applied to the rated SHGC of the *vertical fenestration* which has at least 50 percent of the area located directly opposite of the shading surfaces and no higher from the street level than the difference between the shading surface height and the shading surface distance from the façade. Orientation must be determined following Section 5.5.4.5.

ii. For all other buildings area types, the margin by which the proposed *envelope performance factor* exceeds the *base envelope performance factor* shall be not greater than 7 percent. For compliance with this requirement, the *base envelope performance factor* shall be calculated using metal framing fixed windows.

iii. For mixed-use buildings, the margin shall be calculated as the *gross wall area*-weighted average of options *a* and *b*.

2.19 Amendments to Section 11.4.3.2 Annual Energy Costs

11.4.3.2 Annual Energy Costs.

The *design energy cost* and *energy cost budget* shall be determined using rates for *purchased energy* (such as electricity, gas, oil, propane, steam, and chilled water) that are approved by the *adopting authority*. Where *on-site renewable energy* or *site-recovered energy* is used, the *budget building design* shall be based on the *energy* source used as the backup *energy* source, or electricity if no backup *energy* source has been specified. Where the proposed design includes electricity generated from sources other than *on-site renewable energy,* the baseline design shall include the same generation system.

2.20 Amendments to Table 11.5.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost Budget

Table 11.5.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost

Proposed Design **(Column A)** ***Design Energy Cost*** **(DEC)**	***Budget Building Design*** **(Column B)** ***Energy Cost Budget*** **(ECB)**
1. Design Model	
a. The simulation model of the *proposed design* shall be consistent with the design documents, including proper accounting of *fenestration* and *opaque* envelope types and area; interior lighting power and *controls; HVAC system* types, sizes, and *controls*; and *service water-heating systems* and *controls*. b. All *conditioned spaces* in the *proposed design* shall be simulated as being both heated and cooled, even if no cooling or heating *system* is being installed. Temperature and humidity *control set points* and schedules, as well as *temperature control throttling range*, shall be the same for *proposed design* and *baseline building design*. c. When the *Energy Cost Budget* Method is applied to *buildings* in which *energy*-related features have not yet been designed (e.g., a *lighting system*), those yet-to-be-designed features shall be described in the *proposed design* so that they minimally comply with applicable mandatory and prescriptive requirements from Sections 5 through 10. Where the *space* classification for a *building* is not known, the *building* shall be categorized as an office *building*.	The *budget building design* shall be developed by modifying the *proposed design* as described in this table. Except as specifically instructed in this table, all *building systems* and *equipment* shall be modeled identically in the *budget building design* and *proposed design.*
2. Additions and Alterations	
It is acceptable to demonstrate compliance using *building* models that exclude parts of the *existing building*, provided all of the following conditions are met: a. Work to be performed under the current permit application in excluded parts of the *building* shall meet the requirements of Sections 5 through 10. b. Excluded parts of the *building* are served by *HVAC systems* that are entirely separate from those serving parts of the *building* that are included in the *building* model. c. Design *space* temperature and *HVAC system* operating *set points* and schedules on either side of the boundary between included and excluded parts of the *building* are identical. d. If a declining block or similar utility rate is being used in the analysis and the excluded and included parts of the *building* are on the same utility meter, the rate shall reflect the utility block or rate for the *building* plus the addition.	Same as *proposed design.*

Table 11.5.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost *(Continued)*

***Proposed Design* (Column A)** ***Design Energy Cost* (DEC)**	***Budget Building Design* (Column B)** ***Energy Cost Budget* (ECB)**
3. Space Use Classification	
The *building* area type or *space* type classifications shall be chosen in accordance with Section 9.5.1 or 9.6.1. The user or designer shall specify the *space* use classifications using either the *building* area type or *space* type categories but shall not combine the two types of categories within a single permit application. More than one *building* area type category may be used for a *building* if it is a mixed-use facility.	Same as *proposed design*.
4. Schedules	
The schedule types listed in Section 11.4.1.1(b) shall be required input. The schedules shall be typical of the *proposed design* as determined by the designer and approved by the *authority having jurisdiction*. Required schedules shall be identical for the *proposed design* and *budget building design*.	Same as *proposed design*.

Table 11.5.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost *(Continued)*

***Proposed Design* (Column A) *Design Energy Cost* (DEC)**	***Budget Building Design* (Column B) *Energy Cost Budget* (ECB)**
5. Building Envelope	
All components of the *building envelope* in the *proposed design* shall be modeled as shown on architectural drawings or as installed for *existing building envelopes*. **Exceptions:** The following *building* elements are permitted to differ from architectural drawings. 1. Any *building envelope* assembly that covers less than 5 percent of the total area of that assembly type (e.g., exterior walls) need not be separately described. If not separately described, the area of a *building envelope* assembly must be added to the area of the adjacent assembly of that same type. When the total area of penetrations from mechanical equipment listed in Table 6.8.1-4 exceeds 1 percent of the *opaque* above-grade wall area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a default U-factor of 0.5. Where mechanical equipment has been tested in accordance with testing standards approved by the *authority having jurisdiction*, the mechanical equipment penetration area may be calculated as a separate wall assembly with the U-factor as determined by such test. 2. Exterior surfaces whose azimuth *orientation* and tilt differ by no more than 45 degrees and are otherwise the same may be described as either a single surface or by using multipliers. 3. The exterior *roof* surface shall be modeled using the aged solar *reflectance* and thermal *emittance* determined in accordance with Section 5.5.3.1.1(a). Where aged test data are unavailable, the *roof* surface shall be modeled with a solar *reflectance* of 0.30 and a thermal *emittance* of 0.90. 4. Manually operated *fenestration* shading devices, such as blinds or shades, shall not be modeled. Permanent shading devices, such as fins, overhangs, and lightshelves, shall be modeled.	The *budget building design* shall have identical *conditioned floor area* and identical exterior dimensions and orientations as the *proposed design*, except as follows: a. *Opaque* assemblies, such as *roof, floors, doors,* and *walls*, shall be modeled as having the same *heat capacity* as the *proposed design* but with the minimum *U-factor* required in Table C402.1.4 for new buildings or additions and Section C503.3 for alterations. *Opaque* assemblies in semi-heated spaces shall be modeled as having the same *heat capacity* as the *proposed design* but with the minimum *U-factor* required in Section 5.5. b. The exterior *roof* surfaces shall be modeled with a solar *reflectance* and thermal *emittance* as required in Section 5.5.3.1.1(a). All other *roofs*, including *roofs* exempted from the requirements in Section 5.5.3.1.1, shall be modeled the same as the *proposed design*. c. No shading projections are to be modeled; *fenestration* shall be assumed to be flush with the *wall* or *roof*. If the *fenestration area* for new *buildings* or additions exceeds the maximum allowed by Section 5.5.4.2, the area shall be reduced proportionally along each exposure until the limit set in Section 5.5.4.2 is met. If the *vertical fenestration* area facing west or east of the *proposed design* exceeds the area limit set in Section 5.5.4.5 then the *energy cost budget* shall be generated by simulating the *budget building design* with its actual *orientation* and again after rotating the entire *budget building design* 90, 180, and 270 degrees and then averaging the results. *Fenestration* U-factor shall be equal to the criteria from Table C402.4 for the appropriate climate, and the *SHGC* shall be equal to the criteria from C402.4 for the appropriate climate. For portions of those tables where there are no *SHGC* requirements, the *SHGC* shall be equal to that determined in accordance with Section C3.6(c). The *VT* shall be equal to that determined in accordance with Section C3.6(c). The *fenestration* model for *building envelope alterations* shall reflect the limitations on area, *U-factor*, and *SHGC* as described in Section 5.1.3. **Exceptions:** When trade-offs are made between an addition and an *existing building*, as described in the exception to Section 4.2.1.2, the *building envelope* assumptions for the *existing building* in the *budget building design* shall reflect existing conditions prior to any revisions that are part of this permit.

Table 11.5.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost *(Continued)*

***Proposed Design* (Column A) *Design Energy Cost* (DEC)**	***Budget Building Design* (Column B) *Energy Cost Budget* (ECB)**
6. Lighting	
Lighting power in the *proposed design* shall be determined as follows: a. Where a complete *lighting system* exists, the actual lighting power for each *thermal* block shall be used in the model. b. Where a *lighting system* has been designed, lighting power shall be determined in accordance with Sections 9.1.3 and 9.1.4. c. Where no lighting exists or is specified, lighting power shall be determined in accordance with the *Building* Area Method for the appropriate *building area type*. d. *Lighting system* power shall include all *lighting system* components shown or provided for on plans (including *lamps*, *ballasts*, task *fixtures*, and furniture-mounted *fixtures*). e. The lighting schedules in the *proposed design* shall reflect the mandatory *automatic* lighting *control* requirements in Section 9.4.1 (e.g., programmable *controls* or occupancy sensors) **Exception:** *Automatic* daylighting controls required by Section 9.4.1 shall be modeled directly in the proposed design or through schedule adjustments determined by a daylighting analysis approved by the building official. f. *Automatic* lighting *controls* included in the *proposed design* but not required by Section 9.4.1 may be modeled directly in the *building* simulation or be modeled in the building simulation through schedule adjustments determined by a separate analysis approved by the *authority having jurisdiction*. As an alternative to modeling such lighting controls, the *proposed design* lighting power may be reduced for each *luminaire* under *control* by dividing the rated lighting power of the *luminaire* by the factor (1 + ΣCF), where ΣCF indicates the sum of all applicable *control* factors (CF) per Section 9.6.3 and Table 9.6.3.	a. Lighting power in the *budget building design* shall be determined using the same categorization procedure (*Building* Area Method or Space-by-Space Method) and categories as the *proposed design* with lighting power set equal to the maximum allowed for the corresponding method and category in Tables C405.3.2(1) and C405.3.2(2). Additional interior lighting power for nonmandatory *controls* allowed under Section 9.6.3 shall not be included in the *budget building design*. b. Power for *fixtures* not included in the lighting power calculation shall be modeled identically in the *proposed design* and *budget building design*. c. Mandatory *automatic* lighting *controls* required by Section 9.4.1 shall be modeled the same as the *proposed design*.
7. Thermal Blocks – HVAC Zones Designed	
Where *HVAC zones* are defined on HVAC design drawings, each *HVAC zone* shall be modeled as a separate *thermal block*. **Exceptions:** Different *HVAC zones* may be combined to create a single *thermal block* or identical *thermal blocks* to which multipliers are applied, provided all of the following conditions are met: 1. The *space*-use classification is the same throughout the *thermal block*. 2. All *HVAC zones* in the *thermal* block that are adjacent to glazed *exterior walls* and glazed *semiexterior walls* face the same *orientation* or their orientations are within 45 degrees of each other. 3. All of the zones are served by the same *HVAC system* or by the same kind of *HVAC system*.	Same as *proposed design*.

Table 11.5.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost *(Continued)*

***Proposed Design* (Column A)** ***Design Energy Cost* (DEC)**	***Budget Building Design* (Column B)** ***Energy Cost Budget* (ECB)**
8. Thermal Blocks – HVAC Zones Not Designed	
Where the *HVAC zones* and *systems* have not yet been designed, *thermal blocks* shall be defined based on similar internal load densities, occupancy, lighting, thermal and space temperature schedules, and in combination with the following: a. Separate *thermal blocks* shall be assumed for interior and perimeter *spaces*. Interior *spaces* shall be those located more than 15 ft from an *exterior wall* or *semiexterior* wall. Perimeter *spaces* shall be those located closer than 15 ft from an *exterior wall* or *semiexterior wall*. A separate thermal zone does not need to be modeled for areas adjacent to *semiexterior walls* that separate *semiheated space* from *conditioned space*. b. Separate *thermal blocks* shall be assumed for *spaces* adjacent to glazed *exterior walls* or glazed *semiexterior walls*; a separate zone shall be provided for each *orientation*, except that orientations that differ by no more than 45 degrees may be considered to be the same *orientation*. Each zone shall include all *floor* area that is 15 ft or less from a glazed perimeter *wall*, except that *floor* area within 15 ft of glazed perimeter *walls* having more than one *orientation* shall be divided proportionately between zones. c. Separate *thermal blocks* shall be assumed for *spaces* having *floors* that are in contact with the ground or exposed to ambient conditions from zones that do not share these features. d. Separate *thermal* blocks shall be assumed for *spaces* having *roof* assemblies from zones that do not share these features.	Same as *proposed design*.
9. Thermal Blocks – Multifamily *Residential Buildings*	
Residential spaces shall be modeled using one *thermal block* per *space* except that those facing the same orientations may be combined into one *thermal block*. Corner units and units with *roof* or *floor* loads shall only be combined with units sharing these features.	Same as *proposed design*.

Table 11.5.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost *(Continued)*

Proposed Design **(Column A)** ***Design Energy Cost*** **(DEC)**	***Budget Building Design*** **(Column B)** ***Energy Cost Budget*** **(ECB)**
10. HVAC Systems	
The *HVAC system* type and all related performance parameters, such as *equipment* capacities and efficiencies, in *the proposed design* shall be determined as follows: a. Where a complete *HVAC system* exists, the model shall reflect the actual *system* type using actual component capacities and efficiencies. b. Where an *HVAC system* has been designed, the HVAC model shall be consistent with design documents. Mechanical *equipment* efficiencies shall be adjusted from actual *design conditions* to the standard rating conditions specified in Section 6.4.1 if required by the simulation model. Where *efficiency* ratings include supply fan energy, the *efficiency* rating shall be adjusted to remove the supply fan *energy* from the *efficiency* rating in the *budget building design*. The equations in Section 11.5.2 shall not be used in the *proposed design*. The *proposed design HVAC system* shall be modeled using *manufacturers'* full- and part- load data for the *HVAC system* without fan power. c. Where no heating *system* exists, or no heating *system* has been specified, the heating *system* shall be modeled as *fossil fuel*. The *system* characteristics shall be identical to the *system* modeled in the *budget building design*. *d.* Where no cooling *system* exists, or no cooling *system* has been specified, the cooling *system* shall be modeled as an air-cooled *single-zone system*, one unit per *thermal block*. The *system* characteristics shall be identical to the *system* modeled in the *budget building design.*	The *HVAC system* type and related performance parameters for the *budget building design* shall be determined from Figure 11.5.2, the *system* descriptions in Table 11.5.2-1 and accompanying notes, and in accord with rules specified in Section 11.5.2(a) through 11.5.2(k).

Table 11.5.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost *(Continued)*

***Proposed Design* (Column A)** ***Design Energy Cost* (DEC)**	***Budget Building Design* (Column B)** ***Energy Cost Budget* (ECB)**
11. Service Water-Heating Systems	
The *service water-heating system* type and all related performance parameters, such as *equipment* capacities and *efficiencies*, in the *proposed design* shall be determined as follows: a. Where a complete *service water-heating system exists*, the model shall reflect the actual *system* type using actual component capacities and efficiencies. b. Where a *service water-heating system* has been designed, the *service water-heating model* shall be consistent with design documents. c. Where no *service water-heating system* exists or is specified, no *service water heating* shall be modeled.	The *service water-heating system* type in the *budget building design* shall be identical to the *proposed design*. The *service water-heating system* performance of the *budget building design* shall meet the requirements of Section C404.2, and where applicable the requirements of C404.2.1 and C404.2.2, without exception. **Exceptions:** 1. If the *service water heating system* type is not listed in Table C404.2, it shall be identical to the *proposed design*. 2. Where Section 7.5.1 or 7.5.2 applies, the *boiler* shall be split into a separate *space*-heating *boiler* and *hot-water heater*. 3. For 24-hour facilities that meet the prescriptive criteria for use of condenser heat recovery *systems* described in Section 6.5.6.2, a *system* meeting the requirements of that section shall be included in the *baseline building design*, regardless of the exceptions to Section 6.5.6.2. If a condenser heat recovery *system* meeting the requirements described in Section 6.5.6.2 cannot be modeled, the requirement for including such a *system* in the actual *building* shall be met as a prescriptive requirement in accordance with Section 6.5.6.2 and no heat recovery *system* shall be included in the *proposed design* or *budget building design*.
12. Miscellaneous Loads	
Receptacle, motor, and *process loads* shall be modeled and estimated based on the *building area type* or *space* type category and shall be assumed to be identical in the *proposed* and *budget building designs*. These loads shall be included in simulations of the *building* and shall be included when calculating the *energy cost budget* and *design energy cost*. All end-use load components within and associated with the *building* shall be modeled, unless specifically excluded by Sections 13 and 14 of Table 11.5.1, including exhaust fans, parking garage *ventilation* fans, exterior *building* lighting, swimming *pool* heaters and pumps, elevators and escalators, refrigeration *equipment*, and cooking *equipment*.	Receptacle, motor, and *process loads* shall be modeled and estimated based on the *building area type* or *space* type category and shall be assumed to be identical in the *proposed design* and *budget building design*. These loads shall be included in simulations of the *building* and shall be included when calculating the *energy cost budget* and *design energy cost*. All end-use load components within and associated with the *building* shall be modeled, unless specifically excluded by Sections 13 and 14 of Table 11.5.1, including exhaust fans, parking garage *ventilation* fans, exterior *building* lighting, swimming *pool* heaters and pumps, elevators and escalators, refrigeration *equipment*, and cooking *equipment*.

Table 11.5.1 Modeling Requirements for Calculating Design Energy Cost and Energy Cost *(Continued)*

***Proposed Design* (Column A) *Design Energy Cost* (DEC)**	***Budget Building Design* (Column B) *Energy Cost Budget* (ECB)**
13. Modeling Exceptions	
All elements of the *proposed design building envelope*, HVAC, *service water heating*, lighting, and electrical *systems* shall be modeled in the *proposed design* in accordance with the requirements of Sections 1 through 12 of Table 11.5.1. **Exceptions:** Components and *systems* in the *proposed design* may be excluded from the simulation model provided that 1. component *energy* use does not affect the *energy* use of *systems* and components that are being considered for trade-off and 2. the applicable prescriptive requirements of Sections 5.5, 6.5, 7.5, and either 9.5 or 9.6 applying to the excluded components are met.	None
14. Modeling Limitations to the *Simulation Program*	
If the *simulation program* cannot model a component or *system* included in the *proposed design*, one of the following methods shall be used with the approval of the *authority having jurisdiction*: a. Ignore the component if the *energy* impact on the trade-offs being considered is not significant. b. Model the component substituting a thermodynamically similar component model. c. Model the *HVAC system* components or *systems* using the *budget building design*'s *HVAC system* in accordance with Section 10 of Table 11.5.1. Whichever method is selected, the component shall be modeled identically for both the *proposed design* and *budget building design*.	Same as *proposed design*.

2.21 Amendments to Section G1.2.1 Mandatory Provisions

G1.2.1 Mandatory Provisions.

This *performance rating method* requires conformance with the following provisions:

1. All requirements of Sections 5.4, 6.4, 7.4, 8.4, 9.4, 10.4, and Sections C408 and Appendix CC (if mandated by local ordinance) of the 2018 IECC (as amended) shall be met. These sections contain the mandatory provisions of the standard and are prerequisites for this rating method.
2. The interior lighting power shall not exceed the *interior lighting power allowance* determined using either Tables G3.7 or G3.8 and the methodology described in Sections 9.5.1 and 9.6.1.

2.22 Amendments to Section G1.2.2 Performance Rating Calculation

G1.2.2 Performance Rating Calculation.

The performance of the *proposed design* is calculated by either the provisions of G1.2.2.1 Performance Cost Index or G1.2.2.2 Performance Source Energy Index.

2.23 Addition of New Section G1.2.2.1 Performance Cost Index

G1.2.2.1 Performance Cost Index.

The performance of the proposed design is calculated in accordance with provisions of this appendix using the following formula:

Performance Cost Index =
Proposed building performance / Baseline building performance

Both the *proposed building performance* and the *baseline building performance* shall include all end-use load components within and associated with the building when calculating the Performance Cost Index.

2.24 Addition of New Section G1.2.2.2 Performance Source Energy Index

G1.2.2.2 Performance Source Energy Index.

The performance of the proposed design is calculated in accordance with provisions of this appendix using the following formula:

Performance Source Energy Index =
Proposed building source energy / Baseline building source energy

Both the *proposed building source energy* and the *baseline building source energy* shall include all end-use load components within and associated with the building when calculating the Performance Source Energy Index.

2.25 Amendments to Section G2.4.1 On-site Renewable Energy and Site-Recovered Energy

G2.4.1 On-site Renewable Energy and Site-Recovered Energy.

Site-recovered energy shall not be considered *purchased energy* and shall be subtracted from the *proposed design energy* consumption prior to calculating the *proposed building performance. On-site renewable energy* generated by *systems* included on the *building* permit used by the *building* shall be subtracted from the *proposed design energy* consumption prior to calculating the *proposed building performance* or *proposed building source energy*. The reduction in *proposed* *building performance* or *proposed building source energy* associated with *on-site renewable energy* systems shall not exceed 5 percent of the calculated *baseline building performance* or *baseline building source energy*, respectively.

2.26 Amendments to Section G2.4.2 Annual Energy Costs

G2.4.2 Annual Energy Costs.

The *design energy cost* and baseline *energy* cost shall be determined using either actual rates for *purchased energy* or State average *energy* prices published by DOE's Energy Information Administration (EIA) for commercial *building* customers, but rates from different sources may not be mixed in the same project. Where *on-site renewable energy* or *site-recovered energy* is used, the *baseline building design* shall be based on the *energy* source used as the backup *energy* source, or the baseline *system energy* source in that category if no backup *energy* source has been specified. Where the proposed design includes electricity generated from sources other than *on-site renewable energy,* the baseline design shall include the same generation system.

2.27 Amendments to Table G3.1 Modeling Requirements for Calculating Proposed and Baseline Building Performance (No. 5 Building Envelope)

Table G3.1 Modeling Requirements for Calculating Proposed and *Baseline Building Performance*

No.	Proposed Building Performance	Baseline Building Performance
5. Building Envelope		
a.	All components of the *building envelope* in the *proposed design* shall be modeled as shown on architectural drawings or as built for *existing building envelopes*. **Exceptions:** The following *building* elements are permitted to differ from architectural drawings: 1. All uninsulated assemblies (e.g., projecting balconies, perimeter edges of intermediate *floor* stabs, concrete *floor* beams over parking garages, *roof* parapet) shall be separately modeled using either of the following techniques: a. Separate model of each of these assemblies within the *energy* simulation model. b. Separate calculation of the *U-factor* for each of these assemblies. The *U-factors* of these assemblies are then averaged with larger adjacent surfaces using an area-weighted average method. This average *U-factor* is modeled within the *energy* simulation model. Any other *building envelope* assembly that covers less than 5% of the total area of that assembly type (e.g., *exterior walls*) need not be separately described,	Equivalent dimensions shall be assumed for each *building envelope* component type as in the *proposed design*; i.e., the total gross area of *walls* shall be the same in the *proposed design* and *baseline building design*. The same shall be true for the areas of roofs, *floors,* and *doors,* and the exposed perimeters of concretes slabs on *grade* shall also be the same in the *proposed design* and *baseline building design*. The following additional requirements shall apply to the modeling of the *baseline building design*. a. ***Orientation.*** The *baseline building performance* shall be generated by simulating the *building* with its actual *orientation* and again after rotating the entire *building* 90, 180, and 270 degrees, then averaging the results. The *building* shall be modeled so that it does not shade itself. **Exceptions:** 1. If it can be demonstrated to the satisfaction of the *rating authority* that the *building orientation* is dictated by site considerations. 2. *Buildings* where the *vertical fenestration area* on each *orientation* varies by less than 5

provided that it is similar to an assembly being modeled. If not separately described, the area of a *building envelope* assembly shall be added to the area of an assembly of that same type with the same *orientation* and thermal properties. When the total area of penetrations from mechanical equipment listed in Table 6.8.1-4 exceeds 1% of the *opaque above-grade wall* area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a default *U-factor* of 0.5. Where mechanical equipment has been tested in accordance with testing standards approved by the *authority having jurisdiction*, the mechanical equipment penetration area may be calculated as a separate *wall* assembly with the *U-factor* as determined by such test.

2. Exterior surfaces whose azimuth *orientation* and tilt differ by less than 45 degrees and are otherwise the same may be described as either a single surface or by using multipliers.
3. The exterior *roof* surface shall be modeled using the aged solar *reflectance* and thermal *emittance* determined in accordance with Section 5.5.3.1.1(a). Where aged test data are unavailable, the *roof* surface may be modeled with a reflectance of 0.30 and a thermal *emittance* of 0.90.
4. *Manual fenestration* shading devices, such as blinds or shades, shall be modeled or not modeled the same as in the *baseline building design*. Automatically controlled *fenestration* shades or blinds shall be modeled. Permanent shading devices, such as fins, overhangs, and light shelves shall be modeled.
5. Automatically controlled *dynamic glazing* may be modeled. Manually controlled *dynamic glazing* shall use the average of the minimum and maximum *SHGC* and *VT*.

b. *Infiltration* shall be modeled using the same methodology, air leakage rate, and adjustments for weather and *building* operation in both the *proposed design* and the *baseline building design*. These adjustments shall be made for each simulation time step and must account for but not be limited to weather conditions and *HVAC system* operation, including strategies that are intended to positively pressurize the *building*. The air leakage rate of the *building envelope* (I_{75Pa}) at a *fixed building* pressure differential of 0.3 in. of water shall be 0.4 cfm/ft^2. The air leakage rate of the *building envelope* shall be converted to appropriate units for the *simulation program* using one of the methods in Section G3.1.1.4.

Exceptions: When whole-*building* air leakage testing, in accordance with ASTM E779, is specified during design and completed after *construction*, the *proposed design* air percent.

b. ***Opaque* Assemblies**. *Opaque* assemblies used for new *buildings, existing buildings, or* additions shall conform with assemblies detailed in Appendix A and shall match the appropriate assembly maximum *U-factors* in Tables G3.4-1 through G3.4-8:
   - Roofs--Insulation entirely above deck (A2.2).
   - *Above-grade walls*--Steel-*framed* (A3.3).
   - *Below-grade walls*--Concrete block (A4).
   - *Floors--Steel-joist* (A5.3).
   - *Slab-on-grade floors* shall match the *F-factor* for unheated slabs from the same tables (A6).
   - *Opaque door* types shall be of the same type of *constructions* as the *proposed design* and conform to the *U-factor* requirements from the same tables (A7).

c. ***Vertical Fenestration Areas.*** For *building* area types included in Table G3.1.1-1, *vertical fenestration areas* for new *buildings* and additions shall equal that in Table G3.1.1-1 based on the area of gross *above-grade walls* that separate *conditioned spaces* and *semiheated spaces* from the exterior. Where a *building* has multiple *building* area types, each type shall use the values in the table. The *vertical fenestration* shall be distributed on each face of the *building* in the same proportion as in the *proposed design*. For *building* areas not shown in Table G3.1.1-1, *vertical fenestration area* for new *buildings* and additions shall equal that in the *proposed design* or 40% of gross *above-grade wall* area, whichever is smaller, and shall be distributed on each face of the *building* in the same proportions in the *proposed design*. The *fenestration area* for an *existing building* shall equal the existing *fenestration area* prior to the proposed work and shall be distributed on each face of the *building* in the same proportions as the *existing building*. For portions of those tables where there are no *SHGC* requirements, the *SHGC* shall be equal to that determined in accordance with Section C3.6(c).

d. ***Vertical Fenestration* Assemblies.** *Fenestration* for new *buildings, existing buildings,* and additions shall comply with the following:
   - *Fenestration U-factors* shall match the appropriate requirements in Tables G3.4-1 through G3.4-8 for the applicable glazing percentage for U_{all}.
   - *Fenestration SHGCs* shall match the appropriate requirements in Tables G3.4-1 through G3.4-8 using the value for $SHGC_{all}$ for the applicable

leakage rate of the *building envelope* shall be as measured.	vertical glazing percentage. • All *vertical fenestration* shall be assumed to be flush with the *exterior* wall, and no shading projections shall be modeled. • *Manual* window shading devices such as blinds or shades are not required to be modeled. e. ***Skylights* and Glazed Smoke Vents.** *Skylight* area shall be equal to that in the *proposed design* or #%, whichever is smaller. If the *skylight* area of the *proposed design* is greater than 3%, baseline *skylight* area shall be decreased by an identical percentage in all *roof* components in which *skylights* are located to reach 3%. *Skylight orientation* and tilt shall be the same as in the *proposed design*. *Skylight U-factor* and *SHGC* properties shall match the appropriate requirements in Tables G3.4-1 through G3.4-8 using the value and the applicable *skylight* percentage. f. ***Roof* Solar *Reflectance* and Thermal *Emittance*.** The exterior *roof* surfaces shall be modeled using a solar *reflectance* of 0.30 and a thermal *emittance* of 0.90. g. ***Roof* Albedo.** All *roof* surfaces shall be modeled with a reflectivity of 0.30.

PART 3

3 Amendments to 2018 International Energy Conservation Construction Code Residential Provisions

3.1 Amendments to Section 401.2

R401.2 Compliance. Projects shall comply with one of the following:

1. The provisions of Sections R401 through R404.
2. The provisions of Sections R401 through R404 and the provisions of Section R408 (passive house).
3. The provisions of Section R406 (ERI).
4. For *Group* R-2, *Group* R-3 *and Group* R-4 *buildings*, the provisions of Section R405 (simulated performance) and the provisions of Sections R401 through R404 labeled "Mandatory." The building energy cost shall be equal to or less than 80 percent of the standard reference design building.

3.2 Amendments to Table R402.1.2 Insulation and fenestration requirements by component

Table R402.1.2
Insulation and Fenestration Requirements by Component[a]

Climate Zone	Fenestration U-factor[h]	Skylight U-factor[h]	Glazed fenestration SHGC[h]	Ceiling R-Value	Wood Frame Wall[b,c] R-Value	Mass Wall[d] R-Value	Floor R-Value	Basement Wall[e] R-Value	Slab[f] R-Value and Depth	Crawl Space Wall[e] R-Value
4	0.27	0.50	0.4	49	21 int. or 20+5 or 13+10	15/20	30[g]	15/19	10,4 ft	15/19
5	0.27	0.50	NR	49	21 int. or 20+5 or 13+10	15/20	30[g]	15/19	10,4 ft	15/19
6	0.27	0.50	NR	49	20+5 or 13+10	15/20	30[g]	15/19	10,4 ft	15/19

NR = Not Required

For SI: 1 foot = 304.8 mm.

a. R-values are minimums. U-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed R-value of the insulation shall be not less than the R-value specified in the table.

b. Int. (intermediate framings) denotes standard framing 16 inches on center. Headers shall be insulated with a minimum of R-10 insulation.

c. The first value is cavity insulation, the second value is continuous insulation. Therefore, as an example, "13+10" means R-13 cavity insulation plus R-10 continuous insulation.

d. Mass walls shall be in accordance with Section R402.2.5. The second R-value applies when more than half the insulation is on the interior of the mass wall.

e. 15/19 means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall.

f. R-10 continuous insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation R-value for slabs as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

g. Alternatively, insulation sufficient to fill the framing cavity and providing not less than an *R*-value of R-19.

h. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

3.3 Amendments to Table R402.1.4 Equivalent U-factors

Table R402.1.4
Equivalent U-factors[a]

Climate Zone	Fenestration U-factor	Skylight U-factor	Ceiling U-factor	Frame Wall U-factor	Mass Wall U-factor[b]	Floor U-factor	Basement Wall U-factor	Crawl Space Wall U-factor
4	0.27	0.50	0.026	0.045	0.056	0.033	0.050	0.042
5	0.27	0.50	0.026	0.045	0.056	0.033	0.050	0.042
6	0.27	0.50	0.026	0.045	0.056	0.033	0.050	0.042

a. Nonfenestration U-factors shall be obtained from measurement, calculation or an approved source.
b. Mass wall shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall U-factor shall not exceed 0.056.

3.4 Amendments to Section R402.2.2 Ceilings without attic spaces

R402.2.2 Ceiling without attic spaces. Where Section R402.1.2 requires insulation R-values greater than R-38 in the ceiling and the design of the roof/ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation R-value for such roof/ceiling assemblies shall be R-38. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section R402.1.2 shall be limited to 500 square feet (46 m^2) or 20 percent of the total insulated ceiling area, whichever is less. This reduction shall not apply to the U-factor alternative approach in Section R402.1.4 and the Total UA alternative in Section R402.1.5.

3.5 Amendments to Section R402.4.1.1 Installation

R402.4.1.1 Installation. The components of the *building thermal envelope* as indicated in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instruction and the criteria indicated in Table R402.4.1.1 as applicable to the method of construction. An approved agency shall inspect all components and verify compliance. The inspection shall include an open wall visual inspection of all components included in Table R402.4.1.1 and shall be installed so that the insulation material uniformly fills each cavity side-to-side and top-to-bottom, without substantial gaps or voids around obstructions, and is split, installed, or fitted tightly around wiring and other penetrations in the cavity. No more than 2 percent of the total insulated area shall be compressed below the thickness required to attain the labeled R-value or contain gaps or voids in the insulation.

3.6 Amendments to Section R403.3 Ducts

R403.3 Ducts. All ducts and air handlers shall be installed in accordance with Section R403.3.1 through R403.3.8, where applicable. The duct system in new buildings and additions shall be located in a conditioned space in accordance with Sections R403.3.7 (1) and R403.3.7 (2).

3.7 Addition of New Section R403.3.8 Duct system sizing (Mandatory)

R403.3.8 Duct system sizing (Mandatory). Ducts shall be sized in accordance with ACCA Manual D based on calculations made in accordance with Sections R403.7 and R403.8.

3.8 Amendments to Section R403.5 Service hot water systems

R403.5 Service hot water systems. Energy conservation measures for service hot water systems shall be in accordance with Sections R403.5.1 through R403.5.5

3.9 Amendments to Section R403.5.4 Drain water heat recovery units

R403.5.4 Drain water heat recovery units. Drain water heat recovery units shall have a minimum efficiency of 40 percent if installed for equal flow or a minimum efficiency of 52 percent if installed for unequal flow. Vertical drain water heat recovery units shall comply with CSA B55.2 and be tested and labeled in accordance with CSA B55.1 or IAPMO 346. Sloped drain water heat recovery units shall comply with IAPMO PS 92 and be tested and labeled in accordance with IAPMO 346. Potable water-side pressure loss of drain water heat recovery units shall be less than 3 psi for individual units connected to one or two showers. Potable water-side pressure loss of drain water heat recovery units shall be less than 2 psi for individual units connected to three or more showers.

3.10 Addition of New Section R403.5.5 Supply of heated water

R403.5.5 Supply of heated water. In new *buildings*, heated water supply piping shall be in accordance with one of the following:

R403.5.5.1 Maximum allowable pipe length method. The maximum allowable pipe length from the nearest source of heated water to the termination of the fixture supply pipe shall be in accordance with the maximum pipe length in Table R403.5.5.1. Where the length contains more than one size of pipe, the largest size shall be used for determining the maximum allowable length of the piping in Table R403.5.5.1.

R403.5.5.2 Maximum allowable pipe volume method. The water volume in the piping shall be calculated in accordance with Section R403.5.5.2.1. The maximum volume of hot or tempered water in the piping to public lavatory faucets shall be 2 ounces. For fixtures other than public lavatory faucets, the maximum volume shall be 64 ounces for hot or tempered water from a water heater or boiler; and 24 ounces for hot or tempered water from a circulation loop pipe or an electrically heat-traced pipe. The water volume in the piping shall be calculated in accordance with Section R403.5.5.2.1.

R403.5.5.2.1 Water volume determination. The volume shall be the sum of the internal volumes of pipe, fittings, valves, meters and manifolds between the source of hot water and the termination of the fixture supply pipe. The volume shall be determined from the "Volume" column of Table R403.5.5.1. The volume contained within fixture shutoff valves, flexible water supply connectors to a fixture fitting, or within a fixture fitting shall not be included in the water volume determination. Where hot or tempered water is supplied by a circulation loop pipe or a heat-traced pipe, the volume shall include the portion of the fitting on the branch pipe that supplies water to the fixture.

Table R403.5.5.1
Pipe Volume and Maximum Piping Lengths

Nominal Pipe or Tube Size (inch)	VOLUME (Liquid Ounces Per Foot Length)	Maximum Pipe or Tube Length		
		System without a circulation loop or heat-traced line (feet)	System with a circulation loop or heat-traced line (feet)	Lavatory faucets – public (metering and nonmetering (feet)
1/4[a]	0.33	50	16	6
5/16[a]	0.5	50	16	4
3/8[a]	0.75	50	16	3
1/2	1.5	43	16	2
5/8	2	32	12	1
3/4	3	21	8	0.5
7/8	4	16	6	0.5
1	5	13	5	0.5
1 1/4	8	8	3	0.5
1 1/2	11	6	2	0.5
2 or larger	18	4	1	0.5

a. The flow rate for ¼-inch size pipe or tube is limited to 0.5 gallons per minute; for 5/16-inch size, it is limited to 1 gpm; for 3/8-inch size, it is limited to 1.5 gpm.

R403.5.5.3 Drain water heat recovery units. New buildings shall include a drain water heat recovery unit that captures heat from at least one shower, and such drain water heat recovery unit must have a minimum efficiency of 40 percent if installed for equal flow or a minimum efficiency of 52 percent if installed for unequal flow. Vertical drain water heat recovery units shall comply with CSA B55.2 and be tested and labeled in accordance with CSA B55.1 or IAPMO 346. Sloped drain water heat recovery units shall comply with IAPMO PS 92 and be tested and labeled in accordance with IAPMO 346. Potable water-side pressure loss of drain water heat recovery units shall be less than 3 psi for individual units connected to one or two showers.

Potable water-side pressure loss of drain water heat recovery units shall be less than 2 psi for individual units connected to three or more showers.

R403.5.5.4 Recirculation Systems. Projects shall include a recirculation system with no more than 0.5-gallon (1.9 liter) storage. The storage limit shall be measured from the point where the branch feeding the fixture branches off the recirculation loop to the fixture. Recirculation systems must be based on an occupant-controlled switch or an occupancy sensor, installed in each bathroom, which is located beyond a 0.5-gallon stored-volume range from the water heater.

3.11 Addition of New Section R403.6.2 Balanced and HRV/ERV systems (Mandatory)

R403.6.2 Balanced and HRV/ERV systems (Mandatory). In new buildings, every dwelling unit shall be served by a heat recovery ventilator (HRV) or energy recovery ventilator (ERV) installed per manufacturer's instructions. The HRV/ERV must be sized adequately for the specific application, which will include the building's conditioned area, and number of occupants.

Exception: In Climate Zone 4, a balanced *ventilation* system designed and installed according to the requirements of Section M1507.3 of the 2015 International Residential Code (IRC) that uses the return side of the building's heating and/or cooling system air handler to supply outdoor air, shall be permitted to comply with this section. When the outdoor air supply is ducted to the heating and/or cooling system air handler, the mixed air temperature shall not be less than that permitted by the heating equipment manufacturer's installation instructions. Heating and/or cooling system air handlers used to distribute outdoor air shall be field-verified to not exceed an efficacy of 45 W/CFM if using furnaces for heating and 58 W/CFM if using other forms of heating. In the balanced system design, an equivalent exhaust air flow rate shall be provided simultaneously by one or more exhaust fans, located remotely from the source of supply air. The balanced system's exhaust and supply fans shall be interlocked for operation, sized to provide equivalent air flow at a rate greater than or equal to that determined by IRC Table M1507.3.3(1) and shall have their fan capacities adjusted for intermittent run time per Table M1507.3.3(2). Continuous operation of the balanced *ventilation* system shall not be permitted.

3.12 Addition of New Section R403.6.3 Verification

R403.6.3 Verification. Installed performance of the mechanical *ventilation* system shall be tested and verified by an *approved agency* and measured using a flow hood, flow grid, or other airflow measuring device in accordance with Air Conditioning Contractors of America (ACCA) HVAC Quality Installation Verification Protocols – ANSI/ACCA 9QIvp-2016.

3.13 Amendments to Section R404.1 Lighting equipment (Mandatory)

R404.1 Lighting equipment (Mandatory). Not less than 90 percent of the permanently installed lighting fixtures shall use lamps with an efficacy of at least 65 lumens per watt or have a total luminaire efficacy of at least 45 lumens per watt.

R404.1.1 Lighting equipment (Mandatory). Fuel gas lighting systems shall not have continuously burning pilot lights.

3.14 Addition of New Section R404.2 Electrical power packages (Mandatory)

R404.2 Electrical power packages (Mandatory). New buildings shall comply with the following:

1. Solar-ready zone. Detached one and two-family dwellings and townhouses where the conditioned space is greater than 1,400 square feet shall comply with the requirements of Appendix RA.
2. Electrical Vehicle Service Equipment Capable. Detached one or two-family dwellings and townhouses with parking area provided on the *building site* shall provide a 208/240V 40-amp outlet for each dwelling unit or panel capacity and conduit for the future installation of such an outlet. Outlet or conduit termination shall be adjacent to the parking area. For residential occupancies where there is a common parking area, provide either:
   a. Panel capacity and conduit for the future installation of 208/240V 40-amp outlets for 5 percent of the total parking spaces, but not less than one outlet, or
   b. 208/240V 40-amp outlets for 5 percent of the total parking spaces, but not less than one outlet.

3.15 Amendments to Table R406.4 Maximum Energy Rating Index

Table R406.4
Maximum Energy Rating Index

Climate Zone	Energy Rating Index[a]
4	50
5	50
6	50

a. Where *on-site renewable energy* is included for compliance using the ERI analysis of Section R406.4, the building shall meet the mandatory requirements of Section R406.2, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or R402.1.4 of the 2015 *International Energy Conservation Code.*

3.16 Addition of New Section R408 Passive House

Section R408
Passive House

R408.1 General. *Buildings* shall comply with either Section R408.1.1 or R408.1.2 and shall comply with Section R408.2.

R408.1.1. Passive House Institute US (PHIUS) Approved Software. PHIUS+. Passive Building Standard - North America, where Specific Space Heat Demand and (sensible only) Cooling Demand, as modeled and field-verified by a Certified Passive House Consultant, is less than or equal to 9kBTU/ft2/year. The *dwelling unit* shall also be tested with a blower door and found to exhibit no more than 0.05 CFM50/ft^2 or 0.08 CFM75/ft^2 of air leakage.

R408.1.2 Passive House Institute (PHI) Approved Software. Passive House Institute: Low Energy Building Standard, where Specific Space Heating and (sensible only) Cooling Demand is less than or equal to 9.5 kBTU/ft^2/year, as modeled and field-verified by a Certified Passive House Consultant. The *dwelling unit* shall also be tested with a blower door and found to exhibit an *infiltration* rate of no more than 1.0 air changes per hour under a pressure of 50 Pascals.

R408.2 Documentation

1. If using the PHIUS software:
   a. Prior to the issuance of a building permit, the following items must be provided to the *code official*:
      i. A list of compliance features; and
      ii. A statement that the estimated Specific Space Heat Demand is "based on plans."
   b. Prior to the issuance of a certificate of occupancy, the following item must be provided to the *code official*:
      i. A copy of the final report submitted on a form that is approved to document compliance with PHIUS+ standards. Said report must indicate that the finished building achieves a Certified Passive House Consultant verified Specific Space Heat Demand of less than or equal to 9 kBTU/ft2/year.

2. If using the PHI software:
    a. Prior to the issuance of a building permit, the following items must be provided to the *code official*:
        i. A list of compliance features; and
        ii. A statement that the estimated Specific Space Heating and Cooling Demand is "based on plans."
    b. Prior to the issuance of a certificate of occupancy, the following item must be provided to the *code official*:
        i. A copy of the final report submitted on a form that is approved to document compliance with PHI standards. Said report must indicate that the finished building achieves a Certified Passive House Consultant verified Specific Space Heating or Cooling Demand is less than or equal to 9.5 kBTU/ft^2/year.

3.17 Amendments to "ACCA" in Chapter 6 Referenced Standards

Manual D—16: Residential Duct Systems
R403.3.8

Manual J—16: Residential Load Calculation Eighth Edition
R403.7

Manual S—14: Residential Equipment Selection
R403.7

3.18 Addition of a new entry for "IAPMO" to Chapter 6 Referenced Standards

IAPMO **International Association of Plumbing and Mechanical Officials**
4755 E. Philadelphia St.
Ontario, CA 91761

IAPMO IGC 346:2017 Test Method for Measuring the Performance of Drain Water Heat Recovery Units
R403.5.4.3

IAPMO PS 92-2013: Heat Exchangers and Indirect Water Heaters
R403.5.4.3

3.19 Addition of a new entry for "PHI" to Chapter 6 Referenced Standards

PHI	**Passive House Institute** **Rheistrasse 44/46** **64283 Darmstadt, Germany**

PHI 2016: Low Energy Building Standard, Version 9f
R408.1

3.20 Addition of a New Entry for "PHIUS" to Chapter 6 Referenced Standards

PHIUS	**Passive House Institute US** **116 West Illinois Street, Suite 5E** **Chicago, IL 60654, USA**

PHIUS+ 2015: Passive Building Standard – North America
R408.1

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State of New York
Andrew M. Cuomo, Governor

New York State Energy Research and Development Authority
Richard L. Kauffman, Chair | Alicia Barton, President and CEO

CODE-19nysc-gm4-v1 7/19

NYStretch Energy Code–2020

Comparison to 2020 Energy Conservation Construction Code of NYS

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Comparison to 2020 Energy Conservation Construction Code of NYS

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The following is a summary of the differences between the 2020 NYStretch Energy Code (NYStretch), the 2020 NYS Energy Code (ECCCNYS-2020), and ASHRAE 90.1 2016. It is not intended to be a replacement for the actual language in the NYStretch Code or the NYS Energy Code. One should always refer to the NYS Energy Code when determining compliance as amended by the 2020 NYStretch Code language.

I. Differences between NYStretch and ECCCNYS-2020: *Residential Buildings*

Compliance Path Options – ONE of FOUR can be used:

1. **Prescriptive and REScheck™** – R401 through R404 (Specific Prescriptive R-value or U-factor) and mandatory requirements; regardless of compliance path, REScheck™ software most often used: or
2. **Passive House** – R401 through R404 and Passive House compliance, or
3. **ERI Path** – (R406), or
4. **Simulated Performance Path** – (R405) and mandatory provisions of R401 through R404. Building energy < 80% of the standard reference design

Table R402.1.2 – Envelope (U-factor Table R402.1.4 changed accordingly. Prescriptive, e.g., can be traded.)

Climate Zone 4	Fen U-Factor	SkyLt U-Factor	SHGC	Ceiling R-Val	Wood Wall R-Value	Mass Wall R-Value	Floor R-Val	Bsmt Wall R-value	Slab R-Value/ Depth	Crawl Sp Wall R-Value
Stretch Code	0.27	0.50	.04	49	21 or 20+5 or 13+10	15/20	30[a]	15/19	10, 4 ft.	15/19
Energy Code	0.32	0.55	0.4	49	20 or 13+5	8/13	19	10/13	10, 2 ft.	10/13

Climate Zone 5	Fen U-Factor	SkyLt U-Factor	SHGC	Ceiling R-Val	Wood Wall R-Value	Mass Wall R-Value	Floor R-Val	Bsmt Wall R-value	Slab R-Value/ Depth	Crawl Sp Wall R-Value
Stretch Code	0.27	0.50	NR	49	21 or 20+5 or 13+10	15/20	30[a]	15/19	10, 4 ft.	15/19
Energy Code	0.30	0.55	NR	49	20 or 13+5	13/17	30[a]	15/19	10, 2 ft.	15/19

Climate Zone 6	Fen U-Factor	SkyLt U-Factor	SHGC	Ceiling R-Val	Wood Wall R-Value	Mass Wall R-Value	Floor R-Val	Bsmt Wall R-value	Slab R-Value/ Depth	Crawl Sp Wall R-Value
Stretch Code	0.27	0.50	NR	49	21 or 20+5 or 13+10	15/20	30[a]	15/19	10, 4 ft.	15/19
Energy Code	0.30	0.55	NR	49	20+5 or 13+10	15/20	30[a]	15/19	10, 4 ft.	15/19
Option 2	.28	0.55	NR	60	23 cav.	19/21	30[a]	15/19	10, 4 ft.	15/19

[a] *Alternatively, insulation sufficient to fill the framing cavity and providing not less than an R-value of R-19.*

Comparison to 2020 Energy Conservation Construction Code of NYS

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

Provisions in NYStretch that are not in NYS Energy Code

- **R402.2.2 Ceilings without attic spaces (cathedralized).** – In the NYStretch Code, minimum insulation R-value is R-38 uncompressed out over exterior walls rather than R-30. As in the NYS Energy Code, this reduction in R-value is limited to 500 sf or 20% of insulated roof area, whichever is less.
- **Table R402.4.1.1 Insulation installation** – NYStretch Code requires open wall visual inspection to ensure the quality of the insulation installation. This requirement asks for more attention to openings around tub/showers, registers, and Recessed Lighting.
- **R403.3 Ducts** – Ducts in new buildings must be located in conditioned space. Buried ducts can be considered in conditioned space as in the NYS Energy Code, and must be installed/buried as prescribed by the NYS Energy Code. In both NYStretch and the NYS Energy Code, duct leakage testing must be performed where ducts are buried in attic insulation. The threshold is less than or equal to 1.5 cfm per 100 sf conditioned floor area for leakage to outdoors.
- **R403.3.8 Duct sizing** – NYStretch Code specifically requires that ducts must be sized in accordance with ACCA Manual D **(mandatory)**.
- **R403.5.4 Drain water heat recovery units** – Drain water heat recovery units must have a minimum efficiency of 40% if installed for equal flow or a minimum efficiency of 52% if installed for unequal flow. Requirements are given for vertical and sloped drain water heat recovery units.
- **R403.5.5 Supply of hot water** – NYStretch Code requires one of the following: 1) maximum allowable pipe length between water heater and fixture; 2) maximum allowable pipe volume between water heater and fixture; 3) drain-water heat recovery; or 4) recirculation system.
- **R403.6.2 Balanced whole house mechanical ventilation** – NYStretch Code requires HRV or ERV in Climate Zones 5 and 6 in every dwelling unit **(mandatory)**. In Climate Zone 4, a central fan integrated system with simultaneous supply and exhaust is an option.
- **R403.6.3 Verification of ventilation** – NYStretch Code requires verification of ventilation air flow by approved agency, tested to ACCA HVAC Quality Installation Verification Protocols.
- **R404.1 Lighting** – NYStretch Code requires 90% high-efficacy lighting, with lamps at a minimum of 65 lumens per watt and luminaires at minimum of 45 lumens/watt **(mandatory)**.
- **R404.2 Electrical power packages. (Mandatory for newly constructed buildings.) NYStretch Code requires:**
  - A solar-ready zone for newly constructed detached one- and two-family homes and townhomes that have more than 1400 sf of conditioned floor area according to Appendix RA of the NYS Energy Code. The solar-ready zone applies to buildings with at least 600 sf roof area between 110 degrees and 270 degrees of true north. Exceptions are given for buildings shaded more than 70% of daylight hours annually and for those where an on-site renewable energy system is permanently installed. Reserved electric panel space, roof-load calculation and electrical pathway from roof to panel is required.
  - Electric vehicle charging capability for one- and two-family detached homes and townhomes. 208V outlet for each dwelling unit or panel space and conduit for future installation of outlet. For common parking areas, the code requires 1) panel capacity and conduit for future installation of 208/240V outlets for 5% of spaces' but with a minimum of at least one space or 2) 208/240V outlets for 5% of parking spaces with a minimum of at least one space..
- **R404.2 ERI path** – NYStretch requires an ERI of 50 PLUS the NYS Energy Code (as amended) mandatory requirements and R403.5.3; NYS Energy Code requires ERI of 62 – Climate Zone 4, 61 for Zones 5 and 6.
- **R408 Passive House** – An optional compliance path in NYStretch; allows use of either PHIUS or PHI approved software along with ECCCNYS-2020 prescriptive AND mandatory requirements. Dwelling unit MUST score a maximum of 9.5 kbtuh/ft2/yr and be blower-door tested to meet air leakage or infiltration rates defined by the passive house entities and NYStretch.

II. Differences between NYStretch and ECCCNYS-2020: *Commercial Buildings*

Compliance Path Options:

1. **ASHRAE 90.1 2016 Prescriptive Path** – (Sections 5 through 10, as amended by NYStretch) plus section C408 (commissioning) of the NYS Energy Code (as amended by NYStretch) and Appendix CC if mandated by local ordinance (Additional power distribution system packages), or
2. **ASHRAE 90.1 2016 Energy Cost Budget Method** – (Section 11, as amended by NYStretch) plus Section C408 (commissioning) of the NYS Energy Code (as amended by NYStretch), and Appendix CC if mandated by local ordinance (additional power distribution system packages), or
3. **ASHRAE 90.1 2016 Appendix G, Performance Rating Method** – (as amended by NYStretch) Section C408 (commissioning) of the NYS Energy Code (as amended by NYStretch), and Appendix CC if mandated by local ordinance (additional power distribution system packages), or
4. **2020 Energy Conservation Construction Code (NYS Energy Code), Prescriptive Path** – (Sections C402 through C406 and C408, as amended by NYStretch) and Appendix CC if mandated by local ordinance (additional power distribution system packages).

Prescriptive Path

TABLE C402.1.4 – Comparison ECCCNYS-2020/NYStretch, U-factor Method ALSO used for ASHRAE 90.1 Prescriptive Path

OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, U-FACTOR METHOD[a, b]

Climate Zone	4		5		6	
	All Other	Group R	All Other	Group R	All Other	Group R
Roofs						
Insulation Entirely above Roof Deck	U-0.032/ U-0.030	U-0.032/ U-0.030	U-0.032/ U-0.030	U-0.032/ U-0.030	U-0.032/ U-0.029	U-0.032/ U-0.029
Metal Buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031/ U-0.028	U-0.031/ U-0.026
Attic and Other	U-0.027/ U-0.020	U-0.027/ U-0.020	U-0.027/ U-0.020	U-0.021/ U-0.020	U-0.021/ U-0.019	U-0.021/ U-0.019
Walls, Above Grade						
Mass[e]	U-0.104/ U-0.099	U-0.090/ U-0.086	U-0.90/ U-0.086	U-0.080/ U-0.076	U-0.080/ U-0.076	U-0.071/ U-0.067
Metal Buildings	U-0.052/ U-0.048	U-0.052/ U-0.048	U-0.052/ U-0.048	U-0.052/ U-0.048	U-0.052/ U-0.048	U-0.052/ U-0.048
Metal Framed	U-0.064/ U-0.061	U-0.064/ U-0.061	U-0.064/ U-0.052	U-0.064/ U-0.052	U-0.064/ U-0.047	U-0.064/ U-0.044
Wood Framed and Other[c]	U-0.064/ U-0.061	U-0.064/ U-0.061	U-0.064/ U-0.048	U-0.064/ U-0.048	U-0.051/ U-0.048	U-0.051/ U-0.046
Walls, Below Grade						
Below-Grade Wall[c]	C-0.119	C-0.119/ C-0.092	C-0.119	C-0.119/ C-0.092	C-0.119/ C-0.092	C-0.119/ C-0.063

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Climate Zone	4		5		6	
	All Other	Group R	All Other	Group R	All Other	Group R
Floors						
Mass[d]	U-0.076/ U-0.057	U-0.074/ U-0.051	U-0.074/ U-0.057	U-0.064/ U-0.051	U-0.064/ U-0.051	U-0.064/ U-0.051
Joist/Framing	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033/ U-0.027	U-0.033/ U-0.027
Slab-on-Grade Floors						
Unheated Slabs	F-0.54/ F-0.52	F-0.54/ F-0.52	F-0.54/ F-0.52	F-0.54/ F-0.51	F-0.54/ F-0.51	F-0.54/ F-0.434
Heated Slabs	F-0.86 0.64/ F-0.63	F-0.86 0.64/ F-0.63	F-0.79 0.64/ F-0.63	F-0.79 0.64/ F-0.63	F-0.79 0.55/ F-0.63	F-0.69 0.55/ F-0.63
Opaque Doors						
Swinging Door	U-0.061/ U-0.050	U-0.061/ U-0.050	U-0.037	U-0.037	U-0.037	U-0.037
Garage Door < 14% Glazing	U-0.031	U-0.031	U-0.031	U-0.031	U-0.031	U-0.031

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m2, 1 pound per cubic foot = 16 kg/ 3 ci = Continuous insulation, NR = No Requirement, LS = Liner System.

[a] Where assembly U-factors, C-factors, and F-factors are established in ANSI/ASHRAE/IESNA 90.1 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/ISNEA 90.1 Appendix A.

[b] Where U-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The R-value of continuous insulation can be added to or subtracted from the original tested design.

[c] Where heated slabs are below grade, below-grade walls shall comply with the U-factor requirements for above-grade mass walls.

[d] "Mass floors" shall be in accordance with Section C402.2.3.

[e] "Mass walls" shall be in accordance with Section C402.2.2.

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TABLE C402.1.3 – Comparison ECCCNYS-2020 versus NYStretch Table CB 102.2 (Also used for ASHRAE 90.1-2016; MUST be adopted specifically by the jurisdiction)

OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a, h]

Climate Zone	4 Except Marine		5		6	
	All Other	Group R	All Other	Group R	All Other	Group R
Roofs						
Insulation Entirely above Roof Deck	R-30ci/ R-33ci	R-30ci/ R-33ci	R-30ci/ R-33ci	R-30ci/ R-33ci	R-30ci/ R-33ci	R-30ci/ R-33ci
Metal Buildings[b]	R-9.5 + R-11 LS	R-9.5 + R-11 LS	R-9.5 + R-11 LS	R-9.5 + R-11 LS	R-9.5 + R-11 LS/ R-30 + R-11 LS	R-9.5 + R-11 LS/ R-30 + R-11 LS
Attic and Other	R-38/ R-53	R-38/ R-53	R-38/ R-53	R-49/ R-53	R-49/ R-53	R-49/ R-53
Walls, Above Grade						
Mass[e]	R-9.5ci/ R-11.4ci	R-11.4ci/ R-13.3ci	R-11.4ci/ R-13.3ci	R-13.3ci/ R-15.2ci	R-13.3ci/ R-15.2ci	R-12.5ci
Metal Buildings	R-13 + R-13ci	R-13 + R-13ci/ R-13 + R-19.5ci	R-13 + R-13ci/ R-13 + R-19.5ci	R-13 + R-13ci/ R-13 + R-19.5ci	R-13 + R-13ci/ R-13 + R-19.5ci	R-13 + R-13ci/ R-13 + R-19.5ci
Metal Framed	R-13 + R-7.5ci/ R-13 + R-8.5ci	R-13 + R-7.5ci/ R-13 + R-8.5ci	R-13 + R-7.5ci/ R-13 + R-11ci	R-13 + R-7.5ci/ R-13 + R-11ci	R-13 + R-7.5ci/ R-13 + R-13.5ci	R-13 + R-7.5ci/ R-13 + R-14.5ci
Wood Framed and Other	R-13 + R-3.8ci or R-20/ R-13 + R-4.5ci or R-19 + R-1.5ci	R-13 + R-3.8ci or R-20/ R-13 + R-4.5ci or R-19 + R-1.5ci	R-13 + R-3.8ci or R-20/ R-13 + R-9ci or R-19 + R-5ci	R-13 + R-7.5ci or R-20 + R-3.8ci/ R-13 + R-9ci or R-19 + R-5ci	R-13 + R-7.5ci or R-20 + R-3.8ci/ R-13 + R-9ci or R-19 + R-5ci	R-13 + R-7.5ci or R-20 + R-3.8ci/ R-13 + R-9.5ci or R-19 + R-6ci
Walls, Below Grade						
Below-Grade Wall[c]	R-7.5ci	R-7.5ci/ R-10ci	R-7.5ci	R-7.5ci/ R-10ci	R-7.5ci/ R-10ci	R-7.5ci/ R-15ci
Floors						
Mass[d]	R-10c/ R-15ci	R-10.4c/ R-16.7ci	R-10c/ R-15ci	R-12.5c/ R-16.7ci	R-12.5c/ R-16.7ci	R-12.5c/ R-16.7ci
Joist/Framing[e]	R-30	R-30	R-30	R-30	R-30/ R-38	R-30/ R-38

Climate Zone	4		5		6	
	All Other	Group R	All Other	Group R	All Other	Group R
Slab-on-Grade Floors						
Unheated Slabs	R-10 for 12" below/ R-15 for 24" below	R-10 for 24" below/ R-15 for 24" below	R-10 for 24" below/ R-15 for 24" below	R-10 for 24" below/ R-15 for 24" below	R-10 for 24" below/ R-15 for 24" below	R-15 for 24" below
Heated Slabs[g]	R-15 for 24" below + R-5 full slab/ R-20 for 48" below + R-5 full slab	R-15 for 24" below + R-5 full slab/ R-20 for 48" below + R-5 full slab	R-15 for 36" below + R-5 full slab/ R-20 for 48" below + R-5 full slab	R-15 for 36" below + R-5 full slab/ R-20 for 48" below + R-5 full slab	R-15 for 36" below + R-5 full slab/ R-20 for 48" below + R-5 full slab	R-15 for 36" below + R-5 full slab
Opaque Doors						
Non-Swinging	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m2, 1 pound per cubic foot = 16 kg/m3, ci = Continuous insulation, NR = No Requirement, LS = Liner System.

[a] Assembly descriptions can be found in ANSI/ASHRAE/IESNA Appendix A.

[b] Where using R-value compliance method, a thermal spacer block shall be provided, otherwise use the U-factor compliance method in Table C402.1.4.

[c] Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

[d] "Mass floors" shall be in accordance with Section C402.2.3.

[e] Steel floor joist systems shall be insulated to R-38.

[f] "Mass walls" shall be in accordance with Section C402.2.2.

[g] The first value is for perimeter insulation and the second value is for slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

[h] Not applicable to garage doors. See Table C402.1.4.

Provisions in NYStretch that are not in NYS Energy Code

- **C402.1.4.2 Thermal Resistance of Mechanical Equipment Penetrations (mandatory)** – When the area of mechanical equipment penetrations exceeds 1% of the opaque above-grade wall area, this shall be considered a separate wall assembly with a default U-factor of 0.5.
- **C402.2.8 Continuous Insulation (mandatory)** – Balconies or parapets that penetrate building thermal envelope must be 1) insulated with continuous insulation having R-value of at least R-3 or 2) incorporate a minimum R-3 thermal break where building envelope is penetrated.
- **C402.5 Air Leakage (mandatory) and C402.5.9 Air Barrier Testing**
    - New buildings between 25,000 sf and 50,000 sf and < 75ft high shall be tested by blower door and have leakage rates < 0.40 cfm/sf @ 75 pascals. These buildings must also comply with NYS Energy Code requirements pertaining to air intakes, exhausts, stairways, and shafts; loading dock weather-seals; and vestibules (C402.5.5, C402.5.6, and C402.5.7).
    - Other new buildings may demonstrate compliance according to the above provisions or by complying with the prescriptive requirements in Sections C402.5.1 through 402.5.8 and C408.4 (see below for description).
- **C403.7.4 Energy Recovery Ventilation (mandatory) (previously C403.2.7)** – Energy recovery ventilation is mandatory when ventilation air flows exceed certain amounts. The NYS Energy Code and NYStretch requirements are the same. NYStretch modified one exception to identify conditions with multiple exhaust fans or outlets.
- **C403.8.1 Allowable Fan HP (mandatory) (previously C403.2.12.1)** – Small differences regarding fan-power limitation between NYS Energy Code and NYStretch, plus additional exceptions in NYStretch.

NYStretch Energy Code–2020

Comparison to 2020 Energy Conservation Construction Code of NYS

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C405 Lighting Controls (prescriptive)

1. Adds corridors and dining areas to locations where occupancy sensors are required **(C405.2.1)**.
2. Adds occupancy sensor controls to dim lighting at building exits when unoccupied **(C405.2.1.4)**.
3. Requires daylight responsive controls in spaces with more than 100 watts (versus 150 watts) of general lighting **(C405.2.3)**.
4. Exterior lighting – unless controlled from within a dwelling unit, exterior lighting must be reduced by at least 50% during certain times of day **(C405.2.6)**.
5. Parking lot lighting – reduced by at least 50% when no activity detected for at least 15 minutes **(C405.2.6.5)**.
6. Interior lighting – allowances for both building area method and space-by-space method there are more stringent by about 10–20% **(Tables C405.3.2([1 and 2])**.
7. Exterior lighting – allowances for some areas that are slightly more stringent **(Table C405.4.2[2])**.

C405.8.1.1 Power Conversion System for Elevators (prescriptive) – Elevators with rise of more than 75ft are required to have power conversion system. Motor shall have Class IE2 efficiency rating or alternative that has equal or better efficiency. Potential energy released during motion shall be recovered and supplied to building electrical system.

C405.9 Commercial Kitchen Equipment (prescriptive) – Efficiency requirements for fryers, hot food holding cabinets, steam cookers, dishwashers, ovens.

C405.10 Electric Vehicle Charging Capability (prescriptive) – Parking garages and lots with more than 10 spaces must provide panel capacity and conduit for 208/240V outlets for at least 5% of parking spaces with a minimum of two or provide the outlets for 5% of spaces with a minimum of two spaces.

C405.11 Solar-Ready Zone (mandatory) – Requires compliance with Appendix CA. Provide designated roof space for future PV or solar thermal system on buildings that are five stories or less and oriented between 110 and 270 degrees of true north. There are some exceptions such as an on-site renewable energy system, a building shaded more than 70% of daylight hours, or a licensed design professional who certifies requirements for extensive rooftop equipment, vegetation, skylights, or other obstruction. Requirements include a plan in design for and electrical conduit to roof from electrical panel, along with panel space for the PV interface and roof-load calculations.

C405.12 Whole Building Energy and C405.13 Whole Building Electrical Monitoring (prescriptive) – Monitoring energy use for all energy sources in new buildings except for buildings <25,000 sf; Group R buildings with <10,000 sf of common area; and fuel use for on-site emergency equipment.

C406.1 Additional Energy Efficiency Packages

- On-site Renewable Energy option is now part of Appendix CC "Additional power distribution system packages."

C407 Total Building Performance Method of Compliance

- Must comply with ASHRAE 90.1 2016 Compliance Path – Section 11 or Appendix G

C408.2 Commissioning this section is required when one of following conditions is met:

1. Building greater than 25,000 sf
2. Mechanical system capacity > 480,000 Btu/h
3. Combined water and space heating > 600,000 Btu/h

Includes more specific requirements/details for commissioning mechanical, renewable energy, and water heating systems. HVAC systems must be balanced in accordance with ANSI/ASHRAE 111, "Testing, Adjusting, and Balancing of Building HVAC Systems."

C408.4 Air Barrier Commissioning – Registered design professional or approved agent shall provide documentation of air barrier components and field inspection reports.

C502 and C503 Existing Buildings/Additions

- Commissioning required for new HVAC, water heating systems, and air barriers in additions.

Appendices

- Optional adoption by local jurisdiction or township
  - Appendix CB: Prescriptive R-value tables
  - Appendix CC: Additional Power Distribution System Packages

Energy Savings and Cost-Effectiveness Analysis of the 2020 NYStretch Energy Code Residential Provisions

Final Report | Report Number 19-37 | July 2019

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Energy Savings and Cost-Effectiveness Analysis of the 2020 NYStretch Energy Code Residential Provisions

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Abstract

This report summarizes the energy savings and cost-effectiveness analysis of the residential provisions of the 2020 NYStretch Energy Code of New York State. This is compared to the residential provisions of the 2016 New York City Energy Conservation Code (NYCECC) in New York City, and the residential provisions of the 2020 ECCC NYS in the rest of the state. The report includes the methodology used in the analysis, assumptions, and results at the applicable climate design zones for New York State. An additional analysis evaluating the energy savings and cost-effectiveness of the additional energy efficiency credits path (R407) is also conducted. The results associated with the analysis are summarized in the Appendix.

Keywords

Energy code, stretch energy code, cost effectiveness, NYSERDA

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Acronyms and Abbreviations

CDZ	climate design zone
CPI	consumer price index
DHW	domestic hot water
DOE	US Department of Energy
DWHR	drain water heat recovery
ECCC NYS	2020 Energy Conservation Construction Code of New York State
EF	energy factor
EIA	Energy Information Association
ERV	energy recovery ventilator
EUL	effective useful life
EV	electric vehicle

ft	feet
HRV	heat recovery ventilator
HVAC	heating, ventilation, and air conditioning
IECC	International Energy Conservation Code
kWh	kilowatt hours
LCC	life cycle cost
lf	linear foot
lm	lumen
LPD	lighting power density
MF	multifamily
m/s	meters per second
MW	megawatts
NAHB	National Association of Home Builders
NPV	net present value
NREL	National Renewable Energy Laboratory
NREM	National Residential Efficiency Measures Database
NYC	New York City
NY	New York
NYCECC	New York City Energy Conservation Code
NYDOS	New York Department of State
NYS	New York State
NYSERDA	New York State Energy Research and Development Authority
PNNL	Pacific Northwest National Laboratory
RGGI	Regional Greenhouse Gas Initiative
SF	single family
SRE	sensible recovery efficiency
UEF	uniform energy factor
W	watts

Summary

This analysis was conducted at the request of the New York State Energy Research and Development Authority (NYSERDA) to assist with the adoption of the 2020 NYStretch Energy Code. The analysis evaluates the energy savings and cost-effectiveness potential of the residential prescriptive and mandatory provisions of the 2020 NYStretch code when compared to the residential provisions of the 2020 Energy Conservation Construction Code of New York State (ECCC NYS) and the 2016 New York City Energy Conservation Construction Code (NYCECC).

The analysis closely follows the methodology set forth by the U.S. Department of Energy (U.S. DOE) for conducting cost-effectiveness analyses of residential code changes (Taylor et al. 2015) and the procedure used for the previous energy and cost-effectiveness evaluation of the 2020 ECCC NYS (NYSERDA 19-32, 2019). The analysis also leverages the residential prototype building models developed by Resource Refocus LLC for the evaluation of the 2020 ECCC NYS, which were in turn developed from the set of DOE residential prototype building models developed by the Pacific Northwest National Laboratory (PNNL) for the 2015 IECC code development analysis. This approach maintains a consistency between the current analysis and past work conducted by NYSERDA, U.S. DOE, and PNNL for New York State (NYSERDA 2019 and Mendon et al. 2016).

The analysis included a qualitative assessment to evaluate the anticipated energy impact of code changes proposed by the 2020 NYStretch code, including a determination of which impacts could be quantified through an energy analysis. An energy analysis was then conducted by creating customized energy models tailored to the code requirements for New York State. The energy savings from the energy analysis were then combined with the incremental construction costs associated with the changes to determine the simple payback, the 10-year net present value (NPV) of energy cost savings and the 30-year Life Cycle Cost (LCC) savings.

Overall, the prescriptive and mandatory provisions of the 2020 NYStretch code are expected to yield positive energy savings and cost-effective benefits to homeowners compared to the baseline 2020 ECCC NYS and the 2016 NYCECC. Table S-1 summarizes the statewide site energy, source energy, and energy cost savings, and Table S-2 summarizes the disaggregated energy and cost savings for each

climate design zone (CDZ). Table S-3 summarizes the disaggregated incremental construction costs and simple payback by building type in each CDZ. Finally, Table S-4 summarizes the average energy cost savings, incremental construction costs and cost-effectiveness results for the prescriptive and mandatory provisions of NYStretch, weighted over the single- and multifamily building construction weights for New York State.

Table S-1. Statewide Average Annual Energy and Cost Savings

	Total Regulated Site Energy (kBtu/dwelling unit)	Total Regulated Source Energy (kBtu/dwelling unit)	Total Energy Costs ($/dwelling unit)
Baseline*	59926.4	91545.1	1514.9
2020 NYStretch	45161.4	71769.2	1216.7
Savings	24.6%	21.6%	19.7%

* The baseline code is the 2016 NYCECC in CDZ 4A-NYC and 2020 ECCC NYS in all other CDZs

Table S-2. Average Annual Energy and Cost Savings by Climate Design Zone

Climate Design Zone	Total Regulated Site Energy Savings	Total Regulated Source Energy Savings	Total Energy Costs Savings
4A-NYC	21.1%	19.9%	19.0%
4A-balance	21.5%	19.8%	18.8%
5A	25.3%	21.9%	19.6%
6A	26.2%	23.1%	20.9%

Table S-3. Average Annual Simple Payback by Building Type and Climate Design Zone

	Single-family			Multifamily		
Climate Design Zone	Total Annual Energy Cost Savings ($/dwelling unit)	Total Incremental Costs ($/dwelling unit)	Simple Payback (Years)	Total Annual Energy Cost Savings ($/dwelling unit)	Total Incremental Costs ($/dwelling unit)	Simple Payback (Years)
4A-NYC	$301	$1,910	6.3	$176	$1,625	9.2
4A-balance	$301	$2,463	8.2	$167	$1,488	8.9
5A	$351	$2,202	6.3	$172	$1,751	10.2
6A	$372	$1,506	4.1	NA	NA	NA
NY State	$348	$2,057	5.9	$171	$1,591	9.3

Table S-4. Weighted Results

For the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code at the State Level

	New York State Average
Annual Energy Cost Savings ($/dwelling unit)	$278
Incremental Costs ($/dwelling unit)	$1,795
Simple Payback (Years)	6.4
10-Year NPV of Cost Savings Including Replacement Costs and Residual Values ($/dwelling unit)	$2,854
30-Yr LCC Savings ($/dwelling unit)	$1,741

While the present analysis focuses on the prescriptive and mandatory provisions of NYStretch, the code offers other compliance paths. The multiple compliance paths in NYStretch are expected to yield equal or higher savings. The performance paths offer flexibility to the builder in meeting the code, resulting in a wide variability in the performance of homes complying with the simulated paths or the passive house path. It should also be noted that this analysis assumes no fuel switching between the baseline and the NYStretch cases. Additionally, while NYStretch contains many elements that encourage better building design, this analysis used conservative savings and incremental cost estimates for many of the measures. In this respect, the estimated energy savings reported from the analysis are likely to be conservative compared to actual energy savings that can be achieved by the 2020 NYStretch code.

1 Introduction

The New York State Energy Research and Development Authority (NYSERDA) developed the 2020 NYStretch Energy Code with guidance from an advisory group composed of public and private stakeholders. It is a voluntary, locally adoptable stretch energy code designed as an overlay to the 2020 Energy Conservation Construction Code of New York State (ECCC NYS) and is expected to be far more efficient than the residential provisions of the 2018 International Energy Conservation Code (IECC) and the commercial provisions of ASHRAE Standard. 90.1-2016.

In order to assist communities in adopting the stretch code, NYSERDA requested an analysis of the energy savings and cost-effectiveness of the 2020 NYStretch code compared to the State baseline codes, the 2016 New York State Energy Conservation and Construction Code (NYSECC) and the 2020 ECCC NYS. This analysis was conducted in each of the three climate design zones (CDZ) in New York State: 4A, 5A, and 6A and results are provided in this technical report, along with a narrative summarizing the findings and their implications for New York State's code development process.

The analysis builds on previous analysis conducted by the team for NYSERDA, including the cost-effectiveness analysis of the 2020 ECCC NYS compared to the previous 2016 NYSECC as well as technical reports and analyses published by the U.S. Department of Energy (U.S. DOE) and the Pacific Northwest National Laboratory (PNNL). Additionally, the methodology also draws from other technical resources as needed. Relevant to the residential scope of the analysis, NYSERDA made available the proposed Draft NYStretch Energy Code, January 2019[1] and results of an energy analysis conducted by the New Buildings Institute (NBI) and Earth Advantage during the stretch code development process. The firm Earth Advantage provided a presentation describing the potential savings for the residential provisions of the 2020 NYStretch code based on their modeling results using REMRate.

2 Qualitative Assessment

This section contains qualitative comparison tables for the prescriptive and mandatory provisions of the proposed 2020 NYStretch Energy Code (NYStretch) compared to the 2020 Energy Conservation Construction Code of New York State (ECCC NYS) in climate design zones (CDZ) 4A, 5A, and 6A. Because CDZ 4A covers New York City, which follows the more stringent 2016 New York City Energy Conservation Code (NYCECC), an additional evaluation of the 2020 NYStretch compared to the 2016 NYCECC is also conducted for New York City.

The qualitative assessment includes an evaluation of the expected energy impact of each provision and whether the change will be captured through energy modeling during the quantitative analysis. The assessment is limited to prescriptive and mandatory provisions of the residential provisions of the code as they apply to new construction only. It does not include editorial, clarification, and administrative type of changes, which are not expected to have a direct impact on energy. Table 1 summarizes the changes between the baseline 2020 ECCC NYS and the proposed 2020 NYStretch code, along with the results of the qualitative assessment.

Table 1. A Preliminary Qualitative Comparison

The Differences with the Largest Energy Impact between the 2020 NYStretch Code and the 2020 ECCC NYS (Prescriptive + Mandatory Provisions)

<table>
<tr><th>Code Section</th><th>Component</th><th>CDZ</th><th colspan="2">2020 ECCC NYS</th><th>2020 NYStretch</th><th>Energy Impact Captured through Energy Modeling (Yes/No)</th></tr>
<tr><td rowspan="12">R402.1</td><td rowspan="3">Fenestration U-factor</td><td>4A</td><td colspan="2">0.32</td><td>0.27</td><td rowspan="12">Yes

The overall impact of the changes to the prescriptive envelope are expected to yield positive energy savings across all CDZs.</td></tr>
<tr><td>5A</td><td colspan="2">0.3</td><td>0.27</td></tr>
<tr><td>6A</td><td>0.3 [a]</td><td>0.28 [a]</td><td>0.27</td></tr>
<tr><td rowspan="3">Fenestration SHGC</td><td>4A</td><td colspan="2">0.4</td><td>0.4</td></tr>
<tr><td>5A</td><td colspan="2">NR</td><td>NR</td></tr>
<tr><td>6A</td><td>NR [a]</td><td>NR [a]</td><td>NR</td></tr>
<tr><td rowspan="3">Ceiling R value</td><td>4A</td><td colspan="2">49</td><td>49</td></tr>
<tr><td>5A</td><td colspan="2">49</td><td>49</td></tr>
<tr><td>6A</td><td>49 [a]</td><td>60 [a]</td><td>49</td></tr>
<tr><td rowspan="3">Wood-framed R-value</td><td>4A</td><td colspan="2">20 or 13+5</td><td>21 int or 20+5 or 13+10</td></tr>
<tr><td>5A</td><td colspan="2">20 or 13+5</td><td>21 int or 20+5 or 13+10</td></tr>
<tr><td>6A</td><td>20+5 or 13+10 [a]</td><td>23 cavity [a]</td><td>20+5 or 13+10</td></tr>
</table>

Table 1 continued

<table>
<tr><th>Code Section</th><th>Component</th><th>CDZ</th><th colspan="2">2020 ECCC NYS</th><th>2020 NYStretch</th><th>Energy Impact Captured through Energy Modeling (Yes/No)</th></tr>
<tr><td rowspan="12">R402.1</td><td rowspan="3">Floor R-value</td><td>4A</td><td colspan="2">19</td><td>30</td><td rowspan="12"></td></tr>
<tr><td>5A</td><td colspan="2">30</td><td>30</td></tr>
<tr><td>6A</td><td>30 [a]</td><td>30 [a]</td><td>30</td></tr>
<tr><td rowspan="3">Basement wall R-value</td><td>4A</td><td colspan="2">10 or 13</td><td>15 or 19</td></tr>
<tr><td>5A</td><td colspan="2">15 or 19</td><td>15 or 19</td></tr>
<tr><td>6A</td><td>15 or 19 [a]</td><td>15 or 19 [a]</td><td>15 or 19</td></tr>
<tr><td rowspan="3">Slab R-value and depth</td><td>4A</td><td colspan="2">10, 2 ft</td><td>10, 4 ft</td></tr>
<tr><td>5A</td><td colspan="2">10, 2 ft</td><td>10, 4 ft</td></tr>
<tr><td>6A</td><td>10, 4 ft [a]</td><td>10, 4 ft [a]</td><td>10, 4ft</td></tr>
<tr><td rowspan="3">Crawlspace wall R-value</td><td>4A</td><td colspan="2">15 or 19</td><td>15 or 19</td></tr>
<tr><td>5A</td><td colspan="2">15 or 19</td><td>15 or 19</td></tr>
<tr><td>6A</td><td>15 or 19*</td><td>15 or 19*</td><td>15 or 19</td></tr>
<tr><td>R402.4.1.1</td><td>Insulation Installation</td><td>all</td><td colspan="2">Grade Not Specified</td><td>No more than 2% of total insulated area shall have compressed insulation or gaps/voids (Grade I insulation required)</td><td>No

Assumptions for the baseline configuration would need significant installation quality data. In absence of such data, the impact of this change cannot be evaluated through energy modeling.

This change is expected to improve insulation installation, resulting in better U-factors for the overall assemblies. Thus, the practical impact of this change is expected to be positive energy savings.</td></tr>
<tr><td>R403.3</td><td>Duct Location</td><td>all</td><td colspan="2">Not controlled</td><td>Duct System is required to be within conditioned space.</td><td>Yes

The savings from this change will not be modeled explicitly, but will be applied to the heating, cooling and fan energy during post-processing.

This change is expected to save conduction and leakage losses from ducts and result in positive energy savings.</td></tr>
</table>

Table 1 continued

Code Section	Component	CDZ	2020 ECCC NYS	2020 NYStretch	Energy Impact Captured through Energy Modeling (Yes/No)
R403.3.8	Duct Sizing	all		Ducts are required to be sized in accordance with ACCA Manual D.	No Modeling this change would require developing a full duct network in *EnergyPlus* as well as adequate information about current trends in duct sizing in the field. Both issues would result in several configurations of the duct layout making the exercise cost prohibitive. This change is expected to save losses from incorrectly sized ducts and result in positive energy savings.
R403.5.5	Supply of heated water	all	None	The new section adds four options for increasing the efficiency of hot water supply. These include limiting the maximum allowable pipe length or volume, installing drain water heat recovery units or recirculation systems.	Yes The savings from this change will not be modeled explicitly but will be applied to the hot water energy during post-processing. This change is expected to reduce losses from domestic hot water (DHW) pipes and is expected to result in positive energy savings.
R403.6.2	Balanced and HRV/ERV systems	all	None	The new section requires an energy or heat recovery ventilator (ERV or HRV) in each dwelling unit in CDZ 5A and 6A. In CDZ 4A, it allows a balanced ventilation system to comply with the requirement.	Yes The impact from this code change will be modeled assuming an ERV/HRV system in CDZ 5A and 6A and balanced ventilation in CDZ 4A and CDZ 4A-balance. This change is expected to reduce heating energy but also comes with an increase in fan energy. The overall impact may thus be neutral.

Table 1 continued

Code Section	Component	CDZ	2020 ECCC NYS	2020 NYStretch	Energy Impact Captured through Energy Modeling (Yes/No)
R403.6.3	Verification of ventilation systems	all	None	The new section requires that the performance of ventilation systems be tested and verified by an approved agency.	No This is a verification requirement and thus cannot be modeled. This change is expected to ensure proper functioning of the ventilation system. The energy impact from this provision is expected to be neutral.
R404.1	Lighting Equipment	all	60 lm/W for lamps over 40 W; 50 lm/W for lamps between 15 W and 40 W; 40 lm/W for lamps 15 W or less.	This change increases the minimum required efficacy of lamps to be 65 lm/W and the total luminaire efficacy to be 45 lm/W.	Yes The savings from this change will be modeled by reducing the lighting power density (LPD) in the models per the revised efficacy limits. This change is expected to reduce losses from inefficient lighting and is expected to result in positive energy savings.
R404.2	Electrical power packages	all	None	This new section adds requirements for a solar ready zone and electrical vehicle (EV) service equipment	No This code change requires the buildings to be solar ready and have EV infrastructure but does not explicitly mandate any specific equipment. This change is expected to yield savings by encouraging design considerations for solar energy and EV infrastructure.

[a] The 2020 ECCC NYS includes two prescriptive envelope options for CZ 6A.

Table 2 summarizes the additional differences between the baseline 2016 NYCECC and the 2020 NYStretch code, along with the results of the qualitative assessment.

Table 2. A Preliminary Qualitative Comparison

The Additional Differences between the 2020 NYStretch Code and the 2016 NYCECC (Prescriptive + Mandatory Provisions)

Component	2016 NYCECC	2020 NYStretch	Energy Impact Captured through Energy Modeling (Yes/No)
Fenestration U-factor	0.32	0.27	Yes The impact is expected to yield positive energy savings in CDZ 4A.
Fenestration SHGC	0.4	0.4	No The exterior walls will be modeled as R-20+5 in both the baseline and the NYStretch cases. All other requirements are the same between the baseline and the 2020 NYStretch code.
Ceiling R value	49	49	
Wood-framed R-value	20+5	21 int or 20+5 or 13+10	
Floor R-value	30	30	
Basement wall R-value	15/19	15/19	
Slab R-value and depth	10,4	10, 4 ft	
Crawlspace wall R-value	15/19	15/19	
Lighting Equipment	75% of permanently installed lamps are required to be high efficacy	90% of permanently installed lamps have to be high efficacy with a minimum required efficacy of lamps to be 65 lm/W and the total luminaire efficacy to be 45 lm/W.	Yes The savings from this change will be modeled by reducing the lighting power density (LPD) in the models per the revised efficacy limits. This change is expected to reduce losses from inefficient lighting and result in positive energy savings.

In summary, the overall energy impact of the 2020 NYStretch code is expected to be positive (energy savings) over the baseline codes.

3 Quantitative Analysis

This section describes the overall quantitative analysis used to assess the stringency and cost-effectiveness of the residential provisions of the proposed 2020 NYStretch Energy Code compared to the 2016 New York City Energy Conservation Code (2016 NYCECC) in New York City and the 2020 Energy Conservation Construction Code of New York State (2020 ECCC NYS) in the rest of the State. The analysis methodology builds on US Department of Energy's (DOE) methodology for determining the cost-effectiveness of residential code changes (Taylor et al. 2015), similar work conducted by the Pacific Northwest National Laboratory (PNNL) in previous code cycles (Mendon et al. 2016) and the previous analysis of the 2020 ECCC NYS conducted by Resource Refocus LLC for NYSERDA (NYSERDA 2019). Additionally, the analysis leverages the DOE residential prototype building models developed by PNNL for the 2015 International Energy Conservation Code (IECC) code development process and modified by Resource Refocus LLC for support to the New York Department of State (DOS) for the 2020 ECCC NYS Rulemaking process (NYSERDA 2019).

3.1 Overview of the Analysis

The 2020 NYStretch is designed to overlay the 2020 ECCC NYS. Thus, the stretch code continues to offer multiple paths for compliance, including a prescriptive option, a Passive House option, and two simulated performance path alternatives. Regardless of the compliance path chosen, additional mandatory requirements need to be met. The multiple compliance paths offer flexibility to the builder in meeting the code, resulting in a wide variability in the performance of homes complying with the simulated performance paths or the passive house path. The prescriptive path on the other hand offer less variability in terms of design and is typically more widely used in residential buildings compared to performance paths. Thus, the present analysis is based on the prescriptive and mandatory provisions of the 2020 NYStretch code. An overview of the analysis along with the methodology involved in the process is described in the following sections.

3.1.1 Determining the Baseline Annual Energy Use and Energy Cost for Residential Prototypes

This task involved the following steps:

1. The energy models developed by Resource Refocus LLC for the previous 2020 ECCC NYS cost-effectiveness analysis were leveraged for this step. The models were modified to reflect the revised federal minimum efficiencies for oil and gas furnaces, heat pumps, and oil boilers.

2. The baseline models for CDZ 4A were further split into two sets: one representing the requirements of the 2016 NYCECC and the other set representing the requirements of the 2020 ECCC NYS. This was done to accurately compute the energy savings and cost-effectiveness of the 2020 NYStretch in New York City because the 2016 NYCECC has different envelope requirements compared to the 2020 ECCC NYS.
3. The two sets of models were used to simulate energy use for the baseline case for single-family and low-rise multifamily units. The set representing the requirements of the 2016 NYCECC was simulated in CDZ 4A, which was selected as the representative climate location for New York City and the other set representing the requirements of the 2020 ECCC NYS was simulated in the balance of CDZ 4A and CDZs 5A and 6A.
4. The annual energy use for the code-regulated end-uses of heating, cooling, fans, lighting, and domestic hot water (DHW) were extracted and converted to energy costs.
5. The annual energy use and energy cost were aggregated to the CDZ and State level using the weights provided by NYSERDA.

3.1.2 Determining the Annual Energy Use, Annual Energy Cost, and Incremental Construction Cost for Residential Prototypes using NYStretch

This task involved the following steps:

1. A detailed evaluation of the residential provisions of the 2020 NYStretch code was conducted as it applies to the three CDZs in the State (4A, 5A, and 6A).
2. A set of NYStretch models was developed to minimally meet the residential prescriptive and mandatory provisions of the 2020 NYStretch Code.
3. The whole building incremental construction costs were calculated for the NYStretch set compared to the respective baseline. These costs were further adjusted for location and inflation.
4. The annual energy use for the code-regulated end uses of heating, cooling, fans, lighting, and DHW was extracted and converted to annual energy costs.
5. The annual energy use and energy cost were aggregated to the CDZ and State level using the weights provided by NYSERDA.

3.1.3 Cost Effectiveness of Residential Provisions of NYStretch

This task involved the following steps:

1. The energy use estimates were used to calculate energy cost savings for each prototype.
2. The energy savings were matched with corresponding incremental construction costs for each case.
3. A simple payback, 10-year present value calculation of energy cost savings, and a 30-year life cycle cost (LCC) savings were calculated.
4. The cost-effectiveness metrics were aggregated to the CDZ and State level using the associated construction weights.

3.2 Suite of Energy Models and Aggregation Scheme

The analysis leverages the models developed by Resource Refocus during the previous 2020 ECCC NYS cost-effectiveness analysis conducted for NYSERDA (NYSERDA 2019). These models, in turn developed from a set of 32 DOE/PNNL 2015 IECC residential prototype models, represent a majority of the new residential building construction stock. The set includes a detached single-family building model (total conditioned floor area of 2,400 ft^2, two stories and 8.5' ceilings) and a low-rise multifamily building model (a three-story apartment building with six dwelling units per floor, in rows of three separated by a central breezeway; conditioned floor area of 1,200 ft^2 per unit and 8.5' ceilings), each configured with four common heating systems (gas-fired furnace, electric resistance furnace, heat pumps, and oil-fired furnaces) and four foundation types (slab-on-grade, heated and unheated basements, and crawlspaces) (Mendon et al. 2014 and Taylor et al. 2015).

These models are supplemented with a set of associated construction weights for the State, provided by NYSERDA and are summarized in Table 3. NYSERDA recommended a smaller subset of models to optimize the analysis effort and accuracy of results, resulting in a total representative construction weight of 93%. Thus, the weights were normalized to total 100% at the CDZ and State level during the analysis.

Table 3. Matrix of Construction Weights Used in the Analysis

	CDZ 4A		CDZ 5A		CDZ 6A		
	SF	MF	SF	MF	SF	MF	TOTALS
Slab-on-Grade, Heat Pump	0.64%	1.69%	2.01%	0.56%	0.86%	0.0%	5.76%
Slab-on-Grade, Oil Furnace	0.0%	0.0%	0.38%	0.0%	0.0%	0.0%	0.38%
Slab-on-Grade, Gas Furnace	1.80%	2.12%	5.68%	0.70%	2.44%	0.0%	12.74%
Heated Basement, Heat Pump	0.81%	2.14%	2.55%	0.71%	1.10%	0.0%	7.31%
Heated Basement, Oil Furnace	0.0%	0.33%	0.48%	0.0%	0.0%	0.0%	0.81%
Heated Basement, Gas Furnace	2.29%	2.69%	7.21%	0.89%	3.09%	0.0%	16.18%
Unheated Basement, Heat Pump	1.30%	3.45%	4.11%	1.15%	1.76%	0.0%	11.77%
Unheated Basement, Oil Furnace	0.0%	0.53%	0.77%	0.0%	0.33%	0.0%	1.64%
Unheated Basement, Gas Furnace	3.69%	4.33%	11.61%	1.44%	4.98%	0.0%	26.05%
Crawlspace, Heat Pump	0.0%	0.99%	1.18%	0.33%	0.51%	0.0%	3.01%
Crawlspace, Gas Furnace	1.06%	1.24%	3.34%	0.41%	1.43%	0.0%	7.50%
			Percentage of total NYS Construction weights				93.14%

The weights for CDZ 4A were further divided between New York City and the balance of CDZ 4A using an average of county-level housing starts from 2014 to 2018 based on data provided by NYSERDA from the Dodge Data and Analytics database. Average housing starts for the counties of Bronx, King, New York, Queens, and Richmond were grouped into "CDZ-4A-NYC" and the counties of Nassau, Suffolk, and Westchester were grouped into "CDZ 4A-balance" as summarized in Table 4.

Table 4. Split of Construction Weights between CDZ 4A-NYC and CDZ 4A-balance

Prototype	CDZ 4A-NYC	CDZ 4A-balance	Total
Single-family	19.6%	80.4%	100.0%
Multifamily	38.0%	62.0%	100.0%

3.3 Energy Analysis

3.3.1 Simulation Tool

The analysis was conducted in version 8.0 of EnergyPlus. While more recent versions of the engine are currently available, the analysis was conducted using the same version of EnergyPlus as the previous cost-effectiveness analysis conducted for the 2020 ECCC NYS to minimize the time required for model upgrades and potential troubleshooting. Additionally, version upgrades often involve changes in estimated energy use and maintaining the same version of EnergyPlus allows for a direct comparison with earlier work conducted by PNNL for New York State (Mendon et al. 2016).

3.3.2 Weather Locations

The analysis was conducted using weather data for New York City (CDZ 4A), Buffalo (CDZ 5A) and Watertown (CDZ 6A). The baseline set of models representing the 2020 ECCC NYS was simulated in all three climate design zones with the exception of a portion of CDZ 4A representing New York City, in which a baseline set representing the 2016 NYCECC was simulated. Correspondingly, the NYStretch models were simulated in all three climate design zones.

3.3.3 Site, Source, and Energy Cost Calculations

Site energy use from the annual simulation was extracted for the major code regulated end-uses, including heating, cooling, ventilation, fans, lighting, and DHW and converted to energy costs using the average fuel costs for electricity, natural gas, and fuel oil for the State, which was published by the Energy Information Association (EIA). Site energy was also converted to source energy using site-source conversion factors for electricity, natural gas, and fuel oil.

3.3.4 Baseline Models for New York State

Energy models representing the baseline 2020 ECCC NYS developed for the previous 2020 ECCNYS cost-effectiveness analysis were leveraged for this analysis. First, the models were modified to use the revised federal minimum equipment efficiencies as shown in Table 5. The baseline set for CDZ 4A was then further split into a set representing the minimum requirements of the 2016 NYCECC.

Table 5. Federal Minimum Equipment Efficiencies

Parameter	Updated Federal Minimum Efficiency2
Gas furnace	80%
Oil furnace	83%
Oil boiler	84%
Heat pump	SEER 14

3.3.4.1 Adjustment for Duct Sealing

The 2020 ECCC NYS models were developed from the 2015 IECC PNNL/DOE models provided by NYSERDA. The PNNL/DOE models do not account for losses associated with an air distribution system, and the savings associated with duct sealing provisions were added to the energy use by PNNL with an involved post-processing setup (Mendon et al. 2013). Consistent with the previous 2020 ECCC NYS cost-effectiveness analysis, this analysis used a conservative estimate of 10% heating and cooling savings across the board from duct sealing provisions for the baseline and NYStretch cases.

3.3.5 Implementation of the 2020 NYStretch Requirements

The 2020 NYStretch code requires more stringent windows, insulation, and lighting compared to the baseline codes. Additionally, it also requires several improvements to the mechanical systems, including requiring ducts to be placed within conditioned zones, efficient hot water delivery systems, and balanced ventilation systems including heat or energy recovery in the colder climate zones. Each change was qualitatively evaluated to identify the changes that would result in an energy impact and could be captured using energy modeling. This section describes the modeling methodology used for evaluating the applicable changes.

3.3.5.1 Envelope Improvements

The 2020 NYStretch code requires a lower U-factor for fenestration in all three climate design zones, improved wall insulation in CDZ 4A and 5A, improved floor insulation in CDZ 4A, improved basement wall insulation in CDZ 4A and higher depth of slab insulation in CDZ 4A and 5A. All these changes were modeled by updating the material properties for the respective assembly layers in the relevant *EnergyPlus* objects. For windows, the U-factor field in the simple glazing object was updated to use a value of 0.27. For exterior walls, basement walls, and floors, the conductivity of the consolidated insulation and framing layer was adjusted to yield the required R value.

The 2020 NYStretch code allows three options for meeting the prescriptive wall insulation requirement in CDZ 4A and 5A, including R-21 intermediate framing (walls with R-10 insulated headers), R-20+5 and R-13+10. This compares with the baseline requirement of R-20 or R-13+5 in the 2020 ECCC NYS and a requirement of R-20+5 in the 2016 NYCECC. This code provision was evaluated by assuming R-21 intermediate framing walls in CDZ 4A-balance and 5A in the NYStretch cases. In CDZ 4A-NYC, because the baseline already required R-20+5, the NYStretch cases were also modeled using the R-20+5 option.

3.3.5.2 Ducts in Conditioned Space

The PNNL/DOE models do not account for losses associated with an air distribution system and cannot be used to determine the energy savings from moving ducts into conditioned space without a major change to the models. Analogous to the treatment of duct sealing, a flat multiplier was applied to heating and cooling energy consumption to account for moving the ducts. A literature review revealed reported savings of 10–25%, but basic assumptions, including CDZ and original duct placement, were often unavailable. Therefore, a simplified modeling exercise was conducted in *BEopt* version 2.8 to evaluate savings in CDZs 4A, 5A, and 6A.

BEopt models of a 2,400 ft^2 two-story, single-family home with three foundation types—slab, unheated basement, and heated basement—were constructed to calculate the savings from moving ducts to conditioned space. All other house characteristics were maintained as the Building America defaults except the duct location.

Table 6 shows the savings from moving ducts with 15% leakage, insulated with R-8, to conditioned space. Broadly, the cooling savings were relatively consistent in all three CDZs – about 15% for the slab, 10% for the unheated basement, and 5% for the heated basement. For heating, CDZs 5A and 6A have similar savings, but the savings in CDZ 4A were about 10 percentage points higher—15% vs 25% for the slab, 10% vs 20% for the unheated basement, and 5% vs. 15% for the heated basement.

Table 6. Savings from Moving Ducts to Conditioned Space

		Duct Location	CDZ 4A	CDZ 5A	CDZ 6A
Cooling	Slab	Attic	16%	17%	16%
	Unheated basement	Basement	11%	10%	13%
	Heated basement	Basement	7%	6%	5%
Heating – electricity[a]	Slab	Attic	22%	12%	12%
	Unheated basement	Basement	19%	8%	7%
	Heated basement	Basement	16%	5%	5%
Heating - gas	Slab	Attic	26%	16%	16%
	Unheated basement	Basement	20%	9%	9%
	Heated basement	Basement	15%	5%	4%

a While the house has a gas furnace, there is a small amount of electricity consumption for heating, particularly fan use.

When combined with the foundation weights for CDZs 4A, 5A, and 6A, the average cooling savings were found to be between 10% and 17%, the fan energy savings between 7% and 22%, and the heating savings between 9% and 26%, depending on the CDZ. Based on these results, an average savings of 20% from the code provision were assumed in CDZ 4A-NYC and CDZ 4A-balance and 10% in CDZs 5A and 6A. These savings were applied only to prototypes with slab-on-grade, crawlspace, and unheated basements because prototypes with heated basements were conservatively assumed to have most of the ducting system located within the conditioned basement, based on Building America House Simulation Protocols (Wilson et al. 2014). For the applicable prototypes, the savings were assumed to be in addition to the 10% savings assumed from the duct sealing provisions in the baseline and implemented as a savings multiplier to the heating, cooling, and fan energy in the 2020 ECCC NYS and 2020 NYStretch cases.

3.3.5.3 Drain Water Heat Recovery

The 2020 NYStretch code includes provisions for improving the efficiency of hot water supply systems. The code offers multiple options, including a compact piping layout with limits on pipe run lengths, drain water heat recovery (DWHR), or a hot water recirculation system. While all three options are designed to cut losses in the hot water delivery systems, they are associated with different costs and challenges. For example, a compact piping layout can be efficiently implemented during the design of a house. However, a DWHR or a recirculation system might be more suitable for a broader range of house configurations. Similarly, the savings that can be harnessed from any of these options vary significantly with the configuration of the house and the hot water usage profile.

The PNNL/DOE models use a simplifying assumption of treating hot water pipes as adiabatic, meaning there is no heat transfer between them and other spaces in the building. Therefore, adding DWHR to the models or shortening pipe lengths does not account for any interactive effects with space heating and cooling. Because the interactive effects are expected to be of the second order in nature, the analysis uses a savings multiplier based on a literature review. Savings percentages ranging from 25–40% were found in the literature including an estimate of 40% from Minnesota Power,[3] an estimate of 25 to 30% from Van Decker,[4] and 25% from Manitoba Hydro.[5] This analysis uses a conservative savings estimate of 25%. These savings are implemented by applying a multiplier of 0.75 to the hot water energy consumption in the 2020 NYStretch cases.

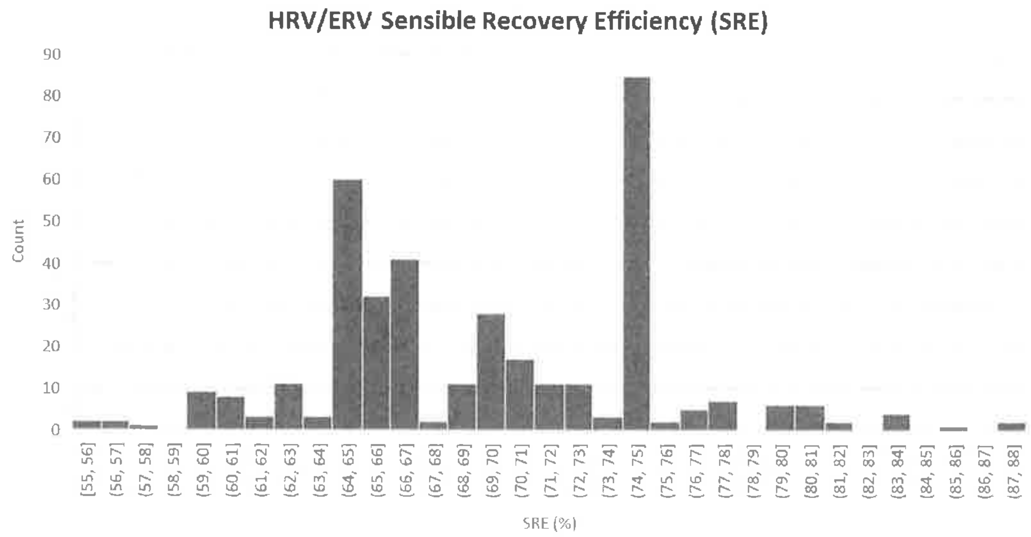
3.3.5.4 Ventilation

The 2020 NYStretch code requires energy recovery ventilation (ERV) or a heat recovery ventilation (HRV) in CDZ 5A and 6A. In CDZ 4A, a balanced ventilation system is allowed to comply. The baseline 2020 ECCC NYS or 2016 NYCECC do not require ERV/HRVs or balanced ventilation. This code provision is evaluated by assuming balanced ventilation in CDZ 4A-NYC and CDZ 4A-balance and HRVs in CDZ 5A and 6A.

Because the 2020 NYStretch code does not include a minimum efficiency requirement for HRVs, the directory of available products from the Home Ventilation Institute (HVI) was reviewed to identify a suitable assumption. Figure 1 shows the distribution of the sensible recovery efficiency (SRE) of products available in the market today. Most of the products have SRE between 64% and 75% with some exceptionally high-efficiency units with SRE greater than 85% also available. The analysis assumes HRVs with SRE of 70% in the NYStretch cases in CDZ 5A and 6A. The HRVs are modeled using the *EnergyPlus* "ZoneVentilation:EnergyRecoveryVentilator" object, by setting latent heat recovery efficiency to zero and sensible heat recovery efficiency to 0.7. In CDZ 4A-NYC and CDZ 4A-balance, the NYStretch models are configured with the "balanced" zone ventilation option in *EnergyPlus*.

Figure 1. Distribution of Sensible Recovery Efficiencies of ERVs/HRVs

See endnotes for more information[6]



3.3.5.5 High Efficacy Lighting

The 2020 NYStretch makes an incremental improvement to the minimum lighting efficacy requirement. Compared to the tiered requirements in the baseline 2020 ECCC NYS and the 75% high-efficacy lighting requirement in the 2016 NYCECC, the 2020 NYStretch code requires 90% of all permanently installed lighting to be high-efficacy with the minimum efficacy of lamps to be 65 lm/W and that of the total luminaire to be 45 lm/W. This code provision is expected to yield a reduction in the annual lighting energy use.

The lighting energy in the DOE/PNNL 2015 IECC models is calculated using the Building America Benchmark specifications (Wilson et al. 2014) and translated to the models as a lighting power density (LPD) or a peak lighting power input (Mendon et al. 2013). A similar approach was utilized in the previous 2020 ECCNYS cost-effectiveness analysis (NYSERDA 2019). The present analysis uses a modified approach based on the same principles by updating the energy ratio (ER) associated with the CFLs in the Building America equations to use 65 lm/W. All other parameters in the equations are left unchanged.

Table 7 shows the calculated lighting energy use for the baseline and 2020 NYStretch for the single-family prototype and each multifamily unit.

Table 7. Lighting Energy Use

	2020 ECCC NYS		2016 NYCECC		2020 NYStretch	
	Single-family	Multifamily	Single-family	Multifamily	Single-family	Multifamily
Interior Hard-Wired Lighting Energy (kWh/yr)	787.1	474.0	867.6	522.4	762.3	459.0
Interior Hard-Wired Lighting LPD (W/ft^2)	0.106	0.106	0.117	0.117	0.103	0.103
Exterior Lighting Energy (kWh/yr)	209.4	104.7	230.9	115.4	202.8	101.4
Exterior Lighting Peak (W)	47.63	47.63	52.50	52.50	46.13	46.13
Garage Lighting Energy (kWh/yr)	14.4	14.4	15.9	15.9	14.0	14.0
Garage Lighting Peak (W)	7.81	7.81	8.61	8.61	7.56	7.56

3.4 Incremental Cost Calculations

The incremental costs associated with the code changes captured in the energy analysis are determined using sources such as RS Means (RS Means 2019), DOE's Building Community Cost database developed by PNNL,[7] the construction cost estimation study conducted by Faithful+Gould for DOE (F+G 2012), National Renewable Energy Laboratory's (NREL) National Residential Efficiency Measures (NREM) database, and technical reports published by DOE. Where required, the costs are adjusted to current dollars using the consumer price index (CPI). Finally, the costs are adjusted using location cost multipliers to come up with representative construction cost estimates for the State.

3.4.1 Location Multipliers

Location multipliers are used to adjust national average costs to account for locational diversity in material and labor costs. This analysis uses location factors from the 2019 RS Means Residential Costs Data Book (RS Means 2019). The data for all available locations in New York State is grouped into CDZs 4A, 5A, and 6A using the 2018 IECC climate zone map (ICC 2017). CDZ 4A is further split into CDZ 4A-NYC and CDZ 4A-balance by separating the factors for New York City and surrounding areas from the remainder of CDZ 4A. The factors are then averaged to yield the overall factors used in this analysis, as summarized in Table 8.

Table 8. Location Cost Multipliers Used in the Analysis

Climate Design Zone	Average Location Factor
4A-NYC	1.374
4A-balance	1.234
5A	1.059
6A	0.998

3.4.2 Incremental Cost for Each Measure

This section describes the assumptions behind the development of incremental costs for each measure that was evaluated in the energy analysis.

3.4.2.1 Fenestration

The 2020 NYStretch requires a more stringent fenestration U-factor of 0.27 in all CDZs. This compares to a baseline requirement of U-0.32 in CDZ 4A and U-0.30 in CDZ 5A and 6A. In CDZ 6A, the 2020 ECCC NYS has an additional prescriptive path with a U-0.28.

Incremental costs associated with code fenestration requirements, especially at higher efficiencies, are often difficult to map to real fenestration products because available products have rated U-factors and SHGC for various combinations of framing and glass and lack the level of granularity used by the code. ENERGY STAR® addresses this complexity by using a regression-based approach in its Cost and Savings Estimates for homes certified under ENERGY STAR Version 3 (ENERGY STAR 2016). The regression uses data from National Residential Efficiency Measures Database (NREM) developed by the National Renewable Energy Laboratory (NREL) to develop a set of regression equations. These regression equations are used to calculate the incremental costs associated with this code provision resulting in an incremental cost of $\$1.04/ft^2$ in CDZ 4A including CDZ 4A-balance, $\$0.62/ft^2$ in CDZ 5A and an average of $\$0.33/ft^2$ based on the two prescriptive baseline options in CDZ 6A. This results in an incremental cost of $391 in CDZ 4A and CDZ 4A-balance, $235 in CDZ 5A, $157 in CDZ 6A for the single-family prototype, $196 in CDZ 4A and CDZ 4A-balance, $117 in CDZ 5A, and $63 in CDZ 6A for each multifamily unit, after adjusting for inflation. These estimates are further multiplied by the location factors before use in the analysis.

3.4.2.2 Exterior Wall Insulation

There are multiple baseline and 2020 NYStretch prescriptive options for wall insulation (Tables 1 and 2). In CDZ 4A-balance and 5A, this analysis assumes R-20 in the baseline and R-21 intermediate framing (with R-10 insulated headers) in the NYStretch case. In CDZ 4A-NYC and 6A, this analysis assumed R-20+5 in both the baseline and NYStretch cases.

The additional cost associated with R-21 int compared to R-20 walls is the cost of insulating the wall headers with R-10 insulation. The analysis assumes the headers are insulated with 2" of extruded polystyrene (XPS) at R-5/inch. Table 9 shows three estimates of incremental cost.

Table 9. Incremental Cost Estimates for Exterior Wall Insulation: R-21 int vs. R-20

Source	Incremental Cost	Notes
F+G (2012)	$1.77/ft^2	$1.62/ft^2 in 2012 dollars, adjusted to 2019 dollars
RS Means (2019)	$1.88/ft^2	
NREL NREM (2019)	$1.70/ft^2	
Assumption	**$1.77/ft^2**	

According to the dimensions of the DOE/PNNL single-family prototype building used by Faithful + Gould in their 2012 cost estimation exercise, the total length of 2x10 headers is 258 feet (F+G 2012). This results in a total incremental cost of $380 associated with this code provision for the single-family prototype. Detailed drawings of the multifamily prototype building are not available. Thus, the analysis assumes that the ratio of headers to exterior wall area is the same in the single- and multifamily prototypes, which translates to an incremental cost of $136 for each multifamily unit. These estimates are further multiplied by the location factors before use in the analysis.

3.4.2.3 Floor Insulation

The 2020 NYStretch code requires R-30 floor insulation in CDZ 4A compared to R-19 required by the 2020 ECCC NYS in CDZ 4A. The analysis assumes that fiberglass blanket insulation is installed between floor joists. Two estimates of incremental cost are shown in Table 10.

Table 10. Incremental Cost Estimates for Floor Insulation: R-30 vs. R-19

Source	Incremental Cost	Notes
F+G (2012)	$0.46/ft^2	$0.42/ft^2 in 2012 dollars, adjusted to 2019 dollars
RS Means (2019)	$0.40/ft^2	
Assumption	**$0.40/ft^2**	

Using $0.40/ft², the total incremental cost works out to $480 for the single-family prototype and $160 for each multifamily unit. Because the 2016 NYCECC already requires floor insulation of R-30 in the areas governed by the code (CDZ 4A-NYC in this analysis), this incremental cost is assumed to apply only to the balance of CDZ 4A (CDZ 4A-balance), after applying applicable location multipliers.

3.4.2.4 Slab Insulation

The 2020 NYStretch code requires slab insulation to be installed up to a depth of four feet compared to the two feet required by the baseline 2020 ECCC NYS in CDZ 4A and 5A. The analysis assumes slab edge insulation to be 2" thick XPS (R-10) with 60 PSI compressive strength. Table 11 shows three estimates of the incremental cost.

Table 11. Incremental Cost Estimates for Slab Insulation: 4' vs. 2' R-10 XPS

Source	Incremental Cost	Notes
F+G (2012)	$1.77/ft²	$3.24/lf for 2' deep slab edge insulation with R-10 XPS in 2012 dollars, adjusted to 2019 dollars
RS Means (2019)	$2.42/ft²	2" thick XPS used in foundation applications
NREL NREM (2019)	$2.00/ft²	2" thick XPS used in foundation applications
Assumption	**$2.00/ft²**	

Using a cost of $2.00/ft², the total incremental cost is $560 for the single-family prototype and $247 for each multifamily unit. Because the 2016 NYCECC already requires four feet of R-10 slab insulation in the areas governed by the code (CDZ 4A-NYC in this analysis), this incremental cost is assumed to apply only to the balance of CDZ 4A (CDZ 4A-balance) and CDZ 5A, after applying applicable location multipliers.

3.4.2.5 Basement Wall Insulation

The 2020 NYStretch code requires R-15 continuous or R-19 cavity insulation for basement walls compared to the R-10 continuous or R-13 cavity insulation required by the baseline 2020 ECCC NYS in CDZ 4A. The analysis assumes basement walls insulation to be kraft-faced fiberglass placed within the wall cavity. Table 12 shows three estimates of incremental cost including the cost of additional insulation as well as deeper framing because R-13 insulation is 3.5" thick and can be placed in a 2 x 4 cavity.

An average incremental cost of $0.8/ft^2$ results in a total incremental cost of $784 for the single-family prototype and $345 for each multifamily unit. Because the 2016 NYCECC already requires R-15/R-19 basement wall insulation in the areas governed by the code (CDZ 4A-NYC in this analysis), this incremental cost is assumed to apply only to prototypes with conditioned basements in the balance of CDZ 4A (CDZ 4A-balance), after applying applicable location multipliers.

Table 12. Incremental Cost Estimates for Basement Wall Insulation: R-19 vs. R-10 Cavity

Source	Incremental Cost	Notes
F+G (2012)	$0.84/ft^2$	$0.77/ ft^2$ in 2012 dollars, adjusted to 2019 dollars
RS Means (2019)	$0.97/ft^2$	
NREL NREM (2019)	$0.5/ft^2$	
Assumption	**$0.8/ft^2$**	

3.4.2.6 Efficient Hot Water Supply

The 2020 NYStretch code has several options for encouraging the efficient delivery of hot water, including an option for a compact piping system, a recirculation system, and a DWHR system. Like other elements of the code that are focused on good design practices, the incremental cost associated with this measure varies from case to case. For example, Klein (2012) lays out several examples for developing a compact hot water delivery system, which when implemented correctly during the early design stages of a project would most likely result in first cost savings by eliminating long pipe runs that require installation and insulation. If a compact hot water delivery system is not feasible for any reason, a DWHR system or recirculation pump in some water heater configurations can help reduce heat loss through pipes or recover a portion of the waste heat.

Similar to the range in energy savings from these systems, the incremental costs also tend to vary. The U.S. Department of Energy (DOE) reports a range of $300 to $500 for installing DWHR systems, noting that installation is likely to be less expensive in new home construction.[8] The final Codes and Standards Enhancement (CASE) report developed by the California Energy Commission on DHWR reports a total cost of $700 to $800 for a complete installation. The study further notes that the product life for DWHR is 30 to 50 years and that no maintenance is required because the equipment has no moving parts. [9] Finally, the third option, recirculating pumps, are cheaper to install depending on the water heater configuration and can be controlled using a timer or a switch. The cost of installing a recirculation pump is approximately $400. [10]

The present analysis assumes a DHWR because it is suitable for a wide range of home designs. Additionally, it is expected that some builders will use the compact piping layout option, thus achieving energy savings for negligible incremental costs. An average incremental cost of $400 is assumed for this measure for both the single-family prototype as well as each multifamily unit. The cost is further adjusted by location factors.

3.4.2.7 Ventilation

The 2020 NYStretch code requires heat recovery ventilation (HRV) or energy recovery ventilation (ERV) in CDZ 5A and 6A. In CDZ 4A, a balanced ventilation system is deemed to comply. As discussed previously in the energy analysis, this analysis assumes a balanced ventilation system in CDZ 4A and an HRV with 70% sensible recovery efficiency (SRE) in CDZ 5A and 6A.

HRVs and ERVs are becoming more popular as the recent energy codes have driven down the air leakage thresholds, thereby introducing the need for controlled mechanical ventilation systems. While point exhaust-based systems are still commonly used to meet the IECC requirement across the country, central fan-integrated supply (CFIS) systems and ERV/HRVs are beginning to be introduced because of the better ventilation effectiveness they provide.

This analysis assumes an average incremental cost of $300 for the single-family prototype and each multifamily unit for the CFIS unit that meets the requirement in CDZ 4A. For CDZs 5A and 6A, the analysis assumes an incremental cost of $1,000 for the single-family prototype and each multifamily unit. These costs are further adjusted using location factors.

Tables 13 and 14 show three estimates of total cost and incremental cost compared to local exhaust-based systems for HRV/ERVs and CFIS.

Table 13. Incremental Cost Estimates for Ventilation: HRV/ERV System vs. Exhaust Ventilation

Source	Total Cost	Incremental Cost	Notes
Moore (2018)	$1,300	$1,103	New construction HRV
Aldrich et al (2013)	$1,500	$1,100	Local ERV system
NREL NREM (2019)	$1,300	$940	HRV with 70% SRE
Assumption		**$1,000**	HRV with 70% SRE

Table 14. Incremental Cost Estimates for Ventilation: CFIS System vs. Exhaust Ventilation

Source	Total Cost	Incremental Cost
Moore (2018)	$310	$113
Aldrich et al (2013)	$650	$250
NREL NREM (2019)	$850	$490
Assumption		**$300**

3.4.2.8 Lighting

The 2020 NYStretch code raises the threshold of high-efficacy lamps to require a minimum of 65 lm/W and that of luminaires to require a minimum of 45 lm/W, while leaving the required percentage of high-efficacy hard-wired lighting unchanged at 90% as the baseline 2020 ECCC NYS. The required percentage of high-efficacy hard-wired lighting in the 2016 NYCECC, however, is 75%.[11]

The overall impact of the 2020 NYStretch code is to require the installation of CFLs at the higher end of the CFL efficacy spectrum or LEDs. Many of the CFLs designed to replace 40-60 W incandescent lamps that are currently labeled under the ENERGY STAR program have efficacies greater than 65 lm/W[12] and would, therefore, meet the NYStretch requirement. LEDs typically have higher efficacies, around 80 lm/W,[13] but this analysis is based on conservative estimates of energy savings and assumes the code provision is met with CFLs. Thus, the incremental cost associated with this change is assumed to be negligible because most CFLs available in the market today easily meet the ENERGY STAR designation for no incremental cost. For CDZ 4A-NYC, however, the baseline 2016 NYCECC requires only 75% of permanently installed lamps to be high efficacy. Thus, the incremental cost of meeting the 2020 NYStretch code provisions for those cases is based on purchasing more CFL bulbs at an incremental cost of $2.93/bulb compared to incandescent lamps. In the single-family prototype, the cost of replacing seven bulbs is assumed to be $20.51; for each multifamily unit, the cost of replacing three bulbs is assumed to be $8.79 (NYSERDA 2019).

3.4.2.9 Ducts in Conditioned Space

The 2020 NYStretch code requires that all ducts be located within conditioned space, while the baseline codes do not regulate the location of ducts. Moving ducts into conditioned zones reduces losses associated with heat transfer and is proven to be a source of significant savings especially in warmer climates.

However, the typical placement of ducts varies widely depending on the house configuration, HVAC layout and even foundation type. Homes with basements tend to have a portion or all the ducts located inside basements while homes with slab-on-grade or crawlspaces tend to have most of the ducts located in the attic space which unless it is conditioned, can result in large losses.

DOE's Building America program developed several case studies and low-cost installation methods for locating ducts within the thermal boundary of a house by implementing dropped ceilings or chases in single-story homes and installing ducts between floor in multi-story ones.[14] They also suggest sealing an attic or crawlspace and insulating them at the perimeter to create a suitable conditioned zone for placing ducts. However, the actual cost associated with this measure depends on many factors as they apply to a given house. Building America found costs ranging from as little as $0.39/ft^2 of conditioned floor area when utilizing efficient chase systems to as much as $2.50/ft^2 when using spray foam insulation (Beal et al. 2011).

In the 2018 IECC, a new code provision related to buried ducts was approved (ICC 2017). This provision, which has been carried through the 2020 ECCC NYS and the 2020 NYStretch code, allows ducts buried within attic insulation to be considered "inside conditioned space" if they meet certain criteria. The criteria includes a lower leakage rate, the air handling unit (AHU) being placed inside conditioned space, and a minimum insulation level above and below the duct surface. The approach is expected to yield good energy savings while still being a lower cost solution.

Research conducted by the National Association of Home Builders (NAHB) Home Innovation Research labs compares different strategies for meeting this code requirement along with a comparison of costs.[15] This analysis assumes that this requirement is met by implementing buried ducts within conditioned space, including building a mechanical closet to house the AHU. The cost for this method per NAHB's research is between $913 and $1,107 for a 2,428 ft^2 single-story, slab-on-grade house configuration. It is further noted that the cost for a two-story design would be proportional to the percentage of living area on the second floor. Because the single-family prototype used in this analysis has 50% of the living area on the second floor, the incremental cost associated with this measure is assumed to be $505 for the single-family prototype. The incremental cost for each multifamily unit is also accordingly assumed to be $505 because the conditioned floor area is half that of the NAHB prototype. The prototypes with conditioned basements are assumed to incur no additional costs because most of the ducts are already assumed to be placed in the conditioned basement as described in section 3.3.5.2. Therefore, the incremental costs are assumed to apply only to the prototypes with slab-on-grade, crawlspace and unconditioned basement.

3.4.2.10 Credit Associated with Down-Sizing HVAC Equipment

The collective impact of the prescriptive and mandatory requirements of the 2020 NYStretch code reduce the design heating and cooling loads of the building and result in a reduction in the size of HVAC equipment required to service the loads for the single- and multifamily dwelling units. Because the analysis employs a whole building cost approach, the impact of equipment downsizing due to improved shell efficiency is considered in the analysis. The HVAC sizing information reported by *EnergyPlus* indicates a range in equipment capacity reduction between different prototypes and CDZs and is more notable on the cooling side. It is also expected that the actual sizes installed in the field will vary based on individual design practices. Thus, the analysis conservatively assumes a 0.5-ton reduction in HVAC equipment in CDZ 4A-balance and 5A where most of the envelope improvements apply over the baseline 2020 ECCC NYS. In CDZ 4A-NYC and 6A, the downsizing in equipment is less noticeable because the envelope requirements are mostly similar between the baseline and the 2020 NYStretch code. Thus, an equipment downsizing credit of $330 was assumed in this analysis only for CDZ 4A-balance and 5A (ENERGY STAR 2016). This credit is subtracted from the total incremental cost after adjusting for inflation and location factors.

3.4.3 Total Incremental Costs by Prototype and Climate Design Zone

The total incremental costs per dwelling unit for each prototype in each climate design zone are shown in Table 15.

Table 15. Total Incremental Costs of the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code Compared to the 2016 NYCECC in CDZ 4A-NYC and 2020 ECCC NYS Elsewhere

	Single-family				Multifamily			
	Slab	Crawlspace	Heated Basement	Unheated Basement	Slab	Crawlspace	Heated Basement	Unheated Basement
4A-NYC	$2,048	$2,048	$1,528	$2,048	$1,763	$1,763	$1,243	$1,763
4A-balance	$3,278	$3,180	$3,087	$3,180	$1,917	$1,810	$1,571	$1,810
5A	$2,900	$2,307	$1,905	$2,307	$2,117	$1,856	$1,455	$1,856
6A	$1,602	$1,602	$1,224	$1,602	$1,509	$1,509	$1,131	$1,509

3.5 Cost-Effectiveness Analysis

Combined with the respective energy cost savings, the incremental construction costs were used to calculate a simple payback, present value of savings over a 10-year period, and 30-year Life-Cycle Cost (LCC) savings. While the cost-effectiveness calculations are based on the parameters and equations laid out in DOE's cost-effectiveness methodology (Taylor et al. 2015), certain economic parameters have been updated using latest New York specific data where available.

3.5.1 Fuel Prices

Energy use from the annual simulation is extracted for the major code regulated end-uses of heating, cooling, ventilation, fans, lighting, and domestic DHW and converted to energy costs using the average fuel costs for electricity, natural gas, and fuel oil for the State published by the Energy Information Association (EIA). The latest full year data published by EIA is for 2017 (EIA 2019a, 2019b, and 2019c). Additionally, NYSERDA provided electricity and natural gas prices specific to New York City, which were used only in CDZ 4A-NYC. The average fuel prices used in the analysis are described in Table 16.

Table 16. Fuel Prices

Fuel	CDZ 4A-NYC	All Other CDZs
Electricity	$ 0.200/kWh	$ 0.180/kWh
Natural gas	$ 0.900/therm	$ 1.167/therm
Fuel Oil	$ 2.774/therm	$ 2.774/therm

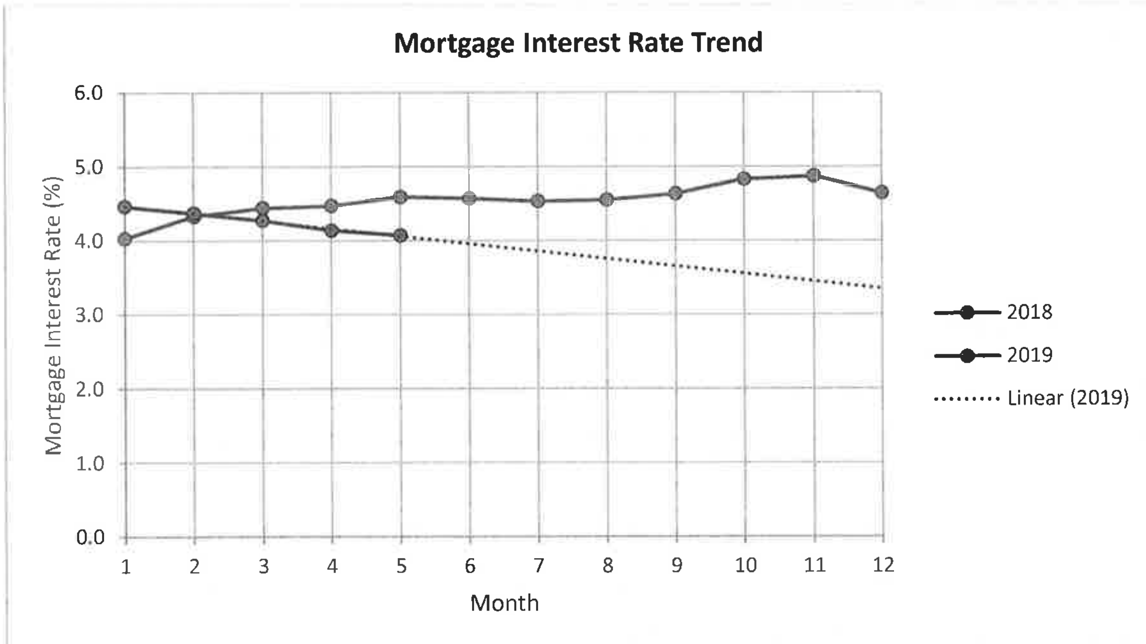
3.5.2 Economic Parameters

The protocols and economic factors used in DOE's cost-effectiveness methodology were followed to calculate the present value and LCC savings. The present value calculation of energy cost savings requested by the State was conducted using a 10-year term, and the LCC savings calculation used a 30-year term to match the typical term used by DOE in its analysis.

3.5.2.1 Mortgage Interest Rate

The mortgage interest rate has averaged around 4.5% in 2018 per latest estimates from Freddie Mac and has been trending downwards in the first half of 2019 as shown in Figure 2.[16]

Figure 2: Mortgage Interest Rate Trends for 2018 and 2019[17]



Based on the trajectory, this analysis uses an estimate of 4.0% mortgage interest rate. The discount rate is maintained the same as the mortgage interest rate per DOE's methodology.

3.5.2.2 Inflation Rate

The analysis uses the latest annualized inflation rate for December 2018 of 1.9%.[18] The home price escalation rate is maintained the same as the inflation rate per DOE's methodology.

3.5.2.3 Fuel Price Escalation Rates

The fuel price escalation rates used in the analysis are the average escalation rates for the 2018–2050 period reported by EIA in its 2019 Annual Energy Outlook for the Mid Atlantic census region.[19] The escalation rate for electricity is assumed to be 0.6%, that for natural gas is assumed to be 0.9% and that for fuel oil is assumed to be 1%.

3.5.2.4 Down Payment Rate

The analysis assumes a 20% down payment rate to be more representative of the current scenario in the State (NYSERDA 2019).

3.5.2.5 Income Tax Rate

The federal income tax rate is assumed to be 15% and the state income tax rate for the State is assumed to be 6.33% for a married filing jointly bracket of $43,000 through $161,550.[20]

3.5.2.6 Property Tax Rate

The property taxes in the State vary widely by location. This analysis uses an average property tax rate of 1.65%. The economic parameters used this analysis are summarized in Table 17.

Table 17. Summary of Economic Parameters

Parameter	Value
Mortgage Interest Rate	4%
Loan Term	30 years
Down Payment Rate	20.0%
Points and Loan Fees	0.5% (non-deductible)
Discount Rate	4% (equal to Mortgage Interest Rate)
Period of Analysis	30 years
Property Tax Rate	1.65%
Income Tax Rate	21.3%
Home Price Escalation Rate	1.9%
Inflation Rate	1.9%
Energy Escalation Rates - Electricity	0.6%
Energy Escalation Rates – Natural Gas	0.9%
Energy Escalation Rates – Fuel Oil	1.0%

3.5.2.7 Useful Measure Life, Replacements, and Residual Value

For building components that have useful lives longer than 30 years, a credit for "residual life" was applied at year 30 in the LCC calculation. For building components with a useful life less than the analysis term, the analysis assumes a like-for-like replacement consistent with the DOE methodology. Table 18 summarizes the effective useful life (EUL) of components assumed in the analysis. In order to streamline the cost-effectiveness analysis and calculations, measures with similar EULs were grouped together. For example, all measures related to opaque insulation requirements and the provision for buried ducts were grouped together into the "opaque insulation" set with an EUL of 60 years. Windows and lighting were individually evaluated with an EUL of 20 years and seven years respectively, and the provisions associated with ventilation were included in the "HVAC" set and evaluated with an EUL of 15 years.

Table 18. Effective Useful Life of Building Components

Component	EUL (Years)
Opaque Insulation	60
Windows	20
Lighting	7
HVAC	15

4 Results

This section summarizes the results of the energy and cost-effectiveness analysis of the 2020 NYStretch Energy Code compared to the 2016 New York City Energy Conservation Code (NYCECC) in CDZ 4A-NYC and 2020 Energy Conservation Construction Code of New York State (ECCC NYS) elsewhere.

4.1 Energy Savings at the Climate Design Zone and State Level

The results of the energy savings analysis of the proposed 2020 NYStretch code over the respective baseline code, by end-use at the climate design zone and State level are included. These results have been aggregated over the entire set of building types, foundation types and heating systems using the construction weights matrix.

4.1.1 Site Energy Savings

Tables 19–21 summarize the site energy savings for code regulated end-uses by CDZ and at the State level. The results for the CDZ 6A baseline have been averaged over the two alternative options and the results for multifamily buildings in CDZ 6A are not included because the associated construction weight was zero. In summary, the results show ~24.6% site energy savings at the State level.

Table 19. Regulated Site Energy Savings for the Prescriptive and Mandatory Provisions the 2020 NYStretch Code for Single-Family Buildings

Climate Zone 4A-NYC						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2016 NYCECC	25990.3	6066.3	5472.2	2937.8	16426.6	56893.3
2020 NYStretch	20244.0	4889.8	4966.9	2309.2	12318.2	44728.1
Savings (%)	22.1%	19.4%	9.2%	21.4%	25.0%	21.4%
Climate Zone 4A-balance						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2020 ECCC NYS	29118.5	6083.7	5093.2	3156.3	16431.5	59883.2
2020 NYStretch	21981.5	4988.1	4966.9	2412.6	12320.5	46669.6
Savings (%)	24.5%	18.0%	2.5%	23.6%	25.0%	22.1%

Table19 continued

Climate Zone 5A						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2020 ECCC NYS	43133.8	3926.1	5096.0	3232.6	18050.4	73438.9
2020 NYStretch	29343.4	3621.9	4969.6	3396.8	13527.8	54859.5
Savings (%)	32.0%	7.7%	2.5%	-5.1%	25.1%	25.3%

Climate Zone 6A						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2020 ECCC NYS	44539.3	3634.2	5083.3	2887.5	19014.7	75159.1
2020 NYStretch	29811.0	3346.4	4957.2	3135.4	14251.9	55502.0
Savings (%)	33.1%	7.9%	2.5%	-8.6%	25.0%	26.2%

Table 20. Regulated Site Energy Savings for the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code for Multifamily Buildings

Climate Zone 4A-NYC						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2016 NYCECC	7896.4	3597.9	2933.5	1492.7	12053.4	27973.9
2020 NYStretch	6171.9	3058.3	2662.1	1233.4	9039.5	22165.2
Savings (%)	21.8%	15.0%	9.3%	17.4%	25.0%	20.8%

Climate Zone 4A-balance						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2020 ECCC NYS	8631.2	3592.6	2730.0	1546.6	12054.4	28554.8
2020 NYStretch	6606.6	3055.2	2662.1	1268.1	9040.0	22632.0
Savings (%)	23.5%	15.0%	2.5%	18.0%	25.0%	20.7%

Table 20 continued

Climate Zone 5A						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2020 ECCC NYS	12643.5	2438.2	2730.0	1610.1	13026.2	32447.9
2020 NYStretch	7078.5	2540.4	2662.1	2134.9	9763.8	24179.6
Savings (%)	44.0%	-4.2%	2.5%	-32.6%	25.0%	25.5%

Table 21. Weighted Average Regulated Site Energy Savings for the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code

Climate Zone 4A-NYC						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2016 NYCECC	14639.4	4517.8	3879.6	2031.2	13683.2	38751.2
2020 NYStretch	11416.1	3740.8	3521.0	1634.4	10261.4	30573.7
Savings (%)	22.0%	17.2%	9.2%	19.5%	25.0%	21.1%
Climate Zone 4A-balance						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2020 ECCC NYS	16266.1	4521.0	3610.7	2146.5	13685.6	40229.9
2020 NYStretch	12336.3	3775.5	3521.0	1694.6	10262.6	31590.0
Savings (%)	24.2%	16.5%	2.5%	21.1%	25.0%	21.5%
Climate Zone 5A						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2020 ECCC NYS	38986.7	3723.7	4774.2	3011.9	17367.0	67863.6
2020 NYStretch	26315.1	3474.8	4655.8	3225.1	13015.9	50686.6
Savings (%)	32.5%	6.7%	2.5%	-7.1%	25.1%	25.3%

Table 21 continued

Climate Zone 6A						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
2020 ECCC NYS	44539.3	3634.2	5083.3	2887.5	19014.7	75159.1
2020 NYStretch	29811.0	3346.4	4957.2	3135.4	14251.9	55502.0
Savings (%)	33.1%	7.9%	2.5%	-8.6%	25.0%	26.2%
New York State						
	Heating (kBtu/dwelling unit)	Cooling (kBtu/dwelling unit)	Lighting (kBtu/dwelling unit)	Fan (kBtu/dwelling unit)	DHW (kBtu/dwelling unit)	Total Regulated Energy (kBtu/dwelling unit)
Baseline	32381.7	3974.2	4440.3	2700.8	16429.4	59926.4
2020 NYStretch	22265.5	3552.5	4330.2	2698.0	12315.3	45161.4
Savings (%)	31.2%	10.6%	2.5%	0.1%	25.0%	24.6%

4.1.2 Source Energy Savings

The site energy savings calculated based on the results of the energy simulation exercise are converted into source energy savings using site-source conversion factors included in Table 4.2.1.2 of the 2020 NYStretch code. Factors for fuels relevant to this analysis are summarized in Table 22.

Table 22. Site to Source Energy Conversion Ratios

Energy Type	New York Ratio
Electricity (Grid Purchase)	2.55
Natural Gas	1.05
Fuel Oil	1.01

Tables 23–25 summarize the source energy savings resulting from the prescriptive and mandatory provisions of the 2020 NYStretch code compared to the respective baseline code in each CDZ.

Table 23. Source Energy Savings for the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code for Single-family Buildings

Climate Zone	Baseline Total Source Energy (kBtu/dwelling unit)	2020 NYStretch Total Source Energy (kBtu/dwelling unit)	Source Energy Savings
4A-NYC	90636.9	72065.8	20.5%
4A-balance	94033.4	74807.6	20.4%
5A	108649.2	84773.9	22.0%
6A	110706.5	85165.4	23.1%

Table 24. Source Energy Savings for the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code for Multifamily Buildings

Climate Zone	Baseline Total Source Energy (kBtu/dwelling unit)	2020 NYStretch Total Source Energy (kBtu/dwelling unit)	Source Energy Savings
4A-NYC	50053.5	40359.2	19.4%
4A-balance	50626.1	41010.5	19.0%
5A	56132.8	44709.6	20.4%

Table 25. Weighted Average Source Energy Savings for the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code

Climate Zone	Baseline Total Source Energy (kBtu/dwelling unit)	2020 NYStretch Total Source Energy (kBtu/dwelling unit)	Source Energy Savings
4A-NYC	65177.7	52175.2	19.9%
4A-balance	66802.6	53605.6	19.8%
5A	101506.3	79324.6	21.9%
6A	110706.5	85165.4	23.1%
NY State Average	91545.1	71769.2	21.6%

4.2 Energy Cost Savings at the Climate Design Zone and State Level

The energy cost savings from the NYStretch code over the 2020 Energy Conservation Construction Code of New York State by fuel type at the CDZ and State level are included in Tables 26-28. The results for the CDZ 6A baseline have been averaged over the two alternative options and the results for multifamily buildings in CDZ 6A are not included because the associated construction weight was zero. In summary, the results show ~19.7% energy cost savings at the State level. Results by building type and climate zone can be found in Appendix B.

Table 26. Annual Energy Cost Savings of the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code for Single-family Buildings

Climate Zone 4A-NYC				
	Electricity Cost ($/dwelling unit)	Natural Gas Cost ($/dwelling unit)	Fuel Oil Cost ($/dwelling unit)	Total Energy Cost ($/dwelling unit)
2016 NYCECC	1207.5	326.6	0.0	1534.1
2020 NYStretch	980.9	251.9	0.0	1232.8
Savings (%)	18.8%	22.9%	NA	19.6%
Climate Zone 4A-balance				
	Electricity Cost ($/dwelling unit)	Natural Gas Cost ($/dwelling unit)	Fuel Oil Cost ($/dwelling unit)	Total Energy Cost ($/dwelling unit)
2020 ECCC NYS	1097.6	456.3	0.0	1553.9
2020 NYStretch	909.1	343.8	0.0	1252.8
Savings (%)	17.2%	24.7%	NA	19.4%
Climate Zone 5A				
	Electricity Cost ($/dwelling unit)	Natural Gas Cost ($/dwelling unit)	Fuel Oil Cost ($/dwelling unit)	Total Energy Cost ($/dwelling unit)
2020 ECCC NYS	1115.2	576.4	81.2	1772.8
2020 NYStretch	960.1	403.9	57.5	1421.5
Savings (%)	13.9%	29.9%	29.1%	19.8%
Climate Zone 6A				
	Electricity Cost ($/dwelling unit)	Natural Gas Cost ($/dwelling unit)	Fuel Oil Cost ($/dwelling unit)	Total Energy Cost ($/dwelling unit)
2020 ECCC NYS	1122.0	612.0	40.7	1774.7
2020 NYStretch	948.7	426.3	28.0	1403.0
Savings (%)	15.4%	30.3%	31.3%	20.9%

Table 27. Annual Energy Cost Savings of the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code for Multifamily Buildings

Climate Zone 4A-NYC				
	Electricity Cost ($/dwelling unit)	**Natural Gas Cost ($/dwelling unit)**	**Fuel Oil Cost ($/dwelling unit)**	**Total Energy Cost ($/dwelling unit)**
2016 NYCECC	810.0	117.1	31.9	958.9
2020 NYStretch	669.1	88.8	24.7	782.5
Savings (%)	17.4%	24.2%	22.6%	18.4%
Climate Zone 4A-balance				
	Electricity Cost ($/dwelling unit)	**Natural Gas Cost ($/dwelling unit)**	**Fuel Oil Cost ($/dwelling unit)**	**Total Energy Cost ($/dwelling unit)**
2020 ECCC NYS	728.9	158.2	33.3	920.4
2020 NYStretch	608.9	118.9	25.5	753.3
Savings (%)	16.5%	24.9%	23.4%	18.2%
Climate Zone 5A				
	Electricity Cost ($/dwelling unit)	**Natural Gas Cost ($/dwelling unit)**	**Fuel Oil Cost ($/dwelling unit)**	**Total Energy Cost ($/dwelling unit)**
2020 ECCC NYS	777.2	207.0	0.0	984.2
2020 NYStretch	680.7	131.8	0.0	812.5
Savings (%)	12.4%	36.3%	NA	17.4%

Table 28. Weighted Average Annual Energy Cost Savings of the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code

Climate Zone 4A-NYC				
	Electricity Cost ($/dwelling unit)	**Natural Gas Cost ($/dwelling unit)**	**Fuel Oil Cost ($/dwelling unit)**	**Total Energy Cost ($/dwelling unit)**
2016 NYCECC	958.1	195.2	20.0	1173.3
2020 NYStretch	785.3	149.6	15.5	950.3
Savings (%)	18.0%	23.4%	22.6%	19.0%

Table 28 continued

Climate Zone 4A-balance				
	Electricity Cost ($/dwelling unit)	Natural Gas Cost ($/dwelling unit)	Fuel Oil Cost ($/dwelling unit)	Total Energy Cost ($/dwelling unit)
2020 ECCC NYS	866.3	269.3	20.9	1156.5
2020 NYStretch	720.7	202.7	16.0	939.4
Savings (%)	16.8%	24.7%	23.4%	18.8%
Climate Zone 5A				
	Electricity Cost ($/dwelling unit)	Natural Gas Cost ($/dwelling unit)	Fuel Oil Cost ($/dwelling unit)	Total Energy Cost ($/dwelling unit)
2020 ECCC NYS	1069.2	526.2	70.1	1665.5
2020 NYStretch	922.1	366.9	49.7	1338.7
Savings (%)	13.8%	30.3%	29.1%	19.6%
Climate Zone 6A				
	Electricity Cost ($/dwelling unit)	Natural Gas Cost ($/dwelling unit)	Fuel Oil Cost ($/dwelling unit)	Total Energy Cost ($/dwelling unit)
2020 ECCC NYS	1122.0	612.0	40.7	1774.7
2020 NYStretch	948.7	426.3	28.0	1403.0
Savings (%)	15.4%	30.3%	31.3%	20.9%
New York State				
	Electricity Cost ($/dwelling unit)	Natural Gas Cost ($/dwelling unit)	Fuel Oil Cost ($/dwelling unit)	Total Energy Cost ($/dwelling unit)
2020 ECCC NYS	1010.8	455.6	48.5	1514.9
2020 NYStretch	859.6	322.6	34.6	1216.7
Savings (%)	15.0%	29.2%	28.6%	19.7%

4.3 Cost-Effectiveness

The results of the cost-effectiveness analysis in terms of simple payback, a 10-year net present value (NPV) of energy cost savings including replacement costs and residual value of efficiency measures, and a 30-yr Life Cycle Cost (LCC) savings are described below.

4.3.1 Simple Payback

Table 29 shows the weighted average annual energy cost savings, the associated total incremental costs, and the resulting simple payback for the 2020 NYStretch code compared to the 2016 NYCECC in CDZ 4A-NYC and 2020 ECCC NYS elsewhere, for the single- and multifamily prototypes.

Table 29. Weighted Average Simple Payback

Climate Design Zone	Single-family			Multifamily		
	Total Annual Energy Cost Savings ($/dwelling unit)	Total Incremental Costs ($/dwelling unit)	Simple Payback (Years)	Total Annual Energy Cost Savings ($/dwelling unit)	Total Incremental Costs ($/dwelling unit)	Simple Payback (Years)
4A-NYC	$301	$1,910	6.3	$176	$1,625	9.2
4A-balance	$301	$2,463	8.2	$167	$1,488	8.9
5A	$351	$2,202	6.3	$172	$1,751	10.2
6A	$372	$1,506	4.1	NA	NA	NA
NY State	$348	$2,057	5.9	$171	$1,591	9.3

4.3.2 10-Year Present Value of Energy Cost Savings

Table 30 shows the 10-year net present value of energy cost savings for the NYStretch code compared to the 2016 NYCECC in CDZ 4A-NYC and 2020 ECCC NYS elsewhere, for the single- and multifamily prototypes. The results include applicable replacement costs for measures with EULs less than the analysis term of 30 years and residual values for measures with EULs longer than the analysis term. The results have been aggregated over the entire set of building types, foundation types, and heating systems using the construction weights matrix. In all cases, the energy cost savings comfortably exceed the first-year incremental costs.

Table 30. Weighted Average Net Present Value (NPV) of Energy Cost Savings over 10 Years

	Single-family		Multifamily	
Climate Design Zone	Total First Year Incremental Costs ($/dwelling unit)	10-Year NPV of Cost Savings Including Replacement Costs and Residual Values ($/dwelling unit)	Total First Year Incremental Costs ($/dwelling unit)	10-Year NPV of Cost Savings Including Replacement Costs and Residual Values ($/dwelling unit)
4A-NYC	$1,910	$2,866	$1,625	$1,784
4A-balance	$2,463	$3,509	$1,488	$1,930
5A	$2,202	$3,590	$1,751	$1,825
6A	$1,506	$3,473	NA	NA
NY State	$2,057	$3,524	$1,591	$1,862

4.3.3 30-year Life Cycle Cost (LCC) Savings

Table 31 summarizes the LCC savings of the NYStretch code over the 2020 ECCC NYS at the CDZ and State level. The results have been aggregated over the entire set of building types, foundation types and heating systems using the construction weights matrix. The residential provisions of NYStretch code are found to be cost-effective for the homeowner and yield positive savings over the life of the home in all cases, except for multifamily buildings in CDZ 5A. However, the overall State average LCC savings are positive.

Table 31. Weighted Average 30-Year LCC Savings

Climate Design Zone	Single-family 30 Year LCC Savings ($/dwelling unit)	Multifamily 30 Year LCC Savings ($/dwelling unit)
4A-NYC	$1,804	$94
4A-balance	$1,763	$649
5A	$2,235	$(442)
6A	$2,724	NA
NY State	$2,275	$226

Table 32 summarizes the average energy cost savings, incremental construction costs, and cost-effectiveness results for the prescriptive and mandatory provisions of NYStretch, weighted over the single- and multifamily building construction weights for the State.

Table 32. Weighted Results for the Prescriptive and Mandatory Provisions of the 2020 NYStretch Code at the State Level

	New York State Average
Annual Energy Cost Savings ($/dwelling unit)	$278
Incremental Costs ($/dwelling unit)	$1,795
Simple Payback (Years)	6.4
10-Year NPV of Cost Savings Including Replacement Costs and Residual Values ($/dwelling unit)	$2,854
30-Yr LCC Savings ($/dwelling unit)	$1,741

4.3.3.1 Consideration of the Avoided Cost of Carbon Emissions

The analysis and results described thus far do not include the impact of carbon emissions in the calculations. However, as New York State moves towards aggressive carbon goals for buildings, accounting for the impact of carbon emissions of different fuels becomes imperative. To understand the magnitude of this impact, an exploratory exercise was conducted by blending in a "avoided cost of carbon emissions" in the fuel prices and recalculating the 30-year LCC savings. These factors for electricity, natural gas, and fuel oil were obtained from NYSERDA's Regional Greenhouse Gas Initiative (RGGI) analysis.

Consistent with the Benefit Cost Analysis Framework adopted by the NYS Public Service Commission, the analysis that developed the avoided cost of carbon emissions uses the U.S. Environmental Protection Agency's estimate of the social cost of carbon (SCC) at the 3% discount rate. For electricity, the net social cost of carbon emissions on a per-MWh basis ($/MWh) is net of the projected RGGI compliance costs included in the New York State Independent System Operator (NYISO) CARIS2 2018 Base Case model, and is derived using the NYS Department of Public Service (DPS) estimate of the marginal emissions factor for electricity (lb. CO_2/MWh) calculated using the CARIS2 2018 Base Case model; a description of the DPS methodology is provided in Attachment B of the Order Establishing the Benefit Cost Analysis Framework (issued January 21, 2016 in NYS PSC Case 14-M-0101, Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision). For natural gas and oil, the social cost of carbon emissions on a per-MMBtu basis ($/MMBtu) is derived using the marginal emissions factors for buildings (lb. CO2e/MMBtu) published in the Final Performance Metrics Report of the NYS Clean Energy Advisory Council – Metrics, Tracking and Performance Assessment Working Group (filed July 19, 2017 in NYS PSC Matter 16-00561).

The fuel prices used in the analysis, before and after including the cost of carbon, are summarized in Table 33 and the revised LCC savings results are included in Table 34.

Table 33. Fuel Prices used in the Analysis, With and Without the Cost of Carbon

Climate Zone	Without the Cost of Carbon			With the Cost of Carbon		
	Electricity ($/kWh)	Natural Gas ($/therm)	Fuel Oil ($/therm)	Electricity ($/kWh)	Natural Gas ($/therm)	Fuel Oil ($/therm)
4A NYC	0.200	0.900	2.774	0.223	1.248	3.258
4A except NYC	0.180	1.167	2.774	0.203	1.515	3.258
5A	0.180	1.167	2.774	0.203	1.515	3.258
6A	0.180	1.167	2.774	0.203	1.515	3.258

Table 34. Weighted Average 30-Year LCC Savings When the Avoided Cost of Carbon is Included

Climate Design Zone	Single-family 30 Year LCC Savings ($/dwelling unit)	Multifamily 30 Year LCC Savings ($/dwelling unit)
4A-NYC	$2,804	$610
4A-balance	$2,810	$1,162
5A	$3,617	$191
6A	$5,088	NA
NY State	$3,838	$769

It is observed that the inclusion of carbon cost in the fuel price increases LCC savings across the board, including multifamily buildings in CDZ 5A. This indicates the added benefit of including such costs in cost-effectiveness analyses for buildings, especially as decarbonization goals replace energy savings goals and since the buildings are likely to exist as they are constructed for the next 70 to 100 years.

5 Discussion

The 2020 NYStretch code contains many elements that encourage better building design such as better hot water piping layouts, better duct placement etc., which can be easy to implement in new construction if planned well at the design stage. This analysis typically uses conservative savings and incremental cost estimates for many of these measures because of the range of designs and performances that can be achieved in the field. Consequently, the energy savings and cost-effectiveness results reported fall on the lower end of potential savings that can be achieved through the 2020 NYStretch code. The actual energy savings that can be achieved in the field are likely to be higher leading to better cost-effectiveness outcomes.

Additionally, this analysis assumes no fuel switching between the baseline and the 2020 NYStretch cases. The energy cost savings and correspondingly lower LCC savings for models with gas furnaces because it is an inexpensive way for water and space heating. It is plausible that newer homes, especially those built under a stretch code, would be more likely to use electric heating to leverage on-site or off-site generation resulting in better cost-effectiveness outcomes across the board. Furthermore, as demonstrated in section 4.3.3.1, when the avoided cost of carbon is included in the analysis, the LCC savings improve substantially. This effect is mainly driven by the models with gas heating. As the State works toward decarbonization goals for buildings, the consideration of carbon in conducting energy and cost-effectiveness analyses for buildings would need to be central in policy development.

6 Conclusion

The prescriptive and mandatory elements of the residential provisions of the 2020 NYStretch Energy Code are expected to yield positive energy savings over the baseline 2020 Energy Conservation Construction Code of New York State (2020 ECCC NYS) and the 2016 New York City Energy Conservation Construction Code (2016 NYCECC). The savings range from 21 to 26% at the CDZ level in terms of site energy savings and from 18 to 21% in terms of energy costs. The provisions are also found to be cost-effective when evaluated using a 10-year net present value of energy cost savings as well as a full 30-year LCC savings calculations from the perspective of the homeowner for single-family buildings and most multifamily buildings.

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Appendix A. Cost-Effectiveness Analysis of Section R407

A.1 Background

This section summarizes the results of an additional analysis of a Section R407 (Additional Energy Efficiency Credits) contained in the draft NYStretch Energy Code version dated January 2019.[21] Section R407 includes a table of additional efficiency credits for various envelope, equipment and generation options, with different points for a single-family versus multifamily dwelling unit. Table A-1 summarizes the additional efficiency credits table along with the available credits. When complying with this path, detached one- and two-family dwellings, semi-detached two-family dwellings and townhouses are required to obtain 2.0 credits from column A and all other residential buildings are required to obtain 3.0 credits from column B.

Table A-1. Summary of the Options and Credits from the R407 Additional Energy Efficiency Credits Table

Category	Option	Measure	Column A	Column B
High-efficiency Envelope Options	1.1	U ≤ 0.042 Exterior Above Grade Walls	1	0.5
	1.2	U ≤0.020 Ceilings + U≤0.25 Windows	0.5	0.5
	1.3	15% Better UA	1.5	1
	1.4	U≤ 0.24 Windows	0.5	0.5
	1.5	2 ACH50 + High-efficiency Fans	0.5	0.5
	1.6	2 ACH50 + High-efficiency Fans + Heat Recovery Ventilation (HRV)	1	1
High-efficiency Equipment and Power Generation Options	2.1	High-efficiency Furnace or Heat Pump	1.5	1
	2.2	Ducted/Ductless Minisplit Heat Pump	0.5	1
	2.3	High-efficiency Water Heater	0.5	1.5
	2.4	Higher-efficiency Water Heater	1	2
	2.5	Minimum 1 kW of photovoltaic power or wind power.	1.0/kW/housing unit (max 2 credits)	1.0/kW/housing unit (max 2 credits)
	2.6	Solar Domestic Hot Water	1.0/dwelling unit	1.0/dwelling unit

Thus, based on the main analysis methodology and building types under consideration, the single-family prototype would need to obtain 2.0 credits from column A and each multifamily unit would need to obtain 3.0 credits from column B. The additional analysis included the energy savings and cost-effectiveness evaluation of two least incremental cost package options that satisfied the requirements of the additional efficiency credits path.

Based on the results of this analysis and a concern that the section as written might face federal preemption, NYSERDA decided to remove the Additional Energy Efficiency Credits section from the final version of NYStretch. This appendix memorializes the approach, assumptions, and results of the cost effectiveness analysis.

A.2 Overview of the Analysis

The scope of the additional analysis included the evaluation of two least incremental cost options that would satisfy the credit requirements set forth in section R407. Because the additional efficiency credits associated with the same measures are different for single-family versus multifamily dwelling units, this analysis optimized the least cost packages separately for the single- and multifamily prototypes. The analysis, however, did not optimize packages at the CDZ level.[22] The packages were evaluated as whole building packages, including the prescriptive and mandatory provisions of the 2020 NYStretch code.

The costs associated with each measure from Table A-2 were calculated and mapped against the credit points offered by each to create optimal combinations to yield the required number of 2.0 credits for the single-family prototype and 3.0 credits for the multifamily prototype. Figures A-1 and A-2 show the spread of incremental costs for various measures related to the associated credits offered for the single-family and multifamily prototypes.

Figure A-1. Incremental Costs versus Additional Efficiency Credit Offered for Each Option for a Single-Family Building

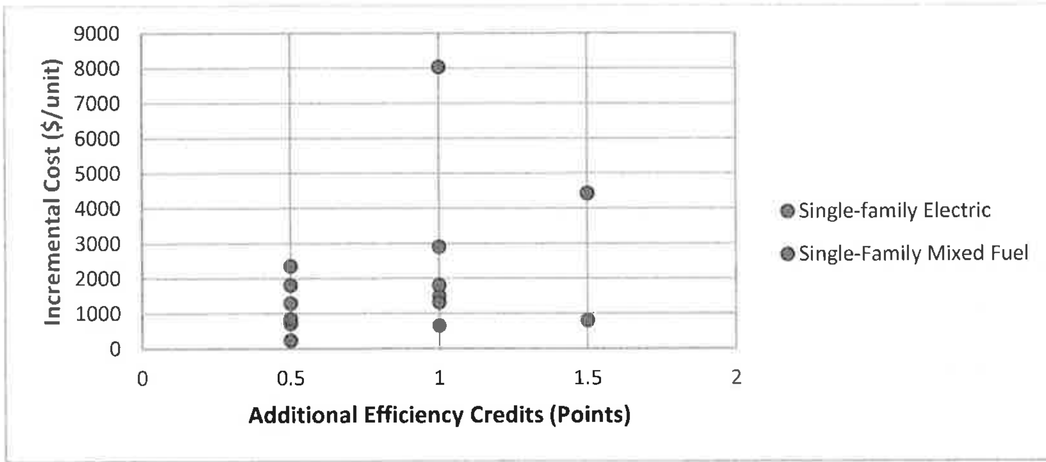
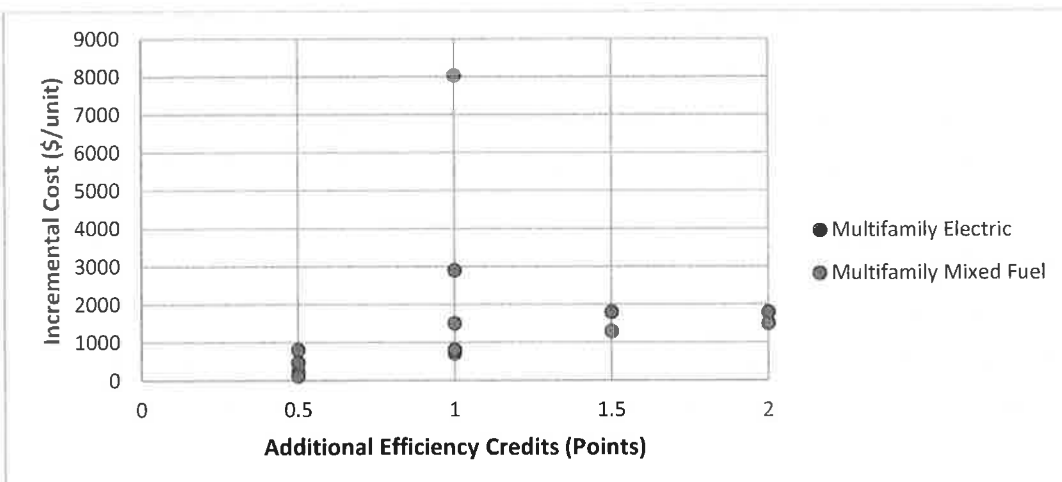


Figure A-2. Incremental Costs versus Additional Efficiency Credit Offered for Each Option for Each Multifamily Unit



For the single-family prototype, high-efficiency space conditioning equipment (option 2.1 in Table A-1) was found to be the least expensive way to obtain 1.5 points out of the required total of 2.0. On the multifamily side, higher-efficiency water heating equipment (option 2.4 in Table A-1) was found to be the least expensive way to obtain 2.0 out of the required total of 3.0 points. Thus, high-efficiency space conditioning equipment was part of both least expensive package options for single-family and higher-efficiency water heating equipment was part of both least expensive package options for multifamily.

A.3 Single-Family Prototype Packages

As described earlier, option 2.1 from Table A-1 was the least expensive way to capture 1.5 points out of the required 2.0 points for the single-family prototype. The high-efficiency space conditioning measure requires an air source heat pump with a heating seasonal performance factor (HSPF) of 9.0, gas or oil-fired furnaces or boilers with an annual fuel utilization efficiency (AFUE) of 94% or a ground-source heat pump (GSHP) with a co-efficient of performance (COP) of 3.3. Because the cost of implementing GSHPs varies widely depending on the site and the set of models used in the analysis does not include a model with a GSHP, this analysis was conducted by assuming higher-efficiency air source heat pumps in the single-family prototype models with heat pumps and higher-efficiency gas and oil-fired furnaces in the single-family prototype models with gas and oil-fired furnaces respectively for the 2020 NYStretch cases. The baseline models in each case are maintained at the standard federal minimum efficiencies specified in Table 5 in the body of this report.

Additional measures that would yield 0.5 points were then required to create the two least first-cost option packages to yield a total of 2.0 credits for the additional energy efficiency credits path. Based on an evaluation of all options available in the additional efficiency credits table, these least expensive options were determined to be option 1.4 (U-0.24 windows) and option 1.5 (tighter envelope option with high-efficiency fans). The elements of the least incremental cost packages assumed in this analysis for the single-family prototype are summarized in Table A-2.

Table A-2. Additional Efficiency Credits Packages Selected for the Single-Family Prototype

No.	Package Description	Points
1	High-eff Furnace/HP + U-0.24 Windows	2.0
2	High-eff Furnace/HP + 2 ACH50 + High-efficiency Fans	2.0

It is noted that the incremental costs associated with some of the options from the additional efficiency credits table are less in some CDZs compared to the others because the baseline code requirements vary by CDZ while the additional credit options do not. For example, the option of U-0.042 walls can be met with R-20+6 walls, which when the baseline wall configuration is R-20+5, such as in CDZ 4A-NYC or CDZ 6A, would require only an additional 0.5" of insulating sheathing. This would make this measure inexpensive for capturing 1.0 point. However, because the packages were not optimized at the CDZ level, the analysis uses the same packages in all CDZs for simplicity.

A.3.1. Energy Modeling

In order to conduct a whole building evaluation, the measures for the two least expensive packages were implemented by modifying the energy models that already include the prescriptive and mandatory provisions of the 2020 NYStretch code.

The high-efficiency gas and oil-fired furnaces were modeled by directly changing the thermal efficiency field in the *EnergyPlus* heating coil objects to 0.90. In the case of heat pumps, the required heating seasonal performance factor HSPF of 9.0 is more typically found in two-stage equipment. Additionally, while option 2.1 does not require an improved seasonal energy efficiency ratio (SEER), typical heat pumps with higher HSPFs also include better SEERs. This analysis assumes an improved SEER of 18 in addition to the HSPF of 9.0 for the high-efficiency heat pumps based on Cutler et al. (2013). The *EnergyPlus* objects associated with heat pumps require a heating and cooling coil COP. This analysis assumes COPs recommended by Cutler et al. (2013) for modeling residential heat pumps at the required SEER and HSPF levels. The efficiencies and COPs assumed in this analysis are summarized in Table A-3.

Table A-3. Heat Pump COPs Used in Analysis

	HSPF	SEER	EER	COP_cooling	COP_heating
Speed 1	9.3	18	14.5	4.25	4
Speed 2			13.3	3.90	3.5

Improved air leakage is modeled by adjusting the effective leakage area (ELA) input to the models based on the methodology for converting results of a blower door test in air changes at 50 Pa (ACH50) to ELA described in Mendon et al. (2013). Table A-4 summarizes the ELA values used in this analysis.

Table A-4. Effective Leakage Areas (ELAs) Used in Analysis for the Single-family Prototype

	ELA at 3 ACH50 (cm^2)	ELA at 2 ACH50 (cm^2)
Living_unit	360.92	240.62

A.3.2. Incremental Costs

The incremental cost associated with high-efficiency space conditioning equipment is calculated over the current federal standards for equipment efficiency as summarized in Table 5. The cost includes equipment and installation as well as additional venting costs for condensing furnaces where applicable.

The National Residential Efficiency Measures Database (NREM) developed by the National Renewable Energy Laboratory (NREL) reports an additional cost of $700 for a installing a gas furnace with an AFUE of 95% compared to a standard furnace with AFUE of 80% and an incremental cost of $800 for installing a heat pump with HSPF 9.3 compared to a standard heat pump with HSPF 7.7. Navigant (2011) reports an incremental cost of $1,438 for 94% AFUE furnaces, replaced on burnout, compared to 80% AFUE furnaces including a labor cost of $308. The installation costs for condensing furnaces are typically higher in retrofit applications due to a higher cost of venting so this cost is likely on the higher end of the spectrum. DOE (2016) reports an average incremental installed cost of $630 in 2015 dollars for an AFUE 95% furnace compared to an AFUE 80% furnace, which when adjusted for inflation works out to $680 in 2019 dollars. This analysis conservatively assumes an incremental cost of $1,000/unit associated with this measure.

The incremental cost associated with the U-0.24 windows is calculated by applying the same regression-based methodology described in section 3.4.2.1 to calculate the additional incremental cost associated with U-0.24 windows compared to the U-0.27 windows. The additional cost of U-0.24 windows over U-0.27 windows is thus assumed to be $0.62/ft^2 (ENERGYSTAR 2016). This works out to an additional incremental cost of $235 for the single-family prototype after adjusting for inflation.

The incremental cost associated with a tighter envelope that meets the 2 ACH50 requirement compared to the 3 ACH50 required in the baseline codes is estimated at $0.31/ft^2 of conditioned floor area by NREM. Additionally, ENERGY STAR (2016) estimates a cost of $0.11/ft^2 for reducing infiltration from 7 ACH50 to 6 ACH50, $0.22/ft^2 for reducing infiltration from 7 ACH50 to 5 ACH50 and $0.31/ft^2 for reducing infiltration from 7 ACH50 to 4 ACH50. This analysis assumes an incremental cost of $0.31/ft^2 for this measure which works out to $744 for the single-family prototype building.

The additional requirement for a high-efficiency ventilation fan can be met either with a fan with an efficiency better than 0.35 W/CFM or alternatively with furnaces with multispeed fans that are controlled to operate at the lowest speed required to provide adequate ventilation in ventilation-only mode. Thus, the incremental cost associated with this measure is assumed to be $100/unit.

These additional costs were combined with the costs associated with the prescriptive and mandatory provisions described in Chapter 3 to yield whole building costs for use in the analysis. Table A-5 summarizes the total incremental cost for each of the two additional efficiency credits packages for the single-family prototype, including the prescriptive and mandatory provisions of the 2020 NYStretch code. All costs are further adjusted for location factors as applicable.

Table A-5. Total Incremental Costs for the Single-family Prototype

CDZ	Single-family Package 1 (High-eff Furnace/HP + U-0.24 Windows)				Single-family Package 2 (High-eff Furnace/HP + 2 ACH50 + High-efficiency Fans)			
	Slab	Crawlspace	Heated Basement	Unheated Basement	Slab	Crawlspace	Heated Basement	Unheated Basement
4A-NYC	$3,745	$3,745	$3,225	$3,745	$4,582	$4,582	$4,062	$4,582
4A-balance	$4,090	$3,992	$3,899	$3,992	$4,842	$4,743	$4,651	$4,743
5A	$4,086	$3,493	$3,092	$3,493	$4,731	$4,138	$3,737	$4,138
6A	$2,835	$2,835	$2,457	$2,835	$3,442	$3,442	$3,064	$3,442

A.3.3. Effective Useful Life

This analysis assumes an effective useful life (EUL) of 20 years for the high-efficiency furnaces and heat pumps based on DOE (2016). For windows, the EUL is assumed to be 20 years, as it is in the main analysis. The EUL of improved envelope tightness is assumed to be 60 years and the EUL of high-efficiency fans is assumed to be 20 years.

A.4 Multifamily Prototype Packages

For multifamily buildings, the additional efficiency credits table includes two options, option 2.3 and option 2.4, for high-efficiency water heating equipment with varying levels of required minimum efficiencies. Option 2.4 with the higher required efficiencies of the two, natural gas or propane water heating with a minimum a uniform energy factor (UEF) of 0.97, or Heat Pump Water Heaters (HPWH) with a minimum UEF of 2.6, was found to be the least expensive method to capture 2.0 points out of the required 3.0 points. Additional measures that would yield 1.0 point were then required to create the two least first-cost option packages that would yield 3.0 credits for the additional efficiency credits path. Based on an evaluation of all options available in the additional efficiency credits table, these least expensive options were determined to be option 1.6 (tighter envelope option with heat recovery ventilation (HRV) and high-efficiency fans) and option 2.1 (high-efficiency space conditioning equipment). The elements of the least incremental cost packages assumed in this analysis for the single-family prototype are summarized in Table A-6.

The 2020 NYStretch code already requires HRVs in CDZ 5A and 6A. However, the code does not specify a required level of efficiency in the mandatory provisions. The basis for the assumption of a sensible recovery efficiency (SRE) of 0.70 used in lieu of a requirement in the prescriptive and mandatory provisions, is described in section 3.3.5.4. Thus, the additional efficiency credit associated with option 1.6 is then only the relative improvement of the SRE to 0.80 in CDZ 5A and 6A.

Table A-6 summarizes the elements of the least incremental cost packages assumed in this analysis for each multifamily unit.

Table A-6. Additional Efficiency Credits Packages Selected for the Multifamily Prototype

No.	Package Description	Points
1	High-eff Furnace/HP + Higher-eff Water Heater	3.0
2	Higher-eff Water Heater + 0.8 SRE HRVs + 2 ACH50 and High-eff Fans	3.0

A.4.1. Energy Modeling

The high-efficiency gas and oil-fired furnaces are modeled using the same procedure as that discussed for the single-family prototype. A similar procedure is used for modeling a tighter envelope for the multifamily prototype as that described for the single-family prototype above. However, for the DOE multifamily prototype used in this analysis, the ELA is proportionally distributed between the wall, ceiling, and floor areas as discussed by Mendon et al. (2013). Thus, the reduction in ELA from option 1.6 is also applied proportionally to the wall, ceiling, and floor areas as summarized in Table A-7.

Table A-7. Effective Leakage Areas (ELAs) Used in Analysis for the Multifamily Prototype

	ELA at 3 ACH50 (cm2)	ELA at 2 ACH50 (cm2)
MF_corner-units-middle-floor	47.01	31.33
MF_middle-units-middle-floor	34.19	22.79
MF_corner-units-other	107.35	71.55
MF_middle-units-other	94.53	63.00

Option 2.4 for high-efficiency water heating requires a natural gas or propane water heater with a UEF of 0.97 or a HPWH with a UEF of 2.6. Consistent with the DOE prototype model assumptions, the multifamily prototypes with natural gas or oil heating are assumed to use natural gas-fired water heaters while the models with heat pumps for space conditioning are assumed to use electric water

heaters in this analysis. In order to model the additional efficiency credit associated with this option, the gas water heaters are assumed to switch to tankless water heaters and the electric water heaters are assumed to switch to HPWHs in the 2020 NYStretch cases.

The *EnergyPlus* model for water heaters uses a burner efficiency and a shell loss factor (UA) to model the performance of the water heater (Mendon et al. 2013). Because this analysis assumes a tankless water heater to meet the UEF requirement for the gas water heater in option 2.4, the shell losses are set to zero in the 2020 NYStretch models. The HPWHs are modeled using the *EnergyPlus* WaterHeater:HeatPump model. The efficiency of HPWH varies depending on its mode of operation. For example, when the HPWH operates in a "pure" heat pump model, the efficiency is the highest compared to when it switches between the pure and "hybrid" supplemental resistance mode. As expected, the efficiency is the lowest when the HPWH operates in resistance mode only. Thus, HPWH manufacturers report UEFs for each mode separately. This analysis assumes that the HPWH operates in pure heat pump mode and the COP is assumed to be 3.1 based on analysis conducted by NRDC.[23]

A.4.2. Incremental Costs

The total incremental costs associated with high-efficiency space conditioning equipment are conservatively assumed to be the same as those described above for the single-family prototype. The cost for a tighter envelope is assumed to be $0.31/ft^2$ based on the reasoning discussed for the single-family prototype and works out to $372 for each multifamily unit.

The average cost of HRVs with 0.8 SRE is difficult to pin-point because of the fewer products that exist in that range, as illustrated in Figure 1. Various sources note a cost from $850 per unit[24] to $1100-$1300 per unit.[25] This analysis assumes average equipment cost of $1,200 for an HRV with a 0.8 SRE. Assuming the labor and installation remain the same between an HRV with a 0.70 SRE, the total installed cost for this option is assumed to be $1,800.

NREM reports a range of $1,800–$3,500 for a gas tankless water heater compared to a storage type water heater. However, the cost is reported only for a retrofit application and the estimate includes cost of removing older equipment. In this case, the lower end of the range is more suitable for new construction. The 2015 California Codes and Standards Enhancement Initiative (CASE) report on the cost-effectiveness of gas instantaneous water heaters assumes an average incremental cost of $725[26] compared to a standard storage water heater. Navigant (2018) reports a total installed cost of $5,215 for a tankless water heater with a UEF of 0.83-0.96 and a total installed cost of $2,013 for a standard storage type water heater with a 40-gallon tank, resulting in an incremental cost of $3,200 associated with this option.[27] A 2018 study conducted by the Energy Information Administration (EIA) reports a total installed cost of $2,550 for a HPWH with an UEF 3.28 compared to a total installed cost of $1,100 for a standard electric resistance storage water heater leading to an incremental cost of $1450 for this measure.[28] The Northeast Energy Efficiency Partnership (NEEP) (2016) reports an incremental cost of $1,053–$1,144 for HPWH with EF_{nc} higher than or equal to 2.6, compared to a baseline storage water heater.[29] This analysis assumes an average incremental cost of $1,200 associated with this option for both tankless gas and HPWHs compared to standard gas and electric storage water heaters respectively. Each unit in the multifamily prototype building is assumed to have an individual water heater.

Additionally, the analysis accounted for all prescriptive and mandatory provisions of the 2020 NYStretch code. Table A-8 summarizes the total incremental cost for each of the two additional efficiency credits packages for each unit in the multifamily prototype. Like the main analysis, this analysis calculated whole package incremental construction costs for the packages compared to the baseline codes and the costs were further adjusted for location factors as applicable.

Table A-8. Total Incremental Costs for Each Unit in the Multifamily Prototype

CDZ	Multifamily Package 1 (Higher-eff Water Heaters +High-eff Furnace/HP)				Multifamily Package 2 (Higher-eff Water Heaters + 2 ACH50 + 0.8 SRE HRVs)			
	Slab	Crawlspace	Heated Basement	Unheated Basement	Slab	Crawlspace	Heated Basement	Unheated Basement
4A-NYC	$4,786	$4,786	$4,266	$4,786	$5,984	$5,984	$5,464	$5,984
4A-balance	$4,352	$4,245	$4,006	$4,245	$5,428	$5,321	$5,082	$5,321
5A	$4,393	$4,132	$3,731	$4,132	$4,575	$4,314	$3,913	$4,314
6A	$3,704	$3,704	$3,326	$3,704	$3,876	$3,876	$3,498	$3,876

A.4.3. Effective Useful Life

This analysis assumes an EUL of 15 years for HRVs like the main analysis. An EUL of 20 years for the high-efficiency furnaces and heat pumps is assumed based on DOE (2016), the EUL of improved envelope tightness is assumed to be 60 years based on Mendon et al. (2013) and the EUL of water heaters is assumed to be 20 years (DOE 2010).

A.5 Results

The energy savings results in terms of site and source energy savings associated with the two least expensive additional efficiency credits packages for the single-family and multifamily prototypes are summarized in Tables A-9 and A-10 respectively. The fuel prices and site-to-source conversion ratios are maintained the same as the main analysis. The additional efficiency options are observed to yield additional 10-15% savings beyond the prescriptive and mandatory provisions of the 2020 NYStretch code.

Table A-9. Site Energy, Source Energy and Energy Cost Savings for the Single-family Prototype

Climate Zone 4A-NYC			
	Total Regulated Site Energy (kBtu/dwelling unit)	Total Regulated Source Energy (kBtu/dwelling unit)	Total Energy Costs ($/dwelling unit)
2016 NYCECCC	56514.2	89670.4	1511.9
2020 NYStretch Package 1	39763.7	65736.1	1151.2
2020 NYStretch Package 2	39989.9	65920.8	1151.5
Savings Package 1(%)	29.6%	26.7%	23.9%
Savings Package 2(%)	29.2%	26.5%	23.8%
Climate Zone 4A-balance			
	Total Regulated Site Energy (kBtu/dwelling unit)	Total Regulated Source Energy (kBtu/dwelling unit)	Total Energy Costs ($/dwelling unit)
2020 ECCC NYS	59883.2	94033.4	1553.9
2020 NYStretch Package 1	41360.5	68060.0	1158.7
2020 NYStretch Package 2	38891.9	64157.7	1093.9
Savings Package 1(%)	30.9%	27.6%	25.4%
Savings Package 2(%)	35.1%	31.8%	29.6%
Climate Zone 5A			
	Total Regulated Site Energy (kBtu/dwelling unit)	Total Regulated Source Energy (kBtu/dwelling unit)	Total Energy Costs ($/dwelling unit)
2020 ECCC NYS	73155.7	107810.3	1755.9
2020 NYStretch Package 1	49147.6	78069.8	1331.0
2020 NYStretch Package 2	45966.6	73936.1	1269.5
Savings Package 1(%)	32.8%	27.6%	24.2%
Savings Package 2(%)	37.2%	31.4%	27.7%

Table A-9 continued

Climate Zone 6A			
	Total Regulated Site Energy (kBtu/dwelling unit)	Total Regulated Source Energy (kBtu/dwelling unit)	Total Energy Costs ($/dwelling unit)
2020 ECCC NYS	75198.4	110746.2	1775.8
2020 NYStretch Package 1	49690.2	78364.1	1314.2
2020 NYStretch Package 2	50090.1	78796.4	1319.4
Savings Package 1(%)	33.9%	29.2%	26.0%
Savings Package 2(%)	33.4%	28.8%	25.7%
New York State			
	Total Regulated Site Energy (kBtu/dwelling unit)	Total Regulated Source Energy (kBtu/dwelling unit)	Total Energy Costs ($/dwelling unit)
Baseline	68021.3	101901.3	1663.3
2020 NYStretch Package 1	45411.7	72759.9	1238.8
2020 NYStretch Package 2	43601.5	70374.0	1203.0
Savings Package 1(%)	33.2%	28.6%	25.5%
Savings Package 2(%)	35.9%	30.9%	27.7%

Table A-10. Site Energy, Source Energy and Energy Cost Savings for the Multifamily Prototype

Climate Zone 4A-NYC			
	Total Regulated Site Energy (kBtu/dwelling unit)	Total Regulated Source Energy (kBtu/dwelling unit)	Total Energy Costs ($/dwelling unit)
2016 NYCECCC	27770.4	49534.6	947.0
2020 NYStretch Package 1	16834.5	31138.4	610.0
2020 NYStretch Package 2	16846.2	31080.4	607.8
Savings Package 1(%)	39.4%	37.1%	35.6%
Savings Package 2(%)	39.3%	37.3%	35.8%
Climate Zone 4A-balance			
	Total Regulated Site Energy (kBtu/dwelling unit)	Total Regulated Source Energy (kBtu/dwelling unit)	Total Energy Costs ($/dwelling unit)
2020 ECCC NYS	28554.6	50625.9	920.4
2020 NYStretch Package 1	17243.8	31725.9	586.8
2020 NYStretch Package 2	15460.2	30367.5	577.0
Savings Package 1(%)	39.6%	37.3%	36.2%
Savings Package 2(%)	45.9%	40.0%	37.3%

Table A-10 continued

Climate Zone 5A			
	Total Regulated Site Energy (kBtu/dwelling unit)	Total Regulated Source Energy (kBtu/dwelling unit)	Total Energy Costs ($/dwelling unit)
2020 ECCC NYS	32447.9	56132.8	984.2
2020 NYStretch Package 1	17994.0	32993.0	597.0
2020 NYStretch Package 2	18261.7	34423.4	631.6
Savings Package 1(%)	44.5%	41.2%	39.3%
Savings Package 2(%)	43.7%	38.7%	35.8%
New York State			
	Total Regulated Site Energy (kBtu/dwelling unit)	Total Regulated Source Energy (kBtu/dwelling unit)	Total Energy Costs ($/dwelling unit)
Baseline	29266.1	51637.4	943.4
2020 NYStretch Package 1	17306.4	31861.6	596.0
2020 NYStretch Package 2	16534.8	31550.1	599.0
Savings Package 1(%)	40.9%	38.3%	36.8%
Savings Package 2(%)	43.5%	38.9%	36.5%

Tables A-11 and A-12 summarize the savings in terms of energy costs and the simple payback for the two prototypes.

Table A-11. Energy Cost Savings and Simple Payback for the Single-family Prototype

Climate Design Zone	Single-family Package 1 (High-eff Furnace/HP + U-0.24 Windows)			Single-family Package 2 (High-eff Furnace/HP + 2 ACH50 + High-efficiency Fans)		
	Total Annual Energy Cost Savings ($/dwelling unit)	Total Incremental Costs ($/dwelling unit)	Simple Payback (Years)	Total Annual Energy Cost Savings ($/dwelling unit)	Total Incremental Costs ($/dwelling unit)	Simple Payback (Years)
4A-NYC	$361	$3,607	10.0	$360	$4,444	12.3
4A-balance	$395	$3,987	10.1	$460	$4,739	10.3
5A	$425	$3,510	8.3	$486	$4,155	8.5
6A	$462	$2,739	5.9	$456	$3,346	7.3
NY State	$428	$3,389	7.9	$471	$4,047	8.6

Table A-12. Energy Cost Savings and Simple Payback for the Multifamily Prototype

Climate Design Zone	Multifamily Package 1 (Higher-eff Water Heaters +High-eff Furnace/HP)			Multifamily Package 2 (Higher-eff Water Heaters + 2 ACH50 + 0.8 SRE HRVs)		
	Total Annual Energy Cost Savings ($/dwelling unit)	Total Incremental Costs ($/dwelling unit)	Simple Payback (Years)	Total Annual Energy Cost Savings ($/dwelling unit)	Total Incremental Costs ($/dwelling unit)	Simple Payback (Years)
4A-NYC	$337	$4,648	13.8	$339	$5,846	17.2
4A-balance	$334	$4,203	12.6	$343	$5,279	15.4
5A	$387	$4,081	10.5	$353	$4,263	12.1
6A	NA	NA	NA	NA	NA	NA
NY State	$347	$4,302	12.4	$344	$5,198	15.1

Finally, Tables A-13 and A-14 summarize the 10-yr Net Present Value (NPV) of energy savings and the 30-year LCC savings for the single-family and the multifamily units respectively. All economic parameters are maintained the same as the main analysis.

Table A-13. Cost-Effectiveness Results for the Single-family Prototype

	Single-family Package 1 (High-eff Furnace/HP + U-0.24 Windows)			Single-family Package 2 (High-eff Furnace/HP + 2 ACH50 + High-efficiency Fans)		
CDZ	Total First Year Incremental Costs ($/dwelling unit)	10-Year NPV of Cost Savings ($/dwelling unit)	30 Year LCC Savings ($/dwelling unit)	Total First Year Incremental Costs ($/dwelling unit)	10-Year NPV of Cost Savings ($/dwelling unit)	30 Year LCC Savings ($/dwelling unit)
4A-NYC	$3,607	$3,112	$137	$4,444	$3,737	$(741)
4A-balance	$3,987	$3,445	$696	$4,739	$4,589	$238
5A	$3,510	$3,753	$1,825	$4,155	$4,991	$2,275
6A	$2,739	$4,071	$2,974	$3,346	$4,481	$2,246
NY State	$3,389	$3,595	$1,408	$4,047	$4,449	$1,005

Table A-14. Cost-Effectiveness Results for the Multifamily Prototype

	Multifamily Package 1 (Higher-eff Water Heaters + High-eff Furnace/HP)			Multifamily Package 2 (Higher-eff Water Heaters + 2 ACH50 + 0.8SRE HRVs)		
CDZ	Total First Year Incremental Costs ($/dwelling unit)	10-Year NPV of Cost Savings ($/dwelling unit)	30 Year LCC Savings ($/dwelling unit)	Total First Year Incremental Costs ($/dwelling unit)	10-Year NPV of Cost Savings ($/dwelling unit)	30 Year LCC Savings ($/dwelling unit)
4A-NYC	$4,648	$3,077	$(2,246)	$5,846	$3,304	$(4,085)
4A-balance	$4,203	$3,226	$(1,346)	$5,279	$3,515	$(2,836)
5A	$4,081	$3,573	$(246)	$4,263	$3,449	$(935)
6A	NA	NA	NA	NA	NA	NA
NY State	$4,302	$3,292	$(1,279)	$5,198	$3,423	$(2,618)

A.6 Conclusions

The additional efficiency credits proposed in section R407 of the draft NYStretch Energy Code version dated January 2019 yield additional positive energy savings of 10–15% over the prescriptive and mandatory provisions of the 2020 NYStretch energy code. An evaluation of two least expensive package options for single-family and multifamily buildings indicates simple paybacks ranging from 8 to 17 years. While the 30-year LCC savings are positive for most single-family buildings, they are negative for multifamily buildings in all climate design zones. It is further noted that because the package combinations are chosen based on the lowest first costs and not optimized based on a LCC perspective, it is possible that some other combinations of the proposed options might be more cost-effective in terms of LCC savings, even if they are more expensive in terms of first costs.

Appendix B. Energy Savings for All Models

This section summarizes the energy cost savings for each model from the prescriptive and mandatory provisions of the 2020 NYStretch energy code over the 2016 New York City Energy Conservation Code (NYCECC) baseline in CDZ 4A-NYC and the 2020 Energy Conservation Construction Code of New York State (ECCC NYS) baseline elsewhere, along with the associated incremental costs, 10-year net present value (NPV) of energy cost savings including replacement costs and 30-year LCC savings.

Table B-1. Energy Cost Savings, Incremental Costs and Cost-Effectiveness Results for the Prescriptive and Mandatory Provisions of the 2020 NYStretch Energy Code

ID	CDZ	Electricity Savings ($)	Natural Gas Savings ($)	Fuel Oil Savings ($)	Total Energy Savings ($)	Incremental Costs ($)	10-yr NPV Energy Cost Savings ($)	30-yr LCC Savings ($)
SF_gasfurnace_crawlspace	4A-NYC	149.1	120.0	0.0	269.0	2048.5	2634.4	1262.4
SF_gasfurnace_heatedbsmt	4A-NYC	34.8	56.3	0.0	91.1	2048.5	1092.0	-1956.6
SF_gasfurnace_slab	4A-NYC	133.8	119.4	0.0	253.2	2048.5	2501.3	979.4
SF_gasfurnace_unheatedbsmt	4A-NYC	139.8	114.7	0.0	254.5	2048.5	2508.3	999.2
SF_hp_crawlspace	4A-NYC	621.0	0.0	0.0	621.0	2048.5	5479.4	7449.2
SF_hp_heatedbsmt	4A-NYC	388.3	0.0	0.0	388.3	2048.5	3532.0	3300.5
SF_hp_slab	4A-NYC	601.7	0.0	0.0	601.7	2048.5	5317.3	7103.9
SF_hp_unheatedbsmt	4A-NYC	601.6	0.0	0.0	601.6	2048.5	5317.0	7103.3
SF_oilfurnace_crawlspace	4A-NYC	141.3	0.0	375.7	517.1	2048.5	4662.7	5966.5
SF_oilfurnace_heatedbsmt	4A-NYC	35.3	0.0	172.9	208.2	2048.5	2049.5	260.4
SF_oilfurnace_slab	4A-NYC	126.9	0.0	372.7	499.6	2048.5	4516.4	5652.5
SF_oilfurnace_unheatedbsmt	4A-NYC	131.9	0.0	360.2	492.1	2048.5	4451.6	5505.9
SF_gasfurnace_crawlspace	4A-bal	113.9	180.4	0.0	294.3	2664.5	3509.4	1693.0
SF_gasfurnace_heatedbsmt	4A-bal	-2.5	97.5	0.0	95.0	2664.5	1772.6	-1920.0

Table B-1 continued

ID	CDZ	Electricity Savings ($)	Natural Gas Savings ($)	Fuel Oil Savings ($)	Total Energy Savings ($)	Incremental Costs ($)	10-yr NPV Energy Cost Savings ($)	30-yr LCC Savings ($)
SF_gasfurnace_slab	4A-bal	109.5	169.1	0.0	278.6	2664.5	3368.4	1404.5
SF_gasfurnace_unheatedbsmt	4A-bal	104.0	170.2	0.0	274.2	2664.5	3332.1	1326.1
SF_hp_crawlspace	4A-bal	569.5	0.0	0.0	569.5	2664.5	5660.9	6465.9
SF_hp_heatedbsmt	4A-bal	345.5	0.0	0.0	345.5	2664.5	3786.3	2472.4
SF_hp_slab	4A-bal	548.5	0.0	0.0	548.5	2664.5	5485.5	6092.3
SF_hp_unheatedbsmt	4A-bal	549.1	0.0	0.0	549.1	2664.5	5490.1	6102.2
SF_oilfurnace_crawlspace	4A-bal	107.6	0.0	433.1	540.7	2664.5	5481.6	6380.3
SF_oilfurnace_heatedbsmt	4A-bal	-0.9	0.0	229.7	228.8	2664.5	2842.6	618.9
SF_oilfurnace_slab	4A-bal	103.0	0.0	411.9	514.8	2664.5	5262.0	5897.8
SF_oilfurnace_unheatedbsmt	4A-bal	97.5	0.0	409.8	507.2	2664.5	5198.2	5760.5
SF_gasfurnace_crawlspace	5A	3.0	260.4	0.0	263.3	2326.0	2924.0	708.4
SF_gasfurnace_heatedbsmt	5A	-44.6	204.6	0.0	160.0	2326.0	2013.0	-1173.7
SF_gasfurnace_slab	5A	1.1	259.2	0.0	260.3	2326.0	2898.1	654.4
SF_gasfurnace_unheatedbsmt	5A	-0.3	255.8	0.0	255.5	2326.0	2854.7	565.7
SF_hp_crawlspace	5A	683.0	0.0	0.0	683.0	2326.0	6217.3	7997.7
SF_hp_heatedbsmt	5A	544.0	0.0	0.0	544.0	2326.0	5054.2	5519.9
SF_hp_slab	5A	694.3	0.0	0.0	694.3	2326.0	6312.2	8199.9
SF_hp_unheatedbsmt	5A	689.5	0.0	0.0	689.5	2326.0	6271.9	8114.2
SF_oilfurnace_crawlspace	5A	1.9	0.0	614.8	616.7	2326.0	5750.1	7422.9
SF_oilfurnace_heatedbsmt	5A	-41.9	0.0	480.7	438.7	2326.0	4242.1	4118.6
SF_oilfurnace_slab	5A	-0.8	0.0	619.4	618.5	2326.0	5766.2	7460.5
SF_oilfurnace_unheatedbsmt	5A	-1.2	0.0	604.4	603.2	2326.0	5635.4	7171.5
SF_gasfurnace_crawlspace	6A	-3.1	273.1	0.0	270.0	1931.5	2693.1	961.8
SF_gasfurnace_heatedbsmt	6A	-46.7	216.6	0.0	169.9	1931.5	1808.6	-863.1
SF_gasfurnace_slab	6A	-4.8	272.8	0.0	268.1	1931.5	2676.8	927.3
SF_gasfurnace_unheatedbsmt	6A	-6.4	268.8	0.0	262.4	1931.5	2626.3	823.9
SF_hp_crawlspace	6A	751.7	0.0	0.0	751.7	1931.5	6495.1	9348.3
SF_hp_heatedbsmt	6A	614.9	0.0	0.0	614.9	1931.5	5350.2	6909.3
SF_hp_slab	6A	766.6	0.0	0.0	766.6	1931.5	6619.8	9614.1

Table B-1 continued

ID	CDZ	Electricity Savings ($)	Natural Gas Savings ($)	Fuel Oil Savings ($)	Total Energy Savings ($)	Incremental Costs ($)	10-yr NPV Energy Cost Savings ($)	30-yr LCC Savings ($)
MF_gasfurnace_crawlspace	4A-NYC	84.4	58.8	0.0	143.2	1763.2	1530.6	-481.9
SF_hp_unheatedbsmt	6A	759.2	0.0	0.0	759.2	1931.5	6558.1	9482.6
SF_oilfurnace_crawlspace	6A	-4.3	0.0	644.1	639.8	1931.5	5650.3	7989.0
SF_oilfurnace_heatedbsmt	6A	-44.1	0.0	508.4	464.3	1931.5	4162.8	4727.4
SF_oilfurnace_slab	6A	-5.8	0.0	642.2	636.4	1931.5	5621.4	7926.3
SF_oilfurnace_unheatedbsmt	6A	-7.6	0.0	634.4	626.8	1931.5	5540.4	7748.3
MF_gasfurnace_heatedbsmt	4A-NYC	12.6	40.0	0.0	52.6	1763.2	756.5	-2111.2
MF_gasfurnace_slab	4A-NYC	86.1	57.4	0.0	143.5	1763.2	1531.9	-477.7
MF_gasfurnace_unheatedbsmt	4A-NYC	85.3	57.7	0.0	143.0	1763.2	1527.8	-486.6
MF_hp_crawlspace	4A-NYC	275.6	0.0	0.0	275.6	1763.2	2588.6	1833.8
MF_hp_heatedbsmt	4A-NYC	153.2	0.0	0.0	153.2	1763.2	1564.5	-348.0
MF_hp_slab	4A-NYC	274.8	0.0	0.0	274.8	1763.2	2582.3	1820.4
MF_hp_unheatedbsmt	4A-NYC	274.7	0.0	0.0	274.7	1763.2	2581.5	1818.7
MF_oilfurnace_crawlspace	4A-NYC	78.4	0.0	191.6	270.0	1763.2	2568.9	1922.9
MF_oilfurnace_heatedbsmt	4A-NYC	13.7	0.0	123.7	137.4	1763.2	1450.5	-506.1
MF_oilfurnace_slab	4A-NYC	79.9	0.0	186.6	266.4	1763.2	2538.5	1854.7
MF_oilfurnace_unheatedbsmt	4A-NYC	79.1	0.0	187.6	266.7	1763.2	2541.1	1861.0
MF_gasfurnace_crawlspace	4A-bal	66.3	81.0	0.0	147.2	1689.7	1796.9	316.7
MF_gasfurnace_heatedbsmt	4A-bal	1.0	56.6	0.0	57.6	1689.7	1026.4	-1299.2
MF_gasfurnace_slab	4A-bal	67.5	79.4	0.0	146.9	1689.7	1792.6	309.2
MF_gasfurnace_unheatedbsmt	4A-bal	66.5	80.0	0.0	146.5	1689.7	1789.7	302.4
MF_hp_crawlspace	4A-bal	245.9	0.0	0.0	245.9	1689.7	2554.4	2015.6
MF_hp_heatedbsmt	4A-bal	135.4	0.0	0.0	135.4	1689.7	1629.8	45.8

Table B-1 continued

ID	CDZ	Electricity Savings ($)	Natural Gas Savings ($)	Fuel Oil Savings ($)	Total Energy Savings ($)	Incremental Costs ($)	10-yr NPV Energy Cost Savings ($)	30-yr LCC Savings ($)
MF_hp_slab	4A-bal	245.2	0.0	0.0	245.2	1689.7	2548.9	2003.8
MF_hp_unheatedbsmt	4A-bal	245.3	0.0	0.0	245.3	1689.7	2549.2	2004.4
MF_oilfurnace_crawlspace	4A-bal	61.1	0.0	204.7	265.8	1689.7	2750.1	2572.3
MF_oilfurnace_heatedbsmt	4A-bal	2.3	0.0	134.8	137.1	1689.7	1663.2	209.1
MF_oilfurnace_slab	4A-bal	62.1	0.0	201.0	263.1	1689.7	2727.2	2521.2
MF_oilfurnace_unheatedbsmt	4A-bal	61.2	0.0	201.3	262.5	1689.7	2722.2	2510.6
MF_gasfurnace_crawlspace	5A	-27.5	139.8	0.0	112.3	1875.2	1382.0	-1453.7
MF_gasfurnace_heatedbsmt	5A	-62.4	124.4	0.0	62.0	1875.2	948.0	-2362.2
MF_gasfurnace_slab	5A	-27.6	138.2	0.0	110.6	1875.2	1365.9	-1486.3
MF_gasfurnace_unheatedbsmt	5A	-27.7	138.6	0.0	110.9	1875.2	1369.1	-1480.1
MF_hp_crawlspace	5A	283.8	0.0	0.0	283.8	1875.2	2699.5	1499.8
MF_hp_heatedbsmt	5A	211.0	0.0	0.0	211.0	1875.2	2091.0	203.4
MF_hp_slab	5A	281.2	0.0	0.0	281.2	1875.2	2678.4	1454.9
MF_hp_unheatedbsmt	5A	282.5	0.0	0.0	282.5	1875.2	2688.9	1477.3
MF_oilfurnace_crawlspace	5A	-24.0	0.0	342.5	318.5	1875.2	3039.1	2457.6
MF_oilfurnace_heatedbsmt	5A	-56.6	0.0	296.9	240.3	1875.2	2378.2	1018.3
MF_oilfurnace_slab	5A	-24.7	0.0	337.6	312.9	1875.2	2991.1	2351.8
MF_oilfurnace_unheatedbsmt	5A	-24.6	0.0	339.0	314.4	1875.2	3003.8	2380.0
SF_gasfurnace_crawlspace	4A-NYC	149.1	120.0	0.0	269.0	2048.5	2634.4	1262.4
SF_gasfurnace_heatedbsmt	4A-NYC	34.8	56.3	0.0	91.1	2048.5	1092.0	-1956.6
SF_gasfurnace_slab	4A-NYC	133.8	119.4	0.0	253.2	2048.5	2501.3	979.4
SF_gasfurnace_unheatedbsmt	4A-NYC	139.8	114.7	0.0	254.5	2048.5	2508.3	999.2
SF_hp_crawlspace	4A-NYC	621.0	0.0	0.0	621.0	2048.5	5479.4	7449.2
SF_hp_heatedbsmt	4A-NYC	388.3	0.0	0.0	388.3	2048.5	3532.0	3300.5
SF_hp_slab	4A-NYC	601.7	0.0	0.0	601.7	2048.5	5317.3	7103.9
SF_hp_unheatedbsmt	4A-NYC	601.6	0.0	0.0	601.6	2048.5	5317.0	7103.3

Table B-1 continued

ID	CDZ	Electricity Savings ($)	Natural Gas Savings ($)	Fuel Oil Savings ($)	Total Energy Savings ($)	Incremental Costs ($)	10-yr NPV Energy Cost Savings ($)	30-yr LCC Savings ($)
SF_oilfurnace_crawlspace	4A-NYC	141.3	0.0	375.7	517.1	2048.5	4662.7	5966.5
SF_oilfurnace_heatedbsmt	4A-NYC	35.3	0.0	172.9	208.2	2048.5	2049.5	260.4
SF_oilfurnace_slab	4A-NYC	126.9	0.0	372.7	499.6	2048.5	4516.4	5652.5
SF_oilfurnace_unheatedbsmt	4A-NYC	131.9	0.0	360.2	492.1	2048.5	4451.6	5505.9
SF_gasfurnace_crawlspace	4A-bal	113.9	180.4	0.0	294.3	2664.5	3509.4	1693.0
SF_gasfurnace_heatedbsmt	4A-bal	-2.5	97.5	0.0	95.0	2664.5	1772.6	-1920.0
SF_gasfurnace_slab	4A-bal	109.5	169.1	0.0	278.6	2664.5	3368.4	1404.5
SF_gasfurnace_unheatedbsmt	4A-bal	104.0	170.2	0.0	274.2	2664.5	3332.1	1326.1
SF_hp_crawlspace	4A-bal	569.5	0.0	0.0	569.5	2664.5	5660.9	6465.9
SF_hp_heatedbsmt	4A-bal	345.5	0.0	0.0	345.5	2664.5	3786.3	2472.4
SF_hp_slab	4A-bal	548.5	0.0	0.0	548.5	2664.5	5485.5	6092.3
SF_hp_unheatedbsmt	4A-bal	549.1	0.0	0.0	549.1	2664.5	5490.1	6102.2
SF_oilfurnace_crawlspace	4A-bal	107.6	0.0	433.1	540.7	2664.5	5481.6	6380.3
SF_oilfurnace_heatedbsmt	4A-bal	-0.9	0.0	229.7	228.8	2664.5	2842.6	618.9
SF_oilfurnace_slab	4A-bal	103.0	0.0	411.9	514.8	2664.5	5262.0	5897.8
SF_oilfurnace_unheatedbsmt	4A-bal	97.5	0.0	409.8	507.2	2664.5	5198.2	5760.5
SF_gasfurnace_crawlspace	5A	3.0	260.4	0.0	263.3	2326.0	2924.0	708.4
SF_gasfurnace_heatedbsmt	5A	-44.6	204.6	0.0	160.0	2326.0	2013.0	-1173.7
SF_gasfurnace_slab	5A	1.1	259.2	0.0	260.3	2326.0	2898.1	654.4
SF_gasfurnace_unheatedbsmt	5A	-0.3	255.8	0.0	255.5	2326.0	2854.7	565.7

Endnotes

1 https://www.nyserda.ny.gov/-/media/Files/Programs/energy-code-training/2019-01-07-draft-NYStretch-energy-code.pdf

2 https://www.ecfr.gov/cgi-bin/text-idx?SID=a9921a66f2b4f66a32ec851916b7b9d9&mc=true&node=se10.3.430_132&rgn=div8

3 http://www.mnpower.com/EnergyConservation/DrainWaterHeatRecovery

4 https://aceee.org/files/pdf/conferences/hwf/2011/4B%20-%20Gerald%20Van%20Decker.pdf

5 https://www.hydro.mb.ca/your_home/water_use/drain_water_heat_recovery/

6 Home Ventilating Institute Products Directory, accessed March 3, 2019

7 www.bc3.pnnl.gov

8 https://www.energy.gov/energysaver/water-heating/drain-water-heat-recovery

9 Codes and Standards Enhancement (CASE) report http://title24stakeholders.com/wp-content/uploads/2017/09/2019-T24-CASE-Report_DWHR_Final_September-2017.pdf

10 https://www.nachi.org/hot-water-recirculation-systems.htm

11 https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2016ECC_CHR4.pdf &section=energy_code_2016

12 https://www.energystar.gov/productfinder/

13 https://www.energy.gov/eere/ssl/led-basics

14 https://www.energy.gov/sites/prod/files/2014/01/f6/1_1g_ba_innov_ductsconditionedspace_011713.pdf

15 http://insulationinstitute.org/wp-content/uploads/2017/01/TechSpec-Buried-Ducts_FINAL.pdf

16 http://www.freddiemac.com/pmms/pmms30.html

17 http://www.freddiemac.com/pmms/pmms30.html (accessed June 12, 2019)

18 https://www.bls.gov/

19 https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2019&region=1-2&cases=ref2019&start=2017&end=2050&f=A&linechart=ref2019-d111618a.3-3-AEO2019.1-2&map=ref2019-d111618a.4-3-AEO2019.1-2&sourcekey=0

20 https://www.tax-brackets.org/newyorktaxtable

21 Draft NYStretch Energy Code-2019 dated January 2019

22 This observation is further explained in section A.3 Single-Family Prototype Packages.

23 https://aceee.org/sites/default/files/pdf/conferences/hwf/2017/Delforge_Session4B_HWF17_2.28.17.pdf

24 http://www.mnshi.umn.edu/kb/scale/hrverv.html

25 https://www.homewyse.com/costs/cost_of_heat_recovery_systems.html

26 https://efiling.energy.ca.gov/GetDocument.aspx?tn=74627&DocumentContentId=16036

27 http://ma-eeac.org/wordpress/wp-content/uploads/RES19_Task5_FinalReport_v3.0_clean.pdf

28 https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/full.pdf

29 https://neep.org/file/4475/download?token=ALT2qBvt

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NEW YORK STATE OF OPPORTUNITY | NYSERDA

City of Kingston, New York

Common Council Resolution
[Resolution Reference #]

Resolution to [**either** "Adopt Amendments to Chapter 172 Article II of the City Code pertaining to Building Energy Code" **or** "Add Provisions for a new energy code under Chapter 172 Article II"] of the City Code.

Department:	[*DEPARTMENT*]	**Sponsors:**	[*SPONSORS*]
Category:	Local Laws	**Functions:**	[*FUNCTIONS*]

WHEREAS, to prevent a statewide patchwork of stricter energy codes, the New York State Energy Research and Development Authority (NYSERDA) developed the NYStretch Energy Code – 2020 (NYStretch);

WHEREAS, a stretch energy code is simply an energy code that is more stringent than the minimum base energy code that can be voluntarily adopted by local jurisdictions. NYStretch is a model stretch code that will be ten to twelve percent (10-12 %) more efficient than the minimum requirements of the base energy code, the 2020 Energy Conservation Construction Code of New York State (2020 ECCCNYS);

WHEREAS, some New York State municipalities have adopted stricter energy standards to ensure reduced energy costs for its residents and businesses;

WHEREAS, under NY Energy Law § 11-109, the City of Kingston is authorized to adopt a local energy code more stringent that the 2020 ECCCNYS;

WHEREAS, [*additional clauses as deemed necessary regarding introduction of NYStretch*];

WHEREAS, the City of Kingston is considering [**either** "amending provisions of Chapter 172 Article II pertaining to Building Energy Code" **or** "adding provisions for a new local energy code under Chapter 172 Article II"] of the City Code; and

WHEREAS, a public hearing was held on [DATE], at which time all persons either for or against said amendments were heard; and

WHEREAS, the [MUNICIAPL GOVERNING BODY] is declared Lead Agency for the purposes of environmental review with respect to the proposed resolution, in accordance with Article 8 of the Environmental Conservation Law of the State of New York, and the regulations promulgated thereunder at 6 NYCRR 617 (collectively, "SEQRA"); and

WHEREAS, the [MUNICIPAL GOVERNING AGENCY], as Lead Agency, has advised that the proposed action meets the criteria of a "Type II Action" under SEQRA; now, therefore, be it further

RESOLVED, that Local Law No. [#] of 2021 is hereby adopted as follows:

LOCAL LAW NO. [#] OF 2021

A LOCAL LAW [either "amending provisions of Chapter 172 Article II pertaining to Building Energy Code" or "adding provisions for a new local energy code under Chapter 172 Article II"] of the City Code;

BE IT ENACTED by the Common Council of the City of Kingston as follows:

Section 1. Legislative Intent

The City of Kingston seeks to protect and promote the public health, safety, and welfare of its residents by mandating energy efficient building standards. On May 12th, 2020 the 2020 Energy Conservation Construction Code of New York State (ECCCNYS), updated by the New York State Fire Prevention and Building Code Council, became effective and must be complied with for residential and commercial buildings, unless a more restrictive energy code is voluntarily adopted by a local jurisdiction. In 2019, the New York State Energy Research and Development Authority (NYSERDA) developed and published the NYStretch Energy Code 2020 (hereinafter referred to as NYStretch), a more energy efficient building code than the 2020 ECCCNYS. This proposed amendment seeks to modify the City Code to adopt NYStretch and to enact more restrictive regulations as they relate to new or substantially renovated buildings.

Section 2. Amendment

Chapter 172 Article II of the Code of the City of Kingston is hereby amended to ["add Section [#]" **or** "amend Section [#]"]:

§[#]

Effective [DATE], the NYStretch Energy Code 2020, published by the New York State Energy Research and Development Authority (hereafter referred to as "NYStretch"), shall be applicable to all new construction and substantial renovations as required by the 2020 ECCCNYS as amended by NYStretch, in the City of Kingston.

Section 3. Authority

The proposed local law is enacted pursuant to New York Energy Law §11-109(1), and Municipal Home Rule Law §10 and in accordance with the procedures detailed in Municipal Home Rule § 20.

Section 4. Severability

If any section or subdivision, paragraph, clause, phrase of this law shall be adjudged invalid or held unconstitutional by any court of competent jurisdiction, any judgment made thereby shall not affect the validity of this law as a whole or any part thereof other than the part or provision so adjudged to be invalid or unconstitutional.

Section 5. Effective Date

This local law shall take effect upon filing with the Secretary of State [i.e., within 30 days of adoption of NYStretch] pursuant to New York Energy Law §11-109(1) and the Municipal Home Rule Law.

AND BE IT RESOLVED, that the City Clerk is hereby directed to publish the following Notice of Adoption:

NOTICE OF ADOPTION

TAKE NOTICE that after a public hearing was held by the City of Kingston on [DATE], the City, at its meeting on [DATE], adopted Local Law No. [#] of 2021 as follows: "A LOCAL LAW [either "amending provisions of Chapter 172 Article II pertaining to Building Energy Code]" or "adding provisions for a new local energy code under Chapter 172 Article II"] of the City Code."

SUMMARY OF LOCAL LAW

These amendments make the City Code consistent with revisions to the New York State Energy Conservation and Construction Code and adopt more stringent regulations as they relate to new construction or substantial renovation projects.

Copies of the proposed local law sponsored by [SPONSORS] are on file in the City Clerk's Office, Monday through Friday, from 8:30am to 4:30pm.

By Order of the Common Council
Kingston, New York
Elisa Tinti, City Clerk