FSEC Energy Research Center

UCF

UNIVERSITY OF CENTRAL FLORIDA

Comparison of the Commercial Provisions of the 2020 Florida Building Code, Energy Conservation, 7th Edition with 2021 IECC & ASHRAE 90.1-2019

FSEC-CR-2113-21

Final Report
June 15, 2021

Submitted to

Department of Business and Professional Regulation
Office of Codes and Standards
2601 Blair Stone Road
Tallahassee, FL 32399
Contract No. B7DE38

Submitted by

Bereket Nigusse and Muthusamy Swami

Disclaimer

Executive Summary

This project was initiated because of the state of Florida desire to conduct qualitative and quantitative analysis of commercial provisions of the 7th Edition (2020) Florida Building Code, Energy Conservation (FBC-EC) against IECC-2021 and ASHREA 90.1-2019. For this purpose, the 2020 FBC-EC, IECC-2021 and ASHRAE 90.1-2019 code changes were reviewed, quantitatively analyzed, energy use and energy cost performance metrics were computed and compared.

Qualitative Analysis:

- Code changes between 2020 FBC-EC and the 2021 IECC
- Code changes between 2020 FBC-EC and the 2019 ASHRAE Standard 90.1

Qualitative analysis of the code changes between 2020 FBC-EC and the 2021 IECC was performed. There were 135 code changes between the 2020 FBC-EC and the 2021 IECC, 33 code modifications were identified to have energy impact and only 18 changes with energy impacts were identified for quantitative analysis.

Similarly review of the code changes between 2020 FBC-EC and the 2019 ASHRAE 90.1 was performed. The ASHRAE based 2020 FBC-EC uses amended ASHRAE 90.1-2016 code as a compliance option for commercial buildings. There were 88 code changes between ASHRAE 90.1-2016 and ASHRAE 90.1-2019, 34 changes with energy impact and 22 were identified for quantitative analysis.

Quantitative Analysis:

- Comparison of the 2020 FBC-EC with the 2021 IECC
- Comparison of the 2020 FBC-EC with the 2019 ASHRAE Standard 90.1

The quantitative analysis compared annual site Energy Use Intensity (EUI) and annual Energy Cost Index (ECI) determined using building energy models and simulation. The analysis was performed using sixteen commercial prototype building types and two climate zones. Miami and Orlando, Florida site locations were used for climate zones 1A and 2A, respectively. EnergyPlus Version 9.0.1, whole building performance simulation program, was used for the analysis. The quantitative analysis performed would result in Florida average annual energy use and energy cost savings summarized in Table I.

Table I Florida Average Annual Site EUI and ECI Commercial Sector

Code Base	2020 FBC-EC	2021 IECC	2019 ASHRAE 90.1	ΔEUI or ΔECI	ΔEUI or ΔECI, %
Annual Energy Utilization Intensity (EUI), kBtu/ft²-yr					
IECC	46.81	43.84	-	2.97	6.35
ASHRAE	47.32	-	44.30	3.02	6.38
Annual Energy Cost Index (ECI), $/ft²-yr					
IECC	1.012	0.936	-	0.076	7.51
ASHRAE	1.010	-	0.955	0.055	5.49

Results of IECC Based 2020 FBC-EC Analysis: The qualitative and quantitative comparison results of the 7th Edition (2020) FBC-EC, which is based on the 2018 IECC, with the 2021 IECC is summarized as follows:

- Code changes from the IECC based 2020 FBC-EC to the 2021 IECC review were performed, and summary of the code changes and their energy and construction cost impacts are in Appendix-A. The qualitative analysis identified 135 approved code changes, 33 code changes have energy impact and only 18 code changes were quantitatively investigated.
- Created prototype buildings models for the IECC based the 7th Edition (2020) FBC-EC and the 2021 IECC prototype buildings energy models for the quantitative analysis. 18 code changes with energy impacts were included in the analysis, and the annual energy use and annual energy cost performance metrics were computed and compared.
- Figure I show annual Florida average site EUI of the IECC based 2020 FBC-EC and the 2021 IECC by end use. The Florida average EUI of the 2020 FBC-EC and the 2021 IECC were 46.81 kBtu/ft^2-yr and 43.84 kBtu/ft^2-yr, respectively. The 2021 IECC on average would save annual site EUI of 2.97 kBtu/ft^2-yr relative to the IECC based 2020 FBC-EC code, i.e., 6.35% energy savings. About 42.0% of the energy savings is from lighting energy use reduction. The Florida average annual total ECI savings of the 2021 IECC compared to the IECC based 2020 FBC-EC would be 7.51 percent, or \$0.076/ft^2-yr.
- The quantitative analysis demonstrated that energy efficiency of commercial buildings constructed in accordance with the IECC based 2020 FBC-EC needs to bring all code modifications of the 2021 IECC into the 8th Edition (2023) FBC-EC such that the 8th Edition (2023) FBC-EC would become equivalent to the 2021 IECC.

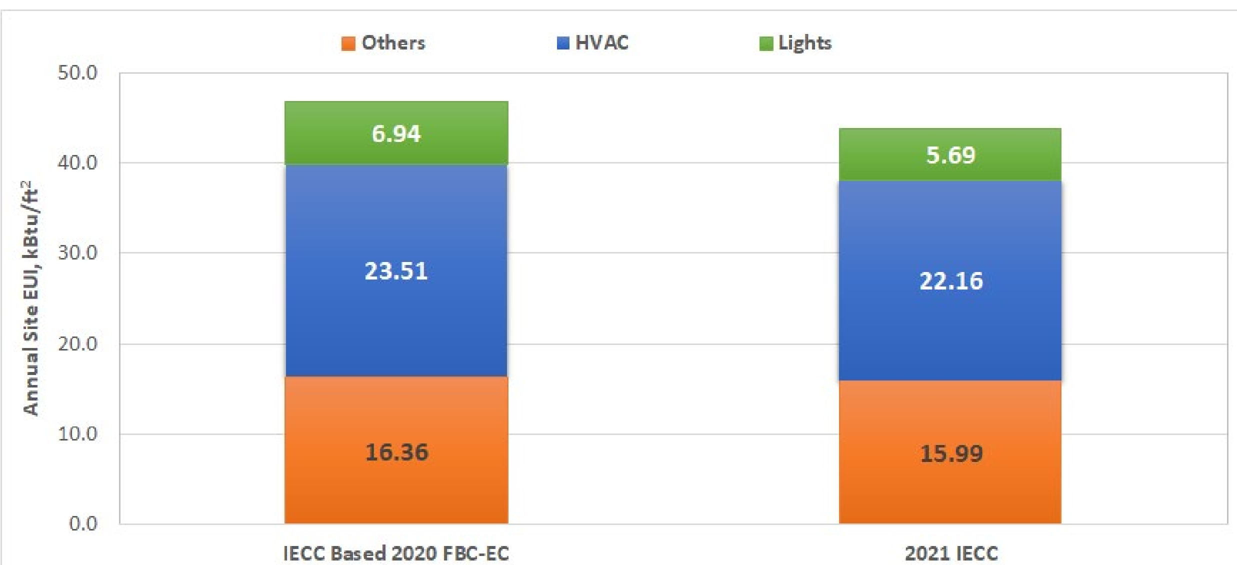

Figure I Annual EUI of the IECC based 2020 FBC-EC and the 2021 IECC

Results of ASHRAE Based 2020 FBC-EC Analysis: The qualitative and quantitative comparison of the 7th Edition (2020) FBC-EC, which is based on ASHRAE 90.1-2016, against ASHRAE Standard 90.1-2019 is summarized as follows:

- Code changes from ASHRAE 90.1-2016 to ASHRAE 90.1-2019 review were performed and summary of the code changes and their energy impact are in Appendix-B. The qualitative code change review identified 88 changes, 34 code changes have energy impact and only 22 changes were quantitatively investigated. The ASHRAE based 7th Edition (2020), which is based on ASHRAE Standard 90.1-2016, excludes interior lighting control of section 9.4.1.1(g), the automatic receptacle control section 8.4.2 and building energy metering section 8.4.3 requirements of ASHRAE Standard 90.1-2016 code. Performance of the amended ASHRAE 90.1-2016 code was analyzed and compared against that of the 2019 ASHRAE 90.1 code.

- Figure II shows Florida average annual site EUI of the ASHRAE-2016 FBC-EC and the 2019 ASHRAE 90.1 code by end uses. The average annual site EUI of ASHRAE-2016 FBC-EC and ASHRAE 90.1-2019 were 47.32 kBtu/ft^2-yr and 44.30 kBtu/ft^2-yr, respectively. The 2019 ASHRAE 90.1 code would save 3.02 kBtu/ft^2 or 6.38% compared to the ASHRAE-2016 FBC-EC code. About 40% the energy savings is from lighting energy use reduction.

- The Florida average annual site ECI of ASHRAE-2016 FBC-EC and ASHRAE 90.1-2019 were \$1.01/ft^2-yr and \$0.95/ft^2-yr, respectively. The 2019 ASHAE 90.1 code relative to the ASHRAE-2016 FBC-EC code on average would save 5.49 percent of annual ECI.

- The quantitative analysis demonstrated that energy efficiency of the commercial provisions of the 2020 FBC-EC needs to bring all addenda to the ASHRAE 90.1-2016 into the 8th Edition (2023) FBC-EC such that the ASHRAE based 2023 (8th Edition) FBC-EC would become equivalent to the 2019-ASHRAE 90.1 code.

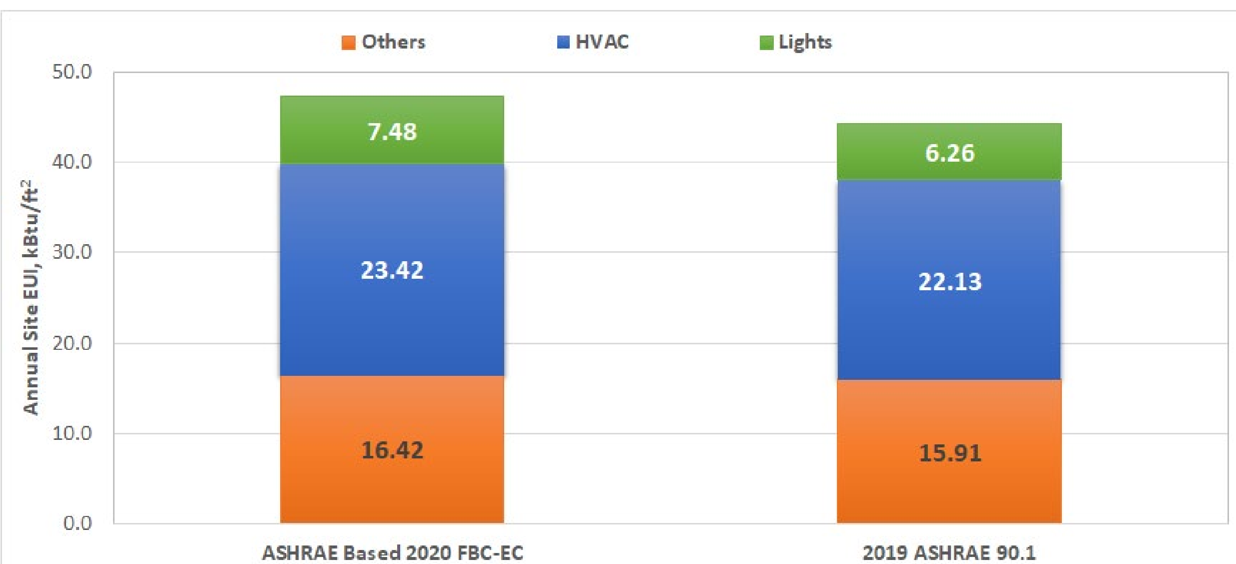

Figure II EUI of ASHRAE based 2020 FBC-EC and ASHRAE 90.1-2019 by end use

Results of Cost-Benefit Analysis: The 7th Edition (2020) IECC based FBC-EC provisions were reviewed and compared against the 2021 IECC. The qualitative code change review identified 33 with energy use impact. Out these 33 code modifications with energy impact, only 18 were quantitatively investigated and sixteen code changes were investigated for cost effectiveness. Fifteen code changes were found cost-effective. These fifteen code modifications are strongly recommended for consideration by Florida Building Commission for addition to the 8th Edition (2023) FBC-EC. Table II summarizes the cost-effectiveness test results for the 2021 IECC changes.

The 7th Edition (2020) FBC-EC ASHRE 90.1 code provisions were reviewed and compared against ASHRAE 90.1-2019 code. The qualitative code change review identified 34 with energy use impact. Out these 34 code changes with energy impact 22 were quantitatively investigated and only 10 code modifications were investigated for cost effectiveness. Nine out of the ten code modifications investigated were cost-effective. Therefore, the ASHRAE based 8th Edition (2023) FBC-EC may need all code modifications, i.e., all addenda to the ASHRAE 90.1-2016 and possibly currently excluded code sections to bring the ASHREA's based state's energy code in parity with the ASHRAE 90.1-2019 code. Table III summarizes the cost-effectiveness test results for the 2019 ASHRAE 90.1 code modifications.

Table II IECC 2021 Code Modification Cost Effectiveness Test Results Summary

Code Mod #	Code Section # and Brief Description	Savings to Investment Ratio (SIR)	Cost-Effective (Yes/No)
CE70-19	Section C402.1.4 Reduces *U*-Factor for opaque swinging doors from 0.61 to 0.37 Btu/(hr-ft^2-°F).	1.85	Yes
CE84-19 CE85-19 CE87-19	Table C402.4 Vertical Fenestration and Skylight Upgrade	1.82	Yes
CE97-19	Section C402.5.1.2 Air barrier compliance. Section C402.5.3 Building thermal envelope testing.	1.73 - 6.09	Yes
CE106-19	Section C402.5.11 Operable openings interlocking. Adds new mandatory section.	7.0	Yes
CE111-19	Adds a new section C403.2.3 Fault Detection and Diagnostics.	1.57 - 15.21	Yes
CE125-19	Adds new sub-section C403.6.5.1 Dehumidification Control Interaction.	2.0 – 2.46	Yes
CE127-19	Section C403.7.1 Demand control ventilation, Reduces people occupancy density threshold from 25 to 15 people or greater per 1,000 ft^2.	2.23	Yes
CE133-19	Section C403.7.4.1 Energy Recovery in Nontransient Dwelling Units.	0.04	No
CE140-19	Adds a new section for ventilation fans with motors less than 1/12 hp (0.062 kW), i.e., section C403.8.5 Low-capacity ventilation fans.	1.46	Yes
CE169-19	Section C405.2.1 Occupant sensor controls in Corridor Spaces.	4.20	Yes
CE185-19	Section C405.2.4.1 changes the daylight responsive control function to continuous dimming from step dimming.	33.33	Yes
CE187-19	Adds secondary sidelit zones requirements to section C405.2.4.2 Sidelit daylight zone.	1.77	Yes
CE206-19	Interior Lighting Power Density Reduction. Building area method in Table C405.3.2(1).	5.77	Yes
CE208-19	Interior Lighting Power Density Reduction. Space-by-space method in Table C405.3.2(2).	3.71	Yes
CE215-19	Section C405.12 Energy Monitoring. New buildings with a gross conditioned floor area of 25,000 ft^2 or larger.	3.44 - 14.01	Yes
CE216-19	Adds mandatory new section C405.11 Automatic Receptacle Control	2.19	Yes

Table III ASHRAE 90.1-2019 Code Modification Cost Effectiveness Test Results Summary

Addenda	Code Section # and Brief Description	Savings to Investment Ratio (SIR)	Cost-Effective (Yes/No)
ap	Revises supply air temperature reset controls in Section 6.5.3.5. A new sub-section 6.5.3.5.1 Dehumidification Control Interaction.	1.24 – 2.37	Yes
au	Eliminates the requirement that zones with DDC have air flow rates that are no more than 20% of the zone design peak flow rate.	∞	Yes
aw	Revise’s fenestration prescriptive criteria in Tables 5.5-0 through 5.5-8.	1.89	Yes
ay	Adds a new 6.5.6.1.1 Nontransient Dwelling Units. Exhaust air energy recovery requirement.	0.10	No
cg	Reduces Table 9.5.1 Lighting Power Density (LPD) Allowances for the Building Area Method.	5.45	Yes
bb	Reduces Table 9.6.1 Lighting Power Density (LPD) Allowance for the Space-by-Space method.	2.84	Yes
cw	Revise’s daylight responsiveness requirements to continuous dimming from step dimming for sidelit and toplit daylighting control.	34.44	Yes
g	Adds new definition for “occupied-standby mode” and adds new ventilation air requirements for zones served rooms in occupied-standby mode. Adds new definition. Unoccupied space does not need to be ventilated per standard 62.1 when spaces air temperature is within the allowed limits.	1.06 - 2.22	Yes
k	Revise’s definition of “networked guest room control system” and aligns HVAC and lighting timeout periods for guest rooms. Reduced the HVAC timeout period from 30 to 20 minutes to match the 20 minutes timeout period for lighting control.	6.0 – 49.6	Yes
v	Adds a new section 6.5.6.3 containing heat recovery requirements for space conditioning in acute inpatient hospitals.	1.33	Yes

Acknowledgments

This report was prepared by Florida Solar Energy Center/University of Central Florida for the Florida Department of Business and Professional Regulation (DBPR). The authors would like to thank Mo Madani and staffs of the Florida DBPR for their support and guidance during the project. The authors would also like to thank chairs of the Florida Building Commission for authorizing funding for the project.

Acronyms and Abbreviations

ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
DOE	U.S. Department of Energy
ECI	Annual Energy Cost Index, $/(ft^2-yr)
EUI	Annual Energy Utilization Intensity, kBtu/(ft^2-yr)
FBC-EC	Florida Building Code, Energy Conservation
FBC	Florida Building Commission
FEC	Florida Energy Code
2020 FBC-EC	7th Edition (2020) Florida Building Code, Energy Conservation
FSEC	Florida Solar Energy Center
HVAC	Heating, ventilation, and air-conditioning
IES	Illuminating Engineering Society of North America
IECC	International Energy Conservation Code
PNNL	Pacific Northwest National Laboratory
X	The EUI or ECI value of a prototype building

Simulation Prototype Terminology

ASHRAE-2016 FBC-EC — A building input designed to simulate the 2016 ASHRAE Standard 90.1 and code changes approved by the Florida Building Commission for the 7th Edition (2020) Florida Building Code, Energy Conservation.

2020 FBC-EC — A building input designed to simulate the 2018 IECC and code changes approved by the Florida Building Commission for the 7th Edition (2020) Florida Building Code, Energy Conservation.

2021-IECC — A building input designed to simulate the 2021 IECC

ASHRAE 90.1-2019 — A building input designed to simulate the 2019 ASHRAE Standard 90.1.

Contents

List of Figures

List of Tables

1. Introduction

The state of Florida desires to review the 7th Edition (2020) commercial buildings energy code and compare it with 2021 IECC and the 2019 ASHRAE 90.1 codes. This report summarizes the code changes review, code changes with energy and construction cost impacts, quantitatively analysis results of energy and energy cost impacts, and cost-benefit analysis results of the code changes with energy impacts.

Reviewed and compared the 2021 IECC changes with the IECC based 7th Edition (2020) Florida Building Code, Energy Conservation (FBC-EC) and the 2018 IECC based on the International Code Council's *Complete Revision History to the 2021 I-Code* document (I-Codes, 2020) as part of the 8th Edition Florida Building Code development cycle. A brief description of each the code modifications and identifies energy and cost impacts of the 2021 IECC changes are documented in Appendix-A. Also reviewed and compared the 2019 ASHRAE 90.1 codes with ASHRAE based 7th Edition (2020) (FBC-EC) based on the addenda to the 2016 ASHRAE 90.1 (ASHRAE, 2019) and preliminary energy savings analysis for ASHRAE Standard 90.1-2019 U.S. DOE report (ASHRAE, 2021). A brief description of each the code changes, energy and cost impacts of the modifications of the 2019 ASHARE Standard 90.1 are listed in Appendix-B.

The quantitative analysis compared annual site Energy Use Intensity (EUI) and annual Energy Cost Index (ECI) determined using building energy models and simulation. The analysis was performed using sixteen commercial prototype building energy models and two climate zones. EnergyPlus Version 9.0.1, whole building performance simulation program, was used for the analysis. The IECC based 2020 FBC-EC, ASHRAE based 2020 FBC-EC, the 2021 IECC and the 2019 ASHRAE 90.1 code prototype building energy models were simulated. Processed the EnergyPlus program output and determined site Energy Use Intensity (EUI) and Energy Cost Index (ECI) for each of the prototype buildings, the two climate zones, and for the two 2020 FBC-EC compliance options. The EUIs and ECIs of the prototype buildings were weighed by Florida climate zones total floor area stock weighing factors and aggregated across the sixteen commercial buildings to determine weighted Florida average site EUI and ECI for the commercial sector. The quantitative analysis is covered Section 4.

Cost benefit analysis of the of code modifications between the 2021 IECC and the IECC based 2020 FBC-EC and between the 2019 ASHRAE 90.1 code and ASHRAE based 2020 FBC-EC are covered in Section 5. The cost effectiveness analysis used annual energy savings determined between the base case, which is the 7th Edition (2020) Florida Building Code, Energy Conservation, and the 2021 IECC and the 2019 ASHREA 90.1 as the upgrade. The cost benefit or cost-effectiveness analysis requires creating a separate baseline and upgrade code prototype building energy model for each code modification that has energy savings potential. The annual and life cycle energy costs for the cost-benefit analysis were computed using Florida energy rates for electricity and natural gas and energy price escalation rates for U.S. south-east region and are summarized in Appendix-C. The cost effectiveness of code modifications was determined by computing Savings to Investment Ratio (SIR) and for a couple of code changes simple payback period was used as additional verification.

2. The 2020 Florida Energy Code Qualitative Comparison

The 7th Edition (2020) Florida Building Code, Energy Conservation (FBC-EC) was compared with the 2021 IECC and the 2019 ASHRAE Standard 90.1. The list of code changes to the 2018 IECC and the IECC based 2020 FBC-EC along with energy and cost impact are provided in Appendix-A. Similarly, the list of code changes to the ASHRAE based 2020 FBC-EC along with energy impact are provided in Appendix-B. The next sub-sections provide an overview code modification.

2.1 The 2020 FBC-EC Qualitative Comparison with IECC-2021

This section summarizes the code changes comparison performed between the IECC based 7th Edition (2020) FBC-EC and the 2021 IECC, and between the 2018 IECC and the 2021 IECC. The code changes review covers the 135 code modifications approved and published in the 2021 IECC. Also, the review identified 33 of the code modifications to have energy use or construction cost impact, and 18 of the code modifications with energy impact were quantitatively analyzed. The list of code changes of the 2021 IECC relative to the 2018 IECC and the IECC based 2020 FBC-EC are summarized in Appendix-A. Summary of the code changes distribution is summarized in Table 1.

Table 1 Distribution of Code Modifications Approved for the 2021 IECC

Commercial Code Section	Code Changes, Count	Code Changes, Percent
Chapter C1: Scope and Administration	4	3.0
Chapter C2: Definitions	19	14.1
Chapter C3: General Requirements	2	1.5
Chapter C4: Commercial Energy Efficiency	105	77.8
Chapter C5: Existing Buildings	3	2.2
Appendix CB: Solar-Ready Zone – Commercial	1	0.7
Appendix CC: Zero Energy Commercial Building Provisions	1	0.7
Total	135	100.0

2.2 The 2020 FBC-EC Qualitative Comparison with ASHRAE 90.1-2019

The qualitative analysis compared code changes between the 2016 ASHRAE Standard 90.1 and 2019 ASHRAE Standard 90.1. The changes review also identified which of the code modifications results in an increase or decrease in energy use. The list of code changes included in the 2019 ASHRAE Standard 90.1 and those changes that have energy use impact are provided in Appendix-B. The list was determined by reviewing the code changes addenda to ASHRAE Standard 90.1-2016 (ASHRAE, 2019) and preliminary energy savings analysis report of ASHRAE Standard 90.1-2019 (U.S. DOE, 2021). Table 2 summarizes the codes changes distribution by various sections of the code. There are 88 code changes addenda included in

ASHRAE Standard 90.1- 2016. Out of the 88 code changes addenda, 34 addenda were identified to have impacts on energy use, and 22 addenda were identified suitable for the quantitative analysis. The 22 addenda items were quantitatively analyzed to determine energy and energy cost impacts of the 2019 ASHRAE Standard 90.1.

Table 2 Distribution of Code Changes Addenda to ASHRAE Standard 90.1-2016

Section	Number of Addenda	Number of Addenda with Energy Impact
Definitions, Abbreviations, and Acronyms	4	-
Administration and Enforcement	4	-
Building Envelope	6	1
Heating Ventilation and Air Conditioning	33	25
Service Water Heating	1	1
Power	-	-
Lighting	10	7
Other Equipment	1	0
Energy Cost Budget Method	5	0
Normative References	2	-
Appendices A – G	22	0
Total	88	34

3. Florida Climate Zones and Prototype Buildings

Based on DOE's climate zones classification the state of Florida is categorized into two climate zones: very hot and humid (1A), and hot and humid (2A). Representative site locations for climate zones 1A and 2A selected for the quantitative analysis were Miami, Florida (1A, very hot, humid) and Orlando, Florida (2A, hot, humid). Orlando was selected as a representative site location for climate zone 2A mainly because it is the geographic center for major cities in climate zone 2A region of the State. Miami is the largest city in climate zone 1A, so it was selected as a representative site location. Representative commercial building stock floor area weighing factors by climate zones and building types and the procedure used to estimate the factors is provided in Appendix-D.

3.1 Prototype Buildings and Floor Area Distribution

Quantitative analysis of the Florida commercial building energy code performance was investigated using the sixteen prototype buildings energy models representing climate zones 1A and 2A. Figure 1 shows the commercial buildings total floor area weighting factors used for Florida by prototype buildings. The eight building types and sixteen prototype energy models shown in Table 3 represent commercial buildings stock floor area and floor area distribution by prototype building in the State of Florida.

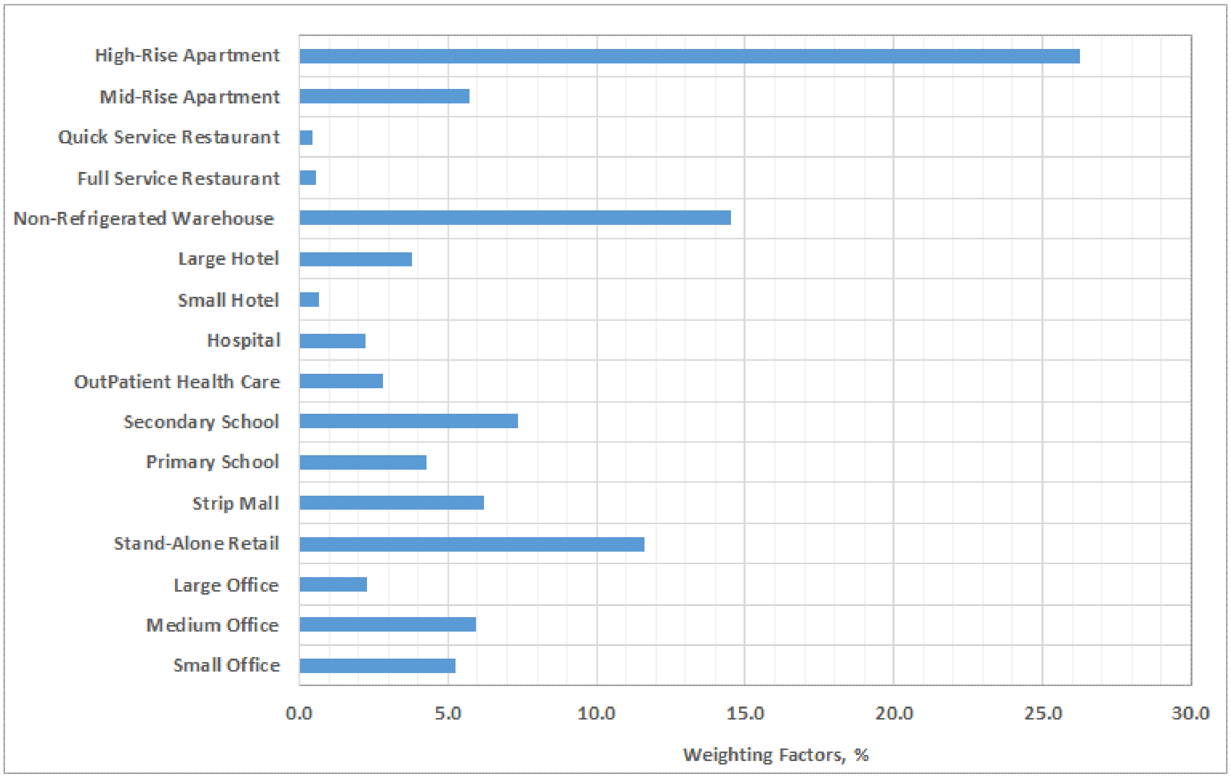

Figure 1 Commercial Prototype Buildings Type and Floor Area Distribution in Florida

The U.S. DOE uses the same prototype buildings to represent the US national commercial building stock for building energy use quantitative analysis and they claim that these building types represent 80% of the US national commercial building floor area stock (DOE, 2018). The prototype building floor area weighting factors presented here are specific for the State of Florida and were determined as described in Appendix-D.

Table 3 Commercial Prototype Buildings Type and Floor Area Distribution in Florida

Building Type	Prototype Building	Prototype Building Floor Area, ft^2	Total Building Floor Area, 1000 ft^2	Floor Area Weighting Factors, %
Office	Small Office	5,502	37,889	5.27
	Medium Office	53,628	42,765	5.94
	Large Office	498,588	16,558	2.30
Retail	Stand-Alone Retail	24,692	83,481	11.60
	Strip Mall	22,500	44,652	6.21
Education	Primary School	73,959	30,815	4.28
	Secondary School	210,887	52,709	7.33
HealthCare	Outpatient Health Care	40,946	20,381	2.83
	Hospital	241,501	16,210	2.25
Lodging	Small Hotel	43,202	4,682	0.65
	Large Hotel	122,120	27,389	3.81
Warehouse	Warehouse	52,045	104,327	14.50
Food Service	Full Service Restaurant	5,502	4,003	0.56
	Quick Service Restaurant	2,501	3,296	0.46
Apartment	Mid-Rise Apartment	33,741	41,402	5.75
	High-Rise Apartment	84,360	188,913	26.25
Total		1,515,674	719,472	100.00

4. Quantitative Analysis of the 2020 Florida Energy Code Performance

The quantitative analysis determined annual site energy use intensity (EUI) and annual Energy Cost Index (ECI) by prototype building. Sixteen commercial prototype buildings type were used to represent the Florida commercial buildings total floor area stock. Compared the annual site energy use and energy cost of the 7th Edition (2020) FBC-EC against the 2021 IECC and 2019 ASHRAE Standard 90.1 code by prototype buildings.

The IECC based 2020 FBC-EC prototype building energy models were created from the 2018-IECC commercial DOE's reference buildings energy models by applying the code changes to the 2020 FBC-EC. The 2021 IECC prototype building energy models were created starting from the 2018-IECC prototype buildings and applying code changes with energy impacts that can be quantitatively analyzed using building energy simulation programs.

The ASHRAE based 2020 FBC-EC prototype building energy models were created from the latest ASHRAE 90.1-2016 reference building energy models by removing the 2020 FBC-EC excluded sections. The 2019 ASHRAE 90.1 code prototype building energy models were DOE reference prototype building energy models published by Pacific Northwest National Laboratory (PNNL) (U. S. DOE, 2020). The DOE reference prototype building energy models were also modified to account for site location and site location dependent parameters such as site water mains temperature and ground temperature. The thirty-two prototype commercial buildings energy models were created for each of the four commercial building codes: the IECC based 2020 FBC-EC, the ASHRAE 90.1-2016 based 2020 FBC-EC, the 2021 IECC and the ASHRAE 90.1-2019. The thirty-two prototype buildings represent the two Florida climate zones. Miami and Orlando were assumed as representative site locations for the two Florida climate zones.

Finally, EUI and ECI of the prototype building energy models for each of the four code categories were computed and evaluated. The EUI and ECI percent difference between the 2020 FBC-EC and 2021 IECC and the 2020 FBC-EC and ASHRAE 90.1-2019 code were calculated as follows:

$$\Delta X = 100 \cdot \frac{X_{2020-FBCEC} - X_{New\ Code}}{X_{2020-FBCEC}}$$

Where X, represents the EUI or ECI value of a prototype building or an aggregate of the sixteen prototype buildings. The EUI for each prototype building was determined by dividing the annual total energy use of a building by its total floor area. The ECI for each prototype building was obtained by dividing the operating annual total energy cost of a building by its total floor area. The operating total energy cost includes annual electric energy cost, demand changes and natural gas energy cost. The rates for electric energy, demand charges and natural gas used in this analysis are provided in Appendix-C. The weighted Florida average site EUI and ECI were determined from the thirty-two commercial prototype buildings using weighting factors that account for the prototypes floor area distribution by building type and climate zones. Table 4 and Table 5 summarize code changes with energy impact included in the quantitative analysis.

Table 4 2021 IECC Changes with Energy Impact and Included in Quantitative Analysis

2021 IECC Section and Title	ICC Code Change No.	Quantitative Analysis, Yes/No	Description
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method	CE61-19, CE73-19	Yes	Impacts warehouse prototype buildings only. This the only metal building prototype.
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method, C402.5.1 Opaque swinging doors	CE70-19	Yes	Reduced swinging doors *U*-Factor for all sixteen prototype buildings in climate zones 1A and 2A.
Table C402.4 Building Envelope Fenestration Maximum U-Factor and SHGC Requirements	CE84-19, CE85-19, CE87-19	Yes	Reduced SHGC and *U*-Factor of fenestrations in all sixteen prototype buildings in climate zones 1A and 2A.
C402.5.11 Operable openings interlocking. Adds new mandatory section. Occupancies that utilize operable opening larger than 40 ft^2 must have the openings interlocked with the heating and cooling system to setback the cooling setpoint to 90°F or heating to 55°F when the operable opening is open in the exterior wall of the building.	CE106-19	Yes	Decreases HVAC energy use by applying thermostat setback when operable opening are opened. Impacts hotel and apartment prototype buildings.
C403.3.2 HVAC equipment performance requirements	CE113-19	Yes	Efficiency upgrade impacts all sixteen prototype buildings in climate zones 1A and 2A.

2021 IECC Section and Title	ICC Code Change No.	Quantitative Analysis, Yes/No	Description
C403.6.5 Supply-air temperature reset controls	CE125-19	Yes	Supply air temperature reset impacts the Large Office, Primary School, Secondary School, and Out-Patient HealthCare prototype buildings in Climate zone 1A only.
C403.7.6.1 Temperature setpoint controls and C403.7.6.2 Ventilation controls	CE135-19	Yes	Impacts large and small hotel prototype buildings but does not alter the stringency of guest room control.
C403.7.4.1 Nontransient dwelling units	CE133-19	Yes	Requires ERV in non-transient dwelling units and impacts high rise and mi rise apartment prototype buildings
C403.8.5 Low-capacity ventilation fans	CE140-19	Yes	Impacts in Out-Patient HealthCare prototype buildings and also included in the cost-benefit analysis.
C405.2.1 Occupant sensor controls, C405.2.1.1 Occupant sensor control function and C405.2.1.4 Occupant sensor control function in corridors	CE169-19	Yes	Impacts eight prototype buildings: Primary School, Secondary School, Out-Patient Health Care, Hospital, Small Hotel, Large Hotel, Mid-Rise Apartment, High-Rise Apartment
C405.2.4.1 Daylight-responsive control function	CE185-19	Yes	Impacts eight prototype buildings.
C405.2.4.2 Sidelit daylight zone	CE187-19	Yes	Impacts twelve prototype buildings: Hospital, Large Hotel, Small Hotel, 3 Offices, Healthcare, 2 Restaurants, schools and warehouse
Table C405.3.2(1) Interior Lighting Power Allowances: Building Area Method	CE206-19	Yes	Reduces lighting power allowance using building area method. Impacts the three office prototype buildings.

2021 IECC Section and Title	ICC Code Change No.	Quantitative Analysis, Yes/No	Description
Table C405.3.2(2) Interior Lighting Power Allowances: Space-by-Space Method	CE208-19	Yes	Reduces lighting power allowance using space-by-space method. Impacts all other prototype buildings except the office prototype buildings.
C405.11 Automatic Receptacle Control, C405.11.1 Automatic receptacle control function	CE216-19	Yes	Included in the quantitative analysis using schedule to account for automatic receptacle control. Impacts large office, medium office, small office, hospital, warehouse, retail standalone, schools, full service restaurant, large hotel, small hotel, and healthcare prototype buildings.
C406.1 Additional energy efficiency credit requirements	CE218-19 CE226-19 CE237-19 CE239-19 CE240-19	Yes	Included in the quantitative analysis using section C406.3.1.

Table 5 2019 ASHRAE 90.1 Changes with Energy Impact and Included in Quantitative Analysis

Addendum	Code Sections Affected	Code Change Summary Between ASHRAE 90.1-2016 and ASHRAE 90.1-2019	Included in quantitative Analysis	Discussion
aw	3.2; Tables 5.5-0 through 5.5-8, 5.8.2.5, 12	Revises the fenestration prescriptive criteria in Tables 5.5-0 through 5.5-8. Fenestration classification is now material neutral and instead grouped into "*fixed*", "*operable*", and "*entrance door*" category.	Yes	Impacts all prototype buildings.
g	3.2, 6.3.2, 6.5.3.8	Provides definition of "occupied-standby mode" and adds new ventilation air requirements for zones served in *occupied-standby mode*. Cooling and heating thermostats setback by at least 1°F.	Yes	Impacts high and mid-rise apartment, offices, outpatient healthcare, and schools prototype buildings.
k	3.2, 6.4.3.3.5	Revise's definition of "networked guest room control system" and aligns HVAC and lighting timeout periods for guest rooms. Reduces the HVAC timeout period from 30 to 20 minutes.	Yes	Impacts small and large hotels prototype buildings.
v	6.5.6.3	Adds section 6.5.6.3 containing heat recovery requirements for space conditioning in acute inpatient hospitals.	Yes	Impacts hospital prototype building.
ap	6.5.3.5	Revises supply air temperature reset controls. Applies supply air temperature reset strategy. This code change will bring up to 5°F supply temperature difference decrease.	Yes	Impacts large office, large hotel, hospital, outpatient healthcare, and schools prototype buildings

au	6.5.2.1	Eliminates the requirement that zones with DDC have air flow rates that are no more than 20% of the zone design peak flow rate. Zone reheated air flow rate can be ventilation requirement per ASHRAE Standard d 62.1 instead of 20% of the peak flow rate.	Yes	Impacts prototype buildings: Medium Office, Large Office, Primary School, Secondary School, Outpatient Health Care, and Large Hotel.
ay	3.2, 6.5.6	Provides separate requirements for nontransient dwelling unit exhaust air energy recovery. New section 6.5.6.1.1 Nontransient Dwelling Units. Requires exhaust energy recovery at least 50% efficiency for cooling and 60% for heating.	Yes	Impacts the Nontransient Dwelling Units are in High and Medium Rise Apartment prototype buildings.
bd	Table 6.8.1-16	Adds the minimum efficiency requirements of Heat Pump and Heat Reclaim Chiller Packages. Adds minimum efficiency requirement for Heat Pump and Heat Reclaim Chiller Packages.	Yes	Impacts hospital prototype building.
be	6.4.1.1; Table 6.8.1-10, 6.8.1-17	Revises the minimum efficiency requirements for Computer Room air conditioners (CRAC). Upgrades the minimum efficiency requirement based on federal minimum efficiency.	Yes	Requires high efficiency CRAC units. Impacts the large office prototype building.
bl	Table 6.8.1-1	Revises Table 6.8.1-1 Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements. Upgrades to federal minimum efficiency requirements.	Yes	Impacts small hotel prototype buildings.
bm	Table 6.8.1-2, 6.8.1-15	Revises Table 6.8.1-2 Electrically Operated Air Cooled Unitary Heat Pumps—Minimum Efficiency Requirements. Adds Table 6.8.1-15. Upgrades the minimum efficiency requirement based on federal minimum efficiency.	Yes	Impacts small office prototype buildings.

bn	3.2, Table 6.8.1-4, Table F3	Revises Table 6.8.1-4 Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps—Minimum Efficiency Requirements.	Yes	Impacts high rise apartment prototype buildings.
bo	3; Table 6.8.1-5; Table F-4	Revises Table 6.8.1-5 Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters—Minimum Efficiency Requirements and adds Table F-4 Residential Warm Air Furnaces – Minimum Efficiency Requirements for sale in the US. (See 10 CFR Part 430).	Yes	Impacts mid-rise apartment, restaurant, office, school, and warehouse prototype buildings depending on capacity.
bp	Table 6.8.1-6; Table F-5	Revises Table 6.8.1.6 – Gas and Oil-Fired Boilers – Minimum Efficiency Requirements and adds table F-5 - Residential Boiler Minimum Efficiency Requirements for applications in the US. (See to 10 CFR 430).	Yes	Impacts hospital, large hotel, schools, Outpatient Healthcare, and large office prototype buildings depending on capacity.
bq	Table 6.8.1-7;	Revises Table 6.8.1-7 Performance Requirements for Heat Rejection Equipment—Minimum Efficiency Requirements. Upgrades to federal minimum efficiency requirements.	Yes	Impacts large office prototype building.
br	Table 6.8.1-11	Revises the previous Tables 6.8.1-12 & 13 and combines them into one table - Table 6.8.1-11 Commercial Refrigerators, Commercial Freezers and Refrigeration—Minimum Efficiency Requirements. *Updates the efficiency levels*.	Yes	Large hotel and Hospital prototype buildings.

bv	6.2.1, 6.6.2, 8.2.1, 8.6.1	Clarifies that designer have the option to use ASHRAE Standard 90.4 Data Centers requirements in computer rooms that have larger than meets >20W/ft^2 or > 10 kW electric, or IT equipment load.	No	Excluded from quantitative analysis because computer rooms in the prototype buildings do not meet this criterion.
bb	Table 9.6.1	Revises the lighting power densities for the Space-by-Space method. The space-by-space method LPDs on average were reduced by 5.0% from 2016 version.	Yes	Impacts all prototype buildings except the office prototype buildings.
cg	Table 9.5.1	Revises Table 9.5.1 Lighting Power Density Allowances Using the Building Area Method. The building area method LPDs on average were reduced by 5.0% from 2016 version.	Yes	Impacts the three office prototype buildings.
cw	9.4.1.1(e), 9.4.1.1(f)	Revises the daylight responsiveness requirements to continuous dimming for sidelight and toplit daylighting controls by (1) eliminating step dimming, (2) using continuous dimming limit set to 20% or less, or off.	Yes	All prototype buildings with daylighting control such as small, medium, and large offices, schools, etc.

4.1 Energy Use Intensity of the 2020 FBC-EC and the 2021-IECC

The IECC based 2020 FBC-EC energy use performance relative to the 2021 IECC was determined using building energy simulation. Sixteen prototype building energy models and two climate zones were used to represent the Florida Commercial Building Sector. In total there are 32 prototype building models representing the IECC based 2020 FBC-EC and the 2021-IECC. The IECC based 2020 FBC-EC prototype building energy models were created from the 2018 IECC DOE reference building energy models applying the code modification approved by Florida Building Commission for the 7th Edition (2020) FBC-EC. The 2021 IECC prototype building energy models were created from the 2018 IECC DOE reference building energy models by applying the code modifications in Table 4.

Energy use performance of the IECC based 2020 FBC-EC and the 2021-IECC were determined using prototype building energy models and simulation. The annual site EUI of each of the prototype buildings for each climate zones were aggregated by Florida climate zone total floor area stock weighing factors to determine the EUI by prototype buildings. Figure 2 shows the annual site EUIs for the commercial prototype buildings of the 2020 FBC-EC and 2021-IECC in the State of Florida. Weighted Florida average annual site EUIs were 46.81 kBtu/ft^2-yr and 43.84 kBtu/ft^2-yr for the IECC based 2020 FBC-EC and the 2021-IECC, respectively. The Florida average annual energy use of the 2020 FBC-EC exceeds that of the 2021-IECC code by 2.97$/ft^2-yr. The Florida average annual site EUI was determined from the sixteen commercial prototype buildings EUIs using weighing factors that account for the commercial buildings total floor area distribution by building type and climate zones.

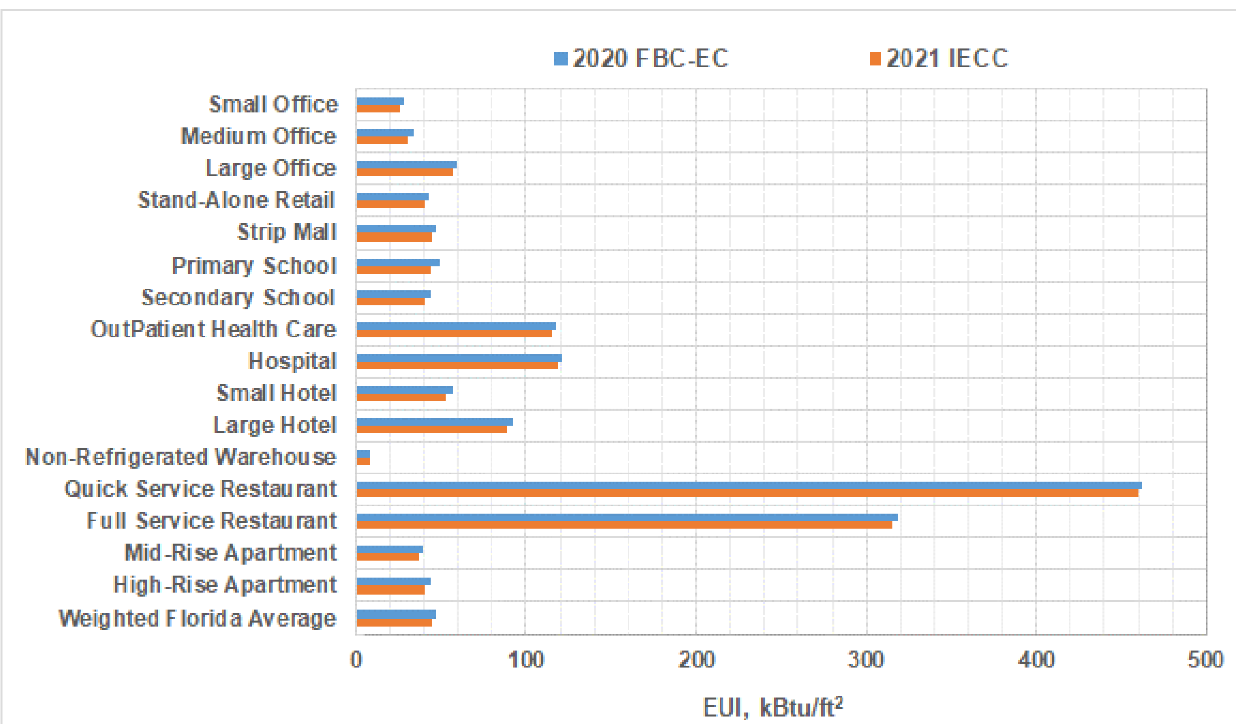

Figure 2 EUI of the IECC based 2020 FBC-EC and the 2021-IECC by Prototype Building

Table 6 summarizes the site annual EUIs of the IECC based 2020 FBC-EC and the 2021-IECC by prototype buildings. The 2021 IECC on average would save 6.35% or 2.97$/ft^2-yr of the annual site energy use relative to the IECC based 2020 FBC-EC. The 2021 IECC Florida average site energy use savings is attributed 42% to lightings, 46% to HVAC and 12% to other end uses.

Table 6 EUI of the IECC based 2020 FBC-EC and the 2021-IECC by Prototype Building

Building Type	**Weighting Factors, %**	**2020-FBC-EC EUI, kBtu/ft^2-yr**	**2021-IECC EUI, kBtu/ft^2-yr**	**ΔEUI, kBtu/ft^2-yr**
Small Office	5.27	28.72	26.1	2.62
Medium Office	5.94	33.87	30.8	3.06
Large Office	2.30	59.64	57.07	2.57
Stand-Alone Retail	11.60	42.49	40.33	2.16
Strip Mall	6.21	47.41	45.23	2.18
Primary School	4.28	49.46	43.76	5.7-
Secondary School	7.33	43.62	40.00	3.62
Outpatient Health Care	2.83	117.57	115.65	1.92
Hospital	2.25	120.96	118.75	2.21
Small Hotel	0.65	56.51	52.35	4.17
Large Hotel	3.81	92.03	88.18	3.85
Warehouse	14.50	8.73	8.59	0.14
Full Service Restaurant	0.56	461.93	459.52	2.42
Quick Service Restaurant	0.46	318.23	315.27	2.97
Mid-Rise Apartment	5.75	39.81	36.25	3.56
High-Rise Apartment	26.25	43.23	38.8	4.44
Florida Average	100.00	46.81	43.84	2.97

4.2 Energy Cost Index of the IECC Based 2020 FBC-EC and 2021-IECC

In addition to energy use performance comparison, the total annual Energy Cost Index (ECI) of the IECC based 2020 FBC-EC prototype building energy models were compared against that of the 2021 IECC. The annual site ECIs of each of the prototype buildings were weighed by Florida climate zones weighing factors to determine the ECI by prototype building. Figure 3 shows the ECIs of the IECC based 2020 FBC-EC and the 2021 IECC in the State of Florida. Florida average ECI was determined by aggregating the sixteen commercial prototype buildings ECI using weighting factors that account for the state's commercial building floor area distribution by the two climate zones and prototype buildings. The Florida average ECIs for the IECC based 2020 FEC and the 2021 IECC were 1.012 $/ft^2-yr and 0.954 $/ft^2-yr, respectively.

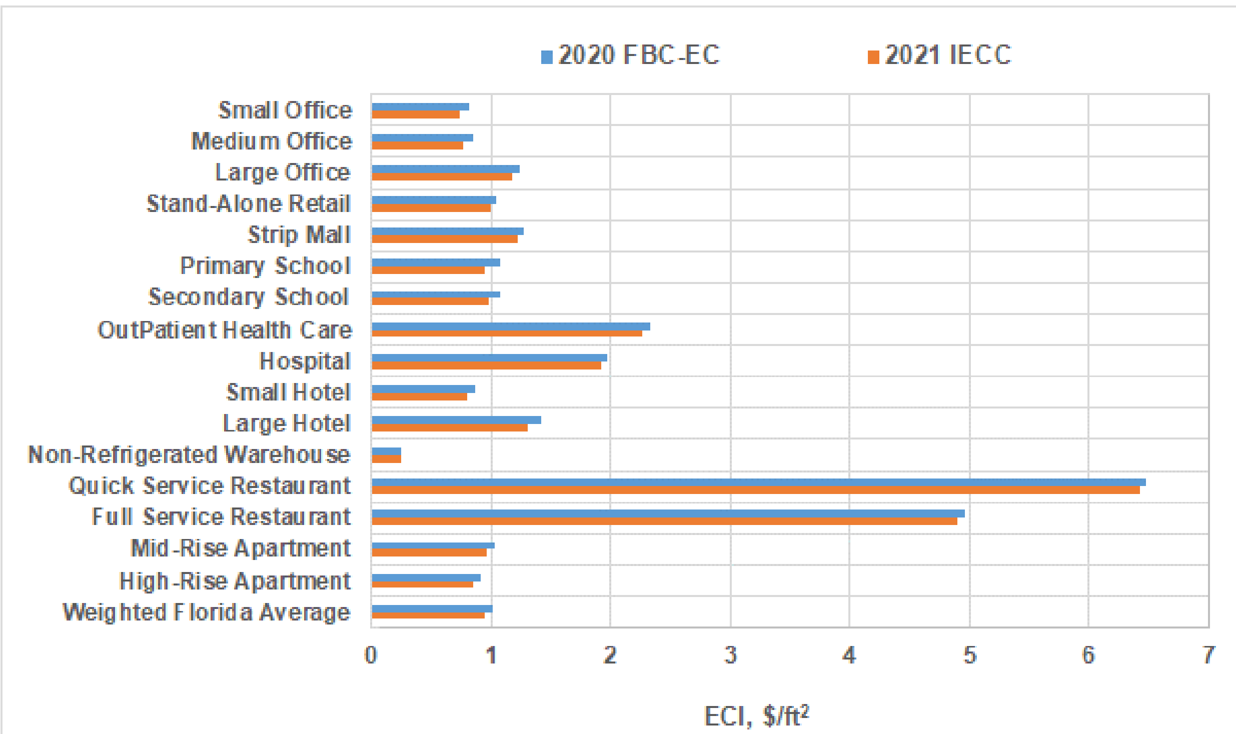

Figure 3 ECI of the IECC based 2020 FBC-EC and the 2021-IECC by Prototype Building

Table 7 summarizes the ECIs of the IECC based 2020 FBC-EC and the 2021 IECC prototype buildings. The 2020 FBC-EC Florida average annual operating ECI, which is an aggregate of the sixteen commercial prototype buildings for the state of Florida, is higher by about $0.076/ft^2-yr, or the 2021 IECC on average would save 7.51% of annual energy cost relative to the 2020 FBC-EC.

Table 7 ECI of the IECC based 2020 FBC-EC and the 2021-IECC by Prototype Building

Building Type	**Weighting Factors, %**	**2020-FBC-EC ECI, $/ft^2-yr**	**2021-IECC ECI, $/ft^2-yr**	**ΔECI, $/ft^2-yr**
Small Office	5.27	0.82	0.75	0.07
Medium Office	5.94	0.86	0.78	0.08
Large Office	2.30	1.24	1.18	0.06
Stand-Alone Retail	11.60	1.05	1.00	0.05
Strip Mall	6.21	1.28	1.22	0.05
Primary School	4.28	1.07	0.95	0.12
Secondary School	7.33	1.08	0.98	0.09
Outpatient Health Care	2.83	2.33	2.27	0.05
Hospital	2.25	1.98	1.93	0.05
Small Hotel	0.65	0.87	0.80	0.07
Large Hotel	3.81	1.42	1.30	0.11
Warehouse	14.50	0.25	0.25	0.00
Full Service Restaurant	0.56	6.48	6.43	0.05
Quick Service Restaurant	0.46	4.97	4.90	0.07
Mid-Rise Apartment	5.75	1.03	0.94	0.08
High-Rise Apartment	26.25	0.92	0.80	0.12
Weighted Florida Average	100.00	1.012	0.936	0.076

4.3 Energy Use Intensity of the 2020 FBC-EC and ASHRAE 90.1-2019

The ASHRAE based 7th Edition (2020) FBC-EC buildings performance was determined and compared against that of the 2019 ASHRAE 90.1 using DOE's sixteen commercial prototype buildings. The code changes addenda to the 2016 ASHRAE 90.1 code quantitatively analyzed are summarized in Table 5. The annual site EUIs of the ASHRAE based 2020 FBC-EC prototype buildings were compared to that of the ASHRAE 90.1-2019 code by prototype buildings. The annual site EUI of each of the prototype buildings type were aggregated by Florida's total floor area stock weighing factors by climate zone to determine the EUI by prototype building types. Figure 4 shows the EUIs of the prototype buildings energy models of the ASHRAE based 2020 FBC-EC and ASHRAE 90.1-2019 code in the State of Florida. The Florida average site annual EUIs for the commercial provisions were 47.32 kBtu/ft^2-yr and 44.30 kBtu/ft^2-yr for the ASHRAE based 2020 FBC-EC and the 2019 ASHRAE 90.1 code, respectively. The 2016 ASHRAE 90.1 based 2020 FBC-EC code results are labeled as ASHARE-2016 FBC-EC.

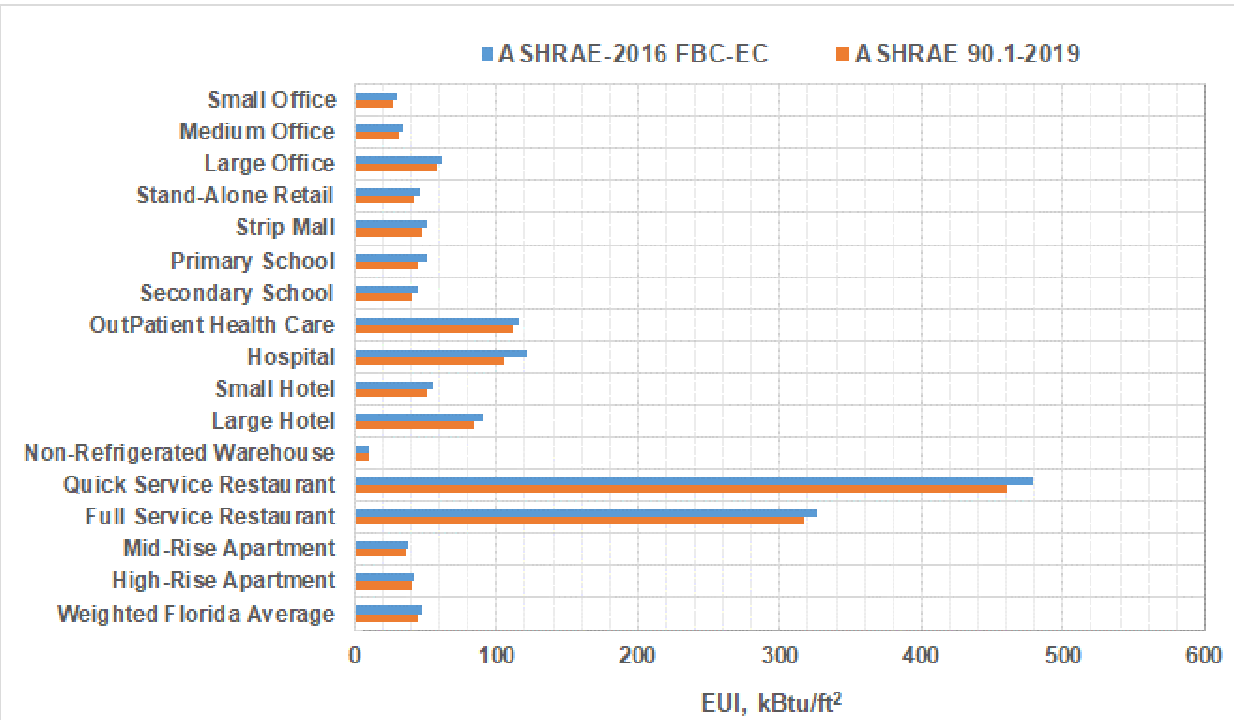

Figure 4 EUI of the ASHRAE based 2020 FBC-EC and the 2019 ASHRAE 90.1 by Prototype Building

Table 8 summarizes the EUIs of the ASHRAE based 2020 FBC-EC and ASHRAE 90.1-2019 code by prototype buildings. All the sixteen prototype buildings energy models designed with the 2020 FBC-EC had site annual EUIs higher than that of ASHRAE 90.1-2019 code energy models. Based on the Florida weighted average annual site EUI value, the ASHRAE based 2020 FBC-EC commercial buildings exceeds the EUI's of the 2019 ASHRAE 90.1 code by 3.02 kBtu/ft^2-Yr, or the 2019 ASHRAE 90.1 code on average would save 6.38% of Florida's commercial buildings annual energy use. The 2019 ASHRAE 90.1 code annual energy use savings attributed 40% to lightings, 43% to HVAC and 17% to other end uses.

Table 8 EUI of the ASHRAE based 2020 FBC-EC and the 2019 ASHRAE 90.1 by Prototype Building

Building Type	Weighting Factors, %	ASHRAE-2016 FBC-EC EUI, kBtu/ft²-yr	ASHRAE 90.1-2019 EUI, kBtu/ft²-yr	ΔEUI, kBtu/ft²-yr
Small Office	5.27	30.21	26.83	3.37
Medium Office	5.94	34.30	31.76	2.54
Large Office	2.30	61.55	57.76	3.80
Stand-Alone Retail	11.60	46.28	42.53	3.76
Strip Mall	6.21	50.52	47.44	3.08
Primary School	4.28	51.07	43.88	7.19
Secondary School	7.33	44.47	40.06	4.41
Outpatient Health Care	2.83	115.64	112.06	3.58
Hospital	2.25	121.98	106.12	15.86
Small Hotel	0.65	54.80	51.72	3.08
Large Hotel	3.81	91.52	83.70	7.82
Warehouse	14.50	9.71	9.43	0.28
Full Service Restaurant	0.56	478.74	460.76	17.98
Quick Service Restaurant	0.46	326.05	317.16	8.88
Mid-Rise Apartment	5.75	38.40	36.35	2.05
High-Rise Apartment	26.25	41.27	40.20	1.06
Weighted Florida Average	100.00	47.32	44.30	3.02

The Florida average annual energy use performance of ASHRAE-2016 FBC-EC code indicates that additional code modifications are required to make the ASHRAE based 2020 FBC-EC perform as good as the 2019 ASHRAE 90.1 code. In this regard, all the code changes addenda to the 2016 ASHRAE 90.1 code and currently excluded code changes are required to bring the ASHRAE based 2020 FBC-EC code equivalent to the 2019 ASHRAE 90.1 code. The ASHRAE based 2020 FBC-EC currently excludes automatic receptacle control section 8.4.2, interior lighting control section 9.4.1.1(g) and electrical energy monitoring section 8.4.3 of the 2016 ASHRAE 90.1 code. Therefore, the performance difference between ASHRAE based 2020 FBC-EC and the 2019 ASHRAE 90.1 code is partly due to exclusion of two of these code sections. ASHRAE 90.1-2016 and ASHRAE 90.1-2019 codes require automatic receptacle control in space types such as private offices, conference rooms, printing and copying rooms, classrooms, break rooms, and private workstation (ASHRAE, 2016; 2019). The Large Hotel, Small Hotel, Hospital, Medium Office, Large Office, Small Office, Standalone Retail, Full-service Restaurant, Primary School, Secondary School, Outpatient Healthcare, and Warehouse prototype buildings of ASHRAE 90.1-2016 and ASHRAE 90.1-2016 codes have automatic receptacle control. Automatic receptacle control in the prototype buildings energy models were accounted for using reduced plug load schedules (U.S. DOE, 2018).

4.4 Energy Cost Index of 2020 FBC-EC and ASHRAE 90.1-2019

In addition to energy use performance comparison, the total annual Energy Cost Index (ECI) of the ASHRAE based 2020 FBC-EC were computed and compared against that of ASHRAE 90.1-2019 code by prototype buildings. The ECIs of each of the prototype buildings were weighed by Florida climate zones weighing factors to determine the ECI by a prototype building. Figure 5 shows the ECI of prototype buildings designed with the ASHRAE based 2020 FBC-EC and ASHRAE 90.1-2019 code for the State of Florida. The 2016 ASHRAE 90.1 based 2020 FBC-EC code results are labeled as ASHARE-2016 FBC-EC.

The Florida average ECIs computed for the commercial provisions were 1.01 $\$/ft^2$-yr and 0.95 $\$/ft^2$-yr for the ASHRAE based 2020 FBC-EC and the 2019 ASHRAE 90.1 code, respectively. Table 9 summarizes the annual ECI's of the ASHRAE based 2020 FBC-EC and the 2019 ASHRAE 90.1 prototype buildings. The ASHRAE based 2020 FBC-EC Florida average annual operating total energy cost index (ECI) was higher by about $\$0.06/ft^2$-yr. In other words the 2019 ASHRAE 90.1 code on average would save about 5.94% or $\$0.06/ft^2$-yr of annual site energy cost relative to the ASHRAE based 2020 FBC-EC.

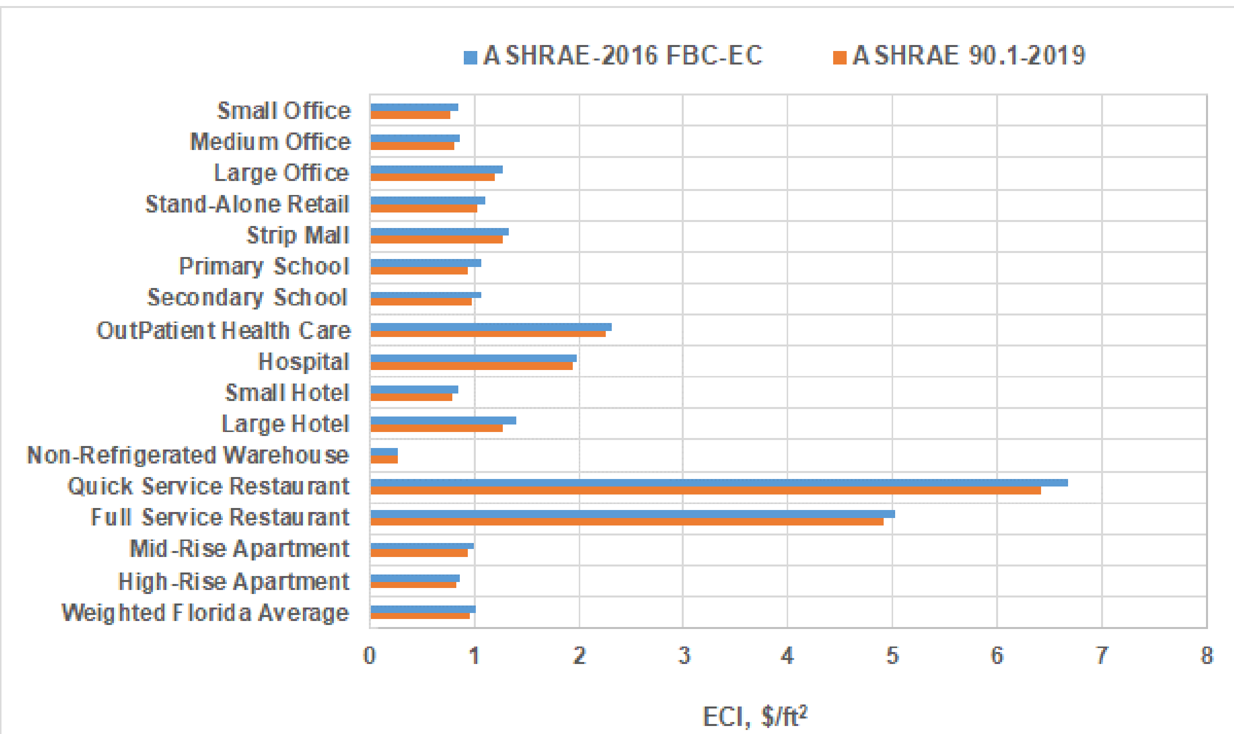

Figure 5 ECI of ASHRAE based 2020 FBC-EC and the 2019 ASHRAE 90.1 by Prototype Building

Table 9 ECI of the ASHRAE based 2020 FBC-EC and the 2019 ASHRAE 90.1 by Prototype Building

Building Type	Weighting Factors, %	ASHRAE 2016 FBC-EC ECI, $/ft^2-yr	ASHRAE 90.1-2019 ECI, $/ft^2-yr	ΔECI, $/ft^2-yr
Small Office	5.27	0.85	0.77	0.08
Medium Office	5.94	0.86	0.81	0.05
Large Office	2.30	1.28	1.20	0.08
Stand-Alone Retail	11.60	1.11	1.04	0.07
Strip Mall	6.21	1.32	1.27	0.05
Primary School	4.28	1.07	0.94	0.13
Secondary School	7.33	1.07	0.97	0.10
Outpatient Health Care	2.83	2.31	2.26	0.06
Hospital	2.25	1.99	1.95	0.04
Small Hotel	0.65	0.85	0.79	0.06
Large Hotel	3.81	1.40	1.27	0.14
Warehouse	14.50	0.27	0.26	0.01
Full Service Restaurant	0.56	6.69	6.43	0.26
Quick Service Restaurant	0.46	5.03	4.92	0.11
Mid-Rise Apartment	5.75	1.00	0.94	0.05
High-Rise Apartment	26.25	0.86	0.83	0.03
Weighted Florida Average	100.00	1.01	0.95	0.06

4.5 Summary of the 2020 Florida Energy Code Performance

This section summarizes energy use performance of the 2020 FBC-EC, 2019 ASHRAE 90.1 code and the 2021 IECC. The 2020 FBC-EC has two performance based compliance options: the IECC based 2020 FBC-EC, which is labeled as 2020 FBC-EC and ASHRAE based 2020 FBC-EC, which is labeled as ASHRAE-2016 FBC-EC. The two 7th Edition (2020) FBC-EC provisions were reviewed, and their performance was compared with that of the 2021 IECC and ASHRAE 90.1-2019 code. Figure 6 shows annual site energy use intensity (EUI) of the IECC based 2020 FBC-EC, ASHRAE based 2020 FBC, the 2021 IECC and the 2019 ASHRAE 90.1 Code. Figure 7 shows annual energy cost index (EUI) of the IECC based 2020 FBC-EC, ASHRAE based 2020 FBC, the 2021 IECC and the 2019 ASHRAE 90.1 Code.

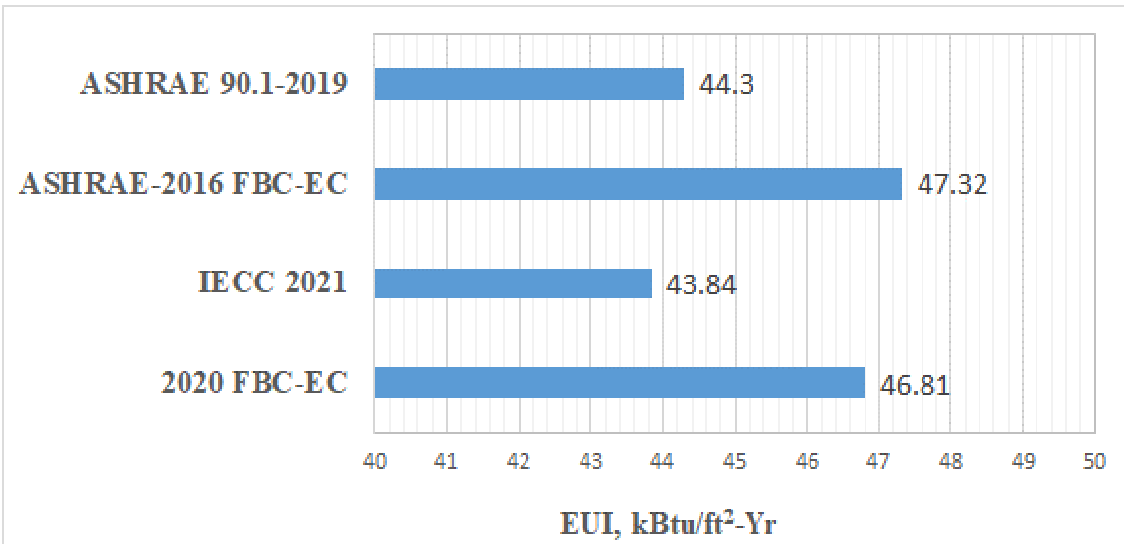

Figure 6 Florida Average Annual Energy Utilization Intensity

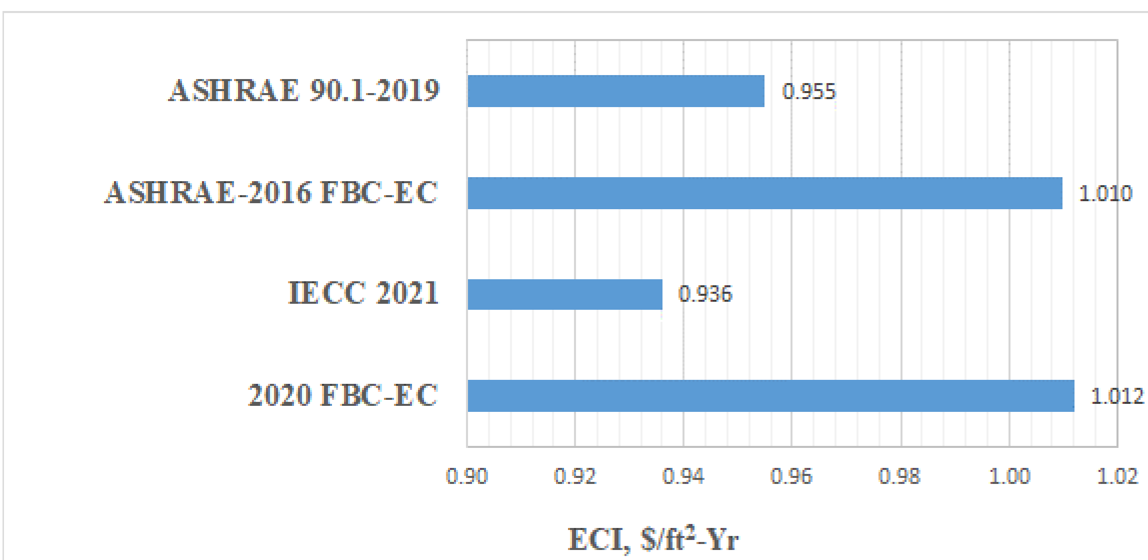

Figure 7 Florida Average Annual Energy Cost Index

5. Economic Analysis of the 2020 Florida Energy Code

Economic analysis is intended to perform cost effectiveness test of code modifications between the 2021 IECC and the IECC based 2020 FBC-EC and between the 2019 ASHRAE 90.1 code and ASHRAE based 2020 FBC-EC. The cost effectiveness analysis used annual energy savings determined between the base case, which is the 7th Edition (2020) Florida Building Code, Energy Conservation, and the 2021 IECC and the 2019 ASHREA 90.1 upgrade. This requires creating a separate baseline and upgrade code prototype building energy model for each of the code modification whose energy savings potential was determined using building energy models and simulations. In some special circumstances where the energy savings of a code modification cannot be determined using building energy models and simulation, published sources were used to estimate the annual energy savings. The annual and life cycle energy costs were computed using Florida energy rates for electricity and natural gas and energy price escalation rates for U.S. south-east region provided in Appendix-C.

The code modification or addenda number along with brief description of the code changes, energy and construction cost impacts are provided in Appendix-A and Appendix-B. Code modifications whose energy impact cannot be analyzed quantitatively, code modifications with no or negligible incremental construction cost, federally enforced minimum code requirements, or those code changes cannot be represented in the existing prototype buildings model are excluded from cost-effectiveness analysis. Details of the cost effectiveness analysis and results are provided in Appendix-E.

5.1 Cost-benefit Analysis of Code Modifications

Cost benefit analysis of selected code modifications was performed by calculating savings to investment ratio (SIR). SIR is ratio of net present value of the energy cost savings over a service life span to net present value of life cycle cost of the investment. The net energy cost savings and net investment cost were determined from the difference between the IECC based 2020 FBC-EC and the 2021 IECC, and between the ASHRAE based 2020 FBC-EC and the 2019 ASHRAE 90.1 Code. Energy savings of code modifications CE111-19 and CE215-19 cannot be determined via building energy model and simulation; hence, their annual energy saving was estimated from published sources.

In the cost-benefit analysis a constant dollar approach with real discount rate of 5.0% was assumed for the life cycle cost calculation. The net present value of energy cost and net present value of their investment cost were determined using EnergyPlus, Whole Building Simulation Software. The SIR values were determined by post processing the EnergyPlus life cycle cost output variables. SIR value less than 1.0 means the net life cycle investment cost exceeds the net life cycle energy savings cost of the code modification or the upgrade; hence, it is considered not economical, or not cost-effective.

5.2 IECC Changes Cost-Benefit Analysis Summary

Sixteen code modifications with energy impact were considered for cost-benefit analysis. Out of the sixteen code modifications investigated for cost-effectiveness for the 2021 IECC changes, fifteen of them had SIR value greater than 1.0; hence they are considered economically feasible and are recommended for consideration by Florida Building Commission for addition to the 8th

Edition (2023) Florida Building Code, Energy Conservation. Whereas one of the code modifications CE133-19, which is Exhaust Air Energy Recovery Ventilators (ERV) in Nontransient Dwelling Units, had SIR value less than 1.0; hence, it is not cost effective. However, the 2021 ICC[1] revision history document claims that this code modification is cost effective. It is strongly recommended that the Florida Building Commission consider funding field study of ERV in Florida to determine and demonstrate monitored energy saving potential and its cost-effectiveness before adopting this code change. Table 10 summarizes cost-benefit test results for each of the sixteen code modifications investigated.

Table 10 IECC 2021 Code Modification Cost Effectiveness Test Results Summary

Code Mod #	**Code Section # and Brief Description of Proposed Code Modifications**	**Savings to Investment Ratio (SIR)**
CE70-19	Section C402.1.4 Reduces *U*-Factor for opaque swinging doors from 0.61 to 0.37 Btu/(hr-ft^2-°F) in climate zones 1 through 4 in Section C402.1.4	1.85
CE84-19 CE85-19 CE87-19	Table C402.4 Vertical Fenestration and Skylight Upgrade	1.82
CE97-19	Section C402.5.1.2 Air barrier compliance. Introduces two new options for measuring air leakage. Section C402.5.2 Dwelling and sleeping unit enclosure testing and Section C402.5.3 Building thermal envelope testing. Building that do not meet these testing requirements are required to comply with the existing prescriptive air barrier requirements of material and assemblies. Section C402.5.3 exempts buildings with floor area larger than 5000 ft^2 from testing requirement in climate zone 1 and 2A. The cost-benefit analysis is conducted using office prototype buildings.	1.73 – 6.09

[1] Complete *Revision History to the 2021 I-Codes*. 2020. International Code Council, Inc. http://shop.iccsafe.org/codes/2018-international-codes-and-references/2018-international-building-code-and-references/complete-revision-history-to-the-2018-i-codes-successful-changes-and-public-comments-pdf-download.html.

Code Mod #	Code Section # and Brief Description of Proposed Code Modifications	Savings to Investment Ratio (SIR)
CE106-19	CE106-19: Section C402.5.11 Operable openings interlocking. Adds new mandatory section. Occupancies that utilize operable opening larger than 40 ft^2 must have the openings interlocked with the heating and cooling system to setback the cooling setpoint to 90°F or heating to 55°F when the operable opening is open in the exterior wall of the building. This code requirement primarily impacts hotel and dwelling buildings. Thus, the code impact analysis was conducted in small and large hotel and the mid and high rise apartment prototype buildings.	7.0
CE111-19	Adds a new section C403.2.3 Fault Detection and Diagnostics. New buildings with an HVAC system serving a gross conditioned floor area of 100,000 ft^2 or larger must have a fault detection and diagnostics (FDD) system to monitor the HVAC system's performance and automatically identify faults. The change requires permanently installed sensors, sample data every 15 minutes, and communicate faults and recommended repair remotely. R-1 and R-2 group buildings are exempted from this requirement.	1.57 – 15.21
CE125-19	Adds new sub-section C403.6.5.1 Dehumidification Control Interaction. This section says, in climate zones 0A, 1A, 2A, and 3A the HVAC system design must allow supply-air temperature to reset while the dehumidification is provided. When dehumidification is active, air economizer must be locked out. This new requirement implies a change in system design that allows supply air temperature reset while the supply is dehumidified to meet the controlled space air target humidity set-point. There are two ways this can be achiever: (1) dehumidify the outdoor air supply using a dedicated outdoor air system (DOAS), or (2) separately dehumidify the outdoor is in outdoor air system before mixing it with return air.	2.0 – 2.46

Code Mod #	Code Section # and Brief Description of Proposed Code Modifications	Savings to Investment Ratio (SIR)
CE127-19	Section C403.7.1 Demand control ventilation, Reduces people occupancy density threshold from 25 to 15 people or greater per 1,000 ft^2 of floor area. This code now expands demand control ventilation requirement to spaces with occupant density as low as 15 people or greater per 1,000 ft^2, where previously not required.	2.23
CE133-19	Section C403.7.4.1 Energy Recovery in Nontransient Dwelling Units. Adds a new requirement for exhaust air energy recovery for nontransient dwelling unit.	0.04
CE140-19	Adds a new section for ventilation fans with motors less than 1/12 hp (0.062 kW), i.e., section C403.8.5 Low-capacity ventilation fans. This code change requires minimum fan efficacy for ventilation fans with motor size less 62W that are commonly used in bathrooms, utility rooms and heat and energy recovery ventilators. The previous code did not have any requirements for this range fans.	1.46
CE169-19	Section C405.2.1 Occupant sensor controls in Corridor Spaces. The change revised section C405.2.1 Occupant sensor controls to add “Corridor” space type to the list of space types where occupant *sensor controls* must be installed for general lighting to control and a new section C405.2.1.4 was added that corridor space type lighting control must comply. The new sub-section C405.2.1.4 Occupant sensor control function in corridors says that Occupant sensor controls in corridors must uniformly reduce lighting power to not more than 50% of full power within 20 minutes after all occupants have left the space. Exception: corridors provided with less than two foot-candles of illumination on the floor are exempted.	4.20
CE185-19	Section C405.2.4.1 changes the daylight responsive control function to continuous dimming from step dimming for sidelit and toplit daylighting controls.	33.33

Code Mod #	Code Section # and Brief Description of Proposed Code Modifications	Savings to Investment Ratio (SIR)
CE187-19	Adds secondary sidelit zones requirements to section C405.2.4.2 Sidelit daylight zone. The area of secondary sidelit zones must not be considered in the calculation of the daylight zones in Section C402.4.1.1. Adds secondary sidelit zone requirement to section C405.2.4.2 Sidelit daylight zone. Adding secondary sidelit zone increases the daylighting controlled area often doubling it and increases the potential of lighting energy saving. Addition of the secondary sidelit zone aligns the 2021 IECC with the 2019 ASHRAE 90.1 standard.	1.77
CE206-19	Interior Lighting Power Density Reduction. Reduces the interior lighting power density (LPD) for building area method in Table C405.3.2(1).	5.77
CE208-19	Interior Lighting Power Density Reduction. Reduces the interior lighting power density (LPD) for space-by-space method in Table C405.3.2(2).	3.71
CE215-19	Section C405.12 Energy Monitoring. New buildings with a gross conditioned floor area of 25,000 ft^2 or larger must be equipped to measure, monitor, record, and report energy consumption data in accordance with Section C405.12.1 through C405.12.5.	3.44 – 14.01
CE216-19	Adds mandatory new section C405.11 Automatic Receptacle Control that automatically reduce plug load for scheduling control, load-sensing control, and occupancy control devices. The code says, at least 50% of all 125 V, 15 and 20-amp receptacles installed in enclosed offices, conference rooms, rooms used primarily for copy or print functions, breakrooms, classrooms, and individual workstations, including those installed in modular partitions and module office workstation systems must have automatic controls.	2.19

Details of assumptions and the cost-benefit calculations for each of the code modifications investigated are available in Appendix-E.

5.3 ASHRAE 90.1 Changes Cost-Benefit Analysis Summary

Ten addenda items were investigated for cost-effectiveness and found nine of them to be cost-effective and are recommended for consideration by Florida Building Commission for addition to the 8th Edition (2023) Florida Building Code, Energy Conservation. Addenda item *ay*, which requires exhaust air energy recovery ventilators in non-transient dwelling units, found out to have SIR value of 0.10. This value is way below the SIR threshold of 1.0 for cost effectiveness. Therefore, addendum *ay* is not recommended for addition to the 8th Edition (2023) Florida Building Code, Energy Conservation, prior to field demonstration research. Table 11 summarizes cost-effectiveness test results for the ten addenda items investigated.

Table 11 ASHRAE 90.1-2019 Code Modification Cost Effectiveness Test Results Summary

Addenda	**Code Section # and Brief Description of Proposed Code Modifications**	**Savings to Investment Ratio (SIR)**
ap	Revises supply air temperature reset controls in Section 6.5.3.5. This code change brings at least 5.0°F (2.8°C) supply temperature difference reset depending on outdoor air temperature or load and has revised exemption depending on climate zone and system design outdoor air flow rate. A new sub-section 6.5.3.5.1 Dehumidification Control Interaction. In Climate Zones 0A, 1A, 2A, and 3A, requires supply air temperature *reset* while dehumidification is provided.	1.24 – 2.37
au	Eliminates the requirement that zones with DDC have air flow rates that are no more than 20% of the zone design peak flow rate. No construction cost increase for this code modification.	∞
aw	Revise's fenestration prescriptive criteria in Tables 5.5-0 through 5.5-8. Fenestration classification is now material neutral and grouped into "fixed", "operable", and "entrance door" categories. The SHGC change is slightly more stringent, but the *U*-factor stringency depends on the fenestration class. It is more stringent for fixed and relaxed for operable fenestration classes.	1.89
ay	Adds a new section for nontransient dwelling unit exhaust air energy recovery, i.e., section 6.5.6.1.1 Nontransient Dwelling Units. This code impacts multi-family commercial buildings.	0.10

Addenda	Code Section # and Brief Description of Proposed Code Modifications	Savings to Investment Ratio (SIR)
cg	Revises Table 9.5.1 Lighting Power Density (LPD) Allowances for the Building Area Method. The LPD values were reduced for most of the building types. Assumes 100% penetration of LED technologies.	5.45
bb	Revises Table 9.6.1 Lighting Power Density (LPD) Allowance for the Space-by-Space method. The LPD values were reduced for most of the space types. Assumes 100% penetration of LED technologies.	2.84
cw	Revise's daylight responsiveness requirements to continuous dimming from step dimming for sidelit and toplit daylighting control. Stepped dimming is replaced with continuous dimming and minimum power input limit set to 20% or less, or off from 30%, and control daylights to unoccupied setpoint when needed.	34.44
g	Adds new definition for "occupied-standby mode" and adds new ventilation air requirements for zones served rooms in occupied-standby mode. Adds new definition. Unoccupied space does not need to be ventilated per standard 62.1 when spaces air temperature is within the allowed limits. Thus, this code change allows to reduce ventilation air requirement to zero and setbacks cooling and heating thermostats by at least 1°F (0.56°C) for zones served in occupied-standby mode. Furthermore, this code change is intended to tie occupied-standby mode to lighting control requirement in section 9.4.1.1, i.e., when a space is not occupied for more than 20 minutes, lighting is turned off automatically.	1.06 - 2.22
k	Revise's definition of "networked guest room control system" and aligns HVAC and lighting timeout periods for guest rooms. Reduced the HVAC timeout period from 30 to 20 minutes to match the 20 minutes timeout period for lighting control. Similar change was made to the ventilation requirements to account for reduction to the time out period.	6.0 – 49.6

Addenda	Code Section # and Brief Description of Proposed Code Modifications	Savings to Investment Ratio (SIR)
v	Adds a new section 6.5.6.3 containing heat recovery requirements for space conditioning in acute inpatient hospitals. Where heating water is used for space heating, a condenser heat recovery *system* must be installed, , provided all the following conditions are met: • Inpatient hospital building operated 24 hours. • Cooling design conditions exceeds 300 tons. • Simultaneous heating and cooling occur above 60°F outdoor air temperature	1.33

Details of assumptions and the cost effectiveness test calculations for each of the code modifications investigated are available in Appendix-E.

6. Analysis Summary and Conclusion

The code change between the IECC based 2020 FBC-EC and the 2021 IECC, and the changes between ASHRAE based 2020 FBC and the 2019 ASHRAE 90.1 were reviewed, and the code changes energy use and construction cost impacts were identified. Out of the 135 code modifications added to the 2021 IECC, there were 33 code changes with energy impact and 18 of them were quantitatively analyzed. Similarly, there were 88 addenda included in the 2019 ASHRAE 90.1, 34 code changes have energy impact and 22 of them were quantitatively investigated.

The IECC and ASHRAE based 2020 FBC-EC performance were investigated quantitatively using prototype buildings energy models and compared against the 2021 IECC and the 2019 ASHRAE 90.1 code. The quantitative analysis compared annual site Energy Use Intensity (EUI) and annual Energy Cost Index (ECI) determined using commercial prototype buildings energy models and simulation. The analysis used sixteen prototype buildings energy models and two climate zones for each code base. Miami and Orlando, Florida site locations were used for climate zones 1A and 2A, respectively. EnergyPlus Version 9.0.1, whole building performance simulation program, was used for the analysis. Weighted across sixteen prototype buildings and two climate zones in Florida on average the 2021 IECC would save 6.35% (2.97 kBtu/ft^2-yr) annual site energy use and 7.51% building energy cost compared to the IECC based 7th Edition (2020) FBC-EC. Similarly, the ASHRAE 90.1-2019 code weighted across sixteen prototype buildings and two climate zones in Florida on average would save 6.38% (3.02 kBtu/ft^2-yr) annual site energy use or 5.94% energy cost compared to the ASHRAE based 7th Edition (2020) FBC-EC.

There were thirty three code changes with energy impact included in the IECC 2021, eighteen were quantitatively investigated, sixteen were tested for cost effectiveness, and fifteen code modification were cost-effective. These fifteen IECC 2021 code modifications are strongly encouraged for consideration by Florida Building Commission for addition to the 8th Edition (2023) FBC-EC. There were 34 code changes with energy impact added to the 2019 ASHRAE Standard 90.1. Out these 34 code changes with energy impact, only 22 were quantitatively analyzed, and only ten code changes were tested for cost effectiveness. Nine out of the ten code modifications were cost-effective. Therefore, the nine code changes, which are determined cost-effective, are strongly recommended for consideration by Florida Building Commission for addition to the 8th Edition (2023) Florida Building Code, Energy Conservation.

All the other code changes with building energy reduction impact that were not included in the cost-benefit analysis are also recommended for consideration by Florida Building Commission for additions to the 8th Edition (2023) Florida Building Code, Energy Conservation. Details of quantitatively analyzed code changes with Energy impact that are recommended for addition to the 8th Edition Florida Building Code, Energy Conservation are available in Appendix-A and Appendix-B. Details of the cost-benefit analysis results are discussed in Appendix-E.

7. Reference

ASHRAE. 2016. ANSI/ASHRAE/IES Standard 90.1-2016. Energy Standard for Buildings Except Low-Rise Residential Buildings. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Atlanta, Georgia.

ASHRAE. 2019. ANSI/ASHRAE/IES Standard 90.1-2019. Energy Standard for Buildings Except Low-Rise Residential Buildings. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Atlanta, Georgia.

IECC. 2021. 2021 International Energy Conservation Code. International Code Council, Inc. Washington, D.C. 2001.

IECC. 2018. 2018 International Energy Conservation Code. International Code Council, Inc. Washington, D.C. 2001.

I-Codes. 2020. Complete Revision History to the 2021 I-Codes. 2020. International Code Council, Inc. http://shop.iccsafe.org/codes/2018-international-codes-and-references/2018-international-building-code-and-references/complete-revision-history-to-the-2018-i-codes-successful-changes-and-public-comments-pdf-download.html.

Jarnagin, R.E. and G.K. Bandyopadhyay. 2010. Weighting Factors for the Commercial Prototype buildings Used in the Development of ANSI/ASHRAE/IENSA Standard 90.1-2010. PNNL-19116, Pacific Northwest National Laboratory, Richland, Washington.

Thornton, B. A., Wang, W., Cho, H., Xie, Y., Mendon, V. V., Richman, E. E., Zhang, J., Athalye, R. A., Rosenberg, M. I., and Liu, B. 2011. Achieving 30% Goal: Energy and Cost Saving Analysis of ASHRAE/IES Standard 90.1-2010. Pacific Northwest National Laboratory, Richland, Washington. Available at http://www.energycodes.gov/publications/research/documents/codes/PNNL-20405.pdf.

U.S. Department of Energy. 2018. EnergyPlus Whole Building Energy Simulation Program, Version 9.0.1. U.S. Department of Energy, Washington, D.C. Available at https://energyplus.net/.

U.S. Department of Energy. 2021. Preliminary Energy Savings Analysis: ANSI/ASHRAE/IES Standard 90.1-2019: U.S. Department of Energy, Washington, D.C. Available at https://www.energycodes.gov/sites/default/files/documents/20210407_Standard_90.1-2019_Determination_TSD.pdf.

U.S. Department of Energy. 2020. Building Energy Codes Program, Commercial Prototype Building Models. (2020, October). Commercial Prototype Building Models. Accessed October 2020 from https://www.energycodes.gov/development/commercial/prototype_models.

Zhang, J., Xie, Y., Athalye, R.A., Zhuge, J.W., Rosenberg, M.I., Hart, P.R., Liu, B. Energy and Energy Cost Savings Analysis of the 2015 IECC for Commercial Buildings. PNNL-24269, 2015, Pacific Northwest National Laboratory, Richland, Washington.

Appendix-A: Commercial Code Change for 7th Edition (2020) FBC-EC vs. 2021 IECC

Commercial 2021 IECC changes with respect to 2018 IECC and 2020 Florida Energy Code Energy Conservation (FBC-EC) is summarized in Table A. Table A has six columns and are defined as follows.

2021 IECC Section and Title: is the code Section and title for the 2021 IECC.

ICC Code Change No: Proposed code change number in the ICC's *Complete Revision History to the 2021 I-Codes* document.

Change Summary b/t 2018 IECC and 2021 IECC: brief description of the code change between the 2018 IECC and 2021 IECC. The description also includes cost-benefit analysis results summary if cost-effectiveness test were performed.

Change Summary b/t 2020 FBC-EC and 2018 IECC: brief description of the code change between the 2020 FBC-EC and 2021 IECC.

Anticipated Energy Impact on FBC-EC if Adopted: Anticipated energy use impact from the code change if it is adopted in the FBC-EC. This is usually a decrease energy use, an increase energy use, or none. "None" means the code change has no or negligible impact on energy use.

Anticipated Cost Impact on FBC-EC if Adopted: Anticipated construction cost impact from the code change if it is adopted in the FBC-EC. This is usually a decrease in construction cost, increase construction cost, or none. "None" means the code change has no or negligible impact on construction cost.

Table A: Commercial Code Change Summary for 7th Edition (2020) Florida Energy Code vs. 2021 IECC

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Chapter C1: Scope and Administration					
C102.1 General	CE09-19 Part I CE10-19 Part I	Adds text "energy conservation" for clarification	Same as change between 2018 IECC and 2021 IECC	None	None
C103.2 Information on construction documents	CE13-19 Part I	Adds "Compliance Path" to the requirements included in the construction document	Same as change between 2018 IECC and 2021 IECC	None	None
C103.2 Information on construction documents	CE98-19	Modifies the text in item 12 as "*Air barrier and air sealing details, including the location of the air barrier*."	Same as change between 2018 IECC and 2021 IECC.	None	None
C102.1.1 Above code programs	CE42-19 Part I	Above code programs must meet the requirements listed in the new Table C407.2.	Same as change between 2018 IECC and 2021 IECC	None	None
Chapter C2: Definitions					
C202 Biogas	CE21-19	Added new definition for *Biogas*.	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Biomass	CE21-19	Added new definition for *Biomass*.	Same as change between 2018 IECC and 2021 IECC	None	None
C202 On-Site Renewable Energy	CE21-19	Modified an existing definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Demand Recirculation Water System	CE22-19	Modified an existing definition to make it consistent with IPC definition for *Demand Recirculation Water System*.	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Direct Digital Control	CE26-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Networked Guestroom Control System	CE29-19 CE135-19	Modifies text for clarification of *Networked Guestroom Control System* definition.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C202 On-Site Renewable Energy	CE31-19	Modifies definition of *On-site renewable energy*.	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Renewable Energy Resources	CE31-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Wall, Above Grade	CE35-19	Adds clarification to an existing definition for *Wall, Above Grade*.	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Visible Transmittance, Annual [VT_{annual}]	CE39-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Greenhouse	CE56-19	Modifies an existing definition. Adds that *Greenhouses* are those that are erected for a period of 180 days or more.	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Internal Curtain System	CE56-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Vegetative Roof	CE83-19	Adds new definition for "*Vegetative Roof*".	Same as change between 2018 IECC and 2021 IECC.	None	None
C202 Testing Unit Enclosure Area	CE96-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Computer Room	CE108-19	Revises *Computer Room* definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Data Center	CE108-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Data Center Systems	CE108-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Information Technology Equipment (ITE)	CE108-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Fault Detection and Diagnostics (FDD) System	CE111-19 CE239-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Enthalpy Recovery Ratio	CE133-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C202 Fan Nameplate Electrical Input Power	CE136-19 CE139-19	Adds new definition	This definition already exists in the 2020 FBC-EC.	None	None
C202 Fan, Embedded Fan Array Fan Energy Index (FEI) Fan System Electrical Input Power	CE139-19	Adds new definitions	These definitions already exist in the 2020 FBC-EC.	None	None
C202 Large-Diameter Ceiling Fan	CE141-19	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 Thermal Distribution Efficiency (TDE)	CE151-19 Part I	Adds new definition	Same as change between 2018 IECC and 2021 IECC	None	None
C202 General Lighting	CE161-19	Revises general lighting definition	Same as change between 2018 IECC and 2021 IECC	None	None
Chapter C3: General Requirements					
C301.1 General	CE36-19	Updated climate zones classifications in Table C301.1. Some counties were re-classified based on updated climate data.	Same as change between 2018 IECC and 2021 IECC	None	None
C301.3 Climate Zone Definitions	CE36-19	Replaces sub-section title for C303.2 from "*International Climate Zone*" to "*Climate Zone Definitions*", expanded the climate zones classification to 0-8 from 1-8 and updates the equations in	Same as change between 2018 IECC and 2021 IECC. In Florida, some counties (e.g., Palm Beach) moved from the climate zones 2A to 1A, and	Reduces stringency	Slightly decrease for some counties in Florida

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		Table C301.3(1) for climate zone determination for locations not listed in Table C301.1	this may reduce the building envelope stringency.		
C303.1.3 Fenestration product rating	CE39-19	Revises the code that for Tubular Daylighting Devices, VTannual must be measured and rated in accordance with NFRC 203. Adds new referenced standard: NFRC 203 – 2017: Procedure for Determining Translucent Fenestration Product Visible Transmittance at Normal Incidence	Same as change between 2018 IECC and 2021 IECC	None	None
C303.1.2 Insulation mark installation	CE40-19 Part I	Revises the section that insulation materials that are installed without an observable manufacturer's R-value mark, such as blown or draped products, an insulation certificate complying with Section C303.1.1 must be placed after installation by the installer, in a clearly visible location within the building.	Same as change between 2018 IECC and 2021 IECC	None	None
Chapter C4: Commercial Energy Efficiency					

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C402.4.2 Minimum skylight fenestration area	CE39-19	Adds alternative compliance options for minimum skylight area compliance requirements: (1) Adds an alternative compliance for toplit daylight zone of not less than 3% using *VTannual of not less than 0.26*, as determined in accordance with Section C303.1.3 (2) Adds an alternative compliance for a minimum skylight effective aperture determined in accordance with Equation 4-4 not less than 0.66% using a Tubular Daylighting Device's VTannual rating. Also the revision requires that well factor of 1.0 for Tubular Daylighting Devices with VTannual ratings.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.4.2 Minimum skylight fenestration area	CE89-19	Replaces text "*sidelight*" with "*sidelit*" in exception item 5.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.4.2 Minimum skylight fenestration area	CE91-19	Editorial changes for clarification.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.4.2 Minimum skylight fenestration area	CE92-19	Adds new exception item 6 for storm shelters. *Spaces designed as storm shelters must complying with ICC 500.* This exempts storm shelters from skylights requirement. Adds new referenced standard: ICC 500: ICC/NSSA Standard for the Design and Construction of Storm Shelters.	Same as change between 2018 IECC and 2021 IECC	None	Decrease

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		This code change decreases construction cost by exempting storm shelters from skylight requirements.			
C402.4.2.2 Haze Factor	CE39-19	Haze factor greater than 90% requirement exception revised to apply to tubular daylighting devices or when optical diffuser components are used.	Same as change between 2018 IECC and 2021 IECC	None	None
C401.2 Application	CE41-19	Edits commercial buildings compliance paths description and adds new sub-sections C401.2.1 and C401.2.2 for clarity.	Same as change between 2018 IECC and 2021 IECC	None	None
C401.2 Application	CE42-19 Part I	Editorial changes	Same as change between 2018 IECC and 2021 IECC	None	None
C401.2.1 International Energy Conservation Code	CE41-19	Adds new sub-section C401.2.1. Commercial buildings must comply with one of the following: 1. Prescriptive Compliance. The Prescriptive Compliance Option requires compliance with Sections C402 through C406, and C408. 2. Total Building Performance. The Total Building Performance Option requires compliance with Section C407. Adds new exception: Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C401.2.2 ASHRAE 90.1.	CE41-19	Adds new sub-section C401.2.2. Commercial buildings must comply with the requirements of ANSI/ASHRAE/IESNA 90.1	Same as change between 2018 IECC and 2021 IECC	None	None
C402.1 General	CE41-19	Updated referenced code section	Same as change between 2018 IECC and 2021 IECC	None	None
C407.2 Mandatory requirements	CE41-19	Updated referenced code section	Same as change between 2018 IECC and 2021 IECC	None	None
C407.3 Performance-based compliance	CE41-19	Updated referenced code section	Same as change between 2018 IECC and 2021 IECC	None	None
C407.2 Mandatory requirements	CE42-19 Part I CE45-19	Re-organizes the section by combining with section C407.3, adds a compliance requirement to the list in a new table C407.2, and adds a provision that total building performance method requires that the annual energy cost less than or equal to 85% of the annual energy cost of the *standard reference design.*	Same as change between 2018 IECC and 2021 IECC	None	None
Table C407.2 Requirements for Total Building Performance	CE42-19 Part I	Adds new Table C407.2 that summarizes total building performance compliance path requirements	Same as change between 2018 IECC and 2021 IECC	None	None
C407.3 Documentation		Re-numbers Section C407.4	Same as change between 2018 IECC and 2021 IECC	None	None
C407.3.1 Compliance report		Re-numbers Section C407.4.1	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C407.3.2 Additional documentation		Re-numbers Section C407.4.2	Same as change between 2018 IECC and 2021 IECC	None	None
C402.1 General	CE42-19 Part I	Removes "Prescriptive" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.2 Specific building thermal envelope insulation requirements	CE42-19 Part I	Removes "Prescriptive" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.4 Fenestration	CE42-19 Part I	Removes "Prescriptive" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC	None	None
C403.5 Economizers	CE42-19 Part I	Removes "Prescriptive" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC C403.3 Economizers	None	None
C402.5 Air leakage—thermal envelope	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC	None	None
C403.2 System design	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC C403.2 Provisions applicable to all mechanical systems	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C403.2.1 Zone isolation required	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.4.4 and it is not labeled mandatory.	None	None
C403.2.2 Ventilation	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.6 Ventilation.	None	None
C403.3 Heating and cooling equipment efficiencies	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.	None	None
C403.3.1 Equipment sizing	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.2.	None	None
C403.3.2 HVAC equipment performance requirements	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.3.	None	None
C403.3.2.1 Water-cooled centrifugal chilling packages	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.3.1.	None	None
C403.4 Heating and cooling system controls	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		"prescriptive" section labels in favor of a tabular approach.			
C403.4.1 Thermostatic controls	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.1.	None	None
C403.4.1.1 Heat pump supplementary heat	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.1.1.	None	None
C403.4.1.2 Deadband	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.1.2.	None	None
C403.4.1.3 Setpoint overlap restriction	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.1.3.	None	None
C403.4.1.4 Heated or cooled vestibules	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC	None	None
C403.4.2.1 Thermostatic setback	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.2.1.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C403.4.2.2 Automatic setback and shutdown	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.2.2.	None	None
C403.4.2.3 Automatic start and stop	CE42-19 Part I CE120-19	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach. Revises the code such that automatic stop controls must be provided for each HVAC system with direct digital control of individual zones.	The 2020 FBC-EC already has HVAC automatic stop capability requirement. The 2020 FBC-EC Section is C403.2.4.2.3.	None	None
C403.5.5 Economizer fault detection and diagnostics	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.4.7. This section is not labeled mandatory.	None	None
C403.7.1 Demand control ventilation	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.6.1. This section is not labeled mandatory.	None	None
C403.7.2 Enclosed parking garage ventilation controls	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.6.2. This section is not labeled mandatory.	None	None
C403.7.3 Ventilation air heating control	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC does not have equivalent Section.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C403.7.4 Energy recovery ventilation systems	CE42-19 Part I	Removes “Mandatory” from section title as part of formatting change that removes “mandatory” and “prescriptive” section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.7. This section is not labeled mandatory.	None	None
C403.7.5 Kitchen exhaust systems	CE42-19 Part I	Removes “Mandatory” from section title as part of formatting change that removes “mandatory” and “prescriptive” section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.8. This section is not labeled mandatory.	None	None
C403.7.6 Automatic control of HVAC systems serving guestrooms	CE42-19 Part I	Removes “Mandatory” from section title as part of formatting change that removes “mandatory” and “prescriptive” section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.4.8. This section is not labeled mandatory.	None	None
C403.7.7 Shutoff dampers	CE42-19 Part I	Removes “Mandatory” from section title as part of formatting change that removes “mandatory” and “prescriptive” section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.4.3. This section is not labeled mandatory.	None	None
C403.8.1 Allowable fan horsepower	CE42-19 Part I	Removes “Mandatory” from section title as part of formatting change that removes “mandatory” and “prescriptive” section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.12.1. This section is not labeled mandatory.	None	None
C403.8.2 Motor nameplate horsepower	CE42-19 Part I	Removes “Mandatory” from section title as part of formatting change that removes “mandatory” and “prescriptive” section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.12.2. This section is not labeled mandatory.	None	None
C403.8.3 Fan efficiency	CE42-19 Part I	Removes “Mandatory” from section title as part of formatting change that removes “mandatory” and	The 2020 FBC-EC Section is C403.2.12.3. This section is not mandatory.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		"prescriptive" section labels in favor of a tabular approach.			
C403.8.4 Fractional hp fan motors	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.12.4. This section is not labeled mandatory.	None	None
C403.11.1 Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.14.1. This section is not labeled mandatory.	None	None
C403.11.2 Walk-in coolers and walk-in freezers	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.14.2. This section is not labeled mandatory.	None	None
C403.11.2.1 Performance standards	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. This sub-section does not exist.	None	None
C403.10.3 Refrigerated display cases		Deleted.	This section does not exist in the 2020 FBC-EC.	None	None
C403.12.1 Duct and plenum insulation and sealing	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.9.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C403.12.2 Duct construction	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.9.2. This section is not labeled mandatory.	None	None
C403.12.2.1 Low-pressure duct systems	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	See Table C403.2.9.2. This provision is not labeled mandatory.	None	None
C403.12.2.2 Medium-pressure duct systems	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	See Table C403.2.9.2. This provision is not labeled mandatory.	None	None
C403.12.2.3 High-pressure duct systems	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	See Table C403.2.9.2. This provision is not labeled mandatory.	None	None
C403.12.3 Piping insulation	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.10. This section is not labeled mandatory.	None	None
C403.12.3.1 Protection of piping insulation	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	The 2020 FBC-EC Section is C403.2.10.1. This section is not labeled mandatory.	None	None
C403.13 Mechanical systems located outside of the	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and	This Section does not exist in the 2020 FBC-EC.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
building thermal envelope		"prescriptive" section labels in favor of a tabular approach.			
Section C404 Service Water Heating	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC	None	None
C404.8 Energy consumption of pools and permanent spas	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C404.9.	None	None
C404.9 Energy consumption of portable spas	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C404.10.	None	None
C405.1 General	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2 Lighting controls	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.3 Interior lighting power requirements	CE42-19 Part I	Removes "Prescriptive" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.5 Exterior lighting power requirements	CE42-19 Part I	Renumbers Section C405.4. Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C405.4.	None	None
C405.5.3 Gas lighting	CE42-19 Part I	Renumbers Section C405.4.3. Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C405.4.3.	None	None
C405.5 Dwelling electrical meter	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. This is not a standalone section in the 2020 FBC-EC. It is covered in Section C405.5.2.	None	None
C405.6 Electrical transformers	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C405.6.	None	None
C405.7 Electric motors	CE42-19 Part I	Removes "Mandatory" from section title as part of formatting change that removes "mandatory" and "prescriptive" section labels in favor of a tabular approach.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C405.7.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C401.2 Application	CE44-19 CE45-19 CE48-19	Adds a provision that dwelling units and sleeping units in Group R-2 buildings without systems serving multiple units must be in compliance with the prescriptive method provided they comply with Section R406. Moves the text "The building energy cost shall be equal to or less than 85 percent of the standard reference design building" to section C407.2. Moves lists of mandatory code section to Table C407.2 to avoid redundancy and simplify the code. Updates referenced standard: ANSI/RESNET/ICC 301—2019: Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index.	Same as change between 2018 IECC and 2021 IECC.	None	None
	CE49-19	Disapproved.	Same as change between 2018 IECC and 2021 IECC	None	None
C401.3 Thermal envelope certificate	CE55-19	Adds a new mandatory section C401.3 that requires thermal envelope certificate labeling for R-value of envelope insulations, fenestrations *U*-factor and SHGC values, and envelope air leakage testing performed.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C402.1.1 Low-energy buildings and greenhouses	CE56-19	Modifies the title by adding "Greenhouses". Greenhouses are still exempted if they are low energy use. Moves exception item #3 to a new subsection C402.1.1.1. No construction cost increase.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.1.1.1 Greenhouses	CE56-19	Adds new section. This section exempts Greenhouses that are mechanically heated or cooled are exempted provided the building envelope requirements meet certain requirements. Adds new Table C402.1.1.1. Unconditioned Greenhouses and low energy greenhouses that meet section C402.1.1.1 are exempted. This code change does not necessarily increase construction cost but if the greenhouses are conditioned space, then the envelope must meet the current envelope thermal requirements just like any other conditioned space.	Same as change between 2018 IECC and 2021 IECC	Decreases	Increases

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C402.1.2 Equipment buildings	CE58-19	Revises the section that separate buildings floor area limit for thermal envelope requirements increases from 500 to 1,200 ft^2. Replaces the text “electronic” with “electric” to avoid confusion. This change relaxes the stringency of thermal envelope requirement for some space types. This change relaxes the stringency of thermal envelope requirement for some space types/	Same as change between 2018 IECC and 2021 IECC	None	Decrease
C402.1.3 Insulation component *R*-value-based method	CE60-19	Revises the code to clarify how R-values of multiple layers of cavity and continuous insulations is determined.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C402.1.3 Opaque Thermal Envelope Insulation Component Minimum Requirements, *R*-value Method	CE61-19	Increases insulation R-value for metal buildings and attics in climate zones 4 through 8.	Same as change between 2018 IECC and 2021 IECC but the change does not impact FBC-EC.	None	None
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method	CE61-19	Decreases *U*-Factor of roofs in metal buildings, and attic and other in climate zones 1 and 4 through 8. Increases the stringency for metal buildings *U*-Factor requirement. See code change CE73-19.	Same as change between 2018 IECC and 2021 IECC. Decreases the roof *U*-Factor of metal buildings to U-0.035 from U-0.044 for climate zone 1 to make it consistent with R-value in Table C402.1.3. No cost impact on FBC-EC.	Decrease	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, U-Factor Method	CE73-19	Corrects roofs *U*-Factor for metal buildings in climate zone 1. This change makes the roof assembly *U*-Factor consistent with roof insulation R-Value in Table C402.1.3. Same as code change CE61-19. Cost-benefit analysis is not required as the code modification is a correction	Same as change between 2018 IECC and 2021 IECC.	Decrease	None
Table C402.1.3 Opaque Thermal Envelope Insulation Component Minimum Requirements, *R*-value Method	CE63-19	Increases insulation R-value of above grade walls in climate zones 4 through 8 for metal buildings and metal framed walls. This change matches ASHRAE Std. 90.1-2016.	Same as change between 2018 IECC and 2021 IECC but the change does not impact FBC-EC.	None	None
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method	CE63-19	Decreases *U*-Factor for above grade walls in climate zones 4 through 8 to match the increased R-values for metal buildings and metal framed walls. Also corrected *U*-Factor of mass walls in climate zone 8.	Same as change between 2018 IECC and 2021 IECC but the change does not impact FBC-EC.	None	None
Table C402.1.3 Opaque Thermal Envelope Insulation Component Minimum Requirements, *R*-value Method	CE64-19	Increases insulation R-value for below grade walls in climate zones 4 through 8. This change matches ASHRAE Std. 90.1-2016.	Same as change between 2018 IECC and 2021 IECC but the change does not impact FBC-EC.	None	None
C402.1.3 Insulation component *R*-value-based method	CE60-19	Revises the code to clarify how R-values of multiple layers of cavity and continuous insulations is determined.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method	CE64-19	Decreases *U*-Factor for below grade walls in climate zones 4 through 8 to match the increased R-value.	Same as change between 2018 IECC and 2021 IECC but the change does not impact FBC-EC.	None	None
Table C402.1.3 Opaque Thermal Envelope Insulation Component Minimum Requirements, *R*-value Method	CE65-19	Replaces the "NR" to R-13 insulation R-value for Joist/Frame floors in climate zones 1. This change corrects errors in the table and makes the R-value consistent with *U*-Factor in Table C402.1.4. No impact on construction cost.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method	CE65-19	No change to the *U*-Factor for floors for all climate zones.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method	CE66-19	Decreases *U*-Factor for mass and Joist/Frame floors in climate zones 3 through 8. Also removes redundant foot note "f: Steel floor joist systems shall be insulated to R-38" as all framed floors are required to be insulated to R-38.	Same as change between 2018 IECC and 2021 IECC but the change does not impact FBC-EC.	None	None
Table C402.1.3 Opaque Thermal Envelope Insulation Component Minimum Requirements, *R*-value Method	CE67-19	Edited insulation R-value application for slab-on-grade floors in all climate zones. This change adds clarification to the original intent how the insulation coverage is applied and makes the R-value consistent with *F*-Factor. No change on stringency.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method	CE67-19	No change to the *F*-Factor for slab-on-grade floors for all climate zones.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C402.1.3 Opaque Thermal Envelope Insulation Component Minimum Requirements, *R*-value Method	CE68-19	Increases insulation R-value and depth of insulation for unheated slab-on-grade floors in climate zones 3 through 6. This change matches to ASHRAE Std. 90.1-2016.	Same as change between 2018 IECC and 2021 IECC but the change does not impact FBC-EC.	None	None
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method	CE68-19	Decreases *F*-Factor for unheated slab-on-grade floors in climate zones 3 through 6 to match the increased R-values in Table C402.13.	Same as change between 2018 IECC and 2021 IECC but the change does not impact FBC-EC.	None	None
Table C402.1.3 Opaque Thermal Envelope Insulation Component Minimum Requirements, *R*-value Method	CE69-19	Increases insulation R-value and depth of insulation for unheated slab-on-grade floors in climate zones 7 and 8 to match the corresponding *F*-Factors in Table C402.1.4. This change matches to ASHRAE Std. 90.1-2016.	Same as change between 2018 IECC and 2021 IECC but the change does not impact FBC-EC.	None	None
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method	CE69-19	Corrects the *F*-Factor for unheated slab-on-grade floors in climate zones 7 and 8 to match the corresponding improved R-values and insulation depth.	Same as change between 2018 IECC and 2021 IECC but the change does not impact FBC-EC.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C402.1.3 Opaque Thermal Envelope Insulation Component Minimum Requirements, *R*-value Method	CE70-19	Deletes the R-value requirements for non-swinging opaque doors in Table C402.1.3 and replaces with equivalent *U*-factor in Table C402.1.4.	Same as change between 2018 IECC and 2021 IECC. The change impact FBC-EC.	None	None
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, *U*-Factor Method	CE70-19	Reduces *U*-Factor for opaque swinging doors in climate zones 1 through 4. Adds a new 0.31 *U*-factor requirement for non-swinging opaque doors for all climate zones in Table C402.1.4 as a replacement of non-swinging opaque doors insulation R4.75 existing requirement in favor of assembly *U*-Factor requirement. This part has not impact on the construction cost. However, the opaque swinging door *U*-Factor reduction increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with an average SIR value of about 4.14.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, U-Factor Method	CE70-19	Adds new footnote *h*: Swinging doors *U*-factor must be determined in accordance with NFRC-100.	The 2020 FBC-EC already has this provision.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C402.4.5 Doors	CE70-19	Adds clarification that opaque doors must be treated as part of gross area of above-grade wall and comply with above-grade wall thermal envelope requirement.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.5.1 Opaque swinging doors	CE70-19	Adds new section that opaque swinging doors must comply with *U*-factor in Table C402.1.4. This code change increases construction cost but it is cost effective per FSEC's cost-benefit analysis with an average SIR value of about 4.14.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C402.4.5.2 Nonswinging Doors	CE70-19	Adds new section that opaque non-swinging doors with glazing area between 14% and 25% of the total door area must have an assembly *U*-factor less than or equal to 0.44 in Climate Zones 0 through 6 and less than or equal to 0.36 in Climate Zones 7 and 8.	The 2020 FBC-EC already has this provision.	None	None
C402.1.4 Assembly *U*-factor, *C*-factor or *F*-factor-based method	CE71-19	Adds new sub-sections: C402.1.4.1, C402.1.4.1.1, C402.1.4.1.2 and C402.1.4.1.3.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.1.4.1 Roof/Ceiling Assembly	CE71-19	Adds new section. The maximum, roof/ceiling assembly *U*-factor, must not exceed the values specified in Table C402.1.4 based on construction materials used in the roof/ceiling assembly.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C402.1.4.1.1 Tapered, above-deck insulation based on thickness	CE71-19	Adds new section. Clarifies how the *U*-factor calculation is performed for sloped roof assembly.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.1.4.1.2 Suspended ceilings	CE71-19	Adds new section. Insulation installed on suspended ceilings having removable ceiling tiles must not be considered part of the assembly *U*-factor of the roof/ceiling construction.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.1.4.1.3 Joints staggered	CE71-19	Adds new section. Continuous insulation board must be installed in not less than two layers and the edge joints between each layer of insulation must be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.2.1 Roof assembly	CE71-19	Removes some code language, adds new sub-sections C402.2.1.1, C402.2.1.2, C402.2.1.3 and C402.2.1.4 and re-numbers section C402.2.1.1. This change is clarification.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C402.2.2.	None	None
C402.2.1.1 Tapered, above-deck insulation based on thickness	CE71-19	Adds new section. Roof/ceiling assembly R-value calculation; the sloped roof insulation R-value calculation must use the average thickness in inches along with the material R-value-per-inch solely for R-value compliance as prescribed in Section C402.1.3	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C402.2.1.2 Minimum thickness, lowest point	CE71-19	Adds new section. The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, must not be less than 1 inch.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.2.1.3 Suspended ceilings	CE71-19	Adds new section. Insulation installed on suspended ceilings having removable ceiling tiles must not be considered part of the minimum thermal resistance (R-value) of roof insulation in roof/ceiling construction.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.2.1.4 Joints staggered	CE71-19	Adds new section. Continuous insulation board must be installed in not less than two layers and the edge joints between each layer of insulation must be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.2.1.5 Skylight curbs	CE71-19	Re-numbered section C402.2.1.1.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, U-Factor Method	CE74-19	Corrects *U*-Factor for above grade mass wall in climate zones 8. This change makes the mass wall assembly *U*-Factor consistent with mass wall insulation R-Value in Table C402.1.3.	Same as change between 2018 IECC and 2021 IECC. This change does not impact FBC-EC.	None	None
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, U-Factor Method	CE75-19	Corrects *U*-Factor for above grade wood frame wall in climate zone 5 and metal framed above grade wall in climate zone 7. This change makes the wall assembly *U*-Factor consistent with wall insulation R-Values in Table C402.1.3.	Same as change between 2018 IECC and 2021 IECC. This change does not impact FBC-EC.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, U-Factor Method	CE76-19	Corrects *F*-Factor for slab-on-grade heated slab floors in all climate zones. This change makes single *F*-Factor that represents combined impact of the perimeter and full slab insulation consistent with *F*-Factor values in ASHRAE 90.1-2016 standard. Also removes footnote "*f*".	Same as change between 2018 IECC and 2021 IECC. This change does not impact FBC-EC.	None	None
Table C402.1.4 Opaque Thermal Envelope Assembly Maximum Requirements, U-Factor Method	CE77-19	Adds new footnote *i*: Garage doors having a single row of fenestration must have an assembly *U*-Factor less than or equal to 0.44 in Climate Zones 1 through 6 and less than or equal to 0.36 in Climate Zones 7 and 8, provided the glazing area is between 14% and 25% of the total door area.	The 2020 FBC-EC already has this provision.	None	None
C402.2.4 Slabs-on-grade	CE79-19	Renames code section C402.2.4 Slabs-on-grade, designated it "Prescriptive", edits the section text, and adds new sub-section C402.2.4.1 by moving the exception.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C402.2.5.	None	None
C402.2.4.1 Insulation installation	CE79-19	Adds new section that describes the insulation installation requirements.	Same as change between 2018 IECC and 2021 IECC	None	None
C401.2 Application	CE80-19	Edits section C402.2.7 Airspaces to clarify the provision and updates referenced code section.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.3 Roof solar reflectance and thermal emittance	CE82-19 CE83-19	Replaces text "*Roof gardens or landscaped*" with "*Vegetative roofs or landscaped roofs*" in tem 1.3.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C402.4 Building Envelope Fenestration Maximum *U*-Factor and SHGC Requirements	CE84-19 CE85-19	Reduces *U*-Factor of vertical fenestration in all climate zones. Reduces SHGC values of vertical fenestration in climate zones 1, 6, 7, and 8. Reduces *U*-Factor and SHGC values of skylights in climate zones 1, 2, 3, 7 and 8. These changes align vertical fenestrations and skylights *U*-Factor and SHGC values with ASHRAE Standard 90.1-2019. Very small or no construction cost increase. This code change may slightly increase construction cost because of SHGC value decrease in climate zone 1A only whereas the *U*-factor was reduced in climate zones 1A and 2A. FSEC's cost benefit analysis demonstrate that the change is cost-effective with an average SIR value 1.82.	Same as change between 2018 IECC and 2021 IECC	Decrease	Slight Increase
Table C402.4 Building Envelope Fenestration Maximum *U*-Factor and SHGC Requirements	CE87-19	Removes fenestration orientation and replaces it with "fixed" and "Operable" classification and reduces the SHGC values requirements for vertical fenestration in climate zones 1, 2, 3, 7, and 8 to align with ASHRAE Standard 90.1-2019. Also deleted footnote "*a*". Very small or no construction cost increase. This new classification does not always increase construction cost and it also provides design flexibility. There is no	Same as change between 2018 IECC and 2021 IECC	Decrease	Slight Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		significant cost change that warrants cost benefit analysis.			
C402.4.1.2 Increased skylight area with daylight responsive controls	CE89-19	Replaces text “*toplit zones*” with “*toplit daylight zones*”.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C402.4.1.1.	None	None
C402.4.4 Daylight zones	CE89-19	Replaces text “*toplit zones*” with “*toplit daylight zones*” and “*sidelit zones*” with “*sidelit daylight zones*”.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.4 Daylight-responsive controls	CE89-19	Re-numbers section, replaces text “*toplit zones*” with “*toplit daylight zones*” and “*sidelit zones*” with “*sidelit daylight zones*”.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C405.2.3.	None	None
C405.2.4.1 Daylight-responsive control function	CE89-19	Re-numbers section and replaces text “toplit zones” with “toplit daylight zones” and “sidelit zones” with “sidelit daylight zones”.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C405.2.3.1.	None	None
C405.2.4.2 Sidelit daylight zone	CE89-19	Re-numbers and renames section title, and replaces text “sidelit zones” with “sidelit daylight zones”.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C405.2.3.2.	None	None
C405.2.4.3 Toplit daylight zone	CE89-19	Renames Section title and replaces text “toplit zones” with “toplit daylight zones”.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C405.2.3.3.	None	None
C402.4 Fenestration	CE90-19	Editorial changes for clarification	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C402.4.1.1 Increased vertical fenestration area with daylight responsive controls	CE90-19	Editorial changes for clarification	Same as change between 2018 IECC and 2021 IECC	None	None
C402.4.1.2 Increased skylight area with daylight responsive controls	CE90-19	Editorial changes for clarification	Same as change between 2018 IECC and 2021 IECC	None	None
C402.4.2.1 Lighting controls in toplit daylight zones	CE90-19	Editorial changes for clarification	Same as change between 2018 IECC and 2021 IECC	None	None
C402.4.1.2 Increased skylight area with daylight responsive controls	CE91-19	Editorial changes for clarification	Same as change between 2018 IECC and 2021 IECC	None	None
C402.5 Air leakage—thermal envelope	CE96-19	Editorial changes for clarification	Same as change between 2018 IECC and 2021 IECC	None	None
C402.5.1 Air barriers	CE96-19	Editorial changes for clarification	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C402.5.1.2 Air barrier compliance	CE96-19 CE97-19	Removes the text "options" from the title and re-writes the continuous air barrier testing requirements for opaque building envelope and provides three compliance options: (1) Dwelling and sleeping units buildings or portions the building must meet Section C402.5.2. Adds new exception: buildings in Climate Zones 2B, 3C, and 5C. (2) Other than dwelling and sleeping units buildings or portions of buildings must meet testing requirements of Section C402.5.3. Adds three new exceptions: 1. Buildings in Climate Zones 2B, 3B, 3C, and 5C. 2. Buildings larger than 5000 ft^2 floor area in Climate Zones 0B, 1, 2A, 4B, and 4C. 3. Buildings between 5000 and 50,000 ft^2 floor area in Climate Zones 0A, 3A and 5B. (3) Buildings or portions of buildings that do not complete air barrier testing must meet Section C402.5.1.3 Material, or C402.5.1.4 Assembly in addition to Section C402.5.1.5 Building envelope performance verification requirements. This code change is cost effective. See results for CE97-19.	Same as change between 2018 IECC and 2021 IECC. For FBC-EC, buildings of other than group R and group I occupancy and larger than 5000 ft^2 floor area are exempted from envelope air leakage testing requirement.	Decrease	Increase
C402.5.1.3 Materials	CE96-19	Re-numbers section C402.5.1.2.1.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.5.1.4 Assemblies	CE96-19	Re-numbers section C402.5.1.2.2.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C402.5.1.4 Assemblies	CE101-19	Re-numbers section C402.5.1.2.2, edits for clarification and adds reference to new standard, ASTM D8052 for low slope roofs. Adds new referenced standard: ASTM D8052/D8052M-2017: Standard Test Method for Quantification of Air Leakage in Low-Sloped Membrane Roof Assemblies.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C402.5.1.2.2.	None	None
C402.5.2 Dwelling and sleeping unit enclosure testing	CE96-19	Adds new section C402.5.2. This new section requires building thermal envelope must be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the code official and the measured air leakage must not exceed 0.30 cfm/ft^2 of test unit enclosure area at 50 Pa pressure difference. For buildings that have fewer than eight testing units, each unit must be tested. For buildings with 8 units or higher, maximum of 7 units or 20% must be tested. This requirement is the same as existing residential building air leakage testing requirement and it is already proven that it its cost effective. Also see cost effectiveness test of code change CE97-19 below.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C402.5 Air leakage—thermal envelope	CE97-19	Editorial changes for clarification and updated reference sections.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C402.5.1 Air barriers	CE97-19 CE99-19	Edits for clarification and adds reference to a new code Section C402.5.1.3.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.5.3 Building thermal envelope testing	CE97-19	Adds new section C402.5.3. The building thermal envelope must be tested in accordance with ASTM E 779, ANSI/RESNET/ICC 380, or ASTM E1827 or an equivalent method approved by the code official. Alternatively, sampled portions of the building must be tested and the measured air leakages must be area-weighted by the surface areas of the building envelope in each portion and the air leakage must not exceed 0.40 cfm/ft^2 of the building thermal envelope area at 75 Pa pressure difference. When air leakage measured is between 0.40 and 0.60 cfm/ft^2 additional diagnostic test and air sealing is required. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with SIR value range of 1.73 – 6.09 for smaller buildings and our findings are consistent with PNNL's study.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C402.5 Air leakage—thermal envelope	CE98-19	Adds new referenced standard ASTM E3158 as an alternative method for envelope air leakage testing.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		ASTM E3158-18: Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building.			
C402.5.1.5 Building envelope performance verification	CE99-19	Adds new section C402.5.1.5. Installation of the continuous air barrier must be verified by the code official, a registered design professional or approved agency.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.5.1.3 Materials	CE102-19	Re-numbers section C402.5.1.2.1 and removes the requirement that single-ply roof membranes be "*fully adhered*". This change makes the code consistent with ASHRAE Standard 90.1-2016.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C402.5.1.2.1.	None	Decrease
C402.5.11 Operable openings interlocking	CE106-19	Adds new mandatory section. Occupancies that has operable opening larger than 40 ft^2 must have the openings interlocked with the heating and cooling system to setback the cooling setpoint to 80°F or heating to 70°F when the operable opening is open in the exterior wall of the building.	Same as change between 2018 IECC and 2021 IECC	None	None
C402.5.11.1 Operable controls	CE106-19	Adds new mandatory section. Occupancies that utilize operable opening larger than 40 ft^2 must have the openings interlocked with the heating and cooling system to setback the cooling setpoint to 90°F or heating to 55°F when the operable opening is open in the exterior wall of the building.	Same as change between 2018 IECC and 2021 IECC. But the 2020 FBC-EC does not have equivalent Section C403.13.	Decrease	Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with SIR value of 7.0.			
C403.13 Mechanical systems located outside of the building thermal envelope	CE106-19	Re-numbered section C403.12.	The 2020 FBC-EC does not have section C403.13 but has two of its sub-sections under C403.2.4.5 and C403.2.4.6. These sections may need to be re-organized under a new section in order to reference Section C403.13.	None	None
C403.1.1 Calculation of heating and cooling loads	CE107-19	Designates the section as mandatory.	Same as change between 2018 IECC and 2021 IECC	None	None
C403.1 General	CE108-19	Revises the section such that data center systems are now exempt from requirements of Sections C403.4 and C403.5.	Same as change between 2018 IECC and 2021 IECC	None	None
C403.1.2 Data Centers	CE108-19	Adds a new sub-section C403.1.2. Data center systems must comply with Sections 6 and 8 of ASHRAE 90.4 per new Tables C403.1.2(1) and C403.1.2(2).	Same as change between 2018 IECC and 2021 IECC	None	None
Table C403.1.2(1) Maximum Design Mechanical Load Component (Design MLC)	CE108-19	Adds new table that specifies the maximum design mechanical load component requirements for data center by climate zone.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C403.1.2(2) Maximum Annualized Mechanical Load Component (Annualized MLC)	CE108-19	Adds new table that specifies the maximum annualized mechanical load component requirements for data center by climate zone.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.1 General	CE108-19	Revises lighting system controls, the maximum lighting power for interior and exterior applications and electrical energy consumption code provisions to include transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems and must comply with Section 8 of ASHRAE 90.4 in addition to this code.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C405.3.2(2) Interior Lighting Power Allowances: Space-by-Space Method	CE108-19	Revises the space-by-space interior lighting power density requirements of computer rooms to apply to data centers space type.	Same as change between 2018 IECC and 2021 IECC	None	None
ASHRAE 90.4-2016	CE108-19	Adds new referenced standard: ASHRAE 90.4-2016: Energy Standard for Data Centers.	Same as change between 2018 IECC and 2021 IECC	None	None
C403.2 System design	CE111-19	Updates referenced code section; now mechanical systems must be designed to comply with Sections C403.2.1 through C403.2.3.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C403.2.3 Fault Detection and Diagnostics	CE111-19	Adds a new section C403.2.3. New buildings with an HVAC system serving a gross conditioned floor area of 100,000 ft^2 or larger must have a fault detection and diagnostics (FDD) system to monitor the HVAC system's performance and automatically identify faults. Requires permanently installed sensors, sample data every 15 minutes, and communicate faults and recommended repair remotely. R-1 and R-2 group buildings are exempted from this requirement. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with an average payback period of under 2.5 years and an average SIR value of 15.21.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C403.3.2 HVAC equipment performance requirements	CE113-19	Modifies HVAC equipment minimum efficiency requirements by adopting Table 6.8.1-1 through Table 6.8.1-19 from ASHRAE Standard 90.1-2019. Introduces new efficiency metrics SEER2 and HSPF2 for unitary air conditioners and heat pumps with capacity less than 65kBtu/h effective as of 01/01/2023. Increases minimum efficiency of selected equipment in Tables C403.3.2(1), C403.3.2(2), C403.3.2(4), C403.3.2(5), C403.3.2(6), C403.3.2(7) and C403.3.2(10).	Partly the same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.3. Some of the 2020 FBC-EC equipment efficiency tables are equivalent, some of them already have higher efficiency requirements, and some have lower efficiency requirements. Adds six new tables that needs to be incorporated into 8th Edition of the FBCEC. These include: indoor pool	Decreases for some equipment	Slightly increases for some existing equipment

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		Deletes existing Tables C403.3.2(6) and C403.3.2(10). Adds new tables for Variable Refrigerant Flow (VRF) ACs C403.3.2(8), and VRF HPs C403.3.2(9), indoor pool dehumidifiers C403.3.2(11), DOAS units without energy recovery C403.3.2(12), DOAS units with energy recovery C403.3.2(13), water source HPs C403.3.2(14), HP and heat reclaim chiller packages C403.3.2(15), and ceiling-mounted CRACs C403.3.2(16) that were previously not covered in the IECC. Equipment must meet the minimum efficiency requirements of Tables C403.3.2(1) through C403.3.2(16). Federal minimum requirement. Cost effectiveness analysis is not required.	dehumidifiers, DOAS units without energy recovery, DOAS units with energy recovery, water source HPs, HP and heat reclaim chiller packages, and ceiling-mounted CRACs. VRF ACs and VRF HPs in the 2020 FBCEC are Table C403.3.2(11).		
C403.3.2.1 Water-cooled centrifugal chilling packages	CE113-19	Editorial changes and equipment minimum efficiency requirements reference changes to point to tables in Section C403.3.2.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.3.1.	None	None
C403.3.2.2 Positive displacement (air- and water-cooled) chilling packages	CE113-19	Equipment minimum efficiency requirements reference changes to point to tables in Section C403.3.2.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.3.2.	None	None
C403.5.5 Economizer fault detection and diagnostics	CE113-19	Equipment minimum efficiency requirements reference changes to point to tables in Section C403.3.2.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.7.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C403.10 Heat rejection equipment	CE113-19	Equipment minimum efficiency requirements reference changes to point to tables in Section C403.3.2.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.7.	None	None
Table C407.5.1(1) Specifications for the Standard Reference and Proposed Designs	CE113-19	Equipment minimum cooling and heating efficiency requirements in Table C407.5.1(1) now references tables in Section C403.3.2.	Same as change between 2018 IECC and 2021 IECC.	None	None
C408.2.3.1 Equipment	CE113-19	Equipment minimum efficiency requirements reference changes to point to tables in Section C403.3.2.	Same as change between 2018 IECC and 2021 IECC	None	None
C403.3.3 Hot gas bypass limitation	CE114-19	Designates as “mandatory”.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.4.6.	None	None
C403.3.4 Boiler turndown	CE114-19	Designates as “mandatory”.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.4.2.5.	None	None
C403.4.1.1 Heat pump supplementary heat	CE116-19 Part I	Revises the code language; heat pumps supplementary electric resistance heat must have controls that limit supplemental heater operation to only those times when: the vapor compression cycle cannot meet the thermostat setting, the heat pump is in defrost mode, the vapor compression cycle malfunctions, or the thermostat malfunctions.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.1.1.	None	None
C403.4.3.3.2 Heat rejection	CE121-19	Revises the section to use a separation heat exchanger to isolate closed-circuit	Same as change between 2018 IECC and 2021 IECC but no	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		cooling tower to allow shutdown the tower circulation pump. This change impacts climate zones 3 through 8.	impact on FBC-EC. The 2020 FBC-EC Section is C403.4.2.3.2.		
C403.4.3.3.3 Two-position valve	CE122-19	Each hydronic heat pump on the hydronic system having a total pump system power exceeding 10 hp (7.5 kW) must have a two-position automatic valve interlocked to shut off the water flow when the compressor is off. This is clarification of exist requirement.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.4.2.3.3.	None	None
C403.5 Economizers	CE124-19	Adds a new exemption. VRF systems installed with a dedicated outdoor air system does not require air economizer.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.3.	None	None
C403.6.5 Supply-air temperature reset controls	CE125-19	Adds clarifications how the supply air temperature (SAT) reset is applied. The change allows controls that adjust the reset based on zone humidity in Climate Zones 0B, 1B, 2B, 3B, 3C and 4 through 8. Revises existing exemptions: Systems in Climate Zones 0A, 1A, and 3A with less than 3000 cfm of design outside air. Adds two new exemptions: (1) Systems in Climate Zone 2A with less than 10,000 cfm of design outside air. (2) Systems in Climate Zones 0A, 1A, 2A, and 3A with not less than 80% outside air and employing exhaust air *energy* recovery complying with Section C403.7.4.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.4.4.5. The 3rd exemption item referenced code section in 2020 FBC-EC is section C403.2.7 Energy recovery ventilation systems, instead of Section C403.7.4. This code revision provides design Flexibility in Florida climate zones.	None	Decreases Because of increased design air flow threshold for SAT reset requirement. Now SAT reset may be not required for some buildings where previously required hence the code stringency decreases

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C403.6.5.1 Dehumidification Control Interaction	CE125-19	Adds new sub-section C403.6.5.1, which says in climate zones 0A, 1A, 2A, and 3A the system design must allow supply-air temperature reset while the dehumidification is provided. When dehumidification is active, air economizer must be locked out. This code change may increase construction cost but it is cost-effective per FSEC's cost-benefit analysis with average SIR values of 1.41.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C403.7.1 Demand control ventilation	CE127-19	Reduces the people occupancy density threshold from 25 to 15 people or greater per 1,000 ft^2 of floor area. Also demand control ventilation must be provided for all single-zone system required to comply with Sections C403.5 through C403.5.3. In exceptions item 3, reduces the design outdoor airflow threshold from 1,200 to 750 cfm for multiple-zone systems. Also in exception item 4, the threshold for exemption changes from less than 1200 cfm to greater than 75% of the space design outdoor air flow rate is exhausted or used as transfer air. This code change increases construction cost due to demand control ventilation requirement where previously not required. But FSEC's cost-benefit analysis demonstrates that this change is cost-effective with an average SIR value of 2.23.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.6.1.	Decrease	Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C403.7.1 Demand control ventilation	CE128-19	Revises the exemption items 4 and 5: Exemption item 4 now applies to spaces with 75% of the design outdoor air is exhausted or used as transfer air. Exemption item 5 used to apply to any space used for process load, now it applies to the following space types only: correctional cells, education laboratories, barber, beauty and nail salons, and bowling alley seating areas. DCV is cost-effective technology and FSEC agrees with ICC's cost-effectiveness claim especially with decreasing cost of DCV technology. Thus, this change is recommended for consideration for addition to the 8th Edition FBC-EC.	Same as change between 2018 IECC and 2021 IECC	Decrease	May slight increases where DCV is exempted previously
C403.7.2 Enclosed parking garage ventilation controls	CE129-19	Replaces the text "contaminant sensing devices" with "carbon monoxide and nitrogen dioxide detectors". Reduces the exhaust fan flow (CFM) threshold for enclosed parking garage to 8000 from 22,500 cfm and requires to use occupant sensors to activate the full required ventilation rate. Increases the stringency but low-cost CO2 sensor based ventilation control are in general cost effective as claimed by ICC. No analysis was done as there is no prototype building for enclosed parking garage. However, FSEC agrees	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.6.2 Enclosed parking garage ventilation controls.	Decrease	Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		with I-codes claim of cost-effectiveness of the change. Therefore, this change is recommended for consideration by FBC for addition to the 8th Edition FBC-EC.			
C403.7.4 Energy Recovery Systems	CE133-19	Adds new section that replaces an existing code section C403.7.4 Energy recovery ventilation systems. Moves the existing section to the new sub-section C403.7.4.2. The new code requires that Energy recovery ventilation systems must be provided as specified in either Section 403.7.4.1 or 403.7.4.2.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.7 Energy recovery ventilation systems.	None	None
C403.7.4.1 Nontransient dwelling units	CE133-19	Adds new prescriptive section. Requires exhaust air energy recovery system with an enthalpy recovery ratio of at least 50% and 60% for cooling and heating, respectively, in Nontransient dwelling units. Has exceptions depending on climate zone and dwelling unit floor area. This code change increases construction cost and it is not cost-effective per FSEC's cost-benefit analysis with SIR value of less than 1.0. However, I-Codes claims the change is cost-effective.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C403.7.4.2 Spaces other than nontransient dwelling units	CE133-19	Renames title of section C403.7.4 with "Spaces other than nontransient dwelling units" and designated it "Mandatory". Removes the minimum heating heat recovery efficiency requirement for hot and warmer climate zones and the minimum cooling heat recover efficiency requirement for colder climate zones in exemption items 5 and 6, respectively. This code change reduces the stringency and is recommended for consideration by FBC for addition to the 8th Edition FBC-EC.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.7.	None	None
C403.7.6 Automatic control of HVAC systems serving guestrooms	CE135-19	Replaces "occupancy status" with "rented and unrented status" to be consistent with modes of HVAC control requirements.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.8.	None	None
C403.7.6.1 Temperature setpoint controls	CE135-19	Unrented and unoccupied guest room mode must be initiated within 16 hours of the guest room being continuously occupied or where a networked guestroom control system indicates that the guestroom is unrented and the guestroom is unoccupied for more than 20 minutes. Revises that guestroom controls must be provided on each HVAC system that are capable of and configured with three modes of temperature control:	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.8.1.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		"occupied", "rented and un-occupied", and "unrented and un-occupied". This code change has no construction cost impact but saves energy. Cost effectiveness analysis is not required.			
C403.7.6.2 Ventilation controls	CE135-19	Reduces time-out period for unoccupied guestroom from 30 minutes to 20 minutes for consistency between HVAC and the lighting control in Section C405.2.1.1. This code change has no impact on construction cost but saves energy due to reduction of time-out period for turning off ventilation air.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.4.8.2.	Decrease	None
C403.8.2 Motor nameplate horsepower	CE136-19	Edits to correct IP/SI conversion. Also updates the exemptions: Fans equipped with electronic speed control devices to vary the fan airflow as a function of load and a fan nameplate electrical input power of less than 0.89 kW are now exempted.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.12.2 Fan motor selection. Only part of the editorial changes apply.	None	None
C403.8.3 Fan efficiency	CE139-19	Replaces the fan efficiency grade (FEG) metric with Fan Energy Index (FEI), and updates the minimum fan efficiency requirements using FEI. Revises the code that the FEI must be calculated in accordance with a new standard AMCA 208 by an approved, independent testing laboratory and labeled by the manufacturer. Adds new referenced standard:	This code section is already up-to-date. This change has no impact on the 2020 FBC-EC. The 2020 FBC-EC Section is C403.2.12.3.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		AMCA 208-18: Calculation of the Fan Energy Index			
C403.8.5 Low-capacity ventilation fans	CE140-19	Adds new code section for Mechanical ventilation system fans with motors less than 1/12 hp must meet the efficacy requirements of a new Table C403.8.5. This code change may slightly increase construction cost but FSEC's cost benefit analysis determined that the change is cost-effective with SIR value of 1.46.	Same as change between 2018 IECC and 2021 IECC.	Decrease	Slightly increase depending on the product
Table C403.8.5 Low-Capacity Ventilation Fan Efficiency	CE140-19	Adds new Table C403.8.5 that contains the minimum efficiency requirements of low-capacity mechanical ventilation fans less than 1/12 horsepower.	Same as change between 2018 IECC and 2021 IECC.	None	None
C403.9 Large-diameter ceiling fans	CE141-19	Adds new code section. Large diameter ceiling fans must be tested and labeled in accordance with AMCA 230. Adds new referenced standard: ANSI/AMCA 230-15: Laboratory Methods of Testing Air Circulating Fans for Rating and Certification.	Same as change between 2018 IECC and 2021 IECC.	None	None
C402.1 General	CE144-19	Revises the code section that walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers now must comply with Section C403.11, instead of C403.10.1 or C403.10.2 for clarity.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.14.	None	None
C403.11 Refrigeration equipment performance	CE144-19	Re-numbers the section. Adds new exception: Walk-in coolers and walk-in freezers regulated under federal law in accordance with	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		Subpart R of 10 CFR 431.	C403.2.14 Refrigeration equipment performance.		
C403.11 Refrigeration equipment performance	CE146-19	Re-numbers and revises the section to clarify code language, and deletes current tables C403.10.1(1) and C403.10.1(2), adds a new table C403.11.1 and updates the efficiencies to current federal minimum requirements.	The 2020 FBC-EC is already up-to-date. The 2020 FBC-EC Section is C403.2.14.	None	None
C403.11.1 Commercial refrigerators, freezers, refrigerator-freezers and refrigeration	CE146-19	Re-numbers the section, modifies the title, clarifies referenced code sections and standards, and updates tables to make them equivalent to ASHRAE 90.1-2019. Adds new referenced standard: AHRI 1250-(I-P) 2014: Standard for Performance Rating in Walk-in Coolers and Freezers.	The 2020 FBC-EC is already up-to-date. The 2020 FBC-EC Section is C403.2.14.1.	None	None
Table C403.10.1(1) Minimum Efficiency Requirements: Commercial Refrigeration	CE146-19	Deletes table C403.10.1(1) with substitution.	The 2020 FBC-EC is already up-to-date	None	None
Table C403.10.1(2) Minimum Efficiency Requirements: Commercial Refrigerators and Freezers	CE146-19	Deletes table C403.10.1(2) with substitution.	The 2020 FBC-EC is already up-to-date	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C403.11.1 Minimum Efficiency Requirements: Commercial refrigerators, freezers, refrigerator-freezers and refrigeration	CE146-19	Adds a new table with updated efficiency values based on federal minimum requirements.	The 2020 FBC-EC is already up-to-date. The 2020 FBC-EC table number is C403.2.14.1(1).	None	None
C403.11.2 Walk-in coolers, walk-in freezers	CE149-19	Re-numbers the section, and revises walk-in cooler and walk-in freezer refrigeration systems, except for walk-in process cooling refrigeration systems as defined in U.S. 10 CFR 431.302, must meet the requirements of new Tables C403.11.2(1), C403.11.2(2), and C403.11.2(3). Adds new referenced standards: AHRI 1250-(I-P) 2014: Standard for Performance Rating in Walk-in Coolers and Freezers.	The 2020 FBC-EC is already up-to-date. The 2020 FBC-EC Section is C403.2.14.2, and the corresponding tables are C403.2.14.2(1), C403.2.14.2(2) and C403.2.14.2(3)	None	None
Table C403.11.2(1) Walk-in Cooler and Freezer Display Door Efficiency Requirements	CE149-19	Updates Table C403.10.2.1(1).	The 2020 FBC-EC is already up-to-date. See Table C403.2.14.2(1).	None	None
Table C403.11.2(2) Walk-in Cooler and Freezer nondisplay Door Efficiency Requirements	CE149-19	Updates Table C403.10.2.1(2).	The 2020 FBC-EC is already up-to-date. See Table C403.2.14.2(2).	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C403.11.2(3) Walk-in Cooler and Freezer Refrigeration System Efficiency Requirements	CE149-19	Updates Table C403.10.2.1 (3).	The 2020 FBC-EC is already up-to-date. See Table C403.2.14.2(3).	None	None
C403.12.1 Duct and plenum insulation and sealing	CE151-19 Part I	Re-numbers the section, and revises the section that ducts located underground beneath buildings must be insulated as required in this section or have an equivalent thermal distribution efficiency. Requires that underground ducts utilizing the thermal distribution efficiency (TDE) method must be listed and labeled to indicate the R-Value equivalency.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.9.	None	None or slightly decrease (eliminates the need for insulation installation if a buried duct has equivalent TDE)
C403.12.2.3 High-pressure duct systems	CE152-19	Edits the last paragraph by removing the text “by the designer” to clarify the provider of duct testing documentation.	The 2020 FBC-EC does not need this code change. See Table C403.2.9.2	None	None
C403.12.3 Piping insulation	CE153-19	Re-numbers the section and adds radiant system piping to the piping insulation exemption list to avoid misinterpretation.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C403.2.10.	None	None
C404.2.1 High input service water-heating systems	CE156-19	Increases service hot water systems minimum efficiency to 92% from 90% for a singular piece of water-heating equipment that serves the entire building whose rated capacity is 1,000,000 Btu/h or larger. No change for minimum efficiency of multiple pieces of service hot water equipment requirement.	Same as change between 2018 IECC and 2021 IECC. The 2020 FBC-EC Section is C404.2.1.	Decrease	Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		This code change increases the minimum efficiency but uses an existing technology. No prototype building to model such system. This change is recommended for consideration by FBC for addition to the 8th Edition FBC-EC.			
C404.5.2.1 Water volume determination	CE158-19	Revises the code language; water volume in the piping must be determined from the "Volume" column in Table C404.5.1 or from new Table C404.5.2.1.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C404.5.2.1 Internal Volume of Various Water Distribution Tubing	CE158-19	Adds new table C404.5.2.1 for determination of internal volume of piping.	Same as change between 2018 IECC and 2021 IECC	None	None
C404.6.1 Circulation systems	CE159-19 Part I	Combines section C404.6.1 Circulation system and C404.7 Demand recirculation controls as the latter is a special case of the former. Moves section C404.7 Demand recirculation controls to new subsection C404.6.1.1. This change clarifies the requirements for heated water circulation and demand recirculation systems.	Same as change between 2018 IECC and 2021 IECC	None	None
C404.6.1.1 Demand recirculation controls	CE159-19 Part I	Adds new sub-section based on Section C404.7.	Same as change between 2018 IECC and 2021 IECC.	None	None
C404.8.1 Heaters	CE160-19 Part I	Re-numbers section C404.9.1.	Same as change between 2018 IECC and 2021 IECC.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C404.8.3 Covers	CE160-19 Part I	Re-numbers section C404.9.3 and editorial changes to clarify the language and align with other relevant codes.	The 2020 FBC-EC exempts pool cover requirement where more than 70% of the energy for heating, computed over an operating season, is from site-recovered energy such as from a heat pump or solar energy source. But requires editing to remove the test "site-recovered energy such as from".	None	None
C404.9 Portable spas	CE160-19 Part I	Re-numbers section C404.10 and modifies title of the section.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.1 General	CE161-19	Adds code language for clarification; general lighting must consist of all lighting when calculating the total connected interior lighting power in accordance with Section C405.3.1.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.3 Daylight-responsive controls	CE161-19	Daylight-responsive controls complying with Section C405.2.3.1 must be provided to control the general lighting within daylight zones but not specific application lighting. This code change decreases construction cost hence cost-benefit analysis is not required. This change is recommended for consideration by FBC for addition to the 8th Edition FBC-EC.	Same as change between 2018 IECC and 2021 IECC	None	Decrease

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.2.1.2 Occupant sensor control function in warehouses storage areas	CE162-19 CE166-19	Modifies the section title by adding the text "storage areas". Also revises the code language to reduce inconsistency and application confusion as follows: (1) aisle ways lights must be controlled independent of other areas, (2) occupant sensor must automatically reduce lighting power at an unoccupied setpoint not more than 50% of the full power within 20 minutes after all occupants left, (3) lights not controlled by occupant sensor must be turned off by time-switch control according to Section C405.2.2.1, and (4) manual lighting control is required.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.1 General	CE163-19	Adds code language to clarify that general lighting must consist of all lighting when calculating the total connected interior lighting power in accordance with Section C405.3.1 and it must not require specific application controls in accordance with Section C405.2.4.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.1 Occupant sensor controls	CE163-19	Adds new exception; luminaires which are required to have specific application controls in accordance with Section C405.2.4.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.2 Time-switch controls	CE163-19	Re-numbers the exception items. Adds new exception which says, luminaires that are required to have specific application controls in accordance with Section C405.2.4 are	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		now exempted from time-switch controls requirement.			
C405.2.5 Specific application controls	CE163-19	Re-numbers Section C405.2.4 and modifies by adding two new lighting specific application control requirements: (1) luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1, and (2) display lighting for exhibits in galleries, museums and monuments. Also adds a new exception in sleeping units lighting control; task lighting for medical and dental purposes that is in addition to general lighting must be provided with a *manual control*.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.3.1 Total connected interior lighting power	CE163-19	Editorial changes to items #6 and #7 in the list of lighting equipment and applications excluded from calculating total connected lighting power.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.3.2.2.1 Additional interior lighting power	CE163-19	Modifies the code language; additional power must be permitted only where the specified lighting is installed and controlled in accordance with Section C405.2.4. This code language revision is clarification.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.2.1.1 Occupant sensor control function	CE167-19	Revises exception which states, full automatic-on controls with no manual control must be permitted in *corridors*, *interior parking areas*, *stairways*, *restrooms*, *locker rooms*, *lobbies*, *library stacks*, and *areas* where manual operation would endanger occupant safety or security. Eliminates manual controls requirements for some space types. This code change decreases construction cost hence cost-benefit analysis is not required. This change is recommended for consideration by FBC for addition to the 8th Edition FBC-EC.	Same as change between 2018 IECC and 2021 IECC	None	Decrease
C405.2.1 Occupant sensor controls	CE169-19	Adds "Corridor" space type to the list of space types where occupant *sensor controls* must be installed to control lights. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with an average SIR value of 4.2. This analysis covers sub-sections C405.2.1.1 and C405.2.1.4.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C405.2.1.1 Occupant sensor control function	CE169-19	Revises the section; adds that occupant sensor controls in corridors must comply with a new Section C405.2.1.4.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.2.1.4 Occupant sensor control function in corridors	CE169-19	Adds a new section C405.2.1.4. Occupant sensor controls in corridors must uniformly reduce lighting power to not more than 50% of full power within 20 minutes after all occupants have left the space. Exception: corridors provided with less than two foot-candles of illumination on the floor are exempted.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C405.2.1.3 Occupant sensor control function in open plan office areas	CE170-19	Removes item #4, daylight responsive control requirement in open plan office space area and adds a revised code provision in Section C405.2.4.1.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.4.1 Daylight-responsive control function	CE170-19	Adds a new integrated control requirement where an occupant sensor and daylight response based lighting controls are used in a space.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.1.3 Occupant sensor control function in open plan office areas	CE171-19	Editorial changes to reduce confusion and inconsistency.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.1.3 Occupant sensor control function in open plan office areas	CE172-19	Adds new exception under requirement item #2. Exception: Where general lighting is turned off by time-switch control, complying with Section C405.2.2.1 is not required.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2 Lighting controls	CE175-19	Updates and re-numbers referenced code sections	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.2.2 Time-switch controls	CE175-19	Editorial changes.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.2.1 Time-switch control function	CE175-19	Removes redundant texts and adds one new compliance requirement: (1) automatically turn off lights when the space is scheduled to be unoccupied, and (2) moves exceptions item #2 dealing for a set of spaces type with manual control to a new code section C405.2.3.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.2.1 Time-switch control function	CE178-19	Reduces the light reduction control luminaire wattage threshold from 100W to 60 W for spaces with manual control in exception item 2.1. Similarly in item 2.2 the spaces LPD threshold was reduced from 0.6 to 0.45 W/ft^2.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.3.1 Light-reduction control function	CE175-19	Re-numbers Section C405.2.2.2, edits the title, revise the code language and moves the exception to new section C405.2.3.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.3 Light reduction controls	CE175-19	Adds new code section C405.2.3. In spaces without occupancy sensor lighting control complying with Section C405.2.1.1, general lighting control must be provided that comply with section C405.2.3.1. Also adds three new exceptions: luminaires controlled by daylight responsive controls, luminaires controlled by special application controls, and spaces with manual lighting control.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.2.5 Specific application controls	CE175-19	Re-numbers Section C405.2.4 and updates reference code sections.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.4 Daylight-responsive controls	CE175-19	Re-numbers Section C405.2.3 and updates reference code sections.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.3.1 Light-reduction control function	CE181-19	Re-numbers Section C405.2.2.2, and edits the title. Revises the code language; spaces required to have light-reduction controls must have a *manual control* that allows the occupant to reduce the connected lighting load using one of the three methods: (1) Continuous dimming of all luminaires from full output to less than 20% of full power. (2) Lamps switching all luminaires to a reduced output b/n 30% and 70% of full power. (3) Switching alternate luminaires or alternate rows of luminaires to achieve a reduced output b/n 30% and 70% of full power.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.3.1 Light-reduction control function	CE182-19	Re-numbers Section C405.2.2.2, edits the title and deletes the exception without substitute.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.4.1 Daylight-responsive control function	CE185-19	Re-numbers Section C405.2.3.1, and revises the code that daylight responsive controls must dim lights continuously from full light output to 15% of full light output or lower where it is required and must not be limited to space types: *offices, classrooms,*	Same as change between 2018 IECC and 2021 IECC	Decrease	Slightly increases

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		laboratories and library reading rooms. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with an average SIR value of 33.33.			
C405.2.4 Daylight-responsive controls	CE187-19	Re-numbers Section C405.2.3 and introduces requirements for secondary daylighting zones. The code adds revised specific daylight responsive control requirement for primary and secondary daylighting zones.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.4.1 Daylight-responsive control function	CE187-19	Re-numbers Section C405.2.3.1, and adds code language that lights in the primary sidelit zone must be controlled independently of lights in the secondary sidelit zone. Also revises the code language how the adjacent primary and secondary daylighting zones are controlled.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.4.2 Sidelit daylight zone	CE187-19	Re-numbers Section C405.2.3.2, renames the title, and adds a new code language that defines secondary sidelit zones. The area of secondary sidelit zones must not be considered in the calculation of the daylight zones in Section C402.4.1.1. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with an average SIR value of 1.77.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.2.4.2 Sidelit daylight zone	CE190-19	Re-numbers Section C405.2.3.2, renames the title, and reduced the distance from the fenestration to any building or geological formation that would block access to daylight by one half one half of the height from the bottom of the fenestration to the top of the building or geologic formation. This change expands the scope daylight responsive controls requirements. Construction cost may increase due to expansion of sidelit daylight control requirements. Daylighting control are cost effective measures but do not have prototype buildings for this change. This code change aligns IECC with ASHRAE 90.1 standard. This change is recommended for consideration for addition to the 8th Edition FBC-EC.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C405.2.4.2 Sidelit daylight zone	CE191-19	Re-numbers Section C405.2.3.2, renames the title, and revises how the primary and secondary daylighting zones longitudinal distance is calculated, and updates Figure C405.2.3.2 to clarify the code and make it consistent with the primary and secondary daylighting zone definitions.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.2.4.2 Sidelit daylight zone	CE192-19	Re-numbers Section C405.2.3.2, renames the title, and adds a code provision that clarifies whether sidelit zone is used where the fenestration is shaded with overhanging projection. Daylighting responsive controls is not required where there is deep overhanging projection. This code change decreases construction cost hence cost-benefit analysis is not required. This change is recommended for consideration by FBC for addition to the 8th Edition FBC-EC.	Same as change between 2018 IECC and 2021 IECC	None	Decrease
C405.2.4.2 Sidelit daylight zone	CE193-19	Re-numbers Section C405.2.3.2, renames the title, updates referenced figures, and defines the specifications of fenestration as roof top monitor to clarify the intent of the code intent.	Same as change between 2018 IECC and 2021 IECC	None	None
Figure C405.2.4.2(2) Daylight Zone Under a Rooftop Monitor	CE193-19	Editorial change and re-numbers Figure C405.2.3.3(2)	Same as change between 2018 IECC and 2021 IECC	None	None
Figure C405.2.4.2(3) Daylight Zone Under a Sloped Rooftop Monitor	CE193-19	Editorial change and re-numbers Figure C405.2.3.3(3)	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.4.3 Toplit daylight zone	CE193-19	Re-numbers Section C405.2.3.3, renames the title, and deletes requirement item 3 and moves it to	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		Section C405.2.4.2. This change is a clarification of code intent.			
Figure C405.2.4.2(1) Primary and Secondary Sidelit Daylight Zones	CE194-19	Editorial change, re-numbers Figure C405.2.3.2 and updates the caption.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.4.4 Atriums	CE196-19	Adds new code provision for Daylight zones at atrium spaces. Daylight zones at atrium spaces must be established at the top floor surrounding the atrium and at the floor of the atrium space, and not on intermediate floors, as indicated in Figure C405.2.4.4.	Same as change between 2018 IECC and 2021 IECC	None	None
Figure C405.2.4.4 Daylight zones at a multistory atrium	CE196-19	Adds new Figure C405.2.4.4.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.7 Exterior lighting controls	CE197-19	Re-numbers Section C405.2.6 and deletes the text “Decorative lighting systems shall comply with Sections C405.2.6.1, C405.2.6.2 and C405.2.6.4.”	Same as change between 2018 IECC and 2021 IECC	None	None
C405.2.7.2 Building facade and landscape lighting	CE197-19	Re-numbers Section C405.2.6.2 and edits the section title for clarification. This section now applies to building facade and landscaping lighting without any reference to decorative lighting.	Same as change between 2018 IECC and 2021 IECC.	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.2.7.3 Lighting setback	CE198-19	Re-numbers Section C405.2.6.3, reorganizes current exterior lighting control requirements and requires that luminaire serving outdoor parking with a wattage greater than 78W and mounting height of 24 ft or less must be controlled such that the lighting is reduced by at least 50% after 15 minutes of no activity. Also requires that no more than 1500W of lighting power is controlled together.	The 2020 FBC-EC already requires not less than 50% exterior lighting power input reduction. But may need to include the new provision for outdoor parking.	None	None
C405.2.8 Parking Garage Lighting Control	CE199-19	Adds new code Section C405.2.8 for parking garage lighting controls requirement. Adds multiple controls requirements for parking garage lighting: automatic time-switch, automatically reduce lighting by 30% when no activity, lighting power reduction in transition zones at nights, and automatic reduction of lighting near perimeter openings and fenestration in response to daylights. This code change increases construction cost but no prototype buildings to model the code. The lighting control requirements incur small incremental cost; however, this change is proven cost-effective measure. This change also aligns the IECC code with ASHRAE 90.1. Therefore, the change is recommended for consideration by FBC for addition to the 8th Edition FBC-EC.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.3.1 Total connected interior lighting power	CE201-19	Adds antimicrobial lighting used for disinfecting to existing 19 items not included applications list when calculating total connected interior lighting power using Equation 4-10.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.3.2 Interior lighting power allowance	CE202-19	Adds a clarification that buildings with unfinished spaces must use the Space-by-Space Method for interior lighting power allowance calculation.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.3.2.2 Space-by-Space Method	CE202-19	Adds a clarification that where a building has unfinished spaces, the lighting power allowance for the unfinished spaces must be the total connected lighting power for those spaces, or 0.2 W/ft^2, whichever is less.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.3.2 Interior lighting power allowance	CE203-19	Revises the code language to clarify the calculation procedure and code implementation. Also adds a requirement that the interior lighting power allowance for projects that only involve portions of a building must be determined according C405.3.2.2.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.3.2.1 Building Area Method	CE203-19	Deletes and substitutes. Completely re-writes the section to clarify the requirements and avoid confusion and misunderstanding.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.3.2.2 Space-by-Space Method	CE203-19	Deletes and substitutes. Completely re-writes the section to clarify the requirements and avoid confusion and misunderstanding.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C405.3.2(1) Interior Lighting Power Allowances: Building Area Method	CE206-19	Updates the interior lighting power allowances table for building area method. Reduces the LPD values for all building types with the exception of automotive facility, exercise center, library, parking garage, and workshop. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with an average SIR value of 3.71. This change is recommended for consideration for addition to the 8th Edition FBC-EC.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
Table C405.3.2(2) Interior Lighting Power Allowances: Space-by-Space Method	CE208-19	Updates the interior lighting power allowances table for the space-by-space method. Reduces the LPD values for almost all space types. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with an average SIR value of 2.09. This change is recommended for consideration for addition to the 8th Edition FBC-EC.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C405.4 Lighting for plant growth and maintenance	CE209-19	Adds "mandatory" new code section C405.4. Not less than 95% of the permanently installed luminaires used for plant growth and maintenance have a photosynthetic photon efficiency of not less than 1.6 µmol/J as defined in accordance with ANSI/ASABE S640 standards.	Same as change between 2018 IECC and 2021 IECC	Decrease	Slightly increases

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		Adds new referenced standard: ASABE S640-2017: Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms)			
C405.5.2 Exterior lighting power allowance	CE211-19	Re-numbers section C405.4.2 and completely re-writes the section to clarify the exterior lighting power allowance computation.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.5.2.1 Additional exterior lighting power	CE211-19	Re-numbers section C405.4.2.1 and edits the section to clarify the requirements.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.9.1 Elevator cabs	CE212-19	Re-numbers section C405.8.1 and designates the section “Mandatory”.	Same as change between 2018 IECC and 2021 IECC	None	May increase per section C405.9 (note that the section is designated mandatory)
C405.9.2 Escalators and moving walks	CE212-19	Re-numbers section C405.8.2 and designates the section “Mandatory”.	Same as change between 2018 IECC and 2021 IECC	None	May increase per section C405.9 (note that the section is designated mandatory)
C405.9.2.1 Regenerative drive	CE212-19	Re-numbers section C405.8.2.1 and designates the section “Mandatory”.	Same as change between 2018 IECC and 2021 IECC	None	May increase per section C405.9 (note that the section is designated mandatory)
C405.10 Voltage drop in feeders and branch circuits	CE212-19	Re-numbers section C405.9 and designates the section “Mandatory”.	Same as change between 2018 IECC and 2021 IECC	None	None
C407.2 Mandatory requirements	CE212-19	Adds code section C405.1, C405.2, and C405.4 through C405.9 to the mandatory requirements and removes	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		code section C405 from the mandatory requirement.			
C405.9.2 Escalators and moving walks	CE213-19	Re-numbers Section C405.8.2.1 and revises to clarify the compliance requirements. This change provides design flexibility.	Same as change between 2018 IECC and 2021 IECC	None	Decrease
C405.9.2.1 Energy Recovery	CE213-19	Re-numbers Section C405.9.2.1 and replaces the title “Regenerative drive” with “Energy Recovery”. Also revises the provision to clarify the section requirement.	Same as change between 2018 IECC and 2021 IECC	None	Decrease
C405.9 Voltage drop	CE214-19	Modifies the section title. Revises the 5% voltage drop maximum limit is now extended to include customer-owned service conductors in addition to feeder conductors and branch circuits.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C405.12 Energy Monitoring	CE215-19	Adds new mandatory code Section C405.12 and sub-sections. New buildings with a gross conditioned floor area of 25,000 ft^2 or larger must be equipped to measure, monitor, record and report energy consumption data in accordance with Section C405.12.1 through C405.12.5. This code change increases construction cost but it is cost-effective per FSEC’s cost-benefit analysis with a simple payback period under 2.5 years and an average SIR value of 3.44.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.12.1 Electrical energy metering	CE215-19	Adds new code sub-section describing electrical energy metering requirements.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.12.2 End-use metering categories	CE215-19	Adds new code sub-section. Defines meters or other approved measurement devices requirements.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C405.12.2 Energy Use Categories	CE215-19	Adds new table C405.12.2. The table lists energy end-use categories that need to be metered.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.12.3 Meters	CE215-19	Adds new code sub-section defines energy consumption data communication and display requirements.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.12.4 Data acquisition system	CE215-19	Adds new code sub-section that describes data acquisition system requirements.	Same as change between 2018 IECC and 2021 IECC	None	None
C405.12.5 Graphical energy report	CE215-19	Adds new code sub-section defining requirements of permanent and readily accessible building energy consumptions data graphical display, reporting mechanism and accessibility to building operation and management personnel.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C405.11 Automatic Receptacle Control	CE216-19	Adds new mandatory code Section C405.11 and a sub-sections. At least 50% of all 125 V, 15 and 20-amp receptacles installed in enclosed offices, conference rooms, rooms used primarily for copy or print functions, breakrooms, classrooms, and individual workstations, including those installed in modular partitions and module office workstation systems must have automatic controls. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with an average SIR value of 2.19. Thus, this change is recommended for consideration by FBC for addition to the 8th Edition FBC-EC.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C405.11.1 Automatic receptacle control function	CE216-19	Adds new code sub-section C405.11.1 defining requirements of automatically receptacle control function.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
Section C406 Additional Efficiency Requirements	CE218-19 CE226-19 CE240-19	Edits Section C406 title by deleting "Package Options".	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C406.1 Additional energy efficiency credit requirements	CE218-19 CE226-19 CE237-19 CE239-19 CE240-19	Renames the title and revises section C406.1. Now new buildings must achieve a total of 10 credits from new Tables C406.1(1) through C406.1(5) depending on buildings use group and climate zone using credit calculations as specified in relevant subsections of C406 where a building complies with one or more of the prescribed additional efficiency options in sections C406.2 through C406.12. Adds new additional efficiency credit for kitchen equipment as item #9 which says, where not required by Section C405.12 include an energy monitoring system in accordance with C406.10. Adds new compliance option item #10 which says, where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11. Adds five new tables C406.1(1) through C406.1(5). Adds new compliance option item #11 for efficient Kitchen equipment in accordance with Section C406.12.	Same as change between 2018 IECC and 2021 IECC	Decrease	None
Table C406.1(1) Additional Energy Efficiency Credits for Group B Occupancies	CE218-19 CE226-19 CE239-19 CE240-19	Adds new additional efficiency credits table for Group B buildings.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Table C406.1(2) Additional Energy Efficiency Credits for Group R and I Occupancies	CE218-19 CE226-19 CE239-19 CE240-19	Adds new additional efficiency credits table for Group R and I buildings.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C406.1(3) Additional Energy Efficiency Credits for Group E Occupancies	CE218-19 CE226-19 CE239-19 CE240-19	Adds new additional efficiency credits table for Group E buildings.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C406.1(4) Additional Energy Efficiency Credits for Group M Occupancies	CE218-19 CE226-19 CE239-19 CE240-19	Adds new additional efficiency credits table for Group M buildings.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C406.1(5) Additional Energy Efficiency Credits for Other Occupancies	CE218-19 CE226-19 CE239-19 CE240-19	Adds new additional efficiency credits table for other occupancy buildings.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.1.1 Tenant spaces	CE218-19 CE226-19 CE240-19	Revises the compliance requirement with new predetermined credits by building group and climate zone. In the revised code tenant spaces must comply with sufficient options form Tables C406 .1(1) through C406 .1(5) to achieve a minimum number of 5 credits, where credits are selected from Section C406.2, C406.3, C406.4, C406.6 or C406.7. Where the entire building complies using credits from Section C406.5, C406.8 or C406.9,	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		tenant spaces within the building must be deemed to comply with this section.			
C406.2 More efficient HVAC equipment performance	CE113-19 CE218-19 CE224-19 CE226-19 CE240-19	Re-organizes the section and revises the code language such that equipment must exceed the minimum efficiency requirements listed in Section C403.3.2 relevant tables and requires to comply with the new sub-section C406.2.1, C406.2.2, C406.2.3, or C406.2.4. Changes equipment minimum efficiency requirements reference to point to tables in Section C403.3.2. Equipment must meet applicable requirements of Section C403. Energy efficiency credits for heating must be selected from C406.2.1 or C406.2.3 and energy efficiency credits for cooling must be selected from C406.2.2 or C406.2.4. Selected credits must include a heating or cooling energy efficiency credit or both. Equipment not listed in Tables C403.3.2(1) through C403.3.2(9) and for VRF systems not listed in ASHRAE 90.1 must be limited to 10% of the total building system capacity.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.2.1 Five percent heating efficiency improvement	CE218-19 CE224-19 CE226-19 CE240-19	Adds new sub-section. Equipment must exceed the minimum heating efficiency requirements by 5 percent.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C406.2.2 Five percent cooling efficiency improvement	CE218-19 CE224-19 CE226-19 CE240-19	Adds new sub-section. Equipment must exceed the minimum cooling and heat rejection efficiency requirements by 5 percent. Where multiple cooling equipment are provided, the equipment must exceed the annual energy requirement, including IEER, SEER, and IPLV.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.2.3 Ten percent heating efficiency improvement	CE218-19 CE224-19 CE226-19 CE240-19	Adds new sub-section. Equipment must exceed the minimum heating efficiency requirements by 10 percent.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.2.4 Ten percent cooling efficiency improvement	CE218-19 CE224-19 CE226-19 CE240-19	Adds new sub-section. Equipment must exceed the minimum cooling and heat rejection efficiency requirements by 10 percent. In some cases cooling equipment must exceed the annual energy requirement, including IEER, SEER, and IPLV.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.2.5 More than ten percent cooling efficiency improvement	CE224-19	Adds new section. Requires equipment exceed the minimum annual cooling and heat rejection efficiency requirements by more than 10 percent, energy efficiency credits for cooling may be determined using Equation 4-1. In some cases cooling equipment must exceed the annual energy requirement, including IEER, SEER, and IPLV.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.5 On-site renewable energy	CE218-19 CE226-19 CE240-19	Re-organizes the section by adding two new sub-sections. Now buildings must comply either with Section C406.5.1 or the new Section C406.5.2.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C406.5.1 Basic renewable credit	CE218-19 CE226-19 CE240-19	Adds new sub-section. Creates a basic renewable credit Section C406.5.1 from existing Section C406.5 using reduced total minimum ratings of on-site renewable energy systems that does not include Section C406.7.2 and must comply with either of (1) not less than 0.86 Btu/h/ft^2 of conditioned floor area, or (2) not less than 2% of the energy used within the building for building mechanical and service water heating equipment and lighting regulated in Chapter 4.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.5.2 Enhanced Renewable Credits	CE218-19 CE226-19 CE240-19	Adds new sub-section that requires the total minimum ratings of on-site renewable energy systems exceeds the rating in C406.5.1 and the additional energy efficiency credits must be determined based on Equation 4-13.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.7 Reduced energy use in service water heating	CE218-19 CE226-19 CE240-19	Adds new section. Buildings must comply with Section C406.7.1 and Section C406.7.2, C406.7.3 or C406.7.4.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.7.1 Building Type	CE218-19 CE226-19 CE240-19	Re-numbers section C406.7, edits the title and revises the code language. To qualify for this credit, the building must contain one of the building use groups defined in this section and the additional energy efficiency credit must be prorated by conditioned floor area of the portion of these building use groups in the building. Adds new Group E building use group.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C406.7.2 Recovered or renewable water heating	CE218-19 CE226-19 CE240-19	Re-numbers section C406.7.1, edits the title and revises the code language. Revises the code provision that the building service water heating system must have one or more of the following that are sized to provide not less than 30% of the building's annual hot water requirements, or sized to provide 70% of the building's annual hot water requirements if the building must otherwise is required to comply with Section C403.9.5.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.7.3 Efficient fossil fuel water heater	CE218-19 CE226-19 CE240-19	Adds new section that requires the combined input-capacity-weighted-average equipment rating of all fossil fuel water heating equipment in the building must be not less than 95% Et or 0.95 EF. This option receives only half the listed credits for buildings required to comply with C404.2.1.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.7.4 Heat pump water heater	CE218-19 CE226-19 CE240-19	Adds new section that requires (1) all SHW system heating requirements must be met using heat pump technology with a combined input capacity-weighted-average EF of 3.0 where electric resistance water heaters are allowed and (2) air-source heat pump water heaters must not draw conditioned air from within the building except air exhausted to the exterior.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C406.3 Reduced lighting power	CE226-19	Revises the code such that buildings must comply with Section C406.3.1 or C406.3.2 and dwelling units and sleeping units within the building must comply with C406.3.3.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.3.1 Reduced lighting power by more than 10 percent	CE226-19	Re-numbers section C406.3 and edits the title.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.3.2 Reduced lighting power by more than 15 percent	CE226-19	Adds new sub-section. Where the total connected interior lighting power calculated in accordance with Section C405.3.1 is less than 85% of the total lighting power allowance calculated in accordance with Section C405.3.2, additional energy efficiency credits must be determined based on Equation 4-12.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.3.3 Lamp efficacy	CE226-19	Adds new sub-section. Not less than 95% of the interior lighting power from lamps in permanently installed light fixtures in dwelling units and sleeping units must be provided by lamps with a minimum efficacy of 65 lumens per watt.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.4 Enhanced digital lighting controls	CE231-19	Enhanced lighting control is limited to general lighting; removes the "individual user control of overhead general illumination in open offices" from control requirement.	Same as change between 2018 IECC and 2021 IECC	None	Decrease

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C406.10 Energy Monitoring	CE237-19	Adds new code sub-section describing energy metering requirement. Buildings must be equipped to measure, monitor, record and report energy consumption data in compliance with Section C406.10.1 through C406.10.5.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.10.1 Electrical energy metering	CE237-19	Adds new code sub-section. Defines electrical energy metering requirements.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.10.2 End-use metering categories	CE237-19	Adds new code sub-section. Defines meters or other approved measurement devices requirements.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C406.10.2 Energy Use Categories	CE237-19	Adds new table C406.10.2. The table lists energy end-use categories that need to be metered.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.10.3 Meters	CE237-19	Adds new code sub-section defined energy consumption data communication and display requirements.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.10.4 Data acquisition system	CE237-19	Adds new code sub-section describes data acquisition system requirements.	Same as change between 2018 IECC and 2021 IECC	None	None
C406.10.5 Graphical energy report	CE237-19	Adds new code sub-section defining requirements of permanent and readily accessible building energy consumptions data graphical display, reporting mechanism and accessibility to building operation and management personnel.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C406.11 Fault detection and diagnostics system	CE239-19	Adds new section. A fault detection and diagnostics system must be installed to monitor the HVAC system's performance and automatically identify faults. This code change is cost-effective. See the cost-effectiveness analysis for code change CE111-19.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
C406.12 Efficient Kitchen Equipment.	CE240-19	Adds new section. For buildings and spaces designated as Group A-2 or facilities that include a commercial kitchen must comply with (1) achieve performance levels listed in Tables C406.12(1) through C406.12(4), (2) appliance must be installed prior to the issuance of the certificate of occupancy, and (3) performance levels must match the values on the construction documents submitted for permitting. Energy efficiency credits for efficient kitchen equipment must be based on Equation 4-15.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C406.12(1) Minimum Efficiency Requirements: Commercial FRYERS	CE240-19	Adds new table C406.12(1) for commercial fryers.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C406.12(2) Minimum Efficiency Requirements:	CE240-19	Adds new table C406.12(2) for commercial steam cookers.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
Commercial Steam Cookers					
Table C406.12(3) Minimum Efficiency Requirements: Commercial Dish washers	CE240-19	Adds new table C406.12(3) for commercial dish washers.	Same as change between 2018 IECC and 2021 IECC	None	None
Table C406.12(4) Minimum Efficiency Requirements: Commercial Ovens	CE240-19	Adds new table C406.12(4) for commercial ovens.	Same as change between 2018 IECC and 2021 IECC	None	None
	CE240-19	Adds new referenced ASTM standards: ASTM F1361-17: Standard Test Method for Performance of Open Deep Fat Fryers F1484-18: Standard Test Method for Performance of Steam Cookers F1495-14a: Standard Specification for Combination Oven Electric or Gas Fired F1496-13: Standard Test Method for Performance of Convection Ovens F1696-18: Standard Test Method for Energy Performance of Stationary-Rack, Door-Type Commercial Dishwashing Machines F1920-15: Standard Test Method for Performance of Rack Conveyor Commercial Dishwashing Machines F2093-18: Standard Test Method for Performance of Rack Ovens	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		F2144-17: Standard Test Method for Performance of Large Open Vat Fryers F2861-17: Standard Test Method for Enhanced Performance of Combination Oven in Various Modes			
C407.2 Performance-based compliance	CE243-19	Replaces the text "Price and Expenditure Report" with "Data System Prices and Expenditures reports".	Same as change between 2018 IECC and 2021 IECC	None	None
Table C407.5.1(1) Specification for The Standard Reference and Proposed Designs	CE247-19	Revises the above grade wall construction for the standard reference design to be the same as the proposed design. Increases construction cost when the proposed building design for above grade wall construction is wood frame. This code change is intended to eliminate the trade-off loophole.	Same as change between 2018 IECC and 2021 IECC	None	Increase depending on the proposed design wall construction
C408.3.1 Functional testing	CE249-19	Editorial change to clarify code language.	Same as change between 2018 IECC and 2021 IECC	None	None
Chapter C5: Existing Buildings					
C502.1 General	CE250-19	Deletes the text *"Additions* shall comply with Sections C402, C403, C404, C405 and C502.2". *Deletes text "Additions* complying with ANSI/ASHRAE/IESNA 90.1 need not comply with Sections C402, C403, C404 and C405" because the IECC and ASHRAE code compliance paths cannot be combined.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C502.2 Change in space conditioning	CE250-19	Moves Section C503.2 to C502.2 and edited the code language for clarity. Any non-conditioned or low-energy space that is altered to become conditioned space must be required to comply with Section C502.	Same as change between 2018 IECC and 2021 IECC	None	None
C502.3 Compliance	CE250-19	Re-numbers Section C502.2, edits the title and updates referenced code sections. Now additions must comply with Sections C502.3.1 through C502.3.6.2.	Same as change between 2018 IECC and 2021 IECC	None	None
C502.3.1 Vertical fenestration area	CE250-19	Re-numbers Section C502.2.1, edits the title, revises the code language, and re-organizes the section for clarity.	Same as change between 2018 IECC and 2021 IECC	None	None
C502.3.2 Skylight area	CE250-19	Re-numbers Section C502.2.2, revises the code language, and re-organizes the section for clarity.	Same as change between 2018 IECC and 2021 IECC	None	None
C502.3.3 Building mechanical systems	CE250-19	Re-numbers Section C502.2.3, editorial changes and adds compliance requirement for Section C408. New mechanical systems and equipment that are part of the addition and serving the building heating, cooling and ventilation needs must comply with Sections C403 and C408.	Same as change between 2018 IECC and 2021 IECC	None	None
C502.2.6 Lighting power and systems	CE250-19	Editorial changes and adds compliance requirement for Section C408. New lighting systems that are installed as part of the addition must comply with Section Sections C405 and C408.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C503.1 General	CE250-19	Made editorial changes and deleted text "*Alterations* complying with ANSI/ASHRAE/IESNA 90.1 need not comply with Sections C402, C403, C404 and C405" because the IECC and ASHRAE code compliance paths cannot be combined.	Same as change between 2018 IECC and 2021 IECC	None	None
C503.3 Heating and cooling systems	CE250-19	Re-numbers Section C503.4 and adds compliance requirement reference to Section C408.	Same as change between 2018 IECC and 2021 IECC	None	None
C503.4 Service hot water systems	CE250-19	Re-numbers Section C503.5 and adds compliance requirement reference to Section C408.	Same as change between 2018 IECC and 2021 IECC	None	None
C503.5 Lighting systems	CE250-19	Re-numbers Section C503.6 and adds compliance requirement reference to Section C408.	Same as change between 2018 IECC and 2021 IECC	None	None
C503.2 Building envelope	CE250-19	Re-numbers Section C503.3.	Same as change between 2018 IECC and 2021 IECC	None	None
C503.2.1 Roof replacement	CE258-19	Re-numbers Section C503.3.1 and adds a code language that the *R-value* of the roof insulation must not be reduced or the *U-factor* of the roof assembly must be increased as part of the *roof replacement.*	Same as change between 2018 IECC and 2021 IECC	None	None
C503.2.2 Vertical fenestration	CE259-19	Re-numbers Section C503.3.2 and moves Section C401.21 Application to fenestration replacement products to Section 5, re-numbers and edits the title. This change clarifies language and provisions of an existing code.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
C503.2.2.1 Replacement fenestration products	CE259-19	Creates new sub-section by moving Section C401.21 Application to fenestration replacement products to Section 5, re-numbers and edits the title. This change clarifies language and provisions of an existing code.	Same as change between 2018 IECC and 2021 IECC	None	None
C503.2.3 Skylight area	CE259-19	Re-numbers Section C503.3.3.	Same as change between 2018 IECC and 2021 IECC	None	None
APPENNDIX CB: Solar-Ready Zone – Commercial					
CB103.6 Interconnection pathway	CE262-19	Revises the provision by adding a new requirement that the construction document must indicate the pathway for electrical energy storage system area.	Same as change between 2018 IECC and 2021 IECC	None	None
CB103.7 Electrical energy storage system-ready area	CE262-19	Adds a new section. The floor area of the electrical energy storage system-ready area must be not less than 2 feet in one dimension and 4 feet in another dimension, and located in accordance with Section 1207 of the *International Fire Code.* The location and layout diagram of the electrical energy storage system-ready area must be indicated on the construction documents.	Same as change between 2018 IECC and 2021 IECC	None	Increase
CB103.8 Electrical service reserved space	CE262-19	Re-numbers Section CA103.7 and revises service area space installation requirements for a dual-pole circuit breaker future solar electric and a dual-pole circuit breaker future electric energy storage system.	Same as change between 2018 IECC and 2021 IECC	None	Increase

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
CB103.9 Construction documentation certificate	CE262-19	Re-numbers Section CA103.8.	Same as change between 2018 IECC and 2021 IECC	None	Increase
APPENNDIX CC: Zero Energy Commercial Building Provisions					
Section CC101 General	CE264-19	Adds new Section label CC101.	Same as change between 2018 IECC and 2021 IECC	None	None
CC101.1 Purpose	CE264-19	Adds new Section CC101.1. Defines the renewable energy systems capacity requirements to achieve zero net carbon.	Same as change between 2018 IECC and 2021 IECC	None	None
CC101.2 Scope	CE264-19	Adds new Section CC101.2. This appendix applies to new commercial buildings that are addressed by the IEC.	Same as change between 2018 IECC and 2021 IECC	None	None
Definitions Adjusted Off-Site Renewable Energy Building Energy Utilization Intensity(EUI) Off-Site Renewable Energy System On-Site Renewable Energy System Renewable Energy System Zero Energy Performance Index (zEPIPB/EE) Semi-Heated Space	CE264-19	Adds the following new definitions that apply to appendix CC101.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
CC103.1 Renewable energy	CE264-19	Adds new Section CC103.1. On-site renewable energy systems must be installed or off-site renewable energy must be procured to offset the building energy.	Same as change between 2018 IECC and 2021 IECC	Decrease	Increase
Table CC103.1 Energy Utilization Intensity for Building Types and Climates (kBtu/ft²-Yr)	CE264-19	Adds new table CC103.1. When Section C401.2 (2) is used for compliance with the IECC, building energy must be determined by multiplying the gross conditioned floor area plus the gross semi-heated floor area of the proposed building by a EUI selected from Table CC103.1. Use floor area weighted average for mixed-use buildings.	Same as change between 2018 IECC and 2021 IECC	None	None
CC103.2 Calculation of On-Site Renewable Energy	CE264-19	Adds new Section CC103.2. The annual energy production from on-site renewable energy systems must be determined using the PVWatts software or other software approved by the code official.	Same as change between 2018 IECC and 2021 IECC	None	None
CC103.3 Off-Site Renewable Energy	CE264-19	Adds new Section CC103.3. Off-site energy must comply with Sections CC103.3.1 and CC103.3.2.	Same as change between 2018 IECC and 2021 IECC	None	None
CC103.3.1 Qualifying off-site procurement methods	CE264-19	Adds new Section CC103.3.1.	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
		This section lists qualifying off-site renewable energy procurement methods.			
CC103.3.2 Requirements for all procurement methods	CE264-19	Adds new Section CC103.3.2. This sections provides requirements that must apply to all *off-site renewable energy* procurement methods.	Same as change between 2018 IECC and 2021 IECC	None	None
CC103.3.3 Adjusted Off-Site Renewable Energy	CE264-19	Adds new Section CC103.3.3. This section provides a procedure and/or equation used for calculating the adjusted off-site renewable energy.	Same as change between 2018 IECC and 2021 IECC	None	None
Table CC103.3.3 Default Off-Site Renewable Energy Procurement Methods, Classes and coefficients	CE264-19	Adds new table CC103.3.3. This table provides default values off-site renewable energy procurement method, classes, and coefficients.	Same as change between 2018 IECC and 2021 IECC	None	None
Chapter C6: Referenced Standards					
NFRC 203—2017	CE39-19	Adds NFRC 203—2017 to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None
ANSI/RESNET/ICC 301—2019	CE44-19	Updates ANSI/RESNET/ICC 301—2019	Same as change between 2018 IECC and 2021 IECC	None	None
ICC 500 ICC/NSSA	CE92-19	Adds ICC 500: ICC/NSSA to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None
ASTM E3158-18	CE98-19	Adds ASTM E3158 to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None
ASTM D8052/D8052M-2017	CE101-19	Adds ASTM D8052/D8052M-2017 to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None

2021 IECC Section and Title	ICC Code Change No.	Change Summary b/t 2018 IECC and 2021 IECC	Change Summary b/t 2020 FBC-EC and 2021 IECC	Anticipated Energy Impact on FBC-EC if Adopted*	Anticipated Cost Impact on FBC-EC if Adopted*
ASHRAE 90.4-2016	CE108-19	Adds ASHRAE 90.4-2016 to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None
AMCA 208-18	CE139-19	Adds AMCA 208-18 to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None
ANSI/AMCA 230-15	CE141-19	Adds ANSI/AMCA 230-15 to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None
AHRI 1250-(I-P) 2014	CE146-19	Adds AHRI 1250-(I-P) 2014 to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None
AHRI 1250-(I-P) 2014	CE149-19	Adds AHRI 1250-(I-P) 2014 to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None
ASABE/ S640-2017	CE209-19	Adds new standard ASABE/ S640-2017 to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None
ASTM F1361-17 F1484-18 F1495-14a F1496-13 F1696-18 F1920-15 F2093-18 F2144-17 F2861-17	CE240-19	Adds the nine ASTM standards to referenced standard	Same as change between 2018 IECC and 2021 IECC	None	None

Appendix-B: Commercial Code Change for 7th Edition (2020) FBC-EC vs. 2019 ASHRAE 90.1

Table-B summarizes the addenda to the 2016 ASHRAE Standard 90.1-2016 along with brief description of the changes, anticipated energy impact of the change on FBC-EC if adopted, and whether the code change is included in the quantitative analysis or not and discussion. Table B has six columns and are defined as follows:

Addendum: is the code change addenda to the 2016 ASHRAE Standard 90.1 and published in the to the 2019 ASHRAE Standard 90.1.

Code Sections Affected: proposed code change id defined in the addenda to the ASHRAE 90.1-2016. This code number is used to identify the history of the code change.

ASHRAE 90.1-2016 and ASHRAE 90.1-2019: brief description of the code change between the 2016 ASHRAE Standard 90.1 and the 2019 ASHRAE Standard 90.1. The description also includes cost-benefit analysis results summary if cost-effectiveness test were performed.

Anticipated Energy Impact on FBC-EC if Adopted: energy use impact from the code change. This is usually a decrease energy use, an increase energy use, or none. None means the code change has no or negligible impact on building energy use.

Included in quantitative Analysis: if the energy impact can be predicted using whole building simulation programs and DOE reference prototype buildings. This is “Yes” or “No”. Yes means the change is included in the quantitative analysis, No means the change is excluded from the quantitative analysis.

Discussion: describes how the change impacts the implementation in the quantitative analysis, the prototype buildings are impacted and why the analysis is included or not.

Table-B: **Commercial Code Change Summary for ASHRAE 90.1-2016 vs. ASHRAE 90.1-2019**

Addendum	Code Sections Affected	Code Change Summary Between ASHRAE 90.1-2016 and ASHRAE 90.1-2019	Anticipated Energy Impact on FBC-EC if Adopted*	Included in quantitative Analysis	Discussion
3. Definitions, Abbreviations, and Acronyms					
n	3.2	Removes ten unused definitions and changes definition of “unitary cooling equipment” to “unitary air conditioners”.	None	No	
ab	3.2	Modifies definition of “door”, “entrance door”, “fenestration”, and “sectional garage door”.	None	No	
c	3.2	Adds roof monitors to definition of fixed and operable vertical fenestration.	None	No	Modified operable and fixed vertical fenestrations definition to include roof monitor
ac	3.1, 3.2	Clarifies use of defined terms to include the term with different tense or plurality.	None	No	
4. Administration and Enforcement					
x	4.1.1.2, 4.2.1.1, 4.2.1.2, 4.2.1.3	Clarifies compliance paths for new construction, additions, and alterations.	None	No	Provides clarification to compliance paths
s	4.2.1.1, 11.4.3.1, G2.4	Modifies the Performance Cost Index (PCI) equation to implement a 5% limitation on renewable energy usage and clarifies what types of renewable energy systems are eligible.	None	No	Excluded from quantitative analysis because the prototypes are not have on-site generators
bt	Table 4.2.1.1	Revises Table 4.2.1.1 Building Performance Factor (BPF). Updates BPF in Table 4.2.1.1 for the ASHRAE 90.1-2019 code. BPF represent energy cost of the 2019 code against that of 2004 code.	None	No	Excluded from the quantitative analysis. Prototype building do not use building performance factors.
ci	Table 4.2.1.1	Further revises Table 4.2.1.1 Building Performance Factor (BPF). Updates BPF table values for the 2019 code.	None	No	Excluded from the quantitative analysis. Prototype building do not use building performance factors.

5. Building Envelope					
b	5.5.3.1.1, 12	Updates reference to ANSI/CRRC S100 "Standard Test Methods for Determining Radiative Properties of Materials".	None	No	This is reference update hence is not included in the quantitative analysis.
q	5.4.3, 5.5, 5.8.3, 5.9.1	Clarifies and restructures air leakage requirements for the building envelope.	None	No	
ad	5.2 through 11.2	This addendum clarifies the requirements for showing compliance using the methods in Sections 5-10, or Section 11, or Appendix G.	None	No	
aw	3.2; Tables 5.5-0 through 5.5-8, 5.8.2.5, 12	Revises the fenestration prescriptive criteria in Tables 5.5-0 through 5.5-8. Fenestration classification is now material neutral and instead grouped into "*fixed*", "*operable*", and "*entrance door*" category. The SHGC is slightly stringent across all categories due to glass quality improvement but the U-factor stringency depends on the fenestration framing material and it is more stringent for metal framing products and stringency relaxed for wood framing fenestration. This code change slightly increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with SIR value of 1.89.	Decrease	Yes	Improves thermal performance of most fenestration products. Impacts all prototype buildings.
bh	Table 5.8.3.2	Corrects an omission related to nonswinging doors in Table 5.8.3.2.	None	No	
bf	5.4.3.4; 10.4.5	Establishes an alternative to the requirement for vestibules by use of an air curtain that meets specific requirements prescribed in the proposed language. Adds new section 10.4.5. Provides design flexibility.	None	No	Excluded from the quantitative analysis. Cannot be accurately represented in the simulation model.
6. Heating, Ventilating, and Air Conditioning					
a	6.4.3.3.3, 6.3.3.4.2, 6.5.1.1.4	Changes term "ventilation air" to "outdoor air" in multiple locations. Revises tables and footnotes. Clarifies requirements for economizer return dampers.	Decrease	Yes	Reduces fan energy by allowing systems intended to operate continuously not to install motorized outdoor air damper (less pressure drop),

		Changes term "ventilation air" to "outdoor air" in multiple locations. Adds an exception to allow systems intended to operate continuously not to install motorized outdoor air damper. Changes return air dampers to require low leakage ratings.			and reduce cooling energy for systems with air economizers because of lower leakage through return air dampers.
g	3.2, 6.3.2, 6.5.3.8	Provides definition of "occupied-standby mode" and adds new ventilation air requirements for zones served in *occupied-standby mode*. Adds new definition. Unoccupied space doesn't need to be ventilated per standard 62.1 when spaces air temperature is within the allowed limits. Reduces ventilation air requirements to zero and setbacks cooling and heating thermostats by at least 1°F for zones served in *occupied-standby mode*. Also this changes ties the HVAC control to lighting control requirement in section 9.4.1.1. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with SIR value range of 1.06 – 2.22.	Decrease	Yes	Impacts high and medium rise apartment, offices, outpatient healthcare, schools prototype buildings.
h	6.5.6.1, 6.5.6.1.1	Clarifies that exhaust air energy recovery systems should be sized to meet both heating and cooling design conditions unless one mode is not exempted by existing exceptions. Reduces HVAC energy by requiring adequately sized ERVs. No impact on construction cost.	Decrease	Yes	Impacts prototype buildings with ERVs.
j	6.4.3.8	Revises exception to demand control ventilation (DCV) requirements to clarify that the exception only applies to systems with ERV required to meet Section 6.5.6.1. Reduces HVAC energy by preventing a bad design practice of using ERV rather than DCV in climate zones where ERVs are not required and DCV would save more energy.	Decrease	No	Excluded from quantitative analysis, not a typical design

k	3.2, 6.4.3.3.5	Revises definition of "networked guest room control system" and aligns HVAC and lighting timeout periods for guest rooms. Reduces the HVAC timeout period from 30 to 20 minutes to match the 20 minutes timeout period for lighting control. This code change has no impact on construction cost. But FSEC's cost-benefit analysis small incremental cost yields SIR value range of 6.0 – 49.0.	Decrease	Yes	Impacts prototype buildings small and large hotels.
p	Table 6.1.8 - 14	Revises the rating conditions for indoor pool dehumidifiers.	None	No	
o	3.2, 4.2.2.3, 5.5, 5.7 through 11.7, G 1.3	Revises the submittals section of the envelope and power chapters for consistency across the standard.	None	No	
v	6.5.6.3	Adds section 6.5.6.3 containing heat recovery requirements for space conditioning in acute inpatient hospitals. Adds new sub-section. Heat recovery chillers are required in acute inpatient hospitals where: the building operates 24 hours, the chilled water system rated capacity is greater than 300 tons, uses simultaneous heat and cool above 60F, and the heat recovery chiller cooling capacity is greater than 7% of chilled water system rated design capacity. This section has exception depending on on-site recovered or generated energy and climate zones. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with SIR value of 1.33.	Decrease	Yes	Included in the quantitative analysis. Impacts hospital prototype building.
ae	3.2, 6.4.3.6, G3.1.3.18	Clarify humidification and dehumidification control requirements.	None	No	This change is a clarification.
ai	3.2, 4.2.5, 5.2.9, 6.7.2.4, 9.4.3,	Restructures commissioning and functional testing requirements in all sections of Standard 90.1 to require verification for smaller and simpler buildings	Decrease	No	Excluded from the quantitative analysis because cannot be modeled.

	5.9 through 10.9, 11.2	and commissioning for larger and more complex buildings. This change is a clarification.			
aj	3.2, 6.5.1, 6.5.2.3, 6.5.4.4	Adds a new definition "process application" and uses it throughout Standard in place of "process load".	None	No	
am	6.5.6.4	Adds an indoor pool dehumidifier energy recovery requirement in new section 6.5.6.4. Requires 50% energy recovery efficiency for indoor pool dehumidifier energy recovery.	Decrease	No	Excluded from the quantitative analysis because the prototype building do not have indoor pool.
ao	3.2; 6.5.3.1.3;	Introduces the revised fan product efficiency requirement Fan Energy Index (FEI) and complements the fan power limitation in section 6.5.3.1.1. FEI is DOE's new fan efficiency metrics that better represents fan energy use performance.	Decrease	No	Not applicable to the model input.
ap	6.5.3.5	Revises supply air temperature reset controls. Applies supply air temperature reset strategy. This code change will bring up to 5°F supply temperature difference decrease depending on outdoor air temperature or load. This code requirement has exemption depending on climate zone and system design outdoor air flow rate. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with SIR value range of 1.24 – 2.37.	Decrease	Yes	Impacts prototype buildings: large office, large hotel, hospital, outpatient healthcare, and schools.
au	6.5.2.1	Eliminates the requirement that zones with DDC have air flow rates that are no more than 20% of the zone design peak flow rate. Zone reheated air flow rate can be ventilation requirement per ASHRAE Std 62.1 instead of 20% of the peak flow rate. This code change has no construction cost impact. No cost-benefit analysis is not required.	Decrease	Yes	Impacts prototype buildings: Medium Office, Large Office, Primary School, Secondary School, Outpatient Health Care, and Large Hotel.

ay	3.2, 6.5.6	Provides separate requirements for nontransient dwelling unit exhaust air energy recovery. New section 6.5.6.1.1 Nontransient Dwelling Units. Requires exhaust energy recovery at least 50% efficiency for cooling and 60% for heating for non-transient dwelling units (apartments and condos 4 story and higher). This code change increases construction cost but it is not cost-effective per FSEC's cost-benefit analysis with SIR value of 0.1, which is way less than the threshold of 1.0.	Decrease	Yes	Impacts the Nontransient Dwelling Units are in High and Medium Rise Apartment prototype buildings.
bd	Table 6.8.1-16	Adds the minimum efficiency requirements of Heat Pump and Heat Reclaim Chiller Packages. Adds minimum efficiency requirement for Heat Pump and Heat Reclaim Chiller Packages as a new HVAC equipment category.	Decrease	Yes	Impacts hospital prototype building.
be	6.4.1.1; Table 6.8.1-10, 6.8.1-17	Revises the minimum efficiency requirements for Computer Room air conditioners. Upgrades the minimum efficiency requirement based on federal minimum efficiency.	Decrease	Yes	Requires higher efficiency CRAC. Impacts building with computer rooms air conditioners.
bj	6.5.5.1	Adds tables to the list of products that are exempt from meeting the requirements of section 6.5.6 - Heat Rejection Equipment. Updates heat-rejection devices that are exempted from the requirements of section 6.5.6.	None	No	This clarification only.
bl	Table 6.8.1-1	Revises Table 6.8.1-1 Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements. Upgrades the minimum efficiency requirement based on federal minimum efficiency.	Decrease	Yes	Impacts small hotel prototype buildings.

bm	Table 6.8.1-2, 6.8.1-15	Revises Table 6.8.1-2 Electrically Operated Air Cooled Unitary Heat Pumps—Minimum Efficiency Requirements. Adds Table 6.8.1-15. Upgrades the minimum efficiency requirement based on federal minimum efficiency.	Decrease	Yes	Impacts small office prototype buildings.
bn	3.2, Table 6.8.1-4, Table F3	Revises Table 6.8.1-4 Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps—Minimum Efficiency Requirements. Adds Table F-3. Upgrades the minimum efficiency requirement based on federal minimum efficiency.	Decrease	Yes	Impacts high rise apartment prototype buildings.
bo	3; Table 6.8.1-5; Table F-4	Revises Table 6.8.1-5 Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters—Minimum Efficiency Requirements and adds Table F-4 Residential Warm Air Furnaces – Minimum Efficiency Requirements for sale in the US. (See 10 CFR Part 430). Upgrades the minimum efficiency requirement based on federal minimum efficiency.	Decrease	Yes	Impacts mid-rise apartment, restaurant, office, school, and warehouse prototype buildings depending on capacity.
bp	Table 6.8.1-6; Table F-5	Revises Table 6.8.1.6 – Gas and Oil-Fired Boilers – Minimum Efficiency Requirements and adds table F-5 - Residential Boiler Minimum Efficiency Requirements for applications in the US (Refer to 10 CFR 430). Upgrades the minimum efficiency requirement based on federal minimum efficiency.	Decrease	Yes	Impacts prototype buildings with boilers.
bq	Table 6.8.1-7; 12	Revises Table 6.8.1-7 Performance Requirements for Heat Rejection Equipment—Minimum Efficiency Requirements.	Decrease	Yes	Requires higher efficiency dry cooler.

		Upgrades the minimum efficiency requirement of some of the heat rejection equipment category based on federal minimum efficiency.			
br	Table 6.8.1-11	Revises the previous Tables 6.8.1-12 & 13 and combines them into one table - Table 6.8.1-11 Commercial Refrigerators, Commercial Freezers and Refrigeration—Minimum Efficiency Requirements. *Updates the efficiencies levels*.	Decrease	No	Excluded from the quantitative analysis because they are federally regulated.
bv	6.2.1, 6.6.2, 8.2.1, 8.6.1	Clarifies that designers have the option to use ASHRAE Standard 90.4 requirements instead of ASHRAE 90.1 requirements in computer rooms that have an IT equipment load larger than 10 kW. Section 8.6.1 requires to comply with ASHRAE Standard 90.4 and is applicable. The new section: adds new definition for computer room that meets >20W/ft^2 and > 10 kW electric, or IT equipment load, suitable for big data centers, and has more stringent electric efficiency requirement.	None	No	Changed provisions are alternative to the existing and unchanged ones.
ce	6.5.3.1.2	Makes revisions to provide energy savings potential by removing one of three criteria for fan motor selections, increasing the design options for load matching variable-speed fan applications, accommodating new motor and drive technologies, and simplifies the motor selection criteria for fans. This code change impacts fan design and selection, and provides better metric for fan energy savings.	None	No	Removes one of three criteria for fan motor selections and provides flexibility.
cf	6.4.5	Adds vacuum insulating glazing to the list of options for reach-in doors in walk-in coolers and freezers. Provides design flexibility.	None	No	Changed provisions are alternative to the existing and unchanged ones.
cm	6.5.2.1	Revises exceptions related to DDC enabled zones. Removes the exception 2(a), which exempts when the minimum supply air flow rate is less than 25% of the peak design flow rate. This code change makes the section consistent with addenda “ao”.	Decrease	Yes	Similar to Addendum au. Impacts prototype buildings: Medium Office, Large Office, Primary School, Secondary School, Outpatient Health Care, and Large Hotel.

cn	6.4, 6.4.1.1, 6.4.5m Tables 6.8.1-18,19, & 20.	Cleans up outdated language regarding walk-in cooler and walk-in freezer requirements, and make the requirements consistent with current federal regulations that either already came into effect June 5, 2017 or will come into effect July 10, 2020. Adds new section 6.4.5(m) and Tables 6.8.1-18, -19, and -20. Makes the code consistent with federal minimum requirements.	Decrease	No	This change is clarification.
cq	3.2; 6.4.1.2, 6.5.3.1.3	Makes clarifications ensure that the maximum fan power input is properly reported for installations both inside and outside the United States. Adds sections 6.4.1.3 and 6.5.3.1.3. Adds fan power reporting requirement for ceiling fans larger than 84.5 inch in diameter.	None	No	
cu	6.4.1.1, 6.4.1.5, Table 6.8.1-8	Revises requirements for liquid-to-liquid heat exchangers. This is informative change.	None	No	
co	12	Adds new normative references and updates existing ones with new effective dates, including several addenda to ASHRAE Standard 62.1-2016, which enable Simplified Ventilation Procedure.	Decrease	Yes	Updates to include Addendum f to 62.1-2016, which enables Simplified Ventilation Procedure to be used for VAV box minimum setpoint controls and system ventilation control.
dn	6.5.6	Modifies exceptions to exhaust air energy recovery requirements.	Decrease	No	Not part of prototype buildings.
7. Service Water Heating					
bs	Table 7.8; F2; Table F-2	Revises Table 7.8 Performance Requirements for Water-Heating Equipment—Minimum Efficiency Requirements and Table F-2 Minimum Energy Efficiency Requirements for Water Heaters.	Decrease	No	Excluded from the quantitative analysis. Prototype buildings are not impacted by the selected equipment efficiency upgrade.

		Makes the code consistent with federal minimum requirements.			
8. Power					
9. Lighting					
bg (formerly addendum bg to 90.1-2013)	9.2, 9.3 9.3.1, 9.3.2 Tables 9.3.1-1, 9.3.1-2, 9.3.1-3, and 9.3.2	Added new Simplified Building Method Compliance Path for interior lights in offices, schools, or retail buildings, and exterior lights. This is simpler and faster lighting compliance method applicable when at least 80% of floor area is used for office, school, or retail buildings. The method is used in new construction, additions, or alterations with floor area less than 25,000 ft^2. Interior and exterior wattage allowances shall be calculated and complied with separately. All interior lights are counted. The LPD is lower than that of the space-by-space method.	Decrease	No	Provides flexibility for designers but will not impact the prototype buildings. Excluded from quantitative analysis because the exceptions are not used by typical designs as represented by the prototypes.
t	9.4.2, Table 9.4.2-2	Expands the exterior LPD application table to cover additional exterior spaces that are not currently in the exterior LPD table. None typical exterior lighting area applications that are not listed in Table 9.4.2 can be covered by this change. Interior LPDs from Table 9.4.1 are reduced and applied to exterior lighting application that are not listed in Table 9.4.2.	Decrease	No	Excluded from the quantitative analysis. Prototype buildings do not have none-typical exterior lighting application.
ah	9.1.4	Updates the language and terminology of the lighting wattage section. Also adds a section specifically to address using DC power over Cat6 structured cable for connection of LED lighting to a remote power supply.	None	No	This change is a clarification.

		Replaced “luminaire” with “lighting equipment” and “ballast” with “ballast/Driver” to accommodate latest lighting technologies.			
aq	9.1.1, 9.2.2.3, 9.4.1.1, 9.4.1.3, 9.4.4, 9.6.2	Clarifies lighting control requirements for applications not covered in Section 9.6.2, the space-by-space method. Clarifies the lighting control requirements for lighting (special) applications not specifically covered in Table 9.6.1 and aligns them to mandatory control provisions in 9.4.1.	None	No	This is clarification. Needs prototype building models specification check.
bb	Table 9.6.1	Revises the lighting power densities for the Space-by-Space method. The space-by-space method LPDs on average were reduced from 2016 version. Lobby/Hotel reduced from 1.06 to 0.51, Guestroom reduced from 0.77 to 0.41, Class room reduced from .92 to 0.71, Parking area, interior increased from 0.14 to 0.15. This code change increases construction cost but it is cost-effective per FSEC’s cost-benefit analysis with SIR value of 2.84.	Decrease	Yes	Impacts all other except the offices prototype buildings.
cg	Table 9.5.1	Revises Table 9.5.1 Lighting Power Density Allowances Using the Building Area Method. The building area method LPDs on average were reduced from 2016 version. Office reduced from 0.79 to 0.64, Hotel/Motel reduced from 0.75 to 0.56, Retail reduced from 1.06 to 0.84, Warehouse reduced from 0.48 to 0.45. This code change increases construction cost but it is cost-effective per FSEC’s cost-benefit analysis with SIR value of 5.45.	Decrease	Yes	Impacts the three office prototype buildings.

cv	9.4.1.2	Updates lighting control requirements for parking garages in section 9.4.1.2. Increases the stringency of lighting control in parking garages: • Reduces lighting power input from 30% to 50% when no activity • Reduces the timeout period from 20 to 10 minutes Continuous daylight dimming down to 50% for luminaires within 20ft of wall opening. This code change increases construction cost but it is cost-effective measure lighting control. No prototype building to model.	Decrease	No	Excluded from quantitative analysis because the prototype buildings do not have parking garage.
cw	9.4.1.1(e), 9.4.1.1(f)	Revises the daylight responsiveness requirements to continuous dimming for sidelight and toplit daylighting controls by (1) eliminating step dimming, (2) using continuous dimming limit set to 20% or less, or off, and (3) controlling daylights to unoccupied setpoint when needed. This code change increases construction cost but it is cost-effective per FSEC's cost-benefit analysis with SIR value of 34.44.	Decrease	Yes	Impacts prototype buildings with daylighting control such as small, medium and large offices, schools, etc.
cy	9.4.1(e)	Revises requirements for sidelit daylighting: • Modifies a text such that setback distance is horizontal measurement. • Adds natural object as an obstruction • Removes erroneous statement	None	No	Excluded from the quantitative analysis since this not a typical design and none of the prototype buildings has such design feature.

ch	3.2; 9.4.1.1 (e)	Clarifies daylighting area requirements as they relate to skylights and clarifies requirements for primary sidelit areas. This code change applies to daylight area calculation under skylights in multi-story spaces. Also adds an exemption for primary sidelight areas adjacent to vertical fenestrations that have external projections and no vertical fenestration above the external projection.	None	No	Clarification only
10. Other Equipment					
an	3.2, 10.4.7, Table 10.8-6; 12; Appendix E	Provides a new table (Table 10.8-6) of information about the new efficiency requirements for commercial and industrial clean water pumps. It also provides new definitions that are needed to accompany the table. Adds new section 10.4.7 and defines Pump Efficiency Index (PEI).	Decrease	No	Excluded from the quantitative analysis. This is not included in the prototype buildings design.
11. Energy Cost Budget Method					
at	11.5.1; G1.2.2	Revises language for energy accounting at buildings that provide fuel or electricity to vehicles. Energy used for recharging or refueling vehicles used off-site is not counted when calculating proposed building energy cost.	None	No	Excluded from the quantitative analysis since the prototype buildings do not use vehicles on-site.
bi	11.4.2; 12; Appendix C; Appendix G	Updates the reference year for Standard 140 in Sections 11 and 12 as well as Appendix C and G. Adds new requirements for software that support ECB and Appendix G compliance method: • Post Standard 140 results on public website alongside results from reference software • Complete standard 140 reports for falling outside the reference results	None	No	

		• Provide link with modeled submittals			
bk	3.2, 11.4.3.2, G2.4.2	Defines onsite electricity generation systems and clarifies that systems using the performance path must use the same electricity generation systems in the baseline as in the proposed design, except for onsite renewable generation systems. If the proposed building has on-site electric generation (e.g., CHP or Fuel Cell), then the baseline must include the same generation system, but no recovered heat.	None	No	Excluded from the quantitative analysis because the prototype buildings do not include on-site electric generators.
cj	Table 11.5.1.6; Table G3.1.6; Table G3.7	Revises the energy cost budget method in reference to lighting.	No	No	Excluded from the quantitative analysis.
cl	3.2; 11; Appendix G	Clarifies requirements throughout Section 11 to better align with Appendix G providing greater consistency between the two sections.	None	No	This change is clarification only.
12. Normative References					
co	12	Revises the normative references in ASHRAE Standard 90.1.	None	No	
ct	12	Updates the CTI normative reference in ASHRAE Standard 90.1.	None	No	
Appendix: A through G, and I					

dn (formerly addendum dn to 90.1-2013)	A9.4	Allows the use of the R-value of an airspace in enclosed cavities with or without insulation. Expands the R-value table in Appendix A (based on 2009 ASHRAE Handbook—Fundamentals, Chapter 26).	None	No	Accounts for R-value of airspace in the Assembly R-value calculation but the prototype buildings are created based on U-factor. Excluded from quantitative analysis because the prototype buildings are not impacted by this change.
bx	3.2, A6.1, A6.3	Adds heated slab F-factors for multiple combinations of under-slab and perimeter insulation in Appendix A. Adds Table A6.3.1-1 and Table A6.3.1-2.	None	No	Additional factors for condition combinations not currently covered and do not change requirements.
bz	3.2; Appendix C1.4, C2, C3.1.2, C3.3, C3.5.5.1, C3.5.8	Clarifies requirements of Appendix C as they pertain to informative outputs, the schedule of shades, energy costs, and updates references to Section 6.	None	No	This change is clarification.
ca	Table A3.2.3	Adds U-factors to Table A3.2.3 for use of continuous insulation on metal building walls with double layer cavity insulation.	None	No	Provided design flexibility. Needs further checks.
cc	A9.4.6	Clarifies the limitations of the calculation procedures in A9.4.6.	None	No	Provided clarification.
cs	Appendix E	Revises the informative references of the Informative Appendix E.	None	No	
as	Appendix I	Adds an informative appendix specific to commissioning	None	No	

d	Table G3.1.1	Modifies text to make it consistent with other portions of Appendix G for projects undergoing phased permitting. Not yet designed building components are modeled to comply with current prescriptive requirements such that future commitments are not rewarded or penalized.	None	No	Modified text for consistency with other sections. Not included in the quantitative analysis.
e	Table G3.1-11	Adds direction that SWH piping losses shall not be modeled for baseline and proposed building in cost budget compliance method. Pipe insulation is mandatory so, pipe loss modeling is not required. Also when a proposed design includes combined space and service water heating system, then the baseline system must use two separate systems.	None	No	SWH piping losses must not be modeled for both proposed and budget design buildings. Excluded from the quantitative analysis. Needs check.
f	G3.1.2.1	Modified text to require that the capacity used for selecting the system efficiency represents that for the size of the actual zone instead of the size of the zones as combined into a single thermal block. Clarifies that individual zones capacity should determine the equipment efficiency instead of combined zones (block) capacity. This reduced capacity results in small equipment which in turn yields higher efficiency.	None	No	This is modeling practice clarification hence not necessarily impact the quantitative analysis. The prototype buildings are based on predefined thermal zones.
l	Table G3.1.2.9	Adds requirements for fan break horsepower for two systems (baseline HVAC systems 12 and 13). Fixes an oversite where baseline fan power was not prescribed for system 12 and 13.	None	No	May not impact the prototype buildings hence not included in the quantitative analysis

m	Table G3.1.5	Lowers baseline building performance air leakage and sets an air leakage value to be used in conjunction with the air-barrier verification path. Prescribe infiltration rate of 0.6 cfm/ft^2 for proposed building if prescriptive air barrier requirement is met and 1.0 cfm/ft^2 for the baseline building. Previously the infiltration rate was 0.4 cfm/ft^2 for proposed and baseline buildings design.	None	No	Excluded from the quantitative analysis. Prototype buildings already exceeds this specification.
r	G3.1.2.6	Specifies air economizer control types for Appendix G. Clarifies that the baseline economizer must be simulated as integrated with the mechanical cooling.	None	No	This change is clarification hence not included in the quantitative analysis.
y	G3.1.2.2	Fixes duct sizing run parameters within the Appendix G. Clarifies that the baseline oversizing applies only to the heating and cooling capacity, not to the air flow rate.	None	No	May impact the sizing runs of prototype buildings. Verify methods and schedules of prototype buildings.
z	G3.1.2.1, Table G3.5.1, Table G3.5.2	Modifies the formulas in Section 11 and G3.1.2.1 for removing fan energy from baseline packaged heating and cooling efficiency ratings to cap the system capacity equations in Section 11 to levels allowed in Section 6 and provide a fixed baseline efficiency rating for Appendix G. ECB method has an updated baseline no-fan COP calculation formula, which the capacity is capped at 63 ton, for packaged system. Whereas appendix G uses a fixed COP value.	None	No	Not included in the quantitative analysis. Does not impact the prototype buildings.
ag	Table G3.1-12	Provides accounts for the inclusion of automatic receptacle controls in a proposed building.	None	No	This change is a clarification.

		Provides a methodology for receiving credits for installing automatic receptacle control when not required.			
ak	Table G3.1.5, Tables G3.4-1 through G3.4-8	Defines SHGC baseline for buildings in zones where there is no prescriptive maximum SHGC. Provides baseline fenestration default SHGC and VT values as a simplification, instead of referring the users to appendix C.	None	No	Excluded in the quantitative analysis. This is already accounted for using addenda "*aw*".
al	Table G3.1.3, Table G3.1.7	Clarifies the modeling rules within section G3.1. • How thermal zones are combined • Replaced "spaces" with "HVAC zones" • Requires to use space-by-space method for lighting compliance calculation when the space type is known; otherwise, allows to use building area method.	None	No	Impacts alternative compliance path.
ar	Table G3.1.12, G3.1.2.9, Table G 3.5.5, Table G.3.5.6, Table G3.6, Table G3.9.1	Cleanup of motor requirements in Appendix G related to Addenda di in Standard 90.1-2016. Tables minor edits, language cleanup and editorial changes.	None	No	
az	Table G3.1-17	Revises the modeling methodology language to clarify the baseline and proposed designs for refrigeration equipment. Specifies that the proposed building refrigeration system rated in accordance with AHRI 1200 should be modeled with the rated energy use.	None	No	May be included in the quantitative analysis if there is refrigeration equipment in the prototype buildings. Check Hotels, hospitals, restaurants, and school buildings models and verify with the new requirement.

ba	Table G3.1-1 Table G3.1-11	Establishes a methodology for determining the baseline flow rates on projects where service water-heating is demonstrated to be reduced by water conservation measures that reduce the physical volume of service water required. Establishes how the baseline is determined when allowed to differ from the proposed design but the baseline values are unspecified (SWH load, cooking equipment, laboratory equipment, etc): • Use the prescriptive requirement • Use other applicable standards	None	No	Change applies to an alternative compliance path and does not affect the existing requirements.
bu	Table G3.1.1-1, G3.1.1, G3.1.3, Table G3.4-1 through Table G3.4-8	Clarifies requirements in the Appendix G as they related to HVAC zones and baseline heating. Various editorial changes: • Removed leftover references • Replaced "space" with "zones" • Replaced "process loads" with "internal loads"	None	No	This is clarification.

* FSEC assessment of energy impacts consistent with those in the addenda to the 2016 ASHRAE 90.1 unless otherwise noted.

Appendix-C: Florida Energy Rates

A representative standard energy rate structure shown in Table C-1 through C-3 were used for energy cost calculation. The three energy rates represent electric demand under 20 kW, between 20 kW and 500 kW, and between 500 kW and 2000 kW, respectively. Energy price escalation rates shown in Table C-4 was used for life cycle energy cost calculation.

Table C-1 Natural Gas Rate and Standard Electricity Rate for Demand under 20kW

Charges Type	**Charge Items**	**Units**	**Rate**
Customer and Demand Charge			
Customer Charge		$/Month	10.62
Demand Charges	Base Demand Charge	$/kW	0.00
	Capacity Payment Charge	$/kW	0.00
	Conservation Charge	$/kW	0.00
Total Demand Charge		$/kW	10.62
Electric Energy Charges			
Non-Fuel Energy Charges	Base Energy Charge		
	Base Energy Charge	cents /kWh	6.013
	Base Energy Charge	cents /kWh	0
	Conservation Charge	cents /kWh	0.137
	Capacity Payment Charge	cents /kWh	0.225
	Environmental Charge	cents /kWh	0.152
Fuel and Additional Charges	GSLM Program		
	Fuel Charge	cents /kWh	2.216
	Levelized Fuel Charge	cents /kWh	0
		cents /kWh	0
		cents /kWh	0
		cents /kWh	0
	Storm Charge	cents /kWh	0
	Franchise Fee	cents /kWh	0
	Tax clause	cents /kWh	2.216
Total Energy Rate	Levelized Energy Rate	cents /kWh	8.743
		cents /kWh	
		cents /kWh	
		cents /kWh	
Natural Gas Energy Rates			
Customer Charge		$/Month	25.0
Distribution Charge	GS-**1** Range	$/Therm	0.37664
Total Natural Gas Energy Rate		$/Therm	0.37664

Table C-2 Natural Gas Rate and Standard Electricity Rate for Demand 20 - 500 kW

Charges Type	Charge Items	Units	Rate
Customer and Demand Charge			
Customer Charge		$/Month	26.50
Demand Charges	Base Demand Charge	$/kW	9.98
	Capacity Payment Charge	$/kW	0.75
	Conservation Charge	$/kW	0.47
Total Demand Charge		$/kW	11.20
Electric Energy Charges			
Non-Fuel Energy Charges	Base Energy Charge		
	Base Energy Charge	cents /kWh	2.222
	Base Energy Charge	cents /kWh	2.222
	Conservation Charge	cents /kWh	0
	Capacity Payment Charge	cents /kWh	0
	Environmental Charge	cents /kWh	0.139
Fuel and Additional Charges	GSLM Program		
	Fuel Charge	cents /kWh	0.0
	(Jan-May) Levelized Fuel Charge	cents /kWh	2.214
	(Oct-Dec) Levelized Fuel Charge	cents /kWh	2.214
	Jun-Sep, On-Peak Fuel Charge	cents /kWh	3.038
	Jun-Sep, Off-Peak Fuel Charge	cents /kWh	2.106
	Storm Charge	cents /kWh	0
	Franchise Fee	cents /kWh	0
	Tax clause	cents /kWh	0
Total Energy Rate	Jan-May, Oct-Dec, On-Peak Rate	cents /kWh	4.577
	Jan-May, Oct-Dec, Off-Peak Rate	cents /kWh	4.577
	Jun-Sep, On-Peak Energy Rate	cents /kWh	4.906
	Jun-Sep, Off-Peak Energy Rate	cents /kWh	4.434
Natural Gas Energy Rates			
Customer Charge		$/Month	150
Distribution Charge	GS-25K Range	$/Therm	0.32509
Total Natural Gas Energy Rate		$/Therm	0.32509

Table C-3 Natural Gas Rate and Standard Electricity Rate for Demand 500 - 2000 kW

Charges Type	**Charge Items**	**Units**	**Rate**
Customer and Demand Charge			
Customer Charge		$/Month	79.45
Demand Charges	Base Demand Charge	$/kW	12.19
	Capacity Payment Charge	$/kW	0.85
	Conservation Charge	$/kW	0.53
Total Demand Charge		$/kW	13.57
Electric Energy Charges			
Non-Fuel Energy Charges	Base Energy Charge		
	Base Energy Charge	cents /kWh	1.755
	Base Energy Charge	cents /kWh	1.755
	Conservation Charge	cents /kWh	0
	Capacity Payment Charge	cents /kWh	0
	Environmental Charge	cents /kWh	0.138
Fuel and Additional Charges	GSLM Program		
	Fuel Charge	cents /kWh	0.0
	(Jan-May) Levelized Fuel Charge	cents /kWh	2.214
	(Oct-Dec) Levelized Fuel Charge	cents /kWh	2.214
	Jun-Sep, On-Peak Fuel Charge	cents /kWh	3.038
	Jun-Sep, Off-Peak Fuel Charge	cents /kWh	2.106
	Storm Charge	cents /kWh	0
	Franchise Fee	cents /kWh	0
	Tax clause	cents /kWh	0
Total Energy Rate	Jan-May, Oct-Dec, On-Peak Rate	cents /kWh	4.107
	Jan-May, Oct-Dec, Off-Peak Rate	cents /kWh	4.107
	Jun-Sep, On-Peak Energy Rate	cents /kWh	4.931
	Jun-Sep, Off-Peak Energy Rate	cents /kWh	3.999
Natural Gas Energy Rates			
Customer Charge		$/Month	150
Distribution Charge	GS-25K Range	$/Therm	0.32509
Total Natural Gas Energy Rate		$/Therm	0.32509

Table C-4 Energy Price Escalation Rates for U.S. South Region[2]

Year	South Commercial-Electricity	South Commercial-Natural Gas
1	0.99	1.01
2	0.98	1.02
3	0.97	1.05
4	0.98	1.07
5	0.99	1.11
6	1.00	1.13
7	1.00	1.15
8	1.00	1.16
9	1.00	1.17
10	0.99	1.17
11	0.99	1.17
12	0.98	1.17
13	0.98	1.18
14	0.98	1.19
15	0.97	1.19
16	0.97	1.19
17	0.96	1.20
18	0.96	1.20
19	0.96	1.21
20	0.95	1.21
21	0.94	1.21
22	0.94	1.22
23	0.93	1.22
24	0.93	1.22
25	0.93	1.23
26	0.92	1.23
27	0.92	1.24
28	0.92	1.24
29	0.91	1.25
30	0.91	1.26

[2] Energy escalation rates were taken from EnergyPlus V9.4 data sets for the U.S. south region for commercial buildings.

Appendix-D: Florida Commercial Building Floor Area Distribution

Floor Area Weighting Factors Determination

The conditioned floor area weighting factors used in this study were generated by processing building stock information obtained from a PNNL report by Jarnagin and Bandyopadhyay (2010). The information obtained include: total floor areas by building type for the state of Florida and national average building weighting factors by climate zones. The national average weighting factors by building type and climate zones 1A and 2A obtained from the PNNL report were used to split the Florida building stock total floor area into climate zones 1A and 2A for each of the prototype buildings type. Two sets of weighting factors were generated for this investigation: weighting factors for the two Florida climate zones for each prototype buildings type, and the state's average weighting factors by buildings type and climate zone. The former weighting factors for climate zones 1A and 2A were used to estimate the EUI for each of the sixteen prototype buildings in Florida. And the later weighting factors were used to determine an aggregate EUI across the sixteen prototype commercial buildings for the state of Florida. Table D-1 summarizes commercial buildings total floor area stock distribution by prototype building in the state of Florida.

Table D-1 Commercial Prototype Buildings Floor Area Distribution in Florida

Building Type	Prototype Building	Prototype Building Floor Area, ft^2	Total Building Floor Area, 1000 ft^2	Floor Area Weighting Factors, %
Office	Small Office	5,502	37,889	5.27
	Medium Office	53,628	42,765	5.94
	Large Office	498,588	16,558	2.30
Retail	Stand-Alone Retail	24,692	83,481	11.60
	Strip Mall	22,500	44,652	6.21
Education	Primary School	73,959	30,815	4.28
	Secondary School	210,887	52,709	7.33
HealthCare	Outpatient Health Care	40,946	20,381	2.83
	Hospital	241,501	16,210	2.25
Lodging	Small Hotel	43,202	4,682	0.65
	Large Hotel	122,120	27,389	3.81
Warehouse	Warehouse	52,045	104,327	14.50
Food Service	Full Service Restaurant	5,502	4,003	0.56
	Quick Service Restaurant	2,501	3,296	0.46
Apartment	Mid-Rise Apartment	33,741	41,402	5.75
	High-Rise Apartment	84,360	188,913	26.25
Total		1,515,674	719,472	100.00

Floor Area Weighting Factors by Florida Climate Zones

Figure D-1 shows the weighting factors by climate zones for the state of Florida by prototype buildings type. The weighting factors for each prototype building type sum to 1.0. These weighting factors split the total floor areas stock of each of the prototype buildings in the state into climate zone 1A and 2A fractions. For instance, for High Rise Apartment 95.0% of the total floor area in the state of Florida is in climate zone 1A and the remaining 5.0% is in climate zone 2A.

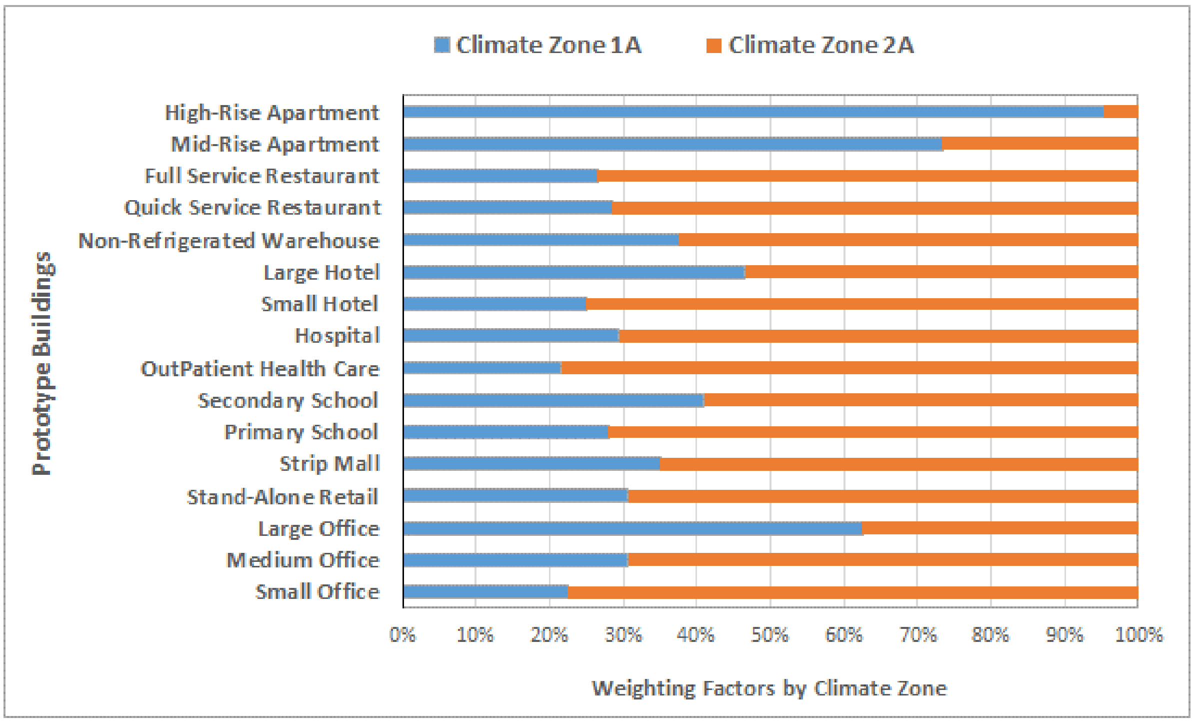

Figure D-1 Florida Floor Area Weighting Factors by Climate Zone and Building Type

Average Floor Area Weighting Factors by Building Type

The average weighting factors were used to determine an aggregate EUI across the sixteen prototype buildings type for the state of Florida. The weighting factors across the sixteen prototype buildings and the two climate zones sum to 1. Figure D-2 shows the average weighting factors by building type (sum of climate zones 1A and 2A) for the state of Florida. The High Rise Apartment building type represents the highest fraction of total floor area stock in the state of Florida, and it is 26.26% of Florida commercial buildings total floor area stock. Warehouse and Standalone Retail commercial buildings type are the second and third largest buildings type by floor area in the state, respectively.

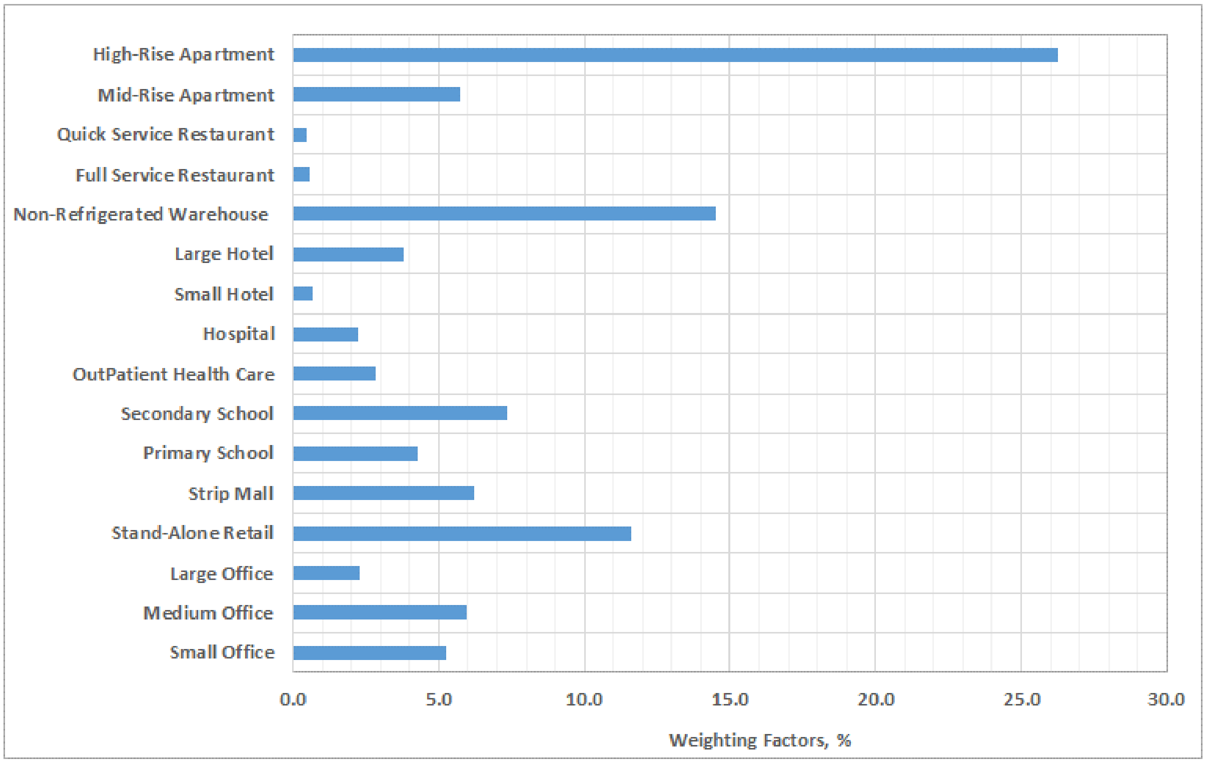

Figure D-2 Commercial Buildings Floor Area Weighting Factors by Prototype Building

The commercial building conditioned floor area distribution for the State of Florida presented here were derived from data published by Jarnagin and Bandyopadhyay (2010). Assumptions were made to split the State's total floor area by climate zones 1A and 2A due to absence commercial floor area distribution by state and climate zones. Florida commercial building conditioned floor area distribution by climate zones and building type needs to be determined from recent new building construction record in the State.

Appendix-E: Cost-Effectiveness Analysis of Code Modifications

Life Cycle cost analysis was performed to determine cost effectiveness of selected code modifications between the 2021 IECC and the IECC based 2020 FBC-EC and between the 2019 ASHRAE 90.1 code and the ASHRAE based 2020 FBC-EC. Cost effectiveness analysis used annual energy savings determined between the base case, which is the 7th Edition (2020) Florida Building Code, Energy Conservation, and the 2021 IECC and the 2019 ASHREA 90.1 upgrade. This requires creating a separate baseline and upgrade code prototype building energy model for each code modification whose energy savings potential can be determined through simulation. In some special circumstances where the code modification cannot be determined via building simulation, other published sources were used to estimate the annual energy savings. The total annual and life cycle energy costs were computed using Florida energy rates for electricity and natural gas and energy price escalation rates summarized in Appendix-C. The code modification or addenda number along with brief description of the change, energy and construction cost impacts are provided in Appendix-A and Appendix-B. Code modifications whose energy impact cannot be analyzed quantitatively, code modifications with no or negligible net first cost, federal minimum code modifications, or those code changes cannot be represented in the existing prototype buildings model are excluded from cost-effectiveness analysis.

Cost-benefit Analysis of the changes to the IECC based 2020 FBC-ECC

This section describes the cost-benefit analysis, assumptions used in the analysis, the energy saving potential and the SIR value for each of the 2021 IECC code modifications considered for cost-effectiveness analysis.

Code Change CE70-19: Reduces *U*-Factor of Opaque Swinging Doors

Reduces *U*-Factor for opaque swinging doors from 0.61 to 0.37 Btu/(hr-ft^2-°F) in climate zones 1 through 4 in Section C402.1.4. For instance, this code modification is roughly equivalent to a change is from un-insulated opaque door to a door with 1 3/8 poly urethane insulation. This code change aligns IECC with ASHRAE 90.1 standard. This change impacts fourteen prototype buildings.

Annual Energy Saving: Simulation of the fourteen prototype buildings with opaque door *U*-Factor of 0.61 for the 7th Edition FBC-EC and *U*-Factor of 0.37 for the 2021 IECC results in energy saving and in a few cases slight increase in energy consumptions. The electric, gas and total net energy saving of the fourteen prototype buildings are summarized in Table E-1.

Table E-1 Annual Energy Saving by Building Type of Code Change CE70-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Small Office	Miami	14	0	14
	Orlando	11	0	11
Medium Office	Miami	72	0	72
	Orlando	89	-3	86
Large Office	Miami	478	-239	239
	Orlando	381	97	478
Stand-Alone Retail	Miami	147	0	147
	Orlando	117	25	142
Strip Mall	Miami	167	3	169
	Orlando	106	103	208
Primary School	Miami	322	6	328
	Orlando	556	61	617
Secondary School	Miami	353	-8	344
	Orlando	631	-8	622
Outpatient Health Care	Miami	136	-1581	-1444
	Orlando	450	397	847
Hospital	Miami	-167	-1011	-1178
	Orlando	28	-633	-606
Small Hotel	Miami	6	0	6
	Orlando	3	0	3
Large Hotel	Miami	117	-22	94

	Orlando	0	0	0
Warehouse	Miami	31	6	36
	Orlando	0	0	0
Quick Service Restaurant	Miami	25	0	25
	Orlando	-14	6	-8
Full Service Restaurant	Miami	14	0	14
	Orlando	11	0	11

Investment Cost: This code change may have small incremental cost increase for reducing the door assembly *U*-Factor. Therefore, incremental cost of \$0.50/ft^2 (\$5.38/m^2) and a service life of 40 years was assumed for each opaque swinging door.

Cost Benefit Analysis: Cost-benefit analysis was determined using the incremental cost and service life assumptions and annual energy cost saving determined using simulation for each of the thirteen prototype buildings. Table E-2 summarizes the net present value of the energy cost saving, net present value of the investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-2 Cost-benefit Analysis Results Summary of Code Change CE70-19

Building Type	City	Life Cycle Energy Cost Saving NPV, \$	Investment Cost NPV, \$	SIR
Small Office	Miami	20	20	1.01
	Orlando	17	20	0.87
Medium Office	Miami	66	60	1.10
	Orlando	107	60	1.78
Large Office	Miami	581	120	4.84
	Orlando	1808	120	15.07
Stand-Alone Retail	Miami	257	80	3.21
	Orlando	219	80	2.74
Strip Mall	Miami	47	239	0.20
	Orlando	12	239	0.05
Primary School	Miami	610	250	2.44
	Orlando	790	250	3.16
Secondary School	Miami	566	320	1.77
	Orlando	563	320	1.76
Outpatient Health Care	Miami	-2	225	-0.01
	Orlando	841	225	3.74
Hospital	Miami	-317	250	-1.27
	Orlando	-150	250	-0.60
Small Hotel	Miami	7	30	0.22

	Orlando	11	30	0.38
Large Hotel	Miami	143	50	2.86
	Orlando	121	50	2.42
Warehouse	Miami	76	40	1.89
	Orlando	40	40	1.00
Quick Service Restaurant	Miami	21	10	2.10
	Orlando	-6	10	-0.55
Full Service Restaurant	Miami	9	10	0.87
	Orlando	7	10	0.69
Weighted Average of Florida		234	126	1.85

Summary: Reducing the opaque door assembly *U*-Factor from 0.61 to 0.37 Btu/(hr-ft^2-°F) of the fourteen prototype buildings were investigated. Weighted Florida average SIR across the fourteen commercial prototype buildings was 1.85. Therefore, reducing the opaque swinging door assembly *U*-Factor is recommended for consideration by Florida Building Commission for addition to the 8th Edition Florida Building Code, Energy Conservation.

Code Change CE84/85/87-19: Vertical Fenestration and Skylight Upgrade

Reduces *U*-Factor of vertical fenestration in all climate zones, reduces SHGC values of vertical fenestration in climate zones 1, 6, 7, and 8 and reduces *U*-Factor and SHGC values of skylights in climate zones 1, 2, 3, 7 and 8 in Table C402.4. These changes align vertical fenestrations and skylights *U*-Factor and SHGC values with ASHRAE Standard 90.1-2019. Assumptions used for the energy saving potential and cost-benefit analysis are summarized in Table E-3.

Table E-3 SHGC and U-Factor Model Inputs by climate zones for code change CE84/85/87-19

Fenestration/Skylights	**7th Edition (2020) FBC-EC**		**2021 IECC**	
	1A	**2A**	**1A**	**2A**
SHGC, (-)				
Vertical Fenestration	0.25	0.25	0.23	0.25
Skylights	0.60	0.60	0.30	0.30
U-Factor, (Btu/hr-ft^2-°F)				
Vertical Fenestration	0.50	0.52	0.45	0.47
Skylights	0.90	0.90	0.70	0.65

Annual Energy Saving: Simulation of the sixteen prototype buildings using the assumption for the baseline and the upgrade results in energy saving and in a few cases it slightly increases in energy consumptions. The net energy saving of the sixteen prototype buildings are summarized in Table E-4.

Investment Cost: This change may incur small incremental cost increase for reducing *U*-factor and SHGC values of vertical fenestration. For skylights, an incremental cost of \$0.20/ft^2 were assumed since both the *U*-Factor and SHGC were reduced. For vertical fenestration, an incremental cost of \$0.18/ft^2 were assumed when SHGC only changed and \$0.20/ft^2 when both changed. Therefore, incremental cost range of \$0.18/ft^2 - \$0.20/ft^2 and a service life of 40 years were assumed for the analysis.

Table E-4 Annual Energy Saving by Building Type of Code Change CE84/85/87-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Small Office	Miami	231	0	231
	Orlando	36	0	36
Medium Office	Miami	3047	-3	3044
	Orlando	8	8	17
Large Office	Miami	25931	231	26161
	Orlando	-2006	1564	-442
Stand-Alone Retail	Miami	-3503	-3	-3506
	Orlando	-4125	-47	-4172
Strip Mall	Miami	694	-3	692
	Orlando	-75	100	25
Primary School	Miami	6389	0	6389
	Orlando	1186	186	1372
Secondary School	Miami	24628	-31	24597
	Orlando	13864	383	14247
Outpatient Health Care	Miami	678	-325	353
	Orlando	317	208	525
Hospital	Miami	1956	-6506	-4550
	Orlando	194	1836	2031
Small Hotel	Miami	858	0	858
	Orlando	-119	31	-89
Large Hotel	Miami	-933	1783	850
	Orlando	0	0	0
Warehouse	Miami	-5017	-122	-5139
	Orlando	0	0	0
Quick Service Restaurant	Miami	167	-8	158
	Orlando	3	64	67
Full Service Restaurant	Miami	361	-8	353
	Orlando	-3	81	78
Mid Rise Apartment	Miami	1528	-3	1525
	Orlando	-283	203	-81
High Rise Apartment	Miami	7281	-75	7206
	Orlando	92	1836	1928

Cost Benefit Analysis: Cost-benefit analysis was performed using the incremental cost and service life assumptions and annual energy cost saving determined using energy models and simulation for each of the thirteen prototype buildings. Table E-5 summarizes the net present value of the energy cost saving, net present value of investment cost and saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-5 Cost-benefit Analysis Results Summary of Code Change CE84/85/87-19

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Small Office	Miami	287	122	2.36
	Orlando	43	110	0.39
Medium Office	Miami	3649	1209	3.02
	Orlando	113	1096	0.1
Large Office	Miami	15641	7086	2.21
	Orlando	-855	6424	-0.13
Stand-Alone Retail	Miami	-4185	220	-19.06
	Orlando	-4868	204	-23.91
Strip Mall	Miami	1216	253	4.8
	Orlando	-201	230	-0.87
Primary School	Miami	5997	1563	3.84
	Orlando	2010	1420	1.42
Secondary School	Miami	20843	3922	5.31
	Orlando	15007	3581	4.19
Outpatient Health Care	Miami	1090	628	1.73
	Orlando	423	570	0.74
Hospital	Miami	939	1729	0.54
	Orlando	714	1567	0.46
Small Hotel	Miami	757	375	2.02
	Orlando	-27	340	-0.08
Large Hotel	Miami	3929	2474	1.59
	Orlando	-59	2243	-0.03
Warehouse	Miami	-6875	175	-39.21
	Orlando	-7357	172	-42.78
Quick Service Restaurant	Miami	174	53	3.28
	Orlando	25	48	0.51
Full Service Restaurant	Miami	369	96	3.84
	Orlando	33	87	0.38
Mid Rise Apartment	Miami	1898	626	3.03
	Orlando	-310	567	-0.55
High Rise Apartment	Miami	9034	2345	3.85
	Orlando	514	2125	0.24
Weighted Average of Florida		2586	1423	1.82

Summary: Impacts of reducing the fenestration and skylights assembly *U*-Factor and SHGC of the fourteen prototype buildings were analyzed. The Florida average SIR value weighted across the fourteen commercial prototype buildings was 1.82. Therefore, reducing the SHGC and U-Factor of vertical fenestration and skylights is cost effective and recommended for consideration by Florida Building Commission for addition to the 8th Edition Florida Building Code, Energy Conservation.

Code Change CE97-19: Air Barrier Compliance

Adds a mandatory new section C402.5.1.2 Air barrier compliance that requires air leakage testing (measurement) depending on building size and climate zones. Introduces two new options for measuring air leakage. Section C402.5.2 Dwelling and sleeping unit enclosure testing and Section C402.5.3 Building thermal envelope testing. Building that do not meet these testing requirements are required to comply with the existing prescriptive air barrier requirements of material and assemblies. Section C402.5.3 exempts buildings with floor area larger than 5000 ft^2 from testing requirement in climate zone 1 and 2A. Thus, the cost-effectiveness analysis was limited to the smaller building sizes. The small and medium size office prototype buildings were selected for the energy impact and cost-benefit analysis. The baseline and upgrade assumed air leakage rate of 1.0 cfm/ft^2 and 0.40 cfm/ft^2, respectively. These assumptions are consistent with assumption used by PNNL[3] study. The energy saving was estimated using simulation with EnergyPlus software.

Annual Energy Saving: Simulation of these two prototype buildings with 1.0 cfm/ft^2 for the 7th Edition (2020) FBC-EC and 0.4 cfm/ft^2 for the 2021 IECC demonstrate the annual energy saving potentials. The electric, gas and total net annual energy saving of these prototype buildings are summarized in Table E-6.

Table E-6 Annual Energy Saving by Building Type of Code Change CE97-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Small Office	Miami	575	0	575
	Orlando	100	3	103
Medium Office	Miami	10,508	69	10,578
	Orlando	10,833	1,022	11,856

Investment Cost: The cost for air leakage measurement depends on the size and complexity of the building. The incremental cost for measuring air leakage assumed were in the range from \$0.07/ft^2 – \$0.247/ft^2 of the buildings floor area and a service life of 40 years were assumed.

Cost Benefit Analysis: Cost-benefit analysis was determined using the incremental cost, service life assumptions and annual energy cost saving determined using energy models and simulation

[3] https://www.osti.gov/servlets/purl/1489004

for the small and medium size office prototype buildings. Table E-7 summarizes the net present value of the energy cost saving, net present value investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-7 Cost-benefit Analysis Results Summary of Code Change CE97-19

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Air Leakage Testing Cost Assumption of $0.07/ft^2$				
Small Office	Miami	800	367	2.18
	Orlando	140	367	0.38
Medium Office	Miami	21912	3575	6.13
	Orlando	24186	3575	6.76
Weighted Average		12590	2068	6.09
Air Leakage Testing Cost Assumption of $0.117/ft^2$				
Small Office	Miami	800	613	1.31
	Orlando	140	613	0.23
Medium Office	Miami	21912	5976	3.67
	Orlando	24186	5976	4.05
Weighted Average		12590	3457	3.64
Air Leakage Testing Cost Assumption of $0.154/ft^2$				
Small Office	Miami	800	807	0.99
	Orlando	140	807	0.17
Medium Office	Miami	21912	7865	2.79
	Orlando	24186	7865	3.07
Weighted Average		12590	4549	2.77
Air Leakage Testing Cost Assumption of $0.247/ft^2$				
Small Office	Miami	800	1289	0.62
	Orlando	140	1289	0.11
Medium Office	Miami	21912	12615	1.74
	Orlando	24186	12615	1.92
Weighted Average		12590	7294	1.73

Summary: The envelope air leakage testing requirement cost-effective was investigated in the two office prototype buildings. The cost-effectiveness outcome was found to be sensitive to the cost of air leakage testing. The medium office building was cost-effective for the entire range of testing cost while the small office building was not as the testing cost increases. However, the weighted average SIR across the two commercial prototype buildings investigated was in the range 1.73 – 6.09, which is cost effective. Therefore, the air leakage test requirements meet the cost-benefit criteria and is recommended for consideration by Florida Building Commission for addition to the 8th Edition Florida Building Code, Energy Conservation.

Code Change CE111-19: Fault Detection and Diagnostics
Adds a new section C403.2.3 Fault Detection and Diagnostics. New buildings with an HVAC system serving a gross conditioned floor area of 100,000 ft^2 or larger must have a fault detection and diagnostics (FDD) system to monitor the HVAC system's performance and automatically identify faults. The change requires permanently installed sensors, sample data every 15 minutes, and communicate faults and recommended repair remotely. R-1 and R-2 group buildings are exempted from this requirement.

Several studies in the last decade demonstrate that there is large energy saving potential by applying FDD of HVAC system. One such large scale study recently conducted by Lawrence Berkeley National Laboratory[4] (LBNL) involved 104 commercial organization, nine building sectors, a total of 567 million square foot floor area in 6500 number of buildings demonstrate significant energy saving potential with a simple pay-back period of about 2.0 years. The energy saving potential estimate was based on actual measured energy cost saving reported by the LBNL. The cost-effectiveness analysis also used the fist and recurring cost estimates provided in this report. The energy cost saving, and cost-effectiveness analysis was performed using the large office prototype building.

Annual Energy Saving: The median annual energy cost saving recorded in the LBNL report for implementing FDD in commercial buildings was \$0.24/ft^2. The minimum, median and maximum energy cost saving are summarized in Table E-8.

Table E-8 Annual Energy Cost Saving of Code Change CE111-19

Prototype Building	Floor Area, ft^2	Annual Energy Cost Saving, \$/ft^2		
		Minimum	Maximum	Median
Large Office	498,588	0.03	0.88	0.24

Investment Cost: The cost for implementing FDD measure depends on the building size, the complexity of the HVAC systems, and number meters and sensor data of the building automation System (BAS). The FDD service implementation primarily requires a one-time software installation and configuration cost, a recurring cost for software maintenance, and on-site labor cost. The assumptions used in this analysis are summarized in Table E-9.

Table E-9 Investment Cost of Code Change CE111-19

Cost Category	One time and Recurring Investment Costs		
	Minimum	Maximum	Average
First Cost, \$/ft^2	0.05	0.20	0.06
Annual Recurring Cost, \$/ft^2-Year	0.0002	0.16	0.02
Annual On-site Labor Cost, \$/Year	7200.0		

Cost Benefit Analysis: Simple pay-back period was determined using the incremental first and recurring costs, and average annual energy cost saving assumptions for the large office prototype

[4]ttps://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Proving%20the%20Business%20Case%20for%20Building%20Analytics_Oct2020.pdf

buildings. Table E-10 summarizes the average annual energy cost saving, total investment cost and calculated SIR values and simple payback periods for the three scenarios based on the large office prototype building.

Table E-10 Cost-benefit Analysis Results Summary of Code Change CE111-19

Building Type	Scenarios	Annual Energy Cost Saving, $	Total Investment Cost, $	Payback Period, years	SIR
Large Office	I	100,089	29,915	0.30	15.21
	II	30,473	44,873	1.47	3.09
	III	20,687	59,831	2.89	1.57

Summary: The FDD service saves significant energy and has a simple payback period that ranges from 3.6 months to 2.89 years. The pay-back period based on median energy cost saving, and an average annual cost was found to be less than a year. Scenarios II, which increases the first and recurring costs by 50% and reduces the energy cost saving by half compared to Scenario I, had a simple pay-back period of 1.47 years. Scenarios III, which doubles the first and recurring costs and reduces the energy cost saving by half compared to Scenario I, had a simple pay-back period of 2.89 years. In all the scenarios this code change is cost effective with a pay-back period under 3.0 years. Savings to investment ratio (SIR) was determined for code change CE111-19 for the three energy cost savings and investment cost combination scenarios and service life span of five years. Saving to investment ratio and simple payback period cost-benefit analysis methods demonstrate that Fault Detection and Diagnostics (FDD) is cost-effective. Therefore, the FDD code change requirement meets the cost-benefit criteria and is recommended for consideration by Florida Building Commission for addition to the 8th Edition Florida Building Code, Energy Conservation.

Code Change CE125-19: Dehumidification Control Interaction
Adds new sub-section C403.6.5.1 which says, in climate zones 0A, 1A, 2A, and 3A the HVAC system design must allow supply-air temperature to reset while the dehumidification is provided. When dehumidification is active, air economizer must be locked out.

This new requirement implies a change in system design that allows supply air temperature reset while the supply is dehumidified to meet the controlled space air target humidity set-point. There are two ways this can be achiever: (1) dehumidify the outdoor air supply using a dedicated outdoor air system (DOAS), or (2) separately dehumidify the outdoor is in outdoor air system before mixing it with return air. The later approach was used to demonstrate the energy saving potential and its cost effectiveness.

This requirement was demonstrated using the large office prototype building and the VAV HVAC system serving the top floor. The large office building's top floor system design outdoor air flow rate meets the threshold for SAT reset in climate zone 1A but not in climate zone 2A. Thus, the analysis is valid for climate zone 1A only; however, the analysis was performed for climate zones 1A and 2A. The baseline has SAT reset with the dehumidification requirement met through conventional control cool reheat design strategy. The upgrade assumed SAT reset, but the dehumidification requirement was met by a separately dehumidifying the outdoor air in the outdoor air intake system by adding a chilled water cooling coil. This dehumidification strategy reduced the reheat energy use and maximized the benefit of supply air temperature reset. The design outdoor supply air flow rate for the top floor system was 5,378 cfm, which meets the SAT reset requirement in climate zone 1A but not in climate zone 2A. The design outdoor air flow rate is 31.1% of the system design supply air flow rate.

Annual Energy Saving: Simulation of the modified large office prototype buildings for baseline representing the 7th Edition (2020) FBC-EC and the upgrade representing the 2021 IECC demonstrate the annual energy saving potentials summarized in Table E-11.

Table E-11 Annual Energy Saving by Building Type of Code Change CE125-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Retail	Miami	-3,472	4,392	919
	Orlando	8,131	2,947	11,078
Weighted Average		-3,472	870	3,851

Investment Cost: The SAT reset while achieving the dehumidification requirement can be met by implementing a system design such that the reheat energy use is reduced. The incremental cost for adding chilled water cooling coil in the outdoor air intake system for dehumidification, thus, is the incremental cost of the hydronic cooling coil. Note that the addition of dehumidifying chilled water cooling coil in the outdoor air intake system proportionally reduces the design cooling load of the mixed air main cooling coil. The incremental installed cost for the net additional 1.6 tons chilled water cooling coil capacity. Two investment scenarios were investigated. Scenarios I equipment cost was $3,500.0, annual maintenance cost of $200.0, and a service life of 20 years. Scenarios II assumed equipment cost of $3,000.0, annual maintenance cost of $150.0, and a service life of 20 years.

Cost Benefit Analysis: Cost-benefit analysis was determined using the incremental cost, service life assumptions and annual energy cost saving determined using simulation for the retail prototype building. Table E-12 summarizes the net present value of the energy cost saving, net present value of investment cost and the saving to investment ratio for climate zone 1A only as the large office building top floor system outdoor design flow rate does not meet the 10,000 cfm threshold.

Table E-12 Cost-benefit Analysis Results Summary of Code Change CE125-19

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Scenario I				
Large Office	Miami	8,054	5,707	1.41

	Orlando	17,014	5,707	2.98
Florida Weighted Average		11,407	5,707	2.00
Scenario II				
Large Office	Miami	8,054	4,637	1.74
	Orlando	17,014	4,637	3.67
Florida Weighted Average		11,407	4,637	2.46

Summary: The system design with SAT reset that achieves dehumidification requirement of Section C403.6.5.1 was investigated in a large office prototype building. The Florida average SIR value of 2.0 for scenario I and 2.46 for scenario II. Both incremental construction cost assumption scenarios are cost effective. Therefore, SAT reset with active dehumidification control that reduces the reheat energy use meets the cost-benefit criteria and is recommended for consideration by Florida Building Commission for addition to the 8th Edition (2023) Florida Building Code, Energy Conservation.

Code Change CE127-19: Reduces People Occupancy Density Threshold
Reduces the people occupancy density threshold from 25 to 15 people or greater per 1,000 ft^2 of floor area in section C403.7.1 Demand control ventilation. Also demand control ventilation must be provided for all single-zone system required to comply with Sections C403.5 through C403.5.3. This code now expands demand control ventilation requirement to spaces with occupant density as low as 15 people or greater per 1,000 ft^2.

Modified the retail prototype building for testing the cost effectiveness of demand control ventilation with this reduced occupant density. The baseline assumed outdoor air economizer without demand control ventilation and the upgrade assumed air economizer with demand control ventilation. The upgrade assumed 15 people per 1,000 ft^2 of floor area. The design outdoor air ventilation requirement, which is based on ASHRAE Standard 62.1-2013, assumed 7.8 cfm/person and 0.12 cfm/ft^2 for both the baseline and upgrade.

Annual Energy Saving: Simulation of the modified retail prototype buildings for baseline representing the 7th Edition (2020) FBC-EC and the upgrade representing the 2021 IECC demonstrate the annual energy saving potentials. The electric, gas and total net annual energy saving of these prototype buildings are summarized in Table E-13.

Table E-13 Annual Energy Saving by Building Type of Code Change CE127-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Retail	Miami	11,394	22	11,417
	Orlando	14,444	6,981	21,425
Weighted Average		13,376	4,542	17,918

Investment Cost: Demand control ventilation is a requirement in spaces with air economizer. The incremental cost for adding demand control ventilation, thus, is the cost of CO2 sensors. The incremental installed cost for CO2 sensors assumed were $300 per a space and annual maintenance cost of $30, and a service life of 15 years. The retail prototype building has 10 retail spaces each with its own outdoor air systems. The total incremental first and annual maintenance costs for the retail buildings were $3000 and $300, respectively.

Cost Benefit Analysis: Cost-benefit analysis was determined using the incremental cost, service life assumptions and annual energy cost saving determined using simulation for the retail prototype building. Table E-14 summarizes the net present value of the energy cost saving, net present value of investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-14 Cost-benefit Analysis Results Summary of Code Change CE127-19

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Small Office	Miami	8,923	5,823	1.53
	Orlando	15,183	5,823	2.61
Florida Weighted Average		12,990	5,823	2.23

Summary: The demand control ventilation requirement at reduced occupant density cost-effectiveness was investigated in a retail prototype building in climate zones 1A and 2A. The Florida average SIR weighted across the two climate zones in a retail prototype building with 15 people per 1,000 ft^2 of floor area occupant density was 2.23, which is cost effective. Therefore, demand control ventilation at the reduced occupant density threshold meets the cost-benefit criteria and is recommended for consideration by Florida Building Commission for addition to the 8th Edition Florida Building Code, Energy Conservation as stated in the 2021 IECC.

Code Change CE133-19: Energy Recovery in Nontransient Dwelling Units

Adds a new requirement for exhaust air energy recovery for nontransient dwelling unit in section C403.7.4.1. This code change requires exhaust energy recovery with enthalpy recovery ratio of at least 50% efficiency for cooling and 60% for heating for non-transient dwelling units. This code change aligns the 2021 IECC with the 2019 ASHRAE 90.1 Standard via addenda ay.

This code change impacts the medium rise and high rise apartment prototype buildings. The energy impact analysis assumed a balanced outdoor air supply system without Energy Recovery Ventilators (ERV) for the baseline and a balance system with ERV for the upgrade. These two systems were simulated in EnergyPlus for mid and high rise apartment prototype buildings and the energy saving potential and cost-benefit analysis were performed.

Annual Energy Saving: Simulation of the two apartment prototype buildings energy models without ERV in the 7th edition Florida Energy Code and with exhaust air ERV technology in the

8th Edition Florida Energy Code results in annual energy saving. The electric, gas and total net annual energy saving of the apartment buildings are summarized in Table E-15.

Table E-15 Annual Energy Saving by Building Type of Code Change CE133-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Mid-Rise Apartment	Miami	3,550	75	3,625
	Orlando	764	1,250	2,014
High-Rise Apartment	Orlando	4,189	561	4,750
	Orlando	803	9,608	10,411
Florida Average	Average	3,809	883	4,692

Investment Cost: There is first cost, a onetime installation cost and annual maintenance cost for each ERV units in the two apartment buildings. First, installation and annual maintenance costs of $600.0, $500.0, and $50.0, respectively and service life of 15 years were assumed for each dwelling unit. There are 23 and 79 dwelling units in the medium rise and high rise apartment buildings, respectively.

Cost Benefit Analysis: Cost-benefit analysis was performed using the incremental cost and service life assumptions and annual energy cost saving determined using energy models and simulation for each of the two apartment prototype buildings. Table E-16 summarizes net present value of energy cost saving, net present value of the investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-16 Cost-benefit Analysis Results Summary of Code Change CE133-19

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Mid-Rise Apartment	Miami	3,034	35,463	0.09
	Orlando	830	35,463	0.02
High-Rise Apartment	Miami	3,649	121,809	0.03
	Orlando	2,065	121,809	0.02
Weighted Average of Florida		3,371	106,287	0.04

Summary: The weighted Florida average SIR of the two apartment prototype buildings was 0.04, which is way below the SIR threshold of 1.0 for cost-effectiveness test. Therefore, the ERV equipment in each nontransient dwelling unit is not cost effective and it is not recommended for addition to the 8th Edition Florida Energy Code.

CE140-19: Section C403.8.5 Low-capacity ventilation fans

Adds a new section for ventilation fans with motors less than 1/12 hp (0.062 kW), i.e., section C403.8.5 Low-capacity ventilation fans. This code change requires minimum fan efficacy for ventilation fans with motor size less 62W that are commonly used in bathrooms, utility rooms and heat and energy recovery ventilators. The outpatient healthcare prototype building was selected for the analysis because it has ten low capacity ventilation exhaust fans. The energy saving potential and cost-benefit analysis were done using this prototype building.

Annual Energy Saving: Simulation of the outpatient healthcare prototype buildings energy models baseline efficacy (2.64 cfm/W) for the 7th edition Florida Energy Code and a premium efficacy (2.8 – 3.5 cfm/W depending on the size) for the 8th Edition Florida Energy Code results in annual energy saving. The electric, gas and total net annual energy saving of the apartment buildings are summarized in Table E-17.

Table E-17 Annual Energy Saving by Building Type of Code Change CE140-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Outpatient Healthcare	Miami	289	0	289
	Orlando	292	0	292
Weighted Average of Florida		291	0	291

Investment Cost: There is incremental is first cost for each of the ten exhaust fans efficiency upgrade in the Outpatient healthcare prototype buildings. Incremental first costs of $12 for each seven smaller fans (about 34W motor size) and $18 for three of the slightly bigger exhaust fans (about 54W motor size) would cost $138 in total, and a service life of 15 years were assumed.

Cost Benefit Analysis: Cost-benefit analysis was performed using the incremental cost and service life assumptions and annual energy cost saving determined using simulation. Table E-18 summarizes the net present value of the energy cost saving, net present value of investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-18 Cost-benefit Analysis Results Summary of Code Change CE140-19

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Outpatient Healthcare	Miami	191	131	1.46
	Orlando	191	131	1.46
Weighted Average of Florida		191	131	1.46

Summary: The weighted average SIR of the Outpatient healthcare prototype buildings was estimated to be about 1.46. Therefore, the low-capacity ventilation fan new efficiency requirement is cost effective and is recommended for consideration for addition to the 8th Edition Florida Building Code, Energy Conservation.

Code Change CE169-19: Occupant sensor controls in Corridor Spaces
This change revised section C405.2.1 Occupant sensor controls to add "Corridor" space type to the list of space types where occupant *sensor controls* must be installed to control general lighting and a new section C405.2.1.4 was added that corridor space type lighting control must comply.

The new sub-section C405.2.1.4 Occupant sensor control function in corridors says that Occupant sensor controls in corridors must uniformly reduce lighting power to not more than 50% of full power within 20 minutes after all occupants have left the space. Exception: corridors provided with less than two foot-candles of illumination on the floor are exempted. This code change impacts eight prototype buildings. The energy saving was determined using lighting schedules that are representative of no lighting controls and schedules that are representative of occupancy sensor based lighting controls in corridor spaces. The annual average lighting schedule value reduction ranges from 0.53 to 0.90 depending on the building type.

Annual Energy Saving: Simulation of the eight prototype buildings no occupancy sensor based lighting control in corridor spaces for the 7th edition Florida Energy Code and with occupancy sensor lighting control for the 8th Edition IECC based FBC-EC results in general lighting Electric Energy Saving. The electric, gas and total net energy saving of the thirteen prototype buildings are summarized in Table E-19. Mostly lighting energy use reduction results an increase in heating gas energy consumptions in cooler months.

Table E-19 Annual Energy Saving by Building Type of Code Change CE169-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Primary School	Miami	7550	-14	7536
	Orlando	6853	-233	6619
Secondary School	Miami	25439	-233	25206
	Orlando	24117	-1178	22939
Outpatient Health Care	Miami	842	-53	789
	Orlando	706	-111	594
Hospital	Miami	7444	0	7444
	Orlando	7344	-700	6644
Small Hotel	Miami	8914	-6	8908
	Orlando	8728	-28	8700
Large Hotel	Miami	12722	-14108	-1386
	Orlando	12714	-14264	-1550
Mid-Rise Apartment	Miami	7553	-14	7539
	Orlando	7386	-172	7214
High-Rise Apartment	Miami	25964	-133	25831
	Orlando	24386	-1494	22892

Investment Cost: This code change incurs construction cost increase for adding occupancy sensor based lighting controls in corridors where it was not required previously. Installed total incremental cost of $400.0 per unit was assumed for each sensor and controller package with additional power pack for multi-channel use. The occupancy sensor[5] costs about $100.0 with multi-channel and a power pack costs about $50.0 to support multi-channel sensors and controllers and installation may cost about $250.0. Service life of 12 years was assumed.

Cost Benefit Analysis: Cost-benefit analysis was determined using the incremental cost and service life assumptions and annual energy cost saving determined using simulation for each of the thirteen prototype buildings. Table E-20 summarizes the net present value of the energy cost saving, net present value of investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-20 Cost-benefit Analysis Results Summary of Code Change CE169-19

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Primary School	Miami	4,932	2,286	2.16
	Orlando	4,633	2,286	2.03
Secondary School	Miami	19,629	4,571	4.29
	Orlando	19,018	4,571	4.16
Outpatient Health Care	Miami	621	2,667	0.23
	Orlando	543	2,667	0.20
Hospital	Miami	4,085	2,667	1.53
	Orlando	3,897	2,667	1.46
Small Hotel	Miami	4,557	1,524	2.99
	Orlando	4,454	1,524	2.92
Large Hotel	Miami	7,501	2,286	3.28
	Orlando	7,716	2,286	3.38
Mid-Rise Apartment	Miami	5,573	1,524	3.66
	Orlando	5,432	1,524	3.56
High-Rise Apartment	Miami	19,146	3,810	5.03
	Orlando	17,818	3,810	4.68
Weighted Average of Florida		13,857	3,298	4.20

Summary: Adding occupancy sensor based lighting controls in corridor spaces, which was not required previously, is cost-effective across all seven prototype buildings out of the eight prototype buildings investigated. The Florida average SIR value weighted across the eight commercial prototype buildings investigated was 4.20. The cost-effectiveness analysis was repeated with reduced installation cost of $150 per unit multi-channel controller resulted in weighted average SIR of 4.77. Therefore, the occupancy sensor based lighting controls code

[5] http://shopl.steinel.net/p/is-345-24-corridor-occupancy-sensor?pp=24

change in corridor spaces is cost-effective and recommended for consideration by Florida Building Commission for addition to the 8th Edition Florida Building Code, Energy Conservation.

Code Change CE185-19: Continuous Dimming Daylight Responsive Control
Section C405.2.4.1 changes the daylight responsive control function to continuous dimming from step dimming for sidelight and toplit daylighting controls. This code change: (1) eliminated stepped dimming, (2) replaced the minimum power input limit set to 20% or less, or off from 30%, and control daylights to unoccupied setpoint when needed. This code modification impacts all prototype buildings except the two apartment and strip mall buildings, which do not have daylighting device. This code change is identical to addenda "cw" to the 2016 ASHRAE Standard 90.1.

Dimming capability are available for all lamp types found in commercial buildings (fluorescent, HID, and LED). Note that lighting power allowanced and maximum LPD in the 2019 ASHRAE 90.1 standard are based on LED lamps, which is more suited for continuous dimming technology application.

Annual Energy Saving: Simulation of the thirteen prototype buildings with step-dimming technology for the 7th edition Florida Energy Code and a continuous-dimming technology and reducing the power input limits to 20% from 30% for the 2021 IECC results significant electric energy saving and in some cases slight increase in reheat gas energy consumptions. The electric, gas and total net energy saving of the thirteen prototype buildings are summarized in Table E-21.

Table E-21 Annual Energy Saving by Building Type of Code Change CE185-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Small Office	Miami	261	0	261
	Orlando	264	0	264
Medium Office	Miami	4236	-3	4233
	Orlando	4022	-50	3972
Large Office	Miami	22242	-456	21786
	Orlando	24850	-256	24594
Stand-Alone Retail	Miami	4792	0	4792
	Orlando	4603	-125	4478
Primary School	Miami	7472	3	7475
	Orlando	7275	8	7283
Secondary School	Miami	25328	-14	25314
	Orlando	24000	-28	23972
Outpatient Health Care	Miami	572	0	572
	Orlando	689	-14	675
Hospital	Miami	925	11	936

	Orlando	942	25	967
Small Hotel	Miami	272	0	272
	Orlando	275	-6	269
Large Hotel	Miami	78	-3	75
	Orlando	75	6	81
Warehouse	Miami	3983	-36	3947
	Orlando	0	0	0
Quick Service Restaurant	Miami	6	-3	3
	Orlando	0	0	0
Full Service Restaurant	Miami	61	-3	58
	Orlando	47	-3	44

Investment Cost: The 2021 IECC is based on market penetration of 100% LED technology and LED are more suited for continuous dimming compared to other lamp types commonly used in commercial buildings such as fluorescent and HID. And this code change may have small incremental cost increase for replacing step dimming with continuous dimming technology[6]. Therefore, incremental cost of $35.0 was assumed for each daylighting control devices and service life of 12 years was assumed.

Cost Benefit Analysis: Cost-benefit analysis was determined using the incremental cost and service life assumptions and annual energy cost saving determined using simulation for each of the thirteen prototype buildings. Table E-22 summarizes the net present value of the energy cost saving, net present value of investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-22 Cost-benefit Analysis Results Summary of Code Change CE185-19

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Small Office	Miami	191	133	1.43
	Orlando	193	133	1.44
Medium Office	Miami	3398	400	8.50
	Orlando	3359	400	8.40
Large Office	Miami	20010	400	50.02
	Orlando	19937	400	49.84
Stand-Alone Retail	Miami	3503	33	105.11

[6]https://www.grainger.com/product/30YH77?ef_id=EAIaIQobChMIwqCUnIeS8AIVGczICh3tqA2tEAQYASABEgJhZPD_BwE:G:s&s_kwcid=AL!2966!3!496359976216!!!g!469738748142!&gucid=N:N:PS:Paid:GGL:CSM-2295:4P7A1P:20501231&gclid=EAIaIQobChMIwqCUnIeS8AIVGczICh3tqA2tEAQYASABEgJhZPD_BwE&gclsrc=aw.ds

	Orlando	3515	33	105.45
Primary School	Miami	6039	600	10.06
	Orlando	5545	600	9.24
Secondary School	Miami	19081	1067	17.89
	Orlando	17945	1067	16.82
Outpatient Health Care	Miami	444	167	2.67
	Orlando	585	167	3.51
Hospital	Miami	872	200	4.36
	Orlando	444	200	2.22
Small Hotel	Miami	193	133	1.45
	Orlando	195	133	1.46
Large Hotel	Miami	37	133	0.27
	Orlando	63	133	0.47
Warehouse	Miami	3194	100	31.94
	Orlando	3368	100	33.68
Quick Service Restaurant	Miami	5	33	0.14
	Orlando	2	33	0.05
Full Service Restaurant	Miami	24	33	0.73
	Orlando	20	33	0.60
Weighted Average of Florida		55,847	178	33.33

Summary: The replacement of step-dimming daylight control device with continuous-dimming technology and a reduced electric power input limit to 20% from 30% was found to be cost-effective across eleven buildings out of the thirteen prototype buildings investigated. The Florida average SIR value weighted across the thirteen commercial prototype buildings investigated was 33.33. Therefore, the continuous dimming daylighting control technology code change is recommended for consideration by Florida Building Commission for addition to the 8th Edition Florida Building Code, Energy Conservation.

Code Change CE187-19: Secondary Sidelit Zones

Adds secondary sidelit zone requirement to section C405.2.4.2 Sidelit daylight zone. The area of secondary sidelit zones must not be considered in the calculation of the daylight zones in Section C402.4.1.1. Addition of secondary sidelit zone to the 2021 IECC aligns the 2021 IECC with the 2019 ASHRAE 90.1 standard. Adding secondary sidelit zone increases the daylighting controlled area often doubling it and increases the potential of lighting energy saving.

Annual Energy Saving: Simulation of the twelve prototype buildings without secondary sidelit zones for the 7th edition Florida Energy Code and with secondary sidelit zones for the 8th Edition IECC based FBC-EC results in general lighting energy saving. The electric, gas and total net energy saving of the thirteen prototype buildings are summarized in Table E-23.

Table E-23 Annual Energy Saving by Building Type of Code Change CE187-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Small Office	Miami	261	0	261
	Orlando	264	0	264
Medium Office	Miami	4236	-3	4233
	Orlando	4022	-50	3972
Large Office	Miami	22242	-456	21786
	Orlando	24850	-256	24594
Primary School	Miami	7472	3	7475
	Orlando	7275	8	7283
Secondary School	Miami	25328	-14	25314
	Orlando	24000	-28	23972
Outpatient Health Care	Miami	572	0	572
	Orlando	689	-14	675
Hospital	Miami	925	11	936
	Orlando	942	25	967
Small Hotel	Miami	272	0	272
	Orlando	275	-6	269
Large Hotel	Miami	78	-3	75
	Orlando	75	6	81
Warehouse	Miami	3983	-36	3947
	Orlando	0	0	0
Quick Service Restaurant	Miami	6	-3	3
	Orlando	0	0	0
Full Service Restaurant	Miami	61	-3	58
	Orlando	47	-3	44

Investment Cost: The addition of the secondary sidelit zone to the 2021 IECC would align the IECC with ASHRAE 90.1. Adding the secondary sidelit zone increases the general lighting energy saving with small incremental cost since many daylight control devices are multi-channel and can use one photosensor and one controller to set different daylight response curves for each channel. Incremental cost of $200 to $9600 depending on the prototype buildings were assumed for the cost-effectiveness analysis.

Cost Benefit Analysis: Cost-benefit analysis was determined using the incremental cost and service life assumptions and annual energy cost saving determined using simulation for each of the twelve prototype buildings. Table E-24 summarizes the net present value of the energy cost saving, net present value of investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-24 Cost-benefit Analysis Results Summary of Code Change CE187-19

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Small Office	Miami	406	914	0.44
	Orlando	403	914	0.44
Medium Office	Miami	4090	3429	1.19
	Orlando	4012	3429	1.17
Large Office	Miami	17206	13714	1.25
	Orlando	25398	13714	1.85
Primary School	Miami	12953	6476	2.00
	Orlando	12972	6476	2.00
Secondary School	Miami	24413	11429	2.14
	Orlando	23384	11429	2.05
Outpatient Health Care	Miami	2222	1429	1.56
	Orlando	2260	1429	1.58
Hospital	Miami	555	457	1.21
	Orlando	601	457	1.31
Small Hotel	Miami	933	914	1.02
	Orlando	931	914	1.02
Large Hotel	Miami	1454	857	1.70
	Orlando	1283	857	1.50
Warehouse	Miami	135	190	0.71
	Orlando	142	190	0.74
Quick Service Restaurant	Miami	545	286	1.91
	Orlando	523	286	1.83
Full Service Restaurant	Miami	1745	762	2.29
	Orlando	1810	762	2.38
Weighted Average of Florida		6366	3597	1.77

Summary: The addition of secondary sidelit area further reduces the lighting energy using daylighting control. This measure is cost-effective based on the estimated energy saving determined using simulation and marginal incremental cost assumption. The Florida average SIR value weighted across the twelve commercial prototype buildings investigated was 1.77. Therefore, addition of secondary sidelit area control is recommended for consideration by Florida Building Commission for consideration for addition to the 8th Edition Florida Building Code, Energy Conservation. This code change also aligns the 2021 IECC code with the 2019 ASHRAE 90.1 Standard.

Code Change CE206/208-19: Interior Lighting Power Density Reduction

Code change CE206-19 reduces the interior lighting power density (LPD) for building area method in Table C405.3.2(1). The building area method LPD values were reduced for all building types except for automotive facility, exercise center, library, parking garage, and workshop. Code change CE208-19 reduces the interior lighting power density (LPD) for space-by-space method in Table C405.3.2(2). The space-by-space method LPD values were reduced for almost all building types.

This change impacts all sixteen prototype buildings; the three office prototype buildings use building area method, and the rest thirteen prototype buildings use space-by-space method for interior lighting power calculation. Floor area weighted interior LPD for the IECC based 2020 FBC-EC and the 2021 IECC by prototype buildings are provided in Table E-25.

Table E-25 Interior LPD values for the 2020 FBC-EC and the 2021 IECC by building type

Prototype Building	Calculation Method	2020 FBC-EC, W/ft^2	2021 IECC, W/ft^2
Offices	Building Area	0.79	0.64
Retail Standalone	Space-by-Space	1.13	0.95
Strip Mall		0.68	0.60
Primary School		0.84	0.68
Secondary School		0.77	0.68
Outpatient Healthcare		0.97	0.81
Hospital		0.93	0.88
Small Hotel		0.76	0.46
Large Hotel		0.79	0.53
Warehouse		0.47	0.45
Quick Service Restaurant		0.84	0.74
Full Service Restaurant		0.81	0.73
Apartments		0.46	0.44

Annual Energy Saving: The annual energy saving due to interior LPD reduction determined using energy models and simulation by building type and climate zones is summarized in Table E-26. The energy saving includes the LPD reduction impact on HVAC system cooling and heating operations.

Investment Cost: Interior LPD upgrade cost assumption summary based on the baseline and upgrade are summarized in Table E-28. The costs are initial installed cost of the fixture and lamps, recurring lamp replacement cost and ballast replacement cost. The lamps are assumed to have five years life span, and the ballast is assumed to have 15 years life span. The baseline assumed 75% T8 lamps and 25% LED and the upgrade assumed 100% LED. The T8 fixture with 2 lamps and a ballast was assumed to cost $70.81 and the LED fixture assumed to cost in the rage $115 - $165. The installation labor cost assumed $75 - $100 per fixture. T8 lamp costs $4 and the lamp replacement cost was assumed to be in in the range $20 - $25.

Table E-26 Annual Energy Saving by Building Type of Code Change CE206/208-19

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Small Office	Miami	2347	0	2347
	Orlando	2331	0	2331
Medium Office	Miami	21800	-11	21789
	Orlando	21017	-158	20858
Large Office	Miami	199064	608	199672
	Orlando	202433	-50	202383
Stand-Alone Retail	Miami	15514	-8	15506
	Orlando	15189	-378	14811
Strip Mall	Miami	20308	-8	20300
	Orlando	19706	-517	19189
Primary School	Miami	36897	8	36906
	Orlando	35703	-19	35683
Secondary School	Miami	69086	-319	68767
	Orlando	71511	-1364	70147
Outpatient Health Care	Miami	14236	-586	13650
	Orlando	20761	-1200	19561
Hospital	Miami	79042	17031	96072
	Orlando	72697	16022	88719
Small Hotel	Miami	38206	-25	38181
	Orlando	37783	-128	37656
Large Hotel	Miami	143839	-12017	131822
	Orlando	139472	-8786	130686
Warehouse	Miami	2256	0	2256
	Orlando	2256	-33	2222
Quick Service Restaurant	Miami	1169	-22	1147
	Orlando	1103	-125	978
Full Service Restaurant	Miami	2228	-22	2206
	Orlando	2239	-139	2100
Mid-Rise Apartment	Miami	7611	-14	7597
	Orlando	7586	-158	7428
High-Rise Apartment	Miami	19472	-89	19383
	Orlando	18308	-1117	17192

Cost Benefit Analysis: The interior LPD upgrade for the building area and the space-by-space methods are cost effective as the predicted SIR values were greater than 1.0 for all prototype buildings. It is anticipated that as the LED lighting device cost continue to decrease, this upgrade becomes highly cost effective. The 2021 IECC LPD reduction assumes 100% market penetration by LED technologies in the commercial building sector. The 2020 FBC-EC LPD was based on 20-30% market penetration by LED technologies. Table E-27 summarizes the net present value of energy cost saving, net present value of investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-27 Cost-benefit Analysis Results Summary of Code Change CE206/208-19

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Small Office	Miami	2028	218	9.31
	Orlando	2013	218	9.24
Medium Office	Miami	18918	4892	3.87
	Orlando	18645	4892	3.81
Large Office	Miami	190243	45540	4.18
	Orlando	192063	45540	4.22
Stand-Alone Retail	Miami	12821	2448	5.24
	Orlando	12624	2448	5.16
Strip Mall	Miami	16597	2564	6.47
	Orlando	15611	2564	6.09
Primary School	Miami	35657	7735	4.61
	Orlando	34849	7735	4.51
Secondary School	Miami	70065	39004	1.80
	Orlando	73758	39004	1.89
Outpatient Health Care	Miami	11867	5980	1.98
	Orlando	16576	5980	2.77
Hospital	Miami	54710	13609	4.02
	Orlando	55213	13609	4.06
Small Hotel	Miami	23831	3946	6.04
	Orlando	24223	3946	6.14
Large Hotel	Miami	117626	13476	8.73
	Orlando	116397	13476	8.64
Warehouse	Miami	2040	1219	1.67
	Orlando	2022	1219	1.66
Quick Service Restaurant	Miami	757	334	2.27
	Orlando	718	334	2.15
Full Service Restaurant	Miami	1487	909	1.64
	Orlando	1507	909	1.66
Mid-Rise Apartment	Miami	6578	3571	1.84
	Orlando	6535	3571	1.83
High-Rise Apartment	Miami	16818	8953	1.88

	Orlando	15665	8953	1.75
Weighted Florida Average		26246	8736	3.00

Summary: The interior lighting power density reduction analysis was based on 5 year service life for Non LED lamps and 15 year service life for LED devices. The average first cost, lamp replacement cost and installation cost estimates used for the analysis are provided in Table E-28. The weighted average SIR value for the commercial sector across the sixteen prototype buildings in Florida climate estimated was about 3.0, which is cost effective. Therefore, this code modification is recommended for consideration by Florida Building Commission for addition to the 8th Edition (2023) Florida Building Energy Code, Energy Conservation.

Table E-28 Interior Lighting Fixture Assumption of Change CE206/208-19

Building Type	**Installed Cost, $**	**Lamp Replacement Cost, $**	**Installed Cost, $**	**Lamp Replacement Cost, $**
	7th Ed. (2020) FBC-EC		**8th Ed. (2023) FBC-EC**	
Small Office	12403	1683	14765	0
Medium Office	107422	13902	130180	0
Large Office	986318	129234	1197942	0
Retail Standalone	80070	10816	96350	0
Strip Mall	44220	5915	54410	0
Primary School	157599	20370	191540	0
Secondary School	418128	53193	526505	0
Outpatient Healthcare	101256	13041	124065	0
Hospital	618274	86947	742770	0
Small Hotel	94190	12672	114395	0
Large Hotel	241556	31542	295686	0
Warehouse	69671	9455	82935	0
Quick Service Restaurant	6099	817	7485	0
Full Service Restaurant	12826	1708	15945	0
Mid-Rise Apartment	45298	6014	56670	0
High-Rise Apartment	106236	14900	134520	0

Code Change CE215-19: Energy Monitoring

Adds a new mandatory section C405.12 Energy Monitoring. New buildings with a gross conditioned floor area of 25,000 ft^2 or larger must be equipped to measure, monitor, record, and report energy consumption data in accordance with Section C405.12.1 through C405.12.5. Several studies have demonstrated that there is significant energy saving potential that can be attained by metering and sub-metering commercial buildings energy use. A review of case studies[7] shows energy cost saving that ranges 0.17 - 0.77 $/ft^2$ at an overall cost range of 0.10 - 1.36 $/ft^2$ and a simple pay-back period that ranges from 1.2 – 3.4 years. The cost-effectiveness

[7] Zhiqiang (John) Zhai and Andrea Salazar. Assessing the implications of submetering with energy analytics to building energy savings. Energy and Built Environment 1 (2020) 27–35.

analysis performed for this code change is based on the investment cost and energy saving estimated from this case study using the large office prototype building.

Annual Energy Saving: The average annual energy cost saving estimate for implementing Energy Monitoring in commercial buildings was \$0.23/ft^2. The minimum, average and maximum energy cost saving based on the review study are summarized in Table E-29.

Table E-29 Annual Average Energy Cost Saving of Code Change CE215-19

Prototype Building	**Floor Area, ft^2**	**Annual Energy Cost Saving, \$/ft^2**		
		Minimum	**Maximum**	**Average**
Large Office	498,588	0.17	0.77	0.23

Investment Cost: The investment cost for implementing energy monitoring depends on the building size and the depth of sub-metering. The minimum, average, and maximum overall investment cost per square foot of building floor area assumptions used in the analysis are summarized in Table E-30.

Table E-30 Investment Cost Per Floor Area of Code Change CE215-19

Prototype Building	**Floor Area, ft2**	**Investment Costs**, \$/ft^2		
		Minimum	**Maximum**	**Average**
Large Office	498,588	0.10	1.36	0.53

Cost Benefit Analysis: Simple pay-back period was determined using the overall investment cost and average annual energy cost saving assumptions for the large office prototype buildings. Table E-31 summarizes the average annual energy cost saving, investment cost, and calculated SIR values and simple payback periods.

Table E-31 Cost-benefit Analysis Results Summary of Code Change CE215-19

Building Type	**Scenarios**	**Annual Energy Cost Saving, \$**	**Total Investment Cost, \$**	**Payback Period, years**	**SIR**
Large Office	Average	112,655	265,731	2.36	3.44
	Minimum	86,140	49,859	0.58	14.01
	Maximum	381,776	678,080	1.78	4.56

Summary: Energy monitoring in commercial buildings provides significant energy saving potential that has simple payback period ranging from 7 months to 2.36 years. The payback period based on the average energy cost saving and average overall investment cost was 2.4 years. The simple payback period based on the minimum energy cost saving and minimum overall investment cost was about 7 months. And the payback period based on the maximum energy cost saving and maximum overall investment cost was about 1.78 years. Overall, the energy monitoring provides an energy saving potential that has a payback period under 2.5 years. Savings to investment ratio (SIR) was determined for code change CE215-19 for the three energy cost saving and investment cost combination scenarios and service life span of ten years. The SIR values range from 3.44 to 14.01. Saving to investment ratio and simple payback period cost-benefit analysis methods demonstrate that Energy Monitoring is cost-effective. Therefore, code change CE215-19 meets the cost-benefit criteria and is recommended for consideration by Florida Building Commission for addition to the 8th Edition Florida Building Code, Energy Conservation.

Cost benefit Analysis of Changes to the ASHRAE Based 2020 FBC-EC

This section describes the cost-benefit analysis, assumptions used in the analysis, the energy saving potential and the SIR value of each of the 2019 ASHRAE 90.1 code modifications considered for cost-effectiveness analysis.

Addenda ap: Supply Air Temperature (SAT) Reset Control

Revises supply air temperature (SAT) reset control strategy. This code change will bring at least 5.0°F (2.8°C) supply temperature difference reset depending on outdoor air temperature or load. This code requirement has exemption depending on climate zone and system design outdoor air flow rate. Section 6.5.3.5 in the 2016 ASHRAE 90.1 code exempts supply air temperature reset control for climate zones 1A and 2A but the 2019 ASHRAE 90.1 now the exemption is applicable only when the design outdoor air flow rate is less than 3000 cfm for climate zone 1A and less than 10000 cfm for climate zone 2A. New the sub-section 6.5.3.5.1 Dehumidification Control Interaction, in Climate Zones 0A, 1A, 2A, and 3A, requires supply air temperature *reset* while dehumidification is provided. The fixed supply air temperature is now replaced with a reset control strategy as follows where applicable:

- Central VAV supply air temperature was reset from a fixed 12.8°C to a range from 12.8°C to 15.56C depending on outdoor air temperature.
- The reset strategy requires dedicated dehumidification cooling coil in the outdoor air intake system to be able to effectively use supply air reset strategy.

This change may impacts six prototype buildings: Large Office, Primary School, Secondary School, Outpatient Health Care, Hospital, and Large Hotel. The Large Office, Primary School, Secondary School, and Outpatient Health Care require SAT reset in Climate zone 1A only. For cost-effectiveness analysis this modification was investigated using large office prototype building. The design outdoor air flow rate for the top floor HVAC zone in large office building was 5378 cfm and exceeds climate zone 1A design outdoor air flow minimum threshold of 3000 cfm.

Annual Energy Saving: this code change impacts selected prototype buildings depending on climate zone and design outdoor air flow rates; Annual energy saving due to application of SAT reset for large office building is summarized in Table E-32.

Table E-32 Annual Energy Cost Saving by Building Type of addenda ap

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Large Office	Miami	-2,994	30,453	27,458
	Orlando	5,531	29,125	34,656

Investment Cost: Therefore, incremental first and installation cost of $3000.0 and incremental annual maintenance cost of $150.0, and service life of 20 years was assumed. This upgrade for the VAV system upgrade serving the top floor.

Cost Benefit Analysis: Cost effectiveness analysis was performed for HVAC system upgrade serving the top floor only. Annual energy cost saving determined, and the incremental investment cost assumption are for the HVAC system upgrade serving the top floor of the for the large office prototype building. Table E-33 summarizes the net present value of the energy cost saving, net present value of investment cost and the saving to investment ratio for climate zones 1A and 2A, although only climate zone 1A meets the design outdoor air flow rate threshold for SAT reset. Interestingly, the analysis confirms both climate zones meet the cost effectiveness criteria.

Table E-33 Cost-benefit Analysis Results Summary of Addenda ap

Building Type	City	Life Cycle Energy Cost Saving, $	Investment Cost NPV, $	SIR
Large Office	Miami	5,732	4,637	1.24
	Orlando	10,969	4,637	2.37
Weighted Average		7,692	4,637	1.66

Summary: The system design with SAT reset that achieves dehumidification requirement per Section 6.5.3.5 and sub-section 6.5.3.5.1 was investigated in a large office prototype building in climate zone 1A and 2A. The average SIR value weighted for climate zones 1A and 2A was determined to be 1.66, which is cost effective. Therefore, SAT reset with dehumidification control interaction control saves energy cost, meets the cost-benefit criteria, and is recommended for consideration by Florida Building Commission for addition to the 8th Edition (2023) Florida Building Code, Energy Conservation.

Addenda au: Minimum Zones Air Flow Rate Limits for Systems with DDC
Eliminates the requirement that zones with DDC have air flow rates that are no more than 20% of the zone design peak flow rate.

zone reheated air flow rate can be determined based ventilation requirement per ASHRAE Standard 62.1 instead of 20% of the one peak supply air flow rate. There are two possible changes that impact the prototype buildings: (1) minimum supply air flow damper position for DDC HVAC system serving some of the HVAC zones (e.g., storage rooms) can be higher than 20% of the peak flow per ASHRAE 62.1 ventilation requirement, instead of fixed 20%, or (2) the DDC minimum supply air flow damper position can be lower than 20% of the peak flow per ASHRAE 62.1 ventilation requirement, instead of fixed 20%. For example, for mechanical, bath and laundry rooms. This code change impacts seven prototype buildings with DDC HVAC control. These prototype buildings include Medium Office, Large Office, Primary School, Secondary School, Outpatient Health Care, Hospital, and Large Hotel.

Annual Energy Saving: Modifying the minimum done air distribution damper position that meets the ventilation air requirement of ASHRAE 62.1 results in annual energy saving across most of the buildings investigated. The annual energy saving due to minimum damper position adjustment are summarized in Table E-34.

Table E-34 Annual Energy Cost Saving by Building Type of au

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Medium Office	Miami	-153	-6	-158
	Orlando	1058	-286	772
Large Office	Miami	-11083	833	-10250
	Orlando	13286	8281	21567
Primary School	Miami	3492	111	3603
	Orlando	10003	1003	11006
Secondary School	Miami	7219	1264	8483
	Orlando	16953	5444	22397
Hospital	Miami	933	622	1556
	Orlando	1256	508	1764
Outpatient Health Care	Miami	1397	4467	5864
	Orlando	-97	2183	2086
Large Hotel	Miami	-71708	-25714	-97422
	Orlando	-68997	-33136	-102133

Investment Cost: this modification needs to adjust the damper position depending on the OA requirements and it does not require any additional devices. Therefore, there is not any incremental first cost or maintenance cost increase associated with this change.

Cost Benefit Analysis: cost-benefit analysis is not required for addenda *au*.

Summary: this code change resulted in modest energy saving in some of the prototype buildings investigated. The code change does not impact construction cost, the analysis change shows mixed energy saving results; however, we still recommend the code change for consideration by Florida Building Commission for addition to the 8th Edition (2023) Florida Building Code, Energy Conservation.

Addenda aw: Vertical Fenestration and Skylight Upgrades

Revise's fenestration prescriptive criteria in Tables 5.5-0 through 5.5-8. Fenestration classification is now material neutral and grouped into "fixed", "operable", and "entrance door" categories. The SHGC change is slightly more stringent, but the *U*-factor stringency depends on the fenestration class. It is more stringent for fixed and relaxed for operable fenestration classes.

This fenestration code change impacts all sixteen prototype buildings; however, only nine prototype buildings were considered for cost-benefit analysis: large office, secondary school, small hotel, large hotel, mid-rise apartment, high-rise apartment, standalone-retail, and full service restaurant.

Two sets of fenestration performance upgrade were investigated: (1) vertical fenestration SHGC reduced from 0.25 to 0.23 for climate zone 1A and no SHGC change for climate zone 2A, and (2) fenestration assembly *U*-Factor was reduced from 0.57 Btu/ft^2-hr-°F to a range from 0.50 to 0.51 Btu/ft^2-hr-°F for climate zone 1A and from about 0.54 Btu/ft^2-hr-°F to a range from 0.45 to 0.49 Btu/ft^2-hr-°F for climate zone 2 depending on prototype building and fenestration class selected. Table E-35 summarizes the SHGC and *U*-Factor upgrades investigated by building type and climate zones.

Table E-35 SHGC and U-Factor Upgrade by Climate Zones of addenda aw

Prototype Building	**SHGC, -**		**U-Factor, Btu/ft^2-hr-°F**	
	ASHRAE 90.1-2016	**ASHRAE 90.1-2019**	**ASHRAE 90.1-2016**	**ASHRAE 90.1-2019**
climate zone 1A				
Large Office	0.25	0.23	0.57	0.50
Stand-Alone Retail	0.25	0.23	0.57	0.50
School	0.25	0.23	0.57	0.51
Hospital	0.25	0.23	0.57	0.51
Small Hotel	0.25	0.23	0.57	0.51
Large Hotel	0.25	0.23	0.57	0.50
Full Service Restaurant	0.25	0.23	0.57	0.50
Mid-Rise Apartment	0.25	0.23	0.57	0.53
High-Rise Apartment	0.25	0.23	0.57	0.53
climate zone 2A				
Large Office	0.25	0.25	0.54	0.46
Stand-Alone Retail	0.25	0.25	0.54	0.45
School	0.25	0.25	0.53	0.47
Hospital	0.25	0.25	0.54	0.46
Small Hotel	0.25	0.25	0.54	0.46
Large Hotel	0.25	0.25	0.54	0.46
Full Service Restaurant	0.25	0.25	0.54	0.45
Mid-Rise Apartment	0.25	0.25	0.53	0.49
High-Rise Apartment	0.25	0.25	0.53	0.49

Annual Energy Saving: All prototype buildings in climate zone 1A showed annual Electric Energy Saving due to reduction in SHGC and U-factor. Only hospital and large hotel buildings, which are operated 24 hours, showed an increase in gas consumption. Annual energy saving due to the fenestration upgrade are summarized in Table E- 36. However, for climate zone 2A, almost all prototype buildings showed an increase in annual electric energy use while showing Gas Energy Saving. The SHGC value did not change for climate zone 2A while the *U*-factor reduced across all buildings investigated.

Table E- 36 Annual Energy Cost Saving by Building Type of addenda aw

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Large Office	Miami	16217	1436	17653
	Orlando	-9689	7594	-2094
Stand-Alone Retail	Miami	200	3	203
	Orlando	-131	64	-67
Secondary School	Miami	8539	494	9033
	Orlando	-1411	2419	1008
Hospital	Miami	2531	-3886	-1356
	Orlando	-281	3383	3103
Small Hotel	Miami	72	11	83
	Orlando	-364	53	-311
Large Hotel	Miami	4100	-206	3894
	Orlando	-1500	2647	1147
Full Service Restaurant	Miami	292	11	303
	Orlando	-53	153	100
Mid-Rise Apartment	Miami	1186	6	1192
	Orlando	-231	175	-56
High-Rise Apartment	Miami	5608	22	5631
	Orlando	-383	1106	722

Investment Cost: This vertical fenestration upgrade does not entail any new technology, rather it is an improvement of product performance. An incremental first cost increase of \$2.14/m^2 was assumed for climate zone 1A and \$1.94/m^2 for climate zone 2A, and service life of 30 years was assumed. Climate zone 1A upgrade incremental cost is higher as it involves both SHGC value reduction and improvement on the assembly U-factor, which climate zone 2A has only U-factor upgrade.

Cost Benefit Analysis: Overall this code change (addenda aw) resulted in better performance in climate zone 1A but not in climate zone 2A. The cost-benefit analysis performed using the incremental first cost and service life assumptions, demonstrated that the SIR value is higher than 1 across all buildings in climate zone 1A but less than 1.0 across all buildings in climate zone 2A. The net present value of the life cycle energy cost saving, net present value of the investment cost, and the cost saving to investment ratio are summarized in Table E-37.

Table E-37 Cost-benefit Analysis Results Summary of Addenda aw

Building Type	City	Life Cycle Energy Cost Saving, \$	Investment Cost NPV, \$	SIR
Large Office	Miami	23897	9448	2.53
	Orlando	-239	8565	-0.03
Stand-Alone Retail	Miami	396	171	2.31

	Orlando	20	155	0.13
Secondary School	Miami	9525	4257	2.24
	Orlando	-447	3859	-0.12
Hospital	Miami	2225	1729	1.29
	Orlando	650	1567	0.41
Small Hotel	Miami	-64	375	-0.17
	Orlando	-246	340	-0.72
Large Hotel	Miami	3903	2474	1.58
	Orlando	-173	2243	-0.08
Full Service Restaurant	Miami	343	96	3.57
	Orlando	22	87	0.26
Mid-Rise Apartment	Miami	2041	626	3.26
	Orlando	-685	567	-1.21
High-Rise Apartment	Miami	6652	2345	2.84
	Orlando	430	2125	0.20
Weighted Average		2459	1300	1.89

Summary: Impacts of reducing the fenestration and skylights assembly *U*-Factor and SHGC of the nine prototype buildings were analyzed. The weighted average SIR across the nine commercial prototype buildings was estimated to be about 1.89. Vertical fenestration upgrade analysis demonstrated that the code change is cost-effective in climate zone 1A but it is not in climate zone 2A. But note that the *U*-factor upgrade is partly due to consolidation of the fenestration product to make them material neutral. Overall, the weighted Florida average SIR value is cost-effective. Therefore, reducing the SHGC and U-Factor of vertical fenestration and skylights can be considered cost effective and recommended for consideration by Florida Building Commission for addition to the 8th Edition Florida Building Code, Energy Conservation.

Addenda ay: Exhaust Air Energy Recovery in Nontransient Dwelling Unit
Adds a new section for nontransient dwelling unit exhaust air energy recovery, i.e., section 6.5.6.1.1 Nontransient Dwelling Units. This code change requires exhaust energy recovery with enthalpy recovery ratio of at least 50% efficiency for cooling and 60% for heating for non-transient dwelling units (apartments and condos 4 story and higher).

This code change impacts the medium rise and high rise apartment prototype buildings. The baseline (2016 ASHRAE 90.1 Standard) assumed an integrated supply fan system without Energy Recovery Ventilators (ERV) and the upgrade (2016 ASHRAE 90.1 Standard) assumed balance system with ERV. These two systems were simulated in EnergyPlus for mid and high rise apartment prototype buildings and the energy saving potential and cost-benefit analysis were performed.

Annual Energy Saving: Simulation of the two apartment prototype buildings energy models without ERV in the 7th edition Florida Energy Code and with exhaust air ERV technology in the 8th Edition Florida Energy Code results in annual energy saving. The electric, gas and total net annual energy saving of the apartment buildings are summarized in Table E-38.

Table E-38 Annual Energy Cost Saving by Building Type of Addenda ay

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Mid Rise Apartment	Miami	14,111	125	14,236
	Orlando	9,025	1,811	10,836
High Rise Apartment	Orlando	4,550	356	4,906
	Orlando	133	7,661	7,794
Florida Average	Average	5,853	680	6,533

Investment Cost: There is equipment first cost, a onetime installation cost and annual maintenance cost for each ERV units in the two apartment buildings. There first, installation and annual maintenance costs of $600.0, $500.0, and $50.0, respectively and service life of 15 years were assumed for each unit. There are 23 and 79 dwelling units in the medium rise and high rise apartment buildings, respectively.

Cost Benefit Analysis: Cost-benefit analysis was performed using the incremental cost and service life assumptions and annual energy cost saving determined using energy models and simulation for each of the two apartment prototype buildings. Table E-39 summarizes net present value of life cycle energy cost saving, net present value of the investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-39 Cost-benefit Analysis Results Summary of Addenda ay

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Mid Rise Apartment	Miami	13,853	37,892	0.37
	Orlando	9,266	37,892	0.24
High Rise Apartment	Miami	5,965	130,150	0.05
	Orlando	2,050	130,150	0.02
Weighted Average of Florida		7,011	113,566	0.10

Summary: The weighted Florida average SIR of the two apartment prototype buildings was 0.10. Therefore, the ERV requirement in non-transient dwelling unit is not cost effective and is not recommended for addition to the 8th Edition Florida Building Code, Energy Conservation.

Addenda bb and cg: Lighting Power Density Allowances
Addenda cg: Revises Table 9.5.1 lighting power density allowances using the building area method. Addenda bb: Revises Table 9.6.1 lighting power densities for the space-by-space method. This change impacts all sixteen prototype buildings; the three office prototype buildings use building area method, and the remaining thirteen prototype buildings use space-by-space method for interior lighting power allowance calculation. Area weighted peak interior Lighting Power Density (LPD) for the 2016 and 2019 ASHRAE 90.1 Standard code by prototype buildings are provided in Table E-40.

Table E-40 Interior LPD reduction from 2016 to 2019 ASHRAE 90.1 by building type

Prototype Building	Calculation Method	2016 ASHRAE 90.1 Std, W/ft^2	2019 ASHRAE 90.1 Std, W/ft^2
Offices	Building Area	0.79	0.64
Retail Standalone	Space-by-Space	1.13	0.95
Strip Mall		0.68	0.60
Primary School		0.84	0.68
Secondary School		0.77	0.68
Outpatient Healthcare		0.97	0.81
Hospital		0.93	0.88
Small Hotel		0.76	0.46
Large Hotel		0.79	0.53
Warehouse		0.47	0.45
Quick Service Restaurant		0.84	0.74
Full Service Restaurant		0.81	0.73
Apartments		0.46	0.44

Annual Energy Saving: The annual energy saving due to interior LPD reduction determined via simulation by building type and climate zones are summarized in Table E-41. The annual energy saving includes the LPD reduction impact on HVAC system cooling and heating operations.

Table E-41 Annual Energy Cost Saving by Building Type of Addenda bb and cg

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Small Office	Miami	2211	0	2211
	Orlando	2206	0	2206
Medium Office	Miami	19808	-3	19806
	Orlando	19186	-53	19133
Large Office	Miami	205597	311	205908
	Orlando	219878	-1494	218383
Stand-Alone Retail	Miami	17208	-36	17172
	Orlando	17228	-447	16781

Strip Mall	Miami	17642	-31	17611
	Orlando	17192	-586	16606
Primary School	Miami	24156	19	24175
	Orlando	25958	-78	25881
Secondary School	Miami	42103	-344	41758
	Orlando	42261	-1422	40839
Outpatient Health Care	Miami	24469	-589	23881
	Orlando	23108	-253	22856
Hospital	Miami	37150	11144	48294
	Orlando	33633	13789	47422
Small Hotel	Miami	34933	-11	34922
	Orlando	34553	-189	34364
Large Hotel	Miami	92950	-3247	89703
	Orlando	91164	-4108	87056
Warehouse	Miami	1936	0	1936
	Orlando	1892	-39	1853
Quick Service Restaurant	Miami	700	-19	681
	Orlando	642	-97	544
Full Service Restaurant	Miami	1694	-25	1669
	Orlando	1733	-122	1611
Mid-Rise Apartment	Miami	6967	-14	6953
	Orlando	6856	-144	6711
High-Rise Apartment	Miami	18172	-75	18097
	Orlando	16922	-825	16097

Investment Cost: Interior LPD upgrade cost assumptions based on the 2016 and 2019 ASHRAE 90.1 code is shown in Table E-28. The costs are initial installed cost of the fixture and lamps, recurring lamp replacement cost and ballast replacement cost. The lamps are assumed to have five years life span, and the ballast is assumed to have 15 years life span. The baseline assumed 75% T8 lamp and 25% LED and the upgrade assumed 100% LED. The T8 fixture with 2 lamps and a ballast was assumed to cost $70.81 and the LED fixture assumed to cost in the rage $115 - $165. The installation labor cost assumed $75 - $100 per fixture. T8 lamp costs $4 and the lamp replacement cost was assumed to be in in the range $20 - $25.

Cost Benefit Analysis: The interior LPD upgrade for the building area and the space-by-space methods are cost effective as the estimated SIR values are greater than 1.0. It is anticipated that as the LED lighting device cost continue to decrease, this upgrade becomes highly cost effective. The 2019 ASHRAE 90.1 code assumes 100% market penetration by LED technologies. The 2016 ASHRAE 90.1 code assumed that is based on 20-30% market penetration by LED technologies in commercial buildings sector. Table E-42 summarizes net present value of energy cost saving, net present value of investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-42 Cost-benefit Analysis Results Summary of Addenda bb and cg

Building Type	City	Life Cycle Energy Cost Saving, $	Investment Cost NPV, $	SIR
Small Office	Miami	1910	218	8.77
	Orlando	1908	218	8.76
Medium Office	Miami	16897	4892	3.45
	Orlando	16749	4892	3.42
Large Office	Miami	186710	45540	4.10
	Orlando	189776	45540	4.17
Stand-Alone Retail	Miami	14175	2448	5.79
	Orlando	14197	2448	5.80
Strip Mall	Miami	13465	2564	5.25
	Orlando	13485	2564	5.26
Primary School	Miami	22611	7735	2.92
	Orlando	21457	7735	2.77
Secondary School	Miami	44690	39004	1.15
	Orlando	44450	39004	1.14
Outpatient Health Care	Miami	18390	5980	3.08
	Orlando	19054	5980	3.19
Hospital	Miami	20259	13609	1.49
	Orlando	23943	13609	1.76
Small Hotel	Miami	21088	3946	5.34
	Orlando	22175	3946	5.62
Large Hotel	Miami	77519	13476	5.75
	Orlando	77755	13476	5.77
Warehouse	Miami	1649	1219	1.35
	Orlando	1526	1219	1.25
Quick Service Restaurant	Miami	383	334	1.15
	Orlando	347	334	1.04
Full Service Restaurant	Miami	1089	909	1.20
	Orlando	1118	909	1.23
Mid-Rise Apartment	Miami	4247	3571	1.19
	Orlando	3522	3571	0.99
High-Rise Apartment	Miami	10907	8953	1.22
	Orlando	10343	8953	1.16
Weighted Florida Average		19577	8736	2.24

Summary: The interior lighting power density reduction analysis was based on 5 year service life for Non LED lamps and 15 year service life for LED devices. The average first cost, lamp replacement cost and installation cost estimates used for the analysis are provided in Table E-28.

The weighted average SIR value for the commercial sector across the sixteen prototype buildings in Florida climate estimated was about 2.24, which is cost effective. Therefore, this code modification is recommended for consideration by FBC addition to the 8th Edition (2023) Florida Building Energy Code, Energy Conservation.

Addenda cw: Continuous Dimming Daylight Responsive Control
Revises the daylight responsiveness requirements to continuous dimming from step dimming for sidelit and toplit daylighting control. Stepped dimming is replaced with continuous dimming and minimum power input limit set to 20% or less, or off from 30%, and controls daylights to unoccupied setpoint when needed. This code change impacts sections 9.4.1.1(e) and 9.4.1.1(f) of the 2019 ASHRAE Standard 90.1. The addenda impact all prototype buildings except the two apartment and the strip mall prototype buildings that do not have daylighting devices. Dimming capability are available for all lamp types found in commercial buildings (fluorescent, HID, and LED). Note that lighting power allowanced and maximum LPD in the 2019 ASHRAE 90.1 standard are already based on LED technologies, which is more suited for continuous dimming technology application.

Annual Energy Saving: Simulation of the thirteen prototype buildings with step-dimming technology for the 7th Edition (2020) FBC-EC and a continuous-dimming technology and reducing the power input limits to 20% from 30% for the 2019 ASHRAE 90.1 results in significant energy saving and in some cases slight increase in space heating gas consumptions. The electric, gas and total net energy saving of the thirteen prototype buildings are summarized in Table E-43.

Table E-43 Annual Energy Cost Saving by Building Type of Addenda cw

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Small Office	Miami	275	0	275
	Orlando	281	0	281
Medium Office	Miami	478	0	478
	Orlando	531	-3	528
Large Office	Miami	2786	11	2797
	Orlando	7508	-281	7228
Stand-Alone Retail	Miami	7256	-8	7247
	Orlando	7003	-153	6850
Primary School	Miami	4886	0	4886
	Orlando	4708	33	4742
Secondary School	Miami	12994	-144	12850
	Orlando	17231	-586	16644
Outpatient Health Care	Miami	1861	-14	1847
	Orlando	1964	-39	1925
Hospital	Miami	1156	-50	1106

	Orlando	892	-72	819
Small Hotel	Miami	1150	-3	1147
	Orlando	1211	-14	1197
Large Hotel	Miami	681	28	708
	Orlando	517	14	531
Warehouse	Miami	3367	0	3367
	Orlando	3456	-44	3411
Quick Service Restaurant	Miami	50	0	50
	Orlando	50	-3	47
Full Service Restaurant	Miami	103	-3	100
	Orlando	175	-6	169

Investment Cost: The 2019 ASHRAE 90.1 code is based 100% market penetration by LED lights technology and the LED lamps are more suited for continuous dimming compared to other lamp types in commercial buildings such as fluorescent and HID. And this code change may have small incremental cost increase for replacing step dimming with continuous dimming technology. Therefore, an incremental cost of $25.0 was assumed for each daylighting control devices and service life of 12 years was assumed.

Cost Benefit Analysis: Cost-benefit analysis was determined using the incremental cost and service life assumptions and annual energy cost saving determined using simulation for each of the thirteen prototype buildings. Table E-44 summarizes the net present value of the energy cost saving, net present value of the investment cost and the saving to investment ratio for the two climate zones and a weighted average for Florida.

Table E-44 Cost-benefit Analysis Results Summary of Addenda cw

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Small Office	Miami	201	95	2.11
	Orlando	205	95	2.15
Medium Office	Miami	275	286	0.96
	Orlando	260	286	0.91
Large Office	Miami	2430	1143	2.13
	Orlando	3232	1143	2.83
Stand-Alone Retail	Miami	5493	24	230.72
	Orlando	5364	24	225.27
Primary School	Miami	3875	429	9.04
	Orlando	3730	429	8.70
Secondary School	Miami	10367	762	13.61
	Orlando	11908	762	15.63

Outpatient Health Care	Miami	1658	119	13.92
	Orlando	1887	119	15.85
Hospital	Miami	699	143	4.89
	Orlando	738	143	5.17
Small Hotel	Miami	616	95	6.47
	Orlando	683	95	7.18
Large Hotel	Miami	316	95	3.31
	Orlando	282	95	2.96
Warehouse	Miami	2935	71	41.09
	Orlando	2726	71	38.16
Quick Service Restaurant	Miami	20	24	0.85
	Orlando	20	24	0.83
Full Service Restaurant	Miami	42	24	1.74
	Orlando	70	24	2.94
Weighted Average of Florida		2195	147	34.44

Summary: The replacement of step-dimming daylight control device with continuous-dimming technology and a reduced electric power input limit to 20% from 30% was found to be cost-effective across eleven buildings out of the thirteen prototype buildings investigated. The weighted average SIR across all the sixteen commercial prototype buildings was estimated to be about 34.44. Therefore, the continuous dimming daylighting control technology is cost effective and is recommended for consideration by Florida Building Commission for addition to the 8th Edition Florida Building Code, Energy Conservation.

Addenda g: Occupied-Standby Mode

Adds new definition for "occupied-standby mode" and adds new ventilation air requirements for zones served rooms in occupied-standby mode. Unoccupied space does not need to be ventilated per standard 62.1 when spaces air temperature is within the allowed limits. Thus, this code change allows to reduce ventilation air requirement to zero and setbacks cooling and heating thermostats by at least 1.0°F (0.56°C) for zones served in occupied-standby mode. Furthermore, this code change is intended to tie occupied-standby mode to lighting control requirement in section 9.4.1.1, i.e., when a space is not occupied for more than 20 minutes, lighting is turned off automatically. Thus, there are two changes for "occupied-standby mode":

- Turn-off ventilation air supply when a space is planned for "occupied-standby mode"
- Setback heating thermostat or setup cooling thermostat by 1.0 °F when a space is planned for "occupied-standby mode"

This change impacts seven prototype buildings: Small Office, Medium Office, Large Office, Primary School, Secondary School, Outpatient Health Care, and Small Hotel. To model this code change office spaces heating, and cooling thermostat set-point temperatures were setback and setup, respectively and cycle-off supply air fan or reduce ventilation air to zero three times a day for an hour during occupied-standby mode.

Annual Energy Saving: Simulation of these seven prototype buildings with and without "occupied-standby mode" control results in annual energy saving. The net energy saving by building type are summarized in Table E-45.

Table E-45 Annual Energy Cost Saving by Building Type of Addenda g

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Small Office	Miami	169	0	169
	Orlando	181	0	181
Medium Office	Miami	164	0	164
	Orlando	181	-6	175
Large Office	Miami	2975	53	3028
	Orlando	6817	819	7636
Primary School	Miami	208	0	208
	Orlando	128	8	136
Secondary School	Miami	-108	8	-100
	Orlando	47	-11	36
Outpatient Health Care	Miami	81	39	119
	Orlando	86	36	122
Small Hotel	Miami	906	3	908
	Orlando	914	8	922

Investment Cost: Occupancy sensor for lighting control is already required in a selected space types such offices, employees meeting and lounge space types. No incremental cost is incurred for thermostat setback or setup control since the same occupancy sensors can be used. The HVAC ventilation control may be is the only component that incur additional cost and current HVAC control come with capability of integrated control technologies for ventilation and lighting control based on occupancy. As the result, the incremental first, installation and maintenance costs are small as the occupancy sensor control are required by code for lighting controls for the selected space types. Therefore, incremental first and installation cost of $40.0 and incremental annual maintenance cost of $10.0, and service life of 12 was assumed for each device serving each space controlled.

Cost Benefit Analysis: Cost-effectiveness was determined using incremental first and maintenance cost, 12 years of service life and annual energy saving determined using simulation of the seven prototype buildings. Table E-46 summarizes the net present value of the Life Cycle Energy Cost Saving, net present value of investment cost and the saving to investment ratio for the two climate zones.

The medium and large offices and Outpatient healthcare prototype buildings do not have annual energy cost saving even though they have annual energy saving whereas the small office, small hotel and primary school buildings show both annual energy cost and annual energy use saving, and their average SIR values were 1.06, 1.32 and 2.22, respectively. This is caused by increased electric demand changes due to pulldown load after the thermostat is reset from an hour long setback is offsetting the energy saving due to Occupied-Standby Mode. Since the packaged HVAC system types are used in small office, small hotel and primary school buildings serving individual spaces, the ventilation control is achieved by turning the supply fan off along with the thermostat setback or setup will essentially turn off the HVAC units. This results in maximizing the energy saving for this code change. However, the same scale of energy saving may not be achieved for spaces served by central system types used in larger buildings. Setting ventilation air flow to zero in individual air terminal VAV boxes equipment does not results in significant energy saving and the small saving cannot offset the increased demand changes due the pull-down load after the thermostat is reset. As the result, we think, we see mixed results depending on the HVAC system serving the prototype buildings. However, the increased demand charges may not be as high in actual building operation.

Summary: Cost benefit analysis demonstrated that the small office, small hotel, and primary school prototype buildings have SIR value of 1.06, 1.40, and 2.22, respectively; hence this code change is cost-effective in these three prototype buildings; however, medium, and large offices, secondary school, and outpatient health care prototype buildings are not cost-effective. This is because of higher electric demand due to increased pulldown load after the thermostat setback or setup was reversed for the buildings served with central air HVAC systems. This is the only viable conclusion that can be draws by in-depth review of the simulation results. Nevertheless, this code change is recommended for consideration by Florida Building Commission for addition to the 8th Edition (2023) Florida Building Code, Energy Conservation.

Table E-46 Cost-benefit Analysis Results Summary of Addenda g

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Small Office	Miami	124	123	1.01
	Orlando	132	123	1.08
Medium Office	Miami	-79	123	-0.65
	Orlando	-42	123	-0.34
Large Office	Miami	-1289	1225	-1.05
	Orlando	-2155	1225	-1.76
Primary School	Miami	503	123	4.11
	Orlando	181	123	1.48
Secondary School	Miami	43	245	0.18
	Orlando	82	245	0.34
Outpatient Health Care	Miami	-5	735	-0.01
	Orlando	-21	735	-0.03
Small Hotel	Miami	322	245	1.31
	Orlando	335	245	1.37

Fixed energy rates are commonly used in DOE's commercial buildings code changes cost-effectiveness analysis[8]. As a matter of curiosity, the cos-effectiveness calculation was repeated using flat energy rates of 0.1052/kWh electricity and $0.752/therm for natural gas. Using the same incremental first and maintenance cost and 12 years of service life and annual energy saving determined for the seven prototype buildings. Table E-47 summarizes the net present value of the life cycle energy cost saving, net present value of investment cost and the saving to investment ratio for the two climate zones. Using flat energy rates all except the Secondary school and Outpatient Healthcare prototype buildings had SIR values greater than 1.0. The low SIR value these two buildings is attributed to low energy saving to begin with. Therefore, this code change is recommended for consideration by Florida Building Commission for addition to the 8th Edition (2023) Florida Building Code, Energy Conservation.

Table E-47 Cost-benefit Analysis Results Summary of Addenda g with Flat Energy Rates

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Small Office	Miami	149	123	1.22
	Orlando	159	123	1.30
Medium Office	Miami	144	123	1.18
	Orlando	157	123	1.28
Large Office	Miami	2622	1225	2.14
	Orlando	6182	1225	5.05
Primary School	Miami	185	123	1.51
	Orlando	115	123	0.94
Secondary School	Miami	-95	245	-0.39
	Orlando	38	245	0.16
Outpatient Health Care	Miami	78	735	0.11
	Orlando	84	735	0.11
Small Hotel	Miami	796	245	3.25
	Orlando	802	245	3.27

Addenda k: Networked Guest Room Control System
Revise's definition of "networked guest room control system" and aligns HVAC and lighting timeout periods for guest rooms. Reduced the HVAC timeout period from 30 to 20 minutes to match the 20 minutes timeout period for lighting control. Thus, there are two sets of changes:

- Applied adjustment to the heating and cooling thermostat settings to account for timeout period reduction from 30 to 20 minutes.
- Similar change was made to the ventilation requirements to account for reduction to the time out period.

[8] https://www.energycodes.gov/sites/default/files/documents/20210407_Standard_90.1-2019_Determination_TSD.pdf

This change impacts two prototype buildings: Small and Large Hotels guest room HVAC control requirements.

Annual Energy Saving: Simulation of the two hotel buildings with and without reduced time for thermostat and ventilation control results in significant energy saving. The annual energy saving by fuel type are summarized in Table E-48.

Table E-48 Annual Energy Cost Saving by Building Type of Addenda k

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Small Hotel	Miami	1453	3	1456
	Orlando	1325	11	1336
Large Hotel	Miami	2122	297	2419
	Orlando	1483	753	2236

Investment Cost: No incremental cost is expected for this equipment, but a nominal net installed incremental cost of $20.0, zero incremental annual maintenance, and service life of 12 was assumed for large and small hotel buildings such that a meaningful SIR value is calculated. The Small Hotel has 65% occupancy on average, while the Large Hotel has 58% occupancy.

Cost Benefit Analysis: A nominal incremental first and maintenance was assumed to get a realistic SIR value based on 12 years of service life and annual energy cost saving determined using simulation for the two hotel prototype buildings. Table E-49 summarizes the net present value of the energy cost saving, net present value of investment cost and the saving to investment ratio for the two climate zones and an average for Florida.

Table E-49 Cost-benefit Analysis Results Summary of Addenda k

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Small Hotel	Miami	879.3	19.1	46.2
	Orlando	965.8	19.1	50.7
	Average	944.2	19.1	49.6
Large Hotel	Miami	196.6	19.1	10.3
	Orlando	44.2	19.1	2.3
	Average	115.2	19.1	6.0

Summary: Since there is no investment cost change for reducing timeout period, this code change is recommended for consideration by Florida Building Commission for addition to the 8th Edition (2023) Florida Building Code, Energy Conservation.

Addenda v: Heat Recovery for Space Conditioning in Acute Inpatient Hospitals
Adds a new section 6.5.6.3 containing heat recovery requirements for space conditioning in acute inpatient hospitals. Where hot water is used for space heating, a condenser heat recovery system must be installed, provided all the following are met:

- The building is an acute inpatient hospital, where the building or portion of a building is used on a 24-hour basis for the inpatient medical, obstetric, or surgical care for patients.
- The total design chilled-water capacity for the acute inpatient hospital, either air cooled, or water cooled, required at cooling design conditions exceeds 300 tons of cooling.
- Simultaneous heating and cooling occur above 60°F outdoor air temperature.

The required heat recovery system must have a cooling capacity that is at least 7% of the total design chilled-water capacity of the acute inpatient hospital at peak design conditions.

This code modification impacts the hospital prototype building, and the following changes were applied to model the change:

- Heat recovery chiller was integrated upstream of the main water cooled chiller.
- The heart recovery hot water loop also integrated into the upstream of the reheat and hot water service boiler.
- Annual energy use performance of the hospital prototype building with and without integrated heat recovery chiller was determined for climate zones 1A and 2A.

Annual Energy Saving: Simulation of the hospital prototype building with and without heat recovery chiller resulted in significant hot water heating energy saving and slight net increase in chiller electric energy consumption. The net annual energy saving for the two climate zones are summarized in Table E-50.

Table E-50 Annual Energy Cost Saving by Building Type of Addenda *v*

Prototype Building	City	Electric Energy Saving, kWh	Gas Energy Saving, kWh	Total Energy Saving, kWh
Hospital	Miami	-65,850	1,211,086	1,145,236
	Orlando	-85,864	1,316,500	1,230,636
	Average	-79,977	1,285,496	1,205,518

Investment Cost: Incremental first and installation cost of $45000.0 and an incremental annual maintenance cost of $4500.0, and a service life of 25 were assumed for the cost-effectiveness analysis.

Cost Benefit Analysis: Cost-benefit analysis was determined using the incremental cost and service life assumptions and annual energy cost saving determined using energy models and simulation for the hospital prototype building. Table E-51 summarizes the net present value of the life cycle energy cost saving, net present value of investment cost and the saving to investment ratio (SIR) for the two climate zones and a Florida average.

Table E-51 Cost-benefit Analysis Results Summary of Addenda *v*

Building Type	City	Life Cycle Energy Cost Saving NPV, $	Investment Cost NPV, $	SIR
Hospital	Miami	152,276	103,260	1.47
	Orlando	130,489	103,260	1.26
	Average	136,897	103,260	1.33

Summary: Integrating heat recovery chiller to a chilled water system and the space heating hot water heating system in 24 hours operating large hospital saves significant amount of energy uses. Using the hospital prototype buildings 1,205,518 kWh of net energy saving per year was realized in Florida. The cost benefit analysis over 25 years' service life span yields an average SIR value of 1.33. Therefore, the code modification is cost effective and is recommended for consideration by Florida Building Commission for addition to the 8th Edition (2023) Florida Building Code, Energy Conservation.