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QUANTITATIVE and ECONOMIC ANALYSIS of THE 7th Edition (2020) FLORIDA BUILDING ENERGY CODE

FSEC-CR-2089-20

Interim Report

February 15, 2019

Submitted to

Department of Business and Professional Regulation
Office of Codes and Standards
2601 Blair Stone Road
Tallahassee, FL 32399
Order No. B2CA96

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Executive Summary

This project was initiated because of the state of Florida desire to review provisions of its proposed 2020 Florida Energy Code (FEC) for commercial buildings in order to make a determination if it meets or performs better than ASHRAE 90.1-2016 code. For this purpose the proposed code modifications were reviewed and quantitative analyzed. Two scenarios of the 2020 Florida Energy Code were investigated: approved and proposed code modifications. The FEC code modifications that has energy impact approved for the 2020 FEC are summarized in Appendix-A and additional code modifications that has energy impact submitted as of December 15, 2018 for addition to the 2020 FEC are summarized in Appendix-B. Out of twenty-three approved 2020 FEC commercial code modifications twenty-one were quantitatively investigated. And out of the nine proposed code modifications submitted, seven code modifications pending approval of the Florida Building commission were also investigated. The quantitative analysis was performed by incorporating the approved and proposed code modifications into commercial prototype building energy models and simulating using EnergyPlus, whole building simulation program.

The 2020 FEC performance were investigated using sixteen prototype commercial building energy models. Two sets of the 2020 FEC prototype building energy models were created: one for the approved code, and another set for the approved and the proposed combined code modifications. The approved 2020 FEC prototype building energy models were created by incorporating the approved only code modifications to the 6th edition FEC prototype building energy models. And the "proposed" 2020 FEC prototype building energy models were created by incorporating the approved and proposed combined code changes to the 6th edition FEC prototype building energy models. The analysis compared energy and energy cost performance of the two 2020 FEC prototype building energy models against that of the 2016 ASHRAE 90.1 code energy models. The 2016 ASHRAE 90.1 code prototype buildings energy models were used as reference. Energy models of the 2020 FEC and ASHRAE 90.1-2016 code prototype buildings were simulated for Miami and Orlando, Florida site locations representing climate zones 1A and 2A, respectively. The building energy simulation results were processed to determine the site energy use intensity (EUI) and Energy Cost Index (ECI) values for each of the prototype buildings energy models weighted for climate zones 1A and 2A.

Weighted Florida average annual energy use performance of the approved 2020 FEC prototype buildings underperformed that of ASHRAE 90.1-2016 code showing 2020 FEC without further modifications would fail to meet ASHRAE 90.1-2016. Figure I shows the EUIs of the approved 2020 FEC and ASHRAE 90.1-2016 code of the sixteen prototype buildings. The weighted Florida average site EUI is 46.64 kBtu/ft^2-Yr and 46.50 kBtu/ft^2-Yr for the approved 2020 FEC and the 2016 ASHRAE 90.1 code, respectively. The quantitative analysis conducted using the approved only code modification demonstrates that the approved 2020 FEC underperforms energy efficiency requirements of ASHRAE 90.1-2016 code by about 0.29 percent.

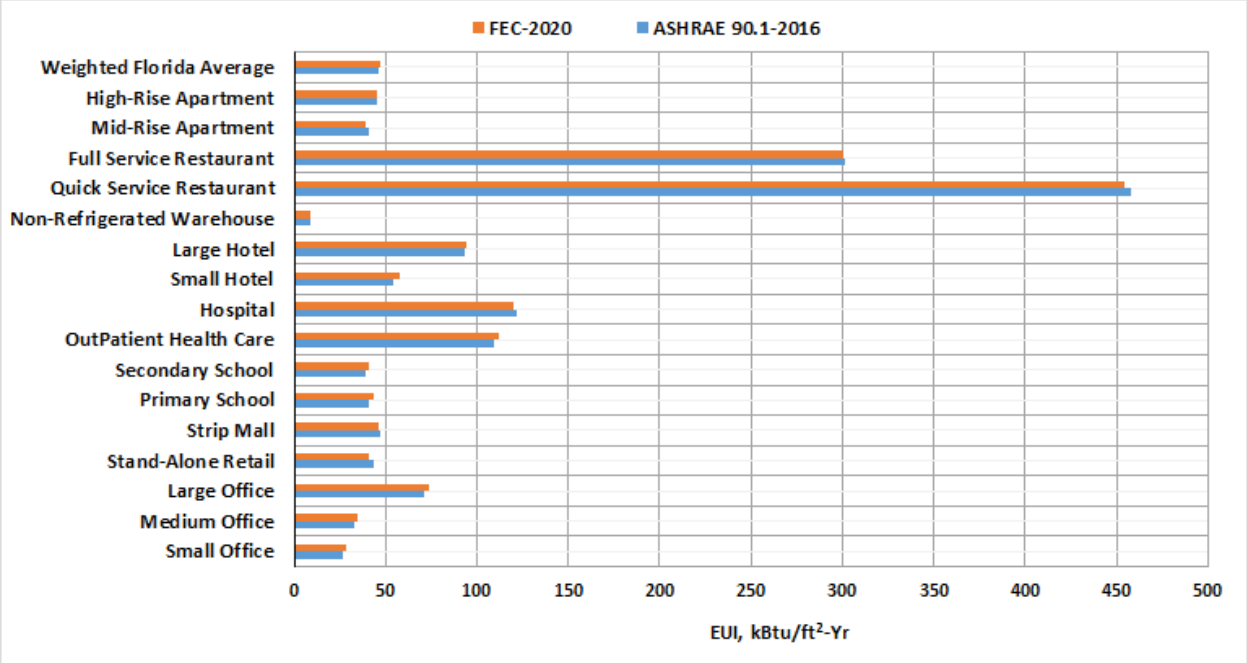

Figure I Annual Energy Use Intensity of the Approved 2020 FEC by Prototype Building

By adding in the proposed modifications, the weighted Florida average annual energy use and operating total energy cost of the "proposed" 2020 FEC prototype buildings is less than ASHRAE 90.1-2016 code. Ten out of sixteen "proposed" 2020 FEC prototype buildings, which represent 72.0% of the commercial buildings stock total floor area, performed better than ASHRAE 90.1-2016 code performance. The remaining six prototype buildings energy models slightly underperformed the 2016 ASHRAE 90.1 code. The primary reason these six "proposed" 2020 FEC prototype buildings underperformed the ASHRAE 90.1-2016 code is that the latter has advanced automatic receptacle and secondary sidelight area control functions that are not required in the 2020 FEC code. However, based on the Florida average EUI and ECI weighted across the sixteen prototype commercial buildings, the "proposed" 2020 FEC performed better than that of ASHRAE 90.1-2016 code.

Figure II shows the EUIs of the "proposed" 2020 FEC and ASHRAE 90.1-2016 code by prototype buildings. The weighted Florida average site EUI is 45.70 kBtu/ft^2-Yr and 46.50 kBtu/ft^2-Yr for the "proposed" 2020 FEC and the 2016 ASHRAE 90.1 code, respectively. The "proposed" 2020 FEC weighted Florida average energy use performed better by about 1.73 percent. Figure III shows the annual operating total energy cost index by prototype building. The weighted Florida average annual total energy cost index of "proposed" 2020 FEC commercial building is lower than that of the 2016 ASHAE 90.1 code building by about 1.92 percent. The quantitative analysis demonstrates that energy efficiency of a commercial building constructed in accordance with the "proposed" 2020 FEC is better than that of ASHRAE 90.1-2016 code. The study recommends five additional code modification submitted that have significant impact be considered for approval by Florida Building Commission.

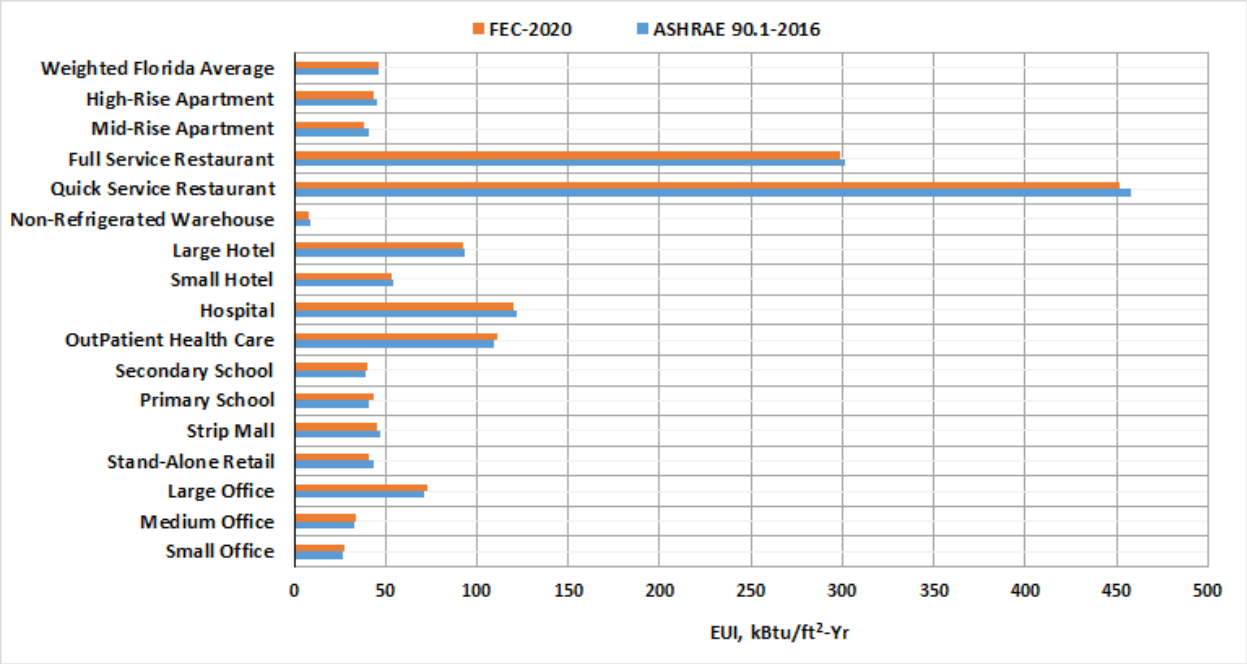

Figure II Annual Energy Use Intensity of the "Proposed" 2020 FEC by Prototype Building

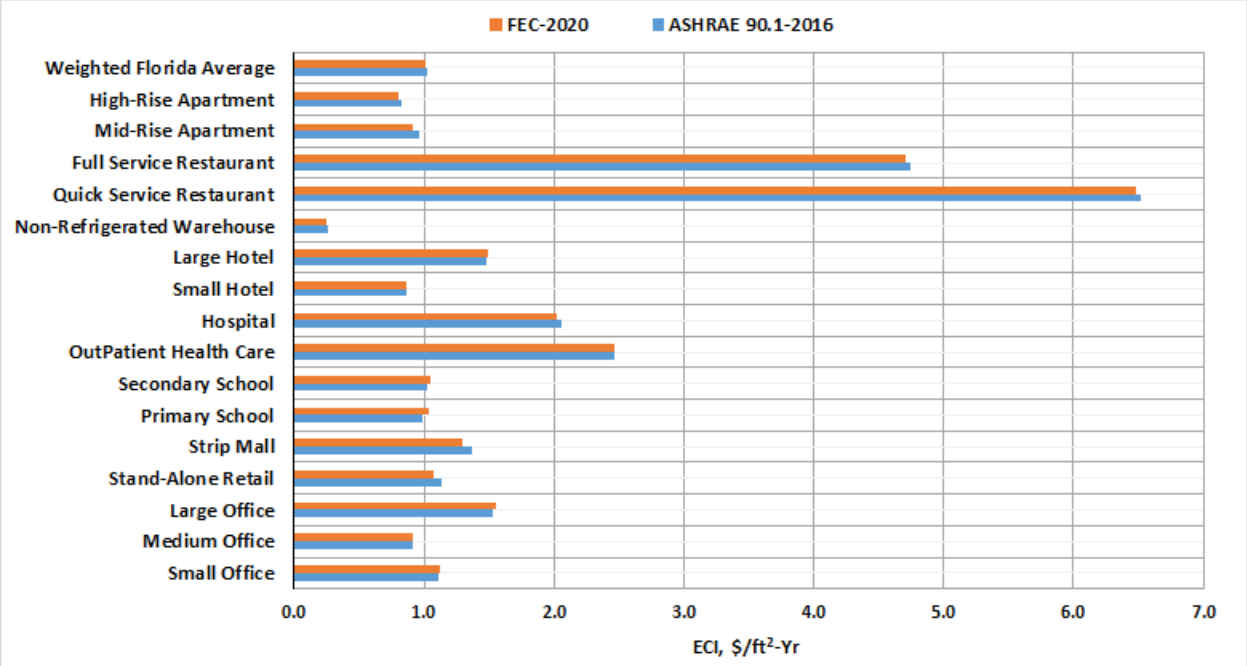

Figure III Annual Total Energy Cost Index of the "Proposed" 2020 FEC by Prototype Building

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. The authors would like to thank Mr. Robin Vieira, Director of Buildings Research at Florida Solar Energy Center, for reviewing the report and providing constructive feedback.

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 use intensity, kBtu/(ft^2-yr)
FEC	Florida Commercial Energy Code
FEC-2020	2020 Florida Energy Code
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 building

Simulation Prototype Terminology

approved 2020 FEC A building input designed to simulate the baseline and changes approved by the Florida Building Commission as of October 31, 2018 for the 2020 (seventh edition) Florida Building Code, Energy Conservation.

"proposed" 2020 FEC A building input designed to simulate the approved 2020 FEC and those proposals that could be quantified (See Appendix-B) that had been submitted to the Florida Building Commission as of December 15, 2018 for the 2020 (seventh edition) Florida Building Code, Energy Conservation.

ASHRAE 90.1-2016 A building input designed to simulate the ASHRAE 90.1-2016 standard.

Contents

List of Figures

List of Tables

1. Introduction

The state of Florida desires to review provisions of its proposed 2020 (7th Edition) commercial buildings energy code in order to make a determination if it meets or performs better than the 2016 ASHRAE 90.1 code. This report summarizes the analysis performed and the evaluation carried out to make determination whether the 2020 Florida Energy Code meets or performs better than ASHRAE 90.1-2016 code. Summary of the tasks performed include:

- Reviewed all approved and proposed code modifications as of December 15, 2018 to Florida base energy code and evaluated the modified code against provisions of the 6th Edition FEC to make assessment for quantitative analysis.
- Reviewed the sixteen the 2015 IECC prototype commercial building energy models originally created by PNNL (DOE, 2018) and later modified by FSEC for the 6th Edition (2017) FEC.
- Starting with these models we updated input assumptions and created the 2020 FEC equivalent prototype building energy models for climate zones 1A and 2A. Two sets of the 2020 FEC prototype building energy models were created: one based on the approved only code changes, and another based on the approved and proposed combined code modifications. The code modifications analysis covered: Building Envelope, Building Mechanical Systems, Service Water Heating, and Electric Power and Lighting sections of the Florida commercial energy code. The analysis effort requires identifying how best to represent the code modification in the prototype building models, perform sizing calculations, and identifying and updating the various minimum efficiency requirements. This step was repeated for each of the approved and proposed code modifications, the sixteen prototype buildings and the two climate zones.
- Obtained the latest DOE ASHRAE 90.1-2016 sixteen reference prototype buildings model decks for climate zones 1A and 2A (DOE, 2018). Modified the climate zone 2A building energy models site location to Orlando, Florida and updated climate and location dependent model parameters. The ASHRAE 90.1-2016 and 2020 FEC prototype buildings energy models were transitioned to EnergyPlus version 8.6 and 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, for the approved only, and the approved and proposed combined code modifications scenarios. The EUIs and ECIs of the prototype buildings were weighed by Florida climate zones floor area weighting factors and aggregated across the sixteen commercial buildings to determine weighted Florida average site EUI for commercial sector. Made determination whether the performance of the 2020 FEC code meets or performs better than ASHRAE 90.1-2016 code by comparing the EUIs and ECIs of the prototype building models. Provided summary of the results and recommendation based on the approved only and proposed 2020 FEC scenarios.
- Conducted preliminary assessment to identify the proposed commercial building code modifications as part of the cost benefit analysis.

2. The 2020 Florida Energy Code Modification

The approved and proposed 2020 Florida Energy Code modifications to the base code, which is the 6th Edition (2017) Florida Energy Code, were reviewed. The list of approved and proposed 2020 FEC code modifications with energy impact along with brief description of the code modifications are provided in Appendix-A and Appendix-B. The total code modifications count for the 2020 FEC with energy impact by the commercial building energy code are summarized in Table 1. Out of the thirty-two code modifications with energy impact, twenty-eight were quantitative analyzed using the sixteen commercial prototype building energy models. Building mechanical system and electric power and lighting sections of code modifications cover 90.6% of the 2020 FEC total code changes investigated while the remaining 9.4% represent building envelope and service water heating. Two scenarios of code modifications were investigated: approved 2020 FEC commercial code modifications only; and proponent proposed modifications from ICC 2018 that were pending approval by the Florida Building Commission.

Table 1 Number of Code Modifications with Energy Impact in the Proposed 2020 FEC

Commercial Code Section	Code Changes Count	Code Changes Percent, %
Section C402 Building Envelope	2	6.25
Section C403 Building Mechanical Systems	12	27.50
Section C404 Service Water Heating	1	3.12
Section C405 Electric Power and Lighting	14	53.13
Total	32	100

3. Florida Climate Zones

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.

4. Quantitative Analysis of the 2020 Florida Energy Code Performance

The quantitative analysis determined and compared annual total energy use intensity (EUI) and annual Energy Cost Index (ECI) by prototype building type and weighted Florida average. Sixteen commercial prototype buildings type were used to represent the Florida commercial buildings total floor area stock. The annual energy use and energy cost comparison was made between prototype buildings energy model designed with the approved and "proposed" 2020 FEC against the 2016 ASHRAE 90.1 code energy models. The approved 2020 FEC prototype building energy models were created from the 6th Edition (2017) FEC prototype energy models and the approved code modifications. The "proposed" 2020 FEC prototype building energy models were created from the 6th Edition (2017) FEC prototype energy models and the approved and the proposed combined code modifications. The proposed code modifications are those code changes submitted for addition to the 2020 FEC but pending approval by Florida Building Commission. The 2016 ASHRAE 90.1 code prototype building energy models were DOE reference prototype building energy model decks published by Pacific Northwest National Laboratory (PNNL) (DOE, 2018). The DOE reference prototype building energy models were also modified for this study to account for site location and site location dependent parameters such as site water mains temperature, and ground temperature. The sixteen prototype commercial buildings energy models of the 2020 FEC and the 2016 ASHRAE 90.1 code were simulated for Miami and Orlando site locations. Finally, EUI and ECI of the prototype building energy models designed with 2020 FEC and ASHRAE 90.1-2016 code were determined and evaluated. The EUI and ECI percent difference between the 2020 FEC and ASHRAE 90.1-2016 code were calculated as follows:

$$\Delta X = 100 \cdot \frac{X_{\text{ASHRAE 90.1–2016}} - X_{\text{FLORIDA–2020}}}{X_{\text{ASHRAE 90.1–2016}}}$$

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 sixteen commercial prototype buildings using weighting factors that account for the prototypes floor area distribution by climate zones and prototype building.

4.1 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 2 represent the commercial buildings stock floor area and floor area distribution by prototype building in the State of Florida.

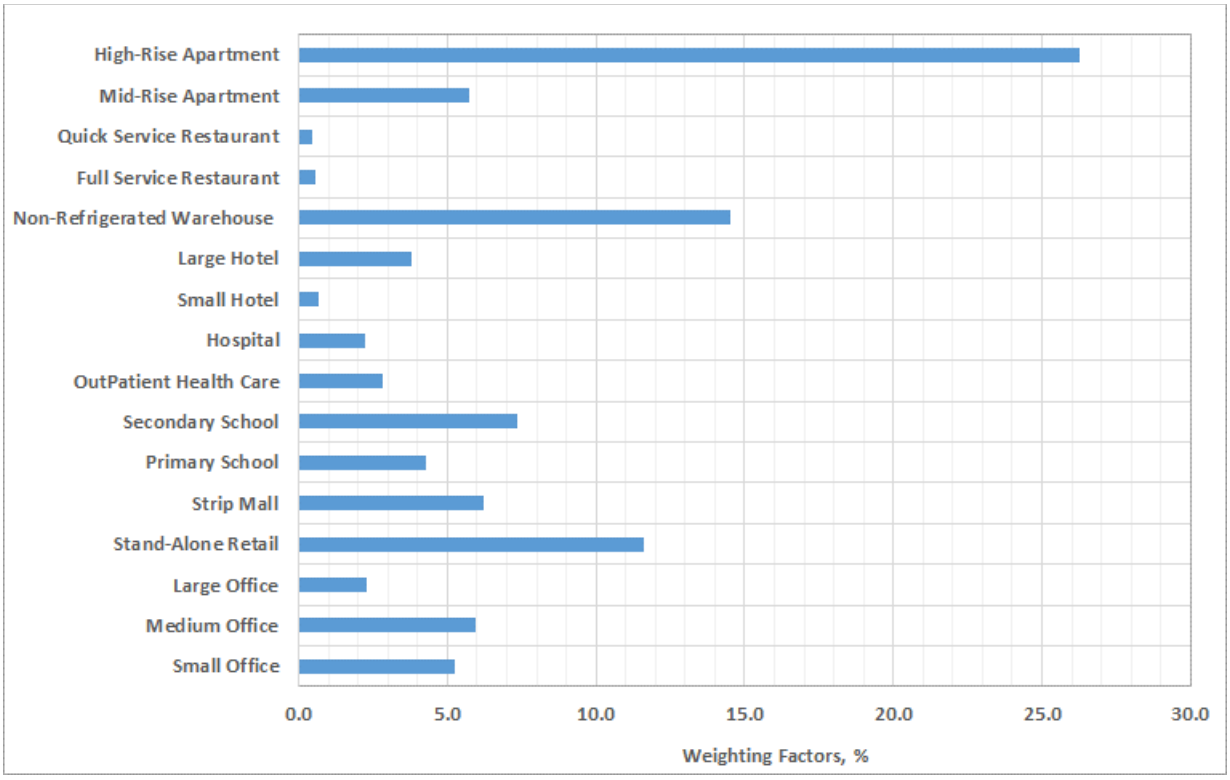

Figure 1 Commercial Prototype Buildings Type and Floor Area Distribution in Florida

The 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 2 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	Non-Refrigerated Warehouse	52,045	104,327	14.50
Food Service	Full Service Restaurant	2,501	4,003	0.56
	Quick Service Restaurant	5,502	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

4.2 Annual Energy Use of Approved 2020 Florida Energy Code

The approved 2020 FEC refers to already approved only code modification to the base code, which is the 6th Edition (2017) FEC. Approved 2020 FEC code modifications that were quantitatively investigated are summarized in Appendix-A. The building energy use performance of the approved 2020 FEC were determined by comparing the site Energy Use Intensity (EUI) against ASHRAE 90.1-2016 code by prototype buildings and weighted Florida average. The site energy use intensity (EUI) of each of the prototype buildings type were aggregated by Florida climate zone floor area weighing factors to determine the EUI by prototype building type for the approved code changes only. Figure 2 shows the EUIs of the commercial prototype buildings designed with the approved 2020 FEC and ASHRAE 90.1-2016 code in the State of Florida. The weighted Florida average site EUI for the commercial sector was determined to be 46.64 kBtu/ft2-Yr and 46.50 kBtu/ft2-Yr for the approved 2020 FEC and the 2016 ASHRAE 90.1 code, respectively.

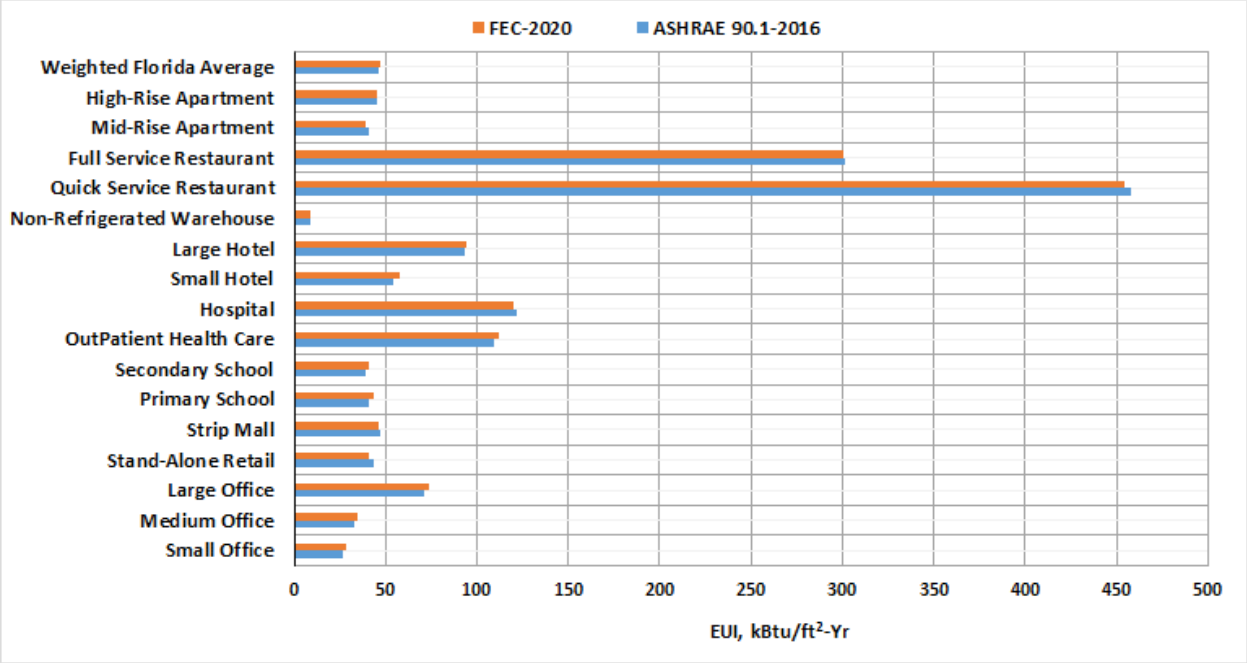

Figure 2 Site Energy Use Intensity for the Approved 2020 FEC by Prototype Building

Figure 3 shows the site EUI difference between the approved 2020 FEC and ASHRAE 90.1-2016 code by the prototype buildings. Also Table 3 summarizes the EUIs of the approved 2020 FEC and the 2016 ASHRAE 90.1 code by prototype buildings and the weighted Florida average. Seven out of the sixteen prototype buildings energy models designed with the approved 2020 FEC have EUIs less than that of ASHRAE 90.1-2016 code whereas the remaining nine prototype buildings energy models have higher EUI values. Based on the Florida weighed average the approved 2020 FEC underperforms the 2016 ASHRAE 90.1 code by about 0.29%.

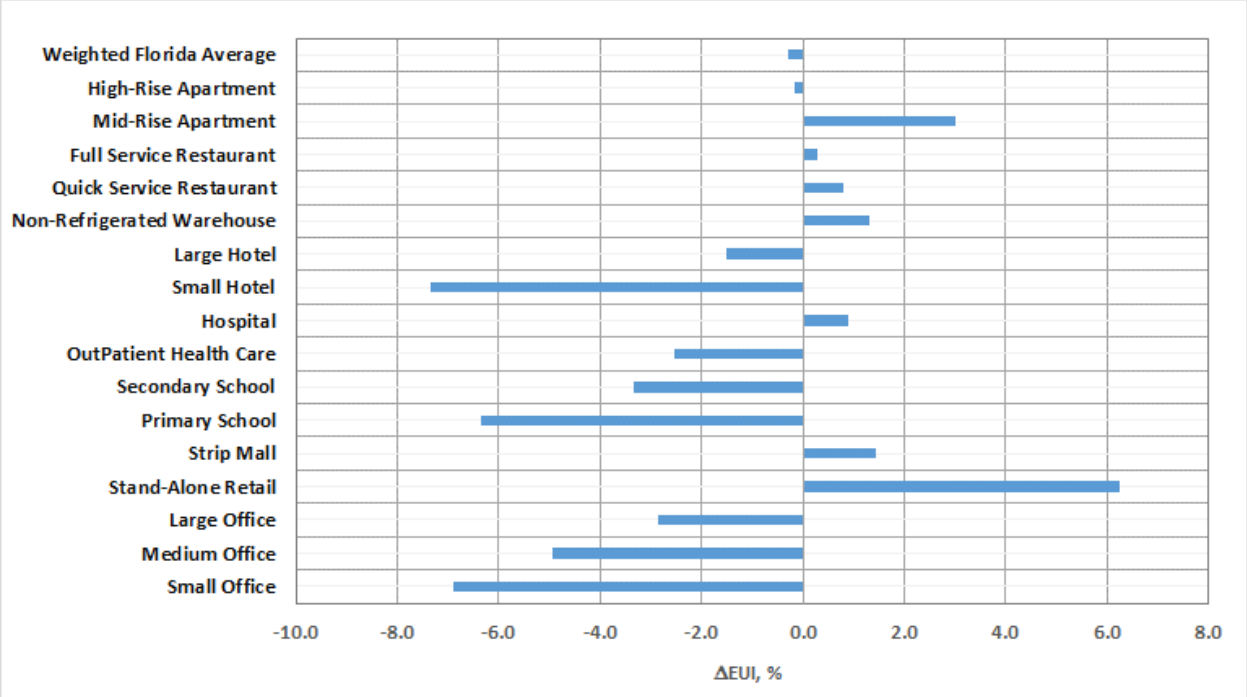

Figure 3 Site Energy Use Intensity Difference by Prototype Building of the Approved 2020 FEC

Table 3 Site Energy Use Intensity for the approved 2020 FEC by Prototype Building

Building Type	Weighting Factors, %	ASHRAE 90.1-2016 EUI, kBtu/ft^2-yr	FEC-2020 EUI, kBtu/ft^2-yr	ΔEUI, %
Small Office	5.27	26.44	28.27	-6.90
Medium Office	5.94	32.92	34.54	-4.94
Large Office	2.30	71.31	73.35	-2.86
Stand-Alone Retail	11.60	43.64	40.91	6.26
Strip Mall	6.21	47.23	46.55	1.44
Primary School	4.28	41.18	43.79	-6.34
Secondary School	7.33	39.13	40.45	-3.35
Outpatient Health Care	2.83	109.47	112.25	-2.54
Hospital	2.25	121.33	120.24	0.90
Small Hotel	0.65	53.77	57.71	-7.33
Large Hotel	3.81	93.03	94.42	-1.50
Non-Refrigerated Warehouse	14.50	8.93	8.81	1.32
Full Service Restaurant	0.56	457.87	454.20	0.80
Quick Service Restaurant	0.46	301.52	300.72	0.27
Mid-Rise Apartment	5.75	40.43	39.21	3.01
High-Rise Apartment	26.25	44.81	44.88	-0.17
Weighted Florida Average	100.00	46.50	46.64	-0.29

The weighted Florida average annual energy use performance determined based on the approved 2020 FEC indicates that additional code modifications are required to make the 2020 FEC perform better than that of the 2016 ASHRAE 90.1 code. In this regard, the additional proposed code changes with energy impact pending approval by the Florida Building Commission were investigated as described in Section 4.4.

4.3 Energy Cost Index of the Approved 2020 Florida Energy Code

In addition to energy use performance comparison, the total annual Energy Cost Index (ECI) of the approved 2020 FEC was determined and compared against ASHRAE 90.1-2016 code by prototype buildings. The Energy Cost Indices (ECIs) of each of the prototype buildings were weighed by Florida climate zones weighting factors to determine the ECI by a prototype building. Figure 4 shows the ECI for commercial prototype buildings designed with the approved 2020 FEC and ASHRAE 90.1-2016 code in the State of Florida.

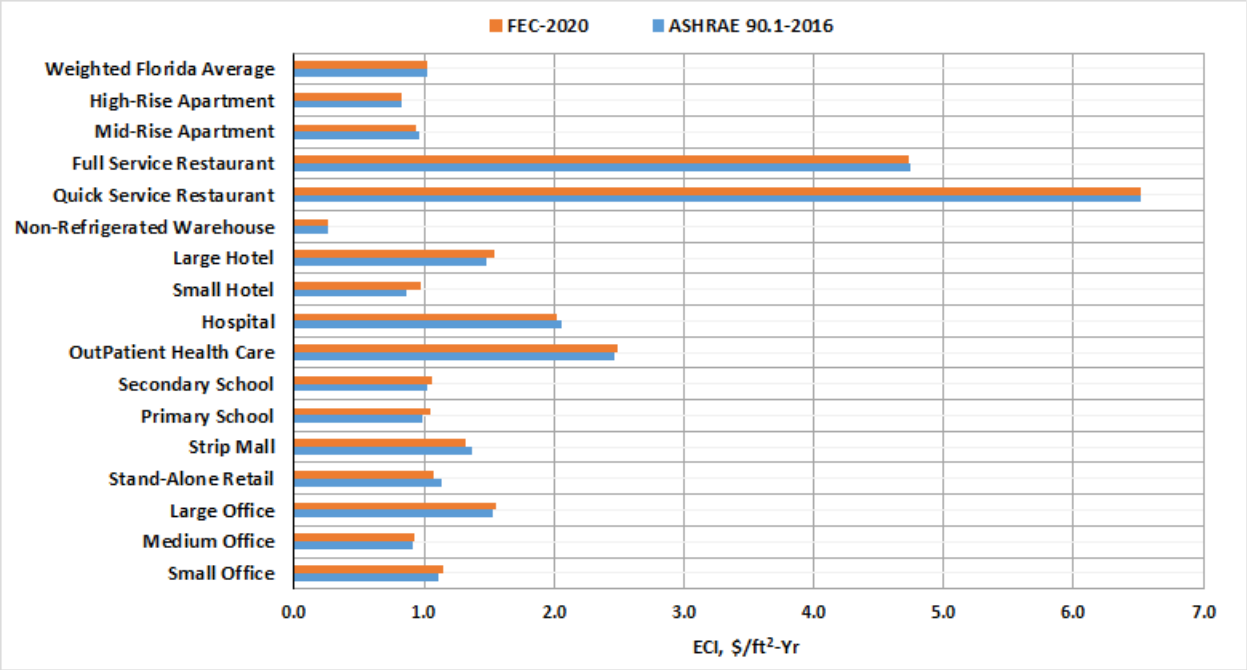

Figure 4 Energy Cost Index for the Approved 2020 FEC by Prototype Building

The weighted Florida average ECI for the commercial sector was estimated to be 1.025 $/ft^2-Yr and 1.027 $/ft^2-Yr for the approved 2020 FEC and the 2016 ASHRAE 90.1 code, respectively. Table 4 summarizes the annual ECI's of the approved 2020 FEC and the 2016 ASHRAE 90.1 prototype building models including the percent differences. The approved 2020 FEC weighted Florida average annual operating total energy cost index (ECI) is lower by about 0.24%. That is the weighted Florida average energy cost performance for the commercial sector slightly surpasses that of the 2016 ASHRAE 90.1 code, by about 0.24%. The approved 2020 FEC total energy cost shows slightly better performance than that of total annual energy use is results of

in part due to difference in energy rates by fuel type as well as total energy cost includes demand charge for this analysis. Nevertheless, the energy and energy cost differences determined between the approved 2020 FEC and the 2016 ASHRAE 90.1 code were within the margin of error of prototype building model assumption. Additional proposed code changes investigation is warranted to demonstrate a clear performance difference between the 2020 FEC and the 2016 ASHRAE 90.1 code. Section 4.4 of this report describes energy use and total energy cost impact of proposed code modification in addition to the already approved 2020 FEC.

Table 4 Energy Cost Index for the Approved 2020 FEC by Prototype Building

Building Type	Weighting Factors, %	ASHRAE 90.1-2016 ECI, $/ft^2-yr	FEC-2020 ECI, $/ft^2-yr	ΔECI, %
Small Office	5.27	1.112	1.145	-2.90
Medium Office	5.94	0.909	0.922	-1.44
Large Office	2.30	1.524	1.555	-2.05
Stand-Alone Retail	11.60	1.140	1.074	5.79
Strip Mall	6.21	1.371	1.317	3.90
Primary School	4.28	0.981	1.051	-7.13
Secondary School	7.33	1.021	1.056	-3.52
Outpatient Health Care	2.83	2.459	2.487	-1.13
Hospital	2.25	2.064	2.025	1.88
Small Hotel	0.65	0.868	0.958	-10.37
Large Hotel	3.81	1.483	1.528	-3.06
Non-Refrigerated Warehouse	14.50	0.264	0.254	3.79
Full Service Restaurant	0.56	6.514	6.514	0.00
Quick Service Restaurant	0.46	4.745	4.732	0.27
Mid-Rise Apartment	5.75	0.957	0.935	2.30
High-Rise Apartment	26.25	0.827	0.828	-0.12
Weighted Florida Average	100.00	1.027	1.024	0.24

4.4 Annual Energy Use of the Proposed 2020 Florida Energy Code

The "proposed" 2020 FEC investigated represents twenty-one code modifications that were already approved and seven proposed for addition to the 2020 FEC pending approval by the Florida Building Commission. The twenty-one code modifications approved as of October 31, 2018 for addition to the 2020 FEC are summarized in Appendix-A and the seven proposed code modification submitted as of December 15, 2018 for addition to the 2020 FEC pending approval by the Florida Building Commission are summarized in Appendix-B. The building energy use performance of the "proposed" 2020 FEC were determined by comparing the site Energy Use Intensity (EUI) against ASHRAE 90.1-2016 code by prototype building models. The EUI of each of the prototype buildings for each climate zones were aggregated by Florida climate zone floor area weighing factors to determine the EUI by prototype building. Figure 5 shows the EUIs for the commercial prototype buildings designed with the proposed 2020 FEC and ASHRAE 90.1-2016 code in the State of Florida. The weighted Florida average site EUI for the commercial sector was determined to be 45.70 kBtu/ft^2-Yr and 46.50 kBtu/ft^2-Yr for the "proposed" 2020 FEC and the 2016 ASHRAE 90.1 code, respectively. The weighted Florida average site EUI was determined from the sixteen commercial prototype buildings EUIs using weighting factors that account for the prototypes floor area distribution by climate zones and prototype building.

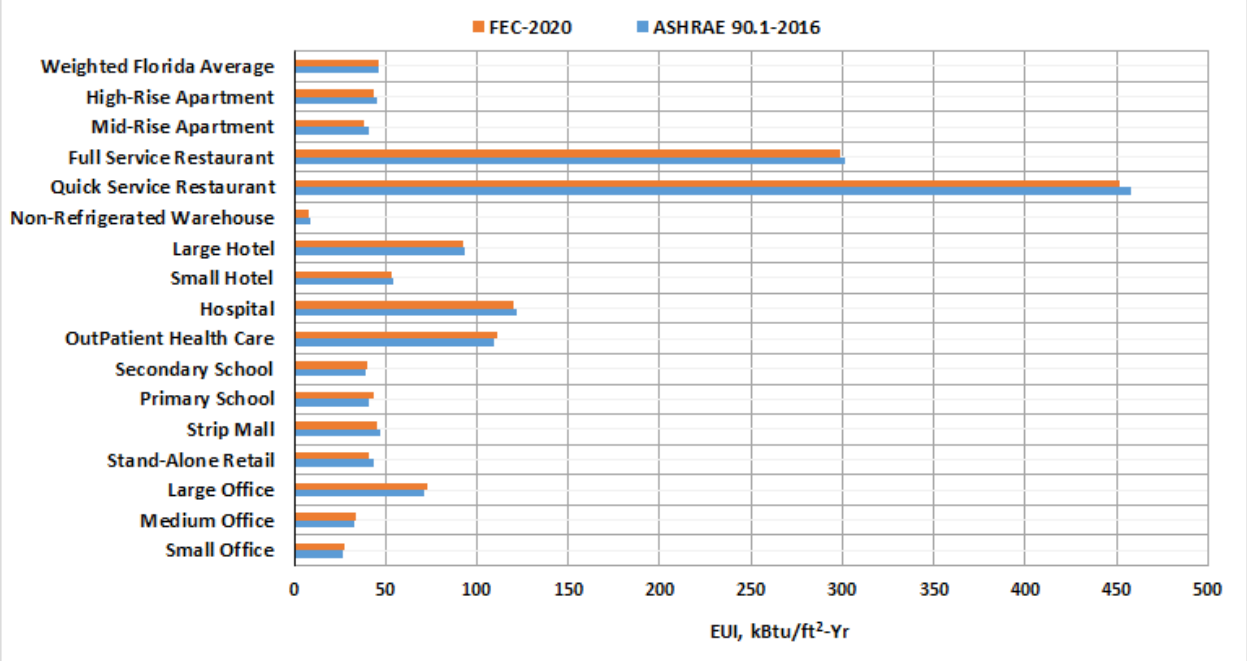

Figure 5 Site Energy Use Intensity for the "Proposed" 2020 FEC by Prototype Building

Figure 6 shows the site EUI difference between the "proposed" 2020 FEC and ASHRAE 90.1-2016 code by the prototype buildings. Also Table 5 summarizes the EUIs of the "proposed" 2020 FEC and the 2016 ASHRAE 90.1 code by prototype buildings.

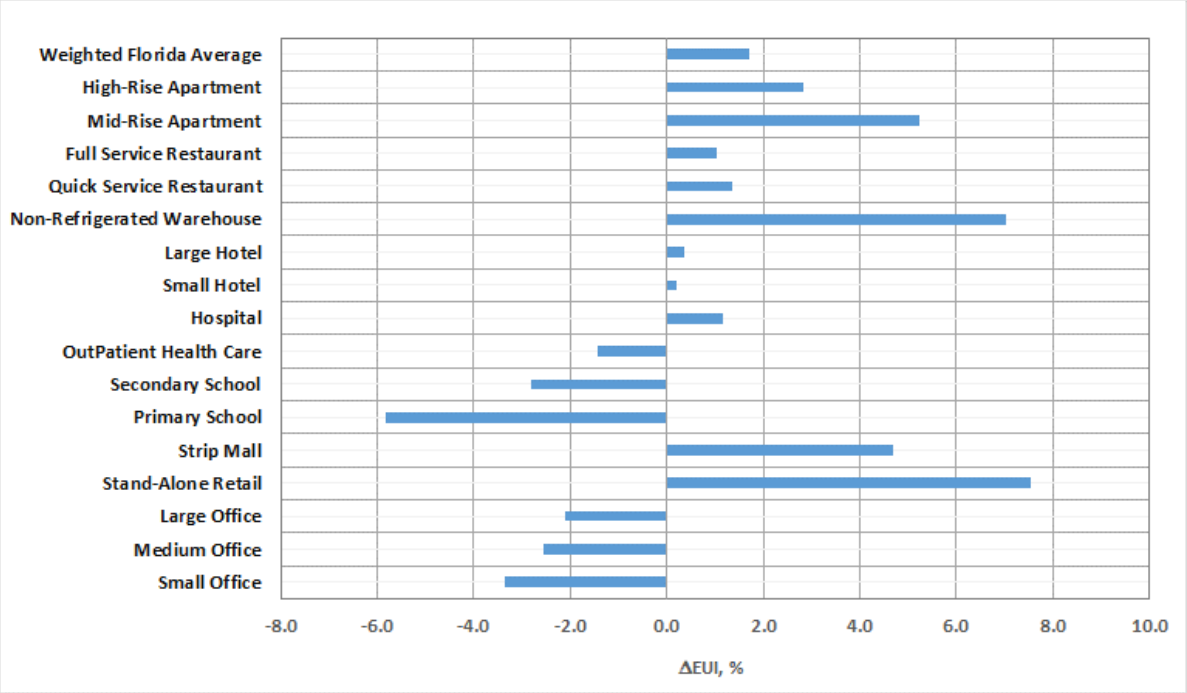

Figure 6 Site Energy Use Intensity Difference by Prototype Building of the "Proposed" 2020 FEC

Table 5 Site Energy Use Intensity for the "Proposed" 2020 FEC by Prototype Building

Building Type	Weighting Factors, %	ASHRAE 90.1-2016 EUI, kBtu/ft^2-yr	FEC-2020 EUI, kBtu/ft^2-yr	ΔEUI, %
Small Office	5.27	26.44	27.33	-3.35
Medium Office	5.94	32.91	33.75	-2.54
Large Office	2.30	71.31	72.80	-2.10
Stand-Alone Retail	11.60	43.64	40.35	7.55
Strip Mall	6.21	47.23	45.02	4.68
Primary School	4.28	41.18	43.57	-5.82
Secondary School	7.33	39.13	40.24	-2.82
Outpatient Health Care	2.83	109.47	111.04	-1.43
Hospital	2.25	121.33	119.94	1.15
Small Hotel	0.65	53.77	53.65	0.21
Large Hotel	3.81	93.03	92.68	0.37
Non-Refrigerated Warehouse	14.50	8.93	8.30	7.03
Full Service Restaurant	0.56	457.87	451.76	1.34
Quick Service Restaurant	0.46	301.52	298.35	1.05
Mid-Rise Apartment	5.75	40.43	38.17	5.58
High-Rise Apartment	26.25	44.81	43.54	2.82
Weighted Florida Average	100.00	46.50	45.70	1.73

Ten out of the sixteen prototype buildings energy models designed with the "proposed" 2020 Florida code have EUIs less than that of ASHRAE 90.1-2016 code buildings. The remaining six prototype buildings slightly underperformed the 2016 ASHRAE 90.1 code. Table 6 summarizes the six "proposed" 2020 FEC prototype buildings energy models underperformed the 2016 ASHRAE 90.1 code. These six prototype buildings underperformed primarily due to absence of one or two of advanced control function in the 2020 FEC. The advanced control functions that are required in ASHRAE 90.1-2016 code but not in the 2020 FEC include: (1) Automatic Receptacle Control (ASHRAE 90.1-2016, Section 8.4.2), and (2) Secondary Sidelight Area Control (ASHRAE 90.1-2016, Section 9.4.1.1). One or more of the advanced control functions were applied to the six ASHRAE 90.1-2016 prototype buildings are not applicable to the 2020 FEC prototype building energy models.

Table 6 Underperformed "Proposed" 2020 FEC Prototype Buildings

Building Type	**Weighting Factors, %**	**ASHRAE 90.1-2016 EUI, kBtu/ft^2-yr**	**FEC-2020 EUI, kBtu/ft^2-yr**	**ΔEUI, %**
Small Office	5.27	26.44	27.33	-3.35
Medium Office	5.94	32.91	33.75	-2.54
Large Office	2.30	71.31	72.8	-2.10
Primary School	4.28	41.18	43.57	-5.82
Secondary School	7.33	39.13	40.24	-2.82
Outpatient Health Care	2.83	109.47	111.04	-1.43

ASHRAE 90.1-2016 code requires automatic receptacle control in spaces types such as private offices, conference rooms, printing and copying rooms, classrooms, break rooms, and private work station (ASHRAE, 2016). The Office, and Education building types designed for ASHRAE 90.1-2016 code have automatic receptacle control. Automatic receptacle control in ASHRAE 90.1-2016 code buildings energy models were accounted for using reduced plug load schedules. In addition to the automatic receptacle control, ASHRAE 90.1-2016 Section 9.4.1.1 allows secondary sidelight area control, which is not a requirement in the 2020 FEC. However, the "proposed" 2020 FEC prototype building energy models weighted Florida average EUI, which is an aggregate across the sixteen commercial buildings and the two Florida climate zones, is lower than that of ASHRAE 90.1-2016 code by about 1.73%. Implying, the "proposed" 2020 FEC energy efficiency is slightly better than that of the 2016 ASHRAE 90.1 code.

4.5 Energy Cost Index of the Proposed 2020 Florida Energy Code

In addition to energy use performance comparison, the total annual Energy Cost Index (ECI) of the "proposed" 2020 FEC prototype building energy models were compared against that of ASHRAE 90.1-2016 code. The Energy Cost Indices (ECIs) of each of the prototype buildings were weighed by Florida climate zones weighting factors to determine the ECI by prototype building. Figure 7 shows the ECI for commercial prototype buildings designed with the 2020 FEC and ASHRAE 90.1-2016 code in the State of Florida. The weighted 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 weighted Florida average ECI for the commercial sector was estimated to be 1.007 $/ft^2-Yr and 1.027 $/ft^2-Yr for the "proposed" 2020 FEC and the 2016 ASHRAE 90.1 code, respectively.

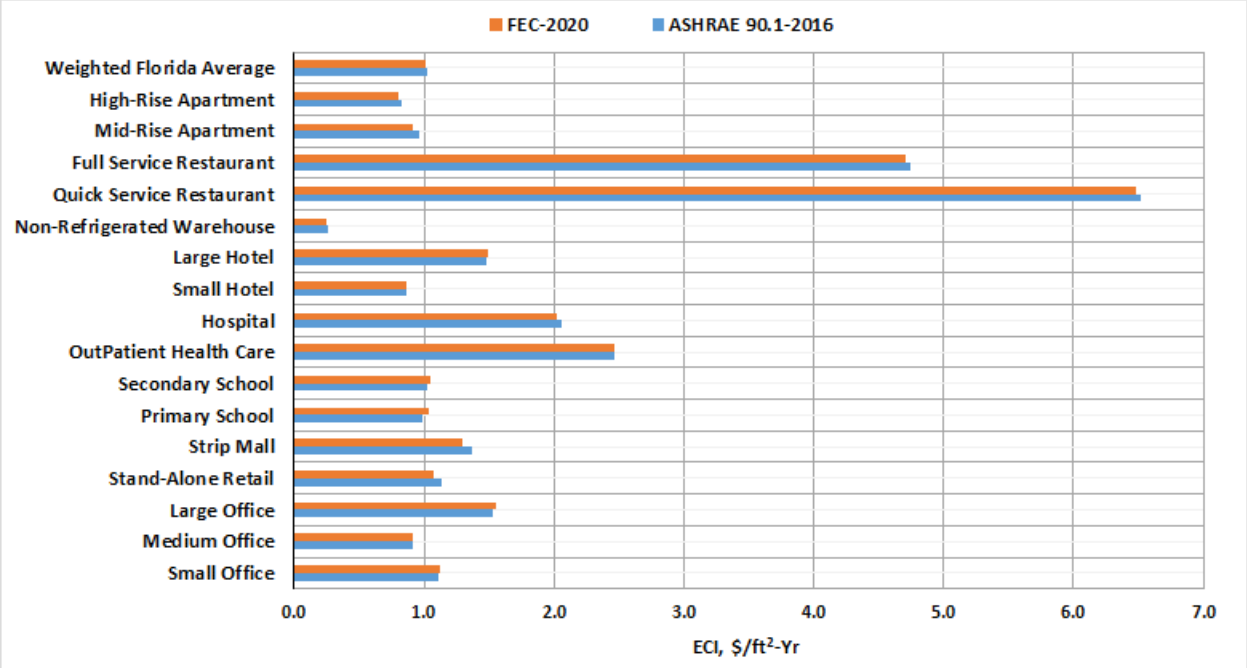

Figure 7 Energy Cost Index for the "Proposed" 2020 FEC by Prototype Building

Table 7 summarizes the annual ECI's of the "proposed" 2020 FEC and the 2016 ASHRAE 90.1 prototype building models including the percent differences. The "proposed" 2020 FEC weighted Florida average annual operating energy cost index (ECI), which is an aggregate of the sixteen commercial prototype buildings for the state of Florida, is lower by about 1.92%.

Table 7 Energy Cost Index for the "Proposed" 2020 FEC by Prototype Building

Building Type	Weighting Factors, %	ASHRAE 90.1-2016 ECI, $/ft^2-yr	FEC-2020 ECI, $/ft^2-yr	ΔECI, %
Small Office	5.27	1.112	1.127	-1.30
Medium Office	5.94	0.909	0.912	-0.34
Large Office	2.30	1.524	1.551	-1.80
Stand-Alone Retail	11.60	1.140	1.068	6.32
Strip Mall	6.21	1.371	1.297	5.36
Primary School	4.28	0.981	1.041	-6.11
Secondary School	7.33	1.021	1.051	-2.94
Outpatient Health Care	2.83	2.459	2.469	-0.41
Hospital	2.25	2.064	2.015	2.37
Small Hotel	0.65	0.868	0.858	1.15
Large Hotel	3.81	1.483	1.488	-0.36
Non-Refrigerated Warehouse	14.50	0.264	0.250	5.22
Full Service Restaurant	0.56	6.514	6.484	0.46
Quick Service Restaurant	0.46	4.745	4.702	0.90
Mid-Rise Apartment	5.75	0.957	0.915	4.39
High-Rise Apartment	26.25	0.827	0.798	3.51
Weighted Florida Average	100.00	1.027	1.007	1.92

4.6 Proposed 2020 Florida Energy Code Energy Impact

The proposed commercial code modification for addition to the 2020 FEC pending approval by the Florida Building Commission were analyzed incrementally. The weighted Florida average annual energy use intensity due to addition of each the proposed code modifications were quantified. Table 8 summarizes the proposed 2020 FEC pending approval by Florida Building Commission. Only seven out of these nine proposed code modifications were quantitatively analyzed.

Table 8 Proposed Code Modifications to the 2020 FEC Pending Approval

Code Mod #	Code Section # and Brief Description of Proposed Code Modifications
EN7318	C405.2.4 Specific application control
EN7536	C403.7.6 Automatic control of HVAC systems serving guest rooms
EN7526	Tables C405.4.2(2) and C405.4.2 (3) Exterior Lighting Power Allowance
EN7515	C402.5.6 Loading dock weatherseals
EN7523	C403.4.1.4 Heated or cooled vestibules
EN7503	C405.2.5.3 Lighting setback (Exterior Lights)
EN7533	C403.2.4.2.3 Automatic start capability of HVAC system
EN7499	C402.4.1.2 Increasing skylight area with daylighting Control
EN7558	C403.7.7 Shutoff dampers

The annual energy use impacts of each of the seven proposed commercial code modifications were predicted and compared against that of the approved only 2020 FEC and the 2016 ASHRAE 90.1 code. Figure 8 show the weighted Florida average EUI for the 2016 ASHRAE 90.1 code, the approved 2020 FEC, the "proposed" 2020 FEC, and incremental impacts of each of the seven proposed commercial code modifications pending approval. It is evident that the approved 2020 FEC weighted Florida average EUI slightly underperforms the 2016 ASHRAE 90.1 code. This diagram also shows incremental impact of each of the seven proposed code modifications on the weighted Florida average EUIs performance of the 2020 FEC. Among the seven proposed code modifications, EN7533 and EF7515 had lower annual energy use saving potential. The EN7515 code modification applies to the warehouse prototype building only, and the infiltration rate reduction allowed due to loading dock weatherseals code change is small compared to other infiltration rates in the model; hence, energy saving potential of code change EN7515 is almost negligible. Code modification EN7533, which is optimal HVAC start control, energy saving impact is small because of an overlap with an existing 6th Edition (2017) Florida Energy Code, Section C403.2.4.2. Otherwise, the other five proposed code modifications EN7318, EN7536, EN7526, EN7523, and EN7503 are strongly recommended for consideration for approval by the Florida Building Commission for addition to the 2020 FEC.

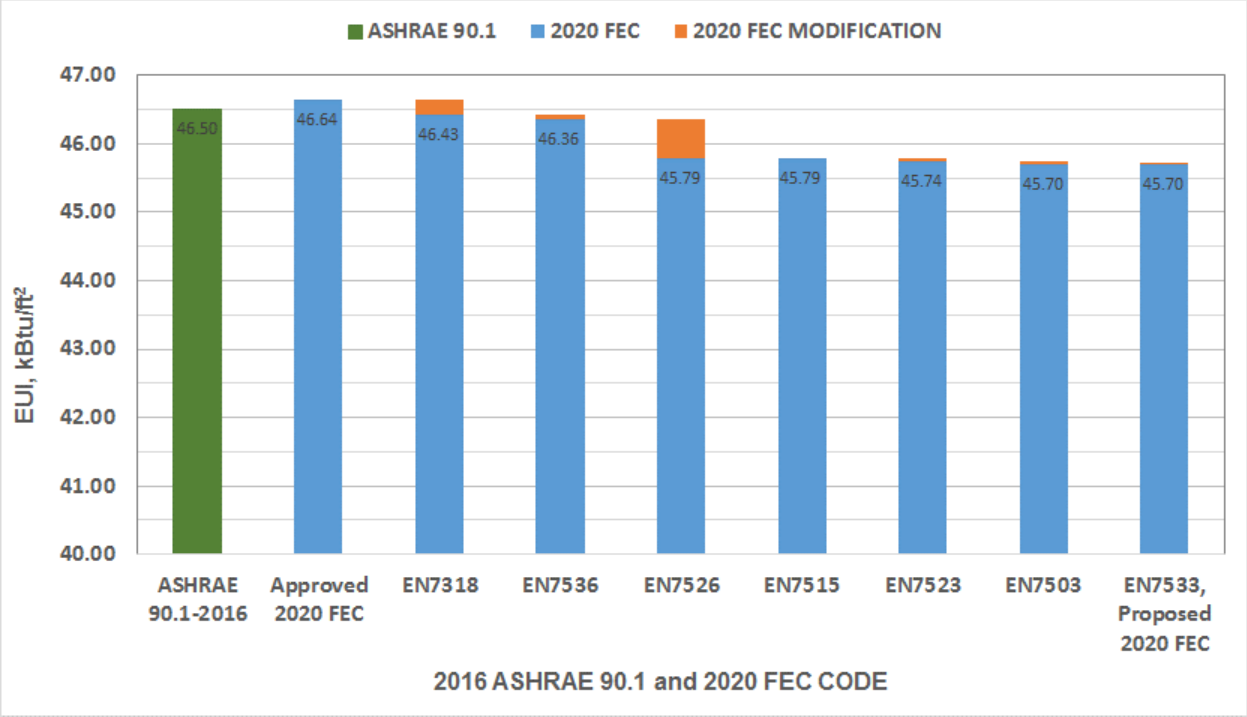

Figure 8 Weighted Average Annual EUI for each of Proposed Code Modifications

5. Economic Analysis of the 2020 Florida Energy Code Modifications

Economic analysis quantifies cost effectiveness of code modifications differences between 7th edition (2020) and 6th Edition (2017) Commercial Florida Energy Code. The economic analysis will use the annual energy savings determined between the base case, which is the 6th Edition (2017) Florida Energy Code, and a proposed code modification. This requires to create a separate baseline and proposed code prototype building energy model for each of the proposed code modifications. Florida energy rates for electricity and natural gas will be used to determine annual total energy cost savings. Preliminary assessment of the code modifications amenable for economic analysis has been selected and provided in Appendix-A and Appendix-B. The selection excludes code modifications whose energy impact cannot be analyzed quantitatively, code modifications with no or negligible net first cost, federal minimum code modifications, and those code changes that has already been approved. Thus, the economic analysis will focus only on the proposed code modifications that are pending approval by the Florida Building Commission.

This section of the report is in progress at the time of reporting.

6. Results Summary

The approved and "proposed" 2020 Florida Energy Code performance were investigated quantitatively using prototype buildings energy models and compared against the 2016 ASHRAE 90.1 code energy models performance. The prototype buildings energy models were created and investigated using EnergyPlus, whole building simulation program. Two sets of the 2020 Florida Energy Code prototype building energy models were investigated. One set for the approved 2020 FEC and another set for the proposed 2020 Florida Energy Code. The approved 2020 FEC prototype building energy models were created by modifying the 6th Edition Florida Energy Code (2017) prototype building models that include the approved only commercial code modifications. And the "proposed" 2020 Florida Energy Code prototype building energy models were created by modifying the 6th Edition Florida Energy Code (2017) prototype building models that include the approved commercial code modifications and those proposed for addition to the 2020 FEC pending approval by the Florida Building Commission. The 2016 ASHRAE 90.1 code reference prototype buildings energy models decks (DOE, 2018) published by PNNL were obtained and modified for Florida climate zones 1A and 2A.

The approved 2020 FEC quantitative analysis determined that seven out of the sixteen prototype buildings site Energy Use Intensity (EUI) were lower than that of ASHRAE 90.1-2016 code whereas the remaining nine prototype buildings underperformed the 2016 ASHRAE 90.1. Aggregated across the sixteen prototype buildings, the weighted Florida average annual energy use performance of the approved 2020 FEC slightly underperformed the 2016 ASHRAE 90.1.

Adding the proposed amendments to the 2020 FEC that have not been incorporated in the FEC determined that ten out of the sixteen "proposed" 2020 FEC prototype buildings energy models site Energy Use Intensity (EUI) were lower than that of ASHRAE 90.1-2016 code building models. These ten prototype buildings represent 72.0% of total floor area of commercial building models investigated. The remaining six commercial prototype building energy models designed with "proposed"2020 FEC had higher Energy Use Intensity than 2016 ASHRAE 90.1 code. These six prototype buildings amount to 28.0% of the total floor area stock of commercial buildings investigated. Since the six prototype building energy models designed with ASHRAE 90.1-2016 code had automatic receptacles control and secondary sidelight area control, their energy use was lower than buildings designed with the "proposed" 2020 FEC. However, averaging across all the sixteen commercial prototype building energy models, the "proposed" 2020 Florida Energy Code performed better than that of the 2016 ASHRAE 90.1 code. The weighted Florida averaged site EUI aggregated across the sixteen prototype buildings type for the "proposed" 2020 FEC was lower than ASHRAE 90.1-2016 code buildings by about 1.73%. This implies a commercial building designed with the "proposed" 2020 FEC in Florida consumes about 1.73% less energy (saves energy) compared to a building designed with the 2016 ASHRAE 90.1 code building.

Among the nine proposed commercial code modifications for the 2020 FEC summarized in Appendix-B, seven of them were quantitatively investigated for energy and energy cost savings, and only five have shown significant savings potential. Proposed code modifications EN7318, EN7536, EN7526, EN7523, and EN7503 are strongly recommended for consideration for approval by the Florida Building Commission for addition to the 2020 FEC.

7. Conclusion

The overall result of the quantitative analysis aggregated across the sixteen prototype buildings type show that the “proposed” 2020 Florida Commercial Building Energy Code exceeds the 2016 ASHRAE 90.1 code. This determination was made by quantitative analysis of thirty-two code modifications. These code modifications quantitatively investigated comprise twenty-three already approved code changes and nine proposed code changes pending approval by the Florida Building Commission. The annual site energy use and total energy cost quantitative analysis demonstrate that the “proposed” 2020 Florida Energy Code (FEC) building is less than that of the 2016 ASHRAE 90.1 code building when weighed for climate zones by total floor area stock and building type across the State. Proposed code modifications EN7318, EN7536, EN7526, EN7523, and EN7503, which were investigated quantitatively, are strongly recommended for consideration for approval by the Florida Building Commission for addition to the 2020 Florida Energy Code.

8. Reference

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Appendix-A: Approved 2020 Florida Energy Code Changes with Energy Impact

Table-A contains summary of approved code changes for the 7th Edition (2020) Florida Commercial Energy Code. The proposed energy code modifications include that has already been approved.

Table-A: Summary of Approved Commercial Code Change between 6th and 7th Edition Florida Energy Code

S. No.	2018 IECC Section and Title, ICC Code # or Other Code	Mod # or Comment	Change Summary b/t 2017 FEC and Proposed 2020 FEC	Included in quantitative Analysis (Yes/No)	Included in Economic Analysis (Yes/No)
Section 402 Building Envelope Requirements					
Section 403 Building Mechanical Systems					
1	C403.10.2.1 Performance standards (Mandatory), CE126-16	Approved	Added new mandatory subsection and related tables: TABLE C403.2.16.1(1), TABLE C403.2.16.1(2) and TABLE C403.2.16.1(3). Increases costs. New US federal minimum efficiency requirement for walk-in coolers and freezers. Also provides design flexibility.	Yes	No. Federal minimum.
2	TABLE C403.2.3(3), CE132-16	Approved	Updated Table C403.2.3(3) Minimum Efficiency Requirements of electrically operated: PTACs, PTHPs, Single Package Vertical ACs, Single Package Vertical HPs, Room ACs and Room Air Conditioner heat Pumps. US federal minimum efficiency requirement increased. Increases cost. DOE analysis shows that minimum payback period is 2.1-10.1 years.	Yes	No. Federal minimum.
3	TABLE C403.3.2 (8), CE152-16	Approved	Changed TABLE C403.2.3 (8) minimum efficiency requirement for Propeller or axial fan closed-circuit cooling towers from 14.0 to 16.1 gpm/hp to match ASHRAE 90.1 requirement. None or minimal effect on first cost.	Yes	No. Federal minimum.
4	TABLE C403.3.2 (5), CE154-16	Approved	Changed TABLE C403.2.3 (5) minimum efficiency requirement for hot water and steam boilers to match the US federal minimum efficiency requirement. Increases first cost but also saves energy.	Yes	No. Federal minimum

Table-A: Summary of Approved Commercial Code Change between 6th and 7th Edition Florida Energy Code (continued)

S. No.	2018 IECC Section and Title, ICC Code # or Other Code	Mod # or Comment	Change Summary b/t 2017 FEC and Proposed 2020 FEC	Included in quantitative Analysis (Yes/No)	Included in Economic Analysis (Yes/No)
Section 403 Building Mechanical Systems					
5	C403.9 Heat rejection equipment, CE165-16	Approved	Modified code section C403.4.3. Heat rejection equipment shall comply with requirements in this section with exception of heat rejection devices whose energy usage is included in the equipment efficiency rating and listed in Tables C403.2.3(6) and C403.2.3(7). Increases first cost but cost effective.	Yes	No. Already approved
6	C403.9.1 Fan speed control, CE165-16	Approved	Modified code section C403.4.3.1. Changed the title from "General" to "Fan speed control". Reduced the variable speed fan motor power threshold from 7.5 hp (5.6 kW) to 5 hp (3.7 kW) and modified the exception. Increases first cost. PNNL study shows that this code change is cost effective, SIR=1.4.	Yes	No. Already approved
7	C403.6.6 Multiple-zone VAV system ventilation optimization control, CE167-16	Approved	Modified code section C403.4.4.6. Deleted exceptions for exhaust air ERV optimization item 2. This code change allows to use OA control for multi-zone system with ERV. This code change is cost effective in all climate zones. This code change is similar to ASHRAE 90.1-2013 addendum j.	Yes	No. Already approved
8	C403.6.7 Parallel-flow fan-powered VAV air terminal control, CE168-16	Approved	Added a new code section C403.4.4.7. Parallel-flow fan-powered VAV air terminals shall have automatic controls configured to turn-off the terminal fan when there is no heating. This is a control logic change. No effect on first cost. Saves energy.	No. Prototype building does not have PFP VAV	No. Already approved

Table-A: Summary of Approved Commercial Code Change between 6th and 7th Edition Florida Energy Code (continued)

S. No.	2018 IECC Section and Title, ICC Code # or Other Code	Mod # or Comment	Change Summary b/t 2017 FEC and Proposed 2020 FEC	Included in quantitative Analysis (Yes/No)	Included in Economic Analysis (Yes/No)
Section 404 Service Water Heating					
9	TABLE C404.2 MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT, CE171-16	Approved	Updated Table C404.2, minimum efficiency values and equations of water heating equipment to meet the US federal minimum efficiency requirement. Increases equipment cost and reduces operating energy cost.	Yes	No. Federal minimum.
Section 405 Electric Power and Lighting Systems					
10	C405.2.1.3 Occupant sensor control function in open plan office areas, CE185-16	Approved	Added new code section C405.2.1.3. Added occupant sensor control function in open plan office areas as a requirement. Increases first cost but cost effective.	Yes	No. Already approved
11	C405.2.1.1 Occupant sensor control function, CE187-16	Approved	Modified code section C405.2.1.1. Lights shutoff time after occupant leaves the unit reduced from 30 to 20 minutes. No cost increase but saves lighting energy significantly.	Yes	No. Already approved
12	C405.2.6.1 Daylight shutoff, CE196-16	Approved	Added new code section C405.2.6.1. Lighting shall be automatically turned off when there is sufficient daylight. No first cost increase.	Yes	No Already approved
13	C405.2.6.2 Decorative lighting shutoff, CE196-16	Approved	Added new code section C405.2.6.2. Building facade and landscape decorative lighting shutoff requirement. No first cost increase.	Yes	No Already approved
14	C405.2.6.3 Lighting setback, CE196-16	Approved	Added new code section C405.2.6.3. Lighting setback requirement. No first cost increase.	Yes	No Already approved
15	C405.2.6.4 Exterior time-switch control function, CE196-16	Approved	Added new code section C405.2.6.4. Exterior time-switch control function requirement. No first cost increase.	Yes	No Already approved

Table-A: Summary of Approved Commercial Code Change between 6th and 7th Edition Florida Energy Code (continued)

S. No.	2018 IECC Section and Title, ICC Code # or Other Code	Mod # or Comment	Change Summary b/t 2017 FEC and Proposed 2020 FEC	Included in quantitative Analysis (Yes/No)	Included in Economic Analysis (Yes/No)
Section 405 Electric Power and Lighting Systems					
16	TABLE C405.3.2 (1), CE206-16	Approved	Reduced the LPD values in Table C405.4.2(1) for most of the building area types. May increases first cost also but decreases energy use. Cost effective especially when the 2018 code become into effect due to decline in LED first cost and maintenance cost.	Yes	No Already approved
17	TABLE C405.3.2 (2), CE206-16	Approved	Reduced LPD values in Table C405.4.2(2) for most of the space types. Cost effective especially when the 2018 code become into effect due to decline in LED first cost and maintenance cost.	Yes	No Already approved
18	C405.3.2.2.1 Additional interior lighting power, CE209-16	Approved	Modified code section C405.4.2.2.1. Edited equation 4-10 and LPD values of additional interior lighting power allowance for retail display area. Increases cost but not life cycle cost, and decreases energy use. This is cost effective due to no net increase in life cycle cost.	Yes	No Already approved
19	C405.3.2.2.1 Additional interior lighting power, CE210-16, same as above	Approved	Modified code section C405.4.2.2.1. Edited equation 4-10 and LPD values of additional lighting power allowance for retail display area. Excludes museum exhibition areas for additional lighting power allowance. Increases cost but not life cycle cost, and decreases energy use. This is cost effective due to no net increase in life cycle cost.	Yes	No Already approved
20	Table C405.6 MINIMUM NOMINAL EFFICIENCY LEVELS FOR 10 CFR 431 LOW-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMERS, CE221-16	Approved	Modified Table C405.7. Added a decimal point to minimum efficiency values for single-phase transformers and increased baseline minimum efficiency values of three-phase transformers due to change in US federal energy efficiency standard. No cost increase but Decreases Energy Use due to efficiency increase.	Yes	No. Federal minimum.

Table-A: Summary of Approved Commercial Code Change between 6th and 7th Edition Florida Energy Code (continued)

S. No.	2018 IECC Section and Title, ICC Code # or Other Code	Mod # or Comment	Change Summary b/t 2017 FEC and Proposed 2020 FEC	Included in quantitative Analysis (Yes/No)	Included in Economic Analysis (Yes/No)
Electric Power and Lighting Systems					
21	C405.7 Electrical motors (Mandatory), CE223-16	Approved	Modified code section C405.8. Added new exceptions for electric motors from minimum efficiency requirements. No first cost increase.	No	No. Already approved
22	Table C405.7(1) MINIMUM NOMINAL FULL-LOAD EFFICIENCY FOR NEMA DESIGN A, NEMA DESIGN B, AND IEC DESIGN N MOTORS (EXCLUDING FIRE PUMP ELECTRIC MOTORS AT 60 HZ) CE223-16	Approved	Modified Table C405.8(1). Modified table format and increased electric motors minimum efficiency requirements due to new US federal minimum motor efficiency change and added new footnotes to this table for clarification. Increases first cost but also decreases energy use compared to the previous minimum efficiency. Cost effective with payback period of 2.9 – 4.5 years.	Yes	No. Federal minimum.
23	Table C405.7(2) MINIMUM NOMINAL FULL-LOAD EFFICIENCY FOR NEMA DESIGN C AND IEC DESIGN H MOTORS AT 60 HZ, CE223-16	Approved	Modified Table C405.8(2). Modified table format and increased electric motors minimum efficiency requirements due to new US federal minimum motor efficiency change and added new footnotes to this table for clarification. Cost effective with payback period of 2.9 – 4.5 years.	Yes	No. Federal minimum.

Appendix-B: Proposed 2020 Florida Energy Code Changes with Energy Impact

Table-B contains summary of proposed code modification for the 7th Edition (2020) Florida Commercial Energy Code that are undergoing public review and pending approval by Florida Building Energy Commission.

Table-B: Summary of Proposed Commercial Code Changes between 6th and 7th Edition Florida Energy Code

S. No.	2018 IECC Section and Title, ICC Code # or Other Code	Mod # or Comment	Change Summary b/t 2017 FEC and Proposed 2020 FEC	Included in quantitative Analysis (Yes/No)	Included in Economic Analysis (Yes/No)
Section 402 Building Envelope Requirements					
1	C402.4.1.2 Increased skylight area with daylight responsive controls, CE97-16	EN7499	Modified code section C402.4.1.2. Skylights area percentage allowed with daylight response control is used increased from 5% to 6%. No net cost first change.	No.	May be
2	C402.5.6 Loading dock weatherseals, CE116-16	EN7515	Modified code section C402.5.6. Door openings shall be equipped with weatherseals to restrict infiltration and provide direct contact along the top and sides of vehicles when parked in the doorway. Increase first cost of construction.	Yes	Yes
Section 403 Building Mechanical Systems					
3	C403.4.1.4 Heated or cooled vestibules (Mandatory), CE136-16	EN7523	Added new code section C403.4.1.4. Defines heating and cooling temperature limits for heated or cooled vestibules and air curtain. It is mandatory. Increases first cost.	Yes	Yes
4	C403.7.6 Automatic control of HVAC systems serving guest rooms, CE138-16	EN7536	Added new code section C403.7.6. Control requirement for each guest room in buildings containing over 50 guest rooms. Increases first cost but cost effective.	Yes	Yes
	C403.7.6.1 Temperature setpoint controls, CE138-16		Added new code section C403.7.6.1. Add set point temperature setback or setup control requirement when each guest room is not occupied. Increases first cost but cost effective.	Yes	Yes
	C403.7.6.2 Ventilation controls, CE138-16		Added new code section C403.7.6.2. Controls shall be provided on each HVAC system that can automatically turn off the ventilation and exhaust fans 30 minutes after the occupant leaves the guest room. Increases first cost but cost effective.	Yes	Yes

Table-B: Summary of Proposed Commercial Code Changes between 6th and 7th Edition Florida Energy Code (continued)

S. No	2018 IECC Section and Title, ICC Code # or Other Code	Mod # or Comment	Change Summary b/t 2017 FEC and Proposed 2020 FEC	Included in Quantitative Analysis (Yes/No)	Included in Economic Analysis (Yes/No)
Section 403 Building Mechanical Systems					
5	C403.7.7 Shutoff dampers (Mandatory), CE139-16	EN7558	Edited code section C403.2.4.3. Restricts gravity dampers use for "exhaust and relief" system only. This change is restrictive and if adopted requires motorized dampers for outdoor air intake. Increases first cost but saves energy use.	No. Not part of prototype building.	No
6	C403.2.4.2.3 Automatic start capability, based on ASHRAE 90.1-2016	EN7533	Modifies Section C403.2.4.2.3 Automatic start capability. Individual heating and cooling systems with setback controls and direct digital control shall have optimum start controls. The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied set point, the outdoor temperature, and the amount of time prior to scheduled occupancy. Increases construction cost.	Yes	Yes
Section 405 Electric Power and Lighting Systems					
7	C405.2.4 Specific application control, CE179-16	EN7318	C405.2.4 Specific application control. Permanently installed luminaires within dwelling units shall be provided with controls complying with Section C405.2.1.1 or C405.2.2.2.	Yes	Yes
8	C405.2.5.3 Lighting setback, CE196-16	EN7503	Increase exterior lighting automatic reduction threshold from 30 to 50 percent by selectively switching off or dimming luminaires. Modifies the new code section C405.2.6.3.	Yes	Yes

Table-B: Summary of Proposed Commercial Code Changes between 6th and 7th Edition Florida Energy Code (continued)

S. No	2018 IECC Section and Title, ICC Code # or Other Code	Mod # or Comment	Change Summary b/t 2017 FEC and Proposed 2020 FEC	Included in Quantitative Analysis (Yes/No)	Included in Economic Analysis (Yes/No)
Section 405 Electric Power and Lighting Systems					
9	Table C405.4.2(2) LIGHTING POWER ALOWANCES FOR BUILDING EXTERIORS, CE215-16	EN7326	Modified Table C405.5.1 (2). Reduced the exterior lighting power allowance values for tradable exterior building surfaces and modified the table format. No first cost increase.	Yes	Yes
	Table C405.4.2(3) INDIVISUAL LIGHTING POWER ALOWANCES FOR BUILDING EXTERIORS, CE215-16		Modified Table C405.5.1 (2). Reduced the exterior lighting power allowance values for non-tradable exterior building surfaces and modified the table format. No first cost increase.	Yes	Yes

Appendix-C: Florida Energy Rates

A representative energy rate structure shown in Table C-1 was used for this analysis. Since the same energy rates were used for the proposed 2020 Florida Energy Code and the 2016 ASHRAE 90.1 prototype building energy models, the impact of energy rates variation by service territory is not significant in the final results of the analysis.

Table C-1 Time of Use Rate Electricity Cost Structure and Natural Gas Rates

Charges Type	Charge Items	Units	Rate
Customer and Demand Charge[1]			
Customer Charge		$/Month	25.46
Demand Charges	Base Demand Charge	$/kW	9.58
	Capacity Payment Charge	$/kW	0.70
	Conservation Charge	$/kW	0.48
Total Demand Charge		$/kW	10.76
Electric Energy Charges			
Non-Fuel Energy Charges	Base Energy Charge		
	On-Peak Base Energy Charge	cents /kWh	4.355
	On-Peak Base Energy Charge	cents /kWh	1.152
	Environmental Charge	cents /kWh	0.105
	General Service Load Management Program	cents /kWh	0.0
	Fuel Charge		
	Jan-Mar, Nov-Dec, On-Peak Fuel Charge	cents /kWh	3.052
	Jan-Mar, Nov-Dec, Off-Peak Fuel Charge	cents /kWh	2.429
	Apr-Oct, On-Peak Fuel Charge	cents /kWh	3.792
	Apr-Oct, Off-Peak Fuel Charge	cents /kWh	2.462
	Storm Charge	cents /kWh	0.091
	Franchise Fee	cents /kWh	0.0
	Tax clause	cents /kWh	0.0
Total Energy Rate	Jan-Mar, Nov-Dec, On-Peak Energy Rate	cents /kWh	7.603
	Jan-Mar, Nov-Dec, Off-Peak Energy Rate	cents /kWh	3.777
	Apr-Oct, On-Peak Energy Rate	cents /kWh	8.343
	Apr-Oct, Off-Peak Energy Rate	cents /kWh	3.810
Natural Gas Energy Rates[2]			
Customer Charge		$/Month	150.0
Distribution Charge	GS-25K Range	$/Therm	0.32696
Total Natural Gas Energy Rate		$/Therm	0.32696

[1] General Service Demand Time of Use. https://www.fpl.com/rates/pdf/electric-tariff-section8.pdf
[2] Florida City Gas Rates. https://www.floridacitygas.com/-/media/files/fcg/17353_FCG_ApprovedRates_directmail_f.pdf

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	Non-Refrigerated Warehouse	52,045	104,327	14.50
Food Service	Full Service Restaurant	2,501	4,003	0.56
	Quick Service Restaurant	5,502	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.

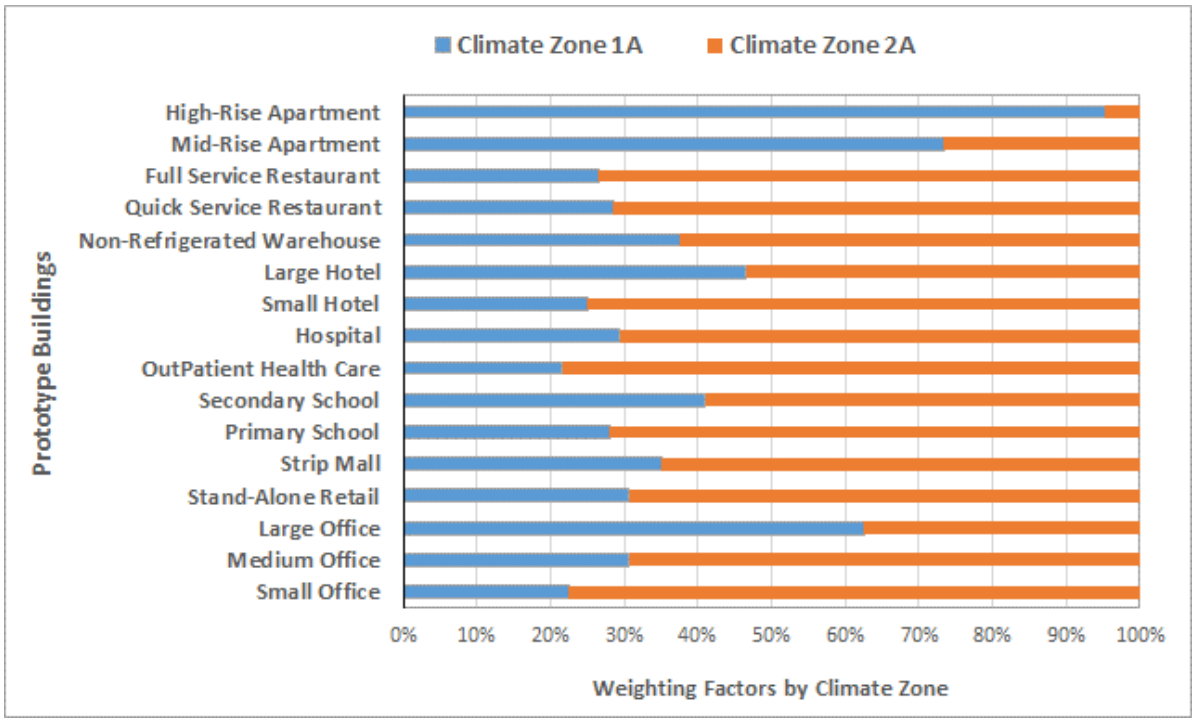

Figure D-1 Florida Floor Area Weighting Factors by Climate Zone and Building Type

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.

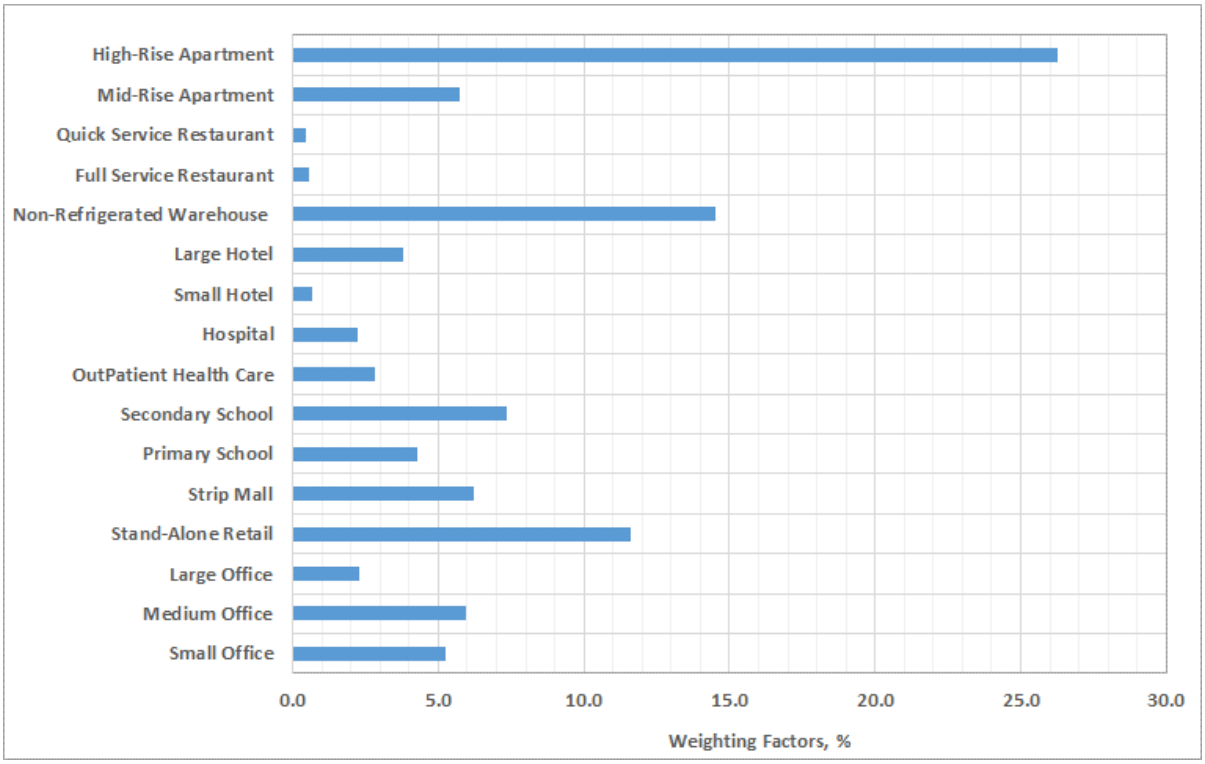

Figure D-2 Commercial Buildings Floor Area Weighting Factors by Prototype Building

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.