FLORIDA SOLAR ENERGY CENTER®

CONTRACT REPORT

Reducing Energy Use in Florida Buildings

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Executive Summary

The 2007 Florida Building Code[1] requires building designers and architects to achieve a minimum energy efficiency rating for commercial buildings located throughout Florida. Although the Florida Building Code is strict in the minimum requirements for new construction, several aspects of building construction can be further improved through careful thought and design. This report outlines several energy saving features that can be used to ensure that new buildings meet a new target goal of 85% energy use compared to the 2007 energy code in order to achieve Governor Crist's executive order to improve the energy code by 15%.

To determine if a target goal of 85% building energy use is attainable, a computer simulation study was performed to determine the energy saving features available which are, in most cases, stricter than the current Florida Building Code. The energy savings features include improvements to building envelop, fenestration, lighting and equipment, and HVAC efficiency. The impacts of reducing outside air requirements and employing solar water heating were also investigated. The purpose of the energy saving features described in this document is intended to provide a simple, prescriptive method for reducing energy consumption using the methodology outlined in ASHRAE Standard 90.1[2].

There are two difficulties in trying to achieve savings in non-residential structures. First, there is significant energy use caused by internal loads for people and equipment and it is difficult to use the energy code to achieve savings in this area relative to a baseline. Secondly, the ASHRAE methodology uses some of the same features that are proposed for the new building, so it may be difficult to claim savings for some strategies that will produce savings such as improved ventilation controls, reduced window area, or reduced plug loads simply because the methodology applies those features to the comparison reference building.

Several measures to improve the building envelope characteristics were simulated. Simply using the selected envelope measures resulted in savings of less than 10% for all building types. However, if such measures are combined with aggressive lighting reductions and improved efficiency HVAC equipment and controls, a target savings of 15% is easily attainable.

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[1] International Code Council, 2008. 2007 Florida Building Code, February.

[2] American Society of Heating, Refrigeration and Air Conditioning Engineers, 2007. ASHRAE Standard 90.1, Atlanta, GA.

Introduction

The State of Florida first mandated a statewide building code during the 1970's to require municipalities and counties to adopt and enforce one of the four state minimum building codes. Over the years, the state minimum building code evolved into a single state building code that is enforced by local governments. As of March 1, 2002, the Florida Building Code supersedes all local building codes. These codes were developed and are maintained by the Florida Building Commission.

The Florida Building Code is based on national model building codes and national consensus standards which are amended when necessary for Florida's specific needs. This report describes methods by which the construction and design community could increase building energy efficiency by 15% over the 2007 Florida Building Code.

To determine if a target goal of 85% building energy use is attainable, a computer simulation study was performed to determine the energy saving features which are, in most cases, stricter than the current Florida Building Code. The purpose of the energy saving features described in this document is intended to provide a simple, prescriptive method for reducing energy consumption using ASHRAE Standard 90.1.

Several building models were used to investigate the applicability of specific energy saving features based on building type. The energy saving features selected for study are based on the recommendations described in ASHRAE's Advanced Energy Design Guides. Additional energy saving features are included to investigate the impact of exterior wall treatments, equipment load control, use of high-efficiency AC systems, and reducing outside air requirements. The following sections describe the building models, energy saving features, and simulation results in greater detail.

Building Models

Building simulation models were developed using the EnergyGuage® Summit Energy Analysis and Rating Software[3]. Each model uses the minimum requirements as specified by the 2007 Florida Building Code. Computer simulations were performed on several building types to represent a diverse building stock. All building simulations were performed using Orlando weather and some comparisons were made using Jacksonville and Miami weather. Current TMY3 weather data were used for all simulations.

Table 1 describes specific building details for each building type. The typical building is single-storey in most cases and includes a 2-storey school building and an 8-storey hotel. Lighting and equipment power densities and occupancy are based on the ASHRAE Standard 90.1 space-by-space method.

[3] Florida Solar Energy Center, 2007. EnergyGuage® Summit Analysis and Rating Software, Florida Solar Energy Center, Cocoa, FL.

Table 1 - Base Case Building Model Characteristics

Building Type	Location	Floor Area (ft^2)	Stories	Base Lighting Power Density (W/ft^2)	Base Equipment Power Density (W/ft^2)	Maximum Number of Occupants
Office	Orlando	4,151	1	1.28	0.89	85
Retail		139,004	1	1.65	1.03	3742
School		22,068	2	1.26	0.92	714
Warehouse		1,344	1	0.81	0.20	4
Hotel		239,832	8	1.04	0.59	2344
Clinic		6,997	1	1.34	0.85	193
Supermarket		39,283	1	1.53	0.96	910

Advanced Energy Design Guides

Advanced energy design guides (AEDG)[4] are intended to provide contractors and designers a simple method for constructing energy efficient buildings. Strategic application of these guides are reported to provide a 30% energy savings when compared to the same building designed using the minimum requirements of ANSI/ASHRAE/IESNA Standard 90.1-1999[5]. AEDG recommendations are not intended to represent a code minimum or standard and are to be used as supplements to existing codes and standards.

The AEDG recommendations were primarily developed through the ASHRAE Special Project 102 Committee (SP-102). Representatives from other organizations also provided a contributing effort to produce the design guide documents. These agencies include:

- United States Department of Energy (DOE)
- American National Standards Institute (ANSI)
- American Society of Heating, Refrigeration, Air-Conditioning Engineers (ASHRAE)
- Illuminating Engineering Society of North America (IESNA)
- American Institute of Architects (AIA)
- United States Green Building Council (USGBC)
- New Buildings Institute (NBI)

To date, guides have been developed for four (4) building types: Small Office Buildings, Small Retail Buildings, K-12 School Buildings, and Small Warehouses and Self-Storage Buildings. A 65% draft guide is currently under review for Highway Lodging.

[4] American Society of Heating, Refrigeration and Air Conditioning Engineers, 2006. Advanced Energy Design Guides, Atlanta, GA.
[5] American Society of Heating, Refrigeration and Air Conditioning Engineers, 1999. ASHRAE Standard 90.1, Atlanta, GA.

These guides specify recommendations for the building envelope, fenestration, skylights, lighting, HVAC, and other building operational controls. The current project will investigate suitable options for increasing the energy efficiency of Florida commercial buildings by an additional 15% over the minimum specifications required by the 2007 Florida Building Code. Table 2 compares the minimum ASHRAE and AEDG recommendations for building envelope construction for a small office building located in Zone 2. Note that the 2007 Florida Building Code is primarily based on ASHRAE Standard 90.1-2004. Complete tables for all building types are provided in Appendix A. These specifications are the basis for the energy saving features selected for this study.

Table 2 – Office Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004		AEDG Recommendation	
		U-max	R-min		
Roof	Insulation entirely above deck	U-0.063	R-15 c.i.	R-15 c.i.	
	Metal building	U-0.065	R-19	R-19	
	Attic and other	U-0.034	R-30	R-38	
	Single rafter	U-0.034	R-30	R-38	
	Surface reflectance/emittance	No recommendation		0.65 initial/0.86	
Walls	Mass (HC>7 Btu/ft^2)	U-0.58	NR	R-7.6 c.i.	
	Metal building	U-0.113	R-13	R-13	
	Stell framed	U-0.124	R-13	R-13	
	Wood framed and other	U-0.089	R-13	R-13	
	Below-grade walls	C-1.40		Comply with Standard 90.1	
Floors	Mass	U-0.137	R-4.2 c.i.	R-6.3 c.i.	
	Steel framed	U-0.052	R-19	R-19	
	Wood framed and other	U-0.051	R-19	R-19	
Slabs	Unheated	F-0.73	NR	Comply with Standard 90.1	
	Heated	F-1.020	R-7.5 for 12 in.	R-7.5 for 12 in.	
Doors	Swinging	U-0.70	NR	U-0.70	
	Non-swinging	U-1.45	NR	U-1.45	
Vertical Glazing	Window to wall ratio (WWR)	50% maximum		20% - 40%	
	Thermal transmittance	Fixed	Operable	U-0.45	
		U-1.22	U-1.27		
	Solar heat gain coefficient (SHGC)	0-40%: 0.25 all / 0.61 North 40-50%: 0.17 all / 0.44 North		N, S, E, W - 0.31	N only - 0.44
	Window orientation	Directional		$(A_N*SHGC_N+A_S*SHGC_S)>$ $(A_E*SHGC_E+A_W*SHGC_W)$	
	Exterior sun control (S, E, W only)	Based on PF		Projection factor (PF) 0.5	

Energy Saving Features

Several energy saving features were identified as feasible options based on ease of installation and applicability to most building types. Other features were included in this study to provide a "measure of opportunity" for additional energy savings. Selected features cover a range of categories: building envelope, lighting, HVAC, equipment, indoor air quality, and solar. Each of the features are described below in further detail.

AEDG recommendations for building materials and equipment were used as a basis for energy saving feature selection.

Table 3 - Energy Saving Features Selected for Study

Feature	Property	Option Description
Roof	Reflectance	Roof Only
	Emittance	
Wall	Reflectance	Wall Only
Window	U-value	Window Only
	Overhang	
Lighting	90% Power Density	Lighting Only
	75% Power Density	75% Lighting
HVAC	System Efficiency	AEDG HVAC
	Fan Efficiency	HiEff Fan
Equipment	90% Power Density	90% Equipment
Outside Air	85% Outside Air	85% Outside Air
Solar Hot Water	HW Heating Energy	Solar Hot Water only

Building Envelope

Building envelope recommendations include: 1) improved roof insulation for attic and single rafter construction with improved reflectance and emittance properties, 2) improved heat transfer characteristics for fenestration, and 3) the use of overhangs on windows facing South, East, and West.

As shown in Table 2, AEDG recommendations for walls and doors in Zone 2 did not change when compared to the minimum requirements specified by ASHRAE Standard 90.1. The recommendations for roofs are unchanged for office buildings, however, increased roof insulation is recommended for other building types. A recommendation for improved exterior wall reflectance is included in this study, however, AEDG recommendations for improved floor insulation (estimated to be a very minor effect for most Florida buildings) was not modeled. AEDG recommendations for window solar heat gain coefficient (SHGC) were sometimes less stringent than ASHRAE 90.1 and were not modeled.

Lighting

Recommendations are made for reducing the lighting power density by building type. The recommendations provided by the AEDG are applicable to the building area method described in ASHRAE 90.1. In most cases, the AEDG recommended a reduction of 10% for lighting power density. Lighting power density reductions for retail and warehouse are specified by AEDG as 86.7% and 75%, respectively. To apply this lighting reduction strategy to this study, the maximum lighting power density specified for the space type using the ASHRAE 90.1 space-by-space method was adjusted according to the recommended percentage reduction in lighting power. In the case of all building types except retail and warehouse, the lighting power

density was reduced to 90 % of the maximum amount allowed for each space type defined in the model buildings.

Several studies have been performed to determine the minimum lighting requirements in buildings. Newsham[6], et. al., showed that up to a 30% reduction in lighting can be achieved before occupants detect a change in lighting output. For this reason, an additional simulation was performed to determine the impact of a 25% reduction in lighting power density when using the ASHRAE 90.1 space-by-space method.

HVAC System

Improving the efficiency of mechanical systems can dramatically reduce building energy consumption. In this study, the HVAC system efficiencies were increased to the AEDG recommendations for one simulation, and increased again to the current efficiency limit available in today's market place. The higher efficiency equipment described in this document refers to mechanical systems with 14 SEER for smaller systems and 11 EER for larger systems.

Improved fan efficiency was also selected as an energy saving measure. Fan efficiency was increased from 0.82 W/cfm to 0.75 W/cfm for constant volume systems and from 1.12 W/cfm to 1.02 W/cfm for variable-volume systems. This translates to an approximate 10% improvement in efficiency for air moving equipment.

Miscellaneous Electric Load

Equipment loads prove to be an ever increasing drain on the electrical energy consumption of buildings. Although manufacturers strive to make equipment as efficient as possible, several equipment models draw a significant amount of electricity even when in stand-by mode. In addition, equipment typically used is often on solely as a convenience instead of on an as-needed basis. For these reasons, the equipment loads were modified to reflect a reduction of 10% over the maximum equipment loads specified by ASHRAE Standard 90.1. These reductions are assumed possible through application of power strips to non-essential equipment that can be turned off when not needed. An alternate method would be to connect non-essential equipment to a dedicated electrical circuit which is controlled manually or scheduled through building automation systems.

Impact of Outside Air

ASHRAE Standard 62.1 specifies the minimum amount of outside air for commercial buildings. The minimum requirement is based on the amount of outside air required per person and/or per floor area. The amount of energy required to condition outdoor air can be significant. Although lowering the minimum amount of outside air may not be a high-priority feature when considering energy savings measures, the impact of

[6] Newsham, G.R., C. Donnelly, S. Mancini, R.G. Marchand, W. Lei, K.E. Charles, and J.A. Veitch. The effect of ramps in temperature and electric light level on office occupants: a literature review and laboratory experiment. *Proc. 2006 ACEEE Summer Study on Energy Efficiency in Buildings* Pacific Grove, CA:4-252-4-264

reducing the minimum outside air requirements by 15% was investigated in this study to identify potential savings due to advanced ventilation control strategies.

Solar Water Heating

Water heating can also pose a high demand on building electrical consumption. The ASHRAE Handbook – HVAC Applications Chapter 49[7] provides a measure of average daily hot water demand which may be used to identify potential savings opportunities when solar water heating methods are employed.

Table 4 - Hot Water Use for Various Building Types

Type of Building	Average Daily Demand	Maximum Daily Hot Water Usage (kWh/day)
Office	1.0 gal./person	10
Elementary Schools	0.6 gal./student	50
Junior or Senior High School	1.8 gal./student	151
Motels, 100 or more rooms	10.0 gal/room	117 ^
Food service A – full meal restaurants	2.4 gal/avg. meal/day	132 *
Food service B – drive-ins, snack shops, etc.	0.7 gal/avg. meal/day	7 #

Notes - ^ assumes 100 rooms
* assumes 20% occupancy for hotel quests
# assumes 10% usage by supermarket shoppers

Applying the hot water usage information to this study involved calculating the daily hot water energy requirements for each building type. The maximum number of occupants shown in Table 1 is used to determine the maximum daily hot water usage. Assumptions for food service include a service factor based on building type. The service hot water set point temperature is assumed to be 120 ºF. Stand-by losses were not considered and are estimated to be less than 5% of the total water heating energy use. The following describes the type of water usage included in the average daily demand by building type.

Office Buildings – Includes hot-water requirements for cleaning and lavatory use by occupants and visitors.

Elementary Schools - Includes hot-water requirements for lavatories, careteria and kitchen use, dishwashers, and general cleaning purposes.

High Schools - Includes hot-water requirements for showers, lavatories, dishwashers, kitchens, and general cleaning.

Motels - Includes hot-water requirements for tubs and showers, lavatories, and general purpose cleaning.

Food Service - Includes hot-water requirements for dish washing, food preparation, cleaning pots and pans and floors, and hand-washing for employees and customers.

[7] American Society of Heating, Refrigeration and Air Conditioning Engineers, 2003. ASHRAE Handbook, HVAC Applications, Atlanta, GA

The final assumptions and calculations for annual hot water heating energy are shown in Table 5. A combination of hot water demand for building types shown in Table 4 was used to determine the estimated annual hot water energy use for all buildings modeled in this study. As shown in Table 5, the percent contribution of water heating to total building energy use ranges from 0.3% to 5.9%.

Table 5 - Building Hot Water Usage Assumptions and Annual Energy Use

Building Type	Days/wk	Combination Used	Energy Use (kWh/day)	Annual Energy Use (kWh)	Percent of Base Building Energy Use (%)
Office	5	Office	10	2,600	1.9
Retail	6	Office	44	13,728	0.3
School	5	Average of School Types	100	26,000	5.9
Warehouse	6	Office	0.5	156	0.9
Hotel	7	Motel + Food Service A	149	54,385	1.5
Supermarket	7	Office + Food Service B	18	6,552	0.7
Clinic	5	Office	23	5,980	3.7

Simulation Results

Each of the energy saving features described previously were applied to the base case building model as shown in Table 6. For each building type, computer simulations were performed for a total of 20 simulations. The first simulation provided a basis of comparison for all other computer simulations. Simulations 2 through 12 show the impact of each energy saving feature compared to the base case model. Simulation 13 shows the impact of building envelope and lighting improvements compared to the base case. Simulations 14 through 20 show cumulative energy savings as each additional option is included in the simulation.

The results of simulations 2 through 12 are shown in Figure 1. Simulation 9 was left out of this single feature analysis so that HVAC efficiency improvements would not be counted twice (approximately 7% for schools and 2% for all other building types – see 16 vs 15 in Figure 2). Lighting, fan efficiency, and HVAC efficiency improvements provide the largest energy savings across all building types. The AEDG recommendation for warehouse building HVAC did not change the results (i.e., same HVAC efficiency). Other options provide energy savings specific to the building type and also vary based on individual building characteristics. It is no surprise that the optional solar water heater can have a large impact when hot water usage is a significant potion of the overall building energy use.

Table 6 - Energy Saving Feature Summary

Simulation ID	Description	Grouping
1	BaseCase (Florida Code 2007)	Florida Code 2007
2	Roof Only	Single Option
3	Walls Only	
4	Window Only	
5	Lighting Only	
6	Overhangs Only	
7	HiEff Fan Only	
8	AEDG HVAC Only	
9	HiEff HVAC Only	
10	OA Only	
11	Equipment Only	
12	Solar Hot Water Only	
13	All Options (building envelope + lighting)	Building Envelope
14	All Options + AEDG HVAC	HVAC Efficiency
15	All Options + AEDG HVAC + Hi Eff Fan	
16	All Options + Hi Eff HVAC + Hi Eff Fan	
17	Reduce Lighting to 75% of ASHRAE 90.1	Lighting
18	Reduce OA to 85% of ASHRAE 60.1	Indoor Air Quality
19	Reduce Equipment Loads	Equipment Control
20	Solar Hot Water	Solar Hot Water only

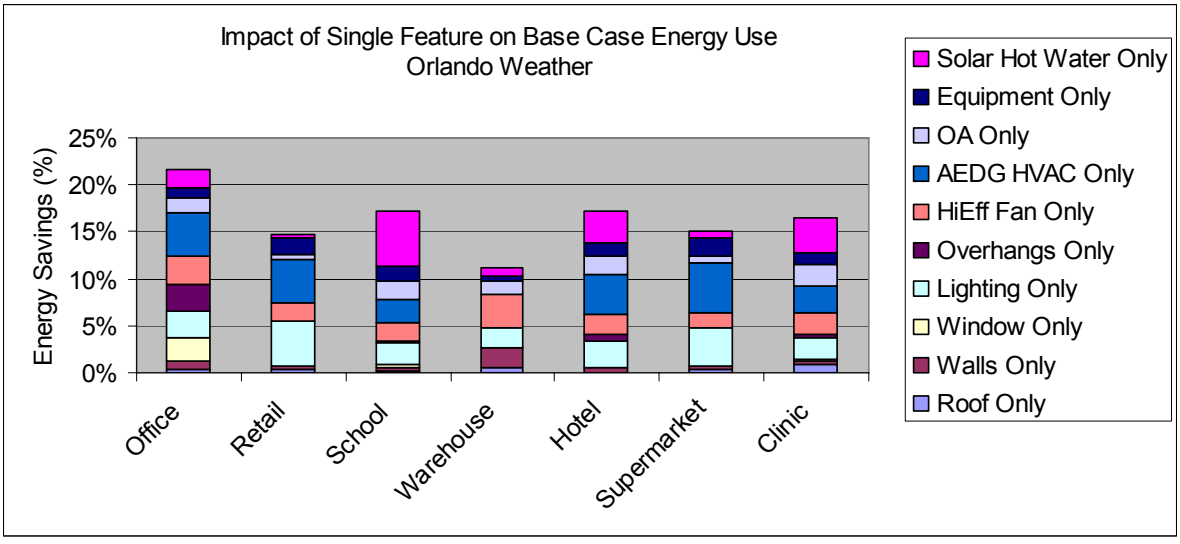

Figure 1 - Energy Savings of Individual Features by Building Type

These results show that improvements to the building envelope are dependent on building type and the amount of energy savings vary based on building architecture. For example, the option for improving the roof insulation is only a cost effective measure when applied to buildings having large roof areas. Similarly, improving window heat transfer

characteristics is only viable for large glazing areas. The usefulness of overhangs also depend on window orientation.

Although reducing the minimum amount of outside air is shown to provide approximately a 1% to 2% savings for several building types, application of this feature is likely to result in code violations without supporting evidence for using such a measure. For example, if building furnishings are shown to release minimal amounts of volatile organic compounds (VOC), the required amount of outside air may be reduced slightly. The use of demand controlled ventilation could also prove to be a significant energy saving feature.

Also of note is the fact that the combination of these energy saving features results in at least a 15% reduction in building energy use over the 2007 Florida Building Code for all building types except warehouse. Since analyzing individual features in this manner does not provide accurate results when investigating cumulative energy savings due to application of multiple energy savings features, additional computer simulations were performed to show the final results. Figure 2 shows the results for sequentially adding energy saving features to the base case building model.

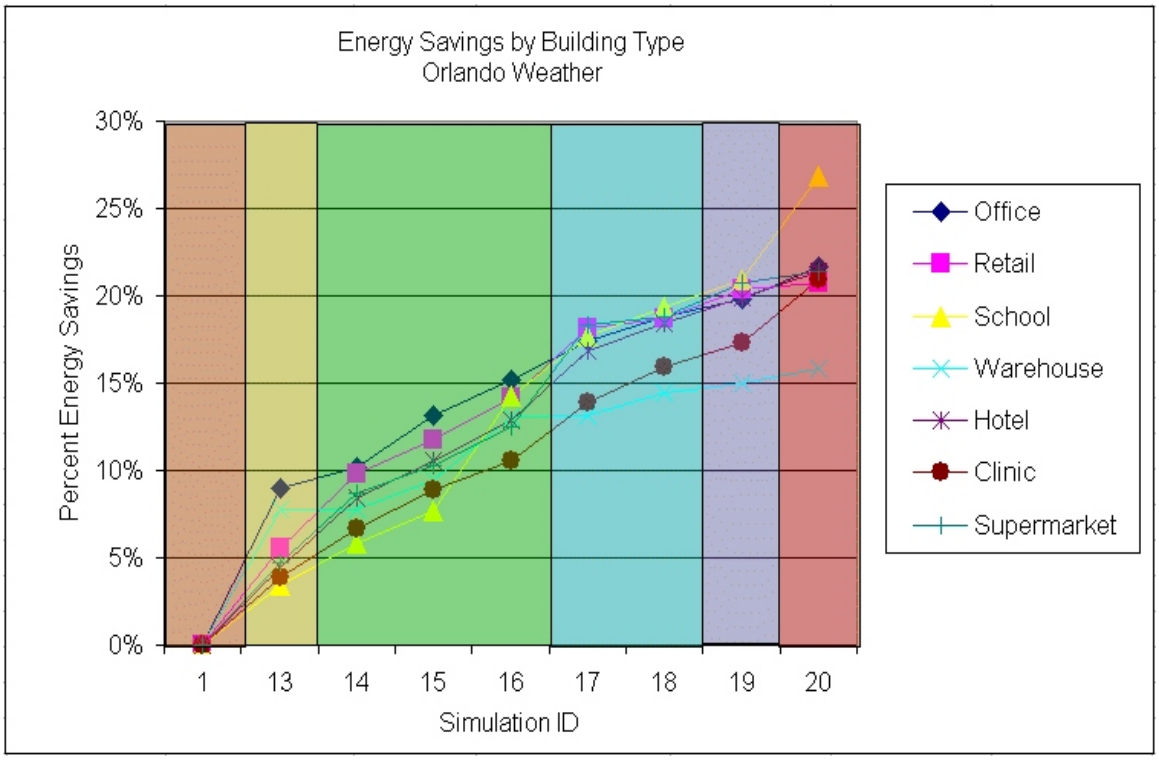

Figure 2 - Cumulative Energy Savings by Building Type

Starting with the base case model, combining all AEDG building envelope and lighting recommendations results in an approximate 3% to 9% energy savings for the building types selected for study (e.g., Simulation ID 13 in Table 6). Adding in the AEDG recommendation for HVAC efficiency improvements yields an additional average improvement of 2.7% (ID 14). Similarly, incrementally adding the remaining features

results in a total energy savings of over 15% for all building types studied. Office buildings were simulated for Miami and Jacksonville with very similar total savings numbers to the Orlando simulations.

Summary of Energy Saving Measures

A summary of the energy saving features used in this study is shown in Table 7. Each energy saving feature specification shown here was used to modify the base case model to provide a single feature analysis compared to the base case model. The roof specifications were combined to show the results when the roof properties were adjusted according to the AEDG recommendations. Cumulative results also used these specifications as applicable. In most cases, the energy savings measures identified in Table 7 reflect the AEDG recommendation. In other cases, improvements beyond AEDG recommendations show performance improvements based on reduced exterior wall absorptance, reduced lighting power density, and improved HVAC efficiency.

Table 7 - Summary of Energy Saving Measures

Building Element	**Improved Building Specifications**						
	Office	**Retail**	**School**	**Warehouse**	**Hotel**	**Supermarket**	**Clinic**
Roof Absorptance	0.35	0.22					
Roof U-value	0.034	0.027					
Wall Absorptance	0.3						
Wall R-value	13 (no change)						
Floor Insulation R-value	19						
Window U-value	0.45	0.49	0.45				
Window SHGC 0-40% WW Ratio	0.61 North, 0.25 all other (no change)						
40-50% WW Ratio	0.44 North, 0.25 all other (no change)						
Overhang Projection Factor (PF)	0.5 (projection half the distance of window height)						
Lighting (% of base case Lighting)	90	86.7	90	75	90	90	90
Lighting (75% of base case Lighting)	75						
HVAC Fan Efficiency (W/cfm)	Constant Volume System 0.75 / Variable Volume System 1.02						
HVAC Cooling < 65,000 Btu/hr	13 SEER/7.7 HSPF						
HVAC Cooling ≥ 65,000 - 135,000 But/hr	10.6 EER / 11.0 IPLV / 3.2 COP						
HVAC Cooling ≥ 135,000 Btu/hr	10.1 EER / 11.5 IPLV / 3.1 COP						
High Efficiency HVAC	11 EER / 14 SEER						

Appendix A

The tables described below represent differences in building characteristics between ASHRAE Standard 90.1 2004 and recommendations made by the Advanced Energy Design Guidelines. Each building model developed during this project used the characteristics shown in the respective table to identify energy savings features selected for study. The majority of energy savings features focused on building envelop, lighting, equipment, and HVAC selection. Other comparisons are shown here for completeness. The information contained in the following tables are intended for illustration purposes only. It is recommended that the ASHRAE 90.1 standard or the individual AEDG documents are consulted for specific information.

Table A 1 - Office Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004		AEDG Recommendation	
		U-max	R-min		
Roof	Insulation entirely above deck	U-0.063	R-15 c.i.	R-15 c.i.	
	Metal building	U-0.065	R-19	R-19	
	Attic and other	U-0.034	R-30	R-30	
	Single rafter	U-0.034	R-30	R-30	
	Surface reflectance/emittance	No recommendation		0.65 initial/0.86	
Walls	Mass (HC>7 Btu/ft^2)	U-0.58	NR	R-7.6 c.i.	
	Metal building	U-0.113	R-13	R-13	
	Stell framed	U-0.124	R-13	R-13	
	Wood framed and other	U-0.089	R-13	R-13	
	Below-grade walls	C-1.40		Comply with Standard 90.1	
Floors	Mass	U-0.137	R-4.2 c.i.	R-6.3 c.i.	
	Steel framed	U-0.052	R-19	R-19	
	Wood framed and other	U-0.051	R-19	R-19	
Slabs	Unheated	F-0.73	NR	Comply with Standard 90.1	
	Heated	F-1.020	R-7.5 for 12 in.	R-7.5 for 12 in.	
Doors	Swinging	U-0.70	NR	U-0.70	
	Non-swinging	U-1.45	NR	U-1.45	
Vertical Glazing	Window to wall ratio (WWR)	50% maximum		20% - 40%	
	Thermal transmittance	Fixed	Operable	U-0.45	
		U-1.22	U-1.27		
	Solar heat gain coefficient (SHGC)	0-40%: 0.25 all / 0.61 North 40-50%: 0.17 all / 0.44 North		N, S, E, W - 0.31	N only - 0.44
	Window orientation	Directional		(A_N*$SHGC_N$+A_S*$SHGC_S$)> (A_E*$SHGC_E$+A_W*$SHGC_W$)	
	Exterior sun control (S, E, W only)	Based on PF		Projection factor (PF) 0.5	
Skylights	Maximum percent of roof area	0%-2%	2.1%-5%	3%	
	Thermal transmittance	U-1.36	U-1.36	U-1.36	
	Solar heat gain coefficient (SHGC)	0.36	0.19	0.19	

Table A 1 (cont.) - Office Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004	AEDG Recommendation
Int. Lighting	Lighting power density (LPD)	1.0 W/ ft^2	0.9 W/ft^2
	Light source (linear fluorescent)	Varies	90 mean lumens/watt
	Ballast		Electronic ballast
	Dimming controls for daylight Harvesting for WWR ≥ 25%		Dim fixtures within 12 ft of N/S window wall or within 8 ft of skylight edge
	Interior room surface reflectances		80%+ on ceilings, 70%+ on walls and vertical partitions
	Additional LPD for adjustable lighting equipment that is specifically designed to highlight merchandise and is controlled separately.		0.4 W/ft^2 (spaces not listed below) 0.6 W/ft^2 (sporting goods, small electronics) 0.9 W/ft^2 (furniture, clothing, cosmetics, artwork) 1.5 W/ft^2 (jewelry, crystal, china)
HVAC	Air conditioner (0-65 Kbtuh)	13.0 SEER	13.0 SEER
	Air conditioner (≥65-135 Kbtuh)	9.9 EER	11.3 EER / 11.5 IPLV
	Air conditioner (≥135-240 Kbtuh)	9.3 EER	11.0 EER / 11.5 IPLV
	Air conditioner (≥240-760 Kbtuh)	9.5 EER / 9.7 IPLV	10.6 EER / 11.2 IPLV
	Air conditioner (≥760 Kbtuh)	9.2 EER / 9.4 IPLV	10.6 EER / 11.2 IPLV
	Gas furnace (0-225 Kbtuh – SP)	78% AFUE or 80% E_t	80% AFUE or E_t
	Gas furnace (0-225 Kbtuh – Split)	78% AFUE or 80% E_t	80% AFUE or E_t
	Gas furnace (≥225 Kbtuh)	80% E_c	80% E_c
	Heat pump (0-65 Kbtuh)	13 SEER / 7.7 HSPF	13 SEER / 7.7 HSPF
	Heat pump (≥65-135 Kbtuh)	9.9 EER / 3.2 COP	10.6 EER / 11.0 IPLV / 3.2 COP
	Heat pump (≥135 - 240 Kbtuh)	9.1 EER / 3.1 COP	10.1 EER / 11.5 IPLV / 3.1 COP
	Heat pump (≥240 Kbtuh)	8.8 EER / 9.0 IPLV / 3.1 COP	10.1 EER / 11.5 IPLV / 3.1 COP
Economizer	Air conditioners/heat pumps - SP	No recommendation	No recommendation
Ventilation	Outdoor air damper	Motorized control	Motorized control
	Demand control	CO_2 sensors	CO_2 sensors
Ducts	Friction rate	No recommendation	0.08 in. w.c. / 100 feet
	Sealing	Seal class C	Seal class B
	Location	No recommendation	Interior only
	Insulation level	R-6	R-6
Service Water Heater	Gas storage	90% E_t(Q/800+√110V)	90% E_t
	Gas instantaneous	90% E_t(Q/800+√110V)	0.81 EF or 81% E_t
	Electric storage 12 kW	EF > 0.93 – 0.0032V	EF > 0.99 – 0.0012*Volume
	Pipe insulation (d<1 ½ in/d >1 ½ in)	½ in. / 1 in	1 in. / 1 ½ in.

Table A 2 – Retail Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004		AEDG Recommendation	
		U-max	R-min		
Roof	Insulation entirely above deck	U-0.063	R-15 c.i.	R-15 c.i.	
	Metal building	U-0.065	R-19	R-19	
	Attic and other	U-0.034	R-30	R-38	
	Single rafter	U-0.034	R-30	R-38	
	Surface reflectance	No recommendation		0.78	
Walls	Mass (HC>7 Btu/ft^2)	U-0.58	NR	R-7.6 c.i.	
	Metal building	U-0.113	R-13	R-13	
	Steel framed	U-0.124	R-13	R-13	
	Wood framed and other	U-0.124	R-13	R-13	
	Below-grade walls	C-1.40		Comply with Standard 90.1	
Floors	Mass	U-0.137	R-4.2 c.i.	R-6.3 c.i.	
	Steel framed	U-0.052	R-19	R-19	
	Wood framed and other	U-0.051	R-19	R-19	
Slabs	Unheated	F-0.73	NR	Comply with Standard 90.1	
	Heated	F-1.020	R-7.5 for 12 in.	R-7.5 for 12 in.	
Doors	Swinging	U-0.70	NR	U-0.70	
	Non-swinging	U-1.45	NR	U-1.45	
Vertical Glazing	Window to wall ratio (WWR)	50% maximum		40% maximum	
	Thermal transmittance	Fixed	Operable	U-0.49	
		U-1.22	U-1.27		
	Solar heat gain coefficient (SHGC)	0-40%: 0.25 all / 0.61 North 40-50%: 0.17 all / 0.44 North		N, S, E, W - 0.4	N only - 0.4
	Window orientation	Directional		(A_N*$SHGC_N$+A_S*$SHGC_S$)> (A_E*$SHGC_E$+A_W*$SHGC_W$)	
	Exterior sun control (S, E, W only)	Based on PF		Projection factor (PF) 0.5	
Skylights	Maximum percent of roof area	0%-2%	2.1%-5%	3%	
	Thermal transmittance	U-1.36	U-1.36	U-1.36	
	Solar heat gain coefficient (SHGC)	0.36	0.19	0.19	

Table A 2 (cont.)– Retail Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004	AEDG Recommendation
Int. Lighting	Lighting power density (LPD)	1.5 W/ ft^2	1.3 W/ft^2
	Light source (linear fluorescent)	Varies	91 mean lumens/watt
	Ballast		Electronic ballast
	Dimming controls for daylight Harvesting for WWR ≥ 25%		Dim fixtures within 12 ft of N/S window wall or within 8 ft of skylight edge
	Interior room surface reflectances		80%+ on ceilings, 70%+ on walls and vertical partitions
	Additional LPD for adjustable lighting equipment that is specifically designed to highlight merchandise and is controlled separately.		0.4 W/ft^2 (spaced not listed below) 0.6 W/ft^2 (sporting goods, small electronics) 0.9 W/ft^2 (furniture, clothing, cosmetics, artwork) 1.5 W/ft^2 (jewelry, crystal, china)
HVAC	Air conditioner (0-65 Kbtuh)	13.0 SEER	13.0 SEER
	Air conditioner (≥65-135 Kbtuh)	9.9 EER	11.3 EER / 11.5 IPLV
	Air conditioner (≥135-240 Kbtuh)	9.3 EER	11.0 EER / 11.5 IPLV
	Air conditioner (≥240-760 Kbtuh)	9.5 EER / 9.7 IPLV	10.6 EER / 11.2 IPLV
	Air conditioner (≥760 Kbtuh)	9.2 EER / 9.4 IPLV	10.6 EER / 11.2 IPLV
	Gas furnace (0-225 Kbtuh – SP)	78% AFUE or 80% E_t	80% AFUE or E_t
	Gas furnace (0-225 Kbtuh – Split)	78% AFUE or 80% E_t	80% AFUE or E_t
	Gas furnace (≥225 Kbtuh)	80% E_c	80% E_c
	Heat pump (0-65 Kbtuh)	13 SEER / 7.7 HSPF	13 SEER / 7.7 HSPF
	Heat pump (≥65-135 Kbtuh)	9.9 EER / 3.2 COP	10.6 EER / 11.0 IPLV / 3.2 COP
	Heat pump (≥135 - 240 Kbtuh)	9.1 EER / 3.1 COP	10.1 EER / 11.5 IPLV / 3.1 COP
	Heat pump (≥240 Kbtuh)	8.8 EER / 9.0 IPLV / 3.1 COP	10.1 EER / 11.5 IPLV / 3.1 COP
Economizer	Air conditioners/heat pumps - SP	No recommendation	No recommendation
Ventilation	Outdoor air damper	Motorized control	Motorized control
	Demand control	CO_2 sensors	CO_2 sensors
Ducts	Friction rate	No recommendation	0.08 in. w.c. / 100 feet
	Sealing	Seal class C	Seal class B
	Location	No recommendation	Interior only
	Insulation level	R-6	R-6
Service Water Heater	Gas storage	90% E_t(Q/800+√110V)	90% E_t
	Gas instantaneous	90% E_t(Q/800+√110V)	0.81 EF or 81% E_t
	Electric storage 12 kW	EF > 0.93 – 0.0032V	EF > 0.99 – 0.0012*Volume
	Pipe insulation (d<1 ½ in/d >1 ½ in)	½ in. / 1 in	1 in. / 1 ½ in.

Table A 3 – K-12 School Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004		AEDG Recommendation
Roof	Insulation entirely above deck	U-0.063	R-15 c.i.	R-25 c.i.
	Metal building	U-0.065	R-19	R-13+R-13
	Attic and other	U-0.034	R-30	R-38
	Single rafter	U-0.034	R-30	R-38
	Surface reflectance	No recommendation		0.78
Walls	Mass (HC>7 Btu/ft^2)	U-0.58	NR	R-7.6 c.i.
	Metal building	U-0.113	R-13	R-16
	Stell framed	U-0.124	R-13	R-13
	Wood framed and other	U-0.089	R-13	R-13
	Below-grade walls	C-1.140		Comply with Standard 90.1
Floors	Mass	U-0.137	R-4.2 c.i.	R-6.3 c.i.
	Steel framed	U-0.052	R-19	R-19
	Wood framed and other	U-0.051	R-19	R-19
Slabs	Unheated	F-0.73	NR	NR
	Heated	F-1.020	R-7.5 for 12 in.	R-7.5 for 12 in.
Doors	Swinging	U-0.70	NR	U-0.70
	Non-swinging	U-1.45	NR	U-1.45
Vert. Glazing	Window to wall ratio (WWR)	50% maximum		35% maximum
	Thermal transmittance	Fixed	Operable	U-0.45
		U-1.22	U-1.27	
	Solar Heat Gain Coefficient (SHGC)	0-40%: 0.25 all / 0.61 North 40-50%: 0.17 all / 0.44 North		SHGC – 0.25
	Exterior sun control (S, E, W only)	Based on PF		Projection factor (PF) 0.5
Int. Finishes	Interior room surface average reflectance	No recommendation		70%+ on ceilings and walls above 7 ft 50%+ on walls below 7 ft

Table A 3 (cont.) – K-12 School Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004	AEDG Recommendation
Interior Lighting- Daylighting option	Classroom daylighting (daylighting fenestration to floor area ratio)	No recommendation	Toplighted – South-facing roof monitors: 8% - 11% North-facing roof monitors: 12%-15%
			Sidelighted- South-facing: 8% - 11% North-facing: 15%-20%
			Combined tiplighted and sidelighted- Southfacing sidelighted: 6% - 8% Toplighted: 2% - 3% Northfacing sidelighted: 9% - 13% Toplighted: 3% - 5%
	Gym toplighting (daylighting fenestration to floor area ratio)	No recommendation	South-facing roof monitors: 5% - 8% North-facing roof monitors: 7% - 10%
	Lighting power density (LPD)	1.2 W/ ft^2	1.2 W/ ft^2
	Light source system efficacy (linear fluorescent)	Varies	75 mean lm/W minimum
	Light source system efficacy (all other sources)		50 mean lm/W minimum
	Occupancy controls		Manual on, auto, off all zones
	Dimming controls daylight harvesting		Dim all fixtures in classrooms and gym and other fixtures within 15 ft of sidelighting edge and within 10 ft of toplighting edge
Interior Lighting- Non-Daylighting option	Lighting power density (LPD)	Varies	1.1 W/ ft^2
	Light source system efficacy (linear fluorescent)		85 mean lm/W minimum
	Light source system efficacy (all other sources)		50 mean lm/W minimum
	Occupancy controls		Manual on, auto, off all zones
	Dimming controls daylight harvesting		Dim fixtures within 15 ft of sidelighting edge and within 10 ft of toplighting edge

Table A 3 (cont.) – K-12 School Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004		AEDG Recommendation
Packaged DX Rooftops (or DX Split Systems)	Air conditioner (0-65 Kbtuh)	13.0 SEER		13.0 SEER
	Air conditioner (≥65-135 Kbtuh)	9.9 EER		11.3 EER
	Air conditioner (≥135-240 Kbtuh)	9.3 EER		11.0 EER
	Air conditioner (≥240 Kbtuh)	8.8 EER / 9.0 IPLV		10.6 EER / 11.2 IPLV
	Heat pump (0-65 Kbtuh)	13 SEER / 7.7 HSPF		13 SEER / 7.7 HSPF
	Heat pump (≥65-135 Kbtuh)	9.9 EER / 9.2 IPLV / 3.2 COP		10.6 EER / 3.2 COP
	Heat pump (≥135 - 240 Kbtuh)	9.1 EER / 9.2 IPLV/ 3.1 COP		10.1 EER / 11.5 IPLV / 3.1 COP
	Heat pump (≥240 Kbtuh)	8.8 EER / 9.0 IPLV / 3.1 COP		10.1 EER / 11.5 IPLV / 3.1 COP
	Gas furnace (<225 kBtuh)	78% AFUE or 80% E_t		80% AFUE or E_t
	Gas furnace (>225 kBtuh)	80% E_c		80% E_c
	Economizer	No recommendation		Comply with ASHRAE 90.1
	Ventilation	No recommendation		Energy recovery or demand control
	Fans	<20,000 cfm	≥ 20,000 cfm	
	Constant Volume:	1.2 hp/1000 cfm	1.1 hp/1000 cfm	1 hp/1000 cfm
	Variable Volume:	1.7 hp/1000 cfm	1.5 hp/1000 cfm	1.3 hp/1000 cfm
WSHP System	Water source heat pump (<65 KBtuh)	Cooling: 12.1 SEER		Cooling: 12 SEER at 86 ºF Heating: 4.5 COP at 68 ºF
	Water source heat pump (≥65 KBtuh)	Cooling: 11.5 SEER		Cooling: 12 SEER at 86 ºF Heating: 4.2 COP at 68 ºF
	Ground source heat pump (GSHP) (<65 kBtuh)			Clg: 14.1 EER at 77ºF, 17 EER at 59ºF Htg: 3.5 COP at 32ºF, 4.0 COP at 50ºF
	GSHP (<65 kBtuh)			Clg: 13 EER at 77ºF, 16 EER at 59ºF Htg: 3.1 COP at 32ºF, 3.5 COP at 50ºF
	Gas boiler	80% E_c		85% E_c
	Economizer	No recommendation		Comply with ASHRAE 90.1
	Ventilation	No recommendation		Energy recovery or demand control
	WSHP duct pressure drop			Total ESP < 0.2 in. H_2O
Fan Coil and Chiller System	Air-cooled chiller efficiency			10.0 EER and 11.5 IPLV
	Water-cooled chiller efficiency			Comply with ASHRAE 90.1
	Gas boiler	80% E_c		80% E_c
	Economizer			Comply with ASHRAE 90.1
	Ventilation			DOAS with either energy recovery or demand control
	Pressure drop			Total ESP < 0.2 in. H_2O

Table A 3 (cont.) – K-12 School Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004	AEDG Recommendation
Fan Coil and Chiller System	Air-cooled chiller efficiency		10.0 EER and 11.5 IPLV
	Water-cooled chiller efficiency		Comply with ASHRAE 90.1
	Gas boiler	80% E_c	80% E_c
	Economizer		Comply with ASHRAE 90.1
	Ventilation		DOAS with either energy recovery or demand control
	Pressure drop		Total ESP < 0.2 in. H_2O
Packaged Rooftop VAV System	Rooftop air condtioner (≥240 kBtuh)		10.0 EER and 11.2 IPLV
	Gas furnace (≥225 kBtuh)		80% E_c
	Gas boiler	80% E_c	80% E_c
	Economizer		Comply with ASHRAE 90.1
	Ventilation		DOAS with either energy recovery or demand control
	Pressure drop		Total ESP < 0.2 in. H_2O
VAV amd Chiller System	Air-cooled chiller efficiency		10.0 EER and 11.5 IPLV
	Water-cooled chiller efficiency		Comply with ASHRAE 90.1
	Gas boiler		80% E_c
	Economizer		Comply with ASHRAE 90.1
	Ventilation		Energy recovery or demand control
Ducts and Dampers	Outdoor air damper	Motorized	Motorized
	Friction rate	No recommendation	0.08 in. w.c. / 100 feet
	Sealing	Seal class C	Seal class B
	Location	No recommendation	Interior only
	Insulation level	R-6	R-6
Service Water Heater	Gas storage	90% E_t(Q/800+√110V)	90% E_t
	Gas instantaneous	90% E_t(Q/800+√110V)	0.81 EF or 81% E_t
	Electric storage 12 kW	EF > 0.93 – 0.0032V	EF > 0.99 – 0.0012*Volume
	Pipe insulation (d<1 ½ in/d >1 ½ in)	½ in. / 1 in	1 in. / 1 ½ in.

Table A 4 - Warehouse and Self-Storage Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004		AEDG Recommendation
		U-max	R-min	
Roof	Insulation entirely above deck	U-0.063	R-15 c.i.	R-20 c.i.
	Metal building	U-0.065	R-19	R-13+R-13
	Attic and other	U-0.034	R-30	R-38
	Single rafter	U-0.034	R-30	R-38
	Surface reflectance	No recommendation		0.78
Walls – Exterior	Mass (HC>7 Btu/ft^2)	U-0.58	NR	R-5.7 c.i.
	Metal building	U-0.113	R-13	R-16
	Steel framed	U-0.124	R-13	R-13
	Wood framed and other	U-0.089	R-13	R-13
	Below-grade walls	C-1.40		Comply with Standard 90.1
Walls – Interior	Partition (between semi-heated and unconditioned)	No recommendation		R-13
Floors	Mass	U-0.137	R-4.2 c.i.	Comply with Standard 90.1
	Steel framed	U-0.052	R-19	Comply with Standard 90.1
	Wood framed and other	U-0.051	R-19	Comply with Standard 90.1
Slabs	Unheated	F-0.73	NR	Comply with Standard 90.1
	Heated	F-1.020	R-7.5 for 12 in.	Comply with Standard 90.1
Doors	Swinging	U-0.70	NR	U-0.70
	Vehicular Dock Thermal Trans.	No recommendation		U-0.50
	Vehicular Dock Infiltration – closed	No recommendation		0.28 cfm/ft^2 of area
	Vehicular Dock Infiltration – open	No recommendation		Weather seals
Vertical Glazing	Window to wall ratio (WWR)	50% maximum		Comply with Standard 90.1
	Thermal transmittance	Fixed	Operable	U-0.45
		U-1.22	U-1.27	
	Solar heat gain coefficient (SHGC)	0-40%: 0.25 all / 0.61 North		N, S, E, W - 0.25
		40-50%: 0.17 all / 0.44 North		
Skylights	Maximum percent of roof area	0%-2%	2.1%-5%	5%-7% Prismatic diffusing
	Thermal transmittance	U-1.36	U-1.36	U-1.36
	Solar heat gain coefficient (SHGC)	0.36	0.19	0.19
	Visible Transmittance (VLT)	No recommendation		0.59

Table A 4 (cont.) - Warehouse and Self-Storage Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004	AEDG Recommendation
Interior Lighting	Lighting power density (LPD)	0.8 W/ ft^2	Bulk and self-storage - 0.6 W/ft^2
			Fine storage - 0.85 W/ft^2
			Office - 0.9 W/ft^2
	Linear fluorescent lamps	Varies	T-SHO or T-8
	Ballast		Electronic ballast
	Dimming controls for daylight harvesting		Automatic dimming or switched
	Occupancy controls		Auto-on/off for all warehouse and storage areas; manual-on/auto-off for office
	Ceiling surface reflectances		80%
Exterior Lighting	Canopied areas	Varies	0.5 W/ft^2

Table A 5 - Highway Lodging Building Envelope Specifications for Zone 2

Item	Component	Florida Code 2007		AEDG Recommendation
		U-max	R-min	
Roof	Insulation entirely above deck	U-0.063	R-15 c.i.	R-20 c.i.
	Metal building	U-0.065	R-19	Not applicable
	Attic and other	U-0.027	R-38	R-38
	Single rafter	U-0.027	R-38	R-38
	Surface reflectance	0.70		0.78
Walls	Mass (HC>7 Btu/ft^2)	U-0.58	NR	R-7.6 c.i.
	Metal building	U-0.113	R-13	Not applicable
	Steel framed	U-0.124	R-13	R-13+R7.5 c.i.
	Wood framed and other	U-0.089	R-13	R-13
	Below-grade walls	C-1.40		Comply with Standard 90.1
Floors	Mass	U-0.137	R-4.2 c.i.	R-6.3 c.i.
	Steel framed	U-0.052	R-19	R-19
	Wood framed and other	U-0.051	R-19	R-19
Slabs	Unheated	F-0.73	NR	Comply with Standard 90.1
	Heated	F-1.020	R-7.5 for 12 in.	Not applicable
Doors	Swinging	U-0.70	NR	U-0.70
	Non-swinging	U-1.45	NR	U-0.50
Vert. Glazing	Window to wall ratio (WWR)	50% maximum		25% maximum
	Thermal transmittance	Fixed	Operable	U - 0.45
		U-1.22	1.27	
	Solar Heat Gain Coefficient (SHGC)	0-40%: 0.25 all / 0.61 North		SHGC – 0.25
		40-50%: 0.17 all / 0.44 North		
	Exterior sun control (S, E, W only)	Based on PF		Projection factor (PF) > 0.5

Table A 5 (cont.) - Highway Lodging Building Envelope Specifications for Zone 2

Item	Component	Florida Code 2007	AEDG Recommendation	
Interior Lighting-Daylighting option	Lighting power density (LPD)	1.0 W/ ft^2	Guest Rooms, Meeting Rooms & Lobbies = 1.1 W/ft^2	
			Corridors = 0.5 W/ft^2	
			Laundry & Stairs = 0.6 W/ft^2	
			Office & Exercise = 0.9 W/ft^2	
	Fluorescent lamps	No recommendation	CFL with electronic ballast, T5HO or T8 with electronic ballast	
	Occupancy controls	Varies	Bi-level in stairs, manual-on/auto-off for all laundry, office, exercise, business center, meeting rooms, and non-public spaces	
	Guest Room Controls		Master control and entry and vacancy control in bathroom	
	Ceiling surface reflectances		0.8	
Exterior Lighting Power Density (LPD)	Lighting Zone 2 = Residential Mixed-use Areas and Neighborhood Business Districts Lighting Zone 3 = All Other areas	Varies	Lighting Zone 2	Lighting Zone 3
	Base Allowance		600 w	750 W
	Parking areas and drives		0.06 W/ft^2	0.10 W/ft^2
	Walkways less than 10 ft wide		0.7 W/ft^2	0.8 W/ft^2
	Walkways 10 ft wide or greater		0.14 W/ft^2	0.16 W/ft^2
	Entry Canopies		0.25 W/ft^2	0.40 W/ft^2
	Façade (use wattage only for façade)		0.10 W/ft^2	0.15 W/ft^2

Table A 5 (cont.) - Highway Lodging Building Envelope Specifications for Zone 2

Item	Component	Florida Code 2007	AEDG Recommendation
HVAC	Heating System (Guest Rooms)		Primary heat source electric heat pump or gas-fired furnace or boiler
	Air conditioner (0-65 Kbtuh)	13.0 SEER	13.0 SEER
	Air conditioner (≥65-135 Kbtuh)	9.9 EER	11.3 SEER/11.5 IPLV
	Air conditioner (≥135-240 Kbtuh)	9.3 EER	11.0 SEER/11.5 IPLV
	Air conditioner (≥240-760 Kbtuh)	9.5 EER / 9.7 IPLV	10.6 SEER/11.2 IPLV
	Air conditioner (≥760 Kbtuh)	9.2 EER / 9.4 IPLV	10.6 SEER/11.2 IPLV
	Gas furnace (0-225 Kbtuh – SP)	78% AFUE or 80% E_t	80% AFUE or Et
	Gas furnace (0-225 Kbtuh – Split)	78% AFUE or 80% E_t	80% AFUE or Et
	Gas furnace (≥225 Kbtuh)	80% E_c	80% Ec
	Packaged Terminal Heat Pump	12.3-(0.213xCap/1000)	EER = 13.6 - (0.233 x Cap/1000) COP = 3.8 - (0.053 x Cap/1000)
	Heat pump (0-65 Kbtuh)	13 SEER / 7.7 HSPF	13.0 SEER/7.7 HSPF
	Heat pump (≥65-135 Kbtuh)	9.9 EER / 3.2 COP	10.6 EER/11.0 IPLV/3.2 Htg COP
	Heat pump (≥135 - 240 Kbtuh)	9.1 EER / 3.1 COP	10.1 EER/11.5 IPLV/3.1 Htg COP
	Heat pump (≥240 Kbtuh)	8.8 EER / 9.0 IPLV / 3.1 COP	10.1 EER/11.5 IPLV/3.1 Htg COP
	Hydronic Heat Pump (0-18 Kbtu/h)	11.2 EER	14.6 EER, 4.6 Htg COP
	Hydronic Heat Pump (>18 Kbtu/h)	12.0 EER	15.0 EER, 4.6 Htg COP
	Hydronic Heat Pump Heat Source		Use condensing boiler for circulating loop heat source
	Pumping for Water Source Heat Pumps		Variable speed pumping, water treatment
	Hydronic Heat Pump Heat Rejection		Control cooling tower to maximize heat pump EER
Ventilation	Ventilation Air Supply		Control ventilation supply volume to match occupancy
	Heat Recovery		Ventilation heat recovery with toilet exhaust
Ducts	Friction Rate		0.08 in. w.c./100 feet
	Sealing		Seal Class B
	Location		Interior Only
	Insulation level		R-6
Service Water Heating	Gas Water Heater Efficiency		Storage - 90% Et, Instantaneous - 0.81 EF or 81% Et
	Electric Storage EF (≤12 kW, ≥ 20 gal)		EF > 0.99 - 0.0012(Volume)
	Hot water usage reduction		Use 1.75 gpm shower heads, 1.0 gpm faucets and water conserving clothes washers. Utilize laundry heat recovery.
	Water Heater Sizing Location		Avoid oversizing and excessive supply temperatures
	Pipe Insulation (d<1½ in/d≥1½ in)		1 in./1½ in.

Table A 6 - Clinic Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004		AEDG Recommendation (use Office Recommendation)	
		U-max	R-min		
Roof	Insulation entirely above deck	U-0.063	R-15 c.i.	R-15 c.i.	
	Metal building	U-0.065	R-19	R-19	
	Attic and other	U-0.034	R-30	R-30	
	Single rafter	U-0.034	R-30	R-30	
	Surface reflectance/emittance	No recommendation		0.65 initial/0.86	
Walls	Mass (HC>7 Btu/ft^2)	U-0.58	NR	R-7.6 c.i.	
	Metal building	U-0.113	R-13	R-13	
	Steel framed	U-0.124	R-13	R-13	
	Wood framed and other	U-0.089	R-13	R-13	
	Below-grade walls	C-1.40		Comply with Standard 90.1	
Floors	Mass	U-0.137	R-4.2 c.i.	R-6.3 c.i.	
	Steel framed	U-0.052	R-19	R-19	
	Wood framed and other	U-0.051	R-19	R-19	
Slabs	Unheated	F-0.73	NR	Comply with Standard 90.1	
	Heated	F-1.020	R-7.5 for 12 in.	R-7.5 for 12 in.	
Doors	Swinging	U-0.70	NR	U-0.70	
	Non-swinging	U-1.45	NR	U-1.45	
Vertical Glazing	Window to wall ratio (WWR)	50% maximum		20% - 40%	
	Thermal transmittance	Fixed	Operable	U-0.45	
		U-1.22	U-1.27		
	Solar heat gain coefficient (SHGC)	0-40%: 0.25 all / 0.61 North 40-50%: 0.17 all / 0.44 North		N, S, E, W - 0.31	N only - 0.44
	Window orientation	Directional		(A_N*$SHGC_N$+A_S*$SHGC_S$)> (A_E*$SHGC_E$+A_W*$SHGC_W$)	
	Exterior sun control (S, E, W only)	Based on PF		Projection factor (PF) 0.5	
Skylights	Maximum percent of roof area	0%-2%	2.1%-5%	3%	
	Thermal transmittance	U-1.36	U-1.36	U-1.36	
	Solar heat gain coefficient (SHGC)	0.36	0.19	0.19	

Table A 6 (cont.) - Clinic Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004	AEDG Recommendation (use Office Recommendation)
Int. Lighting	Lighting power density (LPD)	1.0 W/ ft^2	0.9 W/ft^2
	Light source (linear fluorescent)	Varies	90 mean lumens/watt
	Ballast		Electronic ballast
	Dimming controls for daylight Harvesting for WWR ≥ 25%		Dim fixtures within 12 ft of N/S window wall or within 8 ft of skylight edge
	Interior room surface reflectances		80%+ on ceilings, 70%+ on walls and vertical partitions
	Additional LPD for adjustable lighting equipment that is specifically designed to highlight merchandise and is controlled separately.		0.4 W/ft^2 (spaces not listed below) 0.6 W/ft^2 (sporting goods, small electronics) 0.9 W/ft^2 (furniture, clothing, cosmetics, artwork) 1.5 W/ft^2 (jewelry, crystal, china)
HVAC	Air conditioner (0-65 Kbtuh)	13.0 SEER	13.0 SEER
	Air conditioner (≥65-135 Kbtuh)	9.9 EER	11.3 EER / 11.5 IPLV
	Air conditioner (≥135-240 Kbtuh)	9.3 EER	11.0 EER / 11.5 IPLV
	Air conditioner (≥240-760 Kbtuh)	9.5 EER / 9.7 IPLV	10.6 EER / 11.2 IPLV
	Air conditioner (≥760 Kbtuh)	9.2 EER / 9.4 IPLV	10.6 EER / 11.2 IPLV
	Gas furnace (0-225 Kbtuh – SP)	78% AFUE or 80% E_t	80% AFUE or E_t
	Gas furnace (0-225 Kbtuh – Split)	78% AFUE or 80% E_t	80% AFUE or E_t
	Gas furnace (≥225 Kbtuh)	80% E_c	80% E_c
	Heat pump (0-65 Kbtuh)	13 SEER / 7.7 HSPF	13 SEER / 7.7 HSPF
	Heat pump (≥65-135 Kbtuh)	9.9 EER / 3.2 COP	10.6 EER / 11.0 IPLV / 3.2 COP
	Heat pump (≥135 - 240 Kbtuh)	9.1 EER / 3.1 COP	10.1 EER / 11.5 IPLV / 3.1 COP
	Heat pump (≥240 Kbtuh)	8.8 EER / 9.0 IPLV / 3.1 COP	10.1 EER / 11.5 IPLV / 3.1 COP
Economizer	Air conditioners/heat pumps - SP	No recommendation	No recommendation
Ventilation	Outdoor air damper	Motorized control	Motorized control
	Demand control	CO_2 sensors	CO_2 sensors
Ducts	Friction rate	No recommendation	0.08 in. w.c. / 100 feet
	Sealing	Seal class C	Seal class B
	Location	No recommendation	Interior only
	Insulation level	R-6	R-6
Service Water Heater	Gas storage	90% E_t(Q/800+√110V)	90% E_t
	Gas instantaneous	90% E_t(Q/800+√110V)	0.81 EF or 81% E_t
	Electric storage 12 kW	EF > 0.93 – 0.0032V	EF > 0.99 – 0.0012*Volume
	Pipe insulation (d<1 ½ in/d >1 ½ in)	½ in. / 1 in	1 in. / 1 ½ in.

Table A 7 - Supermarket Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004		AEDG Recommendation	
		U-max	R-min		
Roof	Insulation entirely above deck	U-0.063	R-15 c.i.	R-15 c.i.	
	Metal building	U-0.065	R-19	R-19	
	Attic and other	U-0.034	R-30	R-30	
	Single rafter	U-0.034	R-30	R-30	
	Surface reflectance/emittance	No recommendation		0.65 initial/0.86	
Walls	Mass (HC>7 Btu/ft^2)	U-0.58	NR	R-7.6 c.i.	
	Metal building	U-0.113	R-13	R-13	
	Steel framed	U-0.124	R-13	R-13	
	Wood framed and other	U-0.089	R-13	R-13	
	Below-grade walls	C-1.40		Comply with Standard 90.1	
Floors	Mass	U-0.137	R-4.2 c.i.	R-6.3 c.i.	
	Steel framed	U-0.052	R-19	R-19	
	Wood framed and other	U-0.051	R-19	R-19	
Slabs	Unheated	F-0.73	NR	Comply with Standard 90.1	
	Heated	F-1.020	R-7.5 for 12 in.	R-7.5 for 12 in.	
Doors	Swinging	U-0.70	NR	U-0.70	
	Non-swinging	U-1.45	NR	U-1.45	
Vertical Glazing	Window to wall ratio (WWR)	50% maximum		20% - 40%	
	Thermal transmittance	Fixed	Operable	U-0.45	
		U-1.22	U-1.27		
	Solar heat gain coefficient (SHGC)	0-40%: 0.25 all / 0.61 North 40-50%: 0.17 all / 0.44 North		N, S, E, W - 0.31	N only - 0.44
	Window orientation	Directional		(A_N*$SHGC_N$+A_S*$SHGC_S$)> (A_E*$SHGC_E$+A_W*$SHGC_W$)	
	Exterior sun control (S, E, W only)	Based on PF		Projection factor (PF) 0.5	
Skylights	Maximum percent of roof area	0%-2%	2.1%-5%	3%	
	Thermal transmittance	U-1.36	U-1.36	U-1.36	
	Solar heat gain coefficient (SHGC)	0.36	0.19	0.19	

Table A 7 (cont.) - Supermarket Building Envelope Specifications for Zone 2

Item	Component	ASHRAE 90.1 2004	AEDG Recommendation
Int. Lighting	Lighting power density (LPD)	1.0 W/ ft^2	0.9 W/ft^2
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	Ballast		Electronic ballast
	Dimming controls for daylight Harvesting for WWR ≥ 25%		Dim fixtures within 12 ft of N/S window wall or within 8 ft of skylight edge
	Interior room surface reflectances		80%+ on ceilings, 70%+ on walls and vertical partitions
	Additional LPD for adjustable lighting equipment that is specifically designed to highlight merchandise and is controlled separately.		0.4 W/ft^2 (spaces not listed below) 0.6 W/ft^2 (sporting goods, small electronics) 0.9 W/ft^2 (furniture, clothing, cosmetics, artwork) 1.5 W/ft^2 (jewelry, crystal, china)
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	Air conditioner (≥65-135 Kbtuh)	9.9 EER	11.3 EER / 11.5 IPLV
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	Air conditioner (≥240-760 Kbtuh)	9.5 EER / 9.7 IPLV	10.6 EER / 11.2 IPLV
	Air conditioner (≥760 Kbtuh)	9.2 EER / 9.4 IPLV	10.6 EER / 11.2 IPLV
	Gas furnace (0-225 Kbtuh – SP)	78% AFUE or 80% E_t	80% AFUE or E_t
	Gas furnace (0-225 Kbtuh – Split)	78% AFUE or 80% E_t	80% AFUE or E_t
	Gas furnace (≥225 Kbtuh)	80% E_c	80% E_c
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Economizer	Air conditioners/heat pumps - SP	No recommendation	No recommendation
Ventilation	Outdoor air damper	Motorized control	Motorized control
	Demand control	CO_2 sensors	CO_2 sensors
Ducts	Friction rate	No recommendation	0.08 in. w.c. / 100 feet
	Sealing	Seal class C	Seal class B
	Location	No recommendation	Interior only
	Insulation level	R-6	R-6
Service Water Heater	Gas storage	90% E_t(Q/800+√110V)	90% E_t
	Gas instantaneous	90% E_t(Q/800+√110V)	0.81 EF or 81% E_t
	Electric storage 12 kW	EF > 0.93 – 0.0032V	EF > 0.99 – 0.0012*Volume
	Pipe insulation (d<1 ½ in/d >1 ½ in)	½ in. / 1 in	1 in. / 1 ½ in.