I CAN'T LOOK AT IT ALL!

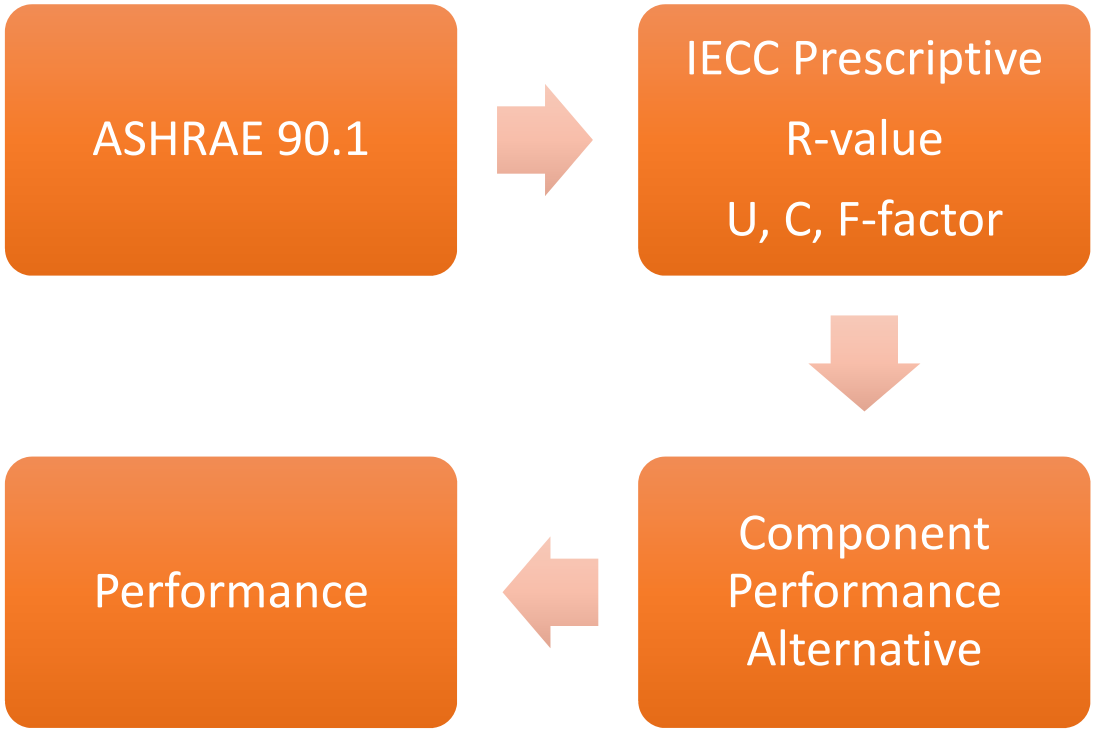
Where Should I direct my Focus in Commercial Buildings?

So much code, so little time

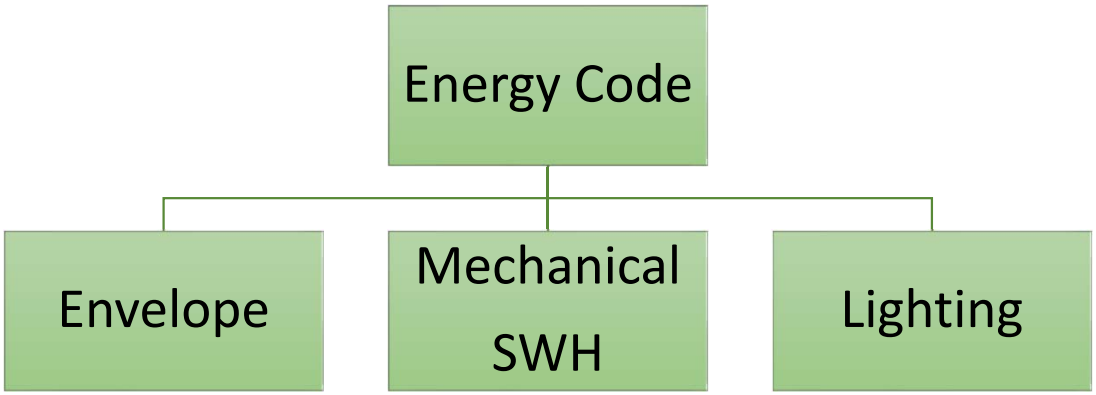
- Building
- Fire
- MEP
- Accessibility
- Energy

So much code, so little time

So many options



No energy for ENERGY



Building envelope values and fenestration areas determined in accordance with Equation 4-2 shall be permitted in lieu of compliance with the U-, F- and C-factors in Tables C402.1.3 and C402.1.4 and the maximum allowable fenestration areas in Section C402.4.1.

Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44°F (7°C) leaving chilled-water temperature and 2.4 gpm/ton evaporator fluid flow and 85°F (29°C) entering condenser water temperature with 3 gpm/ton (0.054 l/s • kW) condenser water flow shall have maximum full-load kW/ton (FL) and part-load ratings requirements adjusted using Equations 4-6 and 4-7.

$FL_{adj} = FL/K_{adj}$ **(Equation 4-6)**

$PLV_{adj} = IPLV/K_{adj}$ **(Equation 4-7)**

where:

K_{adj} = $A \times B$

FL = Full-load kW/ton value as specified in Table C403.2.3(7).

FL_{adj} = Maximum full-load kW/ton rating, adjusted for nonstandard conditions.

$IPLV$ = Value as specified in Table C403.2.3(7).

PLV_{adj} = Maximum *NPLV* rating, adjusted for nonstandard conditions.

A = $0.00000014592 \cdot (LIFT)^4 - 0.0000346496 \cdot (LIFT)^3 + 0.00314196 \cdot (LIFT)^2 - 0.147199 \cdot (LIFT) + 3.9302$

B = $0.0015 \cdot L_{vg}E_{vap} + 0.934$

$LIFT$ = $L_{vg}Cond - L_{vg}E_{vap}$

$L_{vg}Cond$ = Full-load condenser leaving fluid temperature (°F).

$L_{vg}E_{vap}$ = Full-load evaporator leaving temperature (°F).

The FL_{adj} and PLV_{adj} values are only applicable for centrifugal chillers meeting all of the following full-load design ranges:

1. Minimum evaporator leaving temperature: 36°F.
2. Maximum condenser leaving temperature: 115°F.
3. 20°F ≤ *LIFT* ≤ 80°F.

UAS = Sum of the (UA Proposed) values for each skylight assembly.
US = UAS/total skylight area.

What happens to a code book that you don’t understand?

Leaving us with efficiency on paper only

$$\text{efficiency} = \frac{\text{useful energy out}}{\text{total energy in}}$$

Keep it simple

A Top 10 Approach to Energy Code Compliance

Colorado Energy Office and Colorado Code Consulting in association with Group 14 Engineering

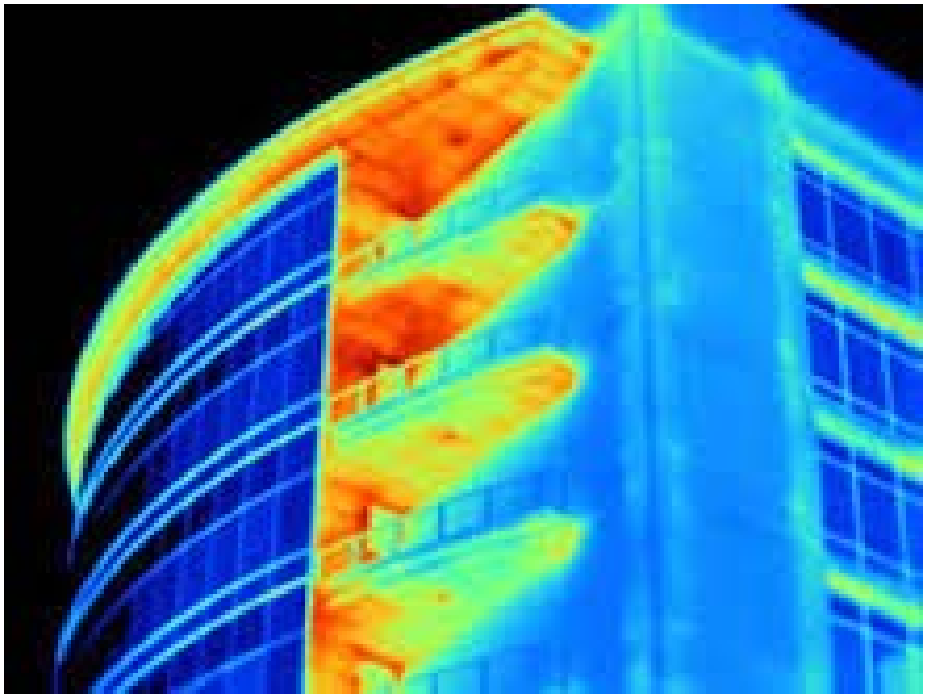
Energy Code Compliance for Commercial Buildings

Our 2016 Study

Why did we do the study?

- A new way to meet ARRA Requirements
- To take a complex code and make it useable
- To give the code official an alternative way to do their job
- To actually get better efficiency in buildings and not just on paper
- Commercial buildings hadn't really been looked at this way

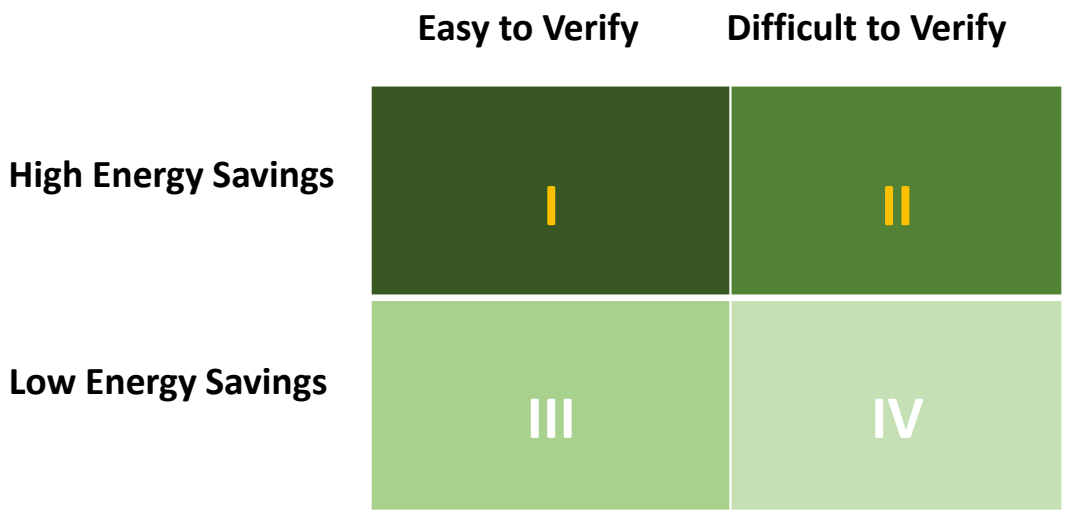
How are commercial buildings consuming energy?



Energy Cost Savings

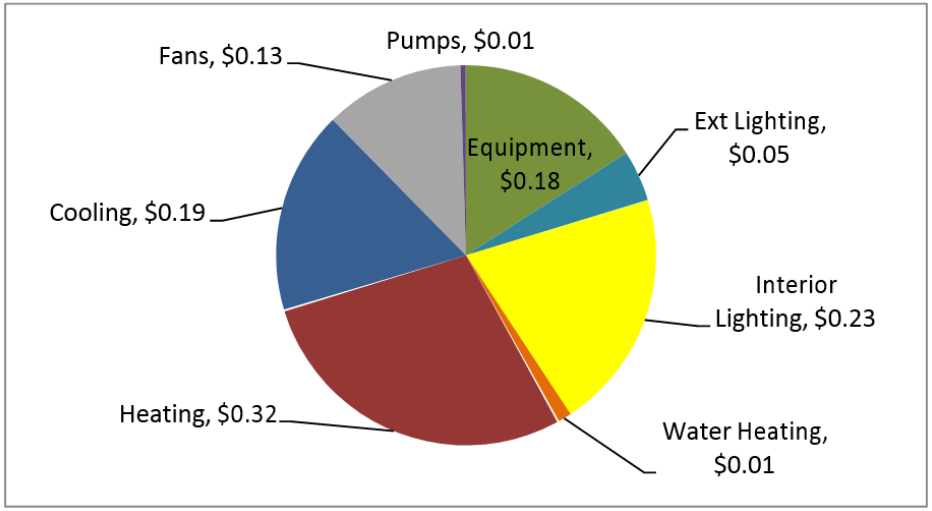
VS

Difficulty in Verification & Enforcement

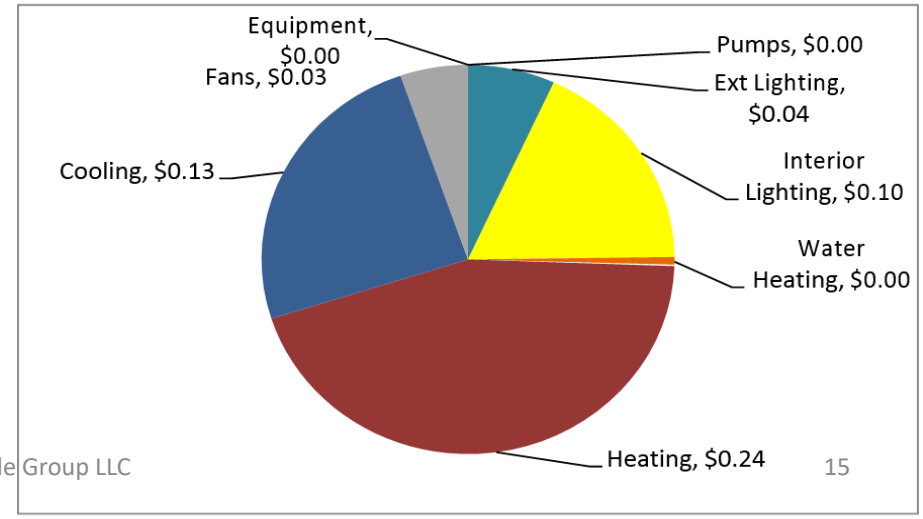


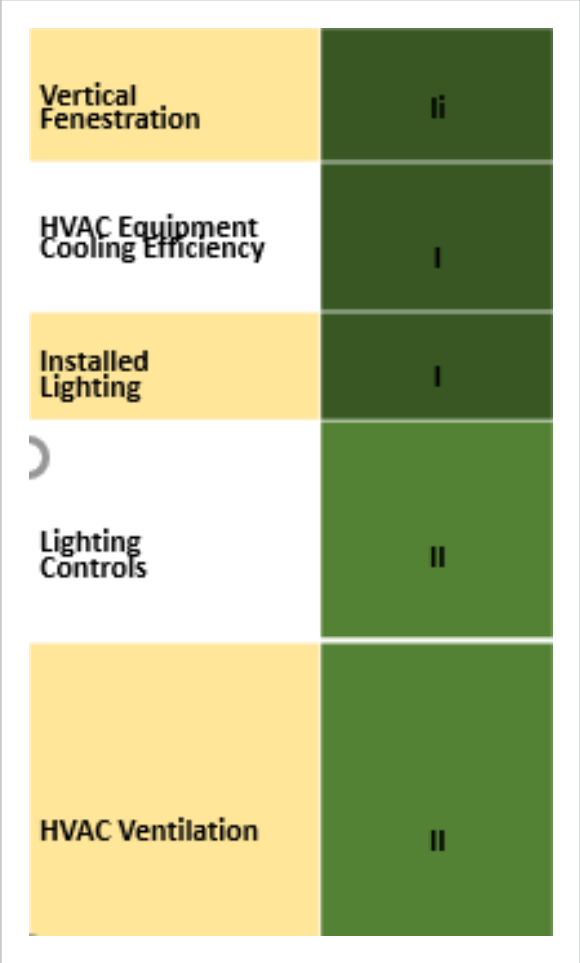
E
D
U
C
A
T
I
O
N

Energy Use Breakdown, $/SF



Energy Savings Breakdown, $/SF





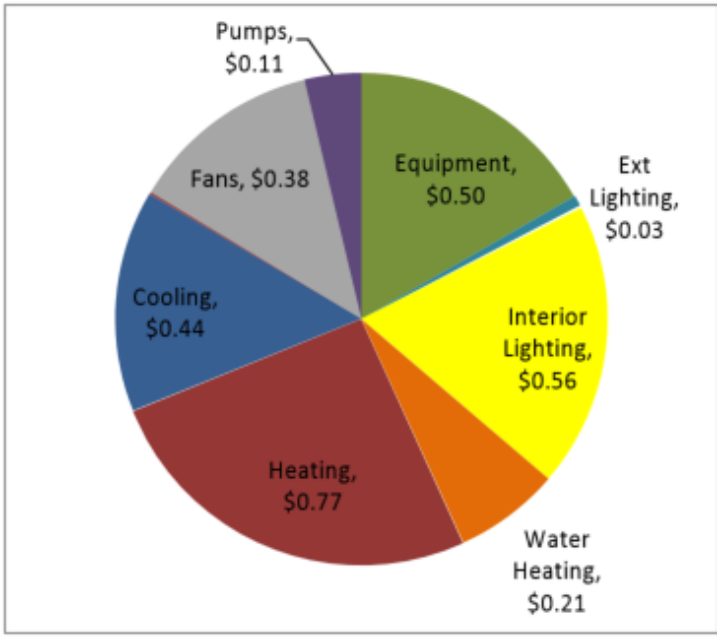
Recommended Educational Building Energy Conservation Measures

Recommended Educational Building Energy Conservation Measures

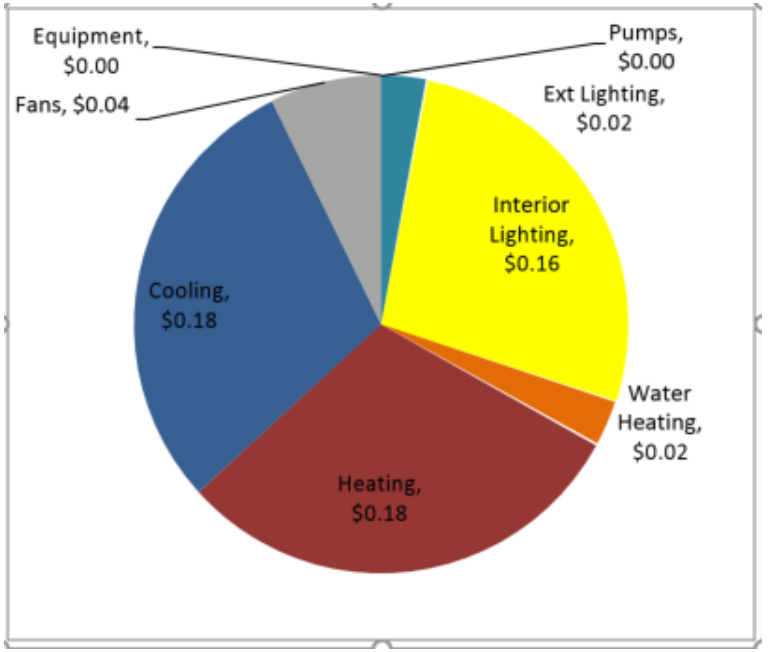
Measure	Measure Category	Measure Description
Service Hot Water Equipment	III	**Service hot water equipment is easy to verify through submittal reviews, but service water heating costs are so low in educational buildings there is little impact.**
Wall and Roof Insulation	II	**While educational buildings tend to have a high ratio of exterior wall area to interior space, glazing improvements, lighting controls and energy recovery are far more cost effective energy conservation measures.**
Service Hot Water Controls	IV	**Controls to reduce service water heating energy use would require functional testing to verify and save very little.**

Healthcare

Energy Use Breakdown, $/SF



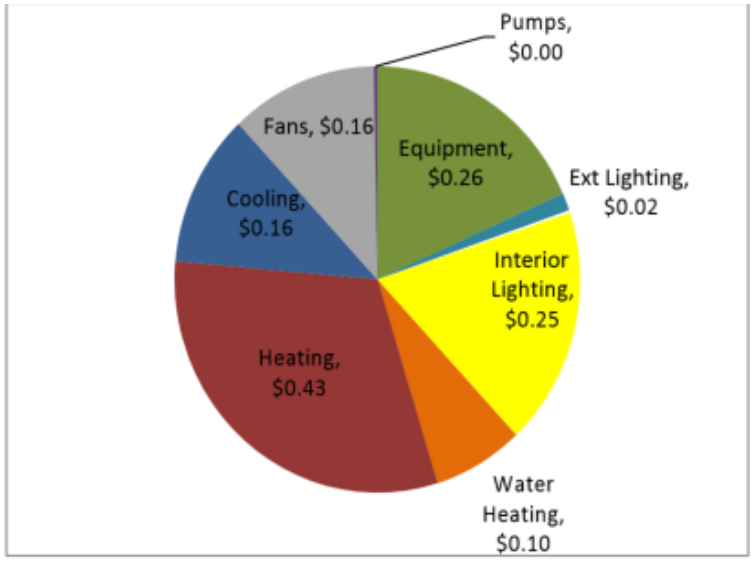
Energy Savings Breakdown, $/SF



Measure	Measure Category	Measure Notes
HVAC Controls	II	High air change requirements with multizone systems (VAVs) typically result in very high reheat loads. Mandating demand-based discharge air reset controls can significantly reduce heating energy use, but requires functional testing and trend analysis to verify and fine tune. Duct static pressure reset sequences are also critical to reducing fan energy use in large, central air handling systems frequently used in hospitals.
Free Cooling	II	Hospitals have a relatively high amount of core space, resulting in year-round cooling requirements. Air-side or water-side "free" cooling systems (economizers) can significantly reduce cold weather energy use and should be encouraged. Economizers typically require seasonal functional testing to verify that they are operating correctly.
Lighting Occupancy Controls	II	Higher space-by-space lighting requirements and intermittent use of many small rooms make occupancy or vacancy lighting sensors impactful in hospitals. Occupancy sensors should be functionally tested to verify the sensors are programmed per the design.
Service Hot Water Equipment	III	Service hot water equipment is easy to verify through submittal reviews, and service hot water requirements are higher in hospital buildings. Energy savings would be small relative to other measures, but inexpensive to implement.
Vertical Fenestration	III	Heating and cooling loads in hospitals are driven by air change requirements and internal gains, so glass selection plays less of a role, but low SHGC glass can still reduce cooling.

HOTELS AND HOSPITALITY

Energy Use Breakdown, $/SF



Energy Savings Breakdown, $/SF

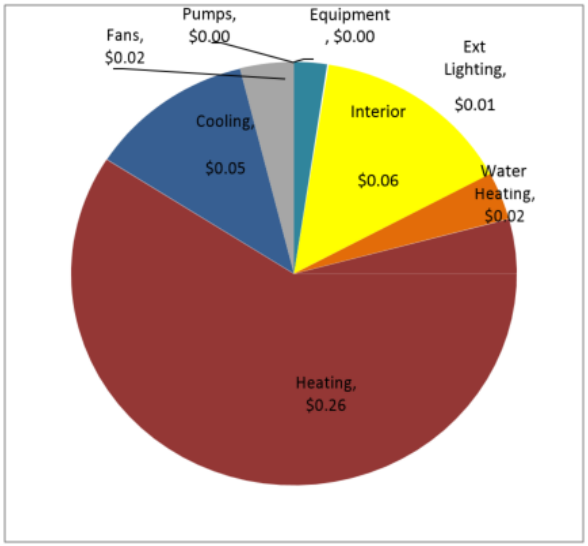
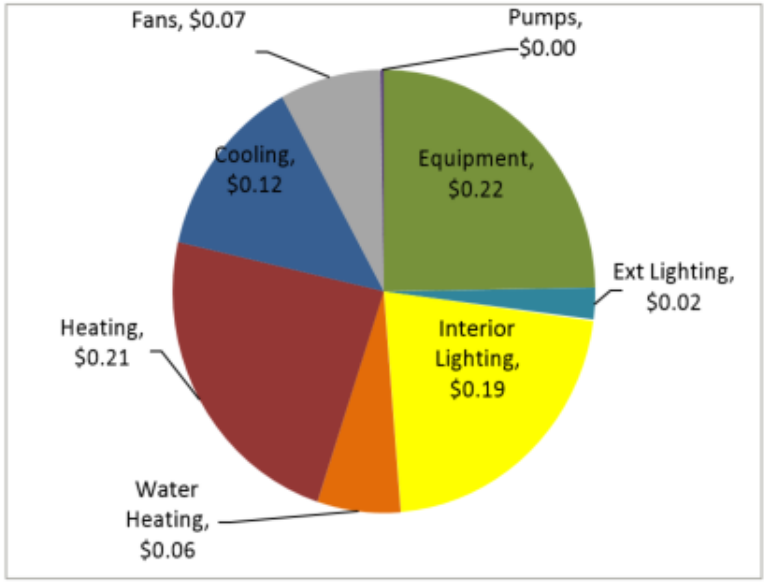


Table 5 – Recommended Hotel Energy Conservation Measures

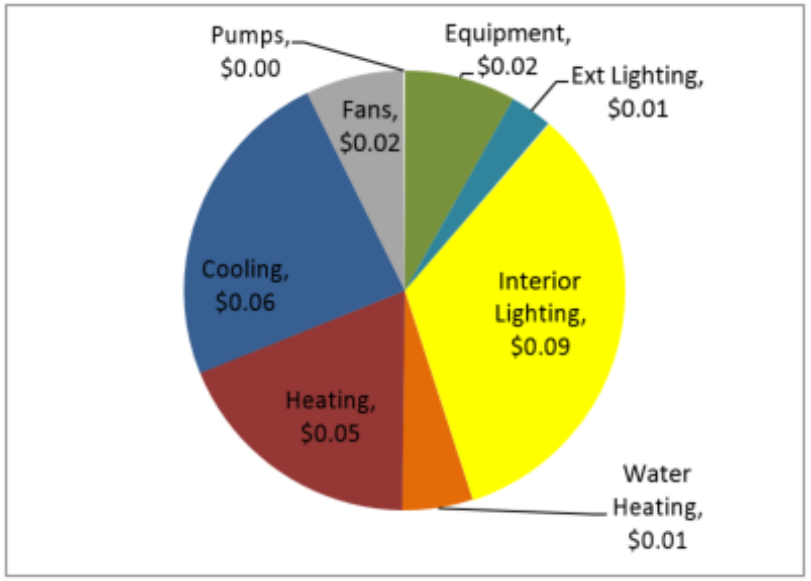
Measure	Measure Category	Measure Notes
Installed Lighting	I	Strict lighting allowances have a high impact on nearly all building types, and can be verified through design and submittal reviews. It is important that lighting requirements apply to portable lighting installed in the guest rooms in addition to hardwired lighting.
Vertical Fenestration: Glazing Area	I	Reducing the window-to-wall area ratio can have a significant impact on reducing total loads on hotel buildings. In-unit HVAC systems tend to be small and less efficient, so reducing the loads in the space in the first place is an easy way to conserve energy.
HVAC Ventilation – Energy Recovery	II	Guest rooms are required to have continuous mechanical ventilation, 24 hours per day. This makes energy recovery on the guest room ventilation cost effective. It is common for hotels to have electric heat pump or fan coils in the guest rooms. Splitting the ventilation system from the guest room conditioning unit provides an opportunity for heat recovery and often reduces electric heating.
Guest Room Occupancy Controls	II	Occupancy rates vary by hotel but are typically around 60%. Occupancy controls that lock out lighting, increase the guest room temperature deadband or set back ventilation rates ensure empty guest rooms don't waste energy.
High Efficiency Service Water Heaters	III	Hotels generally have central water heaters. While the savings potential from high efficiency water heaters isn't great, they are relatively inexpensive to install and easy to verify.

HIGH RISE MULTIFAMILY

Energy Use Breakdown, $/SF



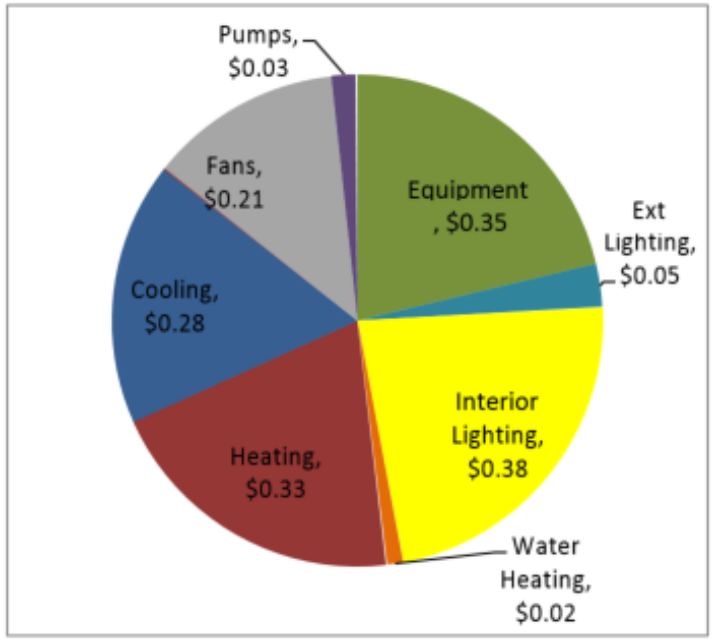
Energy Savings Breakdown, $/SF



Measure	Measure Category	Measure Notes
Installed Lighting	I	Strict lighting allowances have a high impact on nearly all building types, and can be verified through design and submittal reviews. Hardwired lighting in multifamily units usually uses less than what the resident would install themselves. Encouraging hardwired lighting in multifamily units can reduce lighting energy use.
Vertical Fenestration: Glazing Area	I	Reducing the window-to-wall area ratio can have a significant impact on reducing total loads on multifamily buildings. In-unit HVAC systems tend to be small and less efficient, so reducing the loads in the space in the first place is often the easiest way to conserve energy.
Vertical Fenestration: Performance	III	Insulating glass has become standard practice in multifamily. Low SHGC glass can reduce cooling loads, but due to low internal gains can increase heating energy use, offsetting the savings from low-SHGC glass.
HVAC Equipment Cooling Efficiency	III	Cooling is the second highest source of energy cost savings in multifamily. This is primarily from reduced lighting. Because total cooling costs are low, and there are many small systems that need to be upgraded to improve efficiency, improved unitary cooling efficiency is often not cost effective.
Corridor Ventilation	II	Corridors in multifamily buildings need to be conditioned and pressurized 24 hours per day. Keeping the minimum ventilation rate as low as possible while still keeping the corridors pressurized can reduce heating energy use. Examples include nighttime airflow setback or small fan coils conditioning the corridors. Ventilation airflow reduction strategies require functional testing to verify.
Service Hot Water Equipment (Central)	III	Domestic water heating costs are low in multifamily, but if central domestic water heaters are used, high efficiency water heaters are often cost effective. If the central domestic hot water heater is used for both space heating and potable water heating, condensing water heaters are recommended anyway due to lower return water temperatures and condensation issues.

OFFICE

Energy Use Breakdown, $/SF



Energy Savings Breakdown, $/SF

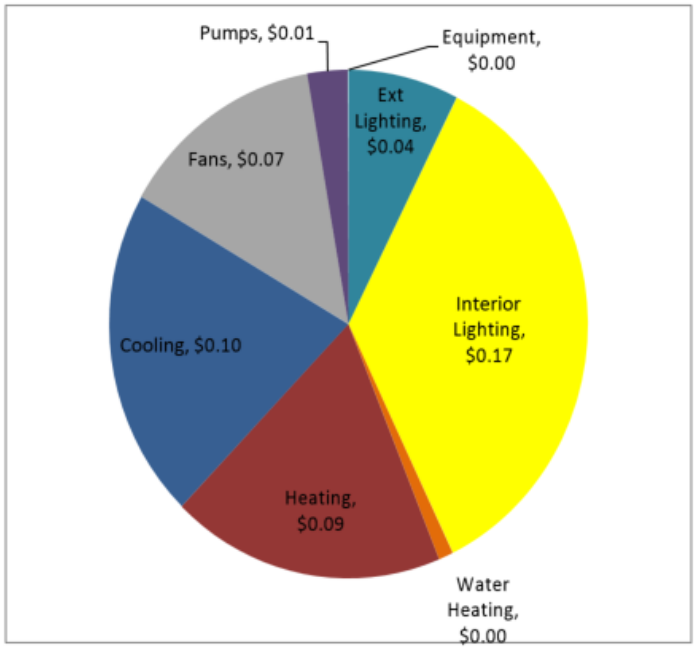


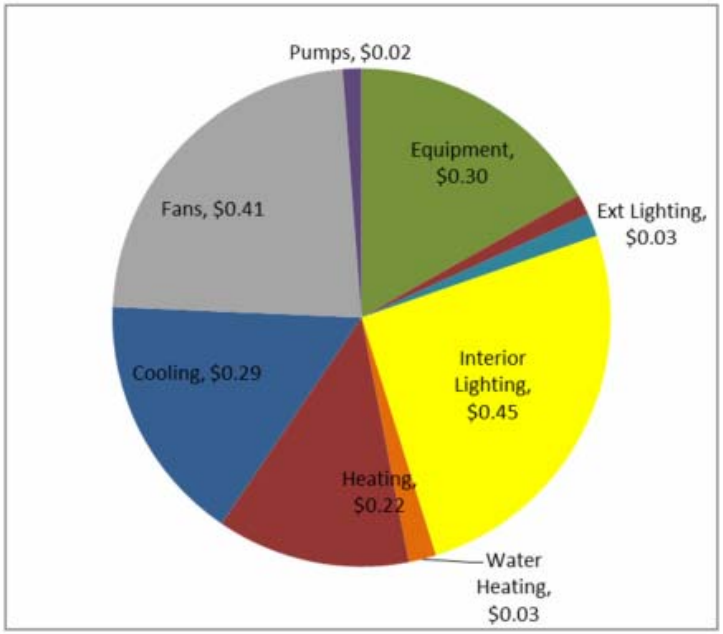
Table 9 – Recommended Office Energy Conservation Measures

Measure	Measure Category	Measure Notes
Installed Lighting	I	Strict lighting allowances have a high impact on nearly all building types, and can be verified through design and submittal reviews. Reduced area lighting supplemented with daylighting and task lights is the simplest and most effective way to conserve energy in offices.
Glazing Performance	I	Offices tend to be cooling dominated and have high window-to-wall area ratios. Reducing maximum allowed solar heat gain requirements would be easy to verify through submittal reviews and effective at reducing cooling energy use.
Lighting Occupancy Controls	II	Offices typically have a significant amount of area devoted to intermittently occupied spaces such as conference rooms, huddle spaces, break rooms and private offices. Motion sensors have been required in some of these spaces for several years, but additional requirements, such as vacancy sensors in perimeter private offices would likely increase savings. Lighting controls would require testing to verify.
Lighting Daylight Controls	II	The open plans and high window-to wall ratios make offices good candidates for automatic daylight dimming. Daylight dimming controls require tuning during construction and need to be verified through testing or trending.

Measure	Measure Category	Measure Notes
HVAC Demand Based Reset	II	Cyclical occupancy and variable heating and cooling loads mean airflow requirements vary significantly in offices. Duct static pressure reset sequences can conserve fan energy when airflow requirements are low, typically in cool or mild weather. Duct static reset sequences require functional testing to verify. A wide temperature reset sequence reduces reheat and fan energy, but also requires testing and tending to verify.

RETAIL

Energy Use Breakdown, $/SF



Energy Savings Breakdown, $/SF

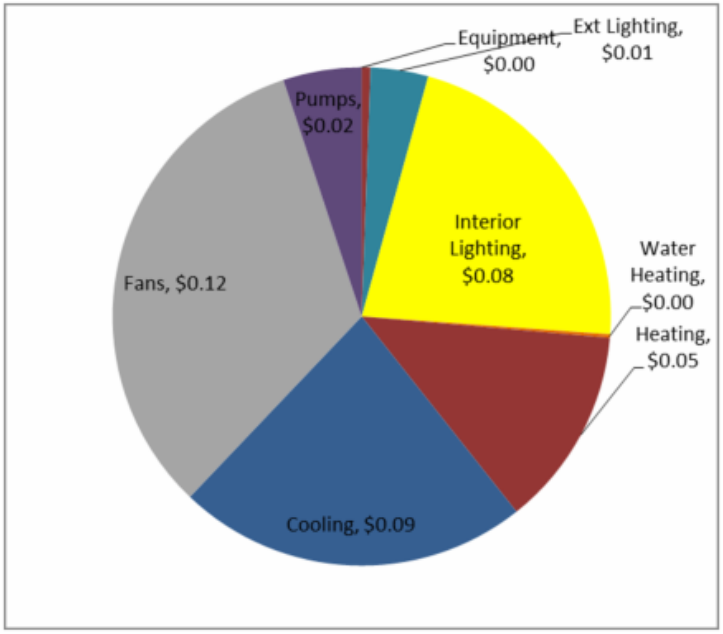
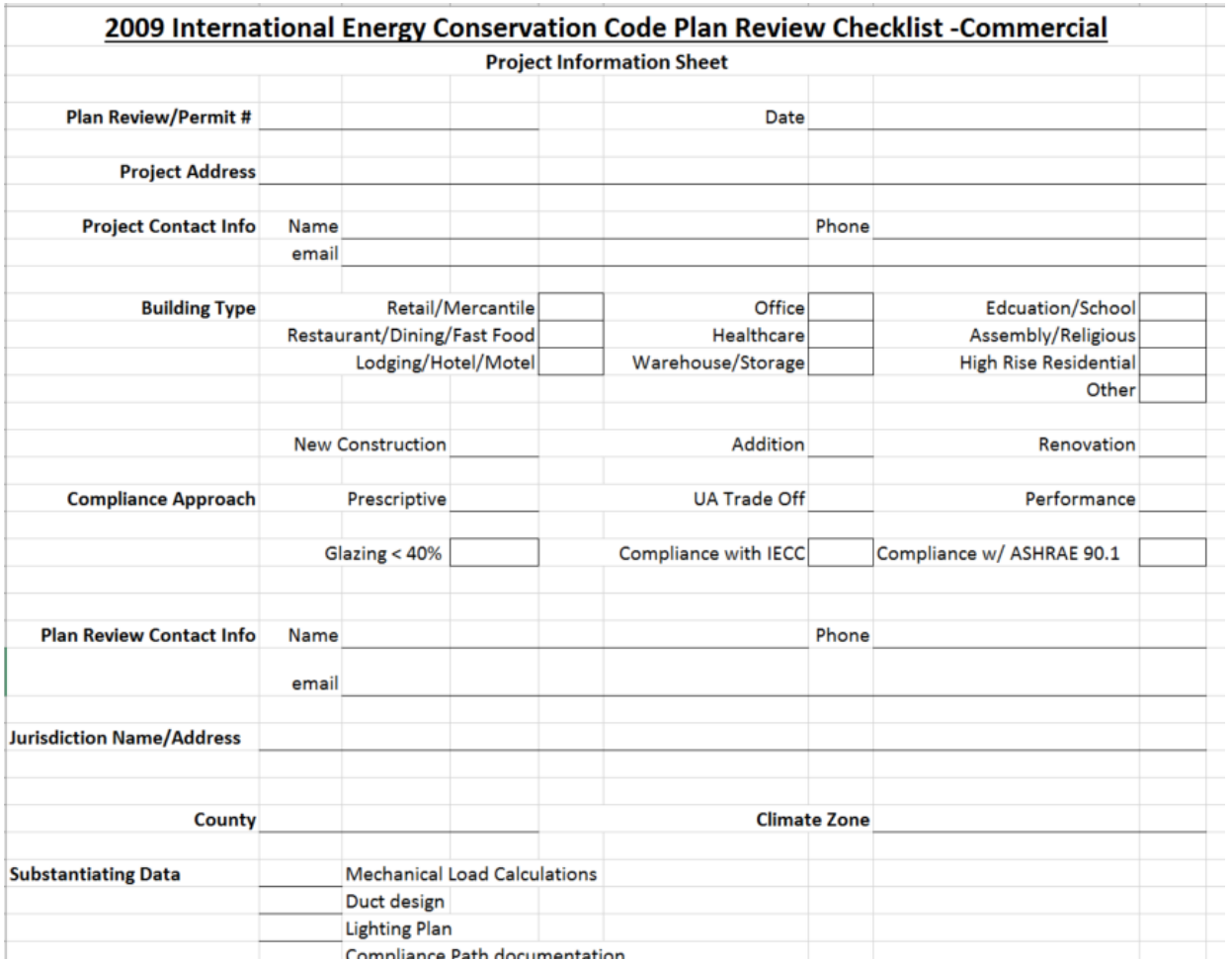


Table 11 – Recommended Retail Energy Conservation Measures

Measure	Measure Category	Measure Notes
Installed Lighting	I	Strict lighting allowances have a high impact on nearly all building types, and can be verified through design and submittal reviews. Reduced area lighting supplemented with daylighting and task lights is the simplest and most effective way to conserve energy in retail.
Lighting Occupancy Controls	II	Retail typically has intermittently occupied spaces such as conference rooms, active storage, break rooms and private offices. Motion sensors, such as requiring vacancy sensors in back-of-house spaces, would likely increase savings. Lighting controls require testing to verify.
Lighting Daylight Controls	II	The open plans make retail good candidates for automatic daylight dimming. Daylight dimming controls require tuning during construction and need to be verified through testing or trending.
HVAC Ventilation	II	High efficiency air distributions systems, which could include either oversized ductwork or efficient fan wall systems can result in significant energy savings, but final fan power must be verified following the test, adjust and balance (TAB) process. If fan power limitations are written into an energy code, it is unclear how it would be enforced if required fan power ends up being higher than the design fan power.
HVAC Demand Based Reset	II	Cyclical occupancy and variable heating and cooling loads mean airflow requirements vary significantly in retail. Duct static pressure reset sequences can conserve fan energy when airflow requirements are low, typically in cool or mild weather. Duct static reset sequences require functional testing to verify. A wide temperature reset sequence reduces reheat and fan energy, but also requires testing and tending to verify.
HVAC Equipment Cooling Efficiency	II	Cooling is the fourth highest source of energy cost savings seen in retail buildings. While cooling savings include lighting and envelope measures, equipment efficiency can make a significant difference.

The Checklist



2009 International Energy Conservation Code Plan Review Checklist -Commercial

Project Information Sheet

Plan Review/Permit # _____ Date _____

Project Address _____

Project Contact Info Name _____ Phone _____

email _____

Building Type

Retail/Mercantile		Office		Edcuation/School	
Restaurant/Dining/Fast Food		Healthcare		Assembly/Religious	
Lodging/Hotel/Motel		Warehouse/Storage		High Rise Residential	
				Other	

New Construction		Addition		Renovation	

Compliance Approach

Prescriptive		UA Trade Off		Performance	
Glazing < 40%		Compliance with IECC		Compliance w/ ASHRAE 90.1	

Plan Review Contact Info Name _____ Phone _____

email _____

Jurisdiction Name/Address _____

County _____ **Climate Zone** _____

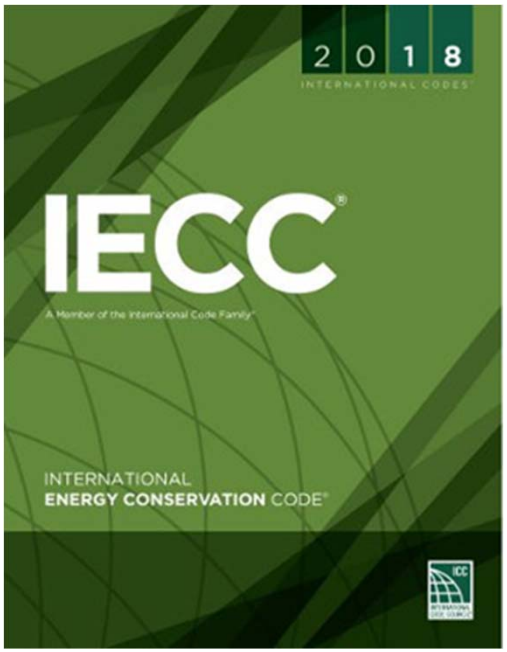
Substantiating Data

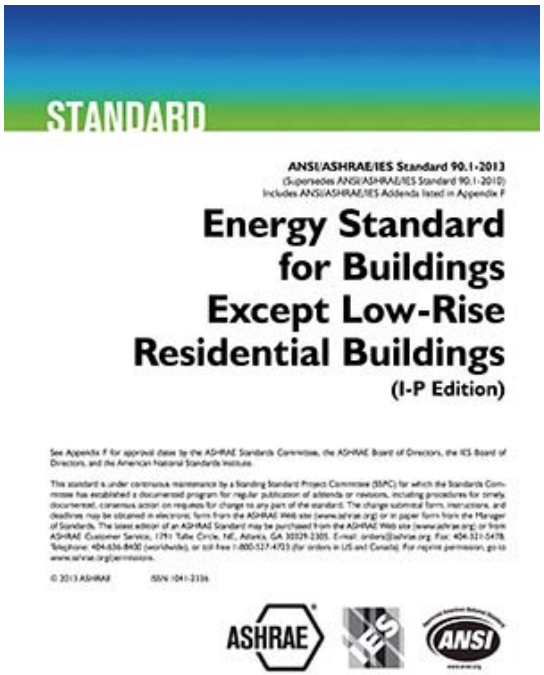
	Mechanical Load Calculations
	Duct design
	Lighting Plan
	Compliance Path documentation

COMPLIANCE CHECKLIST

2009 IECC Section #	Mechanical Rough-In Inspection	Plans Verified Value	Field Verified Value	Complies?	Comments I Assumptions
503.2.3 [ME1]2	HVAC equipment cooling efficiency verified **Efficiency:**			□Complies □Does Not Comply □Not Observable □Not Applicable	
503.2.4.4 [ME4]3	Outdoor air and exhaust systems have motorized dampers that automatically shut when not in use and meet maximum leakage rates. Check gravity dampers where allowed.			□Complies □Does Not Comply □Not Observable □Not Applicable	
503.2.5.1	Demand control ventilation provided for spaces > 500 ft2 and > 40 people/1000 ft2 occupant density and served by systems with air side economizer, auto modulating outside air damper control or design airflow > 3,000 cfm			□Complies □Does Not Comply □Not Observable □Not Applicable	
503.3.1, 503.41 [ME12]1	Air economizers provided where required, meet the requirements for design capacity, control signal, and high-limit shut-off and integrated economizer control.			□Complies □Does Not Comply □Not Observable □Not Applicable	
503.4.2 [ME22]2	VAV fan motors > = 10 hp to be driven by variable speed drive, have a vane-axial fan with variable pitch blades, or have controls or devices to limit fan motor demand.	□VSD □Vane axial fan □Other	□VSD □Vane axial fan □Other	□Complies □Does Not Comply □Not Observable □Not Applicable	
503.2.6 [ME30]1	Exhaust air energy recovery on systems > = 5,000 cfm and 70% of design supply air.			□Complies □Does Not Comply □Not Observable □Not Applicable	

2009 IECC Section #	Rough-In Electrical Inspection			Complies?	Comments I Assumptions
505.2.2.2 [EL1]2	Automatic lighting control to shut off all building lighting installed in buildings > 5,000 ft2.			□Complies □Does Not Comply □Not Observable □Not Applicable	
505.2.2.1 [EL10iecc]1	Lighting controls installed to uniformly reduce the lighting load by at least 50%.	% area in compliance:		□Complies □Does Not Comply □Not Observable □Not Applicable	





What about the rest of the code?

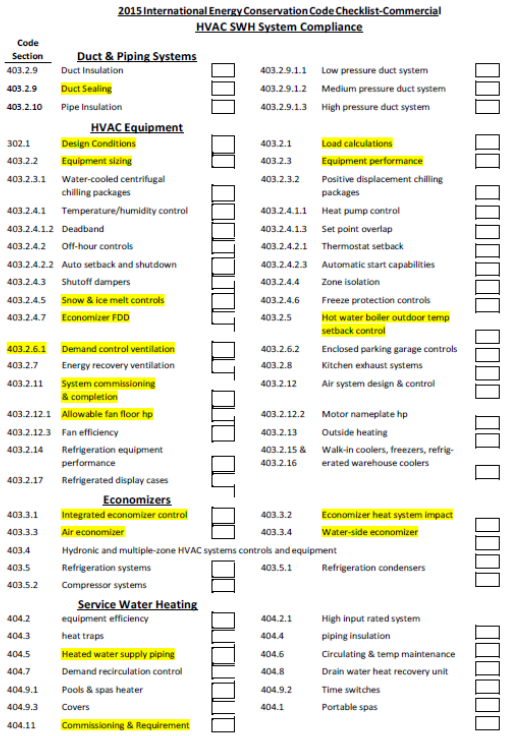
A foot in the door to full code compliance

This approach: One small step for man…

www.Colorado.gov/energycodes

Some other Resources

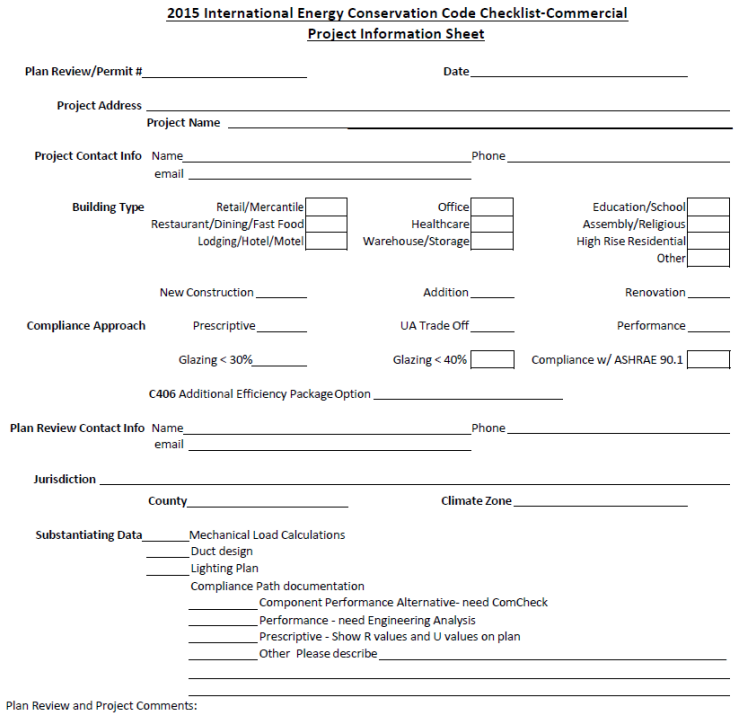
Top Items for Energy Code Plan Review



2015 International Energy Conservation Code Checklist-Commercial
HVAC SWH System Compliance

Code Section				
	Duct & Piping Systems			
403.2.9	Duct Insulation	☐	403.2.9.1.1	Low pressure duct system ☐
403.2.9	Duct Sealing	☐	403.2.9.1.2	Medium pressure duct system ☐
403.2.10	Pipe Insulation	☐	403.2.9.1.3	High pressure duct system ☐
	HVAC Equipment			
302.1	Design Conditions	☐	403.2.1	Load calculations ☐
403.2.2	Equipment sizing	☐	403.2.3	Equipment performance ☐
403.2.3.1	Water-cooled centrifugal chilling packages	☐	403.2.3.2	Positive displacement chilling packages ☐
403.2.4.1	Temperature/humidity control	☐	403.2.4.1.1	Heat pump control ☐
403.2.4.1.2	Deadband	☐	403.2.4.1.3	Set point overlap ☐
403.2.4.2	Off-hour controls	☐	403.2.4.2.1	Thermostat setback ☐
403.2.4.2.2	Auto setback and shutdown	☐	403.2.4.2.3	Automatic start capabilities ☐
403.2.4.3	Shutoff dampers	☐	403.2.4.4	Zone isolation ☐
403.2.4.5	Snow & ice melt controls	☐	403.2.4.6	Freeze protection controls ☐
403.2.4.7	Economizer FDD	☐	403.2.5	Hot water boiler outdoor temp setback control ☐
403.2.6.1	Demand control ventilation	☐	403.2.6.2	Enclosed parking garage controls ☐
403.2.7	Energy recovery ventilation	☐	403.2.8	Kitchen exhaust systems ☐
403.2.11	System commissioning & completion	☐	403.2.12	Air system design & control ☐
403.2.12.1	Allowable fan floor hp	☐	403.2.12.2	Motor nameplate hp ☐
403.2.12.3	Fan efficiency	☐	403.2.13	Outside heating ☐
403.2.14	Refrigeration equipment performance	☐	403.2.15 & 403.2.16	Walk-in coolers, freezers, refrig-erated warehouse coolers ☐
403.2.17	Refrigerated display cases	☐		
	Economizers			
403.3.1	Integrated economizer control	☐	403.3.2	Economizer heat system impact ☐
403.3.3	Air economizer	☐	403.3.4	Water-side economizer ☐
403.4	Hydronic and multiple-zone HVAC systems controls and equipment			☐
403.5	Refrigeration systems	☐	403.5.1	Refrigeration condensers ☐
403.5.2	Compressor systems	☐		☐
	Service Water Heating			
404.2	equipment efficiency	☐	404.2.1	High input rated system
404.3	heat traps	☐	404.4	piping insulation ☐
404.5	Heated water supply piping	☐	404.6	Circulating & temp maintenance ☐
404.7	Demand recirculation control	☐	404.8	Drain water heat recovery unit ☐
404.9.1	Pools & spas heater	☐	404.9.2	Time switches ☐
404.9.3	Covers	☐	404.1	Portable spas ☐
404.11	Commissioning & Requirement	☐		

Full Energy Code Checklist



2015 International Energy Conservation Code Checklist-Commercial
Project Information Sheet

Plan Review/Permit #_____ **Date**_____

Project Address _____

Project Name _____

Project Contact Info Name_____ Phone_____
email _____

Building Type
Retail/Mercantile ☐ Office ☐ Education/School ☐
Restaurant/Dining/Fast Food ☐ Healthcare ☐ Assembly/Religious ☐
Lodging/Hotel/Motel ☐ Warehouse/Storage ☐ High Rise Residential ☐
Other ☐

New Construction _____ Addition _____ Renovation _____

Compliance Approach Prescriptive_____ UA Trade Off_____ Performance _____

Glazing < 30%_____ Glazing < 40% ☐ Compliance w/ ASHRAE 90.1 ☐

C406 Additional Efficiency Package Option _____

Plan Review Contact Info Name_____ Phone_____
email _____

Jurisdiction _____

County_____ **Climate Zone**_____

Substantiating Data_____Mechanical Load Calculations
_____Duct design
_____Lighting Plan
Compliance Path documentation
_____Component Performance Alternative- need ComCheck
_____Performance - need Engineering Analysis
_____Prescriptive - Show R values and U values on plan
_____Other Please describe _____

Plan Review and Project Comments:

Code adoption assistance, code training, research, code development, plan review, compliance studies, code resources

THANK YOU!!!

Presented by:

Shaunna Mozingo

President

The Mozingo Code Group LLC

sdmozingo@shaunnamozingo.com

Training sponsored by The Colorado Energy Office

COLORADO Energy Office