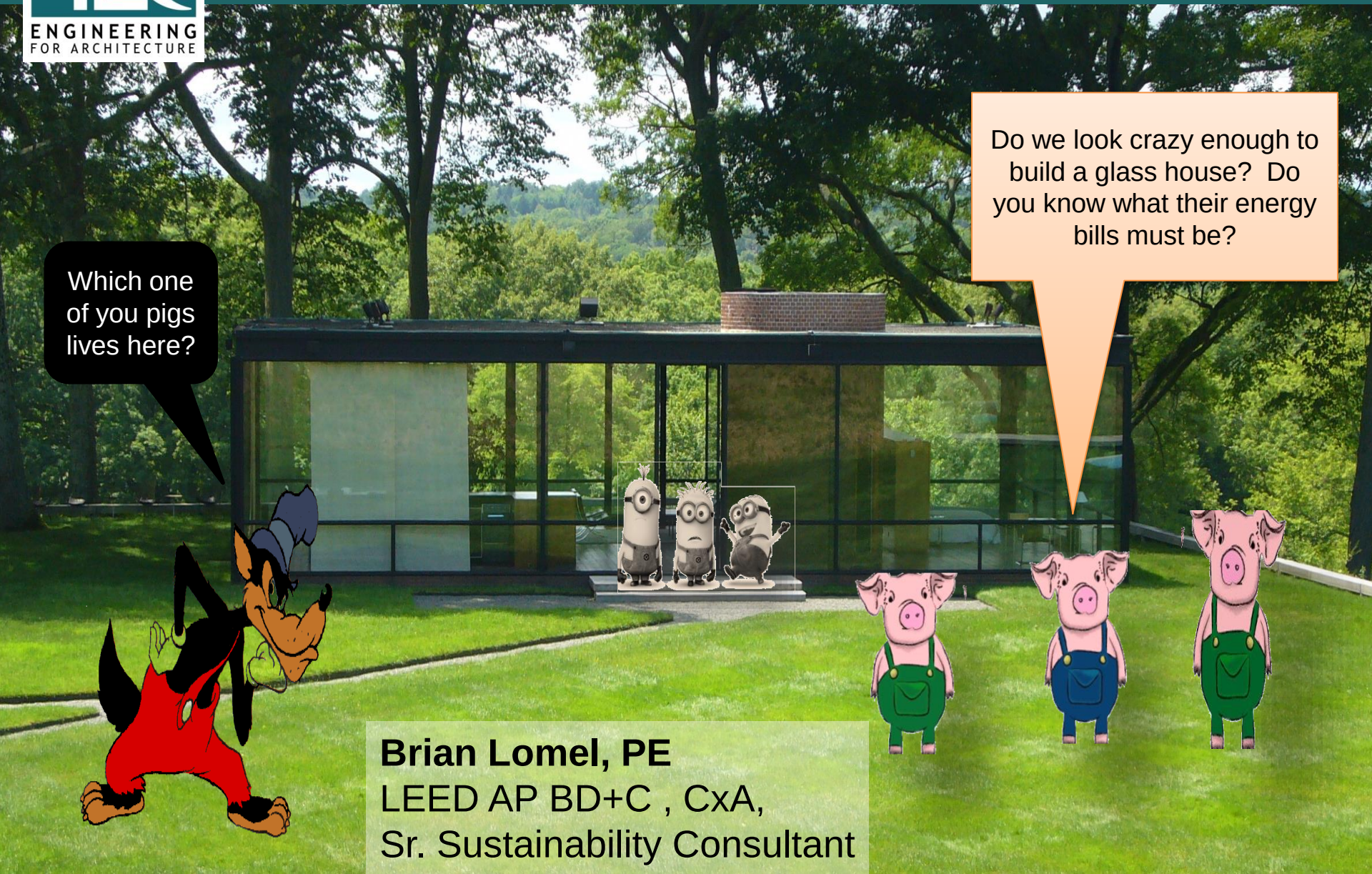
How Energy Codes are Changing the Shape of Architecture



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AABC Commissioning Group
AIA Provider Number: 50111116

How Energy Codes are Changing the Shape of Architecture

Course Number: CXENERGY1517

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TLC Engineering for Architecture

April 29, 2015

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Course Description

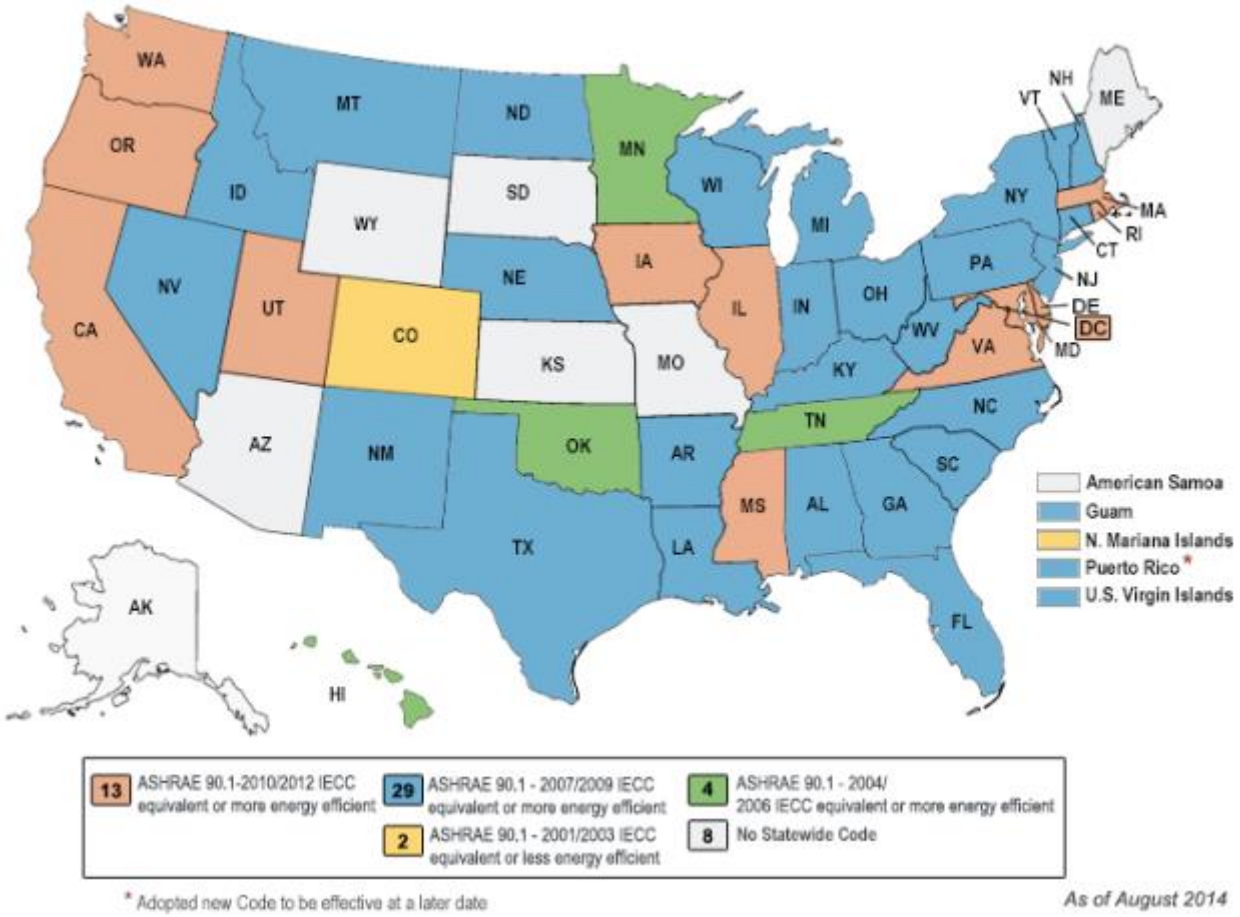
This session provides an overview of how the new Energy Codes, specifically IECC 2012 and ASHRAE 90.1 2010, are impacting the architecture, performance, and operation of buildings. The new codes represent the biggest increase in building energy performance requirements ever, and will change the way buildings are designed, constructed, and commissioned. The session will review the new energy codes' prescriptive and performance compliance paths, mandatory requirements, when they are applicable, and how to implement on projects.

Learning Objectives

At the end of the this course, participants will be able to:

1. Learn how energy codes and standards IECC 2012 and ASHRAE 90.1 2010 are impacting the architecture, performance, and operation of buildings.
2. Understand why IECC 2012 and ASHRAE 90.1 2010 represent the biggest increase in building energy performance requirements ever, and will change the way buildings are designed, constructed, and commissioned.
3. Learn about IECC 2012 and ASHRAE 90.1 2010 prescriptive and performance compliance paths, mandatory requirements, when they are applicable.
4. Understand how to implement the provisions of IECC 2012 and ASHRAE 90.1 2010 on projects.

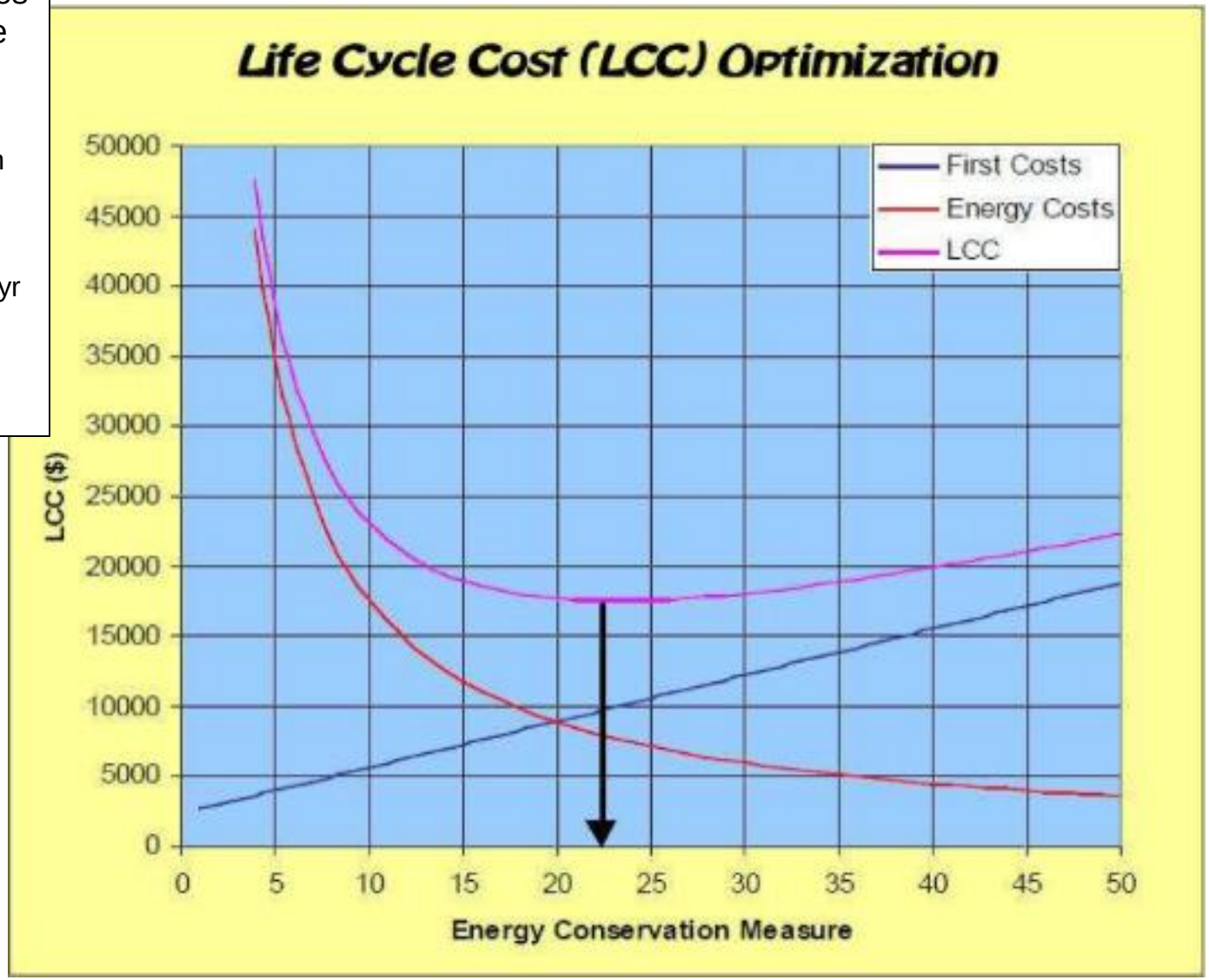
Commercial energy code adoptions



How do they determine what is reasonable?

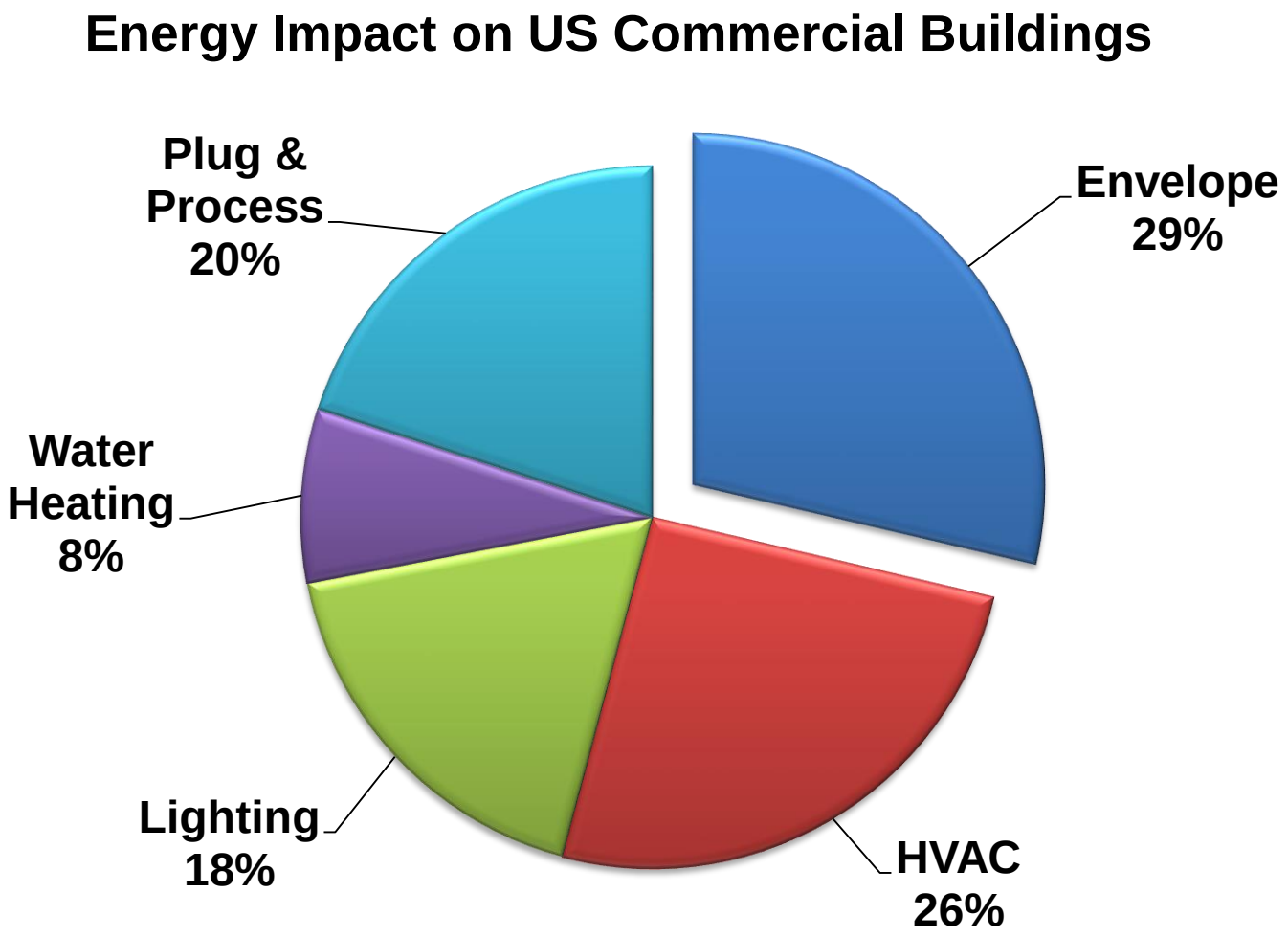
ASHRAE 90.1-2010 optimizes Life Cycle Costs under these assumptions:

- Fuel prices
  - Electricity $0.094/kWh
  - Gas $1.22/therm
- Projection assumptions
  - Cost escalation 3.7%/yr
  - State tax rates 5%
  - Discount rate 7%
  - Interest rate 7%



BUILDINGS USE A LOT OF ENERGY

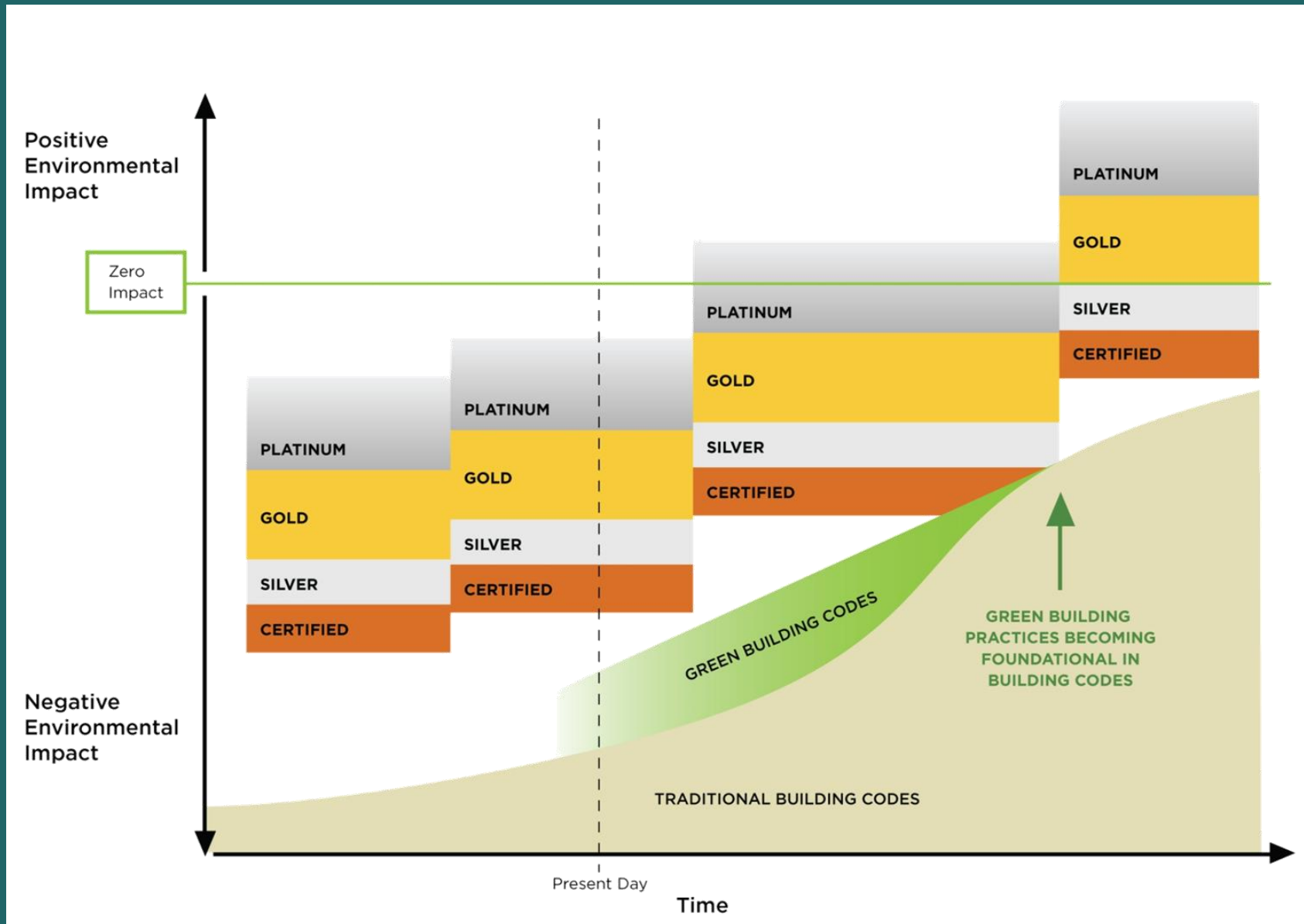
Energy Efficiency Starts with the Envelope



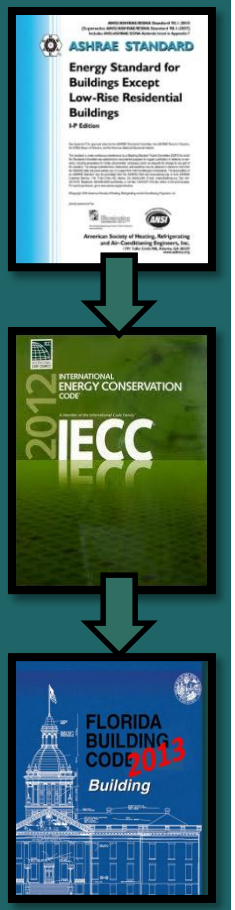
Sources: Department of Energy (DOE), Energy Information Administration, 2003 Commercial Buildings Energy Consumption Survey,

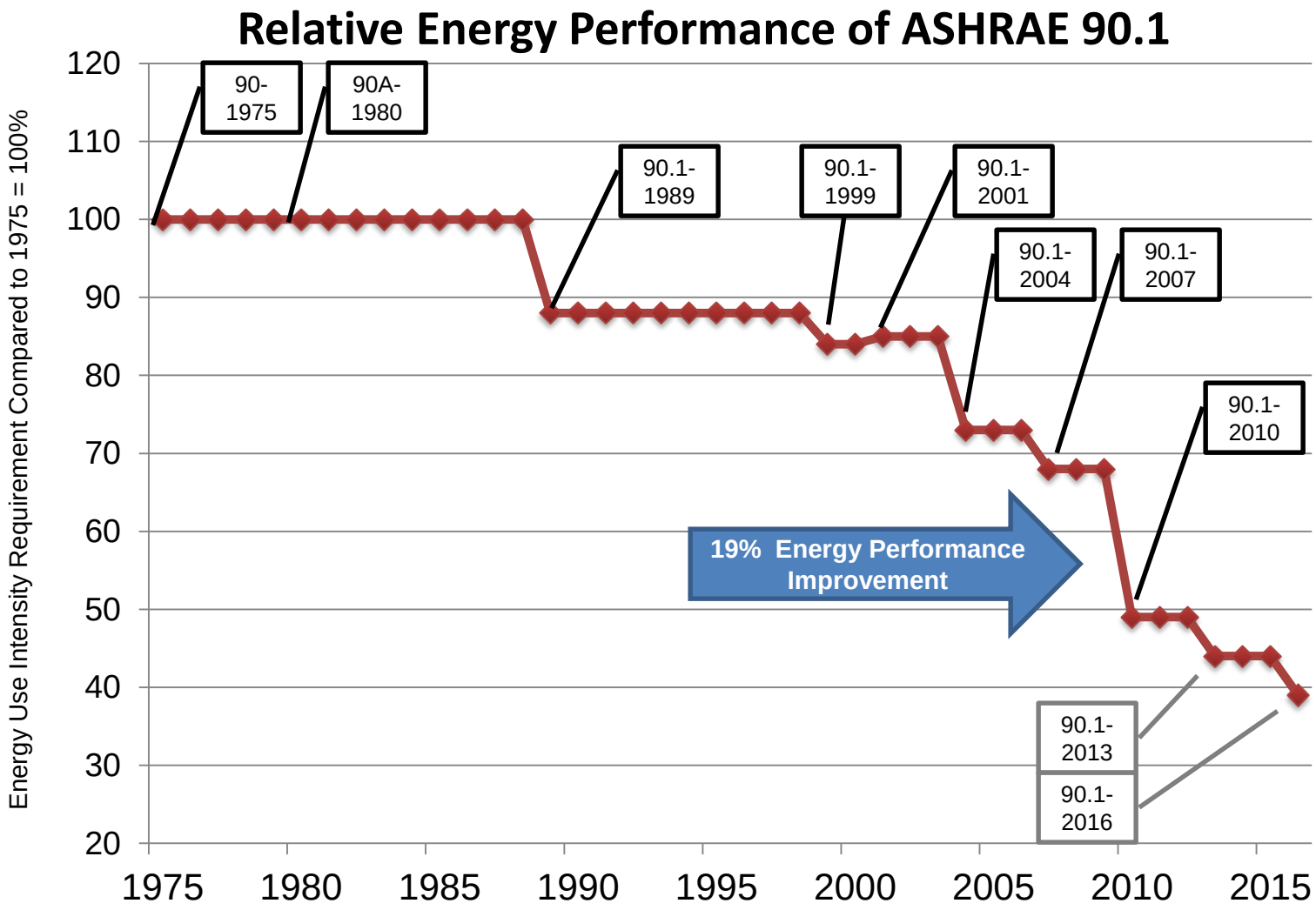
Data for all existing buildings, all climate zones: Old Bldgs, Leaky Bldgs, no Energy Code, etc.

Sustainability Impact on Building Codes



ASHRAE 90.1 Over Time
IECC 2012 Based on ASHRAE 90.1 2010



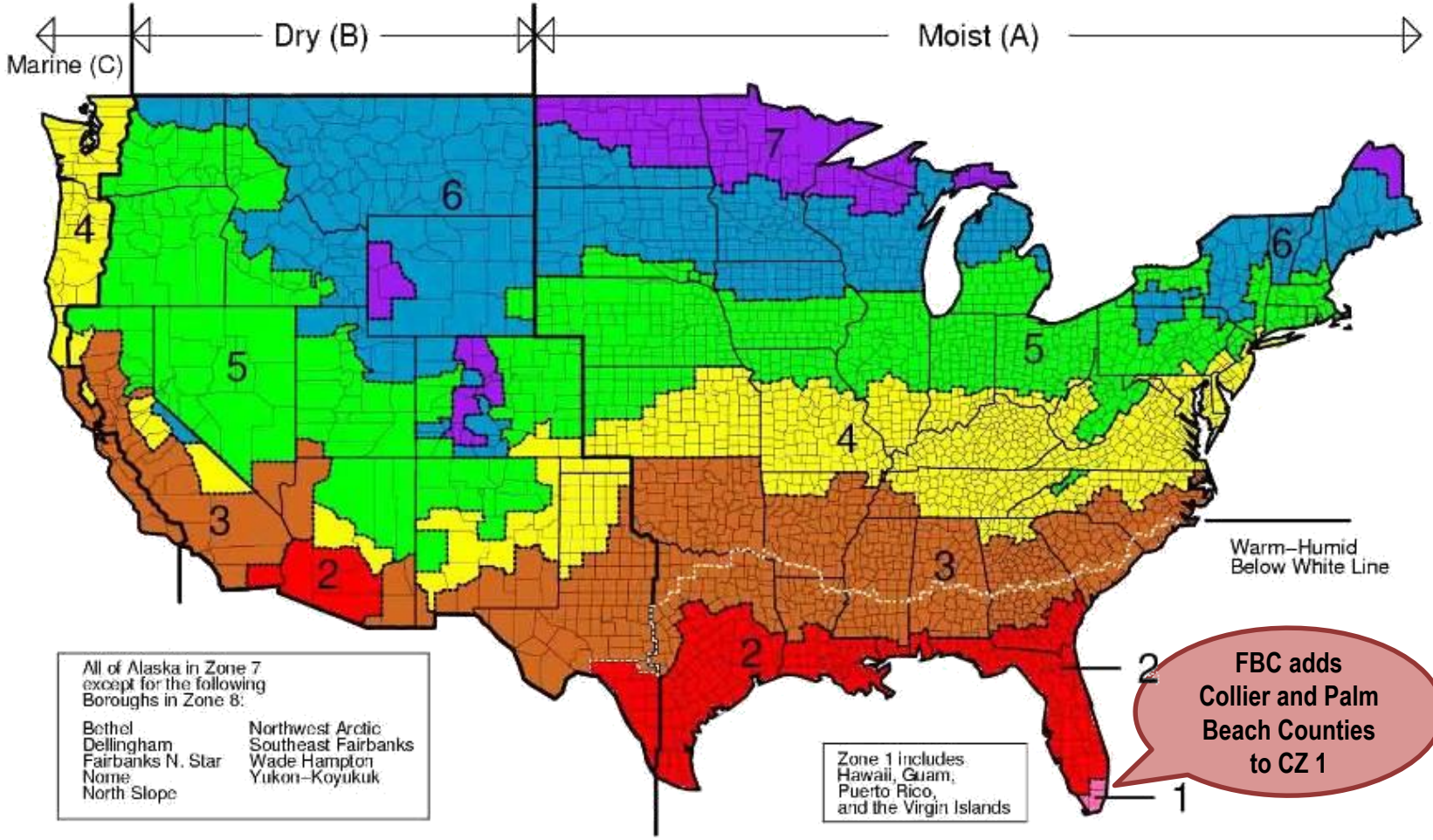


UNDERSTANDING THE NEW CODE

- Overall scope and compliance paths
  - Prescriptive Path
  - Performance Path
  - Mandatory Requirements
- Major Changes to Building Envelope Requirements

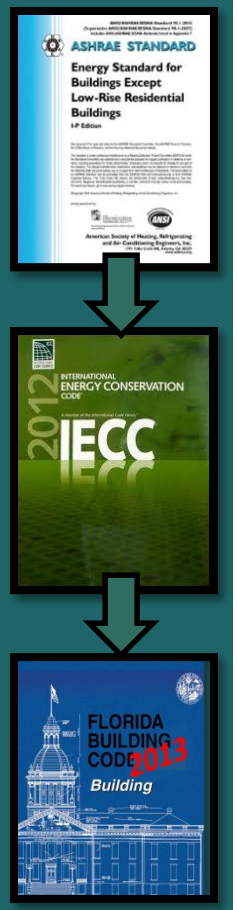
FBC 2013 goes into effect June 2015

Where in the World Are We: Climate Zones, 2012 IECC Chapter 3



Determining Your Climate Zone is the First Step in the Process

Commercial Compliance Options



Performance path

1 **90.1-2010** OR **2** **2012 IECC** OR **3** **2012 IECC**

Prescriptive path

- C402 – Envelope
- C403 – Mechanical
- C404 – SWH
- C405 – Lighting

AND

- Pick One:

  "Additional Efficiency Package Options"

C406.2	C406.3	C406.4
• Eff. HVAC Performance	• Eff. Lighting Systems	• On-site Renewable Energy

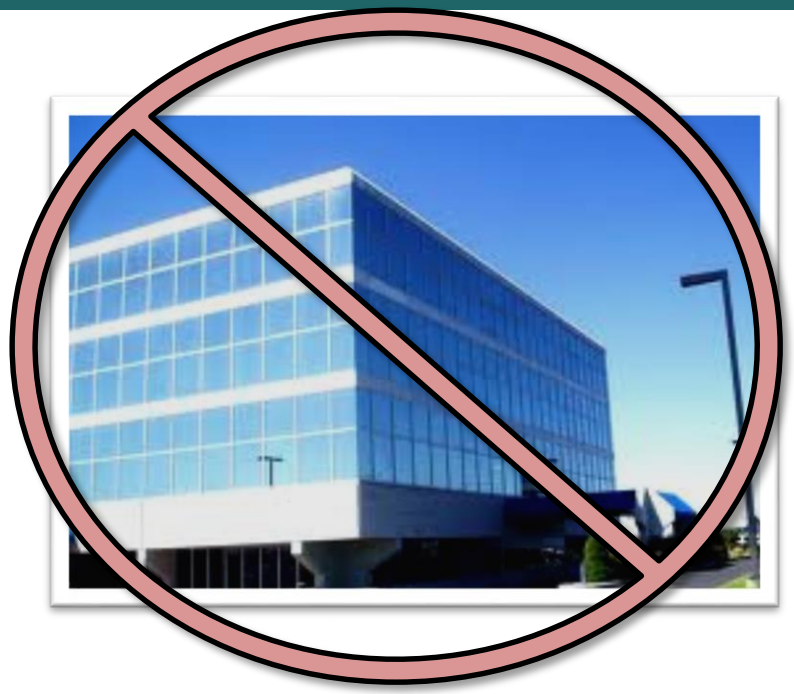
- C407 – Total Building Performance
- C402.4 – Air Leakage (Mandatory)
- C403.2 – Provisions applicable to all mechanical systems
- C404 – SWH
- Lighting Mandatory Sections
  - ✓ C405.2
  - ✓ C405.3
  - ✓ C405.4
  - ✓ C405.6
  - ✓ C405.7
- Building energy cost to be **≤85%** of standard reference design building

Envelope Requirement Changes?

Key changes from

IECC 2009 / FBC 2010

- Almost all the opaque envelope components are more stringent
- Simplified fenestration table
- Skylight requirement in certain spaces
- WWR now capped at 30%, with an allowance up to 40% if substantial daylighting is used
- Daylighting Controls now *required (*so no extra credit for them anymore)



Impact of Envelope on Energy Performance

100K Sf

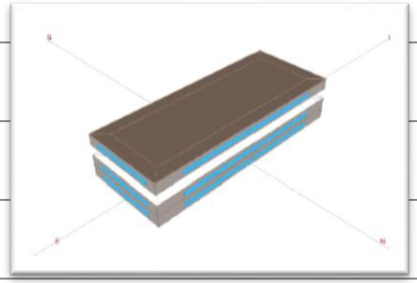
4 Story

Office Bldg

100'x250'

E-W Orientation

CZ 2 (Tampa, Florida)



Cooling Demand (Tons)

180%
170%
160%
150%
140%
130%
120%
110%
100%
90%
80%
70%

280
230
180
130
80

143
149
162
174
172
188
224
256
137
134
131
129

100%
103%
111%
119%
116%
126%
148%
168%
97%
94%
95%
92%

30% WWR
40% WWR
66% WWR
90% WWR
30% WWR
40% WWR
66% WWR
90% WWR
20% WWR
30% WWR ^Glass
30% WWR ^Insul
20% WWR ^Glass ^Insul

All Prescriptive, Differing WWR

"Bad Glass", Differing WWR

"Improved Envelope"

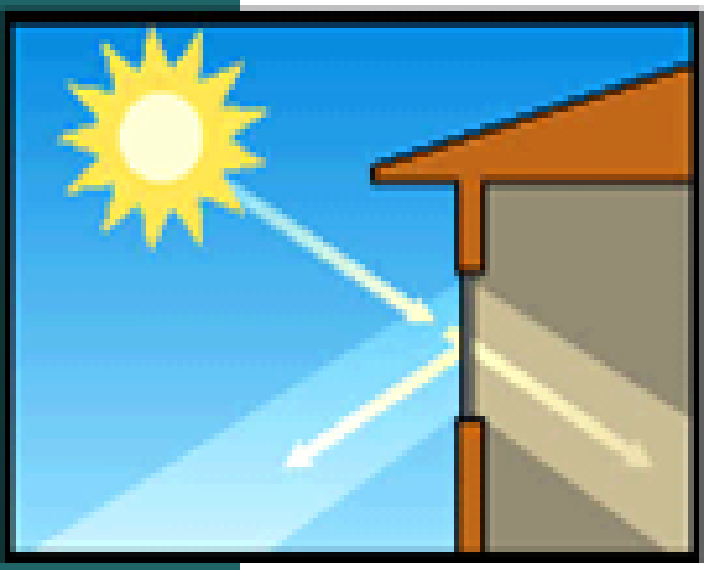
Impact of Envelope on Energy Performance

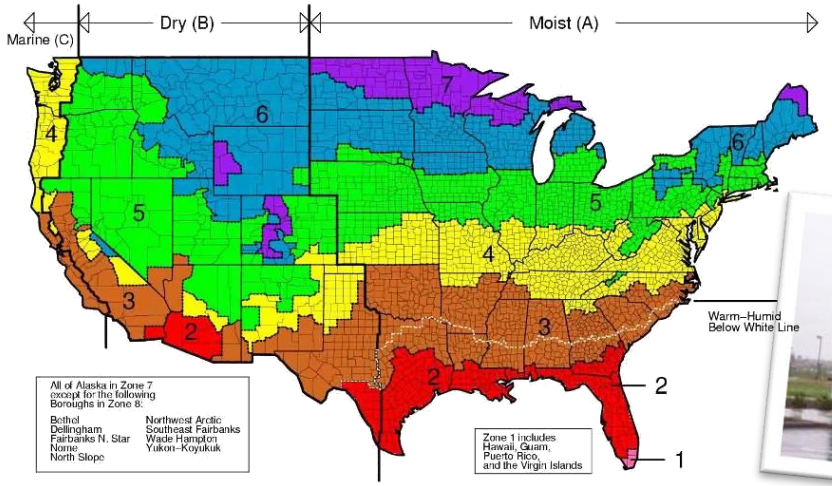
Starting with an envelope that does not meet the prescriptive requirements is like climbing out of an energy hole.

PRESCRIPTIVE REQUIREMENTS

Glazed Fenestration SHGC

What is Solar Heat Gain Coefficient and Why is it Critical in Climate Zones 1, 2, & 3?



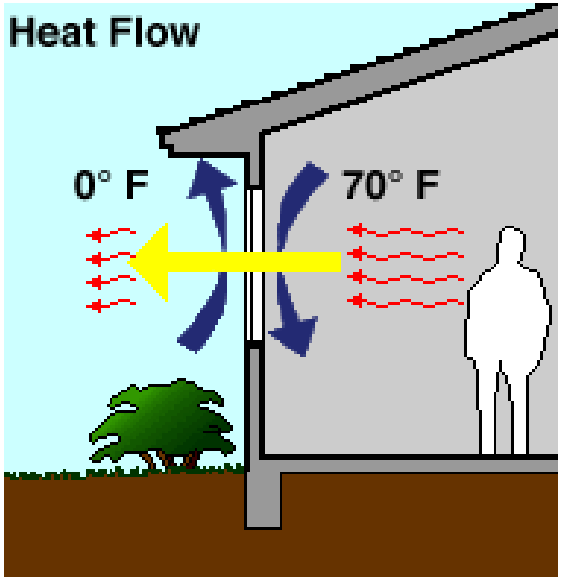


"The ratio of the solar heat gain entering the space through the fenestration assembly to the incident solar radiation."

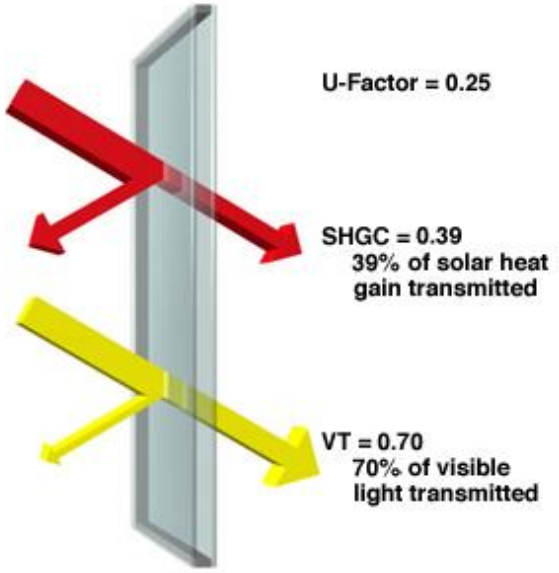
(the lower the SHGC, the better the glass)

Understanding U Value, SHGC, VT

U Value affects Heat Transfer
Based on Temp Diff Inside and Out (Delta-T)
Lower U Value, Less Heat Transfer



SHGC affects Direct Solar Heat Gain
Lower SHGC, Less Heat Gain



In CZ 1-3, SHGC has much more impact on energy performance than U Value

Visual Transmittance (VT) affect Visible Light
Higher VT, more light gets thru

Prescriptive Approach Compliance: Walls/Roofs/Slabs/Doors C402.2

Table C402.2 Excerpts	Climate Zone 1
Roofs: Insulated Above Deck	R-20ci
Walls Above Grade: Mass Walls	R-5.7ci
Walls Above Grade: Metal Framed	R-13+ R-5 ci
Walls Below Grade	NR
Floors: Mass Floors	NR
Slab On Grade: Unheated	NR
Opaque Doors: Swinging	U-0.61

TABLE C402.2 OPAQUE THERMAL ENVELOPE REQUIREMENTS[a]

CLIMATE ZONE	1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R
Roofs																
Insulation entirely above deck	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings (with R-5 thermal blocks)[b, c]	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-25 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-49
Walls, Above Grade																
Mass	R-5.7ci	R-5.7ci	R-5.7ci	R-7.6ci	R-7.6ci	R-9.5ci	R-9.5ci	R-11.4ci	R-11.4ci	R-13.3ci	R-13.3ci	R-15.2ci	R-15.2ci	R-15.2ci	R-25ci	R-25ci
Metal building	R-13+ R-6.5ci	R-13 + R-6.5ci	R13 + R-6.5ci	R-13 + R-13ci	R-13 + R-6.5ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13+ R-13ci	R-13 + R-13ci	R-13 + R-13ci	R-13+ R-19.5ci	R-13 + R-13ci	R-13+ R-19.5ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-7.5ci	R-13 + R-15.6ci	R-13 + R-7.5ci	R-13+ R17.5ci
Wood framed and other	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-3.8ci or R-20	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-7.5ci or R-20 + R-3.8ci	R-13 + R-15.6ci or R-20 + R-10ci	R-13 + R-15.6ci or R-20 + R-10ci
Walls, Below Grade																
Below-grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-7.5ci	R-10ci	R-10ci	R-10ci	R-12.5ci
Floors																
Mass	NR	NR	R-6.3ci	R-8.3ci	R-10ci	R-10ci	R-10ci	R-10.4ci	R-10ci	R-12.5ci	R-12.5ci	R-12.5ci	R-15ci	R-16.7ci	R-15ci	R-16.7ci
Joist/framing	NR	NR	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30[e]	R-30[e]	R-30[e]	R-30[e]	R-30[e]
Slab-on-Grade Floors																
Unheated slabs	NR	NR	NR	NR	NR	NR	R-10 for 24 below	R-10 for 24 below	R-10 for 24 below	R-10 for 24 below	R-10 for 24 below	R-15 for 24 below	R-15 for 24 below	R-15 for 24 below	R-15 for 24 below	R-20 for 24 below
Heated slabs[f]	R-7.5 for 12 below	R-7.5 for 12 below	R-7.5 for 12 below	R-7.5 for 12 below	R-10 for 24 below	R-10 for 24 below	R-15 for 24 below	R-15 for 24 below	R-15 for 36 below	R-15 for 36 below	R-15 for 36 below	R-20 for 48 below	R-20 for 24 below	R-20 for 48 below	R-20 for 48 below	R-20 for 48 below
Opaque Doors																
Swinging	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.61	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Roll-up or sliding	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75	R-4.75

Prescriptive Requirements for Opaque Thermal Envelope

- ✓ Roofs
- ✓ Walls Above Grade
- ✓ Walls Below Grade
- ✓ Floors
- ✓ Slab on Grade
- ✓ Opaque Doors

Prescriptive Approach Compliance: Fenestration C402.3

Was 1.20

Math Refresher:
U Value = 1 / R Value
Lower U Value = Better Glass

TABLE C402.3 BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

CLIMATE ZONE	1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7	8
Vertical fenestration								
***U*-factor**								
Fixed fenestration	0.50	0.50	0.46	0.38	0.38	0.36	0.29	0.29
Operable fenestration	0.65	0.65	0.60	0.45	0.45	0.43	0.37	0.37
Entrance doors	1.10	0.83	0.77	0.77	0.77	0.77	0.77	0.77
SHGC								
SHGC	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
Skylights								
***U*-factor**	0.75	0.65	0.55	0.50	0.50	0.50	0.50	0.50
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

NR = No requirement.

Were
0.70
0.70
1.10

Table C402.3 requirements by these categories:

- ✓ Fixed fenestration
- ✓ Operable fenestration
- ✓ Entrance doors

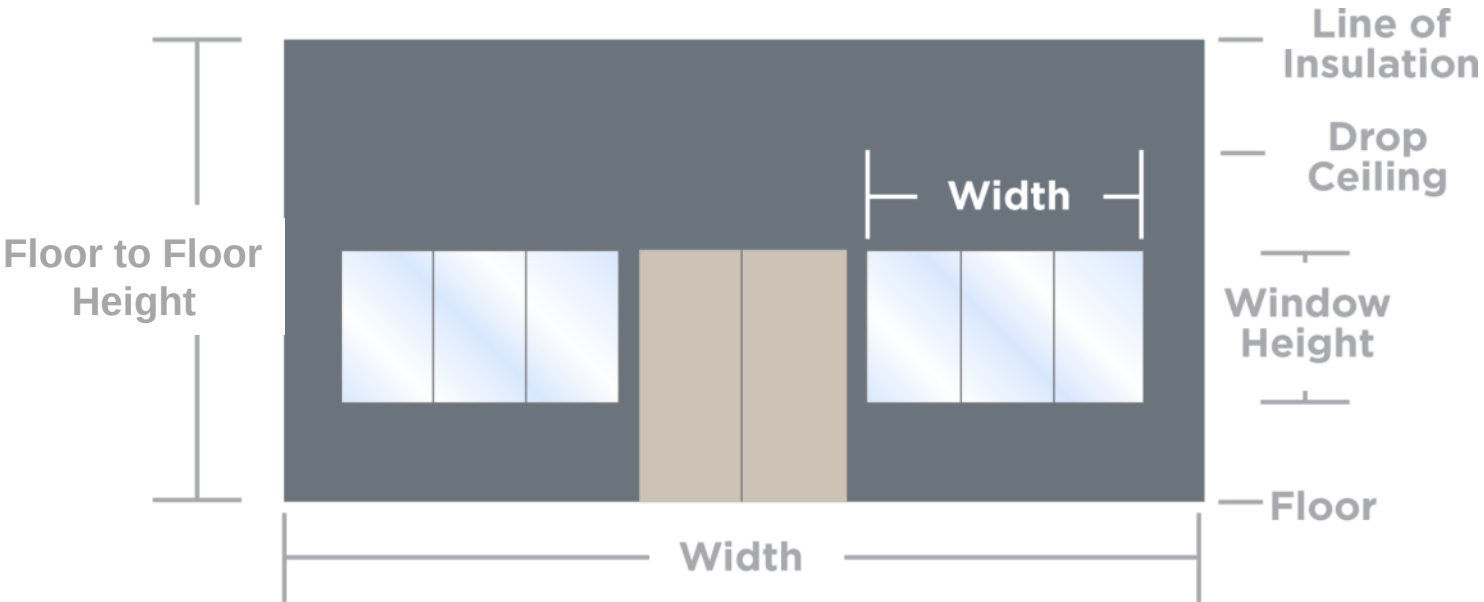
Prescriptive Vertical Fenestration Requirement C402.3.1

Based on above-grade wall area *(gross)*

- Includes walls between conditioned space and unconditioned space or the great outdoors
- Includes walls that are > 15% above grade

Total fenestration area *(includes frame and glazing*)

- Does not include opaque door area



Prescriptive Vertical Fenestration Requirement C402.3.1

How Much Glass Can I Use ?

Percentage of Vertical Fenestration Area to Gross Wall Area

- ✓ Allowed up to **30% maximum** of above grade wall
- ✓ In Climate Zones 1-6, up to 40% maximum of above grade wall with **daylighting controls**

Baptist Medical Center Jacksonville,
South Tower D
Gresham Smith & Partners

Increased Vertical Fenestration with Daylighting Controls - C402.3.1.1

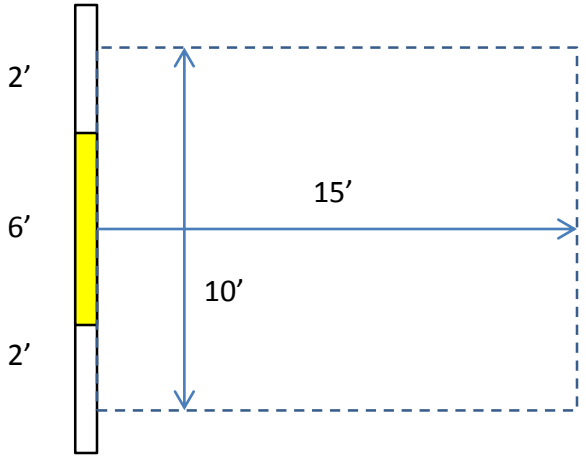
Up to 40% vertical fenestration allowed in **Climate Zone 1–6** provided:

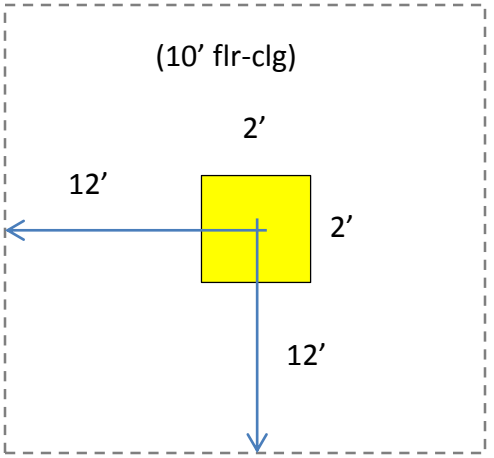
- ✓ No less than 50% of the conditioned floor area is within a daylight zone
- ✓ Automatic daylighting controls are installed in daylight zones; and
- ✓ VT of vertical fenestration is ≥ 1.1 times SHGC

Exception:

Fenestration that is outside the scope of NFRC 200 isn't required to comply with VT

What is a Daylight Zone?





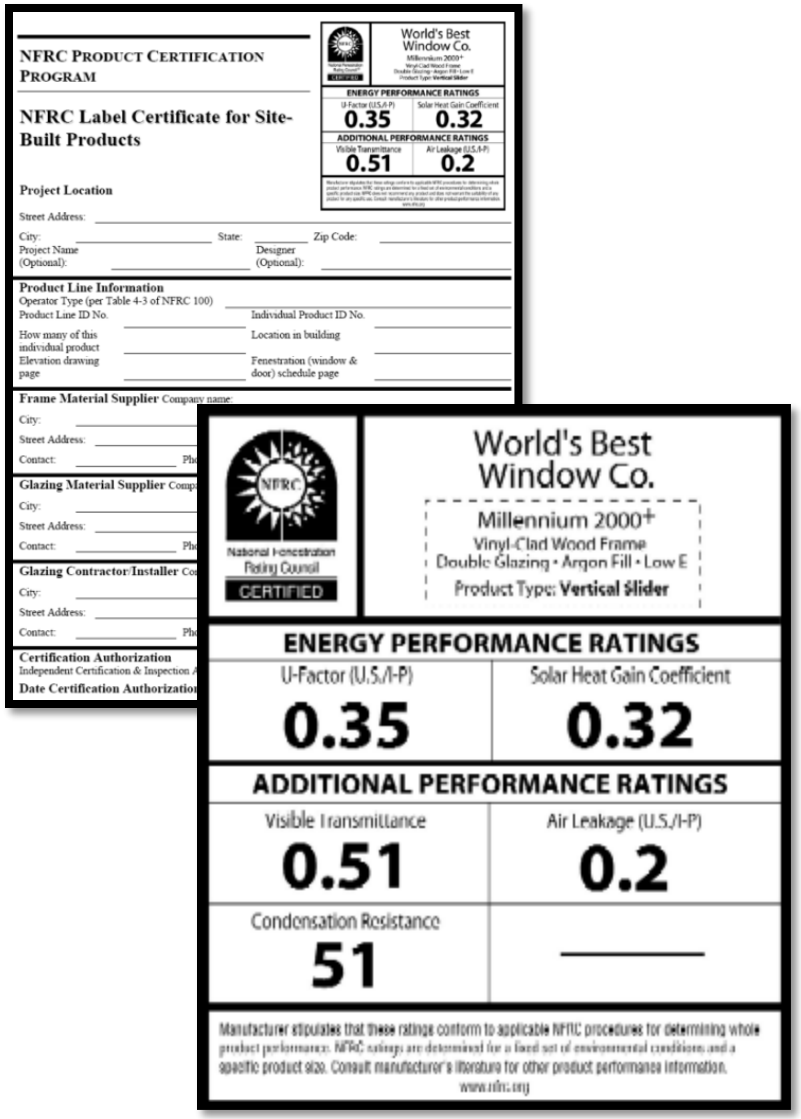
Prescriptive Approach Compliance: Fenestration U-Factor C303.1.3

Q: How Do I Meet the Requirements?

A: NFRC Product Certification

- ✓ Fenestration product rating in accordance to NFRC 100
- ✓ Labeled and certified by the manufacturer

Non-NFRC 100 rated fenestration → Default Glazed Fenestration U-factor Table C303.1.3(1)



Default U-Factors (No NFRC Tag) Tables C303.1.3(1) and (2)

In most cases, ***Default Values*** do not meet the ***Prescriptive Requirements***

TABLE C303.1.3(1)
DEFAULT GLAZED FENESTRATION U-FACTOR

FRAME TYPE	SINGLE PANE	DOUBLE PANE	SKYLIGHT	
			Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
Glazed Block	0.60			

TABLE C303.1.3(2)
DEFAULT DOOR U-FACTORS

DOOR TYPE	*U*-FACTOR
Uninsulated Metal	1.20
Insulated Metal	0.60
Wood	0.50
Insulated, nonmetal edge, max 45% glazing, any glazing double pane	0.35

Prescriptive Approach Compliance: Fenestration C402.3

Was 0.25

Math Refresher:
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Lower U Value = Better Glass

TABLE C402.3 BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

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Operable fenestration	0.65	0.65	0.60	0.45	0.45	0.43	0.37	0.37
Entrance doors	1.10	0.83	0.77	0.77	0.77	0.77	0.77	0.77
SHGC								
SHGC	0.25	0.25	0.25	0.40	0.40	0.40	0.45	0.45
Skylights								
***U*-factor**	0.75	0.65	0.55	0.50	0.50	0.50	0.50	0.50
SHGC	0.35	0.35	0.35	0.40	0.40	0.40	NR	NR

NR = No requirement.

Table C402.3 requirements by these categories:

- ✓ Fixed fenestration
- ✓ Operable fenestration
- ✓ Entrance doors

Fenestration SHGC and VT Product Rating Defaults: Table C303.1.3(3)

Two Options for Meeting the SHGC and VT Requirements

- Fenestration product rated and labeled to NFRC 200, or
- Select default from Table C303.1.3(3)

TABLE C303.1.3(3)
DEFAULT GLAZED FENESTRATION SHGC AND VT

	SINGLE GLAZED		DOUBLE GLAZED		GLAZED BLOCK
	Clear	Tinted	Clear	Tinted	
SHGC	0.8	0.7	0.7	0.6	0.6
VT	0.6	0.3	0.6	0.3	0.6

In most cases, ***Default Values*** do not meet the ***Prescriptive Requirements***

Fenestration SHGC Adjustment C402.3.3.1

- ✓ Overhangs allow a higher SHGC product to be installed
- ✓ Projection factor must be calculated
- ✓ When different windows or glass doors have different PFs, evaluate separately

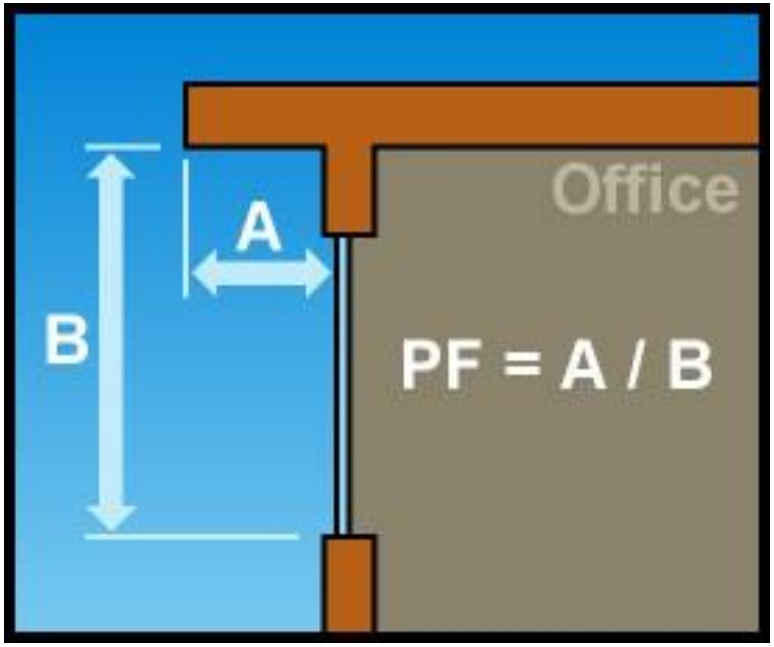


TABLE C402.3.3.1 SHGC ADJUSTMENT MULTIPLIERS

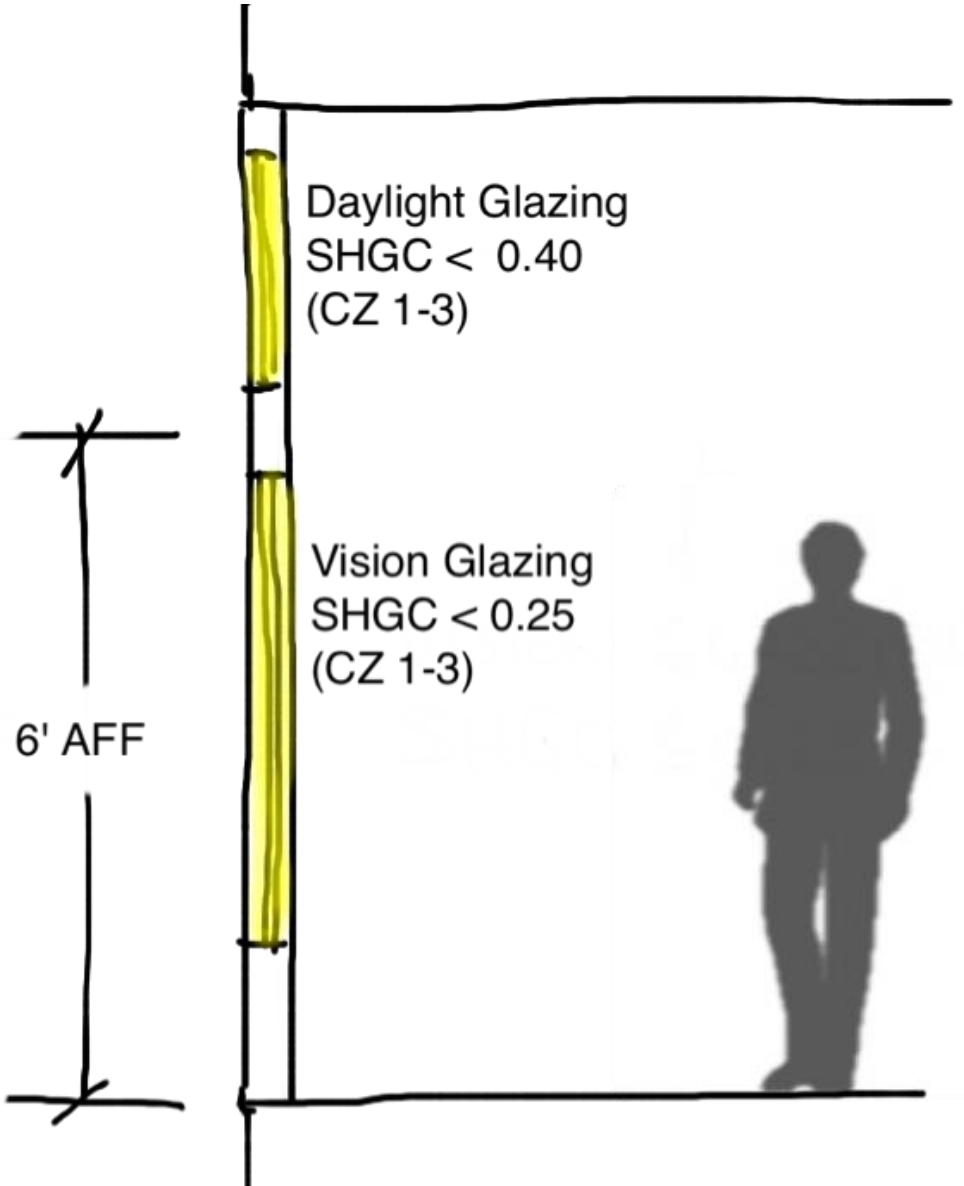
PROJECTION FACTOR	ORIENTED WITHIN 45 DEGREES OF TRUE NORTH	ALL OTHER ORIENTATION
0.2 ≤ PF < 0.5	1.1	1.2
PF ≤ 0.5	1.2	1.6

Would allow SHGC increase from 0.25 to 0.40 in CZ's 1-3

Increased Vertical Fenestration SHGC C402.3.3.2

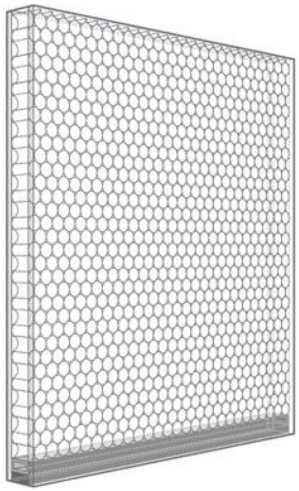
In **Climate Zones 1-3**:

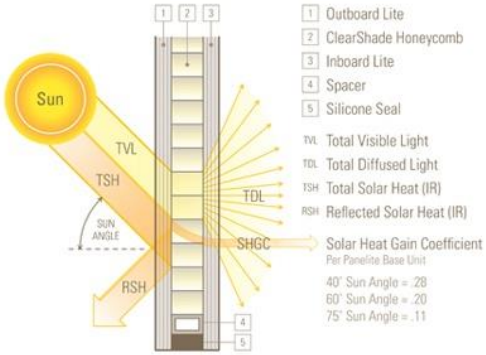
- ✓ Vertical fenestration entirely located above 6 ft AFF is permitted a max SHGC of 0.40



Dynamic Glazing C402.3.3.5

- ✓ SHGC determined using manufacturer's lowest-rated SHGC
- ✓ VT/SHGC ratio determined using maximum VT and maximum SHGC
- ✓ Considered separately from other fenestration
- ✓ Area-weighted averaging isn't allowed





Minimum Skylight Fenestration Area C402.3.2

Skylights ***required*** In certain types of enclosed spaces

- ✓ Greater than 10,000 ft^2
- ✓ Directly under a roof
- ✓ Ceiling heights > 15 ft

Total daylight zone under skylights shall not be less than half the floor area

Exceptions:

- Climate Zones 6-8
- Spaces with LPDs < 0.5 W/ft^2
- Documented shaded spaces
- Daylight area under rooftop monitors is > 50% of floor area

Prescriptive Compliance: Interior Lighting C405.5.2

Lighting Power Limits (LPD)

- Building Area Method
- Space-by-Space Method

Quality Lighting and low LPD are **not** mutually exclusive. Requires proactive, integrated lighting design.

- ✓ Design to prescriptive targets.
- ✓ Use energy-efficient sources.
- ✓ Don't use incandescents. Ever.
- ✓ Put the light where you need it.
- ✓ Take advantage of daylight.
- ✓ Control the lights.
- ✓ Use lightly colored surfaces.

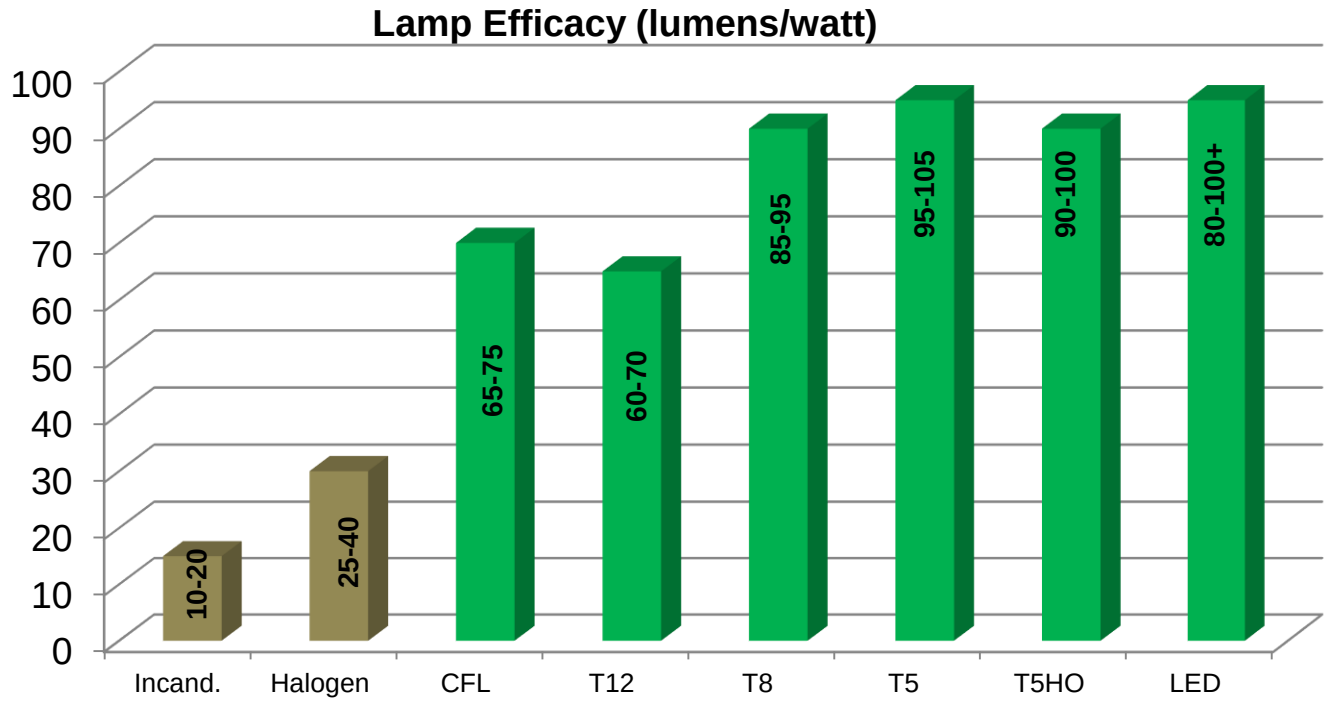
TABLE C405.5.2(1)
INTERIOR LIGHTING POWER ALLOWANCES:
BUILDING AREA METHOD

BUILDING AREA TYPE	LPD (w/ft²)
Automotive facility	0.9
Convention center	1.2
Courthouse	1.2
Dining: bar lounge/leisure	1.3
Dining: cafeteria/fast food	1.4
Dining: family	1.6
Dormitory	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing facility	1.3
Motel	1.0
Motion picture theater	1.2
Multifamily	0.7
Museum	1.1
Office	0.9
Post office	1.1
Religious building	1.3
Retail	1.4
School/university	1.2
Sports arena	1.1
Town hall	1.1
Transportation	1.0
Warehouse	0.6
Workshop	1.4

Select Energy Efficient Light Sources

Halogen is not an "energy efficient" source

Be sure to **spec what you want** and **get what you spec**



Source	Color Rendering Index (CRI)	Color Temp Range (K)	Efficacy (lumens/watt)	Dimmable?
Incandescent	100	2700	10-20	Yes
Halogen	100	2800	25-40	Yes
LED	50-90	2900-6100	80-100+	Yes
CFL	82-90	2700-4100	65-75	Yes

Additional Efficiency Package Options Prescriptive Path C406

One additional efficiency feature must be selected to comply with the IECC

- More efficient lighting system (consistent with 90.1-2010), **OR**
- More efficient HVAC system, **OR**
- Installation of onsite renewables
  - 3% of the regulated energy
  - 1.75 Btu or ≥ 0.50 watts per ft^2 of conditioned floor area

More Efficient Lighting System:
Baptist Medical Center South

High Efficiency HVAC:
FH Memorial

Onsite Renewables:
Darden Restaurant Support Center

PERFORMANCE PATH

Performance Path

The minute you step off the **Prescriptive Path**, your are entering the **Performance Path**.

Energy Modeling is Required

Don’t get hit by the energy bus because you’re looking the wrong way!

Performance Path

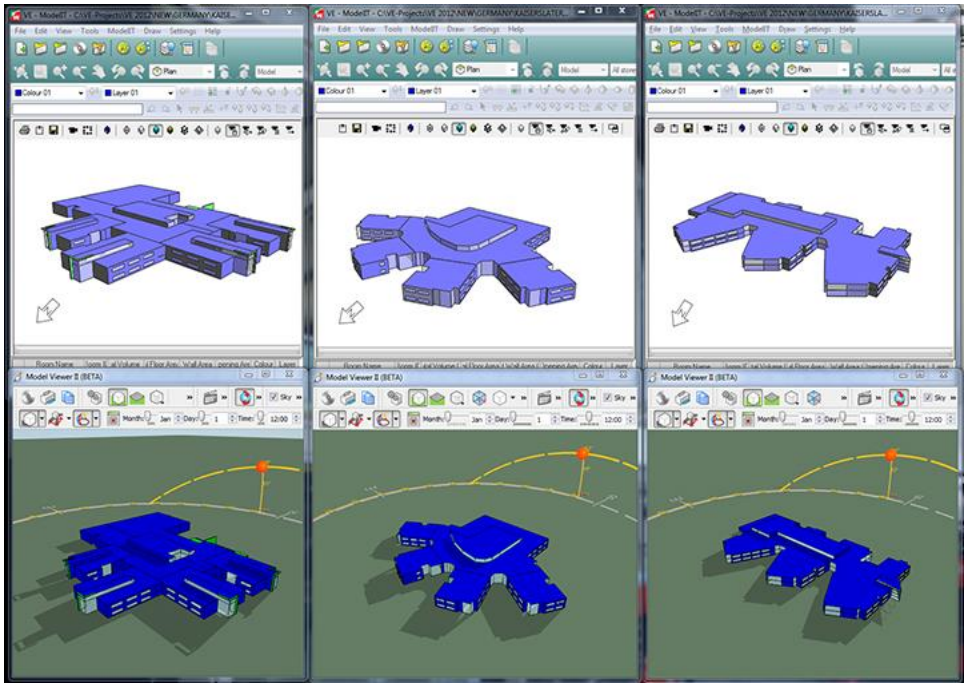
PERFORMANCE PATH:

Modeled building energy cost must be **≤85%** of standard reference design building

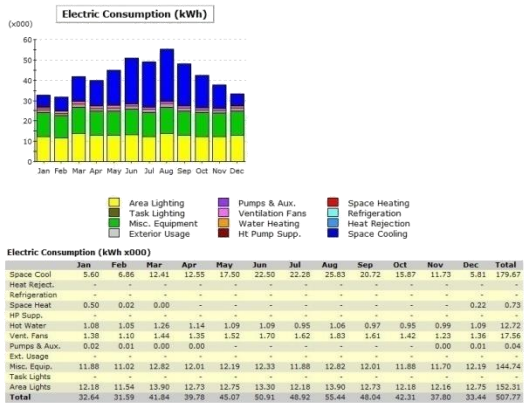
Performance Path

- ✓ Must be used if **ANY** prescriptive requirement is not met. **Requires an energy model.**
- ✓ Allows code compliance to be shown through **a total building performance simulation** rather than a specific set of requirements for each system.
- ✓ Uses an Energy Cost Budget model rather than the Performance Rating Method model used for LEED.
- ✓ Prescriptive path defines standard reference design requirements (baseline model)

Modeling Software
IECC C407.6

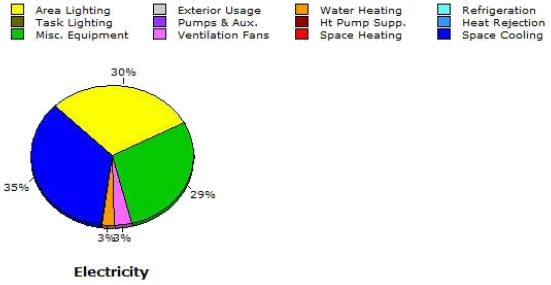


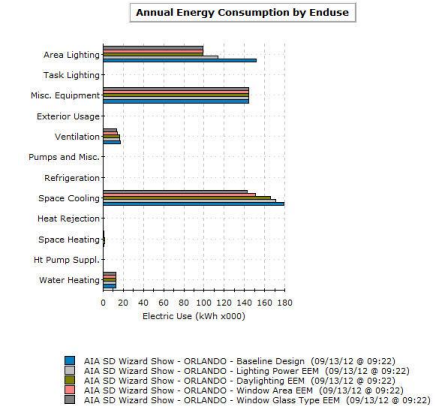
AHJ can approve alternate software



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	5.60	6.86	12.41	12.55	17.50	22.50	22.28	25.83	20.72	15.87	11.73	5.81	179.67
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	0.50	0.02	0.00	-	-	-	-	-	-	-	-	0.22	0.73
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	1.08	1.05	1.26	1.14	1.09	1.09	0.95	1.06	0.97	0.95	0.99	1.09	12.72
Vent. Fans	1.38	1.10	1.44	1.35	1.52	1.70	1.62	1.83	1.61	1.42	1.23	1.36	17.56
Pumps & Aux.	0.02	0.01	0.00	0.00	-	-	-	-	-	-	0.00	0.01	0.04
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	11.88	11.02	12.82	12.01	12.19	12.33	11.88	12.82	12.01	11.88	11.70	12.19	144.74
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	12.18	11.54	13.90	12.73	12.75	13.30	12.18	13.90	12.73	12.18	12.16	12.75	152.31
Total	32.64	31.59	41.84	39.78	45.07	50.91	48.92	55.44	48.04	42.31	37.80	33.44	507.77

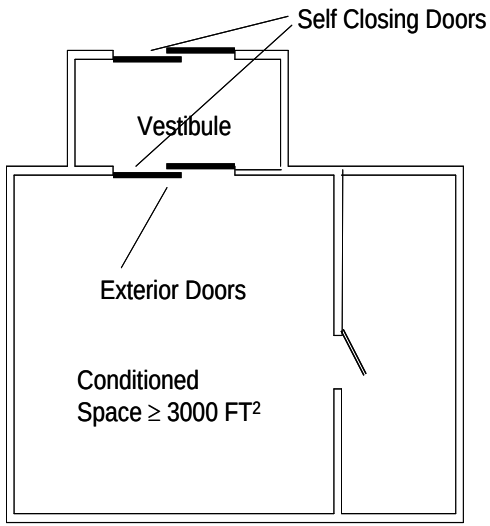




MANDATORY REQUIREMENTS

Mandatory Requirements: Continuous Air Barrier C402.4

- C402.4.1 - Air Barriers
- C402.4.2 – Air Barrier Penetrations
- C402.4.3 - Fenestration air leakage
- C402.4.4 – Doors and access openings to shafts, chutes, stairways, and elevator lobbies
- C402.4.5 - Air intakes, exhaust openings, stairways and shafts
- C402.4.6 - Loading dock weatherseals
- C402.4.7 – Vestibules (CZ 1,2 Exempt)
- C402.4.8 - Recessed lighting



Air Barriers and Construction C402.4.1 and C402.4.1.1

CZ's 1-3 Exempt

Continuous Air Barrier

- Placement allowed
  - Inside of building envelope
  - Outside of building envelope
  - Located within assemblies composing envelope **OR**
  - Any combination thereof
- Continuous for all assemblies part of the thermal envelope and across joints and assemblies

Three ways to comply with air barrier requirements	Requirement	Pressure Differential Testing Requirement	ASTM Standard
1. Materials	Permeance ≤ 0.004	0.3 in w.g	ASTM E 2178
2. Assemblies	Air Leakage ≤ 0.04 cfm/ft^2	0.3 in w.g	ASTM E 2357, 1677 or 283
3. Building	Air Leakage ≤ 0.40 cfm/ft^2	0.3 in w.g	ASTM E779 or equivalent method approved by AHJ
Joints and seams to be sealed per C402.4.2			

Air Leakage of Fenestration C402.4.3

CZ's 1-3 *NOT* Exempt

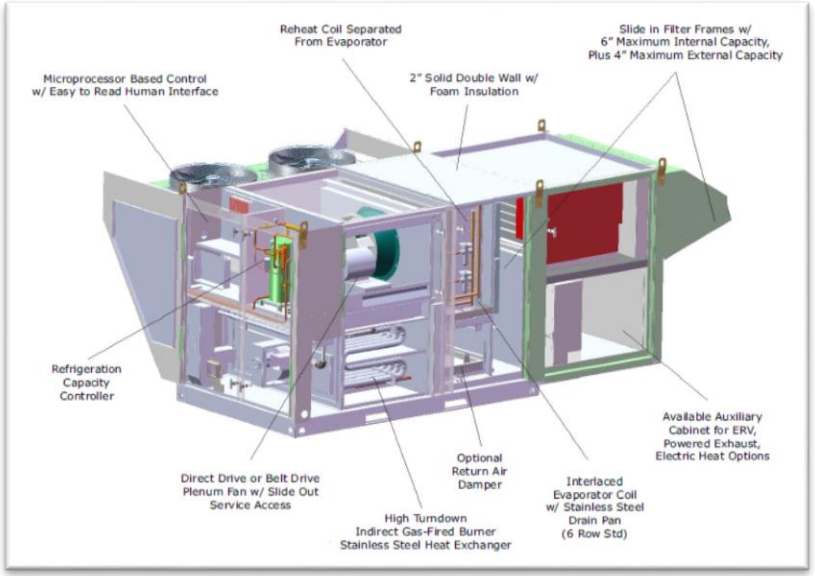
Fenestration Assembly	cfm/ft^2	Test Procedure
Windows, sliding glass doors, and swinging doors	0.20	AAMA/WDMA/CSA 101/I.S.2/A440 or NFRC 400
Skylights - with condensation weepage openings	0.30	
Skylights – all other	0.20	
Curtain walls and storefront glazing	0.06	NFRC 400 or ASTM E283 at 1.57 psf
Commercial glazed swinging entrance doors	1.00	
Revolving doors	1.00	
Garage doors	0.4	ANSI/DASMA 105, NFRC 400, or ASTM E283 at 1.57 psf
Rolling doors	1.00	

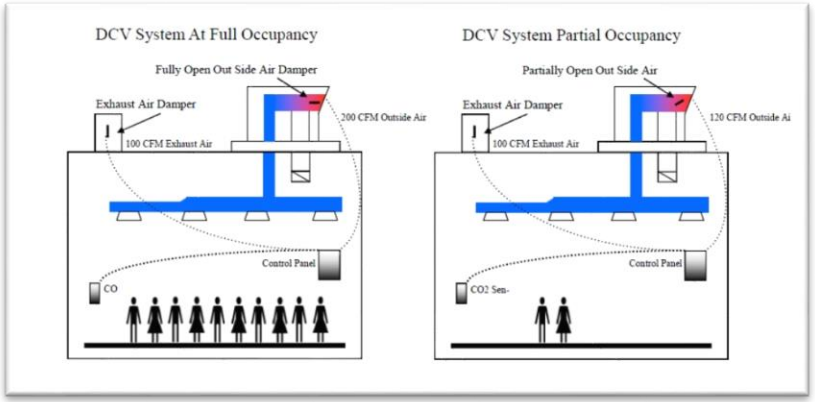
Exceptions:

- Field-fabricated fenestration assemblies
- Fenestration in buildings that meet the building test for air barrier compliance option

Mechanical System Mandatory Requirements C403.2

- ✓ HVAC Load Calculations & Equipment and System Sizing: **Output shall not exceed sizing** from load calcs
- ✓ HVAC Equipment Performance (Efficiency) Requirements
- ✓ HVAC System Controls: 5 deg deadband, off hour, automatic start, humistatic controls
- ✓ **Demand Control Ventilation**
- ✓ **Energy Recovery Systems**
- ✓ HVAC System **Commissioning** and Completion
- ✓ Air System Design and Control (fan hp limits)





Electrical Power & Lighting Systems Mandatory Requirements C405

Automatic Daylight Controls ***Required*** in Daylight Zones

Sidelighted Areas >250sf

Toplighted Space >900sf

Mandatory Lighting Requirements

Automatic Lighting Controls

Additional Lighting Controls

Exterior Lighting Power & Controls

Functional Testing (Cx) of Lighting and Controls

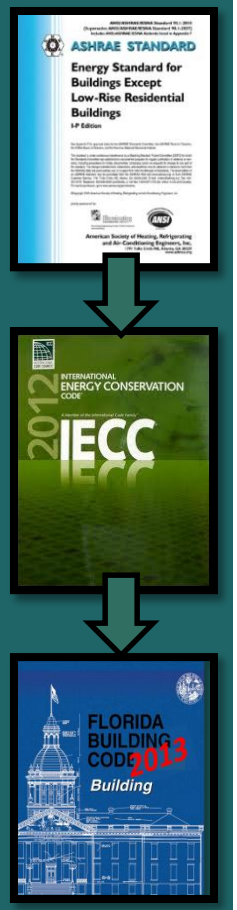
Remember, Interior Lighting Power is ***prescriptive***

Space by Space Method

Building Area Method

Exception:
Enclosed areas with 2 or fewer fixtures

One More Time: Commercial Compliance Options



1 **90.1-2010** OR **2** **2012 IECC** OR **3** **2012 IECC**

Performance path

Prescriptive path

- C402 – Envelope
- C403 – Mechanical
- C404 – SWH
- C405 – Lighting

AND

- Pick One:

"Additional Efficiency Package Options"

C406.2	C406.3	C406.4
• Eff. HVAC Performance	• Eff. Lighting Systems	• On-site Renewable Energy

- C407 – Total Building Performance
- C402.4 – Air Leakage (Mandatory)
- C403.2 – Provisions applicable to all mechanical systems
- C404 – SWH
- Lighting Mandatory Sections
  - ✓ C405.2
  - ✓ C405.3
  - ✓ C405.4
  - ✓ C405.6
  - ✓ C405.7
- Building energy cost to be **≤85%** of standard reference design building

This concludes The American Institute of Architects
Continuing Education Systems Course

TLC Engineering for Architecture

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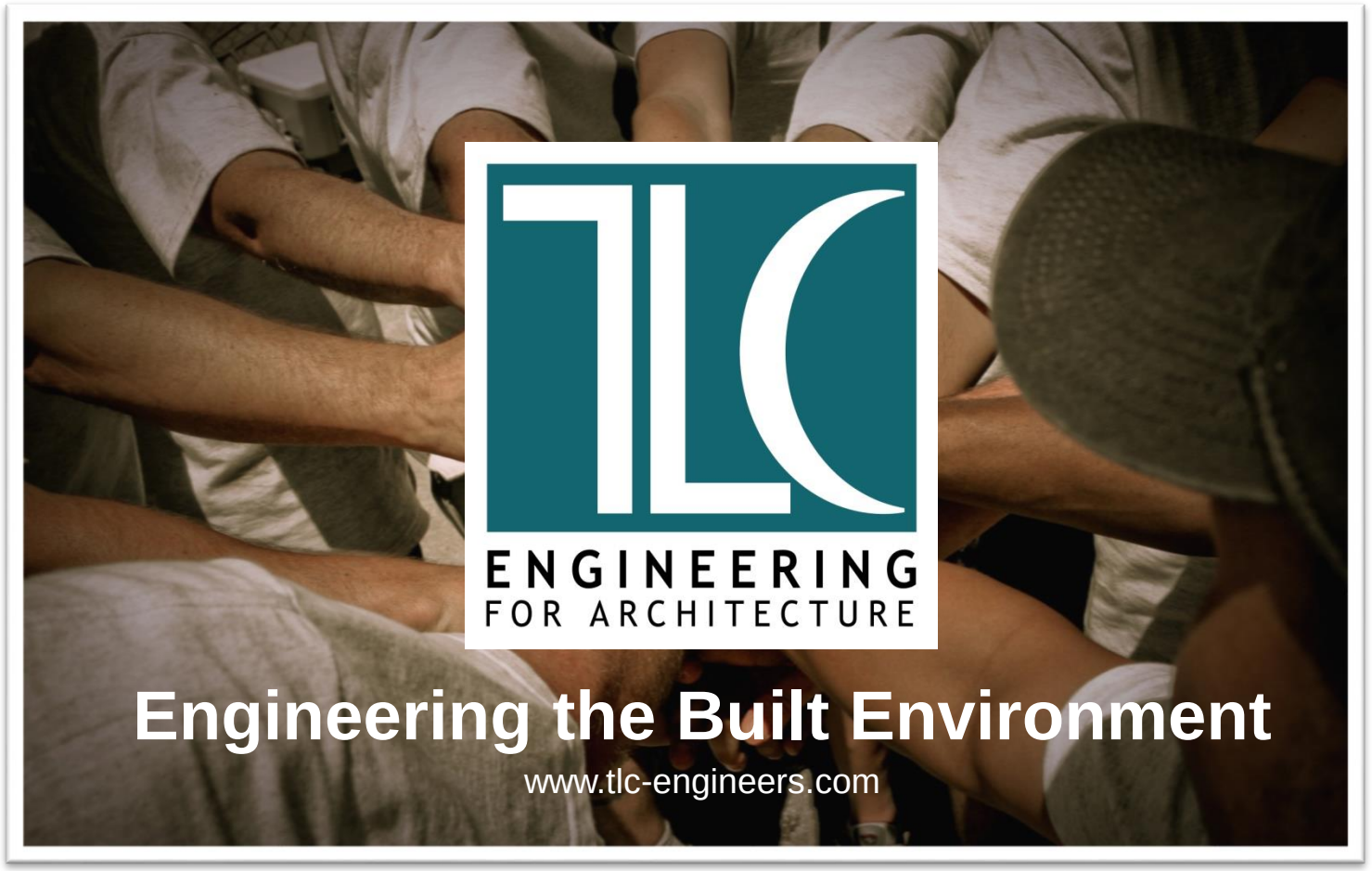
Questions & Discussion



High Performance Design is about **Teamwork**