Pacific Northwest
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Update to ASHRAE Standard 90.1-2016

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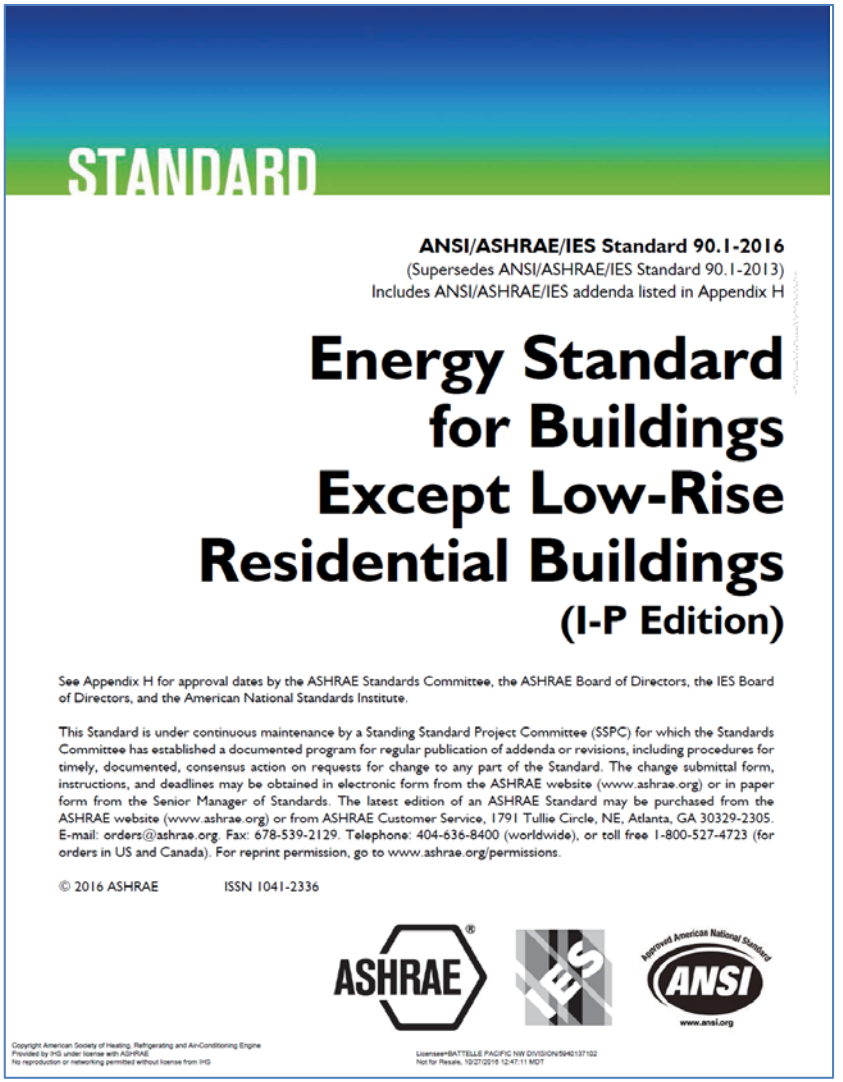
Whole Building Systems, LLC

July 19, 2017

Topics

- Standard 90.1 Goals
- Major Changes in 90.1-2016
- Energy Savings Impact of Standard 90.1-2016



Standard 90.1 Goals

- Standard 90.1 Overall Goal
  - ANSI consensus standard
  - Save energy
  - Technically feasible and cost effective
- 90.1-2016 Specific Goals
  - Easy to use
  - New format to move to e-reading
  - Improvement measured by whole building energy performance

Summary of Changes

- Total of 121 addenda
- Major format changes for ease of use
- New climate maps aligning with ASHRAE Standard 169
- New performance-based compliance path
- Significant whole building energy savings

New Format

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2013

278 total pages

Two-column format

No shading for table rows

Defined terms normal font

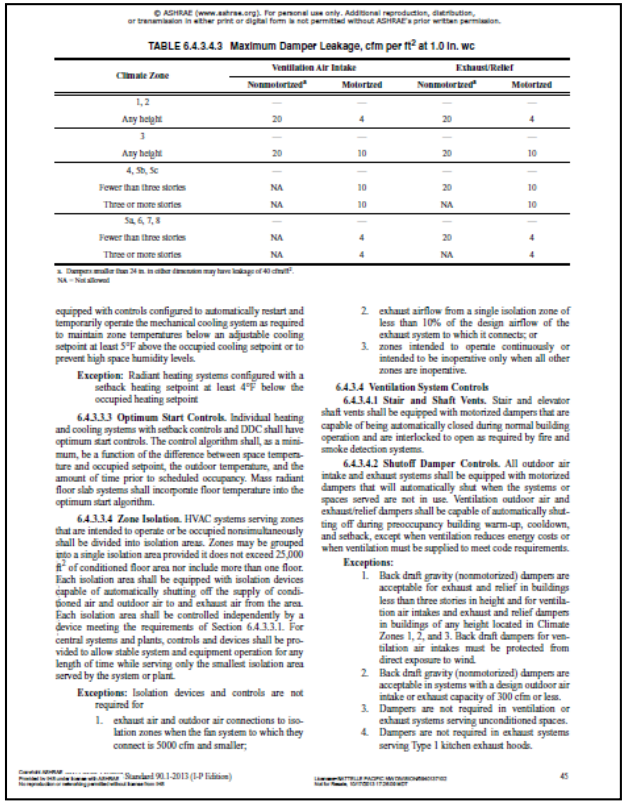


TABLE 6.4.3.4.3 Maximum Damper Leakage, cfm per ft² at 1.0 in. wc

Climate Zone	Ventilation Air Intake		Exhaust/Relief	
	Nonmotorized[a]	Motorized	Nonmotorized[a]	Motorized
1, 2	—	—	—	—
Any height	20	4	20	4
3	—	—	—	—
Any height	20	10	20	10
4, 5b, 5c	—	—	—	—
Fewer than three stories	NA	10	20	10
Three or more stories	NA	10	NA	10
5a, 6, 7, 8	—	—	—	—
Fewer than three stories	NA	4	20	4
Three or more stories	NA	4	NA	4

a. Dampers smaller than 24 in. in either dimension may have leakage of 40 cfm/ft².
NA = Not allowed

equipped with controls configured to automatically restart and temporarily operate the mechanical cooling system as required to maintain zone temperatures below an adjustable cooling setpoint at least 5°F above the occupied cooling setpoint or to prevent high space humidity levels.

Exception: Radiant heating systems configured with a setback heating setpoint at least 4°F below the occupied heating setpoint

6.4.3.3.3 Optimum Start Controls. Individual heating and cooling systems with setback controls and DDC shall have optimum start controls. The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor temperature, and the amount of time prior to scheduled occupancy. Mass radiant floor slab systems shall incorporate floor temperature into the optimum start algorithm.

6.4.3.3.4 Zone Isolation. HVAC systems serving zones that are intended to operate or be occupied nonsimultaneously shall be divided into isolation areas. Zones may be grouped into a single isolation area provided it does not exceed 25,000 ft² of conditioned floor area nor include more than one floor. Each isolation area shall be equipped with isolation devices capable of automatically shutting off the supply of conditioned air and outdoor air to and exhaust air from the area. Each isolation area shall be controlled independently by a device meeting the requirements of Section 6.4.3.3.1. For central systems and plants, controls and devices shall be provided to allow stable system and equipment operation for any length of time while serving only the smallest isolation area served by the system or plant.

Exceptions: Isolation devices and controls are not required for

1. exhaust air and outdoor air connections to isolation zones when the fan system to which they connect is 5000 cfm and smaller;
2. exhaust airflow from a single isolation zone of less than 10% of the design airflow of the exhaust system to which it connects; or
3. zones intended to operate continuously or intended to be inoperative only when all other zones are inoperative.

6.4.3.4 Ventilation System Controls

6.4.3.4.1 Stair and Shaft Vents. Stair and elevator shaft vents shall be equipped with motorized dampers that are capable of being automatically closed during normal building operation and are interlocked to open as required by fire and smoke detection systems.

6.4.3.4.2 Shutoff Damper Controls. All outdoor air intake and exhaust systems shall be equipped with motorized dampers that will automatically shut when the systems or spaces served are not in use. Ventilation outdoor air and exhaust/relief dampers shall be capable of automatically shutting off during preoccupancy building warm-up, cooldown, and setback, except when ventilation reduces energy costs or when ventilation must be supplied to meet code requirements.

Exceptions:

1. Back draft gravity (nonmotorized) dampers are acceptable for exhaust and relief in buildings less than three stories in height and for ventilation air intakes and exhaust and relief dampers in buildings of any height located in Climate Zones 1, 2, and 3. Back draft dampers for ventilation air intakes must be protected from direct exposure to wind.
2. Back draft gravity (nonmotorized) dampers are acceptable in systems with a design outdoor air intake or exhaust capacity of 300 cfm or less.
3. Dampers are not required in ventilation or exhaust systems serving unconditioned spaces.
4. Dampers are not required in exhaust systems serving Type 1 kitchen exhaust hoods.

2016

388 total pages

Single-column format

Alternate shading for table rows

Defined terms italicized

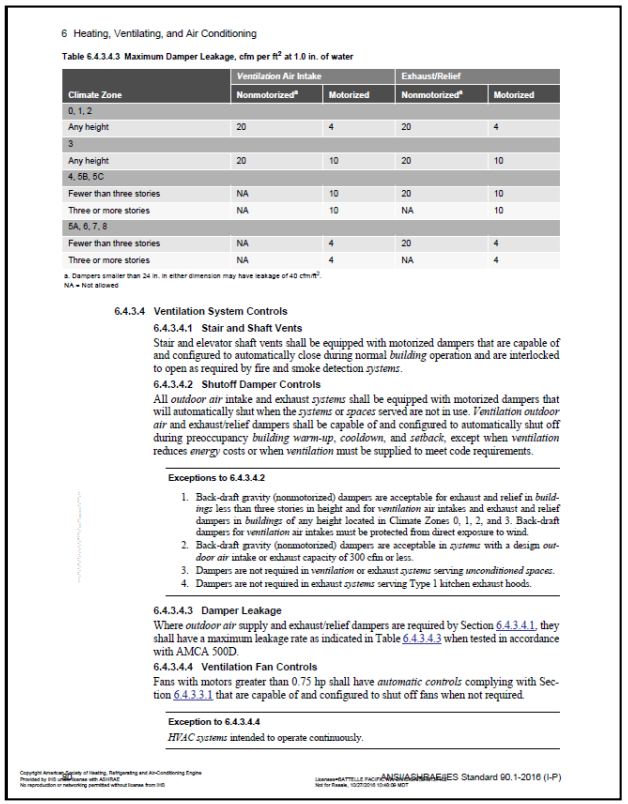


Table 6.4.3.4.3 Maximum Damper Leakage, cfm per ft² at 1.0 in. of water

Climate Zone	Ventilation Air Intake		Exhaust/Relief	
	Nonmotorized[a]	Motorized	Nonmotorized[a]	Motorized
0, 1, 2				
Any height	20	4	20	4
3				
Any height	20	10	20	10
4, 5B, 5C				
Fewer than three stories	NA	10	20	10
Three or more stories	NA	10	NA	10
5A, 6, 7, 8				
Fewer than three stories	NA	4	20	4
Three or more stories	NA	4	NA	4

a. Dampers smaller than 24 in. in either dimension may have leakage of 40 cfm/ft².
NA = Not allowed

6.4.3.4 Ventilation System Controls

6.4.3.4.1 Stair and Shaft Vents

Stair and elevator shaft vents shall be equipped with motorized dampers that are capable of and configured to automatically close during normal *building* operation and are interlocked to open as required by fire and smoke detection *systems*.

6.4.3.4.2 Shutoff Damper Controls

All *outdoor air* intake and exhaust *systems* shall be equipped with motorized dampers that will automatically shut when the *systems* or *spaces* served are not in use. *Ventilation outdoor air* and exhaust/relief dampers shall be capable of and configured to automatically shut off during preoccupancy *building warm-up*, *cooldown*, and *setback*, except when *ventilation* reduces *energy* costs or when *ventilation* must be supplied to meet code requirements.

Exceptions to 6.4.3.4.2

1. Back-draft gravity (nonmotorized) dampers are acceptable for exhaust and relief in *buildings* less than three stories in height and for *ventilation* air intakes and exhaust and relief dampers in *buildings* of any height located in Climate Zones 0, 1, 2, and 3. Back-draft dampers for *ventilation* air intakes must be protected from direct exposure to wind.
2. Back-draft gravity (nonmotorized) dampers are acceptable in *systems* with a design *outdoor air* intake or exhaust capacity of 300 cfm or less.
3. Dampers are not required in *ventilation* or exhaust *systems* serving *unconditioned spaces*.
4. Dampers are not required in exhaust *systems* serving Type 1 kitchen exhaust hoods.

6.4.3.4.3 Damper Leakage

Where *outdoor air* supply and exhaust/relief dampers are required by Section 6.4.3.4.1, they shall have a maximum leakage rate as indicated in Table 6.4.3.4.3 when tested in accordance with AMCA 500D.

6.4.3.4.4 Ventilation Fan Controls

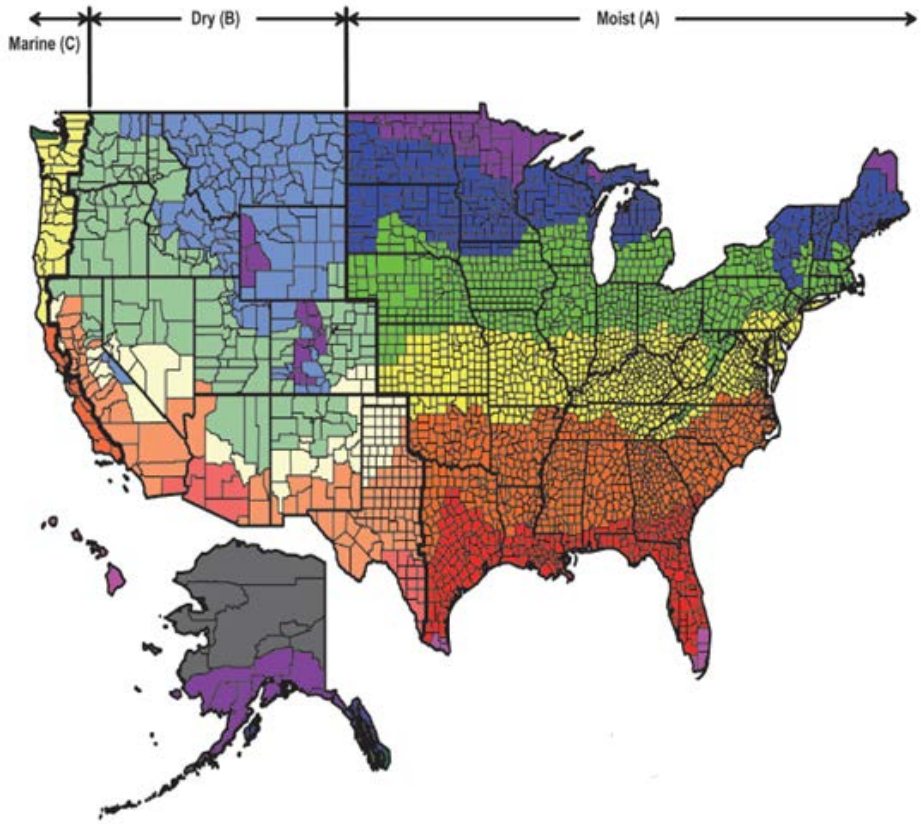
Fans with motors greater than 0.75 hp shall have *automatic controls* complying with Section 6.4.3.3.1 that are capable of and configured to shut off fans when not required.

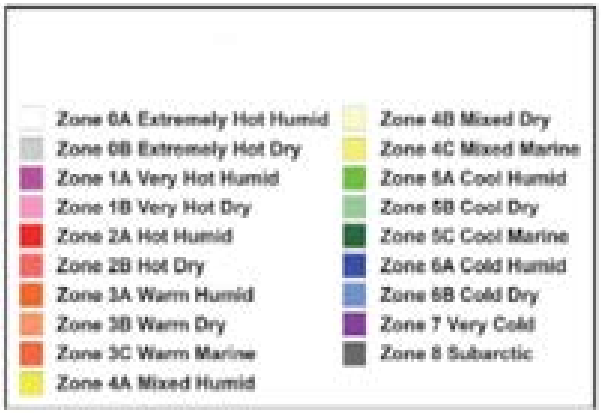
Exception to 6.4.3.4.4

HVAC systems intended to operate continuously.

New Climate Zone Map

- Aligns with new ASHRAE Standard 169-2013
- Reflects global warming trends over the most recent 30 years
- Adds new Climate Zone 0 (extremely hot)
- Approximately 10% of U.S. counties reassigned to a warmer climate zone

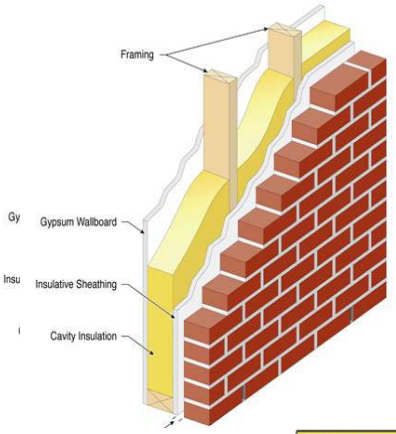


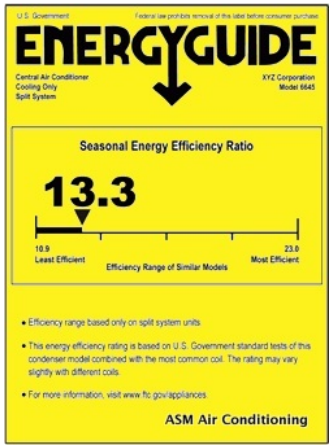


Prescriptive Changes

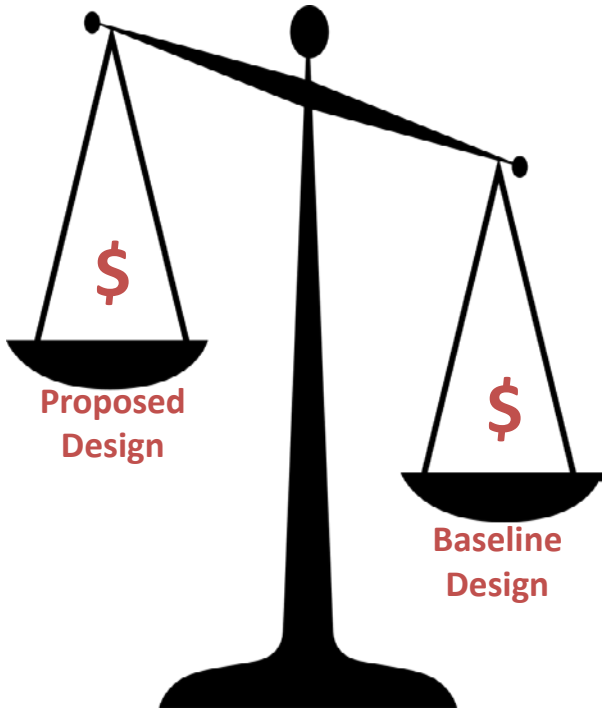
- Standard 90.1 includes two types of compliance paths

Prescriptive path



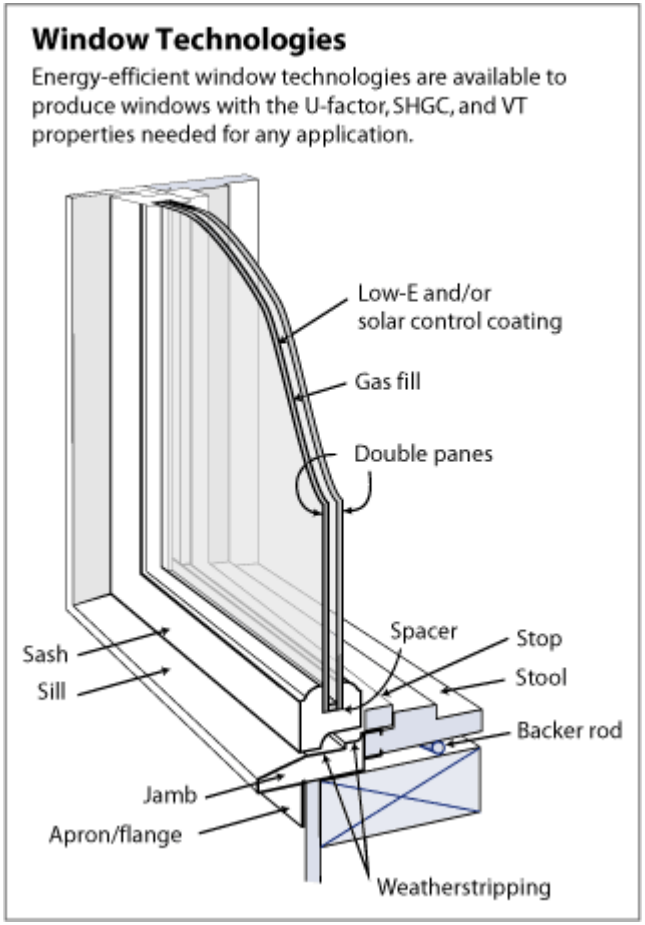


Performance Path



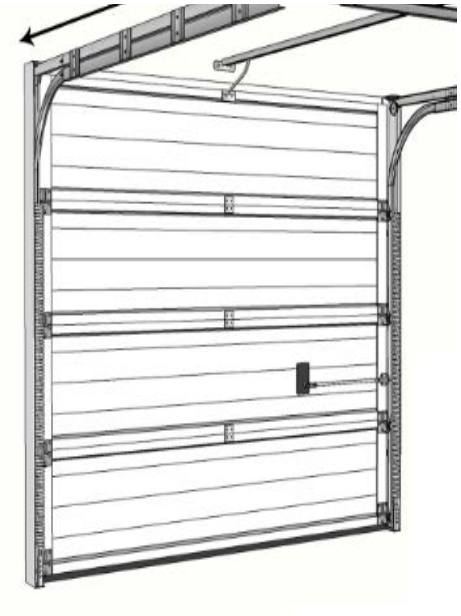
Envelope

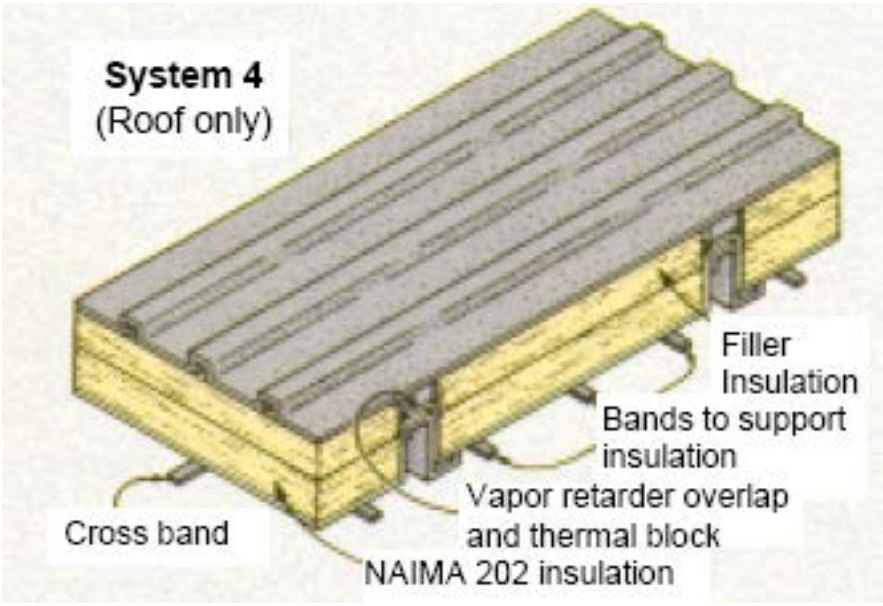
- Fenestration
  - 90.1-2016 includes a comprehensive update to the fenestration prescriptive requirements
    - U-factor reduced by as much as 22% in some climate zones
    - SHGC reduced by as much as 12%



Envelope

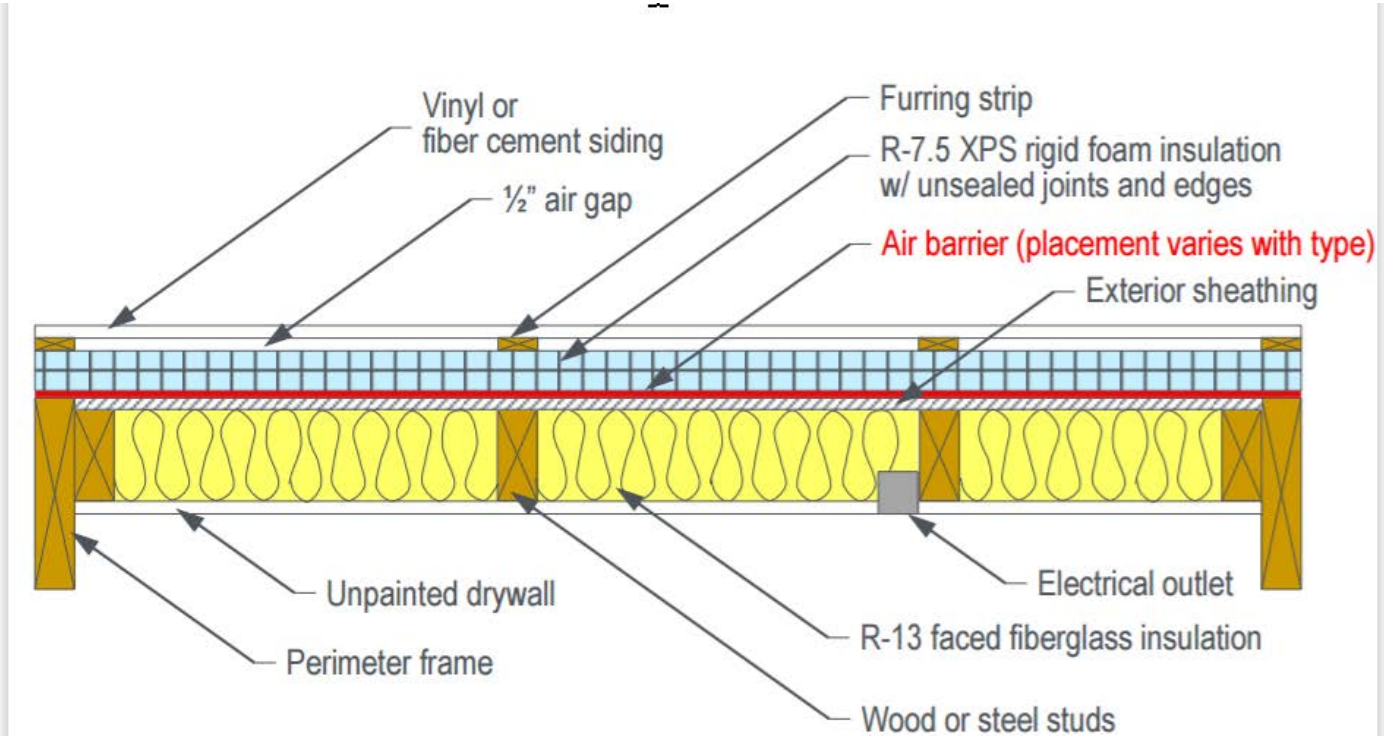
- Walls and Doors
  - Metal building wall thermal properties better defined to enhance compliance
  - U-factors and air leakage limits for doors are improved





Envelope

- Building Air Leakage
  - Whole building air leakage testing added as a compliance option
  - Air barrier design and installation verification required



Mechanical

- Increased HVAC Equipment Efficiency Requirements

Chillers

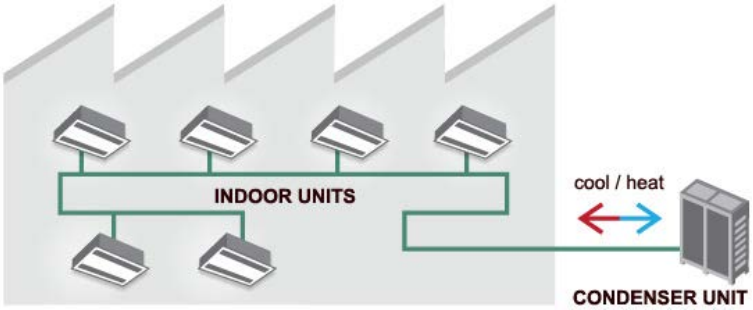
Heat Pumps

Computer Room AC

Dedicated Outdoor Air*

Rooftop AC Units

Cooling Towers



Variable Refrigerant Flow

* Newly regulated equipment

Mechanical

- Replacement equipment now needs to meet many of the requirements formerly for new equipment only. For example:
  - Various controls requirements
  - Economizer requirements
  - Fan efficiency
  - Boiler turndown

Mechanical

- Hotel/Motel Guest Room Controls
  - Heating, cooling, & ventilation automatically reduced when unoccupied
- Chilled Water Plant Metering
  - Large plants required to meter for electricity and efficiency
- Economizer Fault Detection and Diagnostics
  - Ensures that economizers using outdoor air for free cooling are configured and working correctly

Lighting

- Reduced Lighting Power Allowance – Exterior, Interior, Retail Display
  - Primarily based on improved efficacy of LED lighting
  - Exterior lighting power reduced an average of 30%
  - Interior space-by-space reduced an average of 26%
  - Retail display reduced ~25%

Lighting

- Exterior lighting and parking garage lighting requirements to reduce power by 50% during unoccupied periods or after business hours
  - Increased from 30%

Lighting

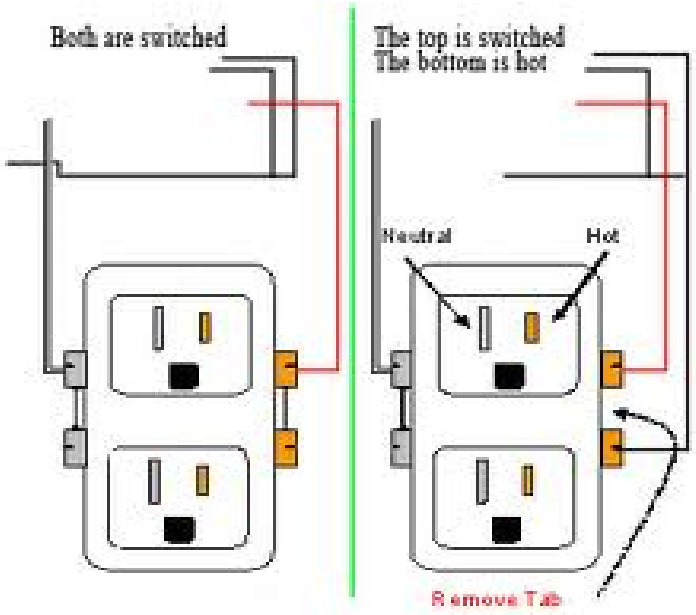
- Parking areas with shorter poles (24 ft or less) & > 78W
  - Lights automatically reduce by at least 50% as detected by occupancy sensors

Lighting

- Dwelling Unit Lighting
  - Apartments, condos, living space must have at least 75% of permanently installed fixtures with minimum lamp efficacy of 55 lumens/Watt
  - Likely requires LED or fluorescent

Power

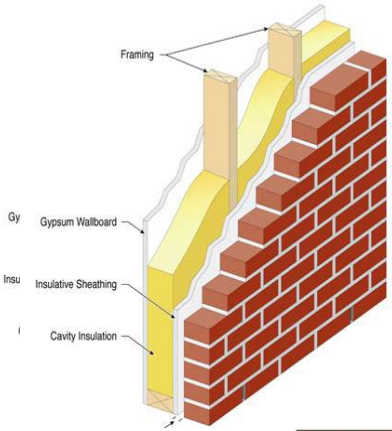
- 50% of receptacles (wall plugs) in a space must have automatic shutoff control
  - Private offices, conference rooms, print/copy, breakroom, classroom individual workstations
  - Requires automatic control (ex: occupancy sensor or time-of-day schedule)
  - Controlled receptacles must be marked and uniformly distributed
  - **Plug-in type devices do not comply**

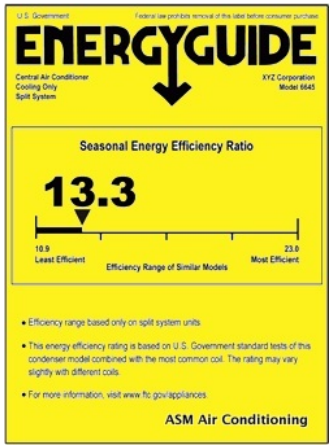


New Compliance Path

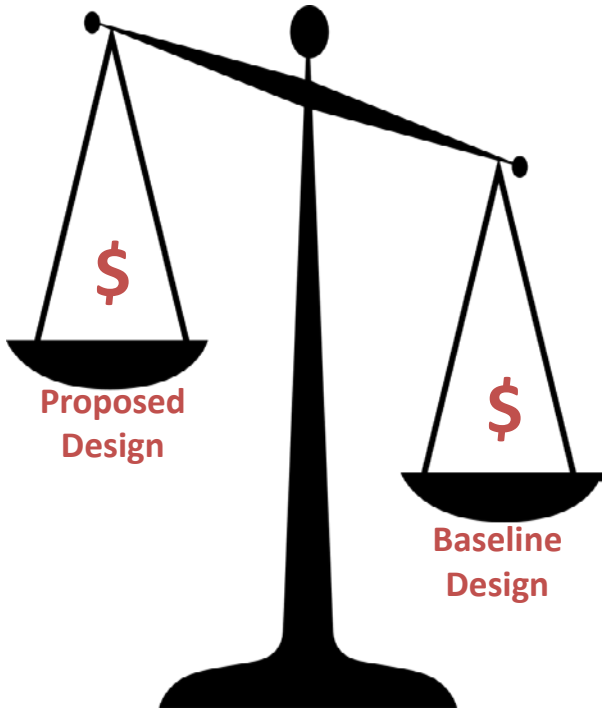
- 90.1-2013 Includes Two Paths for Compliance:

Prescriptive





Performance – Energy Cost Budget (ECB)



EDSL Tas · DesignBuilder · EnergyGauge · TRNSYS 17 · DOE-2 · CoolTool · Carrier HAP · AUTODESK GREEN BUILDING STUDIO · EnerSi · eQUEST · IC3 · ekotrope · APOGEE INTERACTIVE · IES INTEGRATED ENVIRONMENTAL SOLUTIONS · REM/Design · REM/Rate · EnergyInsights™

New Compliance Path

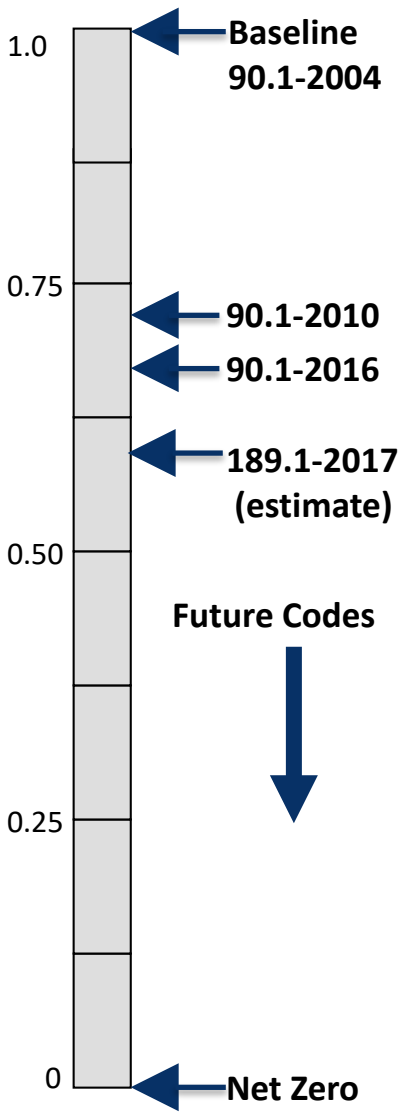
- 90.1-2016 Introduces a Third Path for Compliance
  - Appendix G, Performance Rating Method – similar to Energy Cost Budget but more flexible
  - Not for code compliance (prior to 2016)
  - Used for beyond code programs
    - LEED
    - ASHRAE Standard 189.1
    - International Green Construction Code (IgCC)
    - EPACT Tax Credits
  - Provides credit for good design choices typically not recognized in code
    - Good HVAC systems selection
    - Right sizing of HVAC systems
    - Optimized orientation and use of windows
    - Efficient use of thermal mass

New Compliance Path

- Appendix G requires a Performance Cost Index (PCI) specific to building type and climate zone

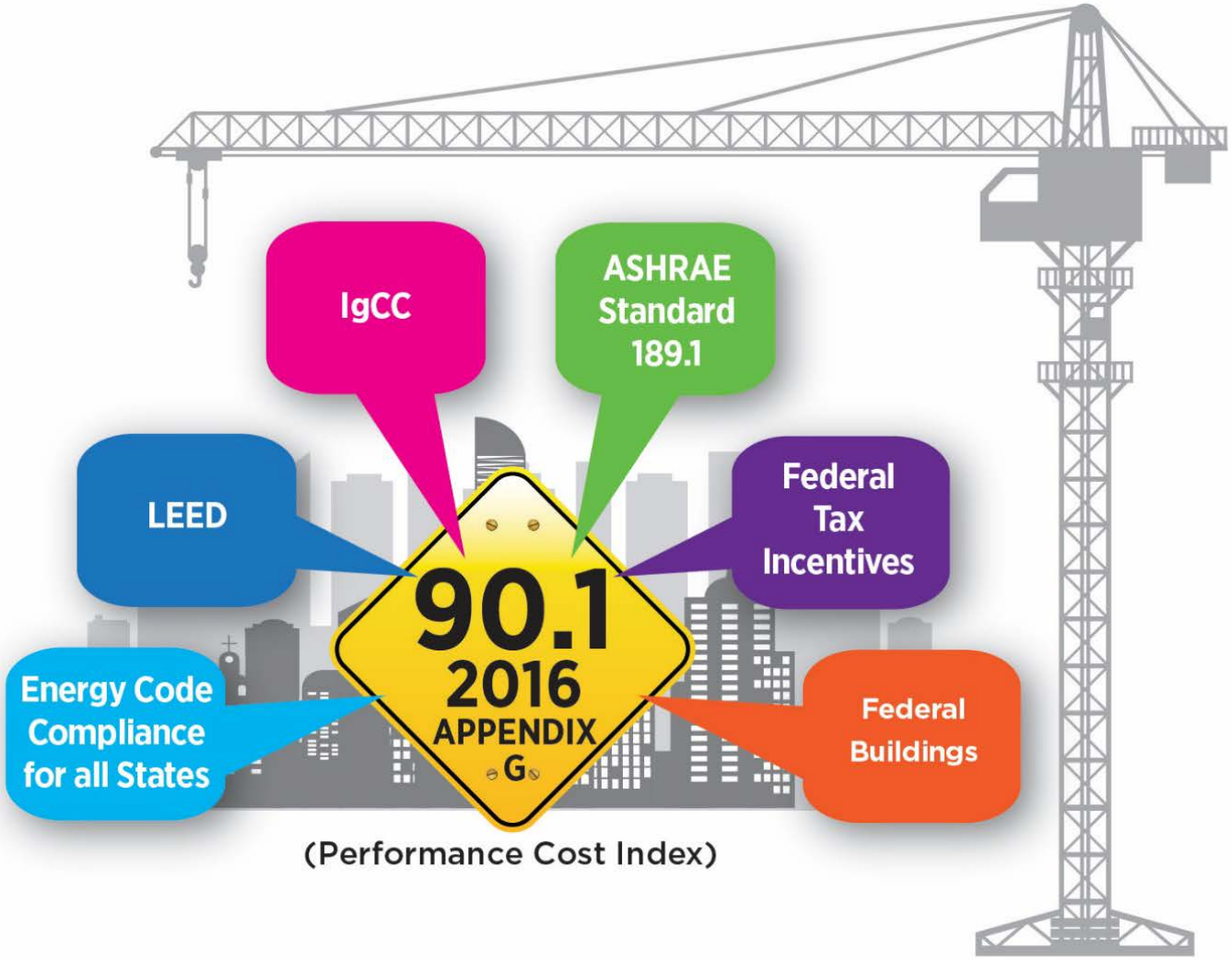
$$Performance\ Cost\ Index\ (PCI) = \frac{Proposed\ Building\ Performance}{Baseline\ Building\ Performance}$$

- Baseline set ~ 90.1-2004
  - Intent is that the stringency of the baseline doesn't change
  - PCI target changes with each version of a code
  - Beyond code programs can choose a PCI to meet their needs



New Compliance Path

- Appendix G - Single Ruleset for Many Purposes



New Performance Path Summary

- 90.1-2016 Introduces a Third Path for Compliance
  - Provides increased flexibility
  - Saves time and money dedicated to energy modeling by allowing a single modeling approach to be used for multiple functions
  - Encourages the creation of tools that automate the simulation process as the market is increased
  - Provides credit for good design practices that were previously not recognized for code compliance

Model Codes Historic Savings

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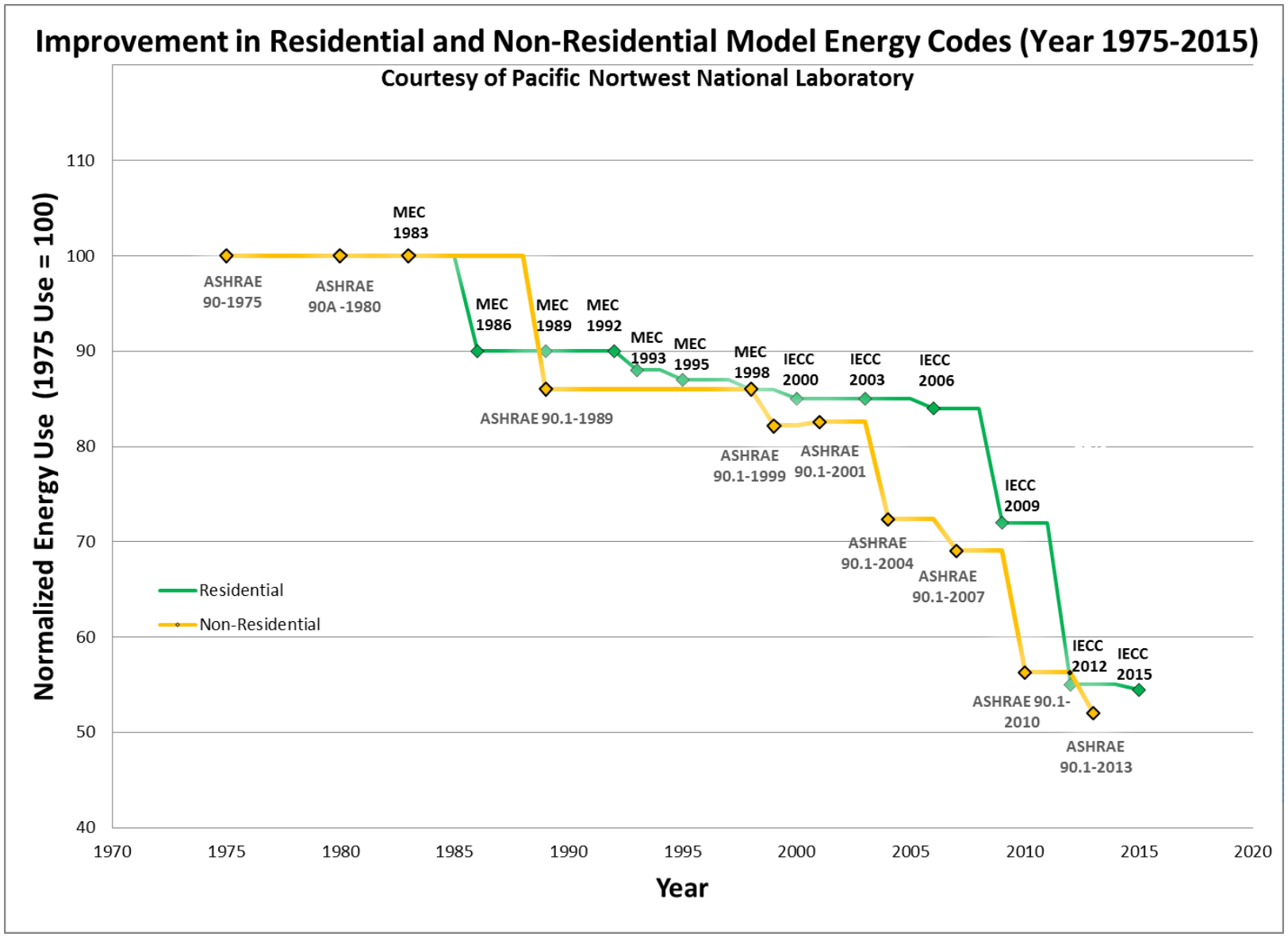

Energy Saving Analysis Method

Develop 16 prototype building models using EnergyPlus

Generate minimally code-compliant models for 90.1-2004, 2007, 2010, 2013 and 2016 editions

Apply to 8 climate zones (17 climate locations)

Assign new building construction weighting factor to each bldg in each climate location

Calculate the national weighted energy use intensity and energy cost index

90.1-2016 Energy Savings Preliminary Results

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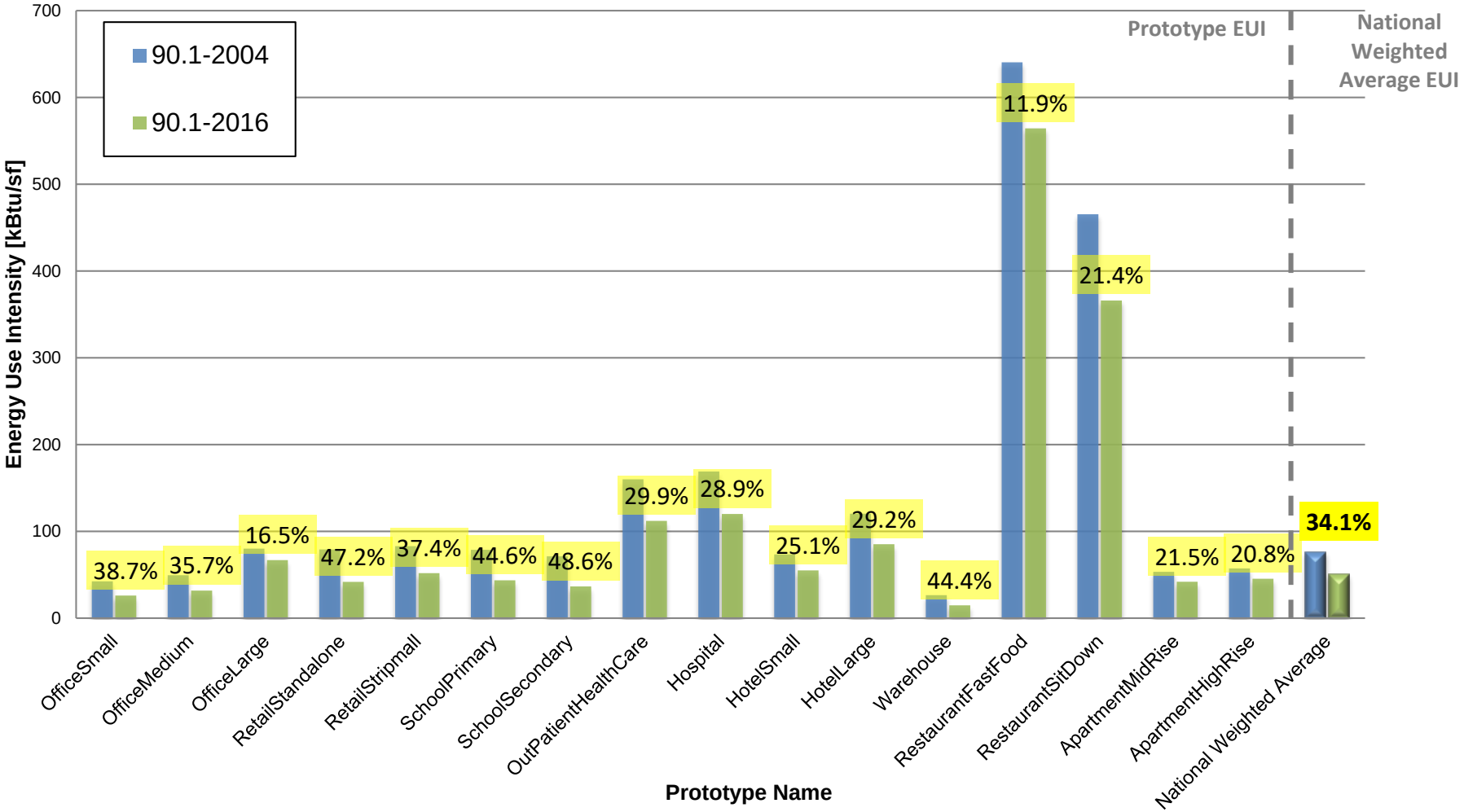

Preliminary Results

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National Weighted Average	Site Energy [kBtu / ft²-yr] Energy Cost [$ / ft²-yr]			% Energy or Cost Savings		
	90.1-2004	90.1-2013	90.1-2016 PI	90.1-2013 vs. 90.1-2004	90.1-2016 PI vs. 90.1-2004	90.1-2016 PI vs. 90.1-2013
Whole Building	76.5	54.1	50.43	29.3%	34.1%	6.8%
	$1.84	$1.32	$1.21	28.5%	34.2%	8.0%

Discussion

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