What's the Latest in the IECC and 90.1 Model Code Development Cycles?

2023 National Energy Codes Conference

May 3, 2023

Agenda

- Residential (IECC-R)
- Commercial (ASHRAE 90.1 and IECC-C)
- Deep Dive on a Few Complex Topics
- Wrap up and Q&A

What to Expect in the 2024 Residential IECC

…and what not to expect…

Steven Winter Associates, Inc.

2024 Residential Code Development

Instead of code hearings, 2024 IECC was developed like a standard

Residential Consensus Committee (48 members, selected in early 2021)

- 15 Code Officials (ID, NJ, NY, MA, ME, TX, GA, NC, IA, FL, VA, LA, CO, MD)
- 10 Builders (NAHB, LBA, Habitat for Humanity, other homebuilders)
- 9 Public Segment (DOE, PNNL, NBI, EECC, SWEEP, MEEA, NRDC)
- 7 Users (Raters, Architects)
- 4 Manufacturers (AHRI, insulation, windows & doors, solar)
- 2 Utilities

Six Sub-Committees: Admin, Envelope, HVAC & HW, EPLR, & Modeling

1st call for proposals were due in October 2021

2024 Residential Code Development

Over 200 proposals received; reviewed by sub-committees and Main by September 2022

~100 failed to attain consensus (i.e., two-thirds or 32 Yes votes)

~100 were approved as submitted, or more often, as modified

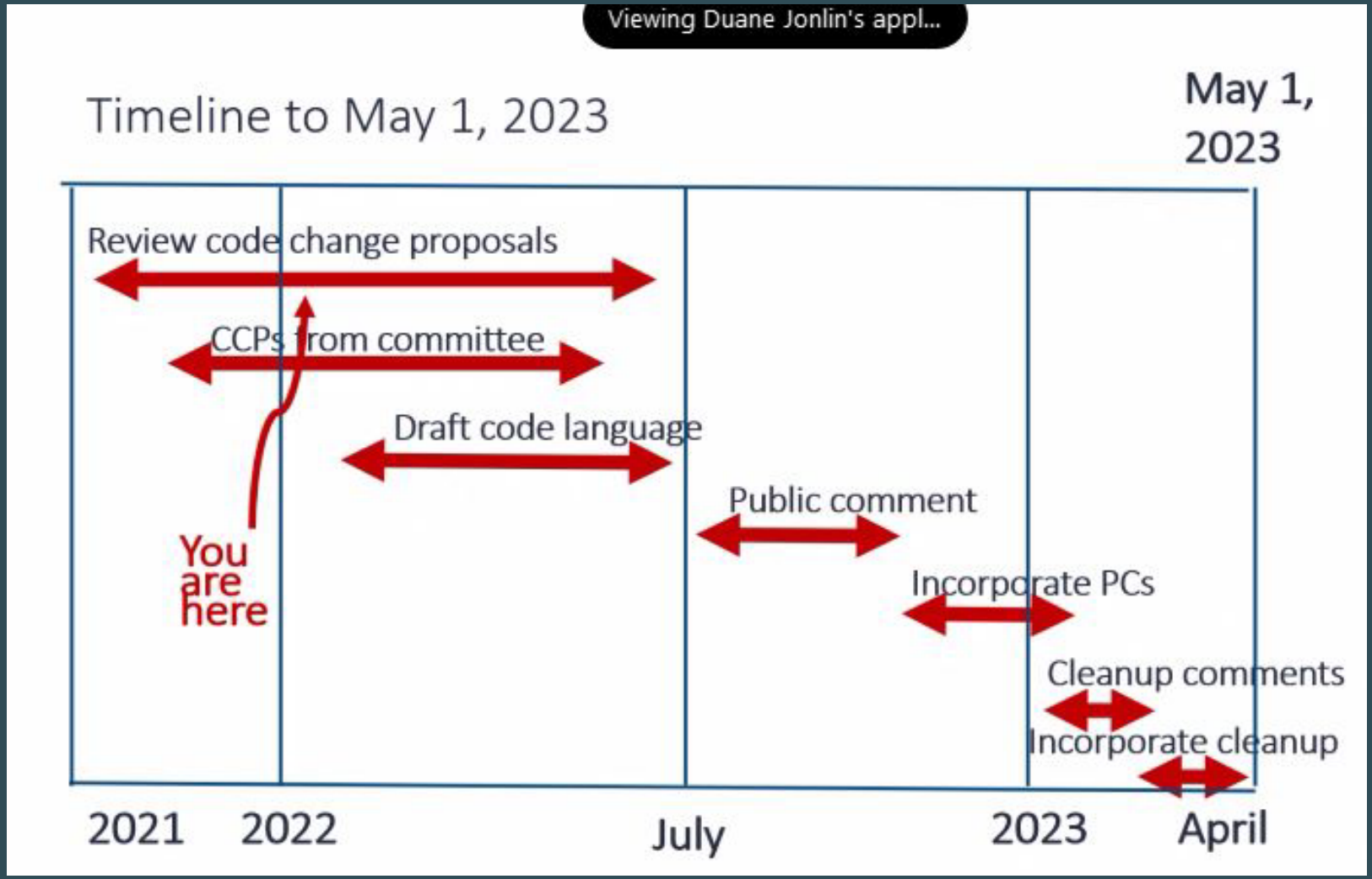
1st Public Comment draft posted online in October 2022

Over 400 proposals received; reviewed by sub-committees and Main by April 2023

2nd Public Comment draft will be posted online in May 2023

Over ## proposals received; reviewed by sub-committees and Main by September 2023

Duane Jonlin was right!



Code Changes to expect in 2024 IECC-R

R401 General

R401.2 Application. Residential buildings shall comply with ~~Section R401.2.5 and~~ either Section R401.2.1, R401.2.2, R401.2.3 or R401.2.4.

~~**R401.2.5 Additional energy efficiency.** This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.~~

~~1. For buildings complying with Section R401.2.1, one of the additional efficiency package options shall be installed according to Section R408.2.~~

~~2. For buildings complying with Section R401.2.2, the building shall meet one of the following:~~

~~2.1. One of the additional efficiency package options in Section R408.2 shall be installed without including such measures in the proposed design under Section R405; or~~

~~2.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.~~

~~3. For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.~~

~~The option selected for compliance shall be identified in the certificate required by Section R401.3.~~

Code Changes to expect in 2024 IECC-R

R402 Building Thermal Envelope

Flipped the rows and columns to match IECC-C format

Changes to fenestration and ceiling insulation U-factors

CLIMATE ZONE	0	1	2	3	4 except Marine	5 and Marine 4	6	7 and 8
FENESTRATION U-FACTOR[fd]	0.50	0.50	0.40	0.30	0.30	~~0.30~~0.28[e]	~~0.30~~0.28[e]	~~0.30~~0.27[e]
SKYLIGHT[d] *U*-FACTOR	~~0.75~~0.60	~~0.75~~0.60	~~0.65~~0.60	~~0.55~~0.53	~~0.55~~0.53	~~0.55~~0.50	~~0.55~~0.50	~~0.55~~0.50
GLAZED FENESTRATION SHGC[d,e]	0.25	0.25	0.25	0.25	0.40	~~0.40~~NR	NR	NR
CEILING *U*-FACTOR[f]	0.035	0.035	~~0.026~~0.030	~~0.026~~0.030	~~0.024~~0.026	~~0.024~~0.026	~~0.024~~0.026	~~0.024~~0.026

New row for ‘Insulation entirely above roof deck’

Code Changes to expect in 2024 IECC-R

R402 Building Thermal Envelope

F-factors for slabs

CLIMATE ZONE	0	1	2	3	4 except Marine	5 and Marine 4	6	7 and 8
UNHEATED SLAB F-FACTOR[g]	0.73	0.73	0.73	0.54	0.51	0.51	0.48	0.48
HEATED SLAB F-FACTOR[g]	0.74	0.74	0.74	0.66	0.66	0.66	0.66	0.66

Total “UA” replaced with “TC”, where TC is UA + FP

What you won’t see:

- Changes to prescriptive wall U-factors
- Anything related to embodied carbon or linear/point thermal bridges

Code Changes to expect in 2024 IECC-R

R402 Building Thermal Envelope

Air Leakage (Technical & Organizational changes)

- Clarify the max allowed for each path & home type
- Increased stringency:
  - R405 & R406: 5 ACH50 drops to 4.0 ACH50
  - Prescriptive:
    - 5 ACH50 drops to 4.0 ACH50 in CZ 0-2
    - 3 ACH50 drops to 2.5 ACH50 in CZ 6-8

Multifamily:

- Increased stringency: 0.30 cfm50/ft^2 drops to 0.27
- Add a sampling protocol for buildings with 8+ units
- Reduced air leakage allowance if using guarded tests

Code Changes to expect in 2024 IECC-R

R403 Systems

R403.1.2 Heat Pump Supplementary Heat

- New language to clarify the controls needed
- Applies to all supplementary heat (electric resistance & other fuels)

Code Changes to expect in 2024 IECC-R

R403 Systems

R403.3 Ducts

- Technical, Editorial, and Organizational changes
  - Revised and added definitions
  - Created a table for max duct leakage values
  - Provide greater leakage allowance where there are more returns
  - Add test exemption for ductless systems (< 10 ft of ductwork)
  - Add a sampling protocol for buildings with 8+ units
  - Added duct sizing requirements (points to IRC and IMC)

Code Changes to expect in 2024 IECC-R

R403 Systems (continued)

R403.5.4 Hot Water Pipe Volume calculations

TABLE R403.5.4
INTERNAL VOLUME OF VARIOUS WATER DISTRIBUTION TUBING

OUNCES OF WATER PER FOOT OF TUBE									
NOMINAL SIZE (inches)	COPPER TYPE M	COPPER TYPE L	COPPER TYPE K	CPVC CTS SDR 11	CPVC SCH 40	CPVC SCH 80	PE-RT SDR 9	COMPOSITE ASTM F1281	PEX CTS SDR 9
3/8	1.06	0.97	0.84	N/A	1.17	-	0.64	0.63	0.64
1/2	1.69	1.55	1.45	1.25	1.89	1.46	1.18	1.31	1.18
3/4	3.43	3.22	2.90	2.67	3.38	2.74	2.35	3.39	2.35
1	5.81	5.49	5.19	4.43	5.53	4.57	3.91	5.56	3.91
1 1/4	8.70	8.36	8.09	6.61	9.66	8.24	5.81	8.49	5.81
1 1/2	12.18	11.83	11.45	9.22	13.20	11.38	8.09	13.88	8.09
2	21.08	20.58	20.04	15.79	21.88	19.11	13.86	21.48	13.86

For SI: 1 foot = 304.8 mm, 1 inch = 25.4 mm, 1 liquid ounce = 0.030L, 1 oz/ft^2 = 305.15 g/m^2.

N/A = Not available.

Code Changes to expect in 2024 IECC-R

R403 Systems (continued)

R403.5.4 Hot Water Pipe Volume calculations

R403.5.5 Demand Responsive Water Heating

- What you won't see: demand responsive HVAC (only as a point in R408)

R403.6.1 Heat or energy recovery ventilation

- Expands requirement into CZ 6

Code Changes to expect in 2024 IECC-R

R403 Systems (continued)

R403.5.4 Hot Water Pipe Volume calculations

R403.5.5 Demand Responsive Water Heating

- What you won't see: demand responsive HVAC (only as a point in R408)

R403.6.1 Heat or energy recovery ventilation

- Expands requirement into CZ 6

R403.7.1 Electric resistance space heating limits

- In CZ 4 to 8, 2 kW max unless at least ONE heat pump is installed
- What you won't see: a prohibition on using gas / oil (see Appendix RE)

Code Changes to expect in 2024 IECC-R

R404 Electrical Power, Lighting, and Renewable Energy Systems

R404.1 to R404.3 Lighting

R404.4 Renewable energy certificate (REC) documentation

R404.5 Electric Readiness

- Provide sufficient electric infrastructure where non-electric cooktop, oven, clothes dryer, or water heater installed
- What you won't see:
  - Electric readiness requirement for space heating

Ted Lasso was not right!

Code Changes to expect in 2024 IECC-R

R404 Electrical Power, Lighting, and Renewable Energy Systems (cont'd)

R404.6 Renewable Energy Infrastructure

- Provide solar-ready zones (some Exceptions)

What you won't see:

- Solar mandate (Appendix only)
- Energy storage mandates (Appendix only)

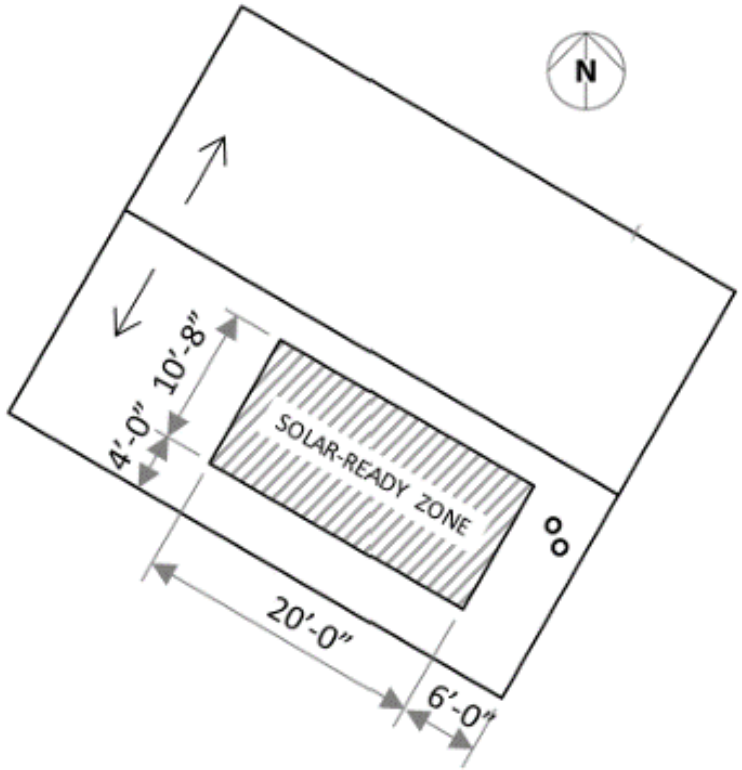


Image Credit: City of Scottsdale

Code Changes to expect in 2024 IECC-R

R404 Electrical Power, Lighting, and Renewable Energy Systems (cont'd)

R404.7 Electric Vehicle Power Transfer Infrastructure

- EV-capable, EV-ready, or EV-installed (some Exceptions)
- Single family (IRC):

  One (1) space per unit
- Group R-2:

  40% of dwelling units or spaces, whichever is less

Code Changes to expect in 2024 IECC-R

R405 Simulated Building Performance

- Clarifies that only dwelling units are modeled; common areas must instead meet prescriptive requirements in R402, R403, and R404.
- Allows credit for HVAC & DHW efficiency and duct location
- 85% energy cost savings required for electric; 80% for mixed-fuel homes
- Homes larger than 5,000 ft^2 have to perform 5% better (80 and 75%)
- Envelope backstop updated from 2009 IECC to 1.08 or 1.15 X $TC_{2024\ IECC}$
- New site-to-source multipliers (2.51 for electric, 1.09 for other fuels)
- New site energy savings alternative to energy cost or source savings
- Requires software to demonstrate compliance with ASHRAE Std 140
- What you won't see: credit for lights, appliances, or renewables

Code Changes to expect in 2024 IECC-R

R406 Energy Rating Index Compliance

- Clarifies that only dwelling units are modeled; common areas must instead meet prescriptive requirements in R402, R403, and R404.
- Requires software tools to demonstrate compliance with ASHRAE Std 140
- Removes the ventilation rate deviation
- Updates to use ANSI 301-2022 instead of 2019
- Same envelope backstop as R405; no different if on-site power is present
- No limit on how much on-site solar PV can contribute to code compliance
  …but if you use OPP, your ERI Max is much lower
- Reduce the ERI Max by 1 point compared to the 2021 IECC table values
- For MF, allows the average ERI to be used to demonstrate compliance

Code Changes to expect in 2024 IECC-R

R406.5 ERI-based compliance. Compliance based on an ERI analysis requires that the *rated design* and each confirmed as-built *dwelling unit* be shown to have an ERI less than or equal to the applicable value indicated in Table R406.5 where compared to the *ERI reference design* as follows*:*

1. Where on-site renewables are not installed, the maximum ENERGY RATING INDEX NOT INCLUDING OPP applies.
2. Where on-site renewables are installed, the maximum ENERGY RATING INDEX INCLUDING OPP applies.

Exceptions:

1. Where the ERI analysis excludes OPP, the maximum ENERGY RATING INDEX NOT INCLUDING OPP shall be permitted.
2. For buildings with twenty or more *dwelling units*, where *approved* by the *code official*, compliance shall be permitted using the Average Dwelling Unit Energy Rating Index, as calculated in accordance with ANSI/RESNET/ICC 301.

CLIMATE ZONE	ENERGY RATING INDEX NOT INCLUDING OPP	ENERGY RATING INDEX WITH OPP
0-1	51	35
2	51	34
3	50	33
4	53	40
5	54	43
6	53	43
7	52	46
8	52	46

Code Changes to expect in 2024 IECC-R

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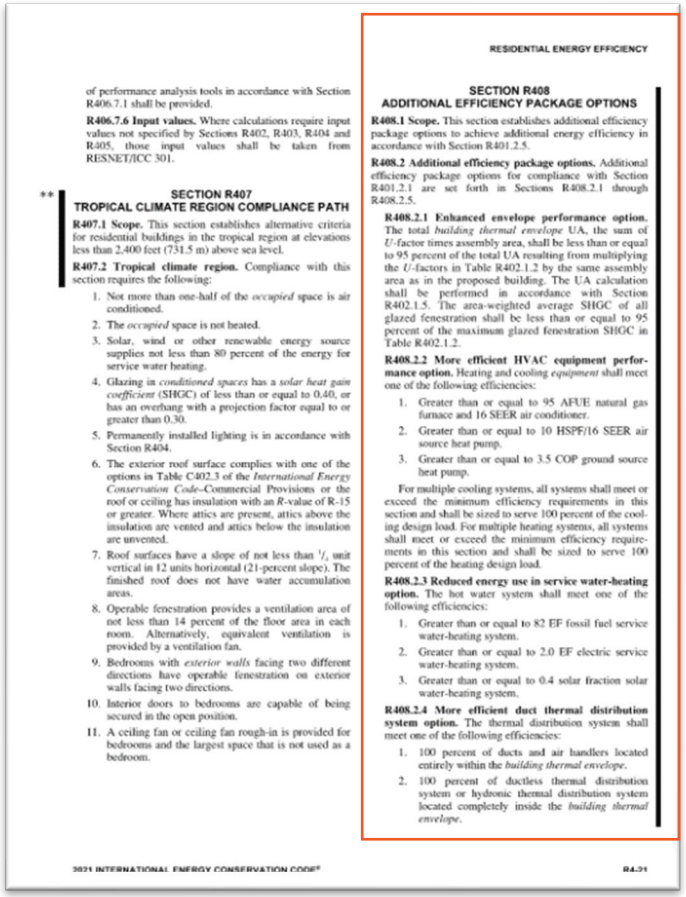
Code Changes to expect in 2024 IECC-R

R408 Additional Efficiency Requirements



of performance analysis tools in accordance with Section R406.7.1 shall be provided.

R406.7.6 Input values. Where calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from RESNET/ICC 301.

**

SECTION R407
TROPICAL CLIMATE REGION COMPLIANCE PATH

R407.1 Scope. This section establishes alternative criteria for residential buildings in the tropical region at elevations less than 2,400 feet (731.5 m) above sea level.

R407.2 Tropical climate region. Compliance with this section requires the following:

1. Not more than one-half of the *occupied* space is air conditioned.
2. The *occupied* space is not heated.
3. Solar, wind or other renewable energy source supplies not less than 80 percent of the energy for service water heating.
4. Glazing in *conditioned spaces* has a *solar heat gain coefficient* (SHGC) of less than or equal to 0.40, or has an overhang with a projection factor equal to or greater than 0.30.
5. Permanently installed lighting is in accordance with Section R404.
6. The exterior roof surface complies with one of the options in Table C402.3 of the *International Energy Conservation Code*–Commercial Provisions or the roof or ceiling has insulation with an *R*-value of R-15 or greater. Where attics are present, attics above the insulation are vented and attics below the insulation are unvented.
7. Roof surfaces have a slope of not less than $^1/_4$ unit vertical in 12 units horizontal (21-percent slope). The finished roof does not have water accumulation areas.
8. Operable fenestration provides a ventilation area of not less than 14 percent of the floor area in each room. Alternatively, equivalent ventilation is provided by a ventilation fan.
9. Bedrooms with *exterior walls* facing two different directions have operable fenestration on exterior walls facing two directions.
10. Interior doors to bedrooms are capable of being secured in the open position.
11. A ceiling fan or ceiling fan rough-in is provided for bedrooms and the largest space that is not used as a bedroom.

SECTION R408
ADDITIONAL EFFICIENCY PACKAGE OPTIONS

R408.1 Scope. This section establishes additional efficiency package options to achieve additional energy efficiency in accordance with Section R401.2.5.

R408.2 Additional efficiency package options. Additional efficiency package options for compliance with Section R401.2.1 are set forth in Sections R408.2.1 through R408.2.5.

R408.2.1 Enhanced envelope performance option. The total *building thermal envelope* UA, the sum of *U*-factor times assembly area, shall be less than or equal to 95 percent of the total UA resulting from multiplying the *U*-factors in Table R402.1.2 by the same assembly area as in the proposed building. The UA calculation shall be performed in accordance with Section R402.1.5. The area-weighted average SHGC of all glazed fenestration shall be less than or equal to 95 percent of the maximum glazed fenestration SHGC in Table R402.1.2.

R408.2.2 More efficient HVAC equipment performance option. Heating and cooling *equipment* shall meet one of the following efficiencies:

1. Greater than or equal to 95 AFUE natural gas furnace and 16 SEER air conditioner.
2. Greater than or equal to 10 HSPF/16 SEER air source heat pump.
3. Greater than or equal to 3.5 COP ground source heat pump.

For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

R408.2.3 Reduced energy use in service water-heating option. The hot water system shall meet one of the following efficiencies:

1. Greater than or equal to 82 EF fossil fuel service water-heating system.
2. Greater than or equal to 2.0 EF electric service water-heating system.
3. Greater than or equal to 0.4 solar fraction solar water-heating system.

R408.2.4 More efficient duct thermal distribution system option. The thermal distribution system shall meet one of the following efficiencies:

1. 100 percent of ducts and air handlers located entirely within the *building thermal envelope*.
2. 100 percent of ductless thermal distribution system or hydronic thermal distribution system located completely inside the *building thermal envelope*.

3. 100 percent of duct thermal distribution system located in *conditioned space* as defined by Section R403.3.2.

R408.2.5 Improved air sealing and efficient ventilation system option. The measured air leakage rate shall be less than or equal to 3.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed. Minimum HRV and ERV requirements, measured at the lowest tested net supply airflow, shall be greater than or equal to 75 percent Sensible Recovery Efficiency (SRE), less than or equal to 1.1 cubic feet per minute per watt (0.03 m^3/min/watt) and shall not use recirculation as a defrost strategy. In addition, the ERV shall be greater than or equal to 50 percent Latent Recovery/Moisture Transfer (LRMT).

Code Changes to expect in 2024 IECC-R

R408 Additional Efficiency Requirements

- Instead of 5 ‘packages’, pick 2 ‘measures’ that sum to 10 or more ‘points’
- Over 45 measures across 11 Measure Categories

1. Enhanced Building Envelope
2. More efficient Heating & Cooling
3. More efficient Hot Water
4. More efficient Duct Distribution
5. More efficient Ventilation
6. Energy Efficient Appliances
7. On-site renewables
8. Off-site renewables
9. Demand response HVAC
10. Opaque Walls
11. Whole home lighting control

Code Changes to expect in 2024 IECC-R

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Code Changes to expect in 2024 IECC-R

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6. Energy Efficient Appliances
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9. Demand response HVAC
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New (or updated) Appendices in 2024 IECC-R

Appendix RC – Zero net energy residential buildings (updated)

Appendix RD – Electric Energy Storage Provisions (new!)

Appendix RE – All-Electric residential buildings (new!)

Appendix RF – Alt. building thermal envelope insulation R-values (new!)

Appendix RP – On-Site Renewable Energy (new!)

Appendix RG – 2024 IECC Stretch Code (new!)

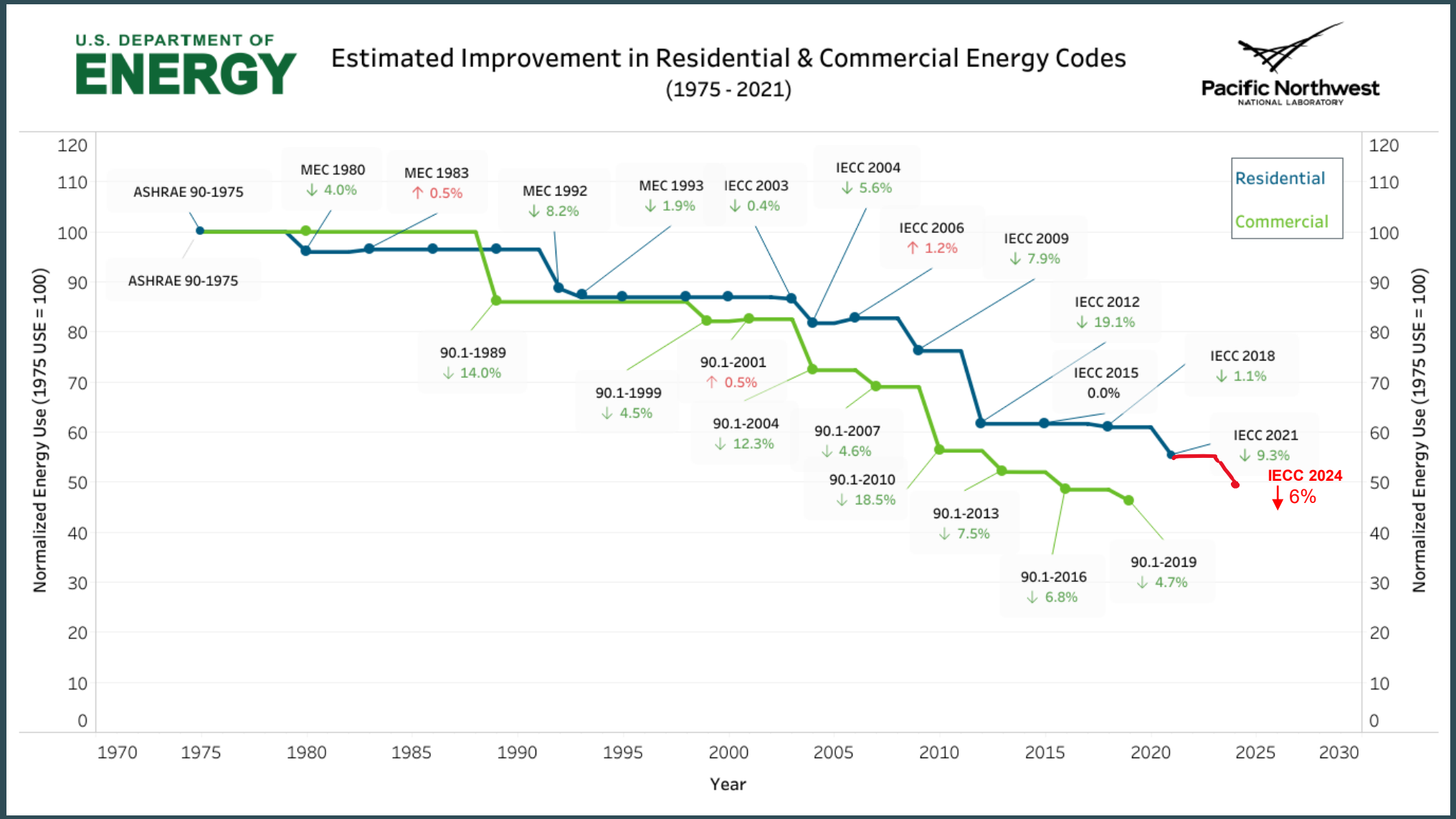
Appendix RH – Operational Carbon Rating and Energy Reporting (new!)

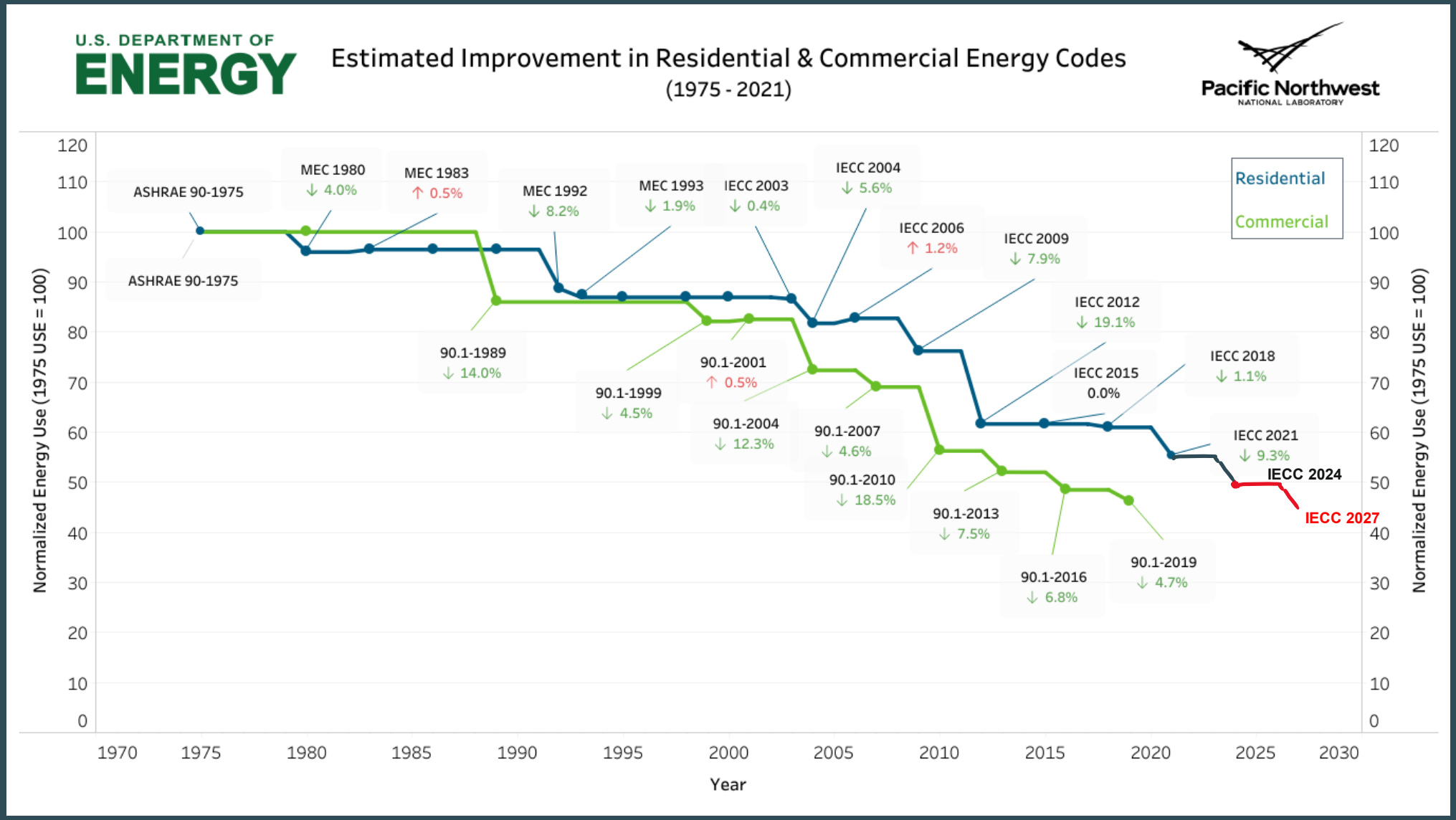
PNNL Progress Indicator (based on 1st draft)

Pacific Northwest NATIONAL LABORATORY

Summary of Results

National Weighted Average		Site Energy [kBtu/ft²-yr] Energy Cost [$/residence-yr] Emissions [tons/kft²-yr]		% Savings
		IECC 2021	IECC 2024	
Whole Building	Site Energy	34	31.7	6.66%
	Energy Cost	2,009	1,881	6.41%
	Emissions	10.79	10.1	6.41%


U.S. DEPARTMENT OF ENERGY
Estimated Improvement in Residential & Commercial Energy Codes
(1975 - 2021)
Pacific Northwest NATIONAL LABORATORY
Residential
Commercial
ASHRAE 90-1975
ASHRAE 90-1975
MEC 1980
↓ 4.0%
MEC 1983
↑ 0.5%
MEC 1992
↓ 8.2%
MEC 1993
↓ 1.9%
IECC 2003
↓ 0.4%
IECC 2004
↓ 5.6%
IECC 2006
↑ 1.2%
IECC 2009
↓ 7.9%
IECC 2012
↓ 19.1%
IECC 2015
0.0%
IECC 2018
↓ 1.1%
IECC 2021
↓ 9.3%
IECC 2024
↓ 6%
90.1-1989
↓ 14.0%
90.1-1999
↓ 4.5%
90.1-2001
↑ 0.5%
90.1-2004
↓ 12.3%
90.1-2007
↓ 4.6%
90.1-2010
↓ 18.5%
90.1-2013
↓ 7.5%
90.1-2016
↓ 6.8%
90.1-2019
↓ 4.7%
Normalized Energy Use (1975 USE = 100)
Normalized Energy Use (1975 USE = 100)
Year
0
10
20
30
40
50
60
70
80
90
100
110
120
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030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Residential
Commercial
ASHRAE 90-1975
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MEC 1980
↓ 4.0%
MEC 1983
↑ 0.5%
MEC 1992
↓ 8.2%
MEC 1993
↓ 1.9%
IECC 2003
↓ 0.4%
IECC 2004
↓ 5.6%
IECC 2006
↑ 1.2%
IECC 2009
↓ 7.9%
IECC 2012
↓ 19.1%
IECC 2015
0.0%
IECC 2018
↓ 1.1%
IECC 2021
↓ 9.3%
IECC 2024
IECC 2027
90.1-1989
↓ 14.0%
90.1-1999
↓ 4.5%
90.1-2001
↑ 0.5%
90.1-2004
↓ 12.3%
90.1-2007
↓ 4.6%
90.1-2010
↓ 18.5%
90.1-2013
↓ 7.5%
90.1-2016
↓ 6.8%
90.1-2019
↓ 4.7%
Normalized Energy Use (1975 USE = 100)
Normalized Energy Use (1975 USE = 100)
Year
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30
40
50
60
70
80
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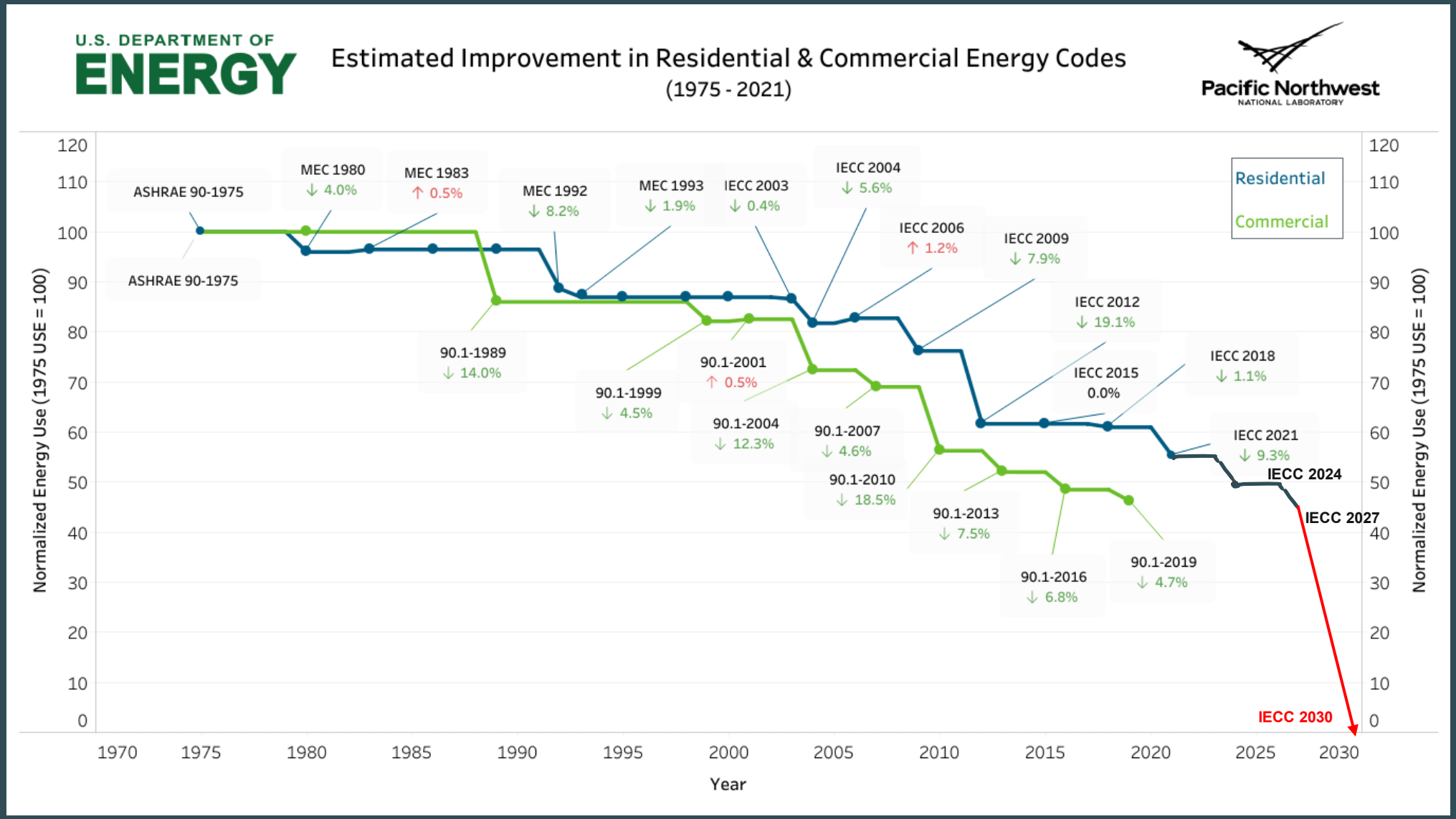
2030


U.S. DEPARTMENT OF ENERGY
Estimated Improvement in Residential & Commercial Energy Codes
(1975 - 2021)
Pacific Northwest NATIONAL LABORATORY
Residential
Commercial
ASHRAE 90-1975
ASHRAE 90-1975
MEC 1980
↓ 4.0%
MEC 1983
↑ 0.5%
MEC 1992
↓ 8.2%
MEC 1993
↓ 1.9%
IECC 2003
↓ 0.4%
IECC 2004
↓ 5.6%
IECC 2006
↑ 1.2%
IECC 2009
↓ 7.9%
IECC 2012
↓ 19.1%
IECC 2015
0.0%
IECC 2018
↓ 1.1%
IECC 2021
↓ 9.3%
IECC 2024
IECC 2027
IECC 2030
90.1-1989
↓ 14.0%
90.1-1999
↓ 4.5%
90.1-2001
↑ 0.5%
90.1-2004
↓ 12.3%
90.1-2007
↓ 4.6%
90.1-2010
↓ 18.5%
90.1-2013
↓ 7.5%
90.1-2016
↓ 6.8%
90.1-2019
↓ 4.7%
Normalized Energy Use (1975 USE = 100)
Normalized Energy Use (1975 USE = 100)
Year
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120
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
2030

What to Expect in the 2024 Residential IECC

…and what not to expect…

Steven Winter Associates, Inc.

Thank you!

Questions?

Contact Us

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COMMERCIAL BUILDING ENERGY CODES CURRENT AND FUTURE REVISION REVIEW

Standards Revisions
Energy Efficiency
New Metrics
New Compliance Paths
Carbon Neutral
Electrification

May 3, 2023
2023 National Energy Codes Conference
Richard Lord, Chair AHRAE 90.1, ASHRAE Fellow, Carrier Fellow

Richard Lord (Dick)

Carrier Sr. Fellow, ASHRAE Fellow – HVAC, Controls, Systems and Regulations

Richard Lord is a Senior Carrier Fellow, as well as an ASHRAE Fellow, with 50 years of experience in the design and application of commercial air conditioning equipment and controls with expertise in systems, fluids, refrigerants, heat transfer, heat exchanger design, software, controls, diagnostics, commercial efficiency and building standards and codes.

He is located in Monteagle, Tennessee, and is member of Carrier's Research and Development Organization working on refrigerants and commercial equipment advanced technology and systems innovation.

He is also involved industry standard, regulations and research and is incoming chair of ASHRAE 90.1, Chair of ASHRAE AES, member of ASHRAE 189.1, ASHRAE 196, ASHRAE 205, ASHRAE 207, IECC HVACR Subcommittee, CSA 424, chair of CSA 401, CSA Scooper, California CEA, UL60335-2-40, AHRI 340/360, AHRI 550/590, AHRI System Steering Committee, vice chair of AHRI Safe Transition Task Force and several other industry committees.

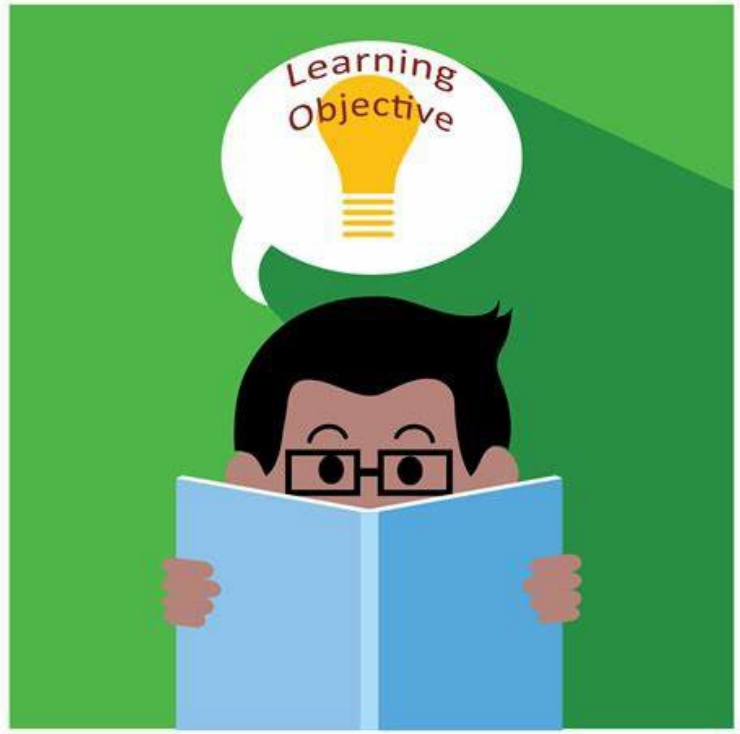
Over his career, he has worked on the design of commercial HVAC equipment including heat exchanger design, air- and water-cooled chillers, rooftops, splits systems, air handlers, advanced controls and systems, and refrigerants. He also has been involved in the multiple refrigerant transitions that have occurred over the past 30 years and is conducting many technical studies for new refrigerant selections for the new global warming potential (GWP) phasedown regulations as well as involvement is Carrier and global environmental initiatives.

Carrier

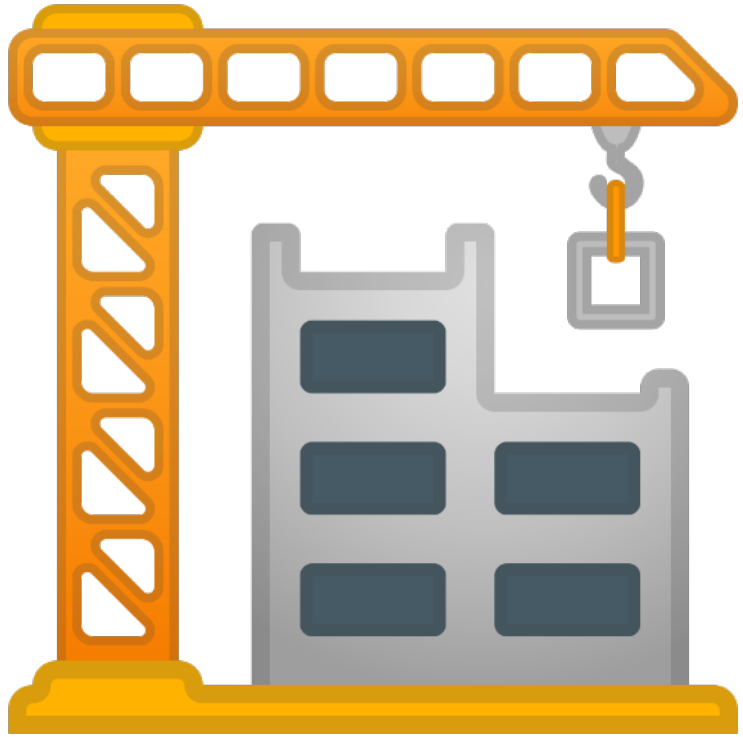
Learning Objectives

The learning objective of this presentation is to give a quick overview of **Commercial Building Energy Codes** including the following;

1. What are the **commonly used** Commercial Minimum efficiency Energy Codes
2. What are their typical **update schedules**
3. How are they **adopted**
4. Federally Controlled Appliance Efficiencies and **Preemption**
5. For the **latest updates what are the major changes** and updates for ASHRAE 90.1-2022 and IECC Commercial 2024
6. **Long range 2031 workplan** for ASHRAE 90.1



OVERVIEW OF COMMERCIAL MINIMUM EFFICIENCY STANDARDS

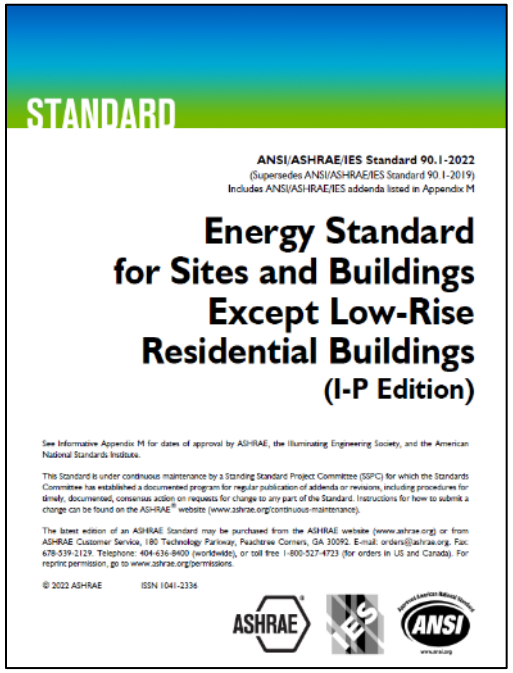


Commercial Building Energy Codes

National Model Codes

Local Generated State Codes (there are others)

ASHRAE 90.1

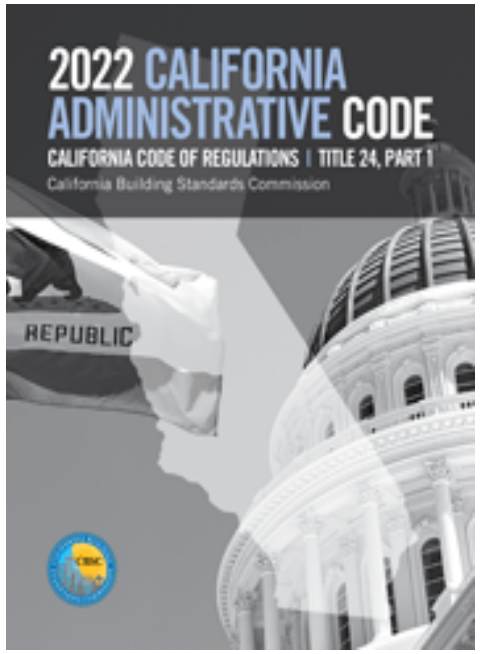


Updated on a **3 yr.** cycle
2019, **2022,** 2025, 2028, 2031

IECC

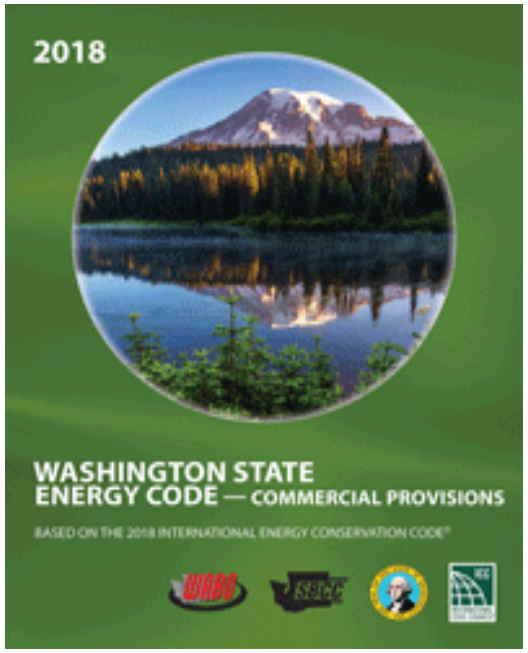
Updated on a **3 yr.** cycle
2018, **2021,** 2024, 2030, 2033

Title 24,20



Updated on a **3 yr.** cycle
2019, **2022,** 2025, 2028, 2031

Washington State Energy



Updated on a **3 yr.** cycle
2018, 2021, 2023
(2021 not yet in effect)

National Model Codes are then adopted by states and sometimes modified

Additional Commercial Efficiency Codes

- Many of the appliance and smaller commercial HVAC system minimum efficiencies are regulated by the US Department of Energy
- For products with capacities less than 65,000 Btu/h covered by **National Energy Conservation Policy Act** DOE has primary control for setting the efficiency metrics
- For products covered by the **Energy Policy Act** ASHRAE 90.1 has primary control of some efficiency levels but many must be ratified by DOE rule makings
- **Federal energy conservation standards** generally **preempt state** laws or regulations concerning energy conservation testing, labeling, and standards. However, DOE can grant waivers of federal preemption for state laws or regulations. (42 U.S.C. 6297), but these are typical not done
  - What this means is federal efficiency requirements for products **will preempt any state efficiency levels** in building efficiency codes that do not align with the efficiency levels set for the metric selected by DOE for regulations

Note there are optional higher efficiency guidelines and programs that set optional higher efficiency levels for rebate programs and optional standards such as Energy Star, CEE, FEMP, IGCC/ASHRAE 189.1, Cal Green and new Energy Credits in ASHRAE 90.1 and IECC

DOE Preemptive Product Efficiencies

Residential Preemptive Products

- Single Phase Residential Split Systems <65K
- Single Phase Residential Split System HP's <65K
- Single Packaged Air Conditioners
- Small Duct High Velocity
- Space Constrained Air Conditioners
- Space Constrained Heat Pumps
- Gas Fired Storage Water Heaters <100 gal
- Oil Fired Storage Water heaters <50 gal
- Electric Storage Water heaters <55 gal
- Tabletop water heaters
- Instantaneous gas fired water heaters <50K
- Instantaneous electric water heaters <2 gal
- grid enable water heaters
- pool heaters
- Room air conditioners
- Residential Furnaces <225K
- Electric Furnaces <225K
- Gas fired hot-water boilers
- Gas fired steam boilers
- Electric hot-water-boilers
- Electric Steam Boilers
- Large-diameter ceiling fans

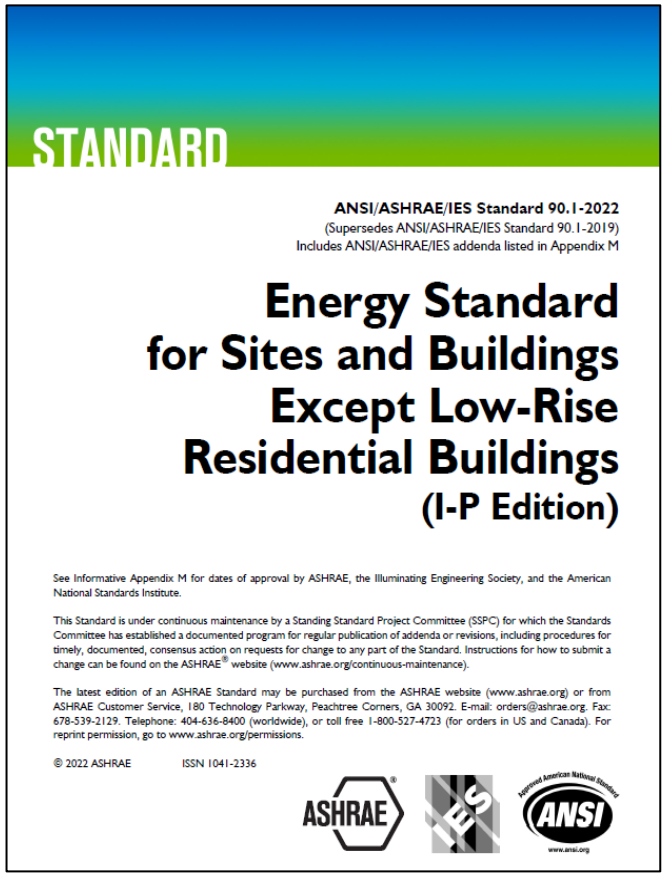
Efficiency requirements are documented in 10 CFR Part 430 and ASHRAE 90.1 appendix F

Commercial Products

- 3 Phase Commercial Split Systems < 760K
- 3 Phase Commercial Split System HP's <760K
- Packaged Air Conditioners <760K
- HP Packaged Air Conditioners <760K
- Commercial Split System <760K
- HP Commercial Split Systems <760K
- 3 Phase Space Constrained Air Conditioners
- 3 Phase Space Constrained Heat Pumps
- PTAC
- PTHP's
- SPVAC
- SPVHP
- Commercial Warm Air Gas and Oil-Fired Furnaces
- Commercial Electric Furnaces <225K
- Warm Air gas Duct furnace
- Warm Air gas and oil unit heaters
- Hot Water gas and oil Boilers
- Steam gas and oil Boilers
- Commercial Fans
- VRF
- Computer Room Air Conditioners
- Water Source heat Pumps
- Commercial Refrigerators and Freezers
- Dedicated Outdoor Air Units
- Commercial Electric Storage Water Heaters
- Commercial Electric Instantaneous Water Heater

There are other products like large rooftops, chiller, ERV and others that are not covered by preemption

What is New in ANSI/ASHRAE/IES 90.1-2022



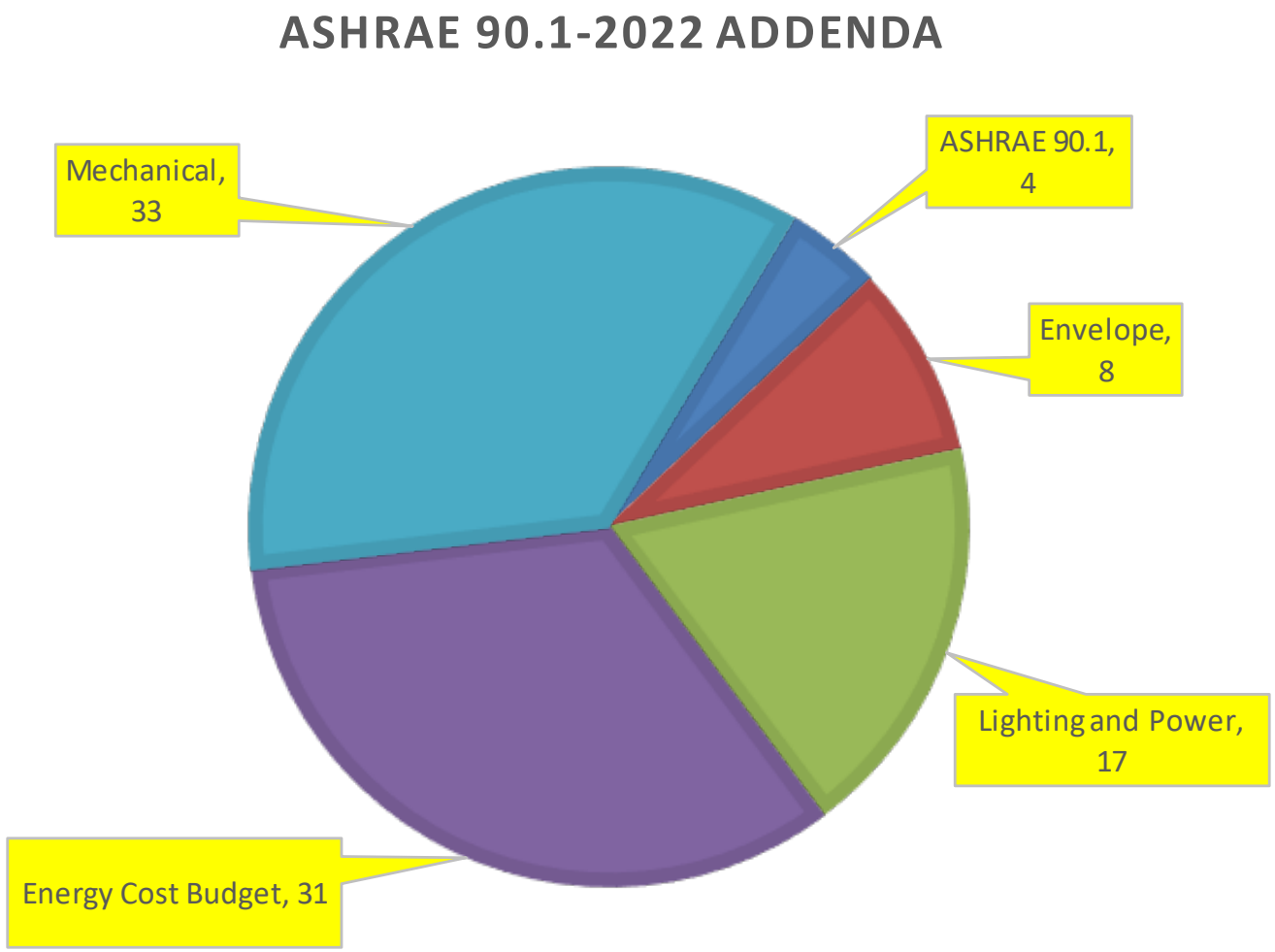
ASHRAE 90.1-2022

- ASHRAE 90.1 is the standards used to define the minimum building efficiency requirements for **commercial buildings**
- ASHRAE 90.1 is applicable to **all commercial buildings and sites** except for **residential buildings less than or equal to 3 stories.**
- The standard covers minimum efficiency requirements for the design and construction and plans for operation and maintenance of
  - new buildings and their systems,
  - new portions of buildings and their systems,
  - new systems and equipment in existing buildings, and
  - new equipment or building systems specifically identified in the standard that are part of industrial or manufacturing processes
- It is a continuous maintenance standard that is undated and republished every 3 years (2016, 2019, 2022, 2025, 2028....)
- Typical with the ASHRAE 90.1 standard there has been significant changes and updates to the current mandatory, prescriptive and optional requirements, but in addition for 2022 there are several new approaches to compliance requirements

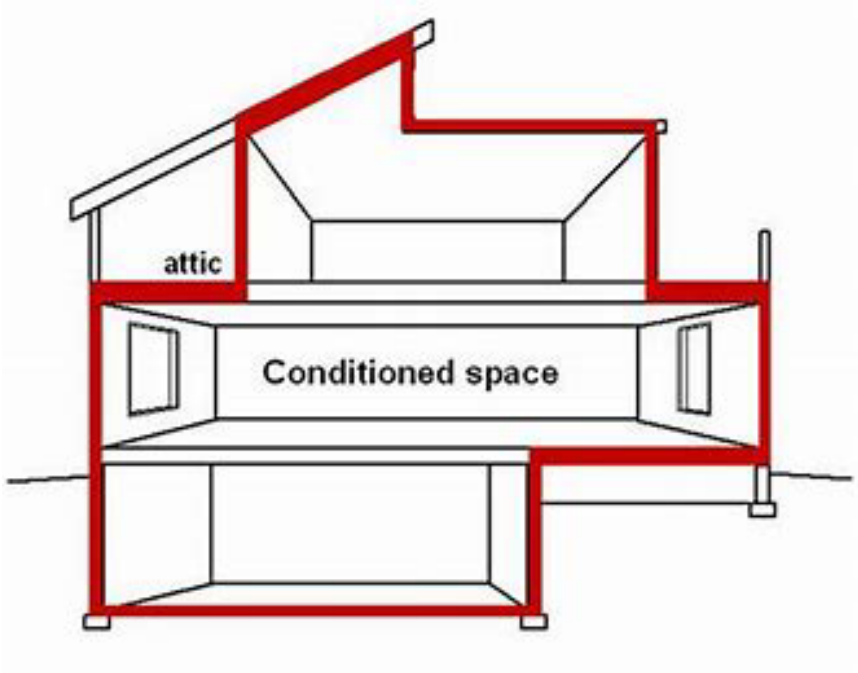
We do not have time to get into all the details of the changes, but ASHRAE is publishing thru the ASHRE journal in 2023, summaries of the changes to the standard in a series of articles

Overview of ASHRAE 90.1-2022 Changes

- Number of pages 2019 = 428 , 2022 = 462
- Number of addenda = 95
  - 88 ANSI Approved Normative Addenda
  - 7 Informative
- ASHRAE 90.1-2022 added new sections and appendices
  - Added Section 11 – Additional Efficiency Requirements (Credits)
  - Informative Appendix I – Using other Metrics in Conjunction with Appendix G Performance Rating Method when Approved by the Rating Authority (Carbon Emissions)
  - Normative Appendix J – Set of Performance Curves (chillers) (used for baseline models for Appendix G)
  - Normative Appendix L – Mechanical System Performance Rating Method (TSPR)



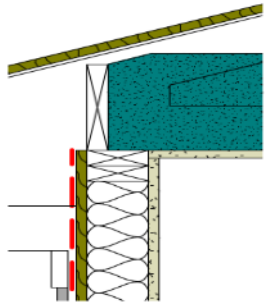
Envelope Changes

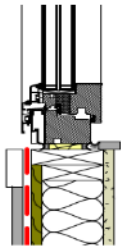


Envelope Changes

Updated Requirements

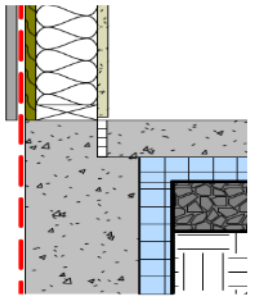
- Air Leakage
- Roof replacements
- Envelope commissioning
- Insulated metal panels (IMP)
- Compliance calculations to steel-framed walls





New Concepts

- Wall solar reflectance
- Thermal bridging (will cover in separate presentation)
- Envelope backstop



HVAC&R and Mechanical System Changes

Mechanical Systems Overview

- Mechanical Systems are covered by the following Sections and Appendices
  - Section 6 – Heating Ventilating, and Air Conditioning
  - Section 7 – Service Water Heating
  - Section 8 – Power
  - Section 10 – Other Equipment
  - Section 11 – Additional Efficiency Requirements (Credits) **(new)**
  - Section 12 – Energy Cost Budget Method
  - Appendix F – US Department of Energy Minimum Energy Efficiency Requirements, Test Procedures and Definitions
  - Appendix G – Performance Rating Method
  - Appendix H – Additional Guidance for Verification, Testing and Commissioning (**new in 2019**)
  - **Appendix J – Sets of Performance Curves for ECB modeling and TSPR (new)**
  - **Appendix L – Mechanical System Performance Rating Method (TSPR) (new)**
- In the 2022 Standard there were 33 addenda which impacted mandatory, and prescriptive requirements, but also additional new procedures and requirements that were added;
  - **Total System Performance Ratio (TSPR)** for mechanical systems level optional performance **(new)**
  - **Mandatory Energy Credits (new)**

Will cover in separate presentations

- In addition, there are several equipment efficiency addenda implemented in 2019 standard that went into effect on 1/1/2023

HVACR Efficiency Tables

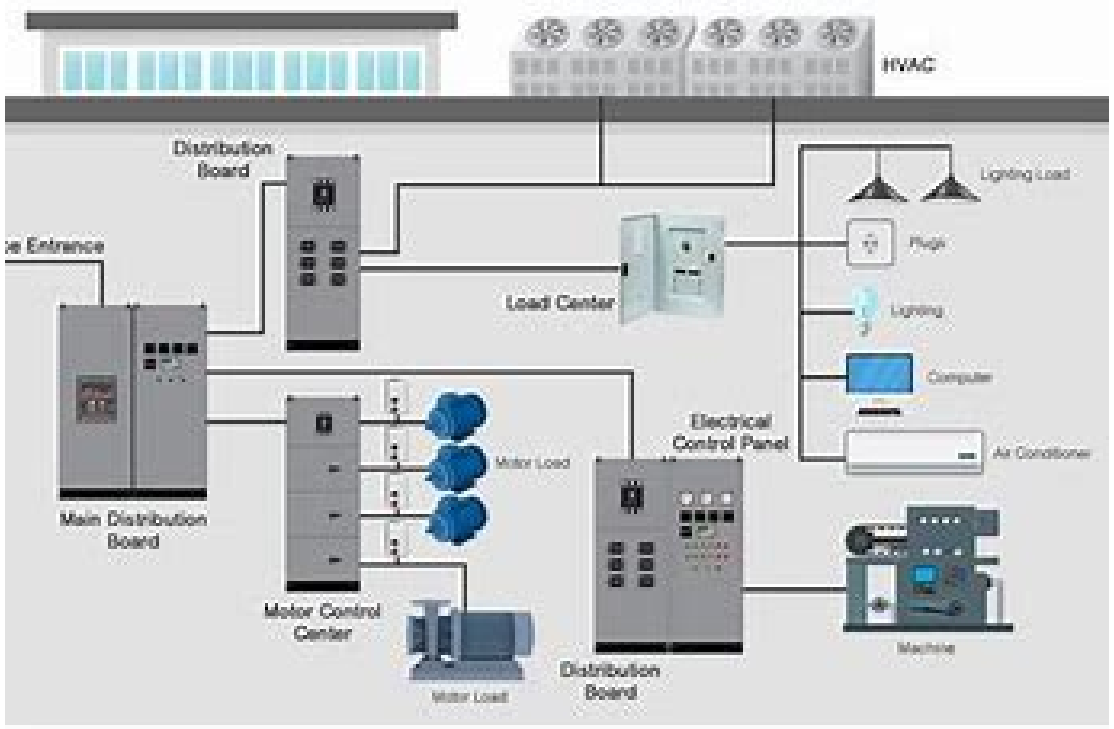
- There has been considerable activity over the past few years by DOE for federally covered products as well ASHRAE and AHRI for other products which impact the efficiency tables 6.8.1-1 thru 6.8.1-21 and tables F-1 thru F-6
    1. Update to table F-1, F-2 and table 6.8.1-1 and 6.8.1-2 for SEER2 and HSPF2. **(In appendix F all the DOE controlled efficiency requirements are included for easy reference)**
    2. As of 1/1/2018 DOE changed the metric for air cooled commercial rooftops <760,000 Btu/h from **EER to IEER** and as of 1/1/2023 the levels are increasing in table 6.8.1-1 and 6.8.1-2
    3. DOE and AHRI completed an **ASRAC negotiated rule on VRF** and implemented a new test procedure which results in changes to the test procedure and some of the efficiency levels
    4. Updates to **Heat Pump Chiller Heating Efficiency Requirements** listed in table 6.8.1-16
    5. DOE updated the efficiency requirements for dry transformers in 2016 and the updated levels are documented in table 8.4.4
    6. **DOAS** equipment covered in tables 6.8.1-13 and 6.8.1-14 have a change in metrics from **ISMRE to ISMRE2** and new efficiency levels
    7. **Ceiling fan efficiency** and use of CFEI

Not covered by ASHRAE 90.1, there is another huge change coming for HVAC product for **refrigerants** that under the approved AIM Act will go into effect to limit refrigerant **GWP to <750** for chillers and refrigeration as of 1/1/2022, Unitary as of 1/1/2025, and VRF as of 1/1/2026. Some state have implemented their own regulations for refrigeration and chillers. For further details see AHRI website for recorded webinars and information

Other Mechanical System Changes

1. Large Boiler efficiency requirements and Large capacity service water heating requirements
2. Demand Control Ventilation as a function of climate zone and use of energy recovery
3. Small unit thermostat setback control
4. Exception for optimal start for residential spaces
5. Garage exhaust ventilation
6. Shaft ventilation damper requirements
7. Chiller efficiency and freeze protection fluid compliance requirements
8. Insulation for service water heating
9. Updates for simplified buildings
10. Compressed air system requirements
11. Dehumidification control requirements to align with ASHRAE 62.1
12. Service Water heating controls
13. Reference to guideline 36 which covers High-Performance Sequences of Operation
14. Elevator requirements lighting, fan power and movement efficiency
15. ERV Bypass Requirements
16. Hospital Heat Recovery
17. Economizer tradeoff efficiency and expanded economizers down to 33,000 Btu/h for units outside a building
18. FEI Rating Clarification
19. Occupied Standby

Power System Revisions



Section 8 - Power

Updated Requirements

- Energy Monitoring (8.4.3.1) | adds refrigeration systems
- Dry-Type Distribution Transformers (8.4.4) | Updates / clarifications to match regulations adopted by U.S. DOE (10 CFR 461.192)
- Minor clarifications and updates

Section 9 – Lighting Changes

Section 9 - Lighting

Updated Requirements

- Editorial reorganization → sub sections match other Sections
- Clarifications / streamline of lighting controls requirements
- Simplified Building Method (9.3.2)
- Exterior Lighting (9.4.2)
- Interior Lighting Power Density (9.5.1 and 9.5.2)

New Concepts

- Horticultural lighting requirements (9.4.4)
- Video conference allowance (9.5.2.2)

Section 10 – Renewable Energy Prescriptive Compliance Path Addition

Section 10 Renewable Energy

New: Prescriptive Compliance Path

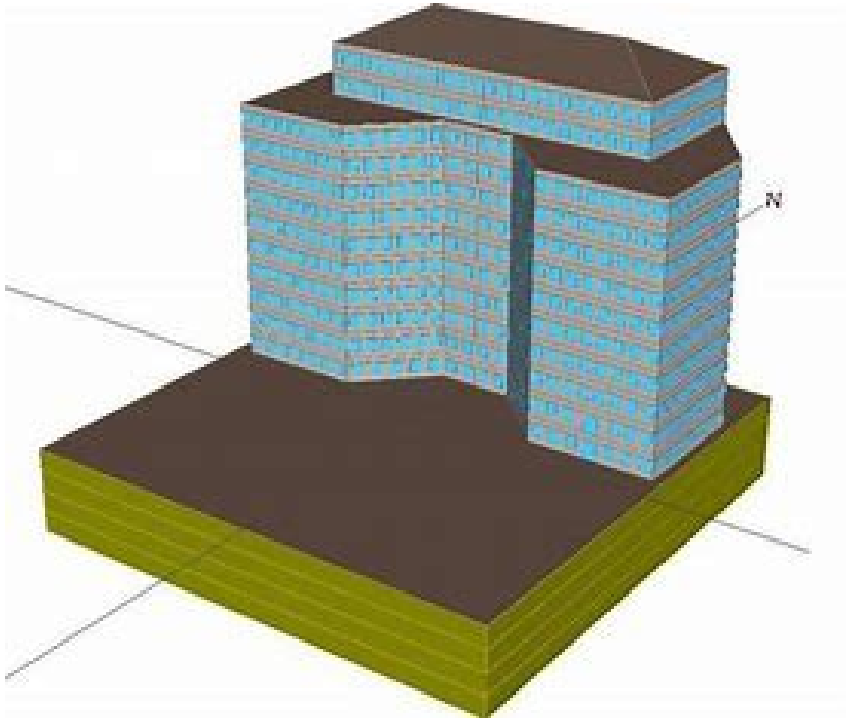
10.5.1 Renewable Energy Resources. *Buildings* shall be served by ***renewable energy resources*** **complying with Section 10.5.1.1.**

10.5.1.1 On-Site Renewable Energy. The *building site* shall have *equipment* for *on-site renewable energy* with a rated capacity of **not less than 0.50 W/ft^2** or 1.7 Btu/ft^2 multiplied by the sum of the *gross conditioned floor area* for all *floors* up to the three largest *floors*.

Exceptions to 10.5.1.1:

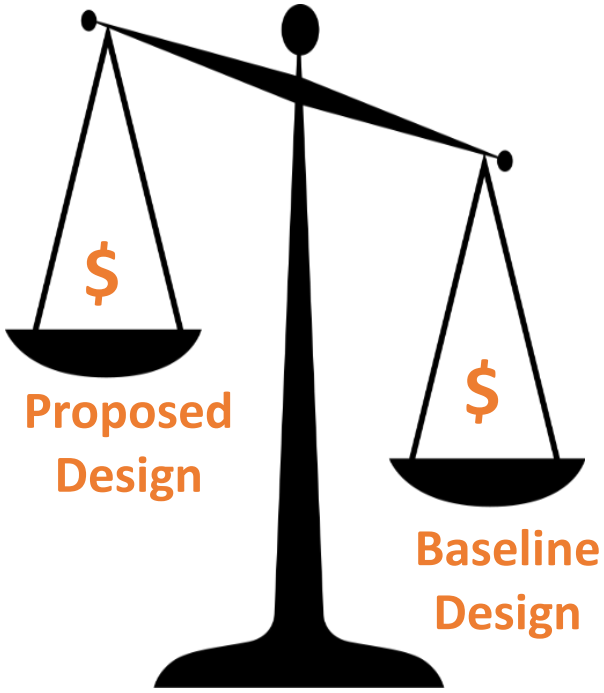
1. Any *building* located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft^2·day.
2. Any *building* where more than 80% of the *roof* area is covered by any combination of *equipment* other than for *on-site renewable energy systems*, planters, vegetated *space*, *skylights*, or occupied *roof* deck.
3. Any *building* where more than 50% of *roof* area is shaded from direct-beam sunlight by natural objects or by *structures* that are not part of the *building* for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
4. New *construction* or *additions* in which the sum of the *gross conditioned floor area* of the three largest *floors* of the new construction or *addition* is less than 10,000 ft2.
5. *Alterations*

Section 12 and Appendix G Energy Cost Budget (Modeling) Changes



Whole Building Performance

- Standard 90.1 Includes Two Whole Building Performance Path Options
  - Both compare the energy cost of a proposed building design to a baseline
    1. **Energy Cost Budget (ECB),** Section 11
    - Baseline systems and components are same as proposed building, but at minimum, current prescriptive efficiency (**dependent baseline**)
    2. **Performance Rating Method (PRM),** Appendix G
    - Baseline systems and components based on the architectural program and location of a building (**independent baseline**)
    - Baseline set at efficiency ~ **equal to 2004** standard with proposed design required to exceed the baseline (**stable baseline**)

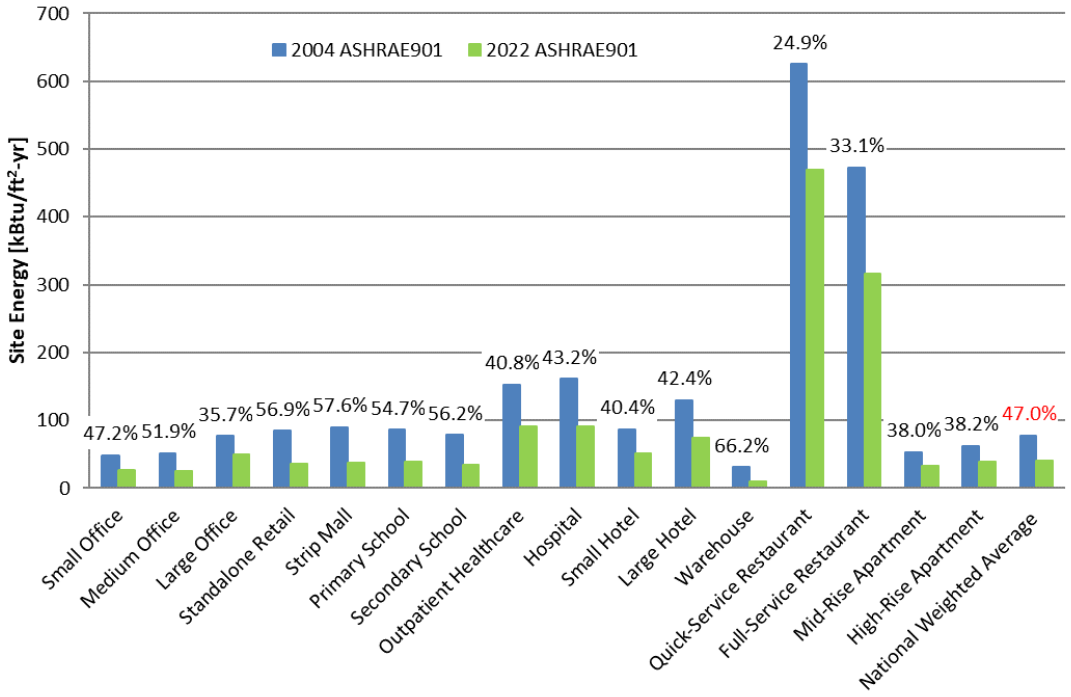


Energy Cost Budget Changes

- 33 Addenda Impacting Energy Cost Budget and Performance Rating Methods (Appendix G)
  - 6 addenda impacting only Energy Cost Budget
  - 13 addenda impacting only Performance Rating Method
  - 14 addenda impacting both ECB and PRM

- The following is a summary of the changes;
  1. **Lighting clarifications** to ensure consistency
  2. Update to the **building performance factors (BPF's)** used to determine compliance (improvement over base 2004 model) (Some increases and decreases)
  3. Added a new appendix J which includes baseline **chiller modeling curves** (more to come in the future)
  4. Addition of Appendix I for **alternate metrics** for carbon calculations and methods to adjust modeling BPF factors
  5. **Renewable Energy modeling** requirements
  6. Baseline HVAC system requirements cleanup
  7. Baseline system selection requirements cleanup
  8. **Retrofit modeling** requirements clarifications
  9. Envelope modeling **backstop**
  10. **Thermal Bridging modeling** requirements
  11. Other addenda for clarification of procedures and requirements

ASHRAE 90.1-2022 Progress Indicator



ASHRAE 90.1-2022 Progress Indicator

- Like most building efficiency standards ASHRAE 90.1 is **updated every 3 years**
- The ASHRAE 90.1-2022 revision was published at the end of 2022 which updated the 2019 standard.
- With every standard 3 year process the ASHRAE 90.1 SSPC **establishes a workplan** to define the plans for the 3-year period including efficiency improvement goals.
- For the 2019-2022 plan the SSPC established the following targets;
  - **Whole building Energy: 45-50% improvement**
  - Relative to ASHRAE/IES Std. 90.1-2004
- The SSPC also has established 16 reference buildings that are used for energy analysis but is also used by PNNL to evaluate the progress of the ASHRAE 90.1 to achieve the work plan targets
- These buildings are modeled using Energy Plus to analysis the addenda that result in energy savings

Progress Indicator Results for 2022 Standard

Pacific Northwest NATIONAL LABORATORY

Results Summary

National Weighted Average	Annual Energy, Cost, or Emissions per Area			Percentage Savings		
	90.1-2004	90.1-2019	90.1-2022	90.1-2019 vs. 90.1-2004	90.1-2022 vs. 90.1-2004	90.1-2022 vs. 90.1-2019
Gross Energy [kBtu/ft²-yr]	77.6	48	43.2	38.1%	44.3%	10.0%
Net Energy [kBtu/ft²-yr]	77.6	48	41.1	38.1%	47.0%	14.4%
Energy Cost [$/ft²-yr]	$1.95	$1.19	$1.01	39.0%	48.2%	15.1%
Emissions [tons/kft²-yr]	12.27	7.52	6.39	38.7%	47.9%	15.0%

FUTURE ASHRAE 90.1 WORK PLAN

Future ASHRAE 90.1 Work Plan

- For every 3 yr. ASHRAE 90.1 code cycle, the ASHRAE 90.1 SSPC develops and approves a 3 yr. plan to define the work for the next code cycle
- Due to the focus on impact carbon emissions are having on the environment and global warming the work plan for ASHRAE 90.1 has been expanded to cover **3 code cycles and 9 yrs**.
- The expanded work plan will focus on;
  - efficiency improvement,
  - expanded coverage of loads and processes not currently regulated,
  - energy recovery and reuse
  - controls and operational requirements
  - expanded requirements for renewable energy both on-site and off-site
- As many states, cities and organization are setting goals for carbon reduction and net zero carbon emissions the future work plan will also address the following;
  - carbon emissions reduction strategies,
  - electrification and electric readiness
  - expanded requirements for effective interaction with energy resources to facilitate the use of low-emissions energy sources

2022-2031 Initiatives

1. Pursue the energy, energy cost, and operational carbon emissions savings targets indicated in the Target section for the 2025 Standard relative to the baseline of Standard 90.1-2004.
2. **Publish the net zero operational carbon emission jurisdictional option Appendix/Annex by the fall of 2023**
3. **Support plan to move the ASHRAE 90.1 standard to a net zero operation carbon emissions standard for new buildings in 3 code cycles with the release of the 2031 standard.**
4. Continue to explore and expand the use of **new optional compliance paths** that consider more of the system including controls and interaction with the grid. This should include further improvements to new approaches introduced in the 2022 standard including **Energy Credits and TSPR**
5. Develop and implement operational carbon **emissions reporting** criteria.
6. Continue to expand the requirements for the use of **on-site and offsite renewable energy**.
7. Expand the requirements of ASHRAE 90.1 to include **management of energy use** in the building through energy storage (thermal and electrical), scheduling, and management of ventilation loads.
8. Continue to explore ways to encourage building resilience including **ongoing durability and, quality assurance and diagnostics.**
9. Continue expanding the use of **software tools** and digital compliance procedures that make the compliance with the requirements easier to implement
10. Continue to evaluate ways to improve the **usability** of the standard and transition from a printed format to a digital format and better supports a digital compliance framework

2019-2031 Work Plan Targets

Years	Energy Cost Savings relative to 2004[1]	Gross Energy Intensity relative to 2004[1,2]	Carbon Emissions relative to 2004[1,3]	% Of 2004 Energy Use Served by Renewable Resources Energy[4]
	%	%	%	%
2019-2022	43%	44%	48%	3%
2022-2025	50%	51%	65%	13%
2025-2028	55%	58%	83%	24%
2028-2031	65%	65%	100%	35%

Notes

1. Energy, cost, and emission savings are relative to a 2004 baseline.
2. Cost savings will be based on the energy economic factors defined in this work plan using the US-weighed climate zone and building weighting.
3. Carbon reductions are CO_2e reductions due to energy efficiency, greater use of renewable energy, and reduction in greenhouse gases emitted. (This includes reduction in operational refrigerant emissions due to leakage and end of life losses, but not embodied carbon of materials)
4. Includes contributions from on-site and off-site renewable energy.

What is New in IECC 2024 Standard

IECC Standard Revisions

- Energy Conservation Code (IECC) is also a standards used to define the minimum building efficiency requirements for both **residential and commercial buildings**
  - The IECC contains two separate sets of provisions with one for commercial buildings and one fore residential buildings.
  - The **IECC—Commercial Provisions** apply to all buildings except for residential buildings three stories or less in height.
  - The **IECC—Residential Provisions** apply to detached one- and two-family dwellings and multiple single-family dwellings as well as Group R-2, R-3 and R-4 buildings three stories or less in height.

- This code intended to regulate the design and construction of buildings for the effective use and conservation of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective.

- The current published version of the **IECC is the 2021 version**, but the 2024 changes are in process and scheduled to be completed by the end of 2023.

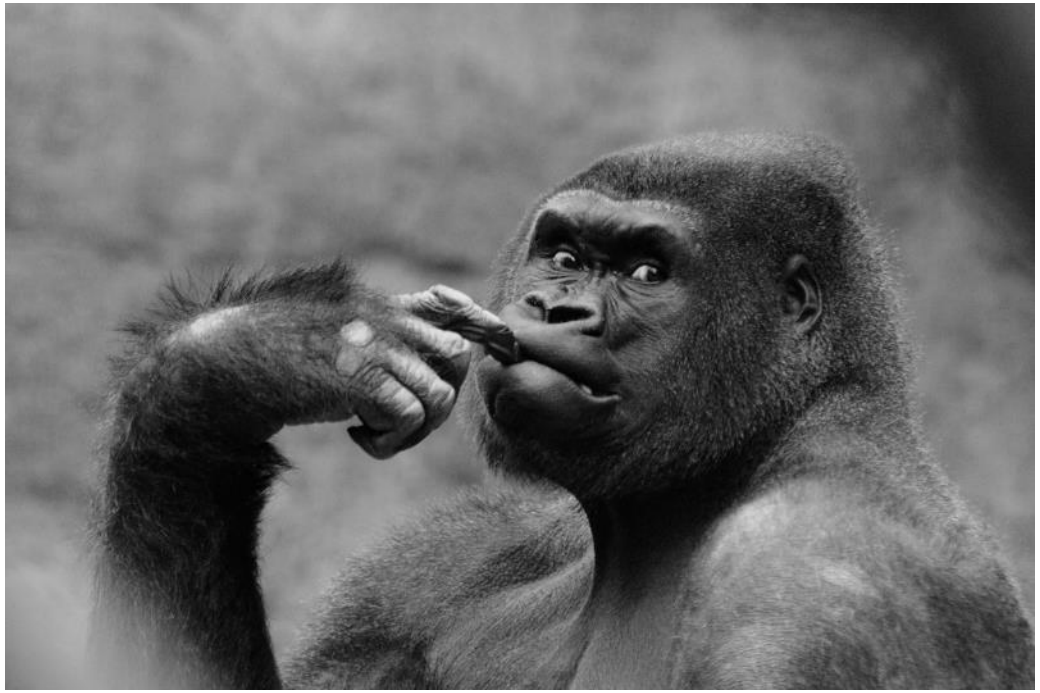
IECC Commercial Code Release Schedule

- The IECC 2024 next revision to the IECC commercial code is not yet completed
- The development of the IECC commercial 2024 code has been in develop in 2022 and 2023 and is nearing completion
- The schedule for final review is:
  - Public review 2 beings May 15 (only open for comments on changes)
  - Ballot 1, May 26
  - Recirculation ballot 2, May 29
  - Ballot 2 close, June 12
  - Meeting will be held on June 21 to discuss any proposals that reach 1/3 vote
    - If any results in changes another limited public review will be held

IECC Commercial 2024 Changes

The changes for the IECC are not finalized but it is likely that the following are some of the major changes will likely be included;

- **Additional efficiency credits** – Credits have been part of IECC codes for several cycles, but the 2024 will be expanded and somewhat align with the new credit option added to ASHRAE 90.1
- Addition of **Total System Performance Ratio** (TSPR)
- **Occupied standby controls** – Allow unoccupied rooms to change setpoint and ventilation during the occupied mode
- **Interior LPA reductions** – Reduction in lighting power levels
- **Egress lighting** off when unoccupied
- **Fan Energy Reductions** – Modification of fan power allowance to use a new watts/cfm and allowances for size of system resulting in a 10% reduction in fan energy. (Note this did not make ASHRAE 90.1-2022)
- **VAV turndown** requirements
- Parking garage ventilation
- 5% increase in renewable energy **to 0.75 w/ft2** for the largest 3 floors
- Adoption of revised **HVAC efficiency tables** from ASHRAE 90.1 2022
- Other miscellaneous changes



QUESTIONS

What's New in Energy Codes–

2023 National Energy Codes Conference

May 2023

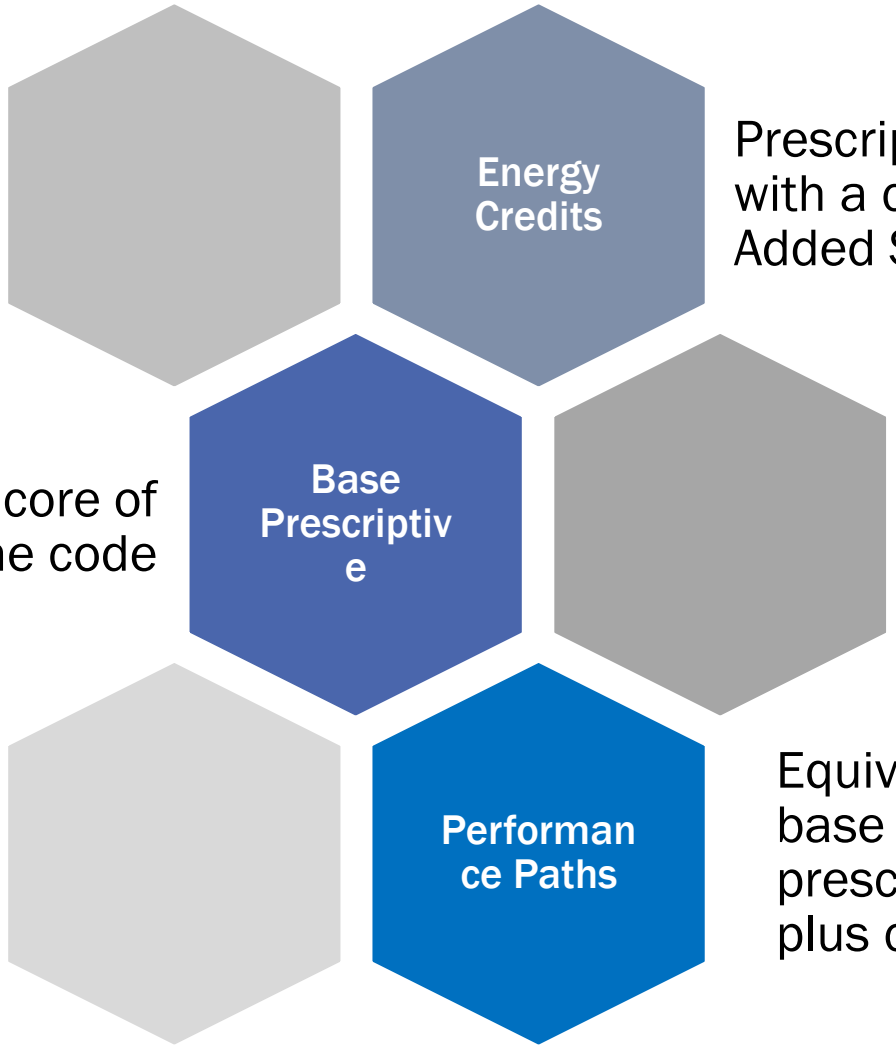
Michael Tillou, PNNL

Topics

- Commercial and Residential Energy Credits
- Thermal Bridging
- Total System Performance Ratio

Energy Credits

Energy Credits



Prescriptive Plus: with a choice; Added Savings

The core of the code

Equivalent to base prescriptive plus credits

How Do Energy Credits Fit?

Energy credits language requires projects to select additional energy efficiency and load management design features to improve overall building energy efficiency.

Energy Credit Characteristics

- Wide range of credits
- May be experimental / new / load management
- Promotes improved HVAC efficiency
- Instead of prescriptive exceptions, pick an alternative savings target
- Rough equivalency across the different credits
- Can support above code or incentives

Energy Credits

Benefits of “Energy Efficiency Credits”

- Credit measures can offer more flexibility
  - Do not need to apply to all buildings
  - Niche oriented savings opportunities can be included
  - Does not require a custom performance analysis
  - Provides flexibility of choice to each project
- Can mix options to achieve a target savings
- Can include choices that may not be strictly cost effective
- Deal with large-saving strategies that may not be appropriate for all buildings
- Lays groundwork for future performance tradeoffs and targets for smaller simple buildings

Commercial Code Energy Credits

IECC 2024 Commercial (proposed) :

- 32 EEM's, 7 renewable and load management measures,
- Requirements achieve 7% building energy cost savings.

ASHRAE Standard 90.1-2022

- 26 EEM's, 1 renewable and 7 load management measures,
- Requirements achieve 5% building energy cost savings.

Common Features

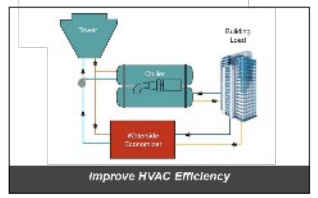
- Each Credit represents ~1/10 % whole building energy cost (ASHRAE 90.1) or whole building site energy (IECC)
- Measure points requirements selected to be cost effective and practical
- Allows a portion of energy credits to be met with Load Management and Renewable Credits
- Credit values calculated using PNNL Commercial prototype energy models across all climate zones

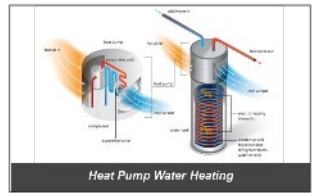
Energy Credit Measures

Efficiency Measures
- Envelope performance
- UA reduction (15%)*
- Envelope leak reduction*
- Add roof insulation*
- Add wall insulation*
- Improve fenestration*

HVAC Measures
- HVAC performance
- Heating efficiency
- Cooling efficiency
- Residential HVAC control
- Ground source heat pump*
- DOAS/fan control

Water Heating Measures
- SHW preheat recovery
- Heat pump water heater
- Efficient gas water heater
- SHW pipe insulation
- Point of use water heaters
- Thermostatic bal. valves
- SHW heat trace system*
- SHW submeters
- SHW flow reduction
- Shower heat recovery





**Only in IECC;*
***Only in Standard 90.1*

Lighting Measures
- Lighting dimming & tuning
- More occupancy sensors
- Increase daylight area
- Residential light control
- Light power reduction

Power & Equipment Measures
- Energy monitoring
- Efficient elevator
- Efficient commercial kitchen equipment
- Residential kitchen equipment
- Fault detection
- Guideline 36 controls**

Renewable & Load Management Measures
- Renewable energy
- Lighting load management
- HVAC load management
- Automated shading
- Electric energy storage
- Cooling energy storage
- SHW energy storage
- Building mass/night flush

Residential Code Energy Credits

IECC 2024 Residential (Proposed) :

Choose from 34 EEM's to achieve ~10% building energy savings (10 credits). Can also choose onsite renewables or demand responsive thermostats.

- Each Credit represents ~1 % whole building site energy savings
- Credits are more prescriptive than Commercial IECC & 90.1
- Measure points requirements selected to be cost effective and practical
- Credit values calculated using PNNL Residential prototype energy models across all climate zones
- Dwelling units larger than 5,000 sq.ft. will be required to earn 50% more credits.

Energy Credit Measures

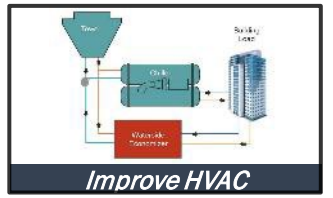
Efficiency Measures
- UA reduction (3 opts. 2.5%, 5%, 7.5%)
- Cool Roof
- Improve fenestration

HVAC Measures
- HVAC Perf. Cooling (2 options)
- HVAC Perf. Gas Furnace (2 options)
- HVAC Perf. Furnace & Cooling (2 options)
- HVAC Perf. Heat Pump (3 options)
- Ground Source Heat Pump
- Ductless Systems (3 options)
- Ground source heat pump*

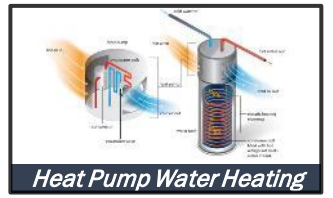
Water Heating Measures
- Gas-fired Storage
- Gas-fired Instantaneous
- Electric water heaters (2 options)
- Solar Hot Water System
- Compact SWH Distribution
- Efficient SWH Distribution


Improve Building Envelope


Improve Lighting


Improve HVAC


Renewable Energy


Heat Pump Water Heating

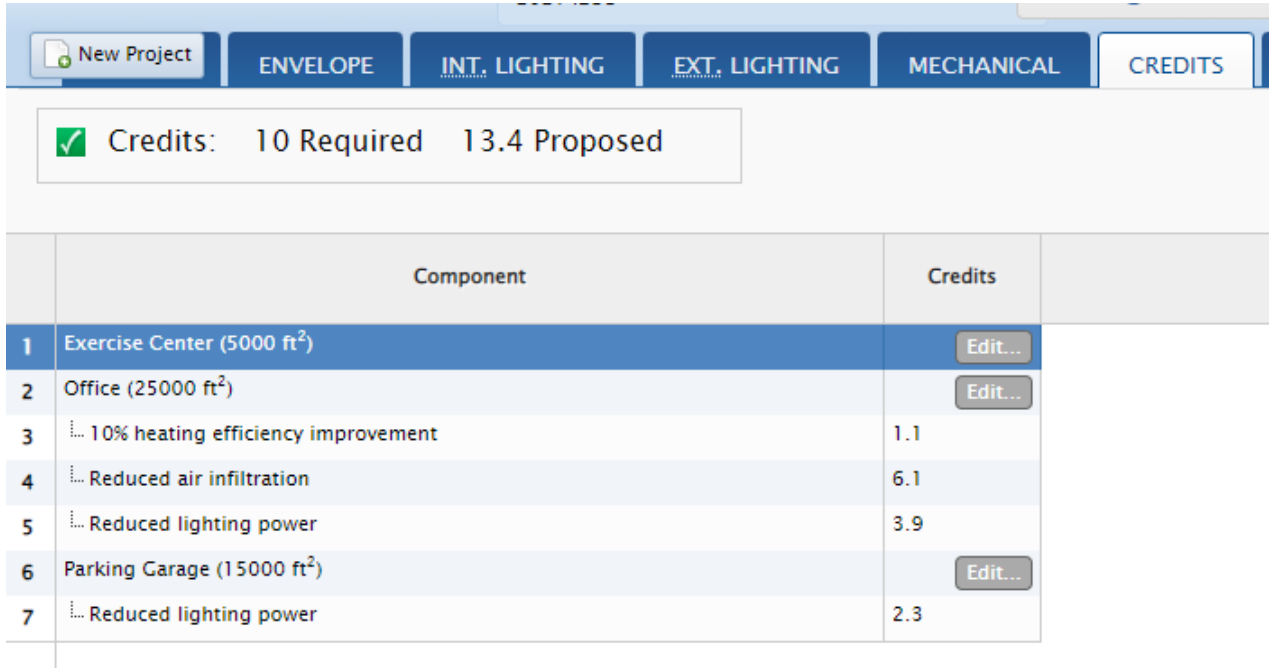
Ducts
- 100% Ducts in Conditioned Spaces

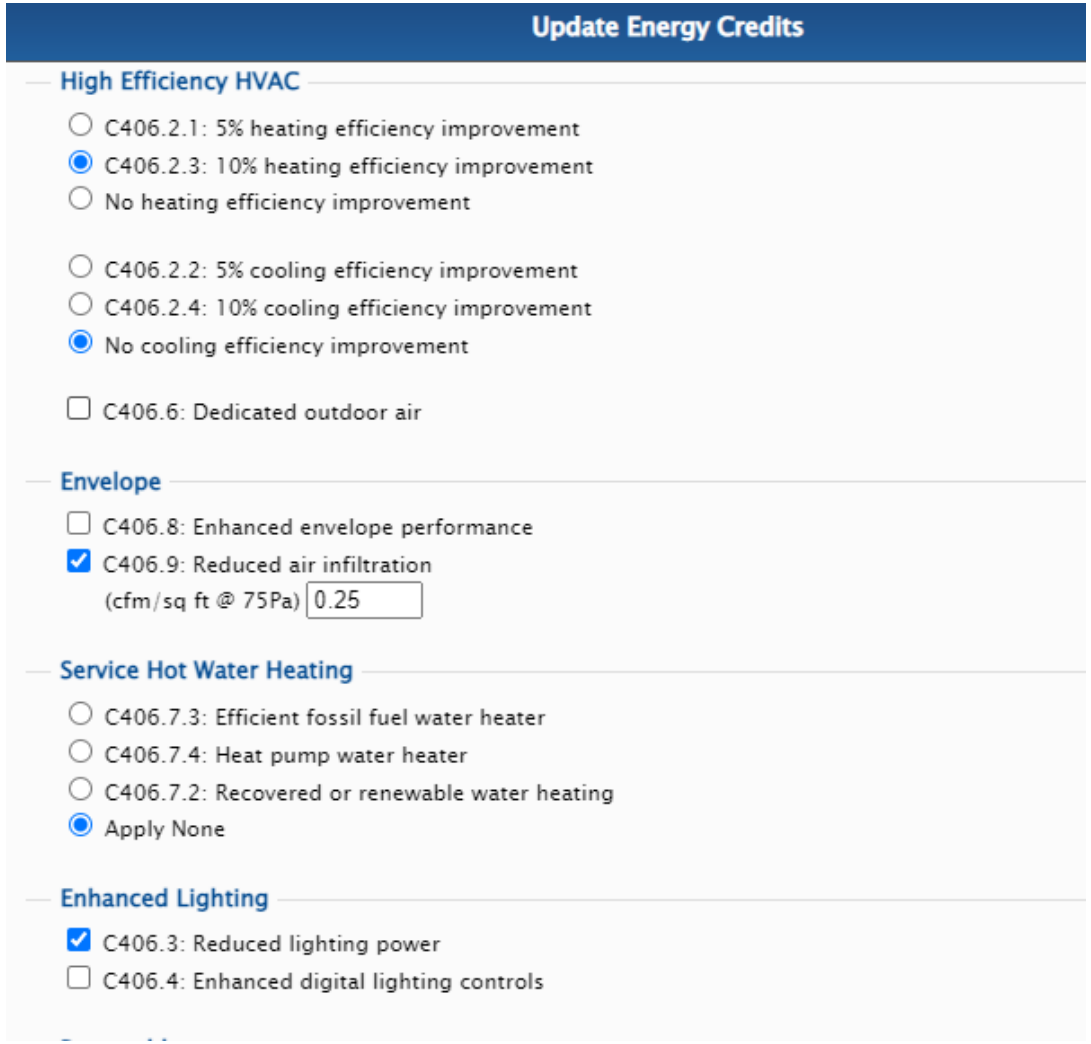
Air Leakage
- 2ACH 50 with ERV
- 2ACH50 with balanced ventilation
- 1.5ACH50 with ERV
- 1.0ACH50 with ERV

Appliances
- Efficient Appliances

Renewable & Load Management Measures
- Renewable energy
- Demand Responsive Thermostats

Compliance with ComCheck or ResCheck





- COMCheck and RESCheck will be setup to document energy credit compliance
- Will pull information from Lighting, Envelope and Mechanical inputs to automatically calculate compliance.
- Will automatically calculate area weighting of credit values.

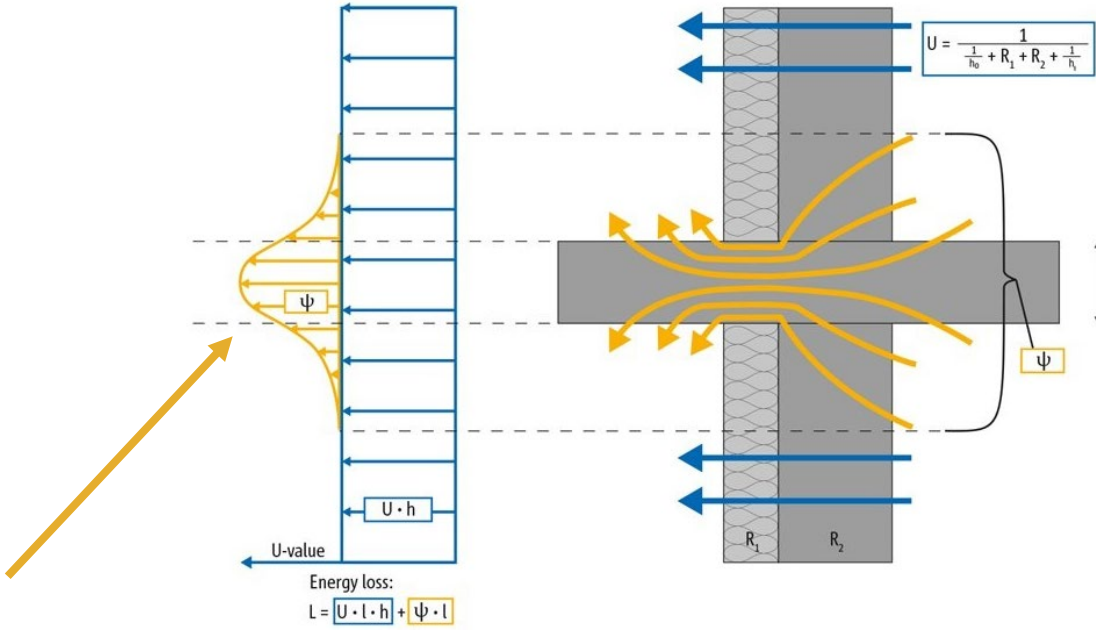
Thermal Bridging

Thermal Bridging

Thermal bridging is the difference in thermal transmittance that occurs at the junction of different materials in a building envelope assembly. Mitigating thermal bridges that increase thermal transmittance is important to ensure the overall energy efficiency of building envelope.

ASHRAE 90.1: Robust thermal bridging requirements for certain linear thermal bridges: Parapets, balconies, cladding supports, vertical fenestration/wall intersections and intermediate floors that penetrate the wall plane.

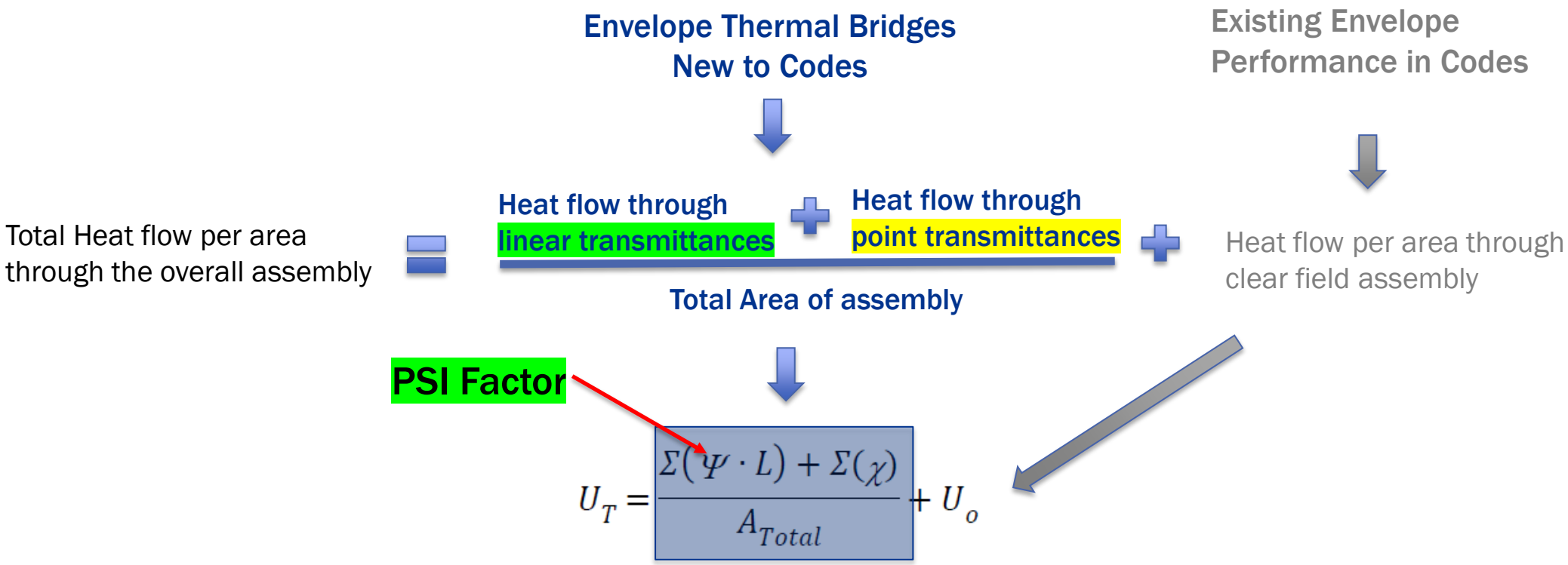
IECC 2024 Commercial: Proposed a simplified version of 90.1 thermal bridging requirements



Representation of the increased thermal transmittance of an uninsulated slab that penetrates an insulated wall plane.

Image: Schöck USA, Inc.

Thermal Bridging: Calculating the Impact



UT = total effective assembly thermal transmittance (Btu/hr·ft2·oF or W/m2K)
Uo = clear field thermal transmittance (Btu/hr·ft2·oF or W/m2K)
Atotal = the total opaque wall area (ft2 or m2)
PSI Factor = Ψ = heat flow from linear thermal bridge (Btu/hr·ft oF or W/mK) –
L = length of linear thermal bridge, i.e. slab width (ft or m)
CHI Factor = X = heat flow from point thermal bridge (Btu/hr· oF or W/K)

Thermal Bridging: What's Covered?

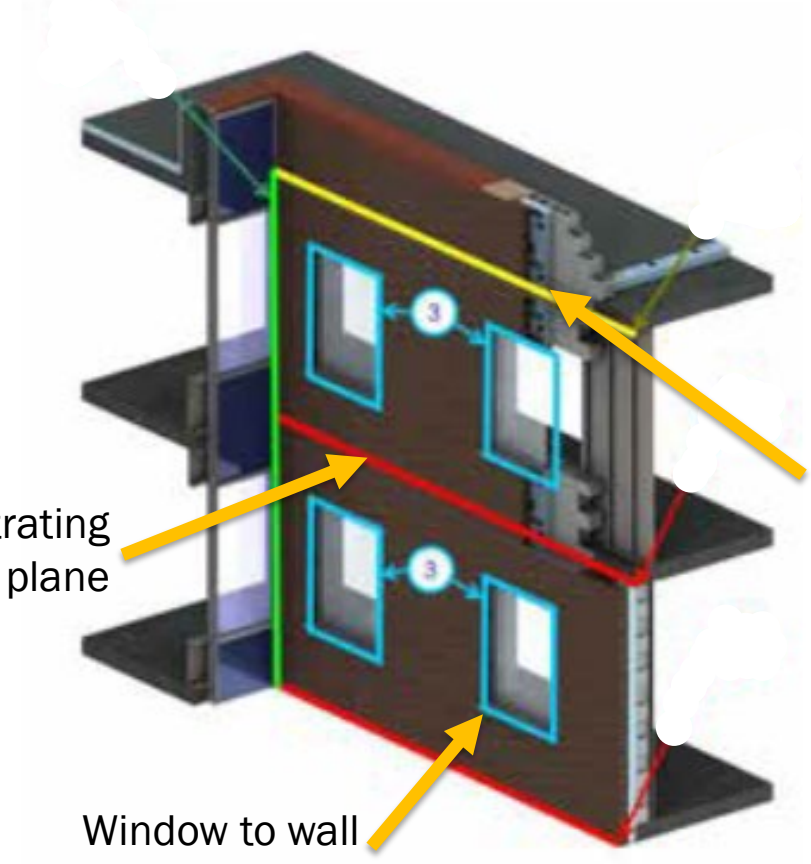
Provisions in ASHRAE 90.1 and proposed for IECC 2024 would prescribe minimum performance of the most common linear thermal bridges.

linear thermal bridge – horizontal, vertical or diagonal linear element that penetrates the insulation in the building envelope.

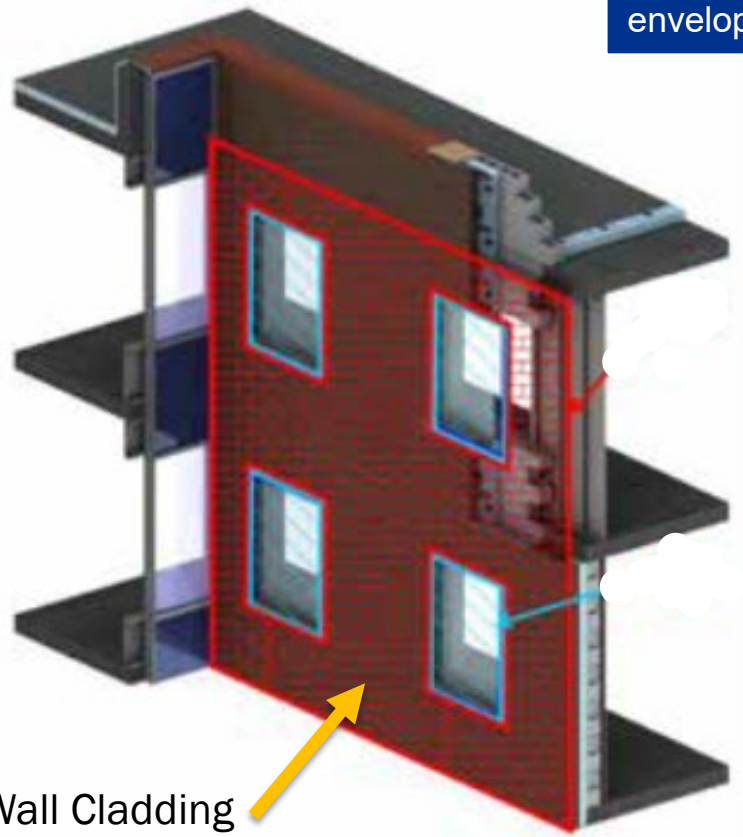
Balconies (not shown)

Floors penetrating the wall plane

Window to wall intersections



Parapets and roof wall intersections



Brick Wall Cladding Supports

Thermal Bridging: Mitigation Targets

IECC 2024 (proposed)

- Common set of mitigated and unmitigated Psi-factors for all above grade wall construction classes
- No requirements to account for point thermal bridges.
- Allows trade-offs using Component Performance Alternative or Total System Performance.

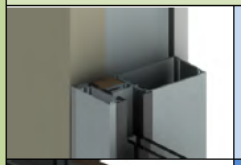
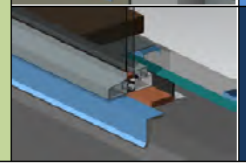
ASHRAE 90.1

- Different mitigated and unmitigated Psi-factors for each above grade wall construction class (ie: wood, steel-frame).
- Requirement to account for certain point thermal bridges
- Option to use whole building performance rather than meeting prescriptive mitigated psi-factors or chi-factors.

		ASHRAE 90.1 (Final)				IECC 2024 (Proposed)	
		Unmitigated		Mitigated Default		Unmitigated	Mitigated Default
		Psi- Factor	Chi- Factor	Psi- Factor	Chi- Factor	Psi- Factor	Psi- Factor
Steel-frame	Roof edge	0.45		0.14			
	Parapet	0.289		0.151		0.4	0.2
	Intermediate floor to wall intersection	0.487		0.177		0.5	0.2
	Intermediate floor balcony or overhang to opaque wall intersection	0.487		0.177		0.5	0.2
	Intermediate floor balcony in contact with Vertical Fenestration	0.974		0.177		0.5	0.2
	Cladding Support	0.314		0.217		0.3	0.2
	Wall to Vertical Fenestration intersection	0.262		0.112		0.3	0.15
	Other Element and Assembly Intersections		1.73		0.91		

Thermal Bridging: What's Next

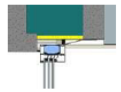
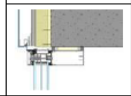
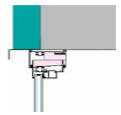
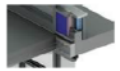
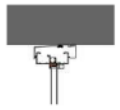
Current thermal bridging targets are based on classifications established in the BC Hydro Envelope Thermal Bridging Guide and are intended to discourage "Poor" thermal bridges.

GLAZING TRANSITIONS	Performance Category		Description and Examples	Linear Transmittance Btu hr ft F	Linear Transmittance W m K
		Efficient	**Well aligned glazing without conductive bypasses** Examples: wall insulation is aligned with the glazing thermal break. Flashing does not bypass the thermal break.	0.12	0.2
		Regular	**Misaligned glazing and minor conductive bypasses** Examples: wall insulation is not continuous to thermal break and framing bypasses the thermal insulation at glazing interface.	0.20	0.35
		Poor	**Un-insulated and conductive bypasses** Examples: metal closures connected to structural framing. Un-insulated concrete opening (wall insulation ends at edge of opening).	0.29	0.5

BC Hydro Envelope Thermal Bridging Guide v1.4 (2020)

Performance Categories have been recently updated and expanded to reflect the improvement and availability of products for thermal bridge mitigation.

BC Hydro Envelope Thermal Bridging Guide v1.6 (2021)

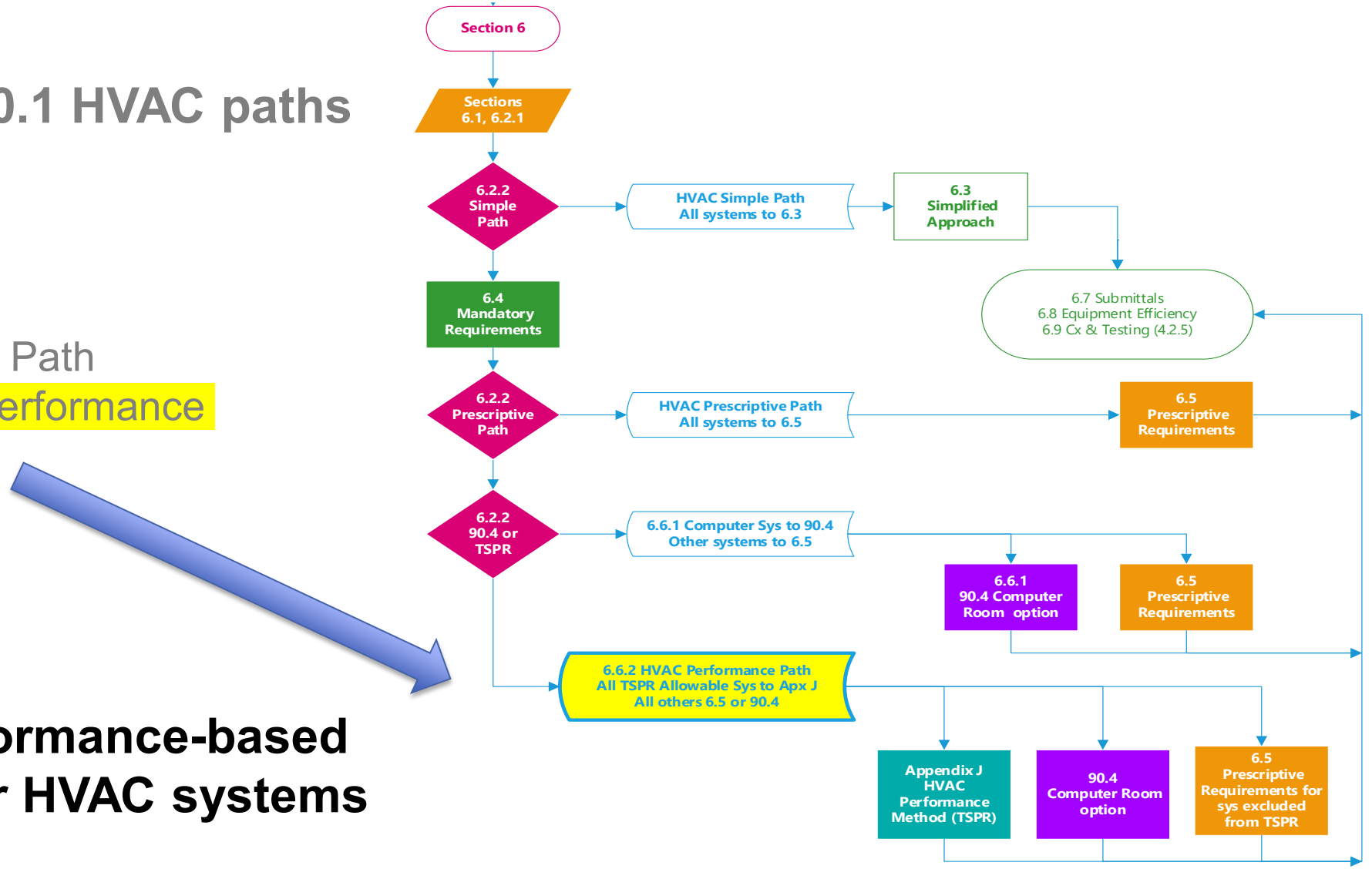
Performance Category	Linear Transmittance Btu hr ft F	Linear Transmittance W m K	Description and Examples	
Thermal Bridge Free	<0.006	<0.01		**Fully exterior insulated and fully aligned thermal insulation between components** Examples: exterior insulated walls at intermediate floors.
				**Well aligned glazing without conductive bypasses and minimal thermal bridging in clear wall** Examples: wall insulation is aligned with the glazing thermal break and insulation is provided around the perimeter of the window framing. Flashing does not bypass the thermal break. Low conductive window frames and/or insulation outboard of the window frame.
Efficient	0.058	0.1		**Fully insulated with only small conductive bypasses** Examples: split insulated wall at intermediate floor, exterior insulated walls at intermediate floors with additional cladding attachment at floor.
				**Well aligned glazing without conductive bypasses** Examples: wall insulation is aligned with the glazing thermal break. Flashing does not bypass the thermal break.
Mitigated	0.12	0.2		**Thermally broken connections with good aliment of adjacent thermal insulation** Examples: large structural thermal breaks where the thickness of the thermal break is similar in size as the thermal insulation.
				**Well aligned glazing with minimal conductive bypasses** Examples: the glazing thermal break is within the wall insulation, but there is thermal bridging related to conductive window frames, flashing partially bypasses the exterior insulation, and un-insulated window perimeters.
Moderate	0.17	0.3		**Thermally broken and intermittent structural connections** Examples: structural thermal breaks where the insulation and break do not have similar thickness or thermal resistance, and stand-off shelf angles.
				**Misaligned glazing and minor conductive bypasses** Examples: wall insulation is not alligned with the window thermal break and the exterior insulation is completely bypassed by flashing or a metal closure.
Regular - Poor	>0.17	>0.3		**Un-insulated, continuous structural connections, and major conductive bypasses** Examples: un-insulated balconies, exposed concrete floor slabs, and shelf angles attached directly to the edge of the floor.
				**Un-insulated and conductive bypasses** Examples: metal closures connected to structural framing. Un-insulated concrete opening (wall insulation does not extend into the window opening).

Total System Performance Ratio

HVAC Total System Performance Ratio (TSPR)

Current ASHRAE 90.1 HVAC paths

- Appendix G
- Section 11 (ECB)
- 6.3 Simplified Path
- 6.5 Prescriptive Path
- 6.6.1 Computer Room Path
- 6.6.2 HVAC System Performance (TSPR/J) Path



TSPR is a new performance-based compliance path for HVAC systems

HVAC Total System Performance Ratio (TSPR)

Basic Idea: Set HVAC system performance requirement and allow equivalent HVAC system tradeoffs by comparing a buildings proposed TSPR to a target TSPR.

Currently TSPR has been adopted into:

ASHRAE 90.1 -2022 (optional)

State of Washington Energy Code (mandatory)

And is being considered as an optional compliance path in:

IECC 2024 Commercial and **NY Stretch 2023**.

Why HVAC Performance (TSPR)?

- A particular building may have trouble with a prescriptive requirement like fan power limits or economizers
- Allows trade off within HVAC system, get credit for higher equipment efficiencies, reduced pump power or more DCV.
- Results in equivalent energy input for a “good” system selection
- Reduces complexity compared to a whole building analysis
- Can drive HVAC performance with out violating EPACT rules

HVAC Performance Metric:

$$\text{TSPR} = \frac{\text{Heating + Cooling Loads Delivered}}{\textbf{Annual HVAC Operating Input*}}$$

TSPR is the HVAC system performance for the whole building HVAC system

HVAC Total System Performance Ratio (TSPR)

Alignment with Appendix G Modeling Process

Compliance achieved when:

$$\text{TSPR}_{\text{proposed}} \text{ must be} \geq \text{TSPR}_{\text{reference}} / \text{ MPF}$$

$$\text{MPF} = \frac{TSPR\ reference}{TSPR\ target}$$

- **Proposed System** – Your Building HVAC System
- **Reference System** – Aligned with Appendix G (ca. 2004)
- **Target System** – Aligned with prescriptive, but not worst option
- **MPF** – Mechanical Performance Factor

Building Area Type	Climate Zone		
	0A and 1A	0B and 1B	2A
Multifamily	0.68	0.70	0.66
Healthcare/	0.60	0.60	0.58

HVAC Total System Performance Ratio (TSPR)

Reference and Target Systems Details

- Reference System based on ASHRAE 90.1 Appendix G
- Target Systems based on Current Prescriptive and “good practice”

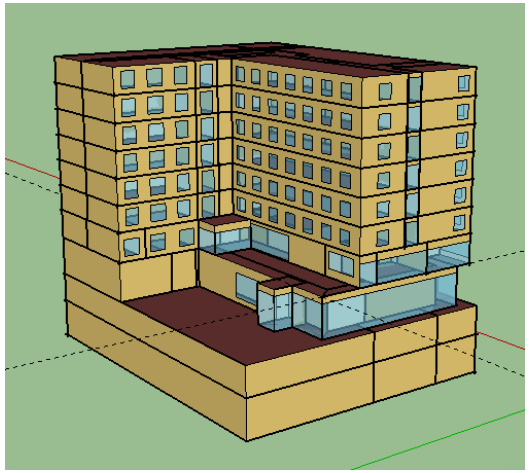
ASHRAE 90.1 Reference and Target System Descriptions

	Building Type Parameter	Large Office	Small Office	Retail	School	Hotel	Apartment
Reference	**System Type (Warm)**	VAV/ RH Water cooled chiller/ Elec RH	Packaged air-source Heat Pump; with air econo-ex CZ 1-2	Packaged air-source Heat Pump; with air econo-ex CZ 1-2	Packaged DX VAV/ Elec RH	Packaged terminal air-source Heat Pump	Packaged terminal air-source Heat Pump
	System Type (Cold)	VAV/ RH Water cooled chiller/ gas boiler	Packaged air-source AC / Furnace; with air econo	Packaged air-source AC / Furnace; with air econo	Packaged DX VAV/ Hydeonic RH/ gas boiler	Packaged terminal AC / Furnace	Packaged terminal AC / Furnace
Target	**System Type (Warm)**	VAV/ RH Water cooled chiller/ Elec RH	Packaged air-source Heat Pump; with air econo-ex CZ 1-2	Packaged air-source Heat Pump; with air econo-ex CZ 1-2	VAV/ RH Water cooled chiller/ Elec RH; ERV	Packaged terminal air-source Heat Pump	Split air-source Heat Pump w/ ERV
	System Type (Cold)	VAV/ RH Water cooled chiller/ gas boiler	Packaged air-source AC / Furnace; with air econo	Packaged air-source AC / Furnace; with air econo	VAV/ RH Water cooled chiller/ gas boiler; ERV	Packaged terminal AC / Furnace	Split air-source AC Gas Furnace / w/ERV

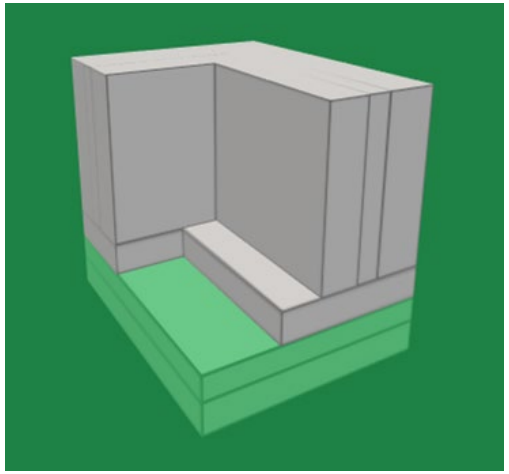
HVAC Total System Performance Ratio (TSPR)

Compliance Calculation Tool

- Based on code language that describes the ruleset
- New tool provided by DOE (free)
- Simplified tool for assessing building energy efficiency
  - Not a prototype approach, based on actual simplified building
- Uses default ASHRAE 90.1 Appendix C loads and schedules
- Lighting, equipment and envelope loads same as reference



Detailed Energy Model



Block Based Simplified Model

Thank you!

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