NATIONAL GLASS ASSOCIATION with GANA

Glass Technical Paper FB74-22

Alignment in US Energy Conservation Codes ASHRAE 90.1 and IECC

The energy conservations codes are focused on the conservation of nonrenewable energy that is used to serve building occupants. In most places in the United States, building energy codes are based on either ASHRAE 90.1 *Energy Standard for Buildings Except Low-Rise Residential Buildings* (ASHRAE 90.1) or the International Energy Conservation Code (IECC). The IECC also references ASHRAE 90.1 as a compliance alternative for commercial buildings and for residential buildings with more than three stories. Federal law in the form of a U.S. statute requires local energy codes be at least as stringent as ASHRAE 90.1, which is referenced in federal law as the basis for federal programs. Both the IECC and ASHRAE 90.1 set energy efficiency provisions for new construction, additions, and new systems and equipment in existing buildings.

IECC or ASHRAE 90.1?

Both IECC and ASHRAE 90.1 are national *model* codes. While the most recent edition is considered the current standard of practice and help drive product decisions, it has no power until adopted by the local jurisdiction, such as the state, county, or city. The local jurisdiction may also make amendments. As such, it is important to know what code is being used at the local building project site – IECC or ASHRAE 90.1 or a state-specific code such as California Title 24? Which edition? Any local amendments?

Where ASHRAE 90.1 is adopted as the local code, then obviously ASHRAE 90.1 must be used. Where IECC is adopted as the local code, it actually allows the option to use either IECC or ASHRAE 90.1 for building projects, but all the requirements from the chosen standard apply to the project rather than picking and choosing sections from each. The commercial fenestration requirements between IECC and ASHRAE 90.1 are mostly aligned; however, differences in other parts of the code could influence the building owner's decision on which standard to follow.

Prescriptive vs. Performance Compliance

The codes allow for two different compliance paths; prescriptive and performance. Per https://www.energycodes.gov/performance_based_compliance: "The prescriptive path establishes criteria for energy related characteristics of individual building components such as minimum R-values of insulation, maximum U-factors and solar heat gain coefficients of fenestration, maximum lighting power allowance, occupancy sensor requirements for lighting control, and economizer requirements for HVAC systems."

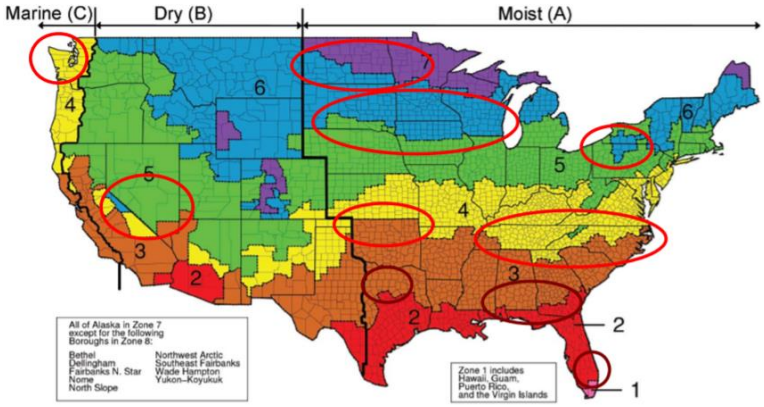
In relation to the performance path the same web page says: "These methods *(performance path)* provide more flexibility by allowing a designer to "trade off" compliance by not meeting some prescriptive requirements if the impact can be offset by exceeding other prescriptive requirements. This is demonstrated using computer simulation to compare a proposed building design to a reference building design commonly referred to as a baseline.

It is observed that a large portion of commercial projects use the Performance Path, in which case some of the added U-factor and SHGC burden may be offset by HVAC and insulation adjustments. It is necessary to get the required U-factor, SHGC and other requirements from the person responsible for the building energy simulation.

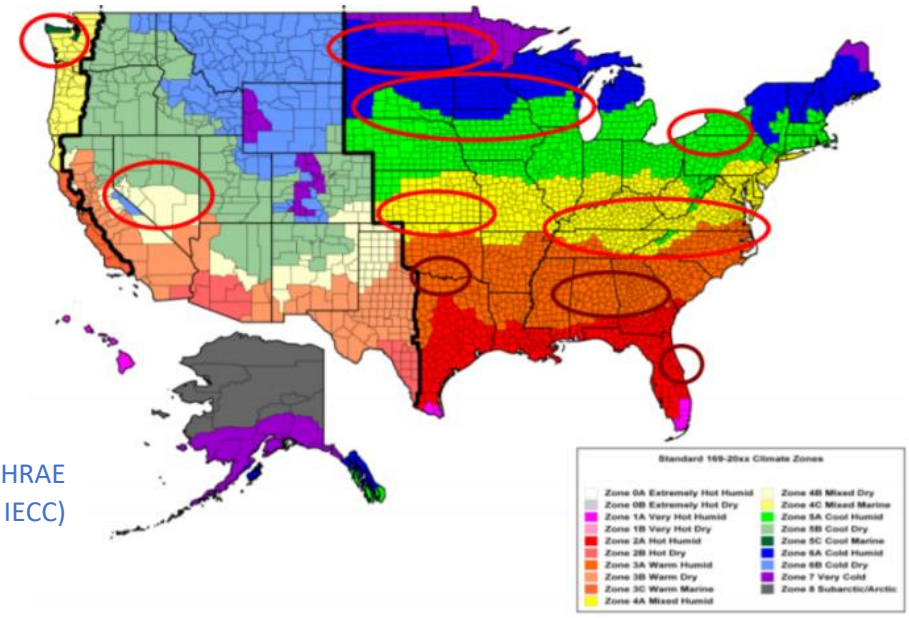
Increases in Stringency

Commercial and Residential energy standards and codes continue to advance in stringency, placing greater demands on glazing systems. For example, over the past 15 years, ASHRAE 90.1, the minimum standard for energy efficiency, has reduced U-factor for commercial windows by 20-60%, depending on climate zone. (Note: Refer to NGA Glass Technical Paper FB50-17 *Building Energy Performance Criteria Terms and References Related to Glass and Glazing* for definitions of terms related to energy performance.)

In the 2016 version, ASHRAE 90.1 introduced a new climate zone map with shifting boundaries. Likewise, the IECC updated the map in its 2021 version to align with the ASHRAE 90.1 standard. Areas that changed are circled in Figure 1, below.



[left]: Previous Climate Zones (ASHRAE 90.1-2013 and before, 2018 IECC and before)



[right]: Updated Climate Zones (ASHRAE 90.1-2016 and after, 2021 IECC)

Figure 1: Energy Code Climate Zone Maps prior to the ASHRAE 90.1-2016 version, compared to the updated zones used in ASHRAE 90.1-2016 and later version(s) and the 2021 IECC.

Other updates in ASHRAE 90.1-2016 included lowering U-factors by 3-24%, with modest reductions in SHGC in middle zones 4-5. New envelope commissioning requirements were introduced, along with stronger daylighting requirements.

Looking to the near-future energy codes, ASHRAE 90.1-2019 was published in October 2019 and the 2021 IECC version aligns closely with ASHRAE 90.1-2019. This code update includes only small changes to residential fenestration requirements but increased stringency to commercial buildings including an additional 5-7% reduction in U-factor. Roughly, this is the equivalent of a "climate zone shift" from the 2016 version, with requirements for zone 7 moving to zone 6, zone 6 to zone 5, etc. Table 1 outlines the changes in U-factor over the last decade for commercial fenestration. Refer to Table 3 for residential U-factor requirements.

Table 1: Prescriptive Commercial Vertical Fenestration U-Factors and Solar Heat Gain Coefficient (SHGC) by Zone

Commercial Vertical Fenestration U-Factors, 2009-2021 ASHRAE and IECC										
Climate Zone	Zone 0	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Energy Code Version
Fixed		1.2	0.7	0.6	0.5	0.45	0.45	0.40	0.40	90.1-2010, 2009 IECC
	0.50	0.57	0.57	0.50	0.42	0.42	0.42	0.38	0.38	90.1-2013
	0.50	0.57	0.54	0.45/0.49	0.38	0.38	0.36	0.33	0.29	90.1-2016
		0.50	0.50	0.46	0.38	0.38	0.36	0.29	0.29	2012, '15, '18 IECC
	0.50	0.50	0.45	0.42	0.36	0.34	0.34	0.29	0.26	90.1-2019, 2021 IECC
Operable		1.20	0.75	0.65	0.55	0.55	0.55	0.45	0.45	90.1-2010, 2009 IECC
	0.65	0.65	0.65	0.60	0.50	0.50	0.50	0.40	0.40	90.1-2013
	0.65	0.65	0.65	0.60	0.46	0.46	0.45	0.40	0.35	90.1-2016
		0.65	0.65	0.60	0.45	0.45	0.43	0.37	0.37	2012, '15, '18 IECC
	0.62	0.62	0.60	0.54	0.45	0.45	0.42	0.36	0.32	90.1-2019, 2021 IECC
Entrance Door		1.20	1.10	0.90	0.85	0.80	0.80	0.80	0.80	90.1-2010, 2009 IECC
	0.83	1.10	0.83	0.77	0.77	0.77	0.77	0.77	0.77	90.1-2013
	0.83	1.10	0.83	0.77	0.68	0.68	0.68	0.68	0.68	90.1-2016
		1.10	0.83	0.77	0.77	0.77	0.77	0.77	0.77	2012, '15, '18 IECC
	0.83	0.83	0.77	0.68	0.63	0.63	0.63	0.63	0.63	90.1-2019, 2021 IECC
SHGC		0.25	0.25	0.25	0.40	0.40	0.40	.045	0.45	90.1-2007, 2009 IECC; 90.1-2010, 2012 IECC; 90.1-2013, 2015 IECC
	0.22	0.25	0.25	0.25	0.36	0.38	0.40	0.45	0.45	90.1-2016, 2018 IECC
Fixed:	0.22	0.23	0.25	0.25	0.36	0.38	0.38	0.40	0.40	90.1-2019, 2021 IECC
Operable*:	0.22	0.21	0.23	0.23	0.33	0.33	0.34	0.36	0.36	

*Note the fixed vs. operable SHGC accounts for the higher frame-to-glass ratio in operable products, but both require the same glazing type. Separate U-factors were previously used for metal and nonmetal framed products in 2006-2009 IECC and ASHRAE 90.1-2007 to -2016. For those older versions, the metal framed U-factors are shown.

Glazing Products for Energy Efficiency

As the standard advances and is adopted, the glazing market has responded with increased use of low-e glass and thermally broken frames to meet the code requirements. Table 2 gives an estimate of the type of commercial glazing system needed to comply with the U-Factors required in ASHRAE 90.1-2016 and -2019 versions. (Note: Refer to the NGA Glass Technical Paper FB63-19 *Products for Energy Applications* for typical glazing products and associated ranges in performance factors, and/or consult with the manufacturer for tested values.)

Table 2: Estimate of Glazing Required to Comply with Prescriptive Commercial Vertical Fenestration U-Factors*

	ASHRAE 90.1-2016	ASHRAE 90.1-2019
Zone 1	Low-e, double glazing	Low-e, double glazing plus lower 0.23 SHGC
Zones 2-3	Low-e double glazing, thermally broken frame	Low-e double glazing, thermally broken frame with air fill. In Zone 2 only, alternative is 'thermally improved' frame (not full thermal break) + argon or warm edge spacer
Zones 4-5	Low-e, thermally broken frame and pick 1: Argon, High performance thermal break, Two low-e coatings (#2 / #4)	Low-e, thermally broken frame and pick 2: Argon, High performance thermal break, Two low-e coatings (#2 / #4), Warm edge spacer
Zone 6	Low-e, thermally broken frame and pick 2: Argon, Warm edge spacer, High performance thermal break, Two low-e coatings (#2 / #4)	Low-e, thermally broken frame and pick 3: Argon, Warm edge spacer, High performance thermal break, Two low-e coatings (#2 / #4)
Zone 7	Low-e, thermally broken frame and pick 3: Argon, Warm edge spacer, High performance thermal break, Two low-e coatings (#2 / #4)	Low-e, thermally broken frame, Argon, Warm edge spacer, High performance thermal break, Two low-e coatings (#2 / #4) in double glazing, or go to triple
Zone 8	All the above in double glazing, or more likely, go to triple glazing	Triple glazing

*Note: Glazing elements noted in the above table are estimates for reference only. This is a general guideline; do not use for code compliance.

Table 3: Prescriptive Residential Vertical Fenestration U-Factors and Solar Heat Gain Coefficient (SHGC) by Zone

Residential Vertical Fenestration U-Factors, 2009-2021 IECC and Energy Star v6									
Climate Zone	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Energy Code Version
U-factor	1.20	0.65*	0.50*	0.35	0.35	0.35	0.35	0.35	2009 IECC
	NR	0.40	0.35	0.35	0.32	0.32	0.32	0.32	2012 IECC
	NR	0.40	0.35	0.35	0.32	0.32	0.32	0.32	2015 IECC
	NR	0.40	0.32	0.32	0.30	0.30	0.30	0.30	2018 IECC
	NR	0.35	0.30**	0.30**	0.30**	0.30**	0.30**	0.30**	2021 IECC
	0.40	0.40	0.40	0.30	0.30	0.27[x]	0.27[x]	0.27[x]	Energy Star v6
SHGC	0.30	0.30	0.30	NR	NR	NR	NR	NR	2009 IECC
	0.25	0.25	0.25	NR	NR	NR	NR	NR	2012 IECC
	0.25	0.25	0.25	0.40	NR	NR	NR	NR	2015 IECC
	0.25	0.25	0.25	0.40	NR	NR	NR	NR	2018 IECC
	0.25	0.25	0.25	0.40	0.40	NR	NR	NR	2021 IECC
	0.25	0.25	0.25	0.40	NR[x]	NR[x]	NR[x]	NR[x]	Energy Star v6

*2009 IECC: For impact rated fenestration, allow U-0.75 in zone 2 and U-0.65 in zone 3.

**New allowance up to U-0.32 in windborne debris regions or > 4000 ft elevation.

[x]Energy Star v6: For northern zone, U up to 0.30 allowed with SHGC >= 0.42.

Energy Code Adoption

Because of the variation in code adoption practices and the development of state and local codes through extensive amendment of the model codes, you should check with the local building code officials to determine the applicable code for each building project. Commercial and Residential Energy Code Adoption Maps are available from Building Codes Assistance Program at bcapcodes.org. and from the US Department of Energy website: www.energycodes.gov/status-state-energy-code-adoption. The maps in Figures 2 and 3 indicate which states have adopted which version of the ASHRAE standard, and the corresponding IECC model code. Note that where the maps indicate no statewide code, local cities and counties, these are "Home Rule states" and may have adopted different energy codes. For example, Denver, CO uses the 2018 IECC and is updating to the 2021 IECC, even though Colorado has no statewide energy code. You should check the website for the most current version of these maps.

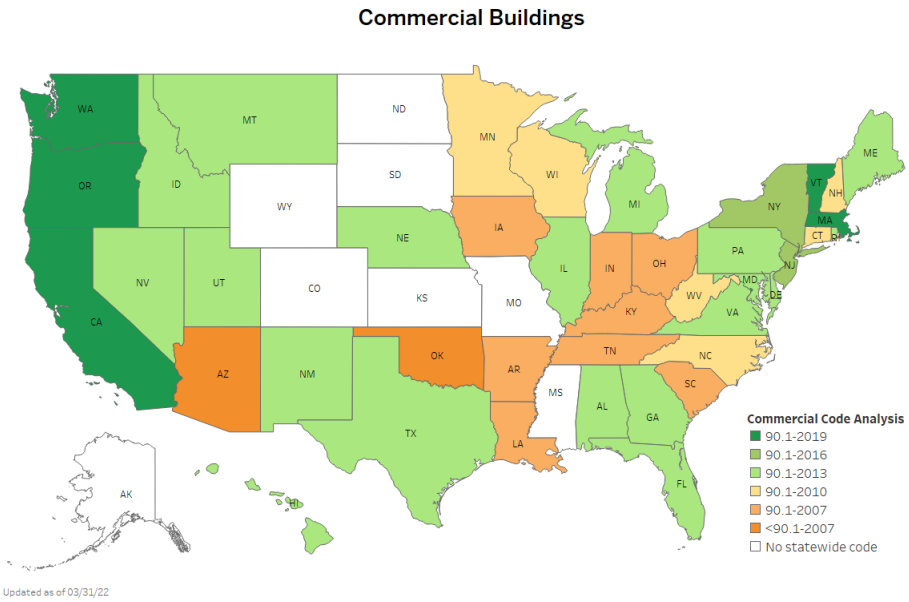


Figure 2: Commercial Energy Code Adoption Maps from the US Department of Energy.

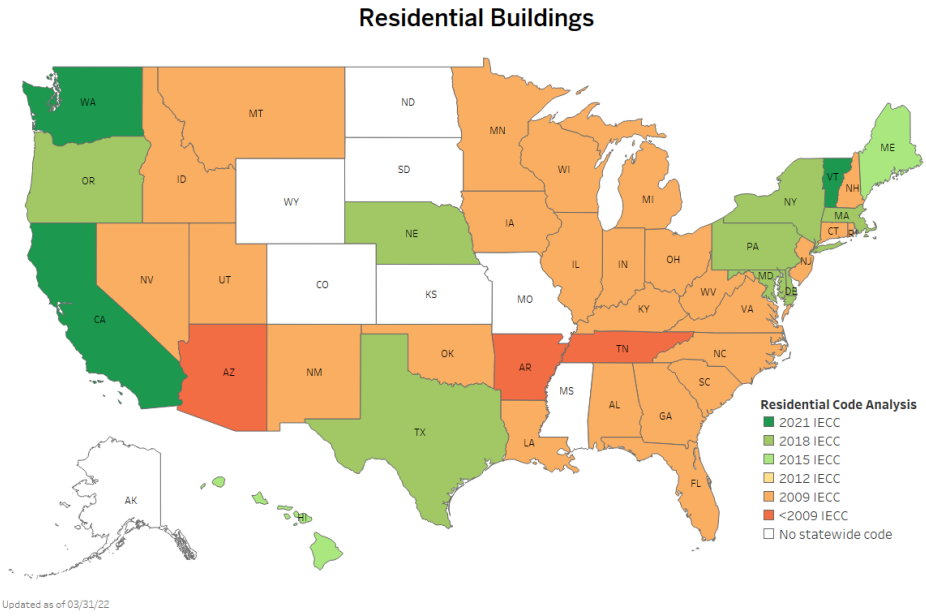


Figure 3: Residential Energy Code Adoption Maps from the US Department of Energy.

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