Analyzing R-value Requirements

Cost paybacks to increases in R-values may not be practical

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Recent increases to the model energy code's building energy-performance requirements have resulted in increased R-values being specified for many buildings' exterior envelopes, including roof systems.

Adoption of the *International Energy Conservation Code,® 2012 Edition* (IECC 2012), which includes significant R-value increases for most roof systems, has been limited. The R-value increases were implemented into the code with minimal to no consideration of the added initial (construction) costs and long-term payback to building owners.

Energy code requirements

The building envelope thermal (prescriptive) requirements contained in IECC 2012 include roof assembly minimum R-value requirements as shown in Figure 1. These R-values apply to all buildings, including roof system replacements, classified by the code as being for "commercial" buildings. IECC 2012 classifies all buildings as commercial except detached one- and two-family dwellings and multiple single-family dwellings (townhouses), as well as Group R-2, R-3 and R-4 buildings three stories or fewer in height above grade plane.

Comparing IECC 2012's minimum prescriptive R-values with those in the *International Energy Conservation Code, 2009 Edition* (IECC 2009) reveals minimum-required R-values for roof assemblies have increased from R-5 to R-10 depending on specific climate zones and building (roof) assembly configurations.

In May 2012, the Department of Energy (DOE) issued a determination indicating IECC 2012 provides greater energy efficiency in buildings than IECC 2009. DOE indicated IECC 2012 makes substantial progress with achieving DOE's goal to provide a 30 percent overall improvement in building energy efficiency compared with the code's previous editions.

Code adoption

Also included in DOE's May 2012 determination is a requirement for individual states to review their current codes and certify by May 17, 2014, their residential energy-efficiency requirements meet or exceed the levels established in IECC 2012. In the past, this type of certification mandate resulted in individual states upgrading their building energy codes to the latest edition of the model code.

To determine the statuses of individual states' energy code adoptions, NRCA conducted a comprehensive survey of states' adoptions and plans for future code upgrades. From this survey, only seven states were discovered to have updated their energy code to IECC 2012's levels by DOE's May 17 certification deadline—Illinois, Iowa, Maryland, Montana, North Carolina, Rhode Island and Washington.

Four additional states—California, Florida, Massachusetts and New York—will upgrade to IECC 2012's levels by Jan. 1, 2015. The remaining states reported they have no immediate intention of upgrading their energy codes; some states have no state-mandated energy code.

NRCA considers the findings of its energy code adoption survey to be significant. High R-value advocates, including some insulation manufacturers, trade associations and special interest groups, are leading designers and building owners to believe 2012 IECC R-values are required throughout the U.S. One roof system manufacturer and one special interest group are going as far as implying compliance with the *International Energy Conservation Code, 2015 Edition* already is required. NRCA's survey reveals these high R-value claims are misleading; in fact, most states do not yet require compliance with IECC 2012.

Minimum prescriptive thermal insulation requirements for commercial buildings

Climate zone	Roof assembly configuration		
	Insulation entirely above deck	Metal buildings (with R-5 thermal blocks)	Attic and other
1	R-20ci	R-19 + R-11 LS	R-38
2	R-20ci	R-19 + R-11 LS	R-38
3	R-20ci	R-19 + R-11 LS	R-38
4	R-25ci	R-19 + R-11 LS	R-38
5	R-25ci	R-19 + R-11 LS	R-38
6	R-30ci	R-25 + R-11 LS	R-49
7	R-35ci	R-30 + R-11 LS	R-49
8	R-35ci	R-30 + R-11 LS	R-49

ci = Continuous insulation

LS = Liner system (a continuous membrane installed below the purlins and uninterrupted by framing members; uncompressed, unfaced insulation rests on top of the membrane between the purlins)

Figure 1: Minimum prescriptive thermal insulation requirements for commercial buildings

NRCA's theoretical energy savings and cost payback analysis

Climate zone	City	R-value increase	Btu savings (heating and cooling)	Payback
1	Miami	R-10 to R-15	14,094,020 Btu	10.8 years
		R-15 to R-20	7,870,571 Btu	22.1 years
		R-20 to R-25	4,561,644 Btu	35.4 years
		R-25 to R-30	3,232,756 Btu	76.7 years
2	Phoenix	R-10 to R-15	17,587,010 Btu	18.5 years
		R-15 to R-20	9,743,286 Btu	38.1 years
		R-20 to R-25	5,620,822 Btu	61.3 years
		R-25 to R-30	3,969,578 Btu	133.0 years
	New Orleans	R-10 to R-15	21,213,494 Btu	15.0 years
		R-15 to R-20	11,760,541 Btu	30.9 years
		R-20 to R-25	6,787,331 Btu	49.7 years
		R-25 to R-30	4,794,863 Btu	107.8 years
3	Atlanta	R-10 to R-15	32,188,755 Btu	7.8 years
		R-15 to R-20	17,795,916 Btu	16.2 years
		R-20 to R-25	10,253,829 Btu	26.1 years
		R-25 to R-30	7,234,929 Btu	56.7 years
	Los Angeles	R-10 to R-15	16,585,533 Btu	11.6 years
		R-15 to R-20	9,175,377 Btu	23.8 years
		R-20 to R-25	5,288,761 Btu	38.2 years
		R-25 to R-30	3,732,720 Btu	83.0 years
	Dallas	R-10 to R-15	27,291,307 Btu	15.2 years
		R-15 to R-20	15,107,897 Btu	31.4 years
		R-20 to R-25	8,711,683 Btu	50.5 years
		R-25 to R-30	6,150,345 Btu	109.6 years
4	Seattle	R-10 to R-15	41,511,732 Btu	10.0 years
		R-15 to R-20	22,875,846 Btu	20.9 years
		R-20 to R-25	13,155,552 Btu	33.7 years
		R-25 to R-30	9,268,949 Btu	73.5 years
	Philadelphia	R-10 to R-15	45,256,460 Btu	7.5 years
		R-15 to R-20	24,967,532 Btu	15.5 years
		R-20 to R-25	14,368,027 Btu	24.9 years
		R-25 to R-30	10,128,298 Btu	54.3 years
4	Kansas City, Mo.	R-10 to R-15	51,295,159 Btu	9.4 years
		R-15 to R-20	28,314,737 Btu	19.4 years
		R-20 to R-25	16,299,591 Btu	31.3 years
		R-25 to R-30	11,492,733 Btu	68.0 years
5	Boston	R-10 to R-15	49,647,013 Btu	6.7 years
		R-15 to R-20	27,375,148 Btu	13.8 years
		R-20 to R-25	15,748,557 Btu	22.3 years
		R-25 to R-30	11,098,822 Btu	48.5 years
	Denver	R-10 to R-15	52,120,379 Btu	12.1 years
		R-15 to R-20	28,732,017 Btu	25.1 years
		R-20 to R-25	16,526,782 Btu	40.4 years
		R-25 to R-30	11,646,024 Btu	88.2 years
	Chicago	R-10 to R-15	58,340,933 Btu	7.5 years
		R-15 to R-20	32,175,508 Btu	15.6 years
		R-20 to R-25	18,512,379 Btu	25.2 years
		R-25 to R-30	13,047,818 Btu	54.7 years
6	Milwaukee	R-10 to R-15	63,370,658 Btu	9.4 years
		R-15 to R-20	34,933,522 Btu	19.4 years
		R-20 to R-25	20,093,821 Btu	31.4 years
		R-25 to R-30	14,159,572 Btu	68.3 years
	Minneapolis	R-10 to R-15	68,995,466 Btu	9.1 years
		R-15 to R-20	38,033,780 Btu	18.8 years
		R-20 to R-25	21,876,909 Btu	30.4 years
		R-25 to R-30	15,415,978 Btu	66.1 years
7	Sault St. Marie, Mich.	R-10 to R-15	78,807,463 Btu	8.5 years
		R-15 to R-20	43,428,492 Btu	17.6 years
		R-20 to R-25	24,975,104 Btu	28.4 years
		R-25 to R-30	17,596,619 Btu	61.8 years
8	Nome, Alaska	R-10 to R-15	119,135,728 Btu	3.7 years
		R-15 to R-20	65,648,986 Btu	7.7 years
		R-20 to R-25	37,752,688 Btu	12.4 years
		R-25 to R-30	26,598,690 Btu	27.0 years

Figure 2: Results of NRCA's theoretical energy savings and cost payback analysis

NRCA is committed to providing accurate and up-to-date information addressing energy code adoption. You can check the status of your state's energy code adoption by accessing the Energy Codes page of the Technical section of NRCA's website at www.nrca.net/technical/energycodes.

Energy savings and payback

NRCA has conducted an energy-savings and payback analysis for roof assembly R-value increases in 16 cities representative of the energy code's eight U.S. climate zones.

A hypothetical project that consisted of insulation above a roof deck assembly on a 10,000-square-foot single-story building was considered. Construction cost increases and corresponding theoretical energy-savings information were developed for changing the hypothetical roof assembly in each city from R-10 to R-15, R-15 to R-20, R-20 to R-25 and R-25 to R-30. City-specific current energy costs (natural gas for heating and electricity for cooling) were used in the analysis. Payback length is determined by dividing the incremental increased cost for adding R-value by the calculated theoretical energy cost savings. The results of NRCA's analysis are shown in Figure 2.

NRCA's 16-city analysis reveals insulation increases from R-10 to R-15 have the relatively shortest paybacks ranging from 3.7 years to 12.1 years. Conversely, increases from R-20 to R-25 and R-25 to R-30 have paybacks ranging from 12.4 years to 133 years. Payback lengths vary by a city's climatic conditions and heating and cooling energy costs. For example, energy costs significantly vary between Boston and Denver, resulting in wide variances in paybacks even when comparing cities in the same climate zone.

Considering current heating and cooling energy costs, NRCA's analysis concludes R-value increases resulting in payback lengths approaching or beyond a roof assembly's anticipated life span are not financially justifiable for building owners. A 2004 study conducted by The Roofing Industry Alliance for Progress revealed the average life span for a commercial low-slope roof system in the U.S. is about 17.4 years.

As heating and cooling energy costs increase, shorter payback lengths will occur and may better justify the current model energy code's high minimum-required R-values.

You can determine theoretical heating and cooling costs (and savings) for roof assembly configurations in specific cities using NRCA's EnergyWise Roof Calculator accessible at http://energywise.nrca.net.

NRCA recommendations

NRCA considers a roof assembly's thermal performance to be an important attribute to overall roof system performance.

NRCA recommends roof assembly designers provide designs that comply with the minimum requirements of the specific energy code applicable to the jurisdiction where a building is located.

Additional information about complying with the roofing-related requirements of IECC 2009 and IECC 2012 is provided in NRCA's *Guidelines for Complying With Energy Code Requirements for Roof Assemblies: International Energy Conservation Code, 2009 and 2012 Editions,* available by accessing shop.nrca.net or contacting NRCA's Customer Service Department at (866) ASK-NRCA (275-6722) or info@nrca.net.

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