INSULATION RECOMMENDATIONS

A Quick Guide to Cost, Health, and Environmental Considerations

PUBLISHED BY BUILDINGGREEN, INC.

About this report

"Insulation Recommendations" is a special edition report produced for BuildingGreen members. The content for this report is excerpted from "Insulation Choices: What You Need to Know About Performance, Cost, Health and Environmental Considerations," which is available through BuildingGreen.com. The full report contains detailed guidance on pros and cons of each insulation type, as well as essential background on using insulation in buildings.

Credits

Editors

Alex Wilson
Tristan Roberts
Nadav Malin
Peter Yost
Paula Melton
Candace Pearson

Graphic Design

Amie Walter

About BuildingGreen

BuildingGreen is an independent publishing and consulting company committed to providing accurate, unbiased, and timely information designed to help building-industry professionals and policy makers improve the environmental performance, and reduce the adverse impacts, of buildings.

Acknowledgments

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Insulation Type		R-value Per Inch*	Estimated Installed Cost Per ft² for R-19**		Vapor Permeability†	Air Barrier‡	Environmental Notes (see below for legend)
			Low end	High end			
FIBER, CELLULOSIC, AND GRANULAR							
Fiberglass	Batt	3.3	$0.88	$1.88	Class III: Semi-Permeable	Not an air barrier—batts especially susceptible to air infiltration	Avoid formaldehyde binders
	Blown-in	3.8	$0.66	$0.83			
	Spray-applied	3.7–4.2	$0.60	$0.79			
Cellulose	Spray-applied	3.8–3.9	$0.73	$1.59	Class III: Semi-Permeable	Not an air barrier, but dense-packed cellulose enhances air resistance of an assembly	
	Loose fill	3.6–3.7	$0.64	$0.80			
Mineral wool		3.3	$1.20	$1.44	Class III: Semi-Permeable	Not an air barrier	Choose low-emitting products
Cotton		3.4	$1.50	$2.16	Class III: Semi-Permeable	Not an air barrier	Shipping energy may be significant
Polyester		3.7	Product not currently available		Class III: Semi-Permeable	Not an air barrier	
Sheep's wool		3.5	$3.50	$4.50	Class III: Semi-Permeable	Not an air barrier	Wool agricultural practices are a high contributor to global warming
Vermiculite		2.1-2.3	NA	NA	Class III: Semi-Permeable	Not an air barrier	Often contains asbestos
Perlite		2.4–3.7	$2.48	$4.13	Class III: Semi-Permeable	Not an air barrier	

About the Environmental Notes

Green indicates significant **recycled content** or renewable material. Red indicates little or no recycled content and fossil-fuel-based materials in typical products.

Green indicates low **embodied energy**. Red indicates high embodied energy and/or embodied carbon.

Green indicates relatively low **toxic emissions** during use from typical products. Red indicates potential high toxic emissions from typical products.

Red indicates high toxic emissions during manufacturing or application.

Blue in all cases indicates ambiguity—explanatory notes are provided in all cases.

Notes are provided for red indications in some cases.

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Insulation Type	R-value Per Inch*	Estimated Installed Cost Per ft² for R-19**		Vapor Permeability†	Air Barrier‡	Environmental Notes (see below for legend)
		Low end	High end			
RIGID BOARDSTOCK						
Polyisocyanurate	6–6.5	$2.47	$3.20	Class III: Semi-Permeable Class I: Impermeable (Foil-faced)	Air barrier material	High global warming potential for urethane-core SIPs Chlorinated flame retardant (otherwise fairly inert) Toxic manufacturing process
Extruded polystyrene (XPS)	4.8–5	$3.99	$4.37	Class II: Semi-Permeable (>1″) Class III (<1″)	Air barrier material	High global warming potential for urethane-core SIPs Brominated flame retardant (otherwise fairly inert) Toxic manufacturing process
Expanded polystyrene (EPS)	3.7–4.5	$4.04	$4.32	Class II Vapor Retarder	Not an air barrier	Brominated flame retardant
Mineral wool	2.4–3.3	$1.80		Class III Vapor Retarder	Not an air barrier	Choose low-emitting products
Fiberglass	3.6–4.5	$4.72	$5.61	Class III Vapor Retarder	Not an air barrier	Formaldehyde binders are common
Cellular glass	3.0	$6.20	$7.50	Class I Vapor Retarder (Vapor barrier)	Air barrier material	

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Key Environmental and Performance Factors for Insulation Materials continued

Insulation Type	R-value Per Inch*	Estimated Installed Cost Per ft² for R-19**		Vapor Permeability†	Air Barrier‡	Environmental Notes (see below for legend)
		Low end	High end			
RIGID BOARDSTOCK continued						
Expanded cork board	3.6	No data available		Class III Vapor Retarder	Not an air barrier	Shipped from Europe
Low-density wood fiber	3.1–3.7	No data available		Class IV Vapor Retarder (Permeable)	Some forms can be an air barrier	Shipped from Europe
Perlite board	2.7	No data available		Unknown	Air barrier material	Uses asphalt binder
FOAM-IN-PLACE						
Closed-cell polyurethane	3.3–5.0	$3.02	$4.06	Class II Vapor Retarder	Air barrier material	High-global-warming-potential blowing agents Offgassing under investigation by EPA Chlorinated flame retardant Highly toxic when applied
Open-cell polyurethane	3.3–5.0	$2.75	$9.54	Class III Vapor Retarder	Varies by type: some types are air barrier materials, some control air leakage but are not air barriers	Offgassing under investigation by EPA Chlorinated flame retardant Highly toxic when applied
Urea- and phenol-formaldehyde	4.5–4.8	$5.20		Unknown	Performance over time unknown	
Cementitious foam (Air-Krete)	3.9	$2.45		Vapor-permeable	Unknown—assumed to be air permeable due to fragile foam consistency	

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Key Environmental and Performance Factors for Insulation Materials continued

Insulation Type	R-value Per Inch*	Estimated Installed Cost		Vapor Permeability†	Air Barrier‡	Environmental Notes (see below for legend)
		Low end	High end			
MISCELLANEOUS						
Radiant barriers	N/A	$0.60–$0.70/ft²		Class I Vapor Retarder (Vapor barrier)	Based on their configuration, these materials are usually air barriers but are not typically used at the building scale to create an air barrier assembly.	See the text of the full BuildingGreen insulation report for more information. These materials tend to be used in specialized applications; difficult to compare impacts with other common insulation materials.
Gas-filled panels	5–11 (Depends on type of gas fill)	No data available		Class I Vapor Retarder (Vapor barrier)		
Translucent panels	3.9	$45–$55/ft²		Class I Vapor Retarder (Vapor barrier)		
Vacuum panels	30–50	No data available		Class I Vapor Retarder (Vapor barrier)		

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* Ranges reflect the variability of products, and for some spray-applied products, a range of installed densities.

** Cost estimates are provided by Vermeulens Cost Estimating and Davis Langdon, and are intended to be relevant throughout the U.S. However, we are not able to anticipate specific project conditions that may be relevant, such as scale, scope, new vs. retrofit, or unique design conditions. Use only as a rough guide to aid decision-making.

† Vapor retarders have four classes:
Class I: less than 0.1 perms – Impermeable (e.g., polyethylene)
Class II: 0.1–1.0 perm – Semi-impermeable (e.g., kraft paper)
Class III: 1.0–10.0 perms – Semi-permeable (e.g., latex paint)
Class IV: greater than 10.0 perms – Permeable (e.g,, Tyvek)

‡ The Air Barrier Association of America (ABAA) defines an air barrier material as having a maximum allowable air leakage rate of 0.02 liters/second/m² at 75 Pascals pressure difference.

Air-barrier materials must be joined with other air-barrier materials to make an air-barrier assembly, and assemblies join to form a continuous air-barrier system for a building. Air-barrier insulation materials can contribute to those assemblies; insulation materials that are not air barriers may be part of the assembly, but other materials should be relied upon for the air barrier.

See the text of the full BuildingGreen insulation report for more detail on all attributes.

For more background on which insulation products perform well in different applications, and our overall recommendations on materials, see BuildingGreen's full report, Insulation Choices.

Sources: Material data compiled from *ASHRAE Fundamentals* and from other industry sources. This is only a guide: check with specifier, manufacturer, and contractor on specific expectations for your project. Simply specifying the material may not get you the R-value shown above, due to variations in products and installation practices.

Bottom-Line Insulation Material Recommendations

This table presents BuildingGreen's top picks of insulation materials for different applications. Our recommendations are focused on insulation materials, not insulation design and best practices. It is critically important to address moisture dynamics, airflow, and how different materials in the assembly—including insulation—interact to deliver the desired performance and durability. Thermal properties, control of air leakage, and moisture management all interact and should be considered together. Doing so ensures durability of the overall assembly and building—a major environmental benefit that transcends material choice. Use this table as a reference for choosing materials, alongside other resources, including professional help.

Recommended Insulation Materials	Environmental Issues	Performance and Cost Issues
RESIDENTIAL CAVITY FILL None of the following recommended products are air barriers; include a continuous air barrier separately from the insulation with all cavity-fill insulation options. All of the following products are vapor-permeable, although hygroscopic properties differ considerably. Insulation choices may be affected by the cavity design, framing materials, and other factors.		
✓ **BuildingGreen Top Pick** **Dense-packed cellulose**	Low embodied energy and carbon. Renewable, high recycled content. Flame retardant toxicity not a big concern.	Fills cavities completely, impedes air leakage. Settling is not a factor with dense-packing. Hygroscopic: can help manage moisture by seasonally absorbing and releasing water vapor as long as at least one side of the assembly is vapor-permeable, and as long as the wetting rate does not exceed the drying rate on an annual basis.
Spray-applied or dense-packed fiberglass	Higher embodied energy than cellulose. Not a renewable material.	Fills cavities completely, impedes air leakage at higher densities.
Mineral wool batts	Higher embodied energy than cellulose. Some emissions concerns.	Use when greater fire rating is desired or as a superior option (compared to fiberglass batts) for small jobs. Can be hard to source.
Air-Krete, cotton batts, polyester batts, or dense-packed wool	Use when the owner has unique air quality concerns about other options.	More expensive than other options and harder to source. Specific performance downsides by insulation type: see body of report.
Fiberglass batts	Higher embodied energy; often poorly installed (see performance issues).	Difficult to install well (requires time to cut carefully around irregularities). Use only for budget-conscious jobs too small for an insulation contractor and where mineral wool batts are not available.

Note: *Recommendations in this table are based on environmental and performance factors—and combinations of the two. Check both columns for background.*

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Recommended Insulation Materials	Environmental Issues	Performance and Cost Issues
COMMERCIAL CAVITY FILL See note above on similar considerations relevant to residential cavity fill. Also note that due to fire codes and other considerations in commercial construction, our recommendations here are somewhat different.		
✓ **BuildingGreen Top Pick** **Spray-applied or dense-packed fiberglass**	JM Spider from Johns Manville has 30% recycled content. Higher embodied energy than cellulose. Fire-resistant without flame retardants.	Impedes air leakage, not susceptible to moisture. Acrylic binder allows installation in an open cavity without netting. "Blow-in-Blanket" systems require netting on the interior faces of framing members.
Mineral-wool batts	Higher recycled content than fiberglass but higher embodied energy than cellulose.	Compared to spray-applied fiberglass, greater potential for gaps and poor installation; follow manufacturer guidelines.
Dense-packed cellulose	Higher recycled content and lower embodied energy than fiberglass.	Recommended for wall cavities with good moisture management and drying potential in at least one direction.
EXTERIOR INSULATING SHEATHING Exterior insulation should be thick enough to maintain the dew point within the material (recommended thickness depends on climate and other factors). Note that the products recommended here have different vapor permeability: polyiso is impermeable if foil-faced, and mineral wool may be impermeable depending on the facing. Design assemblies appropriately for moisture management.		
✓ **BuildingGreen Top Pick** **High-density rigid mineral wool**	Available with high recycled content. Excellent sound control; insect- and moisture-resistant.	Available faced or unfaced. Can be difficult to source and requires tricky detailing for many types of cladding.
Foil-faced polyisocyanurate	Use if rigid mineral wool is unavailable or impractical.	Highest R-value of any common insulation material; affordable. Adds the benefit of a radiant barrier if installed with strapping.
INTERIOR INSULATING SHEATHING Note that the products recommended here have different vapor permeability: polyiso is impermeable if foil-faced, and mineral wool may be impermeable depending on the facing. Design assemblies appropriately for moisture management. Polyiso can be part of the building's air barrier if taped.		
✓ **BuildingGreen Top Pick** **Foil-faced polyisocyanurate (polyiso)**	Performs well. Relatively high embodied energy, but blowing agents with high global warming potential (GWP) have been eliminated.	Highest R-value of any common insulation material; affordable. Adds the benefit of a radiant barrier when installed with interior strapping to provide an air space (can double as a wiring chase).
Rigid mineral wool	Some indoor air quality concerns due to the risk of fiber shedding and formaldehyde emissions.	Specify a product that meets third-party standards for low emissions.
EXTERIOR FOUNDATION WALL		
✓ **BuildingGreen Top Pick** **Cellular glass (FoamGlas)**	High compressive strength, impermeable to moisture, no blowing agents or flame retardants.	Relatively high cost—use if budget permits. Special installation required, including protection during backfilling. Follow manufacturer's instructions.
✓ **BuildingGreen Top Pick** **High-density rigid mineral wool**	Hydrophobic, so it provides an excellent drainage layer.	Use if cellular glass is unavailable or its cost is prohibitive. Harder to install and cover than more common options.

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Bottom-Line Insulation Material Recommendations continued

Recommended Insulation Materials	Environmental Issues	Performance and Cost Issues
Expanded polystyrene (EPS)	Don't confuse with extruded polystyrene (XPS), which we recommend against because of high global warming potential and its HBCD flame retardant.	Use if the cost of cellular glass is prohibitive and rigid mineral wool is unavailable. Specify higher-density EPS than standard. Type II or Type IX is recommended.
INTERIOR FOUNDATION WALL		
✓ **BuildingGreen Top Pick** **Polyisocyanurate**	Relatively high embodied energy, but blowing agents with high global warming potential (GWP) have been eliminated.	Use on poured concrete and CMU walls that provide a relatively flat surface. After one layer of foam board, adding a stud wall with mineral wool or fiberglass is recommended for added insulation depth.
Closed-cell spray polyurethane foam (SPF)	Closed-cell SPF has high global warming potential (GWP), but it can be justified up to two inches thick. For R-values greater than those provided by two-inch SPF, combine SPF with interior cavity wall and cavity-fill insulation.	May be the only viable option for installing insulation against uneven wall surfaces. (Water-blown, very-low-GWP, closed-cell polyurethanes are available, but shrinkage has sometimes been a problem. Once the formulations and installation practices have been refined, only water-blown foam should be used.)
SUB-SLAB RIGID INSULATION		
✓ **BuildingGreen Top Pick** **Cellular Glass (FoamGlas)**	No blowing agents or flame retardants. U.S. factories don't use recycled content but could in the future.	Relatively high cost— Use if budget permits. High compressive strength; impermeable to moisture. Bitumen facing is available for greater abrasion resistance during installation. Special installation is required; follow manufacturer's instructions.
Expanded polystyrene (EPS)	Pollution issues during manufacturing; uses HBCD flame retardant.	Use if higher cost of cellular glass is prohibitive. For greater strength and reduced moisture absorption, specify higher-density EPS: Type II or Type IX is recommended.
ATTIC FLOOR INSULATION A continuous air barrier is often critically important at the attic floor; none of the following recommended products provide that. For good detailing, use drywall or oriented-strand board with taped joints, or selectively apply spray polyurethane foam. Wind-washing, in which convection through attic insulation reduces effective R-value, can be a problem with some products—use practices and products that prevent this.		
✓ **BuildingGreen Top Pick** **Loose-fill cellulose**	Low embodied energy and carbon. Renewable; high recycled content.	Vapor-permeable; impedes airflow better than loose-fill fiberglass. Use "stabilized" cellulose with a small amount of acrylic binder to prevent settling, or install extra thickness to allow settling while maintaining desired R-value.
Spray-applied fiberglass	Higher embodied energy than cellulose; use if particularly concerned about moisture accumulation.	JM Spider fills penetrations well, impedes airflow relatively well and reduces wind-washing. Acrylic binder prevents settling.
Perlite	Moderate embodied energy from mining, transporting, and expanding perlite, but lower than most other insulation materials except cellulose.	Use if low-density (high R-value) perlite is available regionally. Potential for wind-washing, so install a convection barrier, such as a 3" (min.) layer of loose-fill cellulose on top of the perlite layer. Reusable.

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Recommended Insulation Materials	Environmental Issues	Performance and Cost Issues
RAFTER INSULATION (CATHEDRAL CEILING) Refer to building codes for specific design requirements for vented and unvented assemblies.		
✓ **BuildingGreen Top Pick** **Dense-packed cellulose**	Low embodied energy and carbon. Renewable; high recycled content.	Fills cavities completely, effective at blocking air leakage. Dense-packed installations maximize R-value while preventing settling.
Spray-applied or dense-packed fiberglass	Higher embodied energy than cellulose but lighter-weight.	Use if there is strong concern about moisture accumulation or the weight of cellulose.
Open-cell polyurethane	Higher embodied energy than cellulose.	Use in situations where superb air-sealing would otherwise be difficult.
Fiberglass batt	Higher embodied energy than cellulose. Often poorly installed (see performance issues).	Difficult to install well (requires time, cutting carefully around irregularities). Use only for budget-conscious jobs too small for an insulation contractor.
LOW-SLOPE ROOF INSULATION (Commercial Construction)		
✓ **BuildingGreen Top Pick** **Organic- or fiberglass-faced polyisocyanurate**	Relatively high embodied energy, but high-GWP blowing agents have been eliminated.	Highest R-value per inch of any option; can serve as an air barrier with taped joints. Widely available; known to contractors. Not suitable for Inverted Roof Membrane Assembly (IRMA) due to moisture properties.
High-density rigid mineral wool	Relatively high embodied energy; fire-resistant without flame retardants.	Thicker layer required compared with polyiso to achieve same R-value— extra thickness also adds weight. Check with the manufacturer about suitability for IRMA.
Cellular Glass (FoamGlas)	Relatively high embodied energy; fire-resistant without flame retardants.	A good option if the budget permits and a thicker layer is feasible to achieve the desired total R-value. High compressive strength; moisture-impermeable. IRMA configuration not feasible in climates with freeze-thaw cycles.
Extruded polystyrene (XPS)	High global warming potential; uses HBCD flame retardant, which is persistent, bioaccumulative, and toxic.	Recommended if doing an IRMA installation for performance reasons and other options are not feasible.

BuildingGreen's Building Envelope Energy Performance Recommendations

How much insulation is enough? How airtight should a home be? What window and door specifications should you look for? BuildingGreen's building envelope recommendations (see page 14) are aimed at defining high-performance goals for homes and low-rise buildings that we believe all buildings can reasonably achieve.

Coupled with wise selection of appliances, lighting, and mechanical systems, these insulation levels should achieve performance suitable for net-zero-energy homes using rooftop or ground-mounted solar-electric (PV) modules. (In some cases they may be enough to qualify for Passive House certification, but Passive House design requires more detailed specifications.)

Our recommendations have been influenced by numerous sources, including Building Science Corporation, Vermont Energy Investment Corporation, and various building codes. They apply most directly to new construction, but can be used with deep energy retrofits of existing buildings as well.

For comparison, we include prescriptive energy conservation standards from the International Energy Conservation Code (IECC 2012), published by the International Code Council. Our recommendations are organized by climate zone: Hot (U.S. Department of Energy Zones 1–2); Moderate (Zones 3–4); Cold (Zones 5–6); and Coldest (Zones 7–8). In some cases, the IECC 2012 requirements are more finely segregated, in which case you will see two numbers or sets of numbers for our climate zone groupings.

Besides our goal of recommending a very high level of performance, there are a few assumptions we made that are worth explaining.

Round numbers

While IECC requirements are often specific to actual products (R-19 or R-38 being relevant to fiberglass batts, for example), we have avoided that and aimed for round numbers, partly in the belief that fiberglass batts are rarely a good choice for building insulation. Our numbers are also whole-wall or whole-unit values, so an R-19 recommendation, tied to a specific product, doesn't make sense.

What About Cost?

The high insulation levels that we recommend may cost more, but the cheapest time to add more insulation is when you first build, and more insulation can reduce mechanical system size and operating costs. What is the right level of insulation from a cost perspective? There's no single right answer to that, but we argue that aiming high is justified: relying on payback analyses based on today's energy prices is misguided when energy prices are wildly fluctuating, and the effects of climate change are already apparent. It probably makes more sense to use the cost of onsite photovoltaics as a benchmark for how much one should reasonably spend on energy conservation.

> The cheapest time to add insulation is when you first build.

Attic vs. Roof

Our recommendation for installing more insulation in an attic than in a roof (cathedral ceiling) recognizes differences in the cost of installations. It is generally a lot less expensive to install insulation in a flat ceiling (unheated attic floor), so more insulation can be economically justified than when the insulation goes into a roof system.

Whole-Wall Design Flexibility

The IECC requirements for both cavity-fill and rigid insulation in above-grade walls make sense in addressing thermal bridging, but our recommendations address thermal bridging by focusing on whole-wall insulation recommendations. It may be difficult to achieve a whole-wall insulating value of R-25 in Zone 4, for example, without installing some rigid insulation, but it can be done with double-studs that are offset or a system with non-structural trusses hung off the structural wall. Whole-wall recommendations give the designer or builder flexibility.

Fenestration By Climate and Orientation

With fenestration, the variables we address are U-factor and solar heat-gain coefficient (SHGC). Low U-factors block more heat from escaping through windows, so are particularly important in colder climates. Solar gain contributes both to passive solar heating of buildings, which can be beneficial on southern orientations (especially in cold climates, but not limited to cold climates), and to overheating, particularly on east and west facades. Our recommendations reflect these differences by climate and orientation.

Goals for Doors

With doors there are few products today that achieve the listed performance recommendations, so those recommendations can be thought of as aspirational for manufacturers.

Airtightness

Our recommendations range from 1 ACH50 (air changes per hour at 50 pascals of pressure difference) in the coldest climates to 2 ACH50 in warmer climates. These standards aren't as tight as some—the Passive House standard is 0.6 ACH50—but are readily achievable and represent a huge improvement over conventional standards.

BuildingGreen's Recommended Thermal Design Values for Residential New Construction

This table compiles BuildingGreen's (BG) recommended thermal design values for residential new construction and compares them with IECC 2012 code requirements, by climate zone. See the notes below for details on interpreting this table.

RECOMMENDATIONS BY DOE CLIMATE ZONES FOR NORTH AMERICA											
Assembly Area	Hot (Zones 1–2)			Moderate (Zones 3–4)			Cold (Zones 5–6)			Coldest (Zones 7–8)	
	IECC		**BG**	IECC		**BG**	IECC		**BG**	IECC	**BG**
BUILDING ENVELOPE R-VALUES											
Slab	0		0	0	10	10	10		15	10	25
Basement wall	0		10	5/13	10/13	20	15/19		30	15/19	40
Floor above vented crawl space	13		15	19		25	30		40	38	50
Above-grade walls (wood-framed)	13		15	20 or 13+5		25	20 or 13+5	20+5 or 13+10	40	20+5 or 13+10	50
Ceiling – Flat	30	38	50	38	49	40	49		60	49	70
Ceiling – Cathedral			40				50			60	
FENESTRATION											
Window U-factor – E, W, N	NR	0.40	0.35	0.35		0.25	0.32		0.2	0.32	0.15
Windows U-factor – South				0.35			0.25		0.2		
Window SHGC – E, W, N	0.25		<0.2	0.25	0.40	<0.33	NR		NR	NR	NR
Window SHGC – South	<0.3				<0.4		>0.5		>0.4		
Exterior door (unit U-factor)	NA		0.3	NA		0.3	NA		0.25	NA	0.2
AIRTIGHTNESS											
Airtightness (ACH50)	NA		2	NA		2	NA		1.5	NA	1

Notes on IECC requirements:

- Divided columns indicate that requirements differ by the two climate zones shown, with the hotter climate zone appearing first.
- "15/19" means R-15 continuous insulation on the interior or exterior of the home or R-19 cavity insulation at the interior of the basement wall. "15/19" can be met with R-13 cavity insulation on the interior of the basement wall plus R-5 continuous insulation on the interior or exterior of the home.
- "13+5" means R-13 cavity insulation plus R-5 continuous insulation or insulated siding.
- While including prescriptive requirements such as installation of a continuous air barrier, IECC 2012 does not mandate a specific air-tightness performance figure.
- NR: No recommendation
- NA: Not applicable. IECC does not have specific requirements.

Notes on BuildingGreen recommendations:

- R-values for whole-wall or true R-values in which thermal bridging through higher-conductivity materials has been taken into account.
- For R-values, recommendations are for equal or greater than listed values.
- For U-factors, recommendations are for equal or lower than listed values.
- For SHGC values, recommendations may be greater or lesser than listed values, so greater-than or less-than symbols are shown.
- Unvented crawlspaces should be insulated at the perimeter using basement wall recommendations.