

Lincoln's Residential Energy Code: The 2018 IECC

Requirements and Best Practices

Nebraska Energy Code Training Program

Instructor: Matt Belcher

June 29, 2021: 11:30 am – 1:30 pm CST



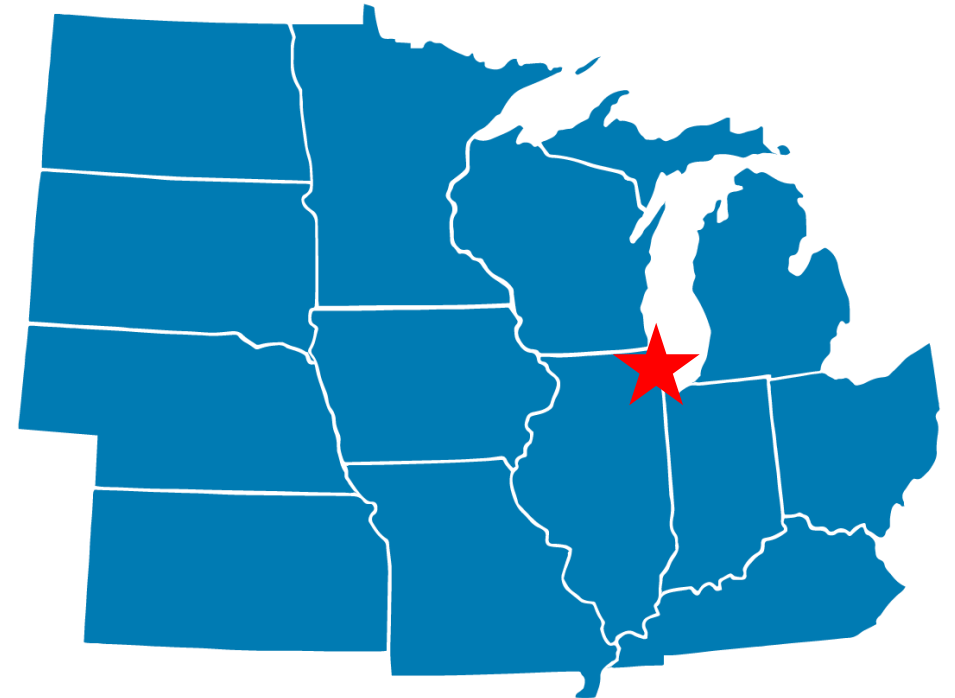
Housekeeping

- Attendees are muted upon entry
- Questions? Enter them in the chat box
- Webinar is being recorded – slides and recording will be sent to attendees
- **CEU's will be available upon request (ICC)**
 - **Course: 28696, CEUs: 0.2**
- Email kgredvig@mwalliance.org with questions



About MEEA

- MEEA is a nonprofit membership organization with 160+ members, including:
 - Utilities
 - Research institutions
 - State and local governments
 - Energy efficiency-related businesses
- MEEA helps stakeholders understand and implement cost-effective energy efficiency strategies



About the Nebraska Training Program

- Goal: prepare the Nebraska workforce for upcoming changes in construction best practices
 - Residential and Commercial Energy Code
 - Building Science
 - Practical Solutions
- Focused on providing training and resources to builders, code officials, design professionals, public officials and students
- For more information, visit:
<https://www.mwalliance.org/nebraska-energy-codes-training-program>



About Verdatek Solutions



Matt Belcher



Introduction Poll #1

- What is your profession?
 - Code Official
 - Home Builder
 - State/local government
 - Energy Rater/Consultant
 - Architect/Engineer
 - Non-profit
 - Academic
 - Utility
 - Other (type in chat)





Introduction Poll #2

- How long have you been in the construction industry?
 - 0-5 years
 - 5-10 years
 - 11-15 years
 - 16-20 years
 - 21+ years



Introduction Poll #3

- How familiar are you with the residential provisions in the 2018 IECC?
 - Extremely Familiar
 - Somewhat Familiar
 - Somewhat Unfamiliar
 - Not familiar at all

Training Objectives

- What is the 2018 Energy Code?
- Inside the Energy Code:
 - Building Envelope
 - Interior Comfort/Health
 - Remodeling
- Marketing Energy Efficient/High Performance Buildings





Today's Agenda

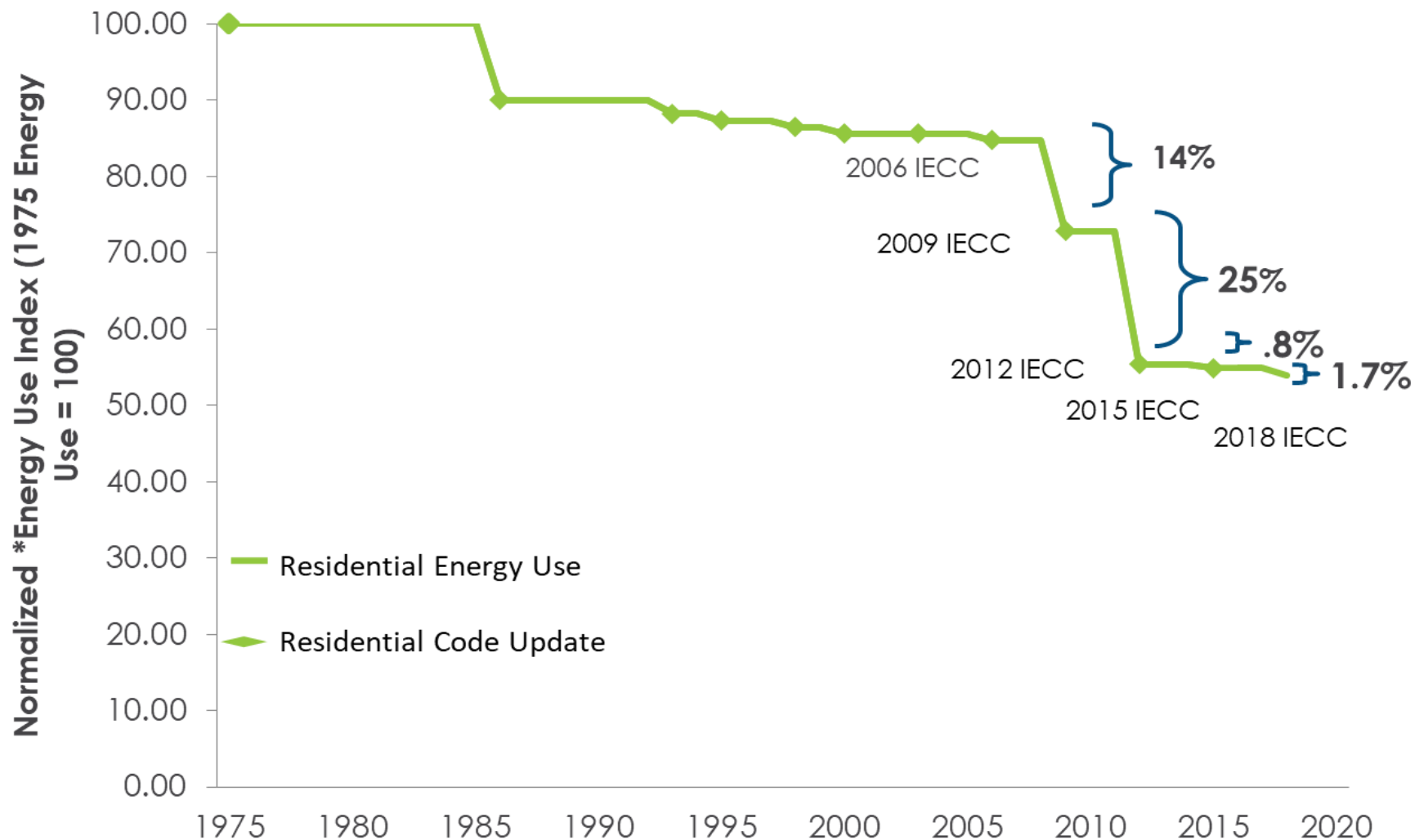
- Code Requirements in the 2018 IECC + Lincoln Amendments
- Performance Testing
- Moisture Management, Air Movement and Heat Transfer
- HVAC System
- Marketing High Performance Homes
- Key Takeaways



What is the 2018 IECC?

(Nothing scary, really!)

Model Energy Code Efficiency



* Energy Use Index: National average energy use by building type and size.

Source: MEEA based on PNNL Analysis

Nebraska Residential Field Study

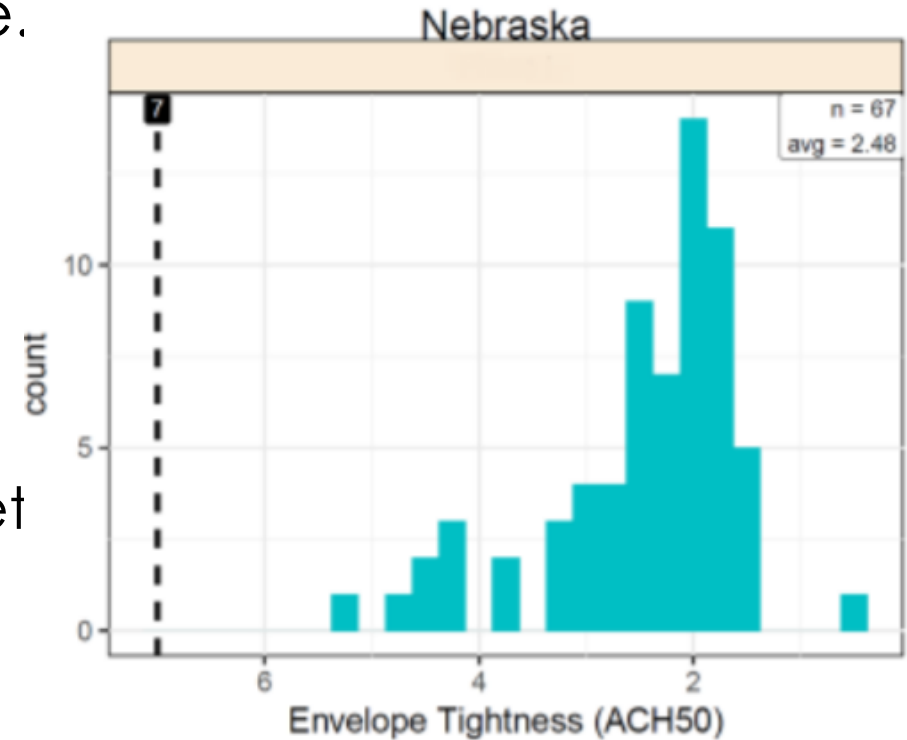
- Conducted in 2017 by **Nebraska Department of Environment and Energy** 2009 IECC was the baseline.
- Collected and analyzed several data points for new homes, including:
 - Envelope air leakage
 - Efficacy in lighting
 - Duct leakage
 - Ceiling & exterior wall insulation
 - Basement & slab insulation
 - Windows

For More Information and Data:

https://www.energycodes.gov/sites/default/files/documents/Nebraska_Residential_Combpliance_Evaluation_final.pdf

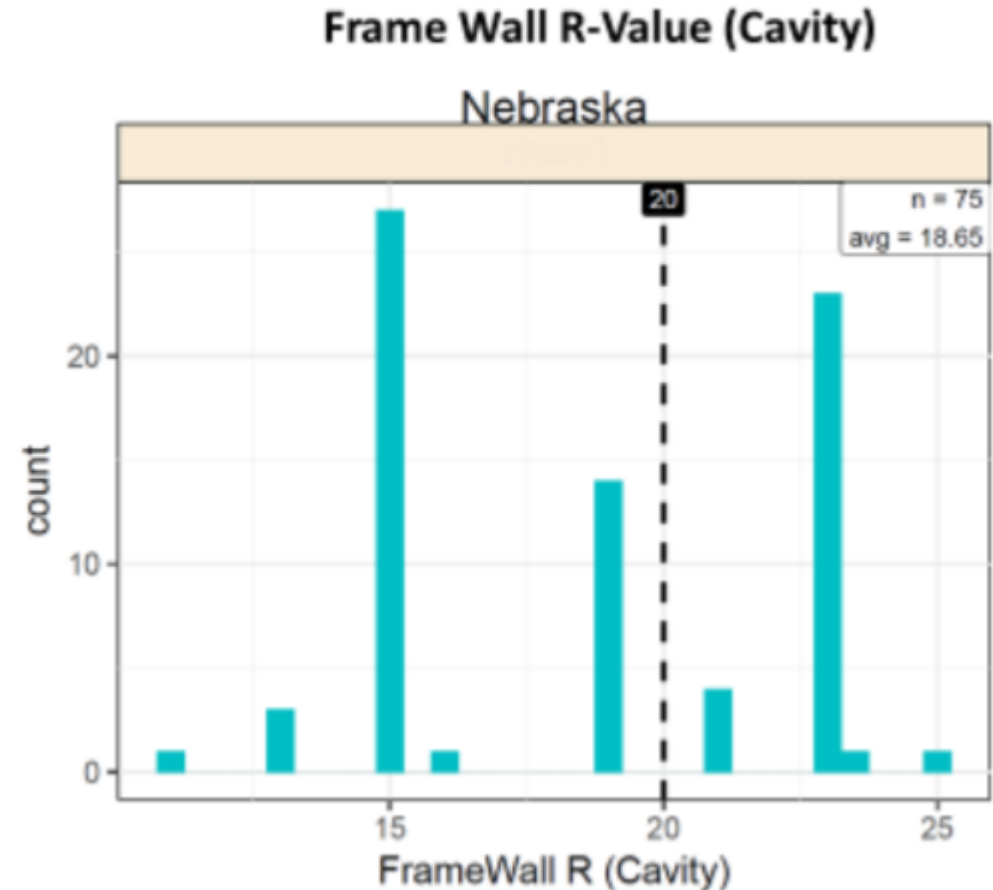
NE Residential Field Study - Results

- Overall, not too bad! But room to improve.
 - **Envelope Air Leakage:** Better than code (7 ACH50)
 - Not all would meet 2018 IECC
 - **Efficacy in Lighting:** Average; some good, some not
 - **Duct Leakage:** Ugh!
 - Needs significant improvement to meet 2018 IECC
 - **Ceiling Insulation:**
 - Amount: Good+ (Average: R-42.5)
 - Install: Not as good. Reduces compliance (R-factor)

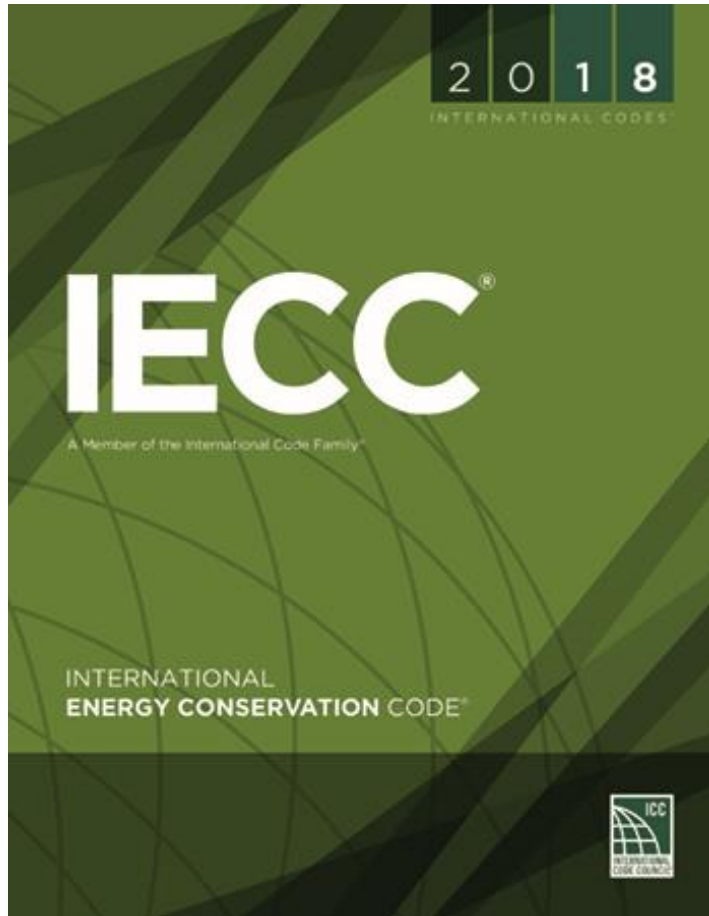


NE Residential Field Study - Results

- Frame Wall Insulation: Most common installation was below code
 - Even continuous insulation < Code
 - Quality of Installation an issue
- Basement Insulation: Meets code (average), but room to improve
- Slab insulation: Meets or exceeds code
- Windows: Meets code but will need to upgrade to meet 2018 IECC



So, What's Changed since 2009?



2018 IECC / IRC Section 11

- Creates a Residential Energy Code separate from the Commercial Energy Code
- Promotes Innovation through Energy Ratings Index (ERI)
 - Uses a HERS-type index as an “equivalent” for residential applications
 - Mandatory requirements still apply

2018 IECC Mandatory Requirements

Energy Certificate

- Energy Certificate located on circuit breaker box includes key energy efficiency measures and is signed by the builder

Air Sealing

- All holes between floors and through exterior walls/ceilings have been sealed in **accordance with table R402.4.1.1**
- **Lincoln Amendment:** Deletes air leakage testing requirements
 - Model Code: Building or dwelling unit is **tested to verify air leakage rate of ≤ 3 Air Changes per Hour (ACH)**
- Building or dwelling unit must have continuous air barrier installed

2018 IECC Mandatory Requirements

Ducts

- All ducts are sealed with approved materials (e.g. mastic or UL 181 tape) - duct tape is not acceptable
- All ducts outside conditioned space are tested to verify duct leakage with a total duct leakage or leakage to the outside test
 - **Lincoln Exception:** Ducts duct air-leakage test shall not be required for ducts that are sprayed with closed cell foam
- Supply & return ducts in attic insulated to $\geq R-6$ when ducts are outside conditioned space and $\geq R-8$ when ducts are outside the building thermal envelope

Building Cavities

- Building framing cavities shall not be used as supply ducts or plenums
 - **Lincoln Exception:** Exception: Interior building cavities may be used as ducts or plenums for return air when completely panned and sealed.

2018 IECC Mandatory Requirements

Heating and Cooling

- Controls: Programmable thermostat installed
- Equipment sized per ACCA Manuals S & J

Lighting

- Minimum of **90% high-efficacy lamps** installed
- Recessed lighting in thermal envelope IC-rated and airtight

Ventilation

- **Lincoln amendment:** Every occupied space shall be ventilated by natural means in accordance with Section 402 or by mechanical means in accordance with Section 403/Lincoln Mechanical Code.
 - *Model Code: Mechanical ventilation required for homes with air leakage rates < 5 ACH*
 - *Will explore in detail later on*

2018 IECC Mandatory Requirements

Other requirements

- Wood-burning fireplaces have tight flue dampers or doors, and outdoor combustion air
- Mechanical system piping insulated to min R-3 for fluids $>105^{\circ}$ F or $<55^{\circ}$ F
- Circulating hot water systems shall be insulated to at least R-2. Systems shall include an automatic, or readily accessible, off-switch.



Energy Code Compliance Pathways

Prescriptive Method Requirements

- All mandatory and prescriptive requirements must be met

Total UA Method Requirements

- All mandatory and prescriptive requirements (other than Table R402.1.2) must be met
- Include documentation to demonstrate compliance with the UA Trade-off method. Compliance software submittal must include completed compliance form, inspection checklist and certificate demonstrating compliance with 2018 IECC levels



Energy Code Compliance Pathways

Simulated Performance Requirements (Section R405)

- All mandatory requirements must be met
- Submit an energy cost analysis report which demonstrates that the proposed design (as built) home is more efficient than the standard reference design home

Energy Rating Index Requirements (Section R406)

- All Mandatory requirements met. Meet or exceed 2009 IECC prescriptive envelope requirements
- ERI score of 61 or lower. Submit report demonstrating compliance

2018 IECC Prescriptive Requirements

Table R402.1.2 Insulation Requirements By Component

 Indicates Change

Requirement	2009 IECC	2018 IECC	Lincoln Energy Code
Ceiling R-value	R-38	R-49	Same as 2018 IECC
Wall R-value	R-20 or R-13+5	R-20 or R-13+5	Same as 2018 IECC
Floors over unconditioned space	R-30	R-30	Same as 2018 IECC
Basement R-value	10/13	15/19	R-13
Slab R-value and depth	10, 2 ft.	10, 2 ft. *R-5 insulation shall be provided under the full area of a heated slab	Same as 2018 IECC
Crawl space wall R-value	10/13	15/19	Same as 2018 IECC

2018 IECC Prescriptive Requirements

 Indicates Change

Table R402.1.2 Fenestration Requirements By Component

Requirement	2009 IECC	2018 IECC/Lincoln Energy Code
Fenestration U-factor (windows, glass, opaque and swinging doors with <50% glazing)	.35	0.30
Skylight U-factor	.60	0.55

2018 IECC Prescriptive Requirements

 Indicates Change

Requirement	2009 IECC	2018 IECC/Lincoln Energy Code
Eave Baffle	NO REQUIREMENT	For air permeable insulations in vented attics, a baffle shall be installed adjacent to soffit and eave vents. Baffles shall maintain an opening equal or greater size than the vent. The baffle shall extend over the top of the attic insulation. The baffle shall be permitted to be any solid material. (402.2.3)
Hot water pipe insulation	NO REQUIREMENT	Insulated to R-3, $\frac{3}{4}$ or larger pipes with exceptions (403.5.3)

2018 IECC Prescriptive Requirements

 Indicates Change

Requirement	2009 IECC	2018 IECC	Lincoln Energy Code
<p>Duct Testing</p>	<p>(Mandatory) All ducts outside conditioned space are tested to verify duct leakage with a total duct leakage or leakage to the outside test</p> <p><u>Post construction:</u> Leakage to Outdoors: 8 cfm/100 sq. ft. Total Leakage: 12 cfm/100 sq. ft.</p> <p><u>Rough-in:</u> Total Leakage: 6 cfm/100 sq. ft. Exception: Duct tightness test not required if most ducts located entirely within building envelope. (403.2.2)</p>	<p>(Mandatory) All ducts outside conditioned space are tested to verify duct leakage with a total duct leakage or leakage to the outside test</p> <p>(Prescriptive) Ducts tested to the following leakage rates: <u>Post construction:</u> Total Leakage: 4 cfm/100 sq. ft.</p> <p><u>Rough-in:</u> Total Leakage: 4 cfm/100 sq. ft. (403.3.4)</p>	<p>(Mandatory) Same as 2018 IECC</p> <p>Lincoln Exception: Ducts duct air-leakage test shall not be required for ducts that are sprayed with closed cell foam</p> <p>(Prescriptive) Same as 2018 IECC</p>

Other changes in the 2018 IECC

 Indicates Change

Requirement	2009 IECC	2018 IECC/Lincoln Energy Code
Duct Insulation	Supply ducts in attics shall be insulated to a minimum of R-4. <u>Exception:</u> Ducts or portions thereof in conditioned space (403.2.1)	Supply and Return ducts in attics shall be insulated to a minimum of R-6 or R-8 , depending on diameter. All other ducts shall be insulated to a minimum of R-6 or R-4 . <u>Exception:</u> Ducts in conditioned space (403.3.1)
Thermally Isolated sunroom U-factor	Maximum fenestration U-factor shall be 0.50 and maximum skylight U-factor shall be 0.75. (402.3.5)	Maximum fenestration U-factor shall be 0.45 and maximum skylight U-factor shall be 0.70. (402.3.5)
Buried Ducts in Attic	Not referenced	Ducts tested to have a maximum leakage rate of 1.5 cfm ₂₅ /100 sq. ft. to the outside, are insulated with \geq R-8 insulation, and have at least R-19 insulation above and to the sides of the ducts, count as being in conditioned space . (403.3.6)

The Science Behind the Code

- Building science helps create the energy code and its requirements
- Goal: to protect building stability and durability and protect human health
- Next: we'll discuss the science behind moisture management and why it's so important





Performance Testing

Not required but a great benefit!



Poll

- Do you typically perform a blower door test on homes you build/see blower door tests being performed on homes?
 - Yes
 - No
 - Sometimes



Poll

- What is the biggest barrier to blower door testing in Lincoln?
 - Cost
 - Availability of equipment to perform test
 - Availability of qualified professionals to perform test
 - Not requiring it in the code
 - Other



Air Sealing

- Proper building tightness will help:
 - Reduce energy consumption
 - Avoid moisture condensation
 - Avoid uncomfortable drafts caused by cold air leaking in
 - Maximize proper HVAC performance

Blower Door Testing

- Can be performed at final inspection or earlier in construction process
- Depressurizes the home to identify areas of leakage
- Leakage calculated in ACH50
 - Indicates how many times the volume of air that is inside the building changes with the outside air under test conditions
 - 3 ACH50 or lower required by model code

Diagnostic Tools

Testing the airtightness of a home using a special fan called a blower door can help to ensure that air sealing work is effective. Often, energy efficiency incentive programs, such as the DOE/ EPA ENERGY STAR Program, require a blower door test (usually performed in less than an hour) to confirm the tightness of the house.

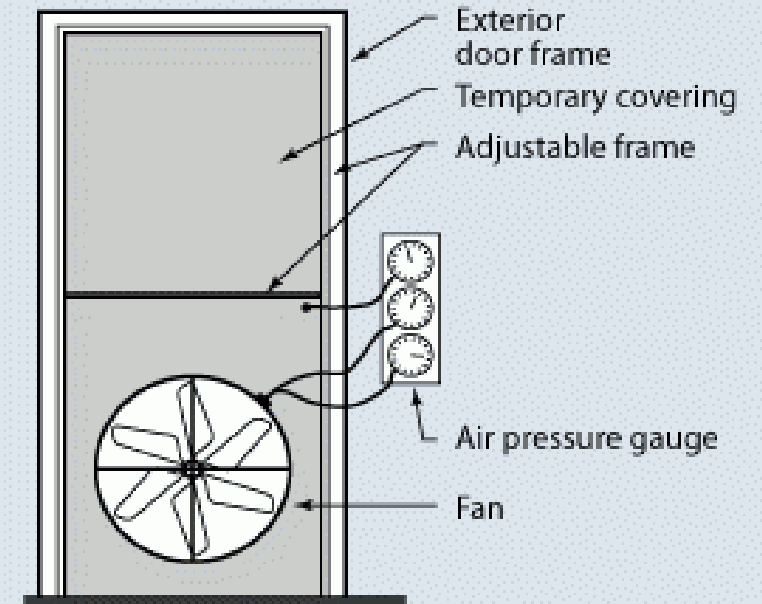


Image: U.S. DOE

Benefits of Blower Door Testing

- Documents and quantifies home's air leakage
- Third party verification (some areas; performed by Inspectors)
- Not required in Lincoln's Energy Code (but still a really good idea!)
 - Provides data needed for understanding ventilation needs, final equipment adjustment and energy use/cost forecast
 - Great liability protection for all involved
 - Improved Home Performance



Image: Green Building Advisor

Air Leakage Report

Date:	May 02, 2012	Rating No.:	81158891-901
Building Name:	123 Main Street	Rating Org.:	Raters USA
Owners Name:	Jane Smith	Phone:	555-555-5555
Property Address:	123 Main Street Omaha, NE 68007	Rater's Name:	John Williams
Builder's Name:	ABC Construction	Rater's No.:	1234567
Weather Site:	Omaha, NE	Rating Type:	Confirmed
File Name:	101682391-097 eSTAR	Rating Date:	12/01/20

AIR LEAKAGE REPORT

Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit	Rating Type:	Confirmed
Weather Site:	Columbia, MO	Rating Date:	12/01/11
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M		

Whole House Infiltration	Blower door test	
	Heating	Cooling
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage	Leakage to Outside Units	Ductwork
CFM @ 25 Pascals:		25
CFM25 / CFMfan:		0.0214
CFM25/CFA:		0.0181
CFM per Std 152:		N/A
CFM per Std 152 / CFA:		N/A
CFM @ 50 Pascals:		39
Eff. Leakage Area: [sq.in]		2.15
Thermal Efficiency:		N/A
Total Duct Leakage Units		CFM25/CFA
Total Duct Leakage:		0.0181

Ventilation	Air Cyclor
Mechanical:	
Sensible Recovery Eff. (%):	0.0
Total Recovery Eff. (%):	0.0
Rate (cfm):	50
Hours/Day:	24.0
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

For this home to comply with ASHRAE Standard 62.2 - 2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 44 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 88 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

REM/Rate - Residential Energy Analysis and Rating Software v12.98

This information does not constitute any warranty of energy cost or savings.
© 1985-2012 Architectural Energy Corporation, Boulder, Colorado.

Air Leakage Report

Whole House Infiltration

	Blower Door Test	
	Heating	Cooling
Natural ACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area (sq. in)	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell (sq. in)	0.96	0.96

AIR LEAKAGE REPORT			
Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit	Rating Type:	Confirmed
Weather Site:	Columbia, MO	Rating Date:	12/01/11
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M		

Whole House Infiltration	Blower door test	
	Heating	Cooling
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage	Leakage to Outside Units	Ductwork
CFM @ 25 Pascals:		25
CFM25 / CFMfan:		0.0214
CFM25/CFA:		0.0181
CFM per Std 152:		N/A
CFM per Std 152 / CFA:		N/A
CFM @ 50 Pascals:		39
Eff. Leakage Area: [sq.in]		2.15
Thermal Efficiency:		N/A
Total Duct Leakage Units		CFM25/CFA
Total Duct Leakage:		0.0181

Ventilation	Air Cyclor
Mechanical:	
Sensible Recovery Eff. (%):	0.0
Total Recovery Eff. (%):	0.0
Rate (cfm):	50
Hours/Day:	24.0
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

For this home to comply with ASHRAE Standard 62.2 - 2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 44 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 88 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

REM/Rate - Residential Energy Analysis and Rating Software v12.98

This information does not constitute any warranty of energy cost or savings.
© 1985-2012 Architectural Energy Corporation, Boulder, Colorado.

Air Leakage Report

Duct Leakage

Leakage to Outside Units	Ductwork
CFM @ 25 Pascals:	25
CFM25/CFM fan:	0.0214
CFM25/CFA:	0.0181
CFM per Std 152:	N/A
CFM per Std 152/CFA:	N/A
CFM @ 50 Pascals:	39
Eff. Leakage Area (sq. in.)	2.15
Thermal Efficiency:	N/A
Total Duct Leakage Units:	CFM25/CFA
Total Duct Leakage:	0.0181

AIR LEAKAGE REPORT			
Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit	Rating Type:	Confirmed
Weather Site:	Columbia, MO	Rating Date:	12/01/11
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M		

Whole House Infiltration	Blower door test	
	Heating	Cooling
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage	Leakage to Outside Units	Ductwork
CFM @ 25 Pascals:	25	
CFM25 / CFMfan:	0.0214	
CFM25/CFA:	0.0181	
CFM per Std 152:	N/A	
CFM per Std 152 / CFA:	N/A	
CFM @ 50 Pascals:	39	
Eff. Leakage Area: [sq.in]	2.15	
Thermal Efficiency:	N/A	
Total Duct Leakage Units	CFM25/CFA	
Total Duct Leakage:	0.0181	

Ventilation	Air Cyclor
Mechanical:	
Sensible Recovery Eff. (%):	0.0
Total Recovery Eff. (%):	0.0
Rate (cfm):	50
Hours/Day:	24.0
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

For this home to comply with ASHRAE Standard 62.2 - 2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 44 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 88 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

REM/Rate - Residential Energy Analysis and Rating Software v12.98

This information does not constitute any warranty of energy cost or savings.
© 1985-2012 Architectural Energy Corporation, Boulder, Colorado.

Air Leakage Report

Ventilation

Mechanical:	Air Cyclcr
Sensible Recovery Eff (%):	0.0
Total Recovery Eff (%):	0.0
Rate (cfm):	50
Hours/Day:	24
Fan Watts:	150.0
Cooling Ventilation:	Natural Ventilation

AIR LEAKAGE REPORT			
Date:	May 02, 2012	Rating No.:	8016891 - 097
Building Name:	802EastMcCartyStreet	Rating Org.:	ASERusa
Owner's Name:	River City Habitat for Humanit	Phone No.:	314-894-2300
Property:	802 East McCarty Street	Rater's Name:	Gary Fries
Address:	Jefferson City, MO 65101	Rater's No.:	8016891
Builder's Name:	River City Habitat for Humanit	Rating Type:	Confirmed
Weather Site:	Columbia, MO	Rating Date:	12/01/11
File Name:	8016891 - 097 - eSTAR 2.0, TC, NR - 802 East M		

Whole House Infiltration	Blower door test	
	Heating	Cooling
NaturalACH:	0.23	0.16
ACH @ 50 Pascals:	3.78	3.78
CFM @ 25 Pascals:	427	427
CFM @ 50 Pascals:	670	670
Eff. Leakage Area: [sq.in]	36.8	36.8
Specific Leakage Area:	0.00018	0.00018
ELA/100 sf shell: [sq.in]	0.96	0.96

Duct Leakage	Leakage to Outside Units	Ductwork
CFM @ 25 Pascals:		25
CFM25 / CFMfan:		0.0214
CFM25/CFA:		0.0181
CFM per Std 152:		N/A
CFM per Std 152 / CFA:		N/A
CFM @ 50 Pascals:		39
Eff. Leakage Area: [sq.in]		2.15
Thermal Efficiency:		N/A
Total Duct Leakage Units		CFM25/CFA
Total Duct Leakage:		0.0181

Ventilation	Mechanical:	Air Cyclcr
Sensible Recovery Eff. (%):		0.0
Total Recovery Eff. (%):		0.0
Rate (cfm):		50
Hours/Day:		24.0
Fan Watts:		150.0
Cooling Ventilation:		Natural Ventilation

ASHRAE 62.2 - 2010 Ventilation Requirements

For this home to comply with ASHRAE Standard 62.2 - 2010 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, a minimum of 44 cfm of mechanical ventilation must be provided continuously, 24 hours per day. Alternatively, an intermittently operating mechanical ventilation system may be used if the ventilation rate is adjusted accordingly. For example, a 88 cfm mechanical ventilation system would need to operate 12 hours per day, as long as the system operates to provide required average ventilation once each hour.

REM/Rate - Residential Energy Analysis and Rating Software v12.98

This information does not constitute any warranty of energy cost or savings.
© 1985-2012 Architectural Energy Corporation, Boulder, Colorado.



Ventilation





Poll

- Do you typically install mechanical ventilation in homes you build/do you see mechanical ventilation installed in homes in NE?
 - Yes, but only bath fans
 - Yes, whole-house mechanical ventilation (exhaust system, supply system, balanced system)
 - No ventilation installed
 - Other (put in chat)

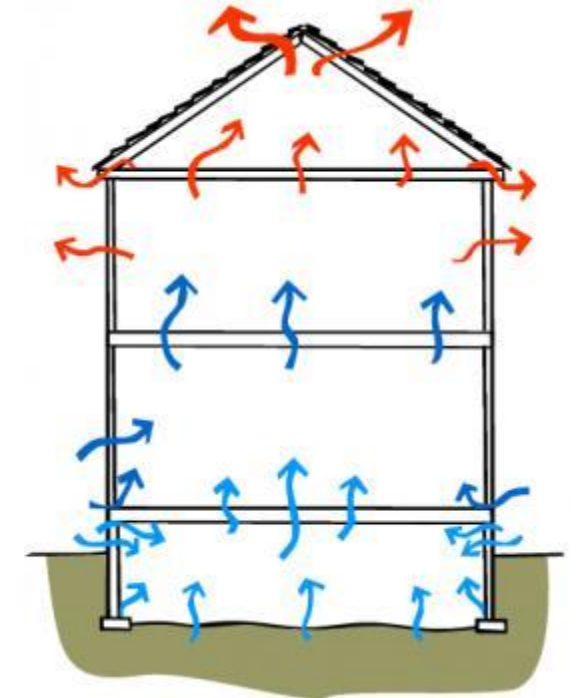


Poll

- What are the barriers to installing mechanical ventilation systems in NE homes?
 - Cost
 - Mechanical ventilation is not required in the code
 - Not knowing where to start
 - Other (put in chat)

Natural Ventilation

- Historically, homes relied on a leaky envelope to provide fresh air
- No control over where fresh air is coming from
 - Make up air comes from unknown sources
- Tighter buildings might not be able to provide enough make up air
 - Backdrafting of atmospherically vented appliances
 - Increased spread of pollutants



Source: build.com.au

Under-ventilated Homes

- Studies have found that improper ventilation causes increased moisture and mold in homes
 - Excess moisture can also damage structural components
- Inadequate ventilation can lead to higher concentrations of moisture and indoor air pollutants (and health issues)
 - Can lead to asthma, allergies, and other respiratory issues
 - More serious diseases like cancer and COPD can be caused by exposure to radon and other pollutants



Source: marthastewart.com

Ventilation and Air Sealing

- Both natural and mechanical ventilation provide fresh air that can dilute and remove indoor pollutant levels
- Per the model IMC/IRC, mechanical ventilation is required when homes are <5 ACH 50
 - Need to do a blower door test to determine leakage rate
 - **Liability concerns when not performed**
- A blower door test measures a building's existing air leakage
- Can not design a code compliant system without knowing air leakage



Source: AC Tool Supply, Inc.

Mechanical Ventilation

- Mechanical ventilation systems circulate fresh air using ducts and fans, rather than relying on airflow through holes or cracks in a home's walls, roof, or floors
 - You don't know where uncontrolled ventilation draws air from
 - Exhaust fans often do not provide rated / code ventilation post installation – air flow should be tested
- ASHRAE 62.2
 - Establishes ventilation and indoor air quality (IAQ) rates in residential buildings (Low rise)
 - Provides criteria for exhaust fans & spot ventilation
 - Minimum Standard!
- **Best Practice: “Build it Tight and Ventilate Right!”**

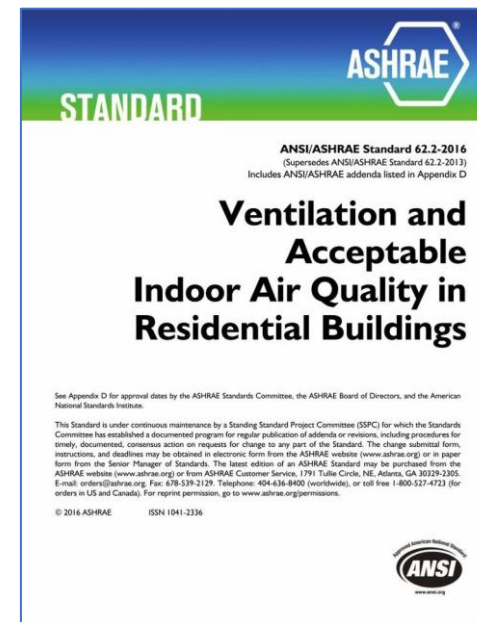


Image:ashrae.org

Ventilation Rate in CFM
(0.01 x total square foot area of house) + [7.5 x (number of bedrooms +1)]





Balanced Ventilation

- Blows air into and out of the house
- Is cost effective by reclaiming energy from exhaust and supply airflows (60%-80%!)
- Balances exhaust and supply flows (minimizes pressure differential)
- Maintains the Minimum Ventilation Guideline automatically with proper set-up



Any questions?





Moisture Management

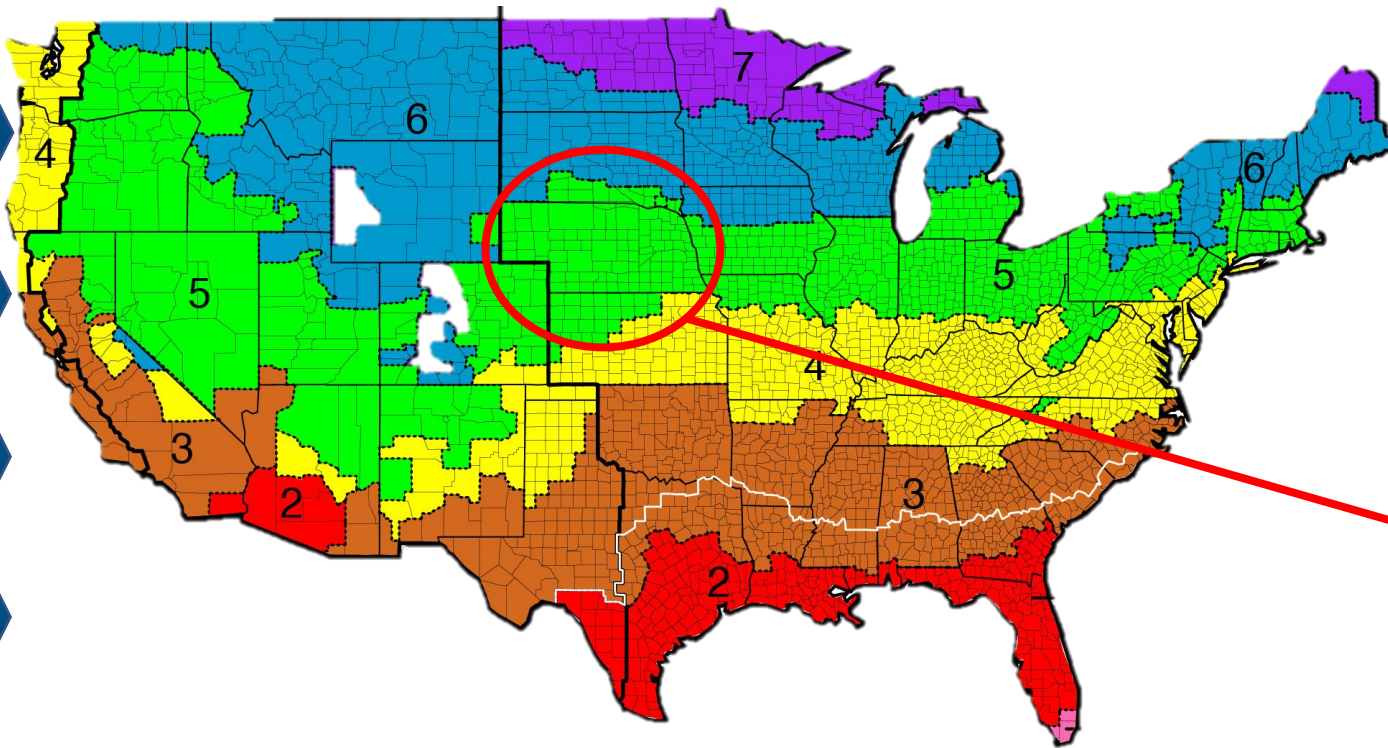
It Connects EVERYTHING!



The Major “Damage Functions”

- Liquid water (bulk and capillary)
- Air-borne water
- Vapor
- Radiation (UV degradation)
- Pests
- People

Climate Zones



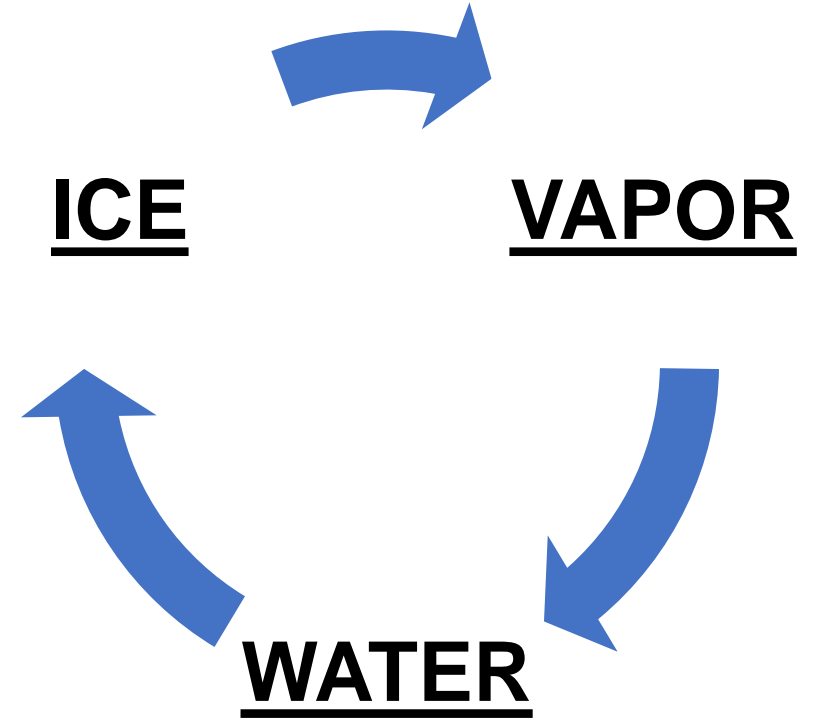
- Nebraska has only one climate zone – 5A
- Cold & Moist climate

Image: International Code Council



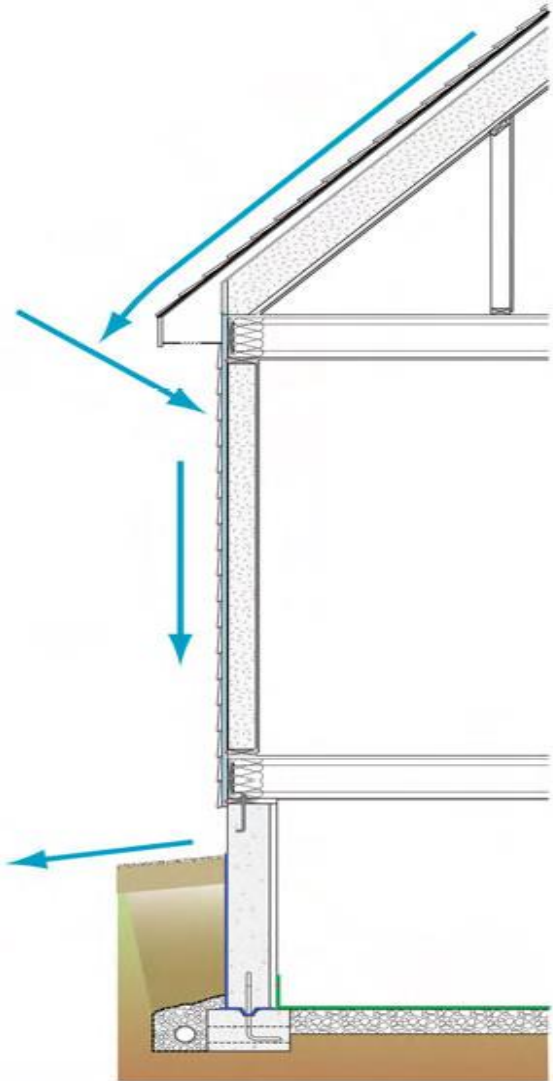
Prioritizing Moisture Movement

- #1 – Bulk Water
- #2 – Capillary Water
- #3 – Air-Transported Moisture
- #4 – Diffusive Moisture Movement



Bulk Water Management – Priority #1

The key is proper drainage!



Always Allow For Drying

Exterior Conditions

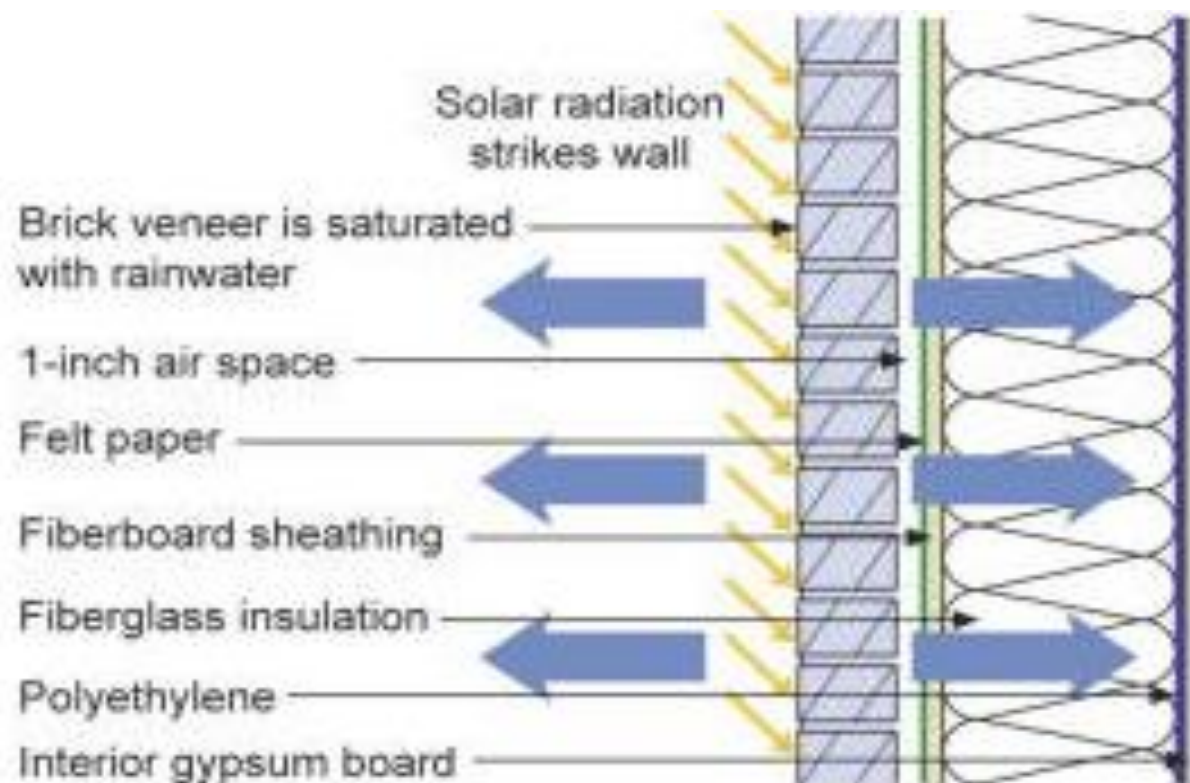
Temperature: 80° F
Relative Humidity: 75%
Vapor Pressure: 2.49 kPa

Conditions Within Cavity

Temperature: 120° F
Relative Humidity: 100%
Vapor Pressure: 11.74 kPa

Interior Conditions

Temperature: 75° F
Relative Humidity: 60%
Vapor Pressure: 1.82 kPa



Vapor is driven both inward and outward by a high vapor pressure differential between the brick and interior and the brick and exterior



Properly Lap Flashing

- The mason's flashing (black) was installed after and in front of the house wrap (green). This is reverse flashing that will trap any drain water that gets past the brick veneer.



Image: Verdatek Solutions

Direct Water Away From Corners



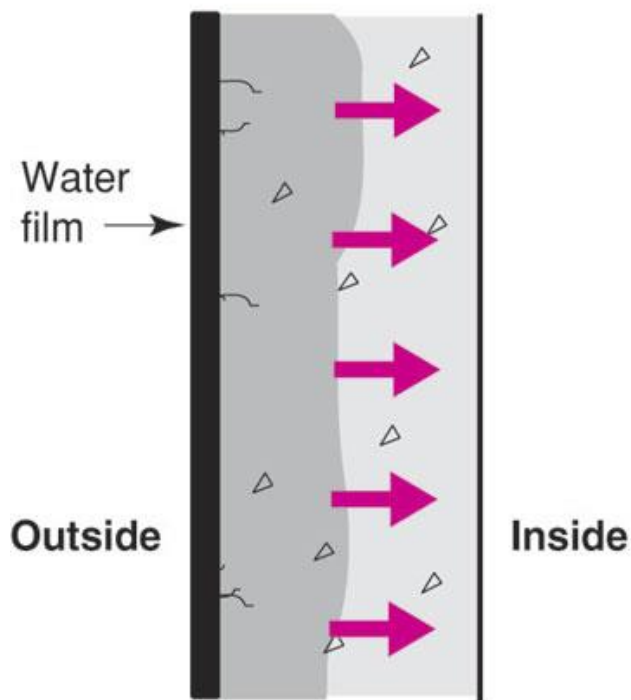
Image: Verdatek Solutions



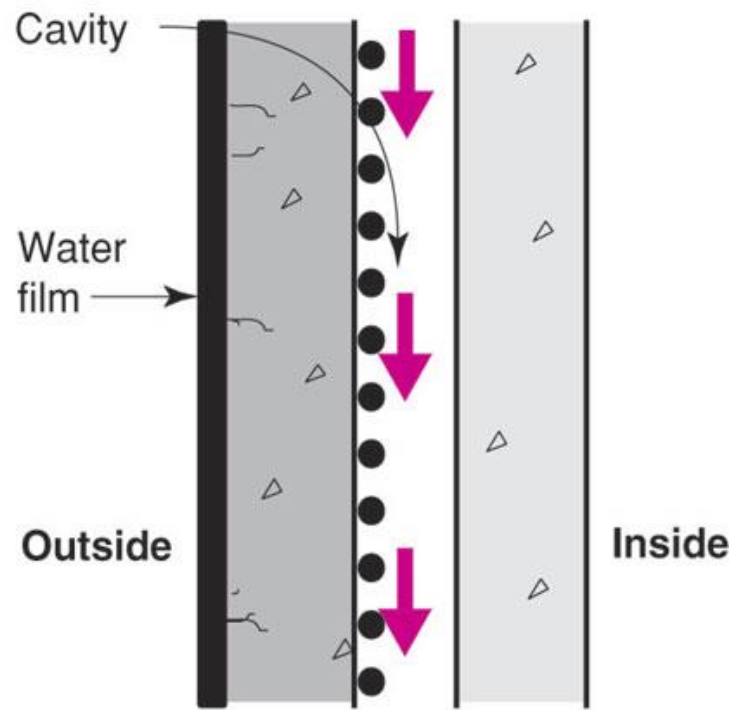
Image: Verdatek Solutions



Capillary Moisture Flows - Priority #2



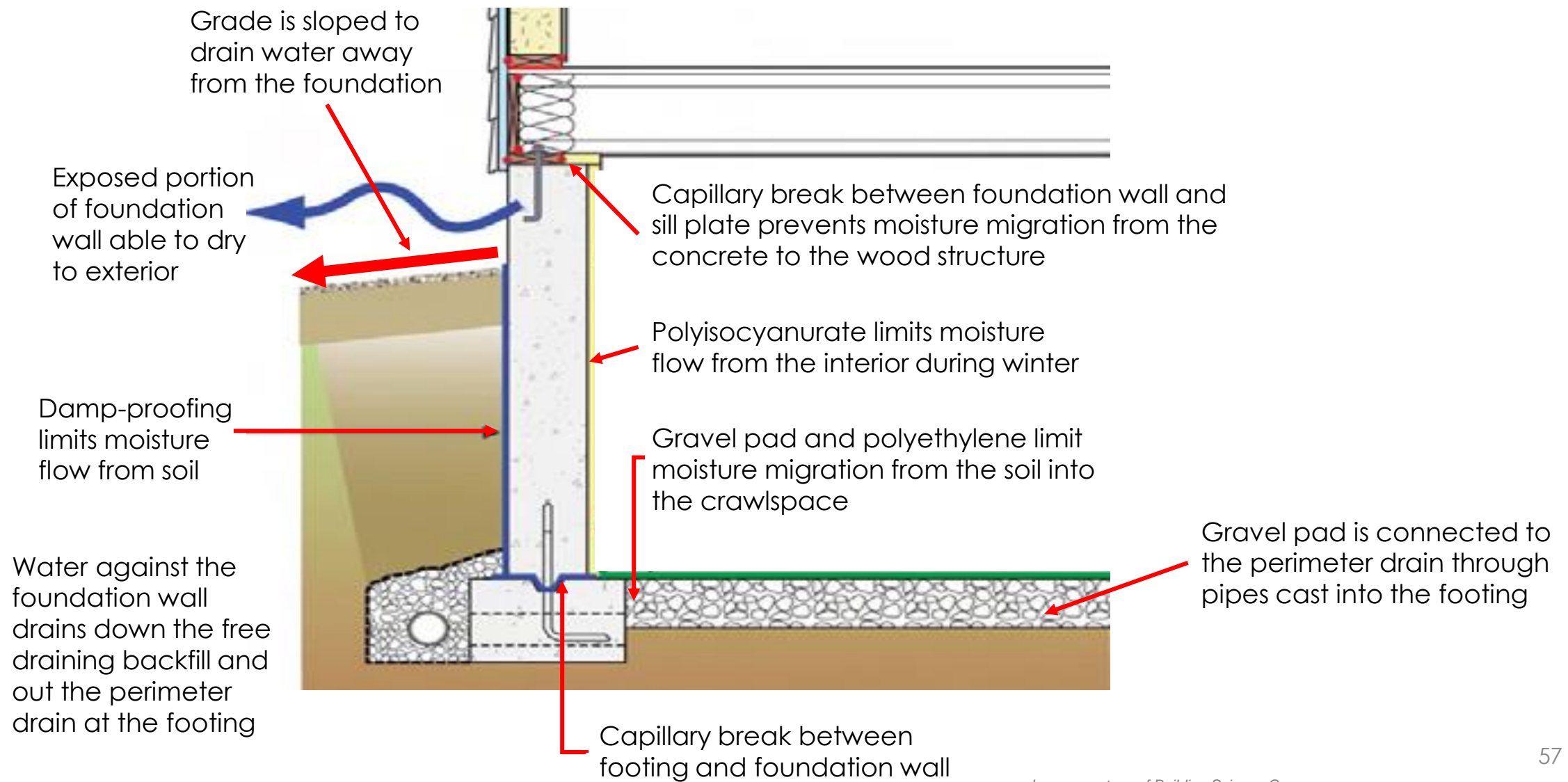
Capillary suction draws water into porous material and tiny cracks



Cavity acts as capillary break and receptor for capillary water interrupting flow

Image courtesy of Building Science Corp.

Foundation Moisture Management



Sill Plates Need Capillary Breaks



Air Transport of Moisture – Priority #3

- Air carries a **lot** of water
- Air leakage
 - Moisture flow
 - 4X8 Drywall
 - 70 F
 - 40% RH
 - 1 square inch hole
- Flow quantity
 - 30 Quarts of water!!

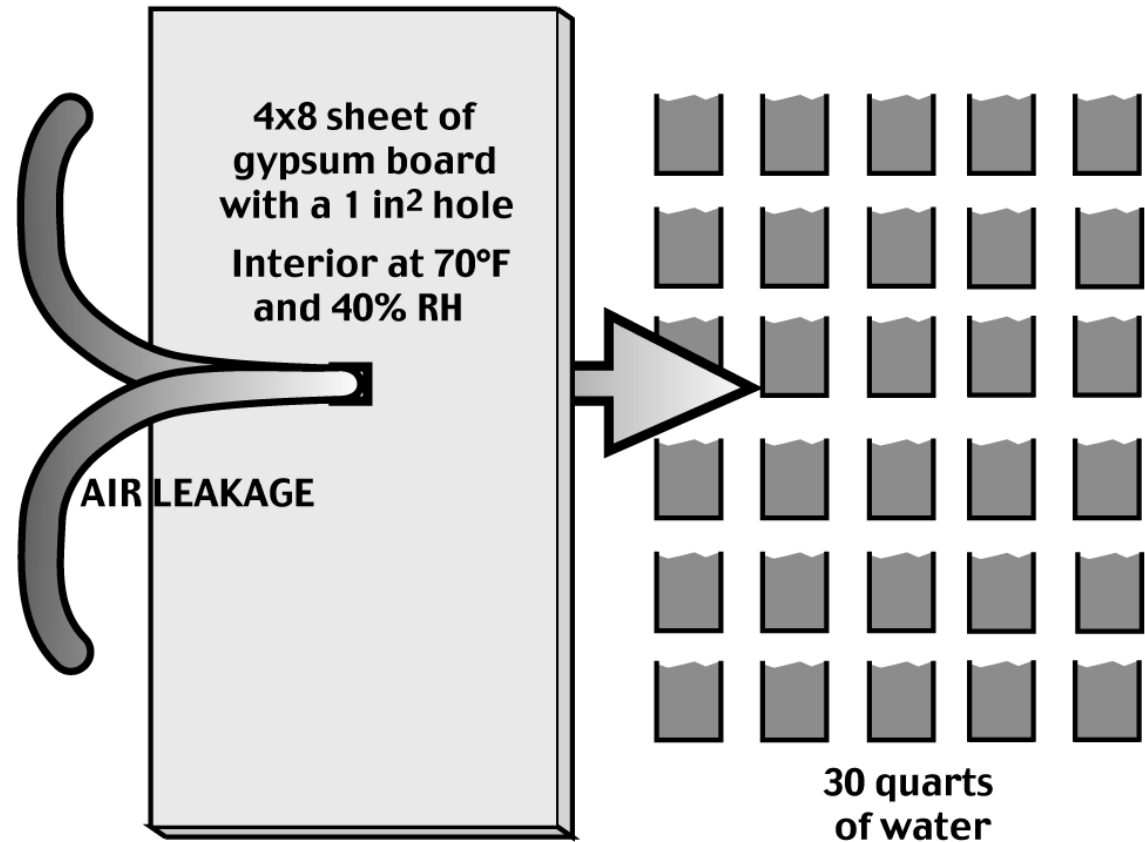


Image courtesy of Building Science Corp.

Diffusion – Priority #4

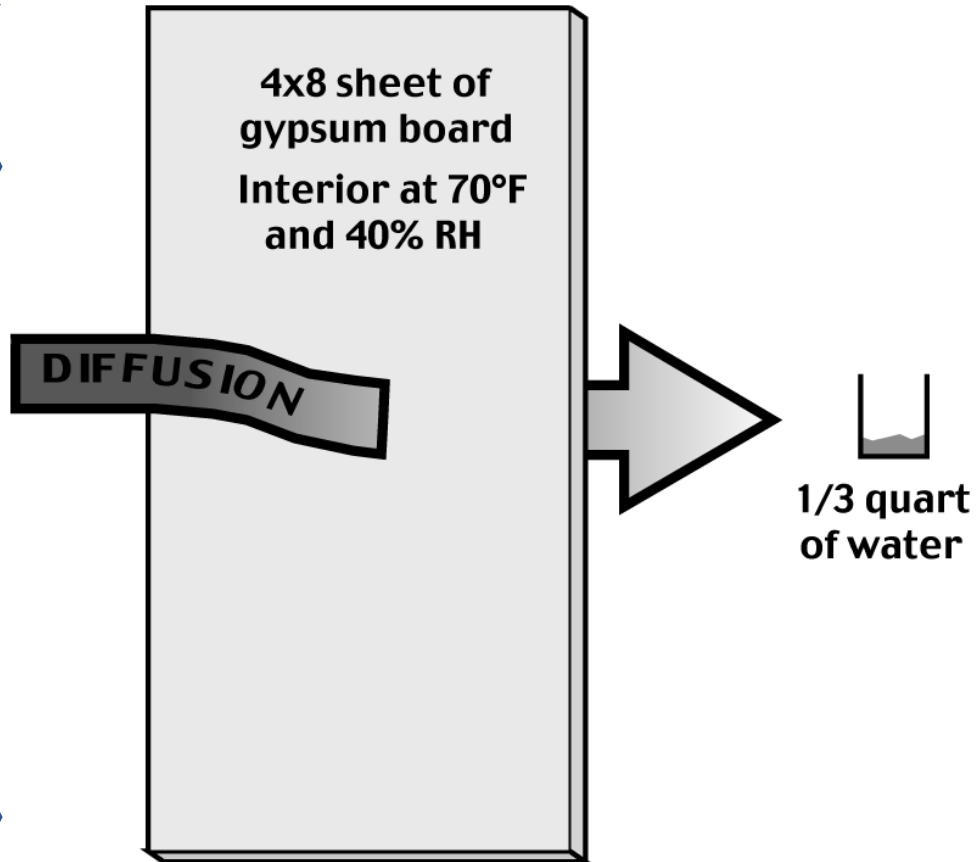


Image courtesy of Building Science Corp.

- Migration of moisture by means of vapor pressure differential
- Occurs in either direction based on climate conditions and exterior/interior levels of humidity
- Different building materials have different permeability



Air Movement

Air Movement Seeks Balance

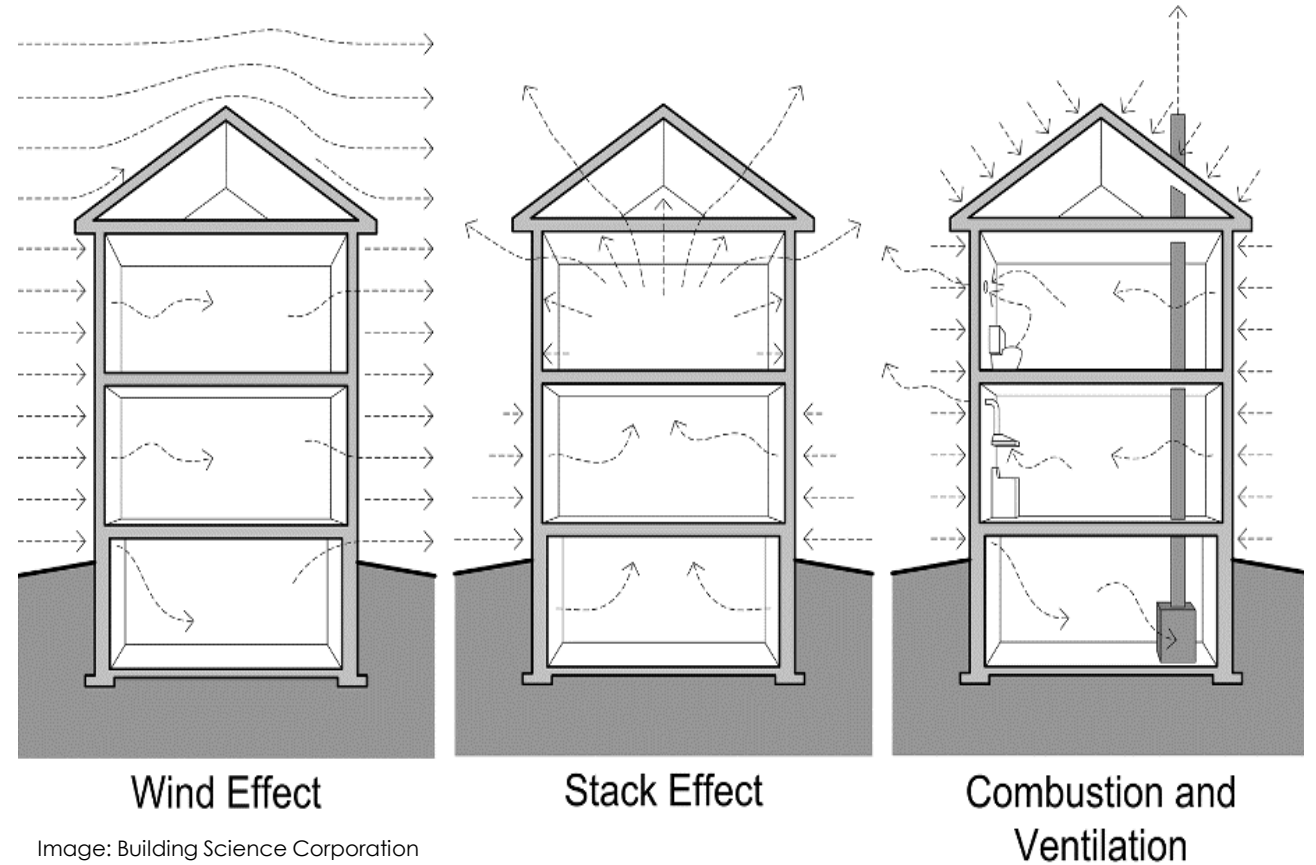


How Does Air Get Around?

Air In = Air Out

For air movement you need:

- A hole
- A driving force
- Another hole



Internally Generated Air Pressure

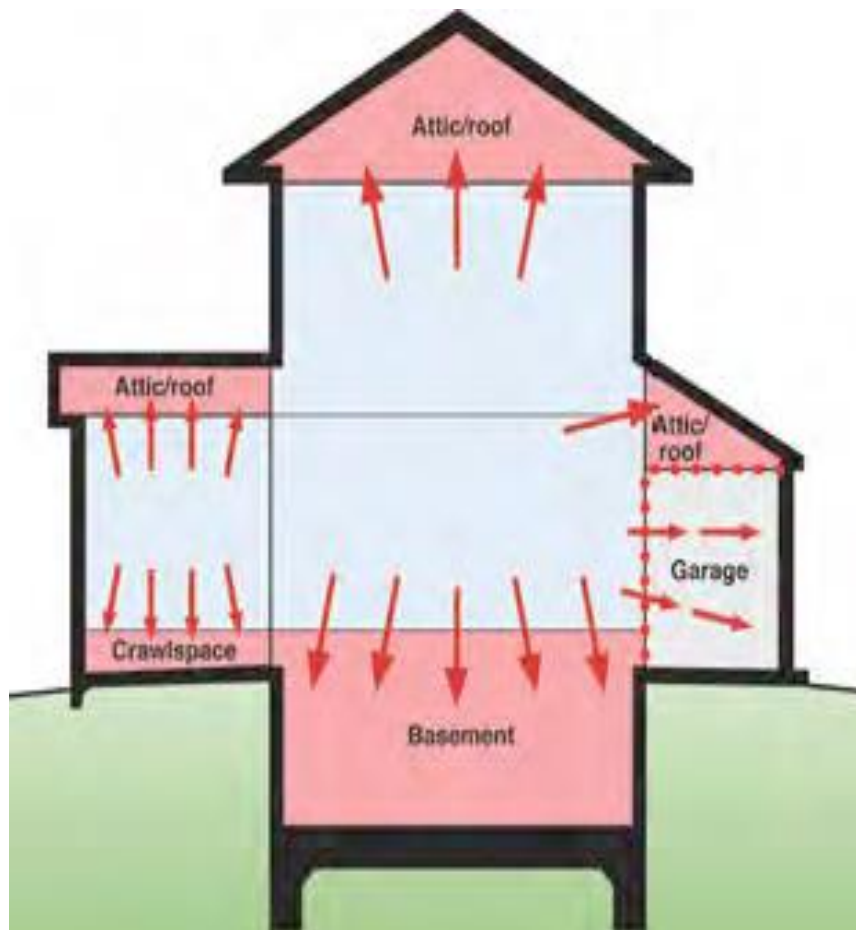


Image by Belcher Homes

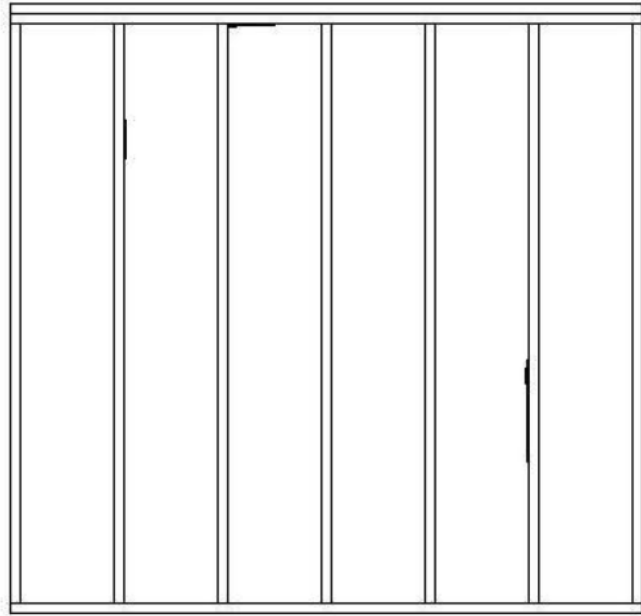
Expansion of Conditioned Space

- Conditioned space boundaries moving towards exterior surfaces of building
- Garage isolated from house by air barrier/pressure boundary
- Garage ventilated and conditioned independently of rest of conditioned spaces

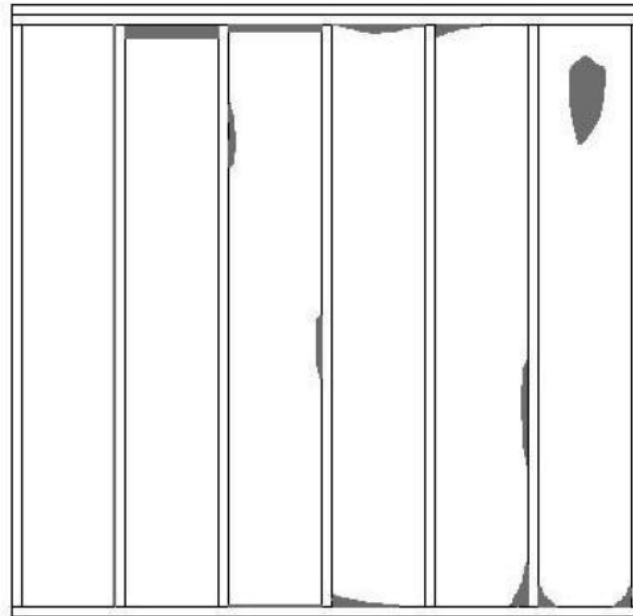
Batt Insulation Grading

Code Compliant

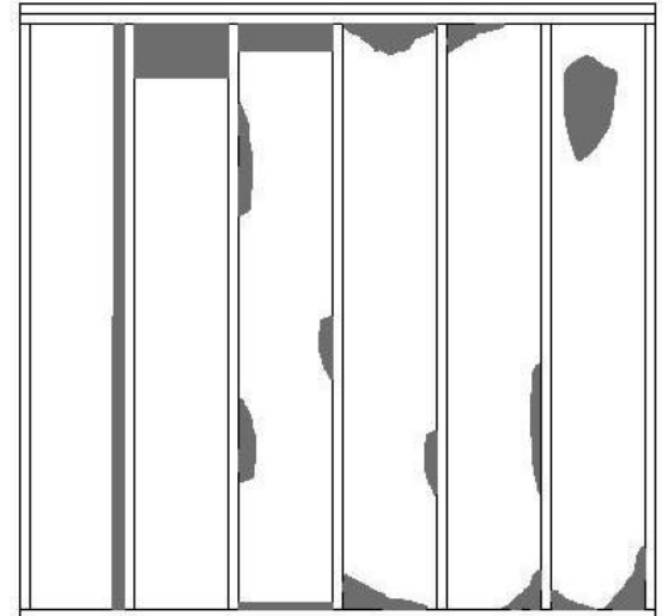
Not Acceptable



Grade I: Almost no gaps



Grade II: Up to 2%



Grade III: 2% - 5%

RESNET protocol for the effect of missing insulation on installation grade

Diagrams from the HERS Standards



Heat Transfer

A Triple Threat



Heat Transfers in 3 Ways

- **Convection** - Through fluids (liquid or gas)
- **Conduction** - Through solids
- **Radiation** - Mostly windows

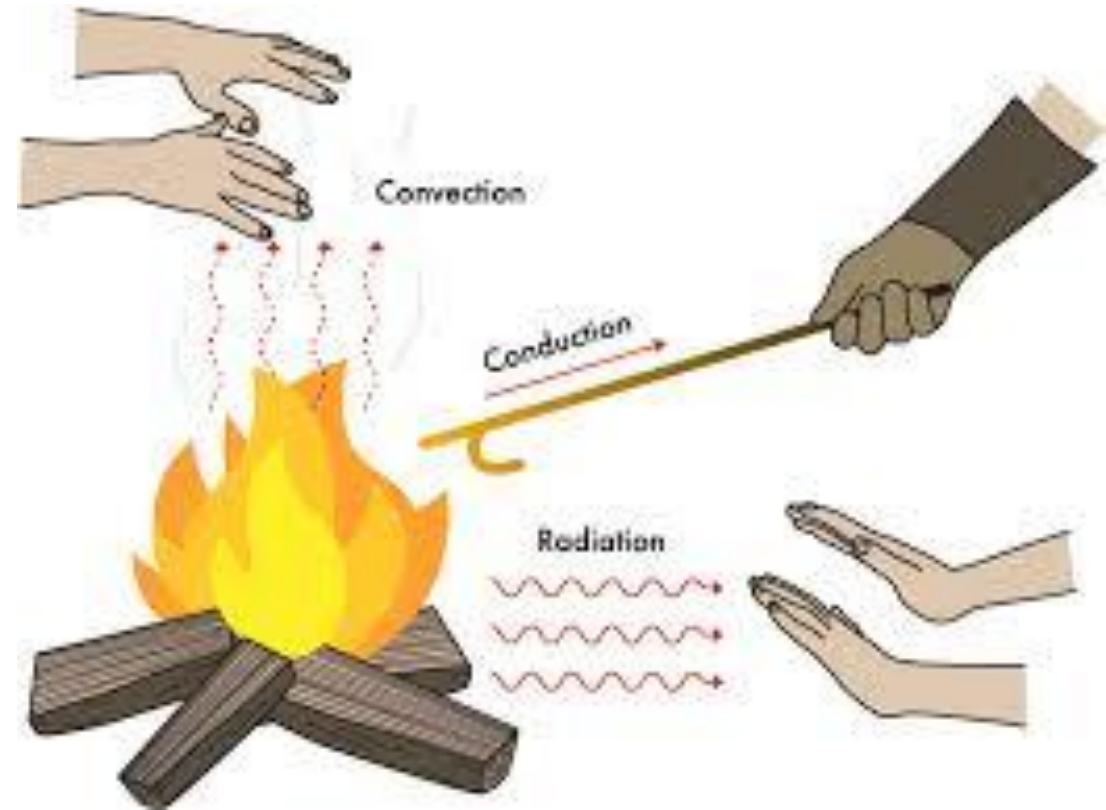
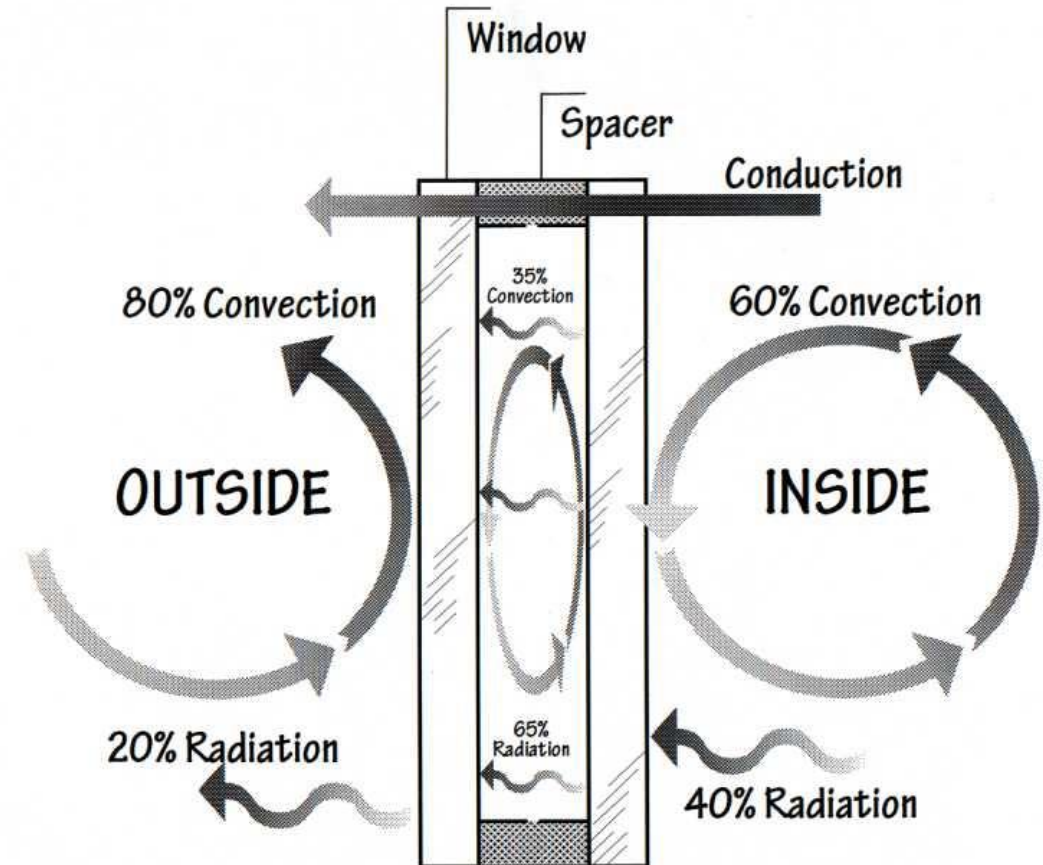


Image: Building Design and Construction

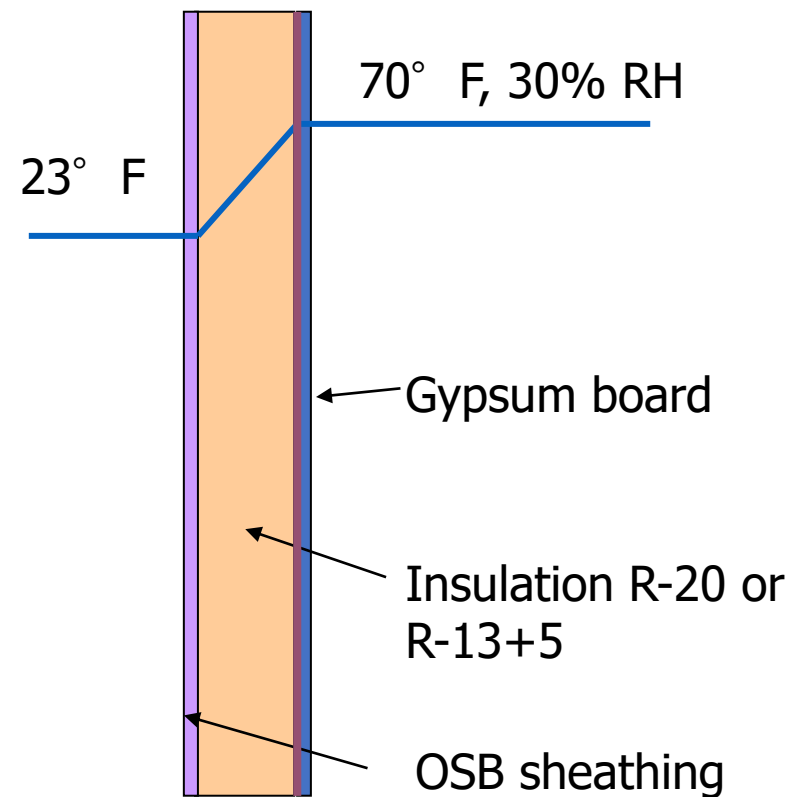
Practical Application - Windows

- Heat always moves from hot to cold
- Always a mix of transfers
- Different rates of transfer can be important



Condensing Surface Temperatures

- Dewpoint of interior air = 37°F
- Where will condensation occur?
Inside surface of exterior sheathing
- One Solution?
Interior vapor retarder, but what type and at what “cost?”





Major Building Envelope Protection Systems

- Water Barrier
- Air Barrier
- Thermal Barrier
- Vapor Profile (not just the designated vapor retarder)
- Maintenance documents

“You don’t get what you expect, you get what you inspect!”



Image: Verdatek Solutions



HVAC System

Don't Forget the "V"



HVAC Design and Loads

Oversized systems:

- Less comfort
- Less efficient
- Poorly handles moisture
- Premature equipment failure

Right-sized systems:

- Better operating efficiencies
- Greater comfort
- Healthier indoor environments
- Better moisture control

HVAC Design and Loads

- Properly designed HVAC systems rely on scientific criteria and a systematic method to match the loads required for health and comfort:
 - *ACCA Manual J – Residential Load Calculation*
 - *ACCA Manual S – Residential Equipment Selection*
 - *ACCA Manual D – Residential Duct Systems*
- Reports should be submitted with permit application





HVAC Design and Loads

Today's homes risk health problems for occupants because:

- They are not properly ventilated:
 - Mechanical ventilation recommended at ≤ 5 ACH
- More chemicals and products are used in and around a house:
 - Concentration levels are often 2 to 100 times higher than outside.

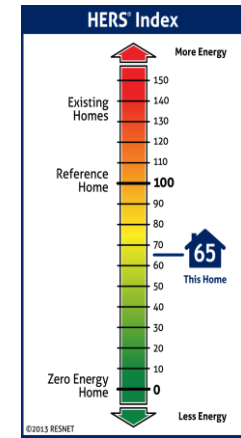


Appraisals and Resale Value



Green Appraisers

- Unlike granite countertops, energy efficiency investments are not always visible at a glance
- Utilize certifications, labels, ratings, and scores
- Make sure appraisers are accurately valuing sustainable properties
 - *Residential Green and Energy Efficient Addendum* - Assists appraisers in analyzing residential “Green” features and properties.



Residential Green and Energy Efficient Addendum!

- Resources for realtors and appraisers on properly valuing energy efficiency/green features
 - Educational materials
 - List of designated appraisers
 - Trainings
- For more information: http://www.appraisalinstitute.org/education/green_energy_addendum.aspx

Client File #:		Appraisal File #:	
Residential Green and Energy Efficient Addendum			
Client:			
Subject Property:			
City:	State:	Zip:	
Additional resources to aid in the valuation of green properties and the completion of this form can be found at http://www.appraisalinstitute.org/education/green_energy_addendum.aspx			
<p>The appraiser hereby certifies that the information provided within this addendum:</p> <ul style="list-style-type: none"> has been considered in the appraiser's development of the appraisal of the subject property only for the client and intended user(s) identified in the appraisal report and only for the intended use stated in the report. is not provided by the appraiser for any other purpose and should not be relied upon by parties other than those identified by the appraiser as the client or intended user(s) in the report. is the result of the appraiser's routine inspection of and inquiries about the subject property's green and energy efficient features. Extraordinary assumption: Data provided herein is assumed to be accurate and if found to be in error could alter the appraiser's opinions or conclusions. is not made as a representation or as a warranty as to the efficiency, quality, function, operability, reliability or cost savings of the reported items or of the subject property in general, and this addendum should not be relied upon for such assessments. <p>Green Building: The practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's lifecycle from siting to design, construction, operation, maintenance, renovation, and deconstruction. This practice expands and complements the classic building design concerns of economy, utility, durability, and comfort (US EPA). High Performance building and green building are often used interchangeably.</p> <p>Six Elements of Green Building: A green building has attributes that fall into the six elements of green building known as (1) site, (2) water, (3) energy, (4) materials, (5) indoor environmental quality, and (6) maintenance and operation. The energy and water elements are the most measurable elements of green or high performance housing. Appraisers need savings amounts to develop an income approach to support energy efficient contributory value.</p>			
THIRD-PARTY VERIFICATIONS (See types defined in glossary)			
The following verified items are classified within the appraisal analysis of the subject property:			
Green Certification		<input type="checkbox"/> Environmental Protection Agency (EPA) <input type="checkbox"/> Indoor AIRPLUS <input type="checkbox"/> WaterSense <input type="checkbox"/> ENERGY STAR <input type="checkbox"/> Energy Department (DOE) <input type="checkbox"/> Zero Energy Ready Home (ZERH)	
Certifications attest that the home meets version minimum thresholds:		Home Innovation Research Labs (HIRL) New Home Remodel: <input type="checkbox"/> Bronze <input type="checkbox"/> Silver <input type="checkbox"/> Gold <input type="checkbox"/> Emerald Home Innovation Research Labs (HIRL) New Home: <input type="checkbox"/> Bronze <input type="checkbox"/> Silver <input type="checkbox"/> Gold <input type="checkbox"/> Emerald LEED Building Challenge (LEED): <input type="checkbox"/> LEED Platinum Certified <input type="checkbox"/> LEED Platinum <input type="checkbox"/> LEED Gold Certified <input type="checkbox"/> LEED Gold <input type="checkbox"/> LEED Silver Certified <input type="checkbox"/> LEED Silver <input type="checkbox"/> LEED Gold <input type="checkbox"/> LEED Platinum Passive House Institute US: <input type="checkbox"/> PHUS 2013 USGBC LEED: <input type="checkbox"/> Certified <input type="checkbox"/> Silver <input type="checkbox"/> Gold <input type="checkbox"/> Platinum Other: _____	
Date Verified: / /		Green Certification Version: _____ Organization URL: _____ ABOVE VALID ONLY IF CHECKED: <input type="checkbox"/> Verification reviewed on site <input type="checkbox"/> Verification attached to this report	
Energy Label Labels disclose the state the home's energy assets.		RESNET's HERG Rating (0 to 150): _____ Estimated energy savings for this home: \$ _____/year _____ kWh rate dated / / <input type="checkbox"/> Sampling Rating Energy Savings includes electricity, heating & Cooling. Score below 100 indicates energy costs are expected to be lower than average local code home per square foot. HERG index Report estimates energy cost based on number of bedrooms plus one. Only a "confirmed rating" is a diagnostic test. <input type="checkbox"/> Projected Rating <input type="checkbox"/> Confirmed Rating DOE's Home Energy Score Score (1 to 10): _____ Estimated energy savings for this home: \$ _____/year _____ kWh rate dated / / <input type="checkbox"/> Official Score Energy Savings includes electricity, heating & Cooling. Score above 5 indicates energy costs are expected to be lower than average local code home. Home Energy Score estimates energy cost based on state average energy rates and the home's energy features. <input type="checkbox"/> Unofficial Score Other Energy Score: _____ Estimated energy savings: \$ _____/year _____ kWh rate dated / / Range (_____ to _____) Describe energy label system: _____	
Date Verified: / /		Score or Rating Version: _____ Organization URL: <input type="checkbox"/> www.resnet.org <input type="checkbox"/> www.homeenergyscore.gov <input type="checkbox"/> Other: _____ ABOVE VALID ONLY IF CHECKED: <input type="checkbox"/> Verification reviewed on site <input type="checkbox"/> Verification attached to this report	
Verified Energy Improvements Explain energy-related improvements. Cost of improvements: \$ _____		Date Verified: / / Certificate of Efficiency Improvements Version: _____ Organization URL: <input type="checkbox"/> www.eenergy.com <input type="checkbox"/> Other: _____ <input type="checkbox"/> energy.com <input type="checkbox"/> www.eenergy.com ABOVE VALID ONLY IF CHECKED: <input type="checkbox"/> Verification reviewed on site <input type="checkbox"/> Verification attached to this report	
Only include improvements with verified documentation.		Completed by: _____ Title: _____ Date: _____	

*NOTICE: The Appraisal Institute publishes this form for use by appraisers where the appraiser deems use of the form appropriate. Depending on the assignment, the appraiser may need to provide additional data, analysis and work product not called for in this form. The Appraisal Institute makes no representations, warranties or guarantees as to, and assumes no responsibility for, the data, analysis or work product provided by the individual appraiser in the specific contents of the Appraisal Institute's "AI Reports" AI-820.04 Residential Green and Energy Efficient Addendum Appraisal Institute 2012. All Rights Reserved. November 2010



Form 820.04





Marketing High Performance homes



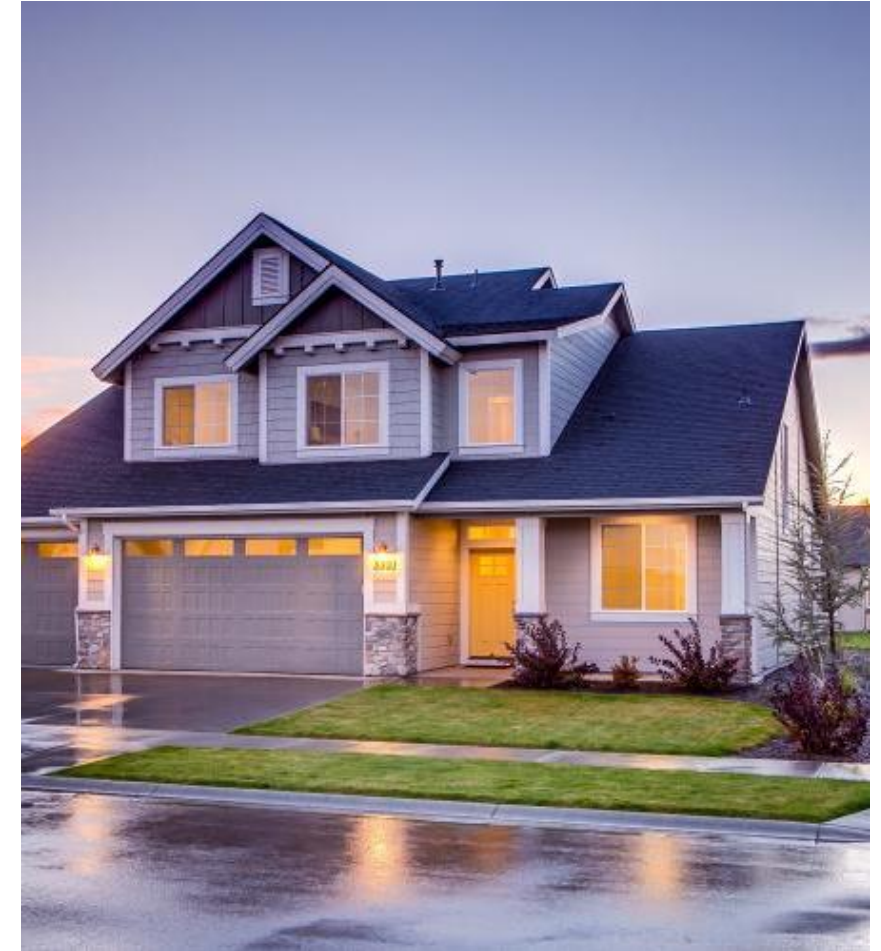


High Performance Homes

- High-performing homes cost less to heat and cool, are more comfortable, and are healthier for their occupants.
- 69% of real estate agents said promoting energy efficiency in listings was very or somewhat valuable
- Immediate benefits – energy savings, comfort, and health
- Long term-benefits – higher selling price

Energy Efficiency is a Must-Have for Home Buyers

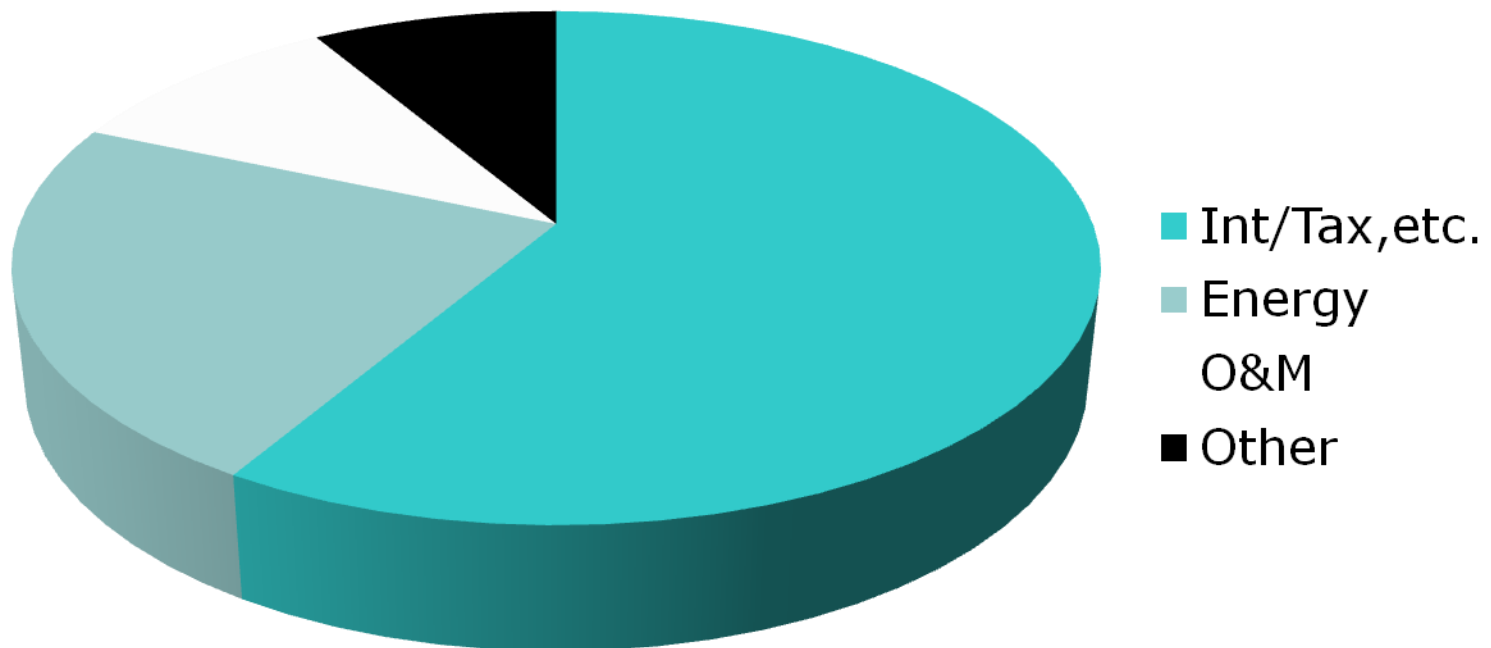
- A survey done by the NAHB in 2018 showed 46% of builders reported that **marketing green homes was easier** than marketing non-green homes
- Energy efficient homes also **keep residents in their homes longer** and **sell more quickly** than non-energy efficient homes.
- Green certified homes have a **higher market value** than less efficient homes
- The odds of **mortgage default are also one-third less** for ENERGY STAR rated homes





Equity!

Cost



Key Takeaways

- Lincoln's new energy requirements include changes to:
 - Air sealing
 - Duct sealing
 - U-Factor
 - R-Values
- Controlling moisture is *critical*
 - Proper air sealing **and testing** is key to improving indoor air quality and other stuff
 - Right-sizing HVAC is required
 - Mechanical ventilation must be installed and takes on new importance

Continuing Education Credits

- Participants of this training are eligible for continuing education credits from the International Code Council
- Course ID: 28696
- CEUs: 0.2
- Certificates will be emailed to attendees. Contact Karin Gredvig (kgredvig@mwalliance.org) with questions.



Upcoming Trainings

July 2021

- July 13 - *Residential Air Sealing Principles and Ventilation Strategies*
- July 28 - *Nebraska's Commercial Energy Code: An Introduction to the 2018 IECC*

September 2021

- September 7 - *Nebraska's Residential Energy Code: An Introduction to the 2018 IECC*
- September 30 - *Commercial Building Envelope Fundamentals*

For more information and to register, visit:

<https://www.mwalliance.org/nebraska-energy-codes-training-program>





Thank you!

Questions?

Matt Belcher, Verdatek Solutions

matt@verda-solutions.com

Nicole Westfall, Midwest Energy Efficiency Alliance

nwestfall@mwalliance.org

