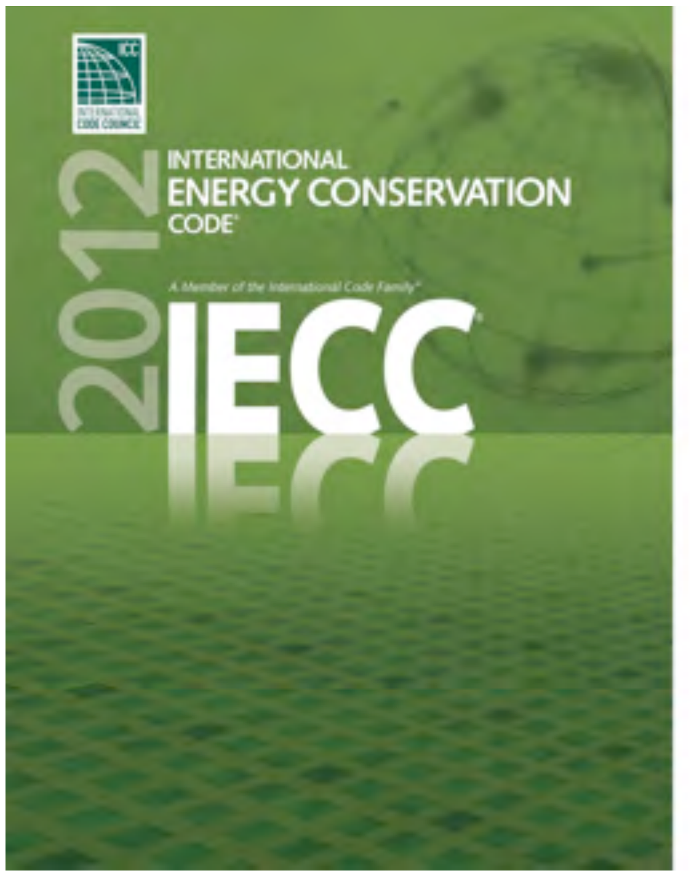
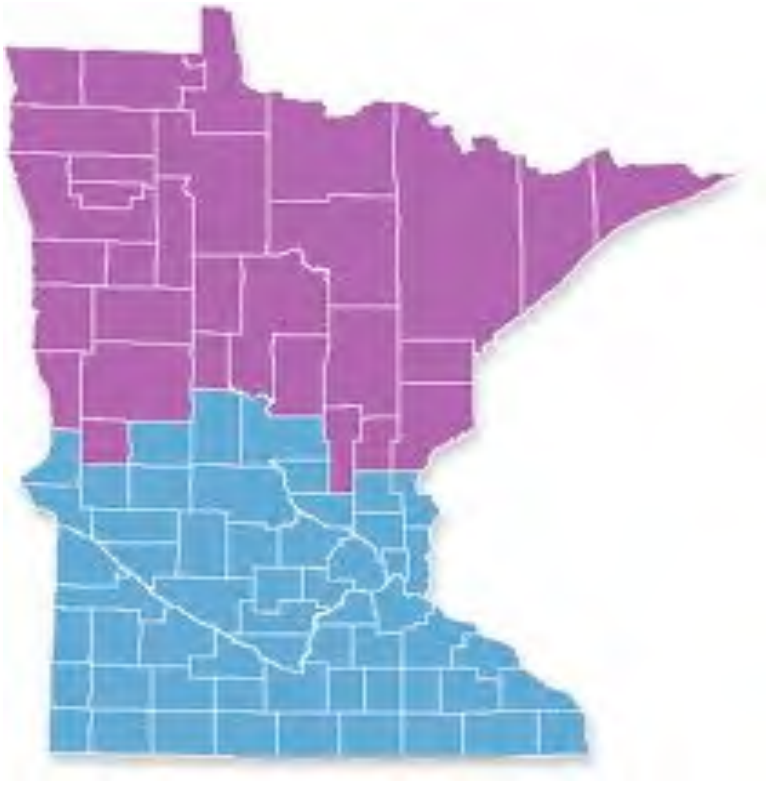
BUILDING KNOWLEDGE

We are a leading training and consulting firm that uses a building science based systems approach to help our clients improve their businesses by Building Better Homes™.

We serve as a resource for the nation's leading energy efficient and green certification programs providing technical, marketing and verification support to developers, builders, contractors, architects and industry professionals.

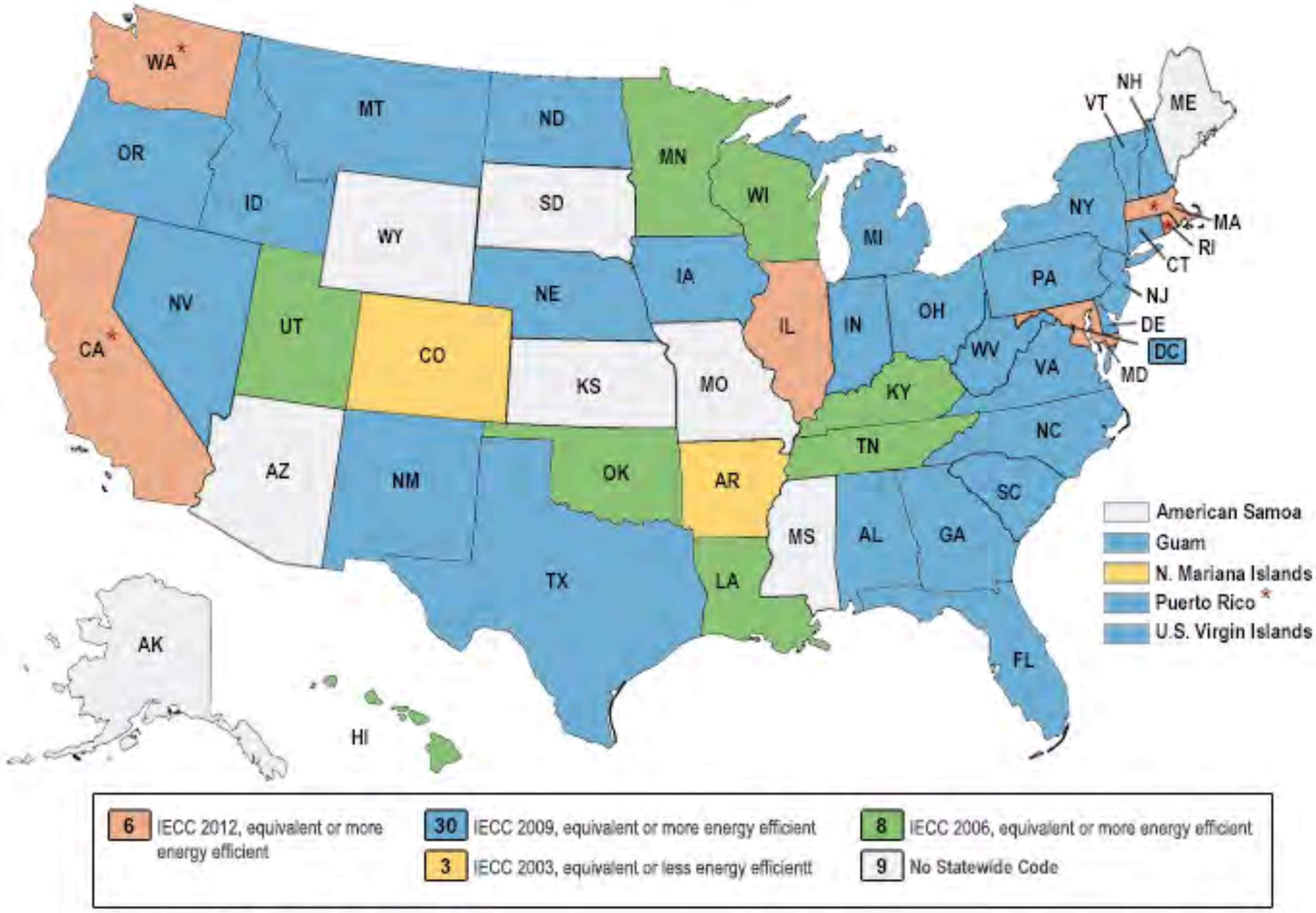
Top 12 2012 Energy Code Changes





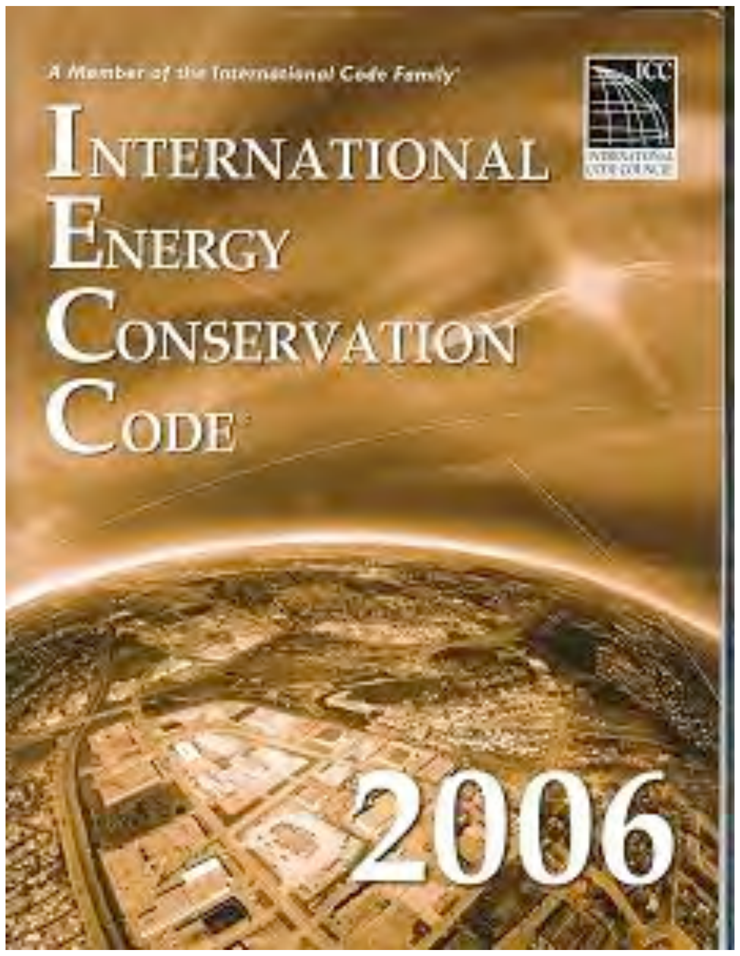
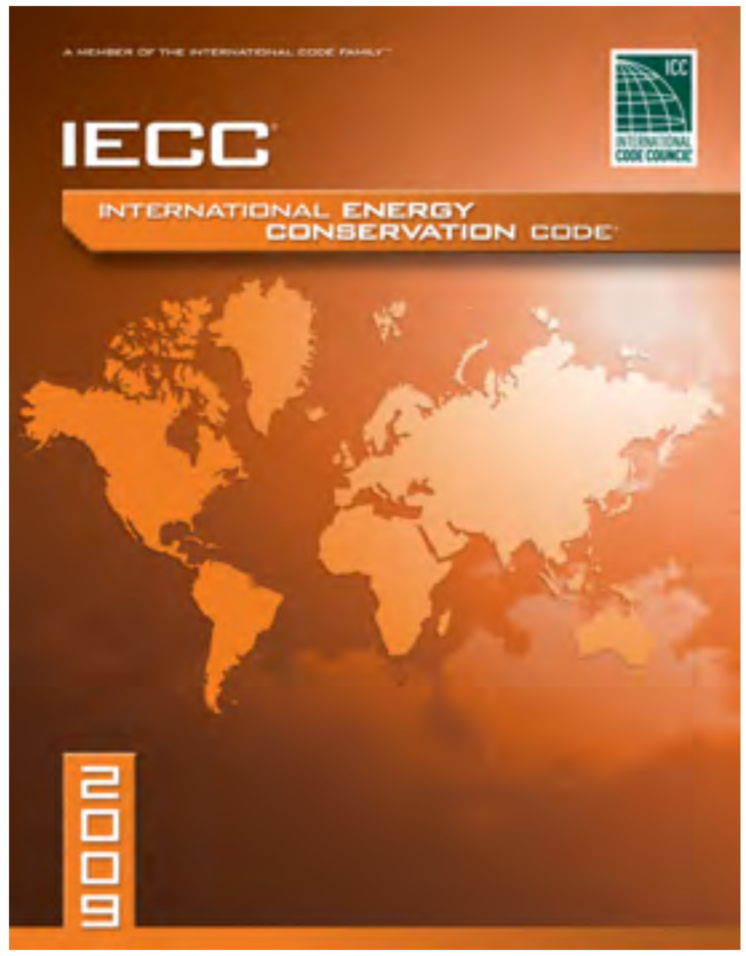
Overview of today's session:

We will review the IECC code and
We will review important changes to the MN Energy Code and what that means for you and your clients

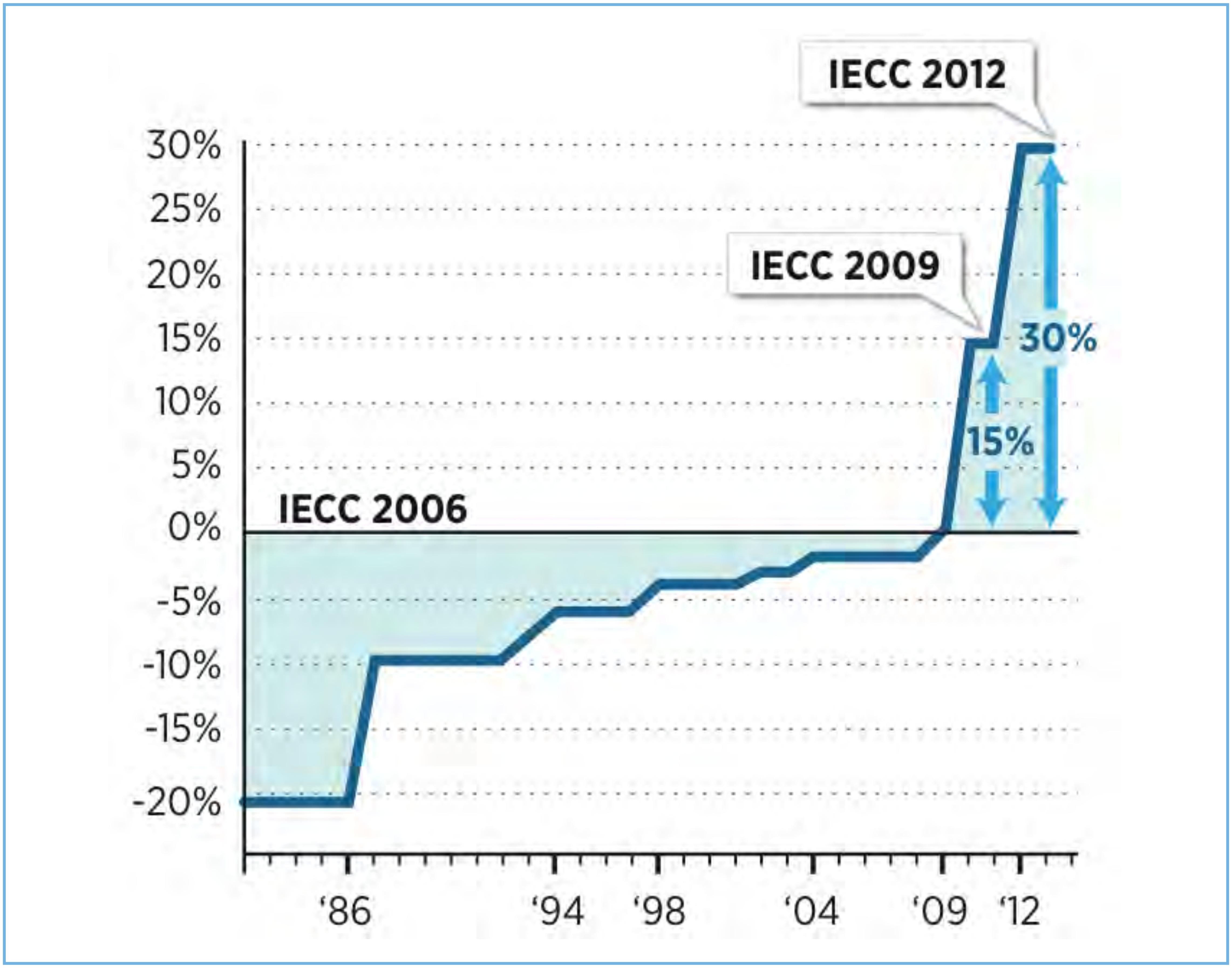


* Adopted new Code to be effective at a later date

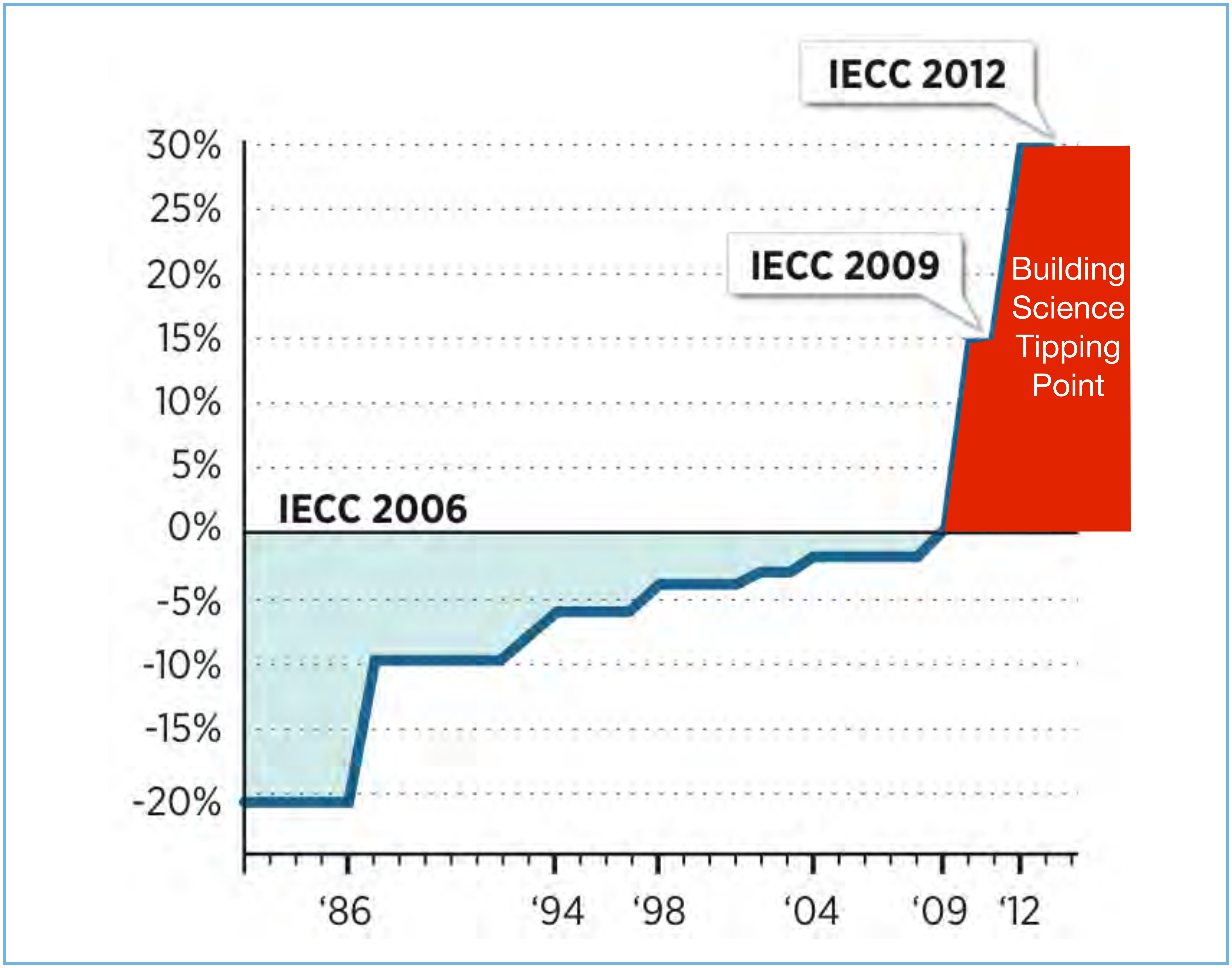
As of August 2013


A Member of the International Code Family
INTERNATIONAL ENERGY CONSERVATION CODE
2006

IECC
INTERNATIONAL ENERGY CONSERVATION CODE
2009

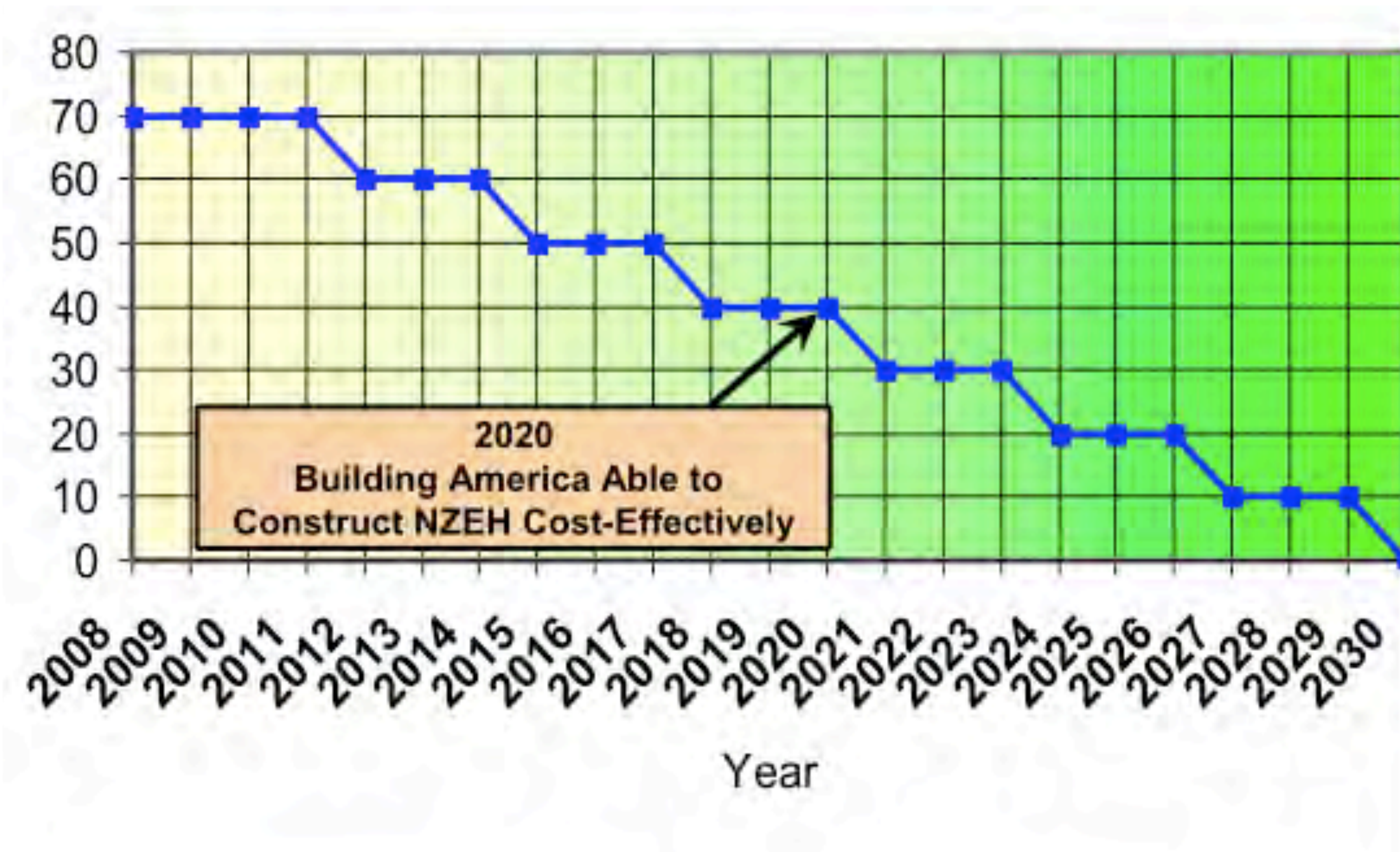
2012
INTERNATIONAL ENERGY CONSERVATION CODE
IECC



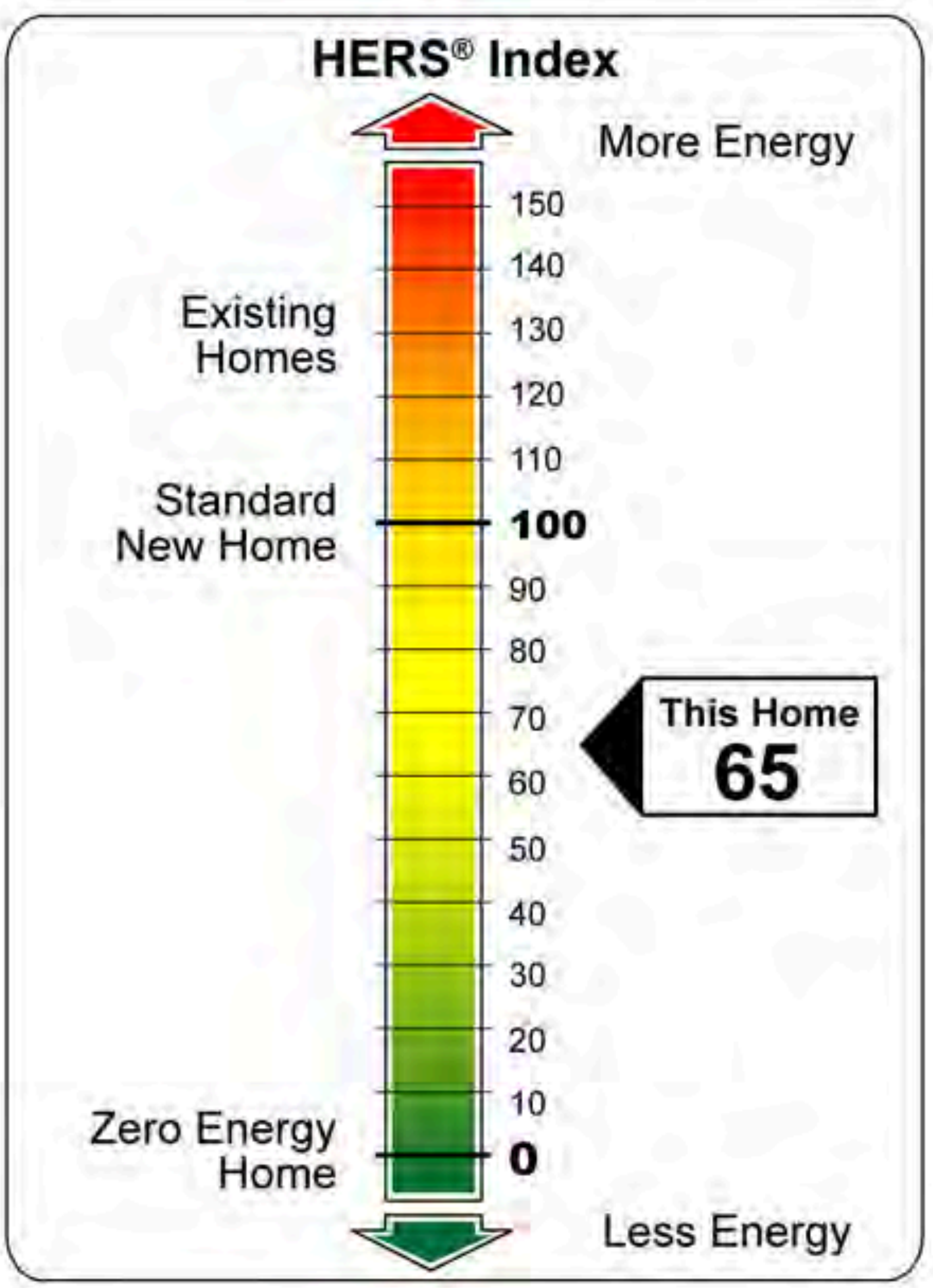
Building Science Tipping Point –
Can't dry out if they get wet
Can't assure adequate IAQ
Greater combustion safety risks



Building Science Tipping Point –
Can't dry out if they get wet
Can't assure adequate IAQ
Greater combustion safety risks



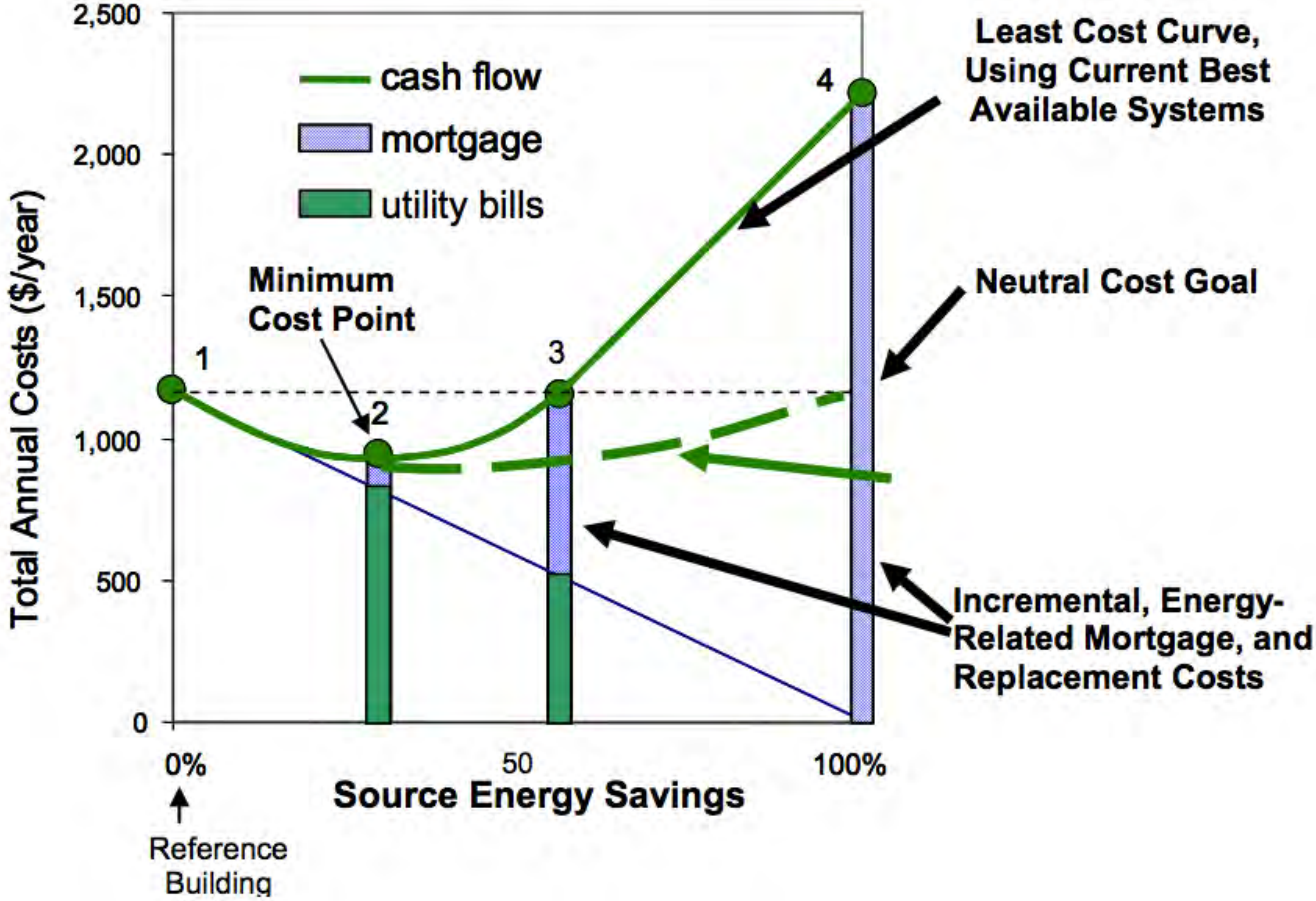
Where are we headed?



HERS Index – Now included as a field in the MLS listings (as well as Green Certified field), allowing us to track the sales prices and length of time on market for energy efficient homes

The University of Minnesota-led NorthernSTAR team is advancing efforts to bring researchers, builders, and owners together around two broad objectives: 1) to develop retrofit strategies for existing homes that achieve 15% to 30% energy savings and ensure safety and quality of the home, and 2) design and produce new homes that use on average 30% to 50% less energy, while improving air quality and comfort, reducing construction time and waste.

Best Practice Guide:
The Business Case for Energy Efficiency
Business Management Tools
Selling Performance
Building Systems
Checklists



Ren Andersen –
ZEH Whole-House Cost/Performance Target
NREL Performance Curve
The following systems represent a minimum set of efficiency improvements required to achieve cost-effective net ZEHs:

• High-R Wall Systems – Durable high-R wall systems for cold, northern marine, and mixed climates, leading to development of an R-30+ wall assembly with an incremental cost of $2/ft2 floor area relative to an R-19 2x6 wall.
• Cold Climate Domestic Hot Water (DHW) – DHW system with $2000 incremental system cost and 30% reduction in annual energy use relative to a gas tankless hot water system with efficiency factor (EF) = 0.8.
• Cold Climate R-10 Window Assembly – R-10 window assembly with a minimum solar heat gain coefficient (SHGC) of 0.3 and a cost of $20/ft2 (incremental cost of $4/ft2 relative to current low-e windows).
Very High Performance (VHP) A/C System A VHP A/C system with 30% reduction in annual energy use and an incremental cost of $1000 relative to a current SEER 18/energy efficiency ratio (EER) 13.4 two speed system with tight ducts in conditioned space.
• MEL Reduction – 30% reduction in miscellaneous electrical energy use with an incremental cost of $1000. –

$2000 per home

2013

Energy Tax Credit

2012 Energy Code changes that will help you build better homes

IECC 2012 has not been adopted in Minnesota.

The State of Minnesota is reviewing

1. More Insulation

- Higher R-value requirements for ceilings, walls, basements and crawl spaces (Table R402.1.1).
- R-5 to R-10 insulated sheathing to the walls, integrated with a water resistive barrier.
- Exterior rigid insulated sheathing also impacts your vapor retarder strategy, refer to Table 702.7.1 for criteria

Insulation	Ceiling R-value		Wood Frame R-value		Basement R-value		Crawlspace R-value	
Climate Zone	2009	2012	2009	2012	2009	2012	2009	2012
6	49	49	20	20 + 5 or 13 + 10	15/19	15/19	10/13	15/19
7	49	49	21	20 + 5 or 13 + 10	15/19	15/19	10/13	15/19

Reference component tables

Vapor retarders

- Class I or II vapor retarders are required on the interior side of frame walls in Climate Zones 6 & 7
- Class I: Sheet polyethylene, unperforated aluminum foil.
- Class II: Kraft-faced fiberglass batts.
- Class III: Latex or enamel paint.
- Class three vapor retarders are permitted in Zone 6 when:
  - Insulated sheathing with R-value ≥ 7.5 over 2 × 4 wall.
  - Insulated sheathing with R-value ≥ 11.25 over 2 × 6 wall

How does this impact your air barriers?
Zone 7:
Insulated sheathing with R-value ≥ 10 over 2 × 4 wall.
Insulated sheathing with R-value ≥ 15 over 2 × 6 wall.

Exterior Rigid Insulation

- R-5 to R-10 exterior rigid foam sheathing to the walls
- Exterior rigid foam sheathing also impacts your vapor retarder strategy

Exterior Rigid Insulation

- Rock wool installed on the exterior side of the water-resistant barrier (WRB)
- Most rock wool board products average around R-4.2 per inch

Exterior Insulation

- Insulated Housewrap
- Air, water and thermal protection
- R-5.0
- Breathable

2. Better Windows

- U-factor 0.32

Fenestration	Window U-Factor		Window SHGC		Skylight U-Factor	
Climate Zone	2009	2012	2009	2012	2009	2012
6	0.35	0.32	NR	NR	0.60	0.55
7	0.35	0.32	NR	NR	0.60	0.55

Reference component tables

3. Tighter Homes

- Comprehensive air barrier and insulation criteria will result in reduced air leakage, improved comfort and energy savings for homeowners
- Develop strategies for addressing each criteria and closely monitor progress in the field with your Home Energy Rater, framer and insulation contractor

(Table R402.4.1.1)

Sealing of top & bottom plates, electrical outlets, plumbing and wiring penetrations, etc.

MN ahead of the game, has had this in the code since 1998

ENERGY STAR Certified Homes, Version 3 (Rev. 07)
Thermal Enclosure System Rater Checklist

Home Address: ________________________________ City: ________________ State: ______ Zip Code: ________

1. High-Performance Fenestration	Must Correct	Builder Verified [1]	Rater Verified	N/A
1.1 *Prescriptive Path:* Fenestration shall meet or exceed ENERGY STAR requirements [2]	☐	☐	☐	☐
1.2 *Performance Path*: Fenestration shall meet or exceed 2009 IECC requirements [2]	☐	☐	☐	☐
2. Quality-Installed Insulation				
2.1 Ceiling, wall, floor, and slab insulation levels shall comply with one of the following options:				
2.1.1 Meet or exceed 2009 IECC levels [3,4,5] **OR**;	☐	☐	☐	☐
2.1.2 Achieve ≤ 133% of the total UA resulting from the U-factors in 2009 IECC Table 402.1.3, excluding fenestration and per guidance in Footnote 3d, AND home shall achieve ≤ 50% of the infiltration rate in Exhibit 1 of the National Program Requirements [4,5]	☐	☐	☐	☐
2.2 All ceiling, wall, floor, and slab insulation shall achieve RESNET-defined Grade I installation or, alternatively, Grade II for surfaces that contain a layer of continuous, air impermeable insulation ≥ R-3 in Climate Zones 1 to 4, ≥ R-5 in Climate Zones 5 to 8	☐	☐	☐	☐
3. Fully-Aligned Air Barriers [6]				
At each insulated location noted below, a complete air barrier shall be provided that is fully aligned with the insulation as follows: • At interior or exterior surface of ceilings in Climate Zones 1-3; at interior surface of ceilings in Climate Zones 4-8. Also, include barrier at interior edge of attic eave in all climate zones using a wind baffle that extends to the full height of the insulation. Include a baffle in every bay or a tabbed baffle in each bay with a soffit vent that will also prevent wind washing of insulation in adjacent bays • At exterior surface of walls in all climate zones; and also at interior surface of walls for Climate Zones 4-8 [7] • At interior surface of floors in all climate zones, including supports to ensure permanent contact and blocking at exposed edge [8,9]				
3.1 Walls [10]				
3.1.1 Walls behind showers and tubs	☐	☐	☐	☐
3.1.2 Walls behind fireplaces	☐	☐	☐	☐
3.1.3 Attic knee walls [11]	☐	☐	☐	☐
3.1.4 Skylight shaft walls	☐	☐	☐	☐
3.1.5 Wall adjoining porch roof	☐	☐	☐	☐
3.1.6 Staircase walls	☐	☐	☐	☐
3.1.7 Double walls	☐	☐	☐	☐
3.1.8 Garage rim / band joist adjoining conditioned space	☐	☐	☐	☐
3.1.9 All other exterior walls	☐	☐	☐	☐
3.2 Floors				
3.2.1 Floor above garage	☐	☐	☐	☐
3.2.2 Cantilevered floor	☐	☐	☐	☐
3.2.3 Floor above unconditioned basement or unconditioned crawlspace	☐	☐	☐	☐
3.3 Ceilings [10]				
3.3.1 Dropped ceiling / soffit below unconditioned attic	☐	☐	☐	☐
3.3.2 All other ceilings	☐	☐	☐	☐
4. Reduced Thermal Bridging				
4.1 For insulated ceilings with attic space above (i.e., non-cathedralized), Grade I insulation extends to the inside face of the exterior wall below at these levels: CZ 1-5: ≥ R-21; CZ 6-8: ≥ R-30 [12]	☐	☐	☐	☐
4.2 For slabs on grade in CZ 4 and higher, 100% of slab edge insulated to ≥ R-5 at the depth specified by the 2009 IECC and aligned with thermal boundary of the walls [4,5]	☐	☐	☐	☐
4.3 Insulation beneath attic platforms (e.g., HVAC platforms, walkways) ≥ R-21 in CZ 1-5; ≥ R-30 in CZ 6-8	☐	☐	☐	☐
4.4 Reduced thermal bridging at above-grade walls separating conditioned from unconditioned space (rim / band joists exempted) using one of the following options: [13]				
4.4.1 Continuous rigid insulation, insulated siding, or combination of the two; ≥ R-3 in Climate Zones 1 to 4, ≥ R-5 in Climate Zones 5 to 8 [14,15,16], **OR**;	☐	☐	☐	☐
4.4.2 Structural Insulated Panels (SIPs) [14], **OR**;	☐	☐	☐	☐
4.4.3 Insulated Concrete Forms (ICFs) [14], **OR**;	☐	☐	☐	☐
4.4.4 Double-wall framing [14,17], **OR**;	☐	☐	☐	☐
4.4.5 Advanced framing, including all of the items below:				
4.4.5a All corners insulated ≥ R-6 to edge [18], **AND**;	☐	☐	☐	☐
4.4.5b All headers above windows & doors insulated ≥ R-3 for 2x4 framing or equivalent cavity width, and ≥ R-5 for all other assemblies (e.g., with 2x6 framing) [19], **AND**;	☐	☐	☐	☐
4.4.5c Framing limited at all windows & doors to one pair of king studs, plus one pair of jack studs per window opening to support the header and sill [20], **AND**;	☐	☐	☐	☐
4.4.5d All interior / exterior wall intersections insulated to the same R-value as the rest of the exterior wall [21], **AND**;	☐	☐	☐	☐
4.4.5e Minimum stud spacing of 16 in. o.c. for 2x4 framing in all Climate Zones and, in Climate Zones 5 through 8, 24 in. o.c. for 2x6 framing [22]	☐	☐	☐	☐

ENERGY STAR Certified Homes, Version 3 (Rev. 07)
Thermal Enclosure System Rater Checklist

5. Air Sealing	Must Correct	Builder Verified[1]	Rater Verified	N/A
5.1 Penetrations to unconditioned space fully sealed with solid blocking or flashing as needed and gaps sealed with caulk or foam				
5.1.1 Duct / flue shaft	☐	☐	☐	☐
5.1.2 Plumbing / piping	☐	☐	☐	☐
5.1.3 Electrical wiring	☐	☐	☐	☐
5.1.4 Bathroom and kitchen exhaust fans	☐	☐	☐	☐
5.1.5 Recessed lighting fixtures adjacent to unconditioned space ICAT labeled and fully gasketed. Also, if in insulated ceiling without attic above, exterior surface of fixture insulated to ≥ R-10 in CZ 4 and higher to minimize condensation potential.	☐	☐	☐	☐
5.1.6 Light tubes adjacent to unconditioned space include lens separating unconditioned and conditioned space and are fully gasketed [23]	☐	☐	☐	☐
5.2 Cracks in the building envelope fully sealed				
5.2.1 All above-grade sill plates adjacent to conditioned space sealed to foundation or sub-floor with caulk, foam, or equivalent material. Foam gasket also placed beneath above-grade sill plate if resting atop concrete or masonry and adjacent to conditioned space [24, 25]	☐	☐	☐	☐
5.2.2 At top of walls adjoining unconditioned spaces, continuous top plates or sealed blocking using caulk, foam, or equivalent material	☐	☐	☐	☐
5.2.3 Drywall sealed to top plate at all unconditioned attic / wall interfaces using caulk, foam, drywall adhesive (but not other construction adhesives), or equivalent material. Either apply sealant directly between drywall and top plate or to the seam between the two from the attic above.	☐	☐	☐	☐
5.2.4 Rough opening around windows & exterior doors sealed with caulk or foam [26]	☐	☐	☐	☐
5.2.5 Marriage joints between modular home modules at all exterior boundary conditions fully sealed with gasket and foam	☐	☐	☐	☐
5.2.6 All seams between Structural Insulated Panels (SIPs) foamed and / or taped per manufacturer's instructions	☐	☐	☐	☐
5.2.7 In multifamily buildings, the gap between the common wall (e.g. the drywall shaft wall) and the structural framing between units fully sealed at all exterior boundaries	☐	☐	☐	☐
5.3 Other openings				
5.3.1 Doors adjacent to unconditioned space (e.g., attics, garages, basements) or ambient conditions made substantially air-tight with weatherstripping or equivalent gasket	☐	☐	☐	☐
5.3.2 Attic access panels and drop-down stairs equipped with a durable ≥ R-10 insulated cover that is gasketed (i.e., not caulked) to produce continuous air seal when occupant is not accessing the attic [27]	☐	☐	☐	☐
5.3.3 Whole-house fans equipped with a durable ≥ R-10 insulated cover that is gasketed and either installed on the house side or mechanically operated [27]	☐	☐	☐	☐

Rater Name: ____________________ Rater Pre-Drywall Inspection Date: __________ Rater Initials: ________

Rater Name: ____________________ Rater Final Inspection Date: __________ Rater Initials: ________

Builder Employee: ____________________ Builder Inspection Date: __________ Builder Initials: ________

Notes:

1. At the discretion of the Rater, the builder may verify up to eight items specified in this Checklist. When exercised, the builder's responsibility will be formally acknowledged by the builder signing off on the checklist for the item(s) that they verified.
2. *For Prescriptive Path:* All windows, doors, and skylights shall meet or exceed ENERGY STAR Program Requirements for Residential Windows, Doors, and Skylights – Version 5.0 as outlined at www.energystar.gov/windows. *For Performance Path:* All windows, doors and skylights shall meet or exceed the component U-factor and SHGC requirements specified in the 2009 IECC – Table 402.1.1. If no NFRC rating is noted on the window or in product literature (e.g., for site-built fenestration), select the U-factor and SHGC value from Tables 4 and 14, respectively, in 2005 ASHRAE Fundamentals, Chapter 31. Select the highest U-factor and SHGC value among the values listed for the known window characteristics (e.g., frame type, number of panes, glass color, and presence of low-e coating). Note that the U-factor requirement applies to all fenestration while the SHGC only applies to the glazed portion. The following exceptions apply:
   a. An area-weighted average of fenestration products shall be permitted to satisfy the U-factor requirements;
   b. An area-weighted average of fenestration products ≥ 50% glazed shall be permitted to satisfy the SHGC requirements;
   c. 15 square feet of glazed fenestration per dwelling unit shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above;
   d. One side-hinged opaque door assembly up to 24 square feet in area shall be exempt from the U-factor requirements and shall be excluded from area-weighted averages calculated using a) and b), above;
   e. Fenestration utilized as part of a passive solar design shall be exempt from the U-factor and SHGC requirements, and shall be excluded from area-weighted averages calculated using a) and b), above. Exempt windows shall be facing within 45 degrees of true South and directly coupled to thermal storage mass that has a heat capacity > 20 btu / ft^3x^oF and provided in a ratio of at least 3 sq. ft. per sq. ft. of South facing fenestration. Generally, thermal mass materials will be at least 2 in. thick.

4. Air Leakage Testing

- The building or dwelling unit shall be tested and verified as having an air leakage rate of not exceeding 3 air changes per hour.

- Testing shall be conducted with a blower door
- Where required by the code official, testing shall be conducted by an approved third party.
- A written report of the results of the test shall be signed by the party conducting the test and provided to the code official. Testing shall be performed at any time after creation of all penetrations of the building thermal envelope.

5. Duct Sealing

- Seal your ducts, air handlers, and filter box (R403.2.2).
- If your HVAC contractor also does commercial work this should be no problem for them.
- Specify mastic to seal your ducts, contractors we have worked with say mastic saves them time and provides for better sealing.

See How Happy He Is?

6. Duct Leakage Testing

- Confirm duct tightness with performance testing (unless the ducts and air handlers are located entirely within the thermal enclosure). (R403.2.2).
- Test one of your current duct installations to benchmark your current leakage, you'll be amazed at how much your ducts leak!
- A Home Energy Rater can perform your benchmark testing.


MINNEAPOLIS
GAUGE
0000
CHANNEL
MODE
RANGE

7. Framing is not Duct Work

- Building framing cavities are not to be used as supplies, returns or plenums. (R403.2.3).
- Take this opportunity to rethink your duct layouts, look to simplify and eliminate conflicts with structural elements.
- Many contractors we work with have actually saved money by framing with the duct work in mind and simplified duct systems.

8. Mechanical Ventilation

- A typical home will require about 15 cfm per person of fresh outdoor air to be distributed by continuous mechanical ventilation to meet the requirements of the International Residential Code or International Mechanical Code. (R403.5) (M1507.3)
- This can be accomplished with a centrally located quiet exhaust fan, an interconnected system to the air handler, HRV/ERV or a combination of devices.

Proposed Minnesota code would require a balanced mechanical ventilation:

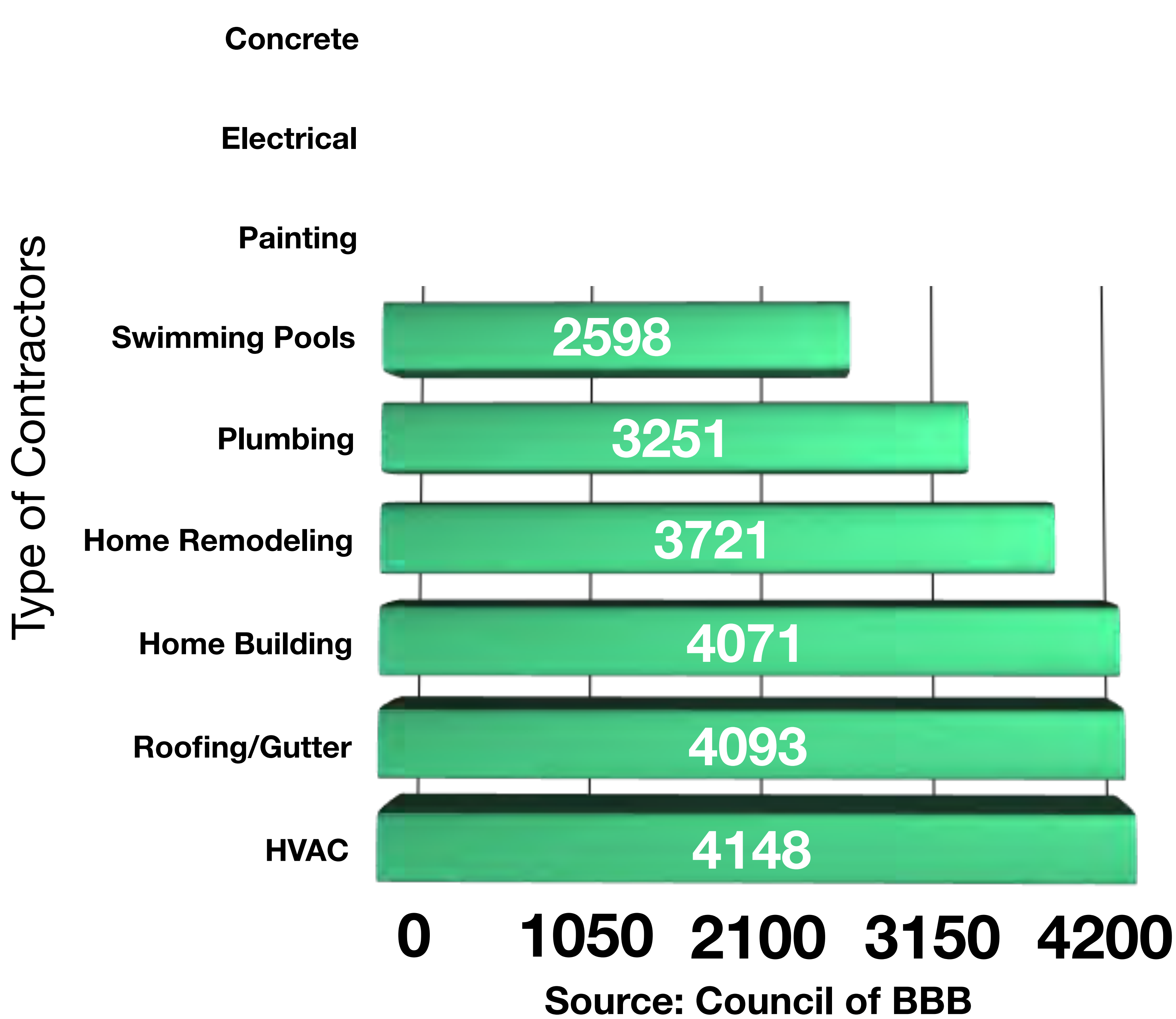
Balanced Ventilation

- An exhaust only system and a supply only system or some other combination thereof [balance within 10% for air flow rates] designed to mechanically exchange indoor air with outdoor air...operating continuously or intermittently...as needed to satisfy the whole house ventilation rates

9. HVAC Sizing

- A quality HVAC contractor should be able to provide the necessary documentation for proper heat loss and heat gain calculations and equipment sizing (R403.6), however make sure the HVAC contractor is provided with the correct information regarding the homes specifications for their inputs (insulation values, window specs, blower door results, etc.).
- The goal is an HVAC system that that is sized to maximize homeowner satisfaction, however bigger is not better. Have your contractor review the calculations and sizing with you and your Home Energy Rater.

Building-Related Complaints



- 60-80% of defect litigation cases are stimulated by failures of the building envelope. (Builder Magazine)
- $9 billion is spent annually on construction defects. (ASHRAE) Water leakage is the #1 consequence of construction defects.
- The average callback costs contractors between $500-$1,500 per home.

67 percent of homes in the U.S. have a room that’s too hot in the summer or too cold in the winter.
The kids room is freezing!!!!

67 percent of homes in the U.S. have a room that’s too hot in the summer or too cold in the winter.
The kids room is freezing!!!!

67 percent of homes in the U.S. have a room that’s too hot in the summer or too cold in the winter.
The kids room is freezing!!!!

1/3

A strong third of all new home installations require a callback for the HVAC system

1/3

of all new home installations require a callback for the HVAC system

A strong third of all new home installations require a callback for the HVAC system

9 of 10

9 out of10 homeowners thermostats are NOT in sync.

9 of 10

Homeowners thermostats are NOT in sync

9 out of10 homeowners thermostats are NOT in sync.

10. Hot water pipe insulation

- R-3 pipe insulation on most types of hot water piping
  - piping under slabs
  - to the kitchen
  - runs over 20’, 3/4” in diameter or larger
  - check the criteria for specifics. (R403.4.2)

11. Efficient lighting

- 75% percent of lighting must be energy efficient (R404.1). Stock up on CFL bulbs.
- Better yet - LED fixtures

12. Performance alternative

- Most items noted are mandatory, however trade-offs for insulation values, windows, airtightness, ventilation and other enclosure components may be done under the Simulated Performance Alternative (R405.1).
- Mechanical system trade-offs (e.g. upgrading the furnace to higher efficiency) are not allowed.
- Developing your own strategies and modeling performance with a Home Energy Rater can result in cost effective solutions that meet code requirements.

2012 IECC OVERALL BUILDING UA COMPLIANCE

Date:	January 17, 2013	Rating No.:	BKI_B012_H0880
Building Name:		Rating Org.:	Building Knowledge, Inc.
Owner's Name:		Phone No.:	9520944-5605
Property:		Rater's Name:	Pat O'Malley
Address:		Rater's No.:	9377462
Builder's Name:			
Weather Site:		Rating Type:	Confirmed
File Name:		Rating Date:	12/28/12

Elements	**Insulation Levels**	
	2012 IECC	As Designed
Shell UA Check		
Ceilings:	19.4	14.6
Above-Grade Walls:	90.4	102.0
Windows and Doors:	88.4	78.1
Basement Walls:	45.3	50.8
Overall UA (Design must be equal or lower):	243.5	245.5
Window U-Factor Check (Section 402.5)		
Window U-Factor (Design must be equal or lower):	0.400	0.300

This home DOES NOT MEET the overall thermal performance requirements and verifications of the International Energy Conservation Code based on a climate zone of 6A. (Section 402, International Energy Conservation Code, 2012 edition.)

2012 IECC OVERALL BUILDING UA COMPLIANCE

Date:	January 17, 2013	Rating No.:	BKI_B012_H0880
Building Name:		Rating Org.:	Building Knowledge, Inc.
Owner's Name:		Phone No.:	9520944-5605
Property:		Rater's Name:	Pat O'Malley
Address:		Rater's No.:	9377462
Builder's Name:			
Weather Site:		Rating Type:	Confirmed
File Name:		Rating Date:	12/28/12

Elements	**Insulation Levels**	
	2012 IECC	As Designed
Shell UA Check		
Ceilings:	19.4	14.6
Above-Grade Walls:	90.4	102.0
Windows and Doors:	88.4	78.1
Basement Walls:	45.3	50.8
Overall UA (Design must be equal or lower):	243.5	245.5
Window U-Factor Check (Section 402.5)		
Window U-Factor (Design must be equal or lower):	0.400	0.300

This home DOES NOT MEET the overall thermal performance requirements and verifications of the International Energy Conservation Code based on a climate zone of 6A. (Section 402, International Energy Conservation Code, 2012 edition.)

2012 IECC ANNUAL ENERGY COST COMPLIANCE

Date:	January 17, 2013	Rating No.:	BKI_B012_H0880
Building Name:		Rating Org.:	Building Knowledge, Inc.
Owner's Name:		Phone No.:	9520944-5605
Property:		Rater's Name:	Pat O'Malley
Address:		Rater's No.:	9377462
Builder's Name:			
Weather Site:		Rating Type:	Confirmed
File Name:		Rating Date:	12/28/12

	Annual Energy Cost ($) 2012 IECC	As Designed
Heating:	536	487
Cooling:	115	76
Water Heating:	168	168
SubTotal - Used to Determine Compliance:	**820**	**731**
Lights & Appliances:	581	578
Photovoltaics:	-0	-0
Service Charge:	264	264
Total:	**1665**	**1573** *

Window U-Factor Check (Section 402.5)

Window U-Factor (Design must be equal or lower):	0.400	0.300
Home Infiltration (Section 402.4.1.2):		PASSES
Duct Leakage (Section 403.2.2):		PASSES
Mechanical Ventilation (Section 403.5):		PASSES

This home MEETS the annual energy cost requirements and verifications of Section 405 of the 2012 International Energy Conservation Code based on a climate zone of 6A. In fact, this home surpasses the requirements by 10.8%.

Name: Pat O'Malley   Signature:

Organization: Building Knowledge, Inc.   Date: January 17, 2013

* Design energy cost is based on the following systems:
Heating: Fuel-fired air distribution, 45.0 kBtuh, 96.0 AFUE.
Water Heating: Conventional, Gas, 0.67 EF.
Cooling: Air conditioner, 12.4 kBtuh, 13.0 SEER.

Performance Verification

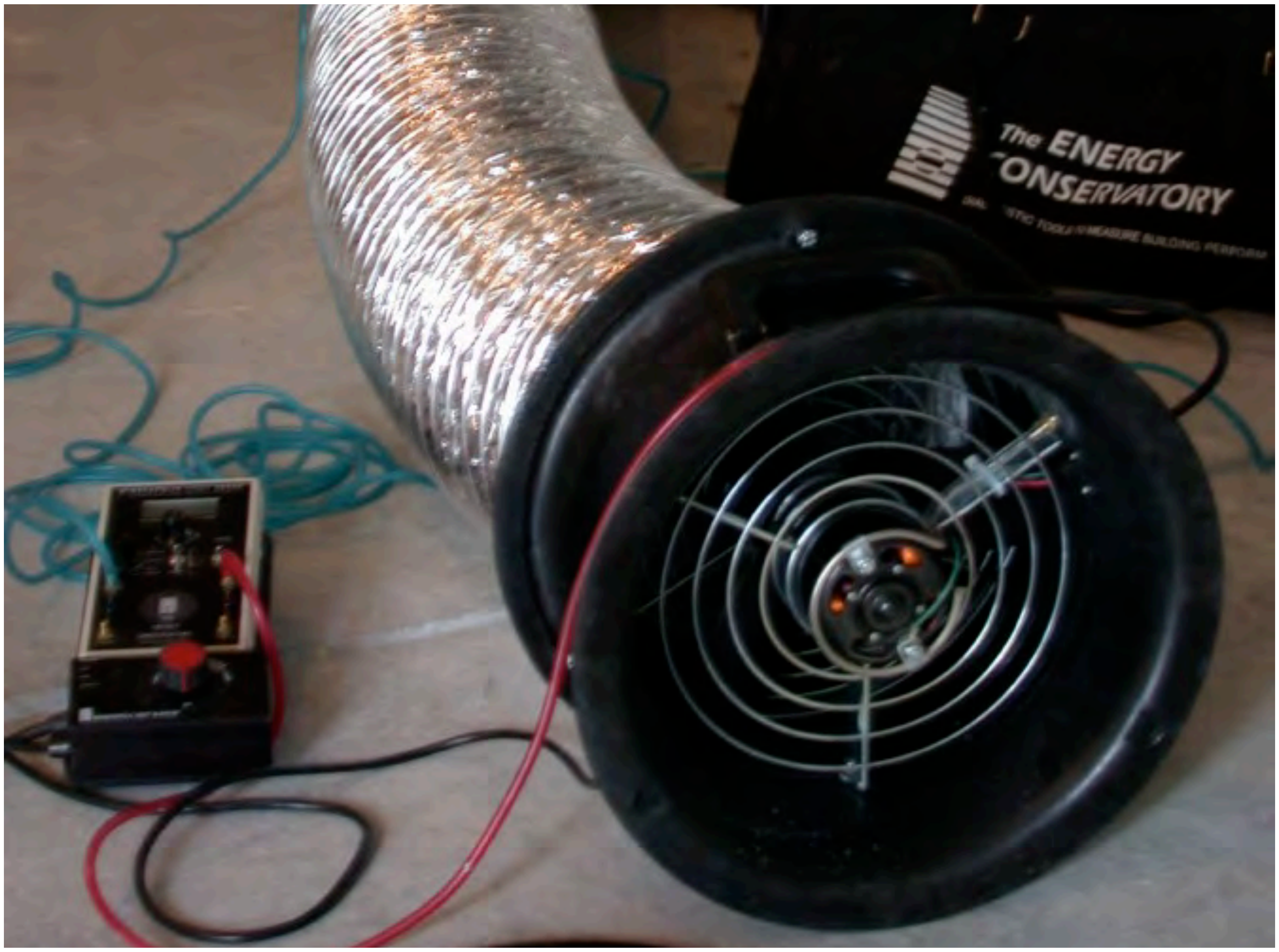
Air leakage testing- blower door

A Blower Door test can be used to quantify air leakage and potential air quality, durability & other issues.

How do we typically measure air flow – We hold our hand over the register, yup its blowing air!
We must be OK!

Airflow Testing

- Exhaust fans
- Supply and return flows based on comfort complaints



Duct leakage testing

HVAC Airflow

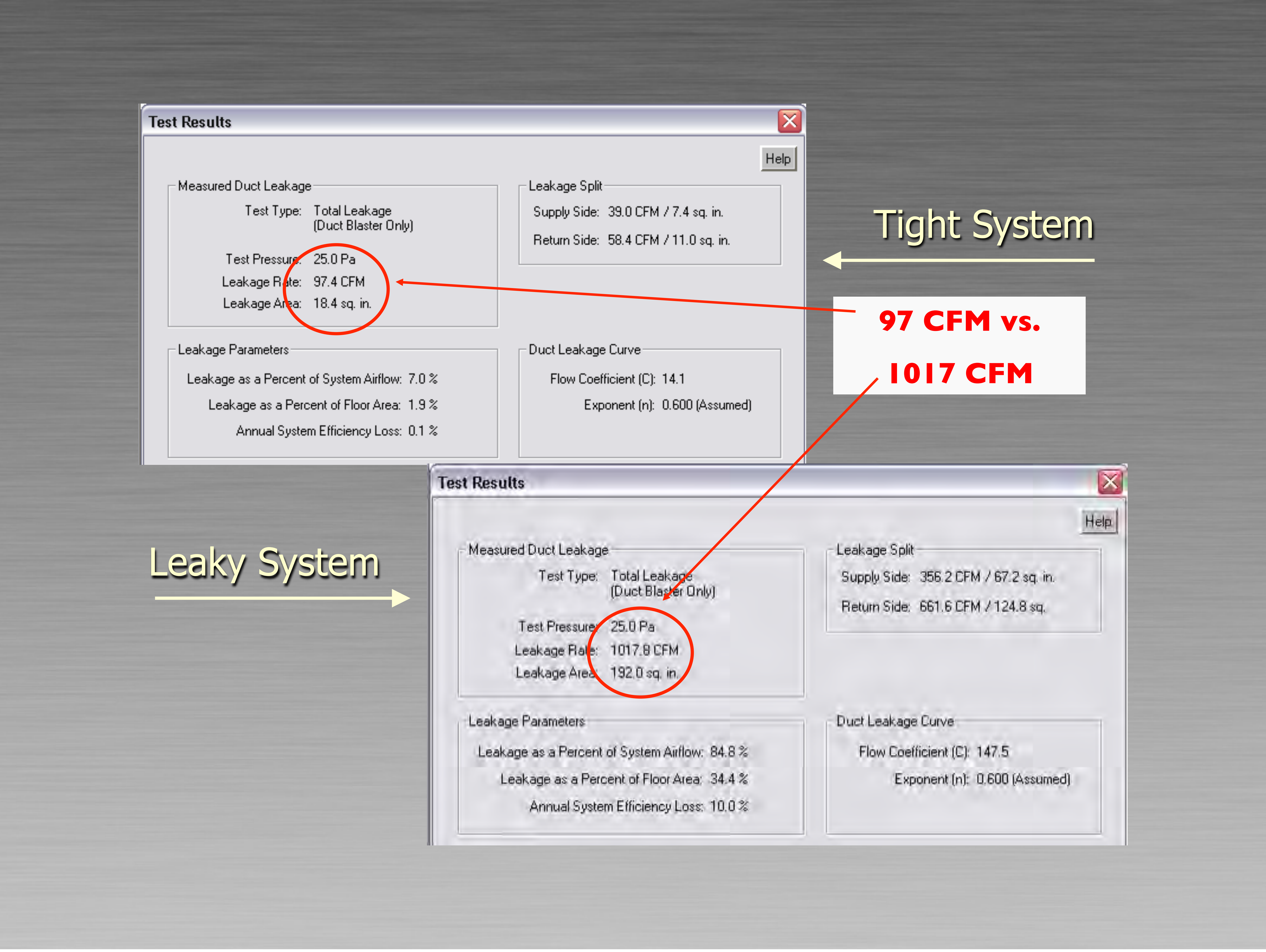
Address:

A/C Size 2.5 tons
Design Air Handler Flow 1,000 CFM @ 400 CFM/ton

	Design		Actual		
	Branch Size	**Airflow (CFM)**	**Branch Size**	**Airflow (CFM)**	**Pressure**
Main Floor Supplies					
Living A	6"	93	6"	50	
Living B	6"	93	6"	47	
Living C	6"	93	6"	42	
Family/Den A	6"	92	6"	37	
Family/Den B	6"	92	6"	46	
Master BR A	6"	85	6"	66	+4.5 pa
Master BR B	6"	85	6"	68	
Master Closet	4"	40	6"	85	
Master Bath	5"	65	6"	79	
BR #2	6"	95	6"	65	+0.4 pa
BR #3	6"	95	6"	79	+1.2 pa
Main Bath	5"	62	6"	77	
Total Supply Flow:		**990**		**741**	
Returns					
Living		175		110	
Family/Den		175		102	

Performance Testing:

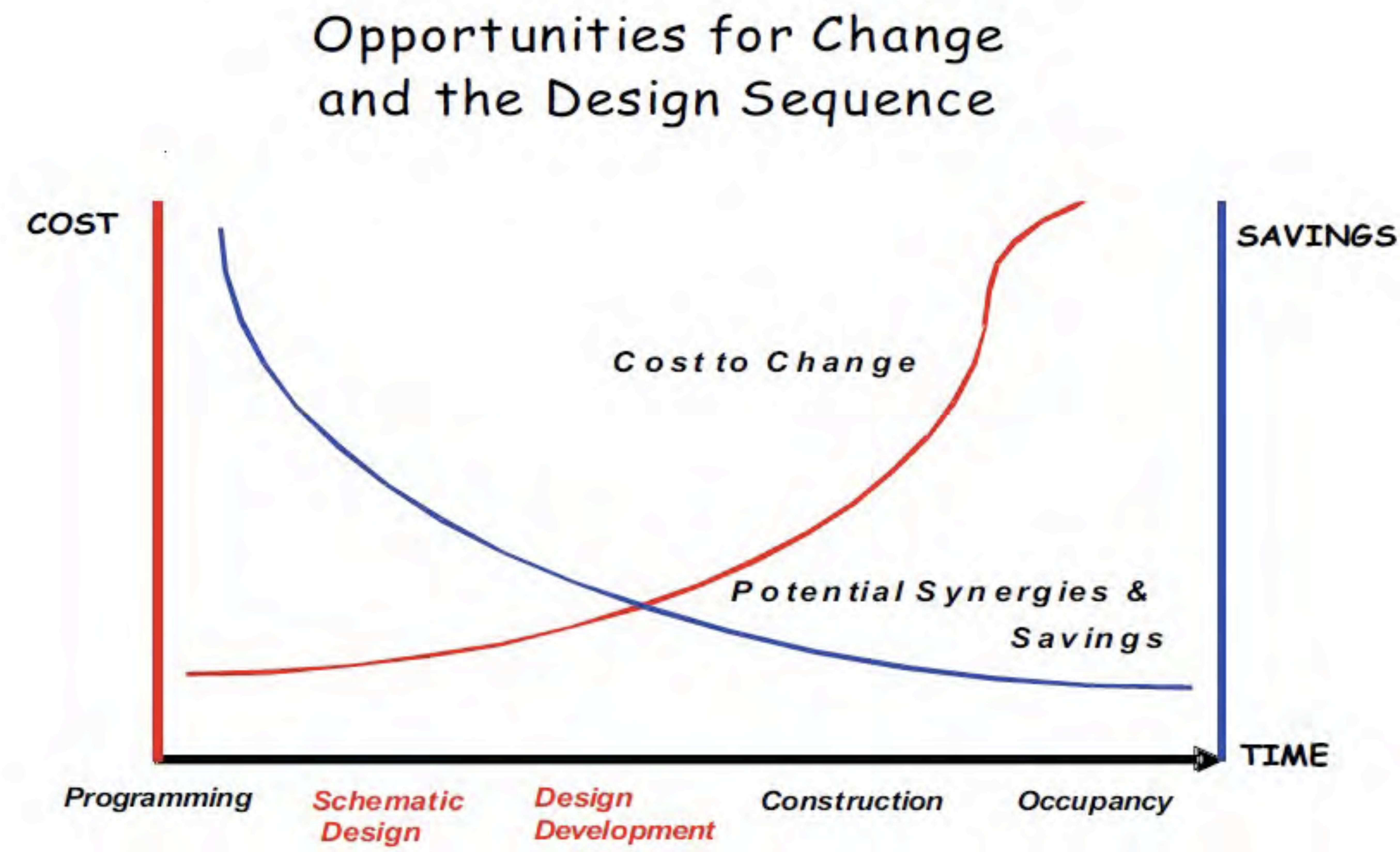
Sample report of measured duct air flow compared to design
Note the differences in the Powder Room and Family Room


Test Results
Help
Measured Duct Leakage
Test Type: Total Leakage (Duct Blaster Only)
Test Pressure: 25.0 Pa
Leakage Rate: 97.4 CFM
Leakage Area: 18.4 sq. in.
Leakage Split
Supply Side: 39.0 CFM / 7.4 sq. in.
Return Side: 58.4 CFM / 11.0 sq. in.
Leakage Parameters
Leakage as a Percent of System Airflow: 7.0 %
Leakage as a Percent of Floor Area: 1.9 %
Annual System Efficiency Loss: 0.1 %
Duct Leakage Curve
Flow Coefficient (C): 14.1
Exponent (n): 0.600 (Assumed)
Tight System
97 CFM vs.
1017 CFM
Leaky System
Test Results
Help
Measured Duct Leakage
Test Type: Total Leakage (Duct Blaster Only)
Test Pressure: 25.0 Pa
Leakage Rate: 1017.8 CFM
Leakage Area: 192.0 sq. in.
Leakage Split
Supply Side: 356.2 CFM / 67.2 sq. in.
Return Side: 661.6 CFM / 124.8 sq.
Leakage Parameters
Leakage as a Percent of System Airflow: 84.8 %
Leakage as a Percent of Floor Area: 34.4 %
Annual System Efficiency Loss: 10.0 %
Duct Leakage Curve
Flow Coefficient (C): 147.5
Exponent (n): 0.600 (Assumed)

Integrated Project Planning

Integrated Design:
Integrated Project Planning -
When the parts fit together, the house is better. The regular way to build is a linear approach that moves neatly from one step to the next. The only problem is that it's not guaranteed to produce the best result. How come?
Key players may not share common objectives for the project, may not understand how their work affects the work of others, and aren't looking for ways to make the house more efficient and less costly to build and operate.
A successful sustainable green home project begins with a common understanding of the project goals.

When everyone involved in the project can gather before construction begins to discuss the



Integrated Design:

Conduct all aspects of design and construction in a coordinated and methodical manner: The architect or designer needs to fully articulate the structure, including interior floor framing layout and specifications (i-joists, open-web trusses, etc.) and the HVAC designer needs to fully specify ducts and equipment. If floor framing is left to the framing contractor and duct sizes and runs left to the HVAC contractor to figure out on the job site, the chances of achieving high performance are low, at best.

The Rule of 1:10:100

1 = PREVENTION
Every dollar, nickel, penny, or hour spent on prevention of problems is a great investment.

10 = INSPECTION
If you let a problem develop and then find it through inspection, it costs 10 times as many dollars, nickels, pennies, or hours.

100 = FIELD FAILURE
If you let something fail in the field it's another factor of 10 in time and money.

A simple way to understand the problem with brute force quality comes from a landmark 1959 study at the renowned Bell Labs, the research division of AT&T. Looking at years of data, they devised the "Rule of 1–10–100," which compares the cost differential with finding problems during inspection and in the field, versus preventing them altogether.

The Rule of 1:10:100

- 1x - Discovered before construction

1 = PREVENTION
Every dollar, nickel, penny, or hour spent on prevention of problems is a great investment.

10 = INSPECTION
If you let a problem develop and then find it through inspection, it costs 10 times as many dollars, nickels, pennies, or hours.

100 = FIELD FAILURE
If you let something fail in the field it’s another factor of 10 in time and money.

A simple way to understand the problem with brute force quality comes from a landmark 1959 study at the renowned Bell Labs, the research division of AT&T. Looking at years of data, they devised the “Rule of 1–10–100,” which compares the cost differential with finding problems during inspection and in the field, versus preventing them altogether.

The Rule of 1:10:100

- 1x - Discovered before construction
- 10X - Discovered during inspection

1 = PREVENTION
Every dollar, nickel, penny, or hour spent on prevention of problems is a great investment.

10 = INSPECTION
If you let a problem develop and then find it through inspection, it costs 10 times as many dollars, nickels, pennies, or hours.

100 = FIELD FAILURE
If you let something fail in the field it's another factor of 10 in time and money.

A simple way to understand the problem with brute force quality comes from a landmark 1959 study at the renowned Bell Labs, the research division of AT&T. Looking at years of data, they devised the "Rule of 1–10–100," which compares the cost differential with finding problems during inspection and in the field, versus preventing them altogether.

The Rule of 1:10:100

- 1x - Discovered before construction
- 10X - Discovered during inspection
- 100x - Discovered during warranty

1 = PREVENTION
Every dollar, nickel, penny, or hour spent on prevention of problems is a great investment.

10 = INSPECTION
If you let a problem develop and then find it through inspection, it costs 10 times as many dollars, nickels, pennies, or hours.

100 = FIELD FAILURE
If you let something fail in the field it's another factor of 10 in time and money.

A simple way to understand the problem with brute force quality comes from a landmark 1959 study at the renowned Bell Labs, the research division of AT&T. Looking at years of data, they devised the "Rule of 1–10–100," which compares the cost differential with finding problems during inspection and in the field, versus preventing them altogether.

The Rule of 1:10:100

- 1x - Discovered before construction
- 10X - Discovered during inspection
- 100x - Discovered during warranty
- 1000X - Discovered by attorney

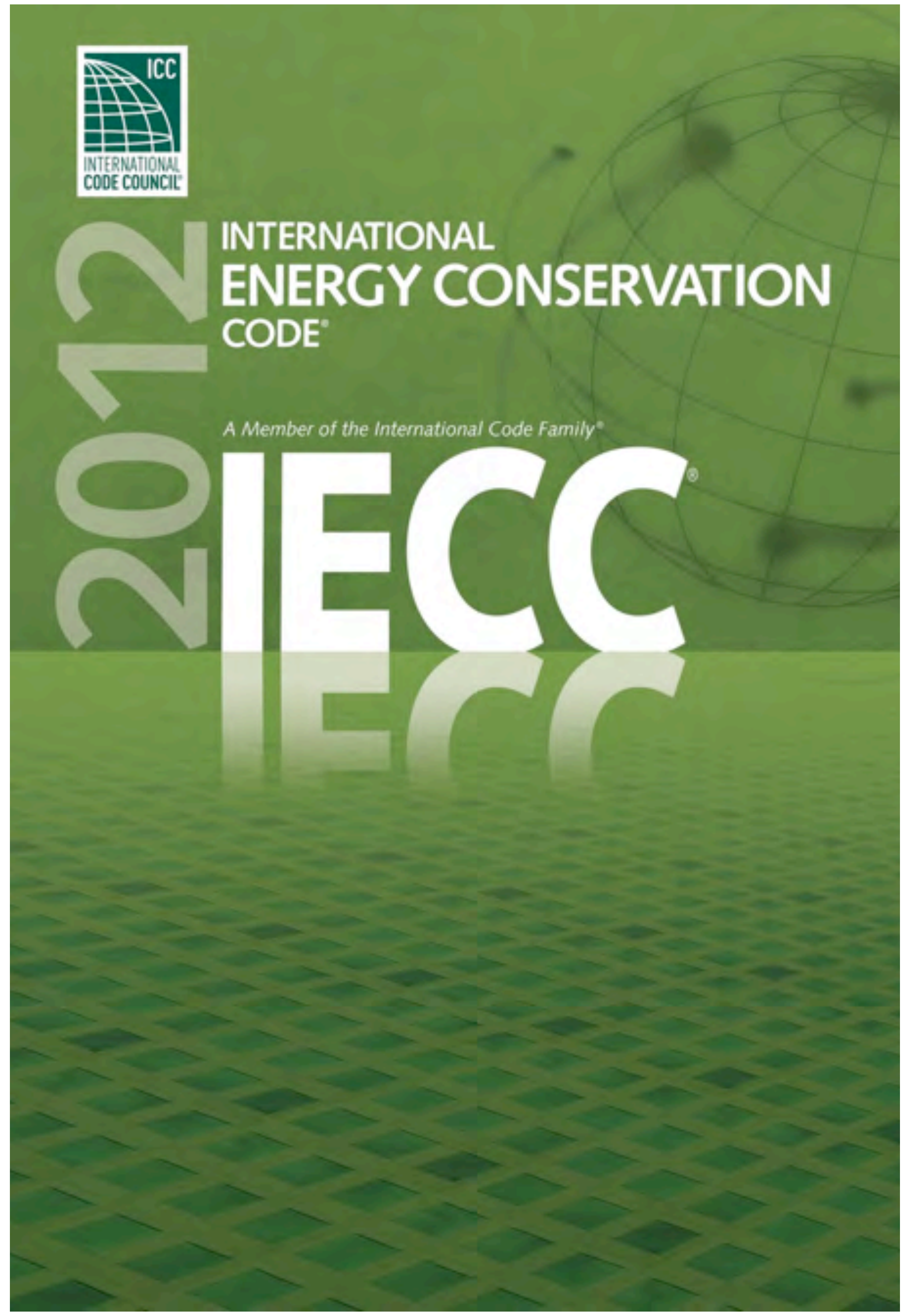
1 = PREVENTION
Every dollar, nickel, penny, or hour spent on prevention of problems is a great investment.

10 = INSPECTION
If you let a problem develop and then find it through inspection, it costs 10 times as many dollars, nickels, pennies, or hours.

100 = FIELD FAILURE
If you let something fail in the field it's another factor of 10 in time and money.

A simple way to understand the problem with brute force quality comes from a landmark 1959 study at the renowned Bell Labs, the research division of AT&T. Looking at years of data, they devised the "Rule of 1–10–100," which compares the cost differential with finding problems during inspection and in the field, versus preventing them altogether.

Q&A


ICC
INTERNATIONAL CODE COUNCIL
2012
INTERNATIONAL ENERGY CONSERVATION CODE
A Member of the International Code Family
IECC

BUILDING
KNOWLEDGE

Thank You!