Residential Building Energy Codes - IECC 2012 and Beyond

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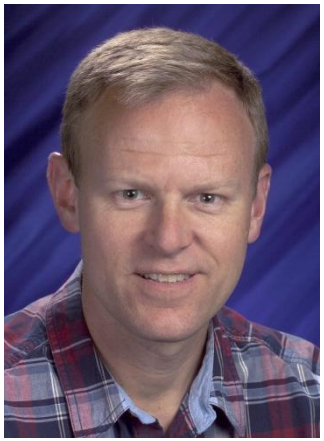
Today's Speaker



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Mr. Taylor specializes in building energy analysis, residential energy code development, large-scale building energy simulation, and analysis of large energy datasets. He is currently Manager of Residential Research and Development in the U.S. Department of Energy's Building Energy Codes Program at PNNL. For more than 25 years, Mr. Taylor has developed energy saving building codes, including the International Energy Conservation Code, ASHRAE Standard 90.2, manufactured housing energy standards, federal residential standards, Pacific Northwest regional codes, and others.

BUILDING ENERGY CODES

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

DOE's Involvement in Residential Energy Codes

Webinar 2011

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Overview of DOE's Involvement in Res Codes

- The world DOE lives in
- What DOE has been doing
- Significant changes in the latest revision of the IECC
- Where DOE is headed

The World of Codes

- 1980's through 2006
  - Minimum codes were truly minimal
  - DOE pushed for marginal improvements (1% to 3% per cycle)
  - DOE proposed (successfully) a major rewrite of the IECC in 2004 (became the 2006 IECC)—emphasis was format, not stringency
- 2009 to present
  - The world has changed
  - DOE working from two goals
    - 30% improvement in 2012 IECC (relative to 2006)
    - 50% improvement in 2015 IECC (relative to 2006)

Current IECC-Related Activities

- Two major code development goals:
  - Improve the 2012 IECC by 30% relative to the 2006 edition
  - Improve the 2015 IECC by 50% relative to the 2006 edition

- One major code implementation goal:
  - Assist states in achieving and documenting 90% compliance with the 2009 IECC by 2017

Things are getting more serious

What in the world has changed?

- Public interest
- Political will
- Pull at ICC

Notable impacts of those changes:

- More efficiency making it into codes
- More detail/complexity being pushed onto code officials
- More need for expertise and analysis tools in code process
- Less distinction between code, beyond-code programs

DOE's Other Than Codes-Related Activities

- NAHB Green Building Standards
- ICC Green Building Standards/Codes
- Development of manufactured housing energy standards
- Various appliance standard rulemakings
- Builder's Challenge, Energy Star, etc.

- These provide valuable inputs to the code development process
- (but cannot be transferred directly)

DOE's approach to advanced code development

- Update the IECC through the International Code Council's process
  - DOE has no regulatory authority, is just a participant in ICC process
  - DOE's public interactions not through rulemakings
- Engage all interested stakeholders in developing code change proposals
  - Occasional meetings (generally attended by 60+)
  - Email list (meeting attendees, historical contacts, by request, etc.)
  - Cooperate with others developing related proposals

So why doesn't DOE just apply beyond-code program experience to the design of residential energy codes?

- NAECA (National Appliance Energy Conservation Act of 1987)
  - Appliance (including residential HVAC equipment) efficiencies regulated by preemptive federal authority
  - Because of this, 2009 IECC prohibits envelope/equipment trade-offs
- Scope mismatch
  - Voluntary programs free to set HVAC efficiencies
  - Voluntary programs free to set other appliance efficiencies

So why doesn't DOE just apply beyond-code program experience to the design of residential energy codes?

- DOE's goals (30%/50%) defined differently from voluntary programs'
  - Limited to end uses regulated by the IECC (heating, cooling, water heating, lighting)
  - Because of NAECA, DOE's goals don't count savings from high-efficiency HVAC equipment
  - Therefore DOE needs to meet its goal using only changes to the envelope, lighting systems, and distribution systems
- So a HERS score of 70 doesn't match DOE's 30% improvement goal
  - Out-of-scope improvements may lower in-scope efficiencies
  - DOE's goal can be substantially harder to reach

More on this later…

Recent IECC Changes of Note

- 2009 IECC
  - Lighting added to IECC scope (at least 50% of lamps must be "high efficacy")
  - Mandatory duct system pressure test
  - No equipment-envelope trade-offs

  - 12% to 15% better than 2006 IECC

2012 IECC

2012 IECC – Overview

- Approximately 30% more efficient than the 2006 IECC
- Now constitutes (by reference) the energy chapter of the International Residential Code (IRC)
- Retains 2009 IECC's prohibition on envelope-equipment tradeoffs
- Scheduled for publication April 2011
- Currently under appeal at the ICC
- Contains a few major and many minor changes

2012 IECC – Major Changes

- New mandatory whole-house pressure test (blower door) with stringent required leakage rates
  - Zones 1-2: ≤ 5 ACH @50 Pa
  - Zones 3-8: ≤ 3 ACH @50 Pa
- Domestic hot water piping must be either
  - Insulated to R3, or
  - Short and skinny (i.e., exempted lengths depend on diameter)
- Duct leakage rates lowered
  - Eliminated “leakage to outdoors” option
  - From 12 to 4 CFM/100sf CFA (after construction)
  - From 6 to 4 CFM/100sf CFA (at rough-in)
- Various R-value/U-factor/SHGC improvements

2012 IECC – Major Prescriptive Envelope Changes

Zone	Ceiling R-Value
1	
2	R30 → R38
3	
4 except Marine	R38 → R49
5 and Marine 4	
6	
7 & 8	

2012 IECC – Major Prescriptive Envelope Changes

Zone	Wood-Frame Wall R-Value	Mass Wall R-Value
1		
2		
3	R13 → R20/R13+5	R5/8 → R8/13
4 except Marine		
5 and Marine 4		
6	R20/R13+5 → R20+5/R13+10	R15/19 → R15/20
7 & 8	R21 → R20+5/R13+10	

Implications of Wall Improvements

- 2x6 construction now “required” in some zones
  - Envelope trade-off options limited
  - Equipment trade-off options prohibited
- Log walls difficult to comply without large diameter logs or furred-in finish layer
- Insulating sheathing now “required” in some zones
  - Bracing options limited, especially with recent IRC changes

2012 IECC – Major Prescriptive Envelope Changes

Zone	Basement Wall R-Value	Crawlspace Wall R-Value
1		
2		
3		
4 except Marine		
5 and Marine 4	R10/13 → R15/19	R10/13 → R15/19
6		
7 & 8		

2012 IECC – Major Prescriptive Envelope Changes

Zone	Fenestration U-Factor	Fenestration SHGC
1	1.2 → 0.50	0.30 → 0.25 (except skylights)
2	0.65 → 0.40 (0.75 → 0.65 skylights)	
3	0.50 → 0.35 (0.65 → 0.55 skylights)	
4 except Marine	(0.60 → 0.55 skylights)	NR → 0.40
5 and Marine 4	0.35 → 0.32 (0.60 → 0.55 skylights)	
6		
7 & 8		

Future Directions

- Continue stakeholder interactions
- Develop specification that is 50% better than 2006 IECC without running afoul of NAECA
- Work to get that specification accepted into the 2015 IECC

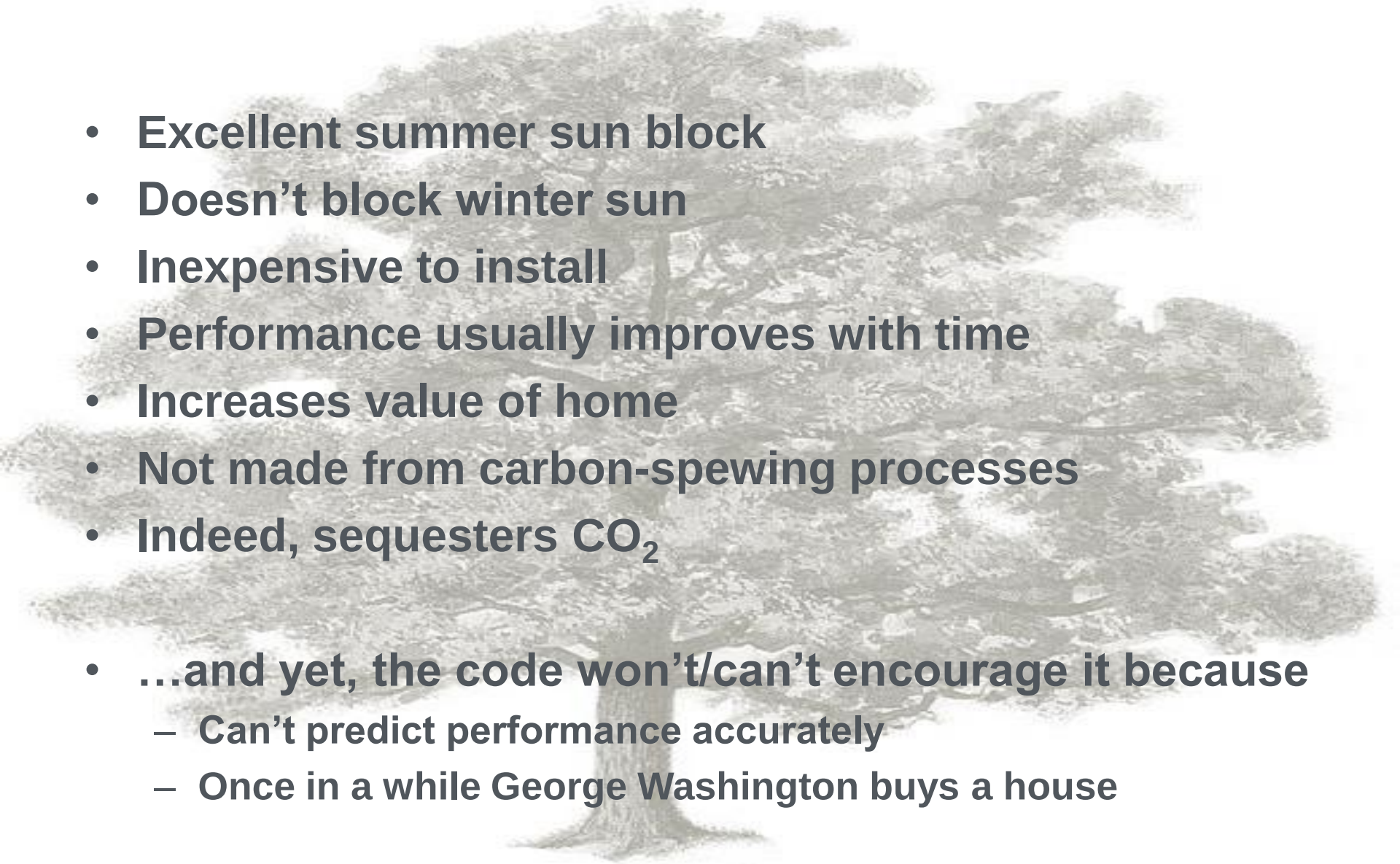
Future Directions, cont'd.

- Develop specification that is 50% better than 2006 IECC without running afoul of NAECA
  - Because high-efficiency equipment is off the table, the existing prescriptive-primary format is unlikely to work
  - DOE will evaluate alternative formats

Possible Future IECC Changes

- 2015 and beyond—what will it take to achieve 50% improvement over the 2006 IECC?
  - Orientation restrictions(?)
  - Requirements sensitive to house size(?)
  - Conversion of options to requirements(?)
  - Scope expansion to include (some) appliances(?)
  - Quality control (refrigerant charging, duct design, thermostat placement, etc.?)
  - Direct incorporation (i.e., requirement) of renewables(?)
  - Exploitation of traditionally shunned (often user-controlled) energy features(?)
    - Curtains
    - Shade trees
    - Green trellises

Deciduous Tree Example



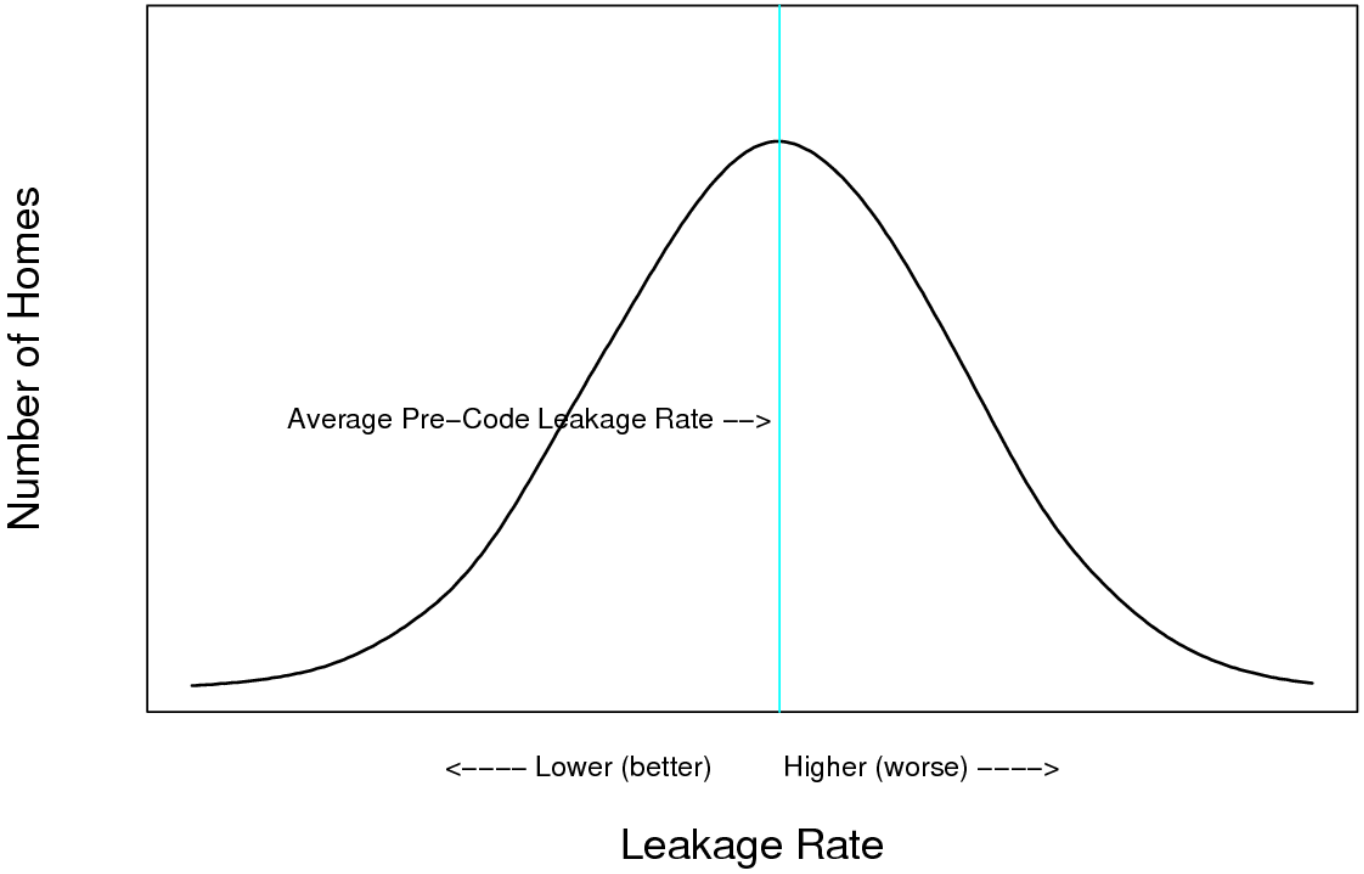
- Excellent summer sun block
- Doesn't block winter sun
- Inexpensive to install
- Performance usually improves with time
- Increases value of home
- Not made from carbon-spewing processes
- Indeed, sequesters CO_2

- …and yet, the code won't/can't encourage it because
  - Can't predict performance accurately
  - Once in a while George Washington buys a house

So why doesn't DOE just apply beyond-code program experience to the design of residential energy codes?

- Calculating the impact of virtually any measure that was not previously regulated is complicated
  - Cutting off tails is different from how code improvements generally work

Air Leakage as an example…



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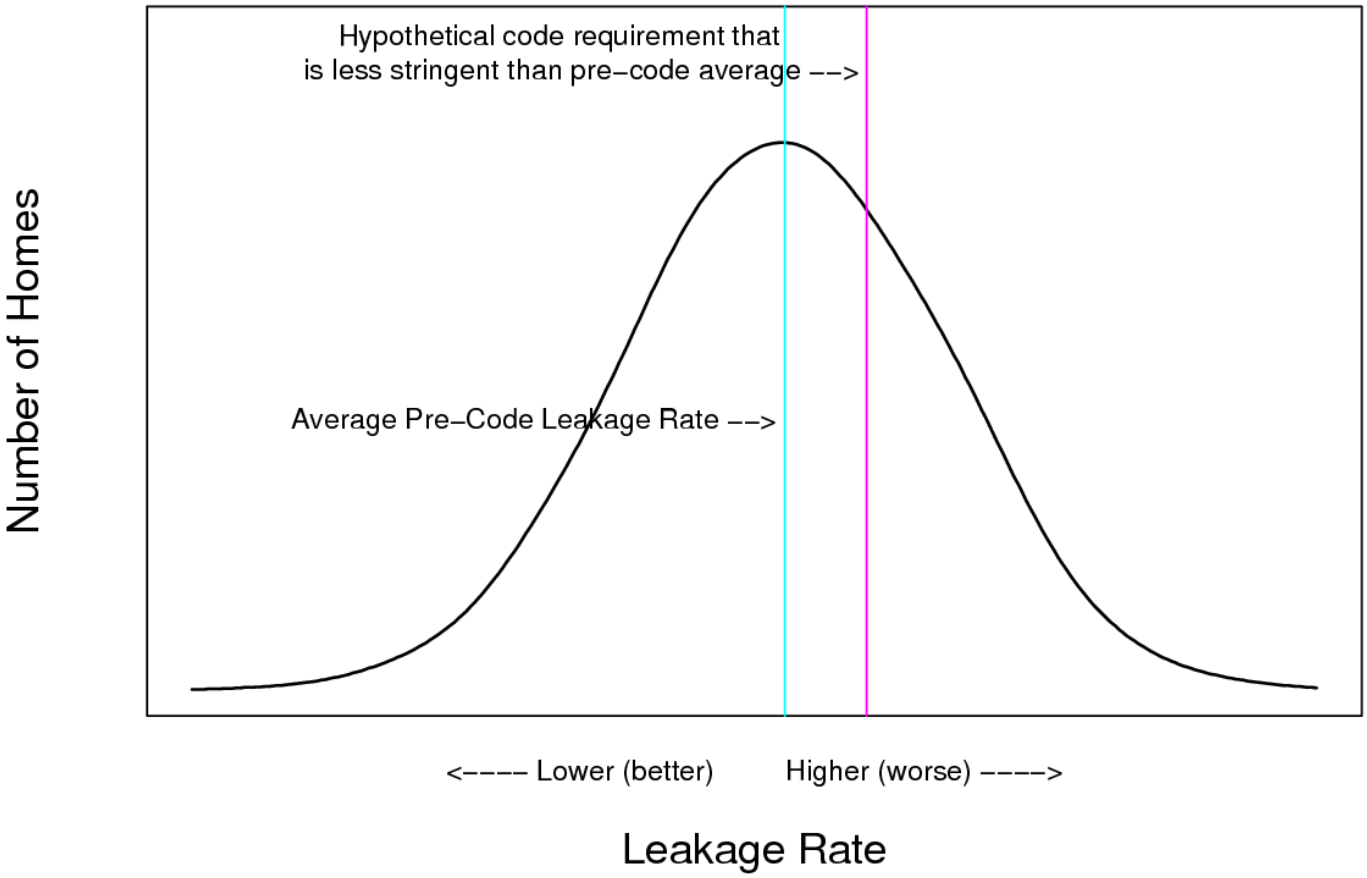

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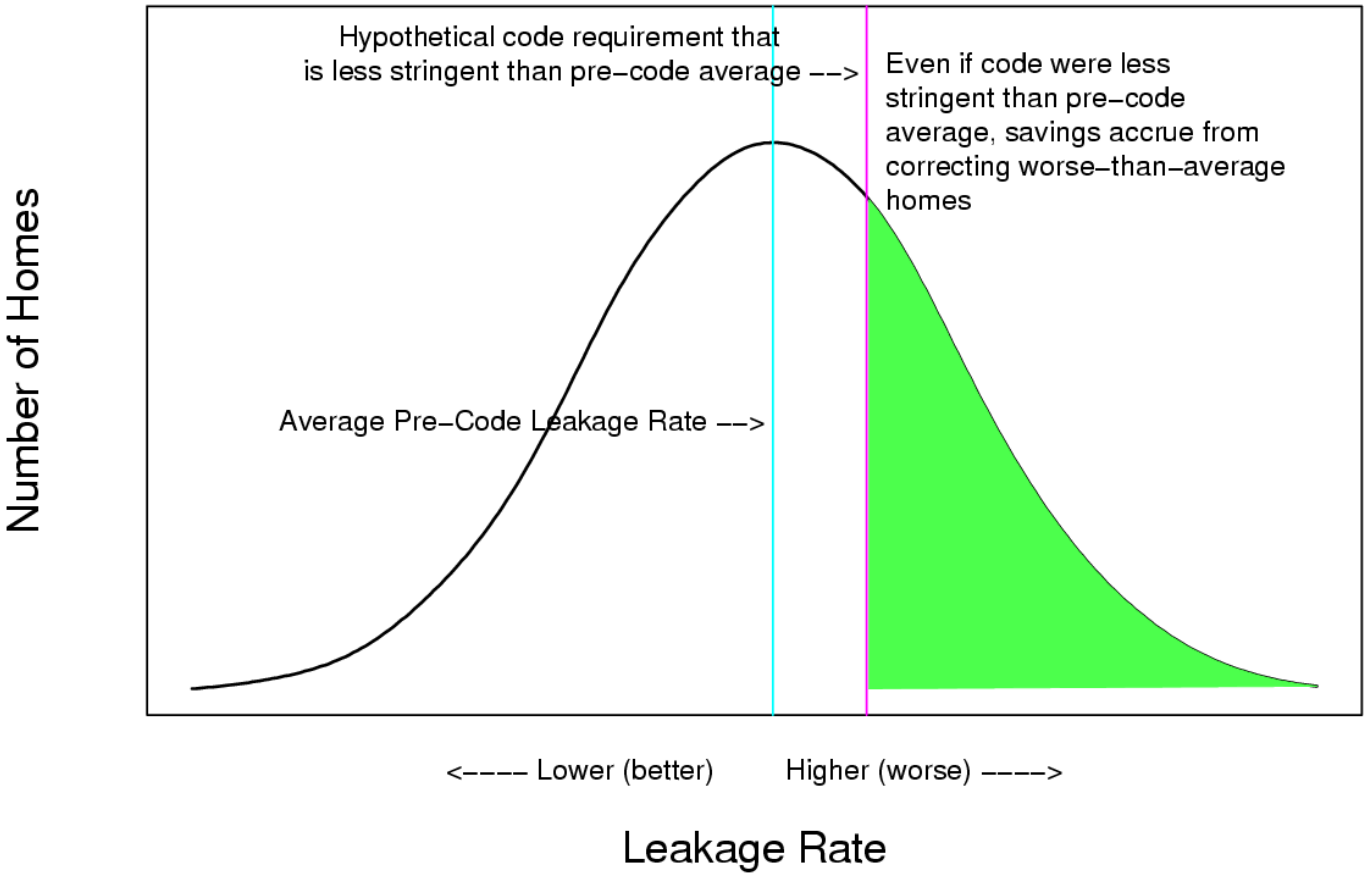

So why doesn't DOE just apply beyond-code program experience to the design of residential energy codes?

- Calculating the impact of virtually any measure that was not previously regulated is complicated
  - Cutting off tails is different from how code improvements generally work
  - HERS and other performance tools typically only compare two buildings (don't deal with tails)

Changes to code format

- It is not clear that 50% improvement can be achieved prescriptively

Zone	Ceiling R	Wall R	Floor R	Glazing U
1	49	22	36	0.25
2	60	30	49	0.15
3	99 (!!)	36 (!!)	60 (I quit)	0.05
…				

Potential new code formats

- It is not clear that 50% improvement can be achieved prescriptively
- Several new approaches have been discussed
  - Prescriptive baseline with a performance requirement of X% better ("prescriptive plus")
  - Annual performance budget (Btu/ft^2)
  - Annual performance budget (Btu…size matters)
  - Annual Carbon budget
  - Any of the above with post-occupancy metering
  - Required renewables (i.e., regardless of performance budgets, cost effectiveness, etc.)
  - Capacity constraints

Potential new code formats

- "Prescriptive plus" (must exceed prescriptive by X%)
  - Strengths
    - Allows some important features to be made essentially mandatory
    - Allows design flexibility to accommodate local conditions (lot/site, specific plan, etc.)
  - Weaknesses
    - A constant %-better requirement may not be fair or even sensible
    - Requires infrastructure that is currently inadequate
    - Enforcement is complicated
    - Incentives are inverted
      - Focus is on showing compliance, not getting the building right
      - Focus is on the simulation, not the building
      - Focus is on pleasing the code official, not the occupant
      - Simulator has divided allegiances

Potential new code formats

- Annual performance budget (Btu/ft^2*yr)
  - Strengths
    - Allows maximum design flexibility to accommodate local conditions
    - Can, in theory, accommodate any energy-saving feature
  - Weaknesses
    - May favor larger homes unless made sufficiently complex
    - Requires infrastructure that is currently inadequate
    - Enforcement is complicated
    - Incentives are inverted
    - Invites new controversies (are all square feet equal?)

Potential new code formats

- Carbon budgets (either per-ft^2 or absolute)
  - Strengths
    - Similar to annual performance budget
    - Able to account for environmental impacts beyond energy use
  - Weaknesses
    - Similar to annual performance budget
    - Invites new controversies
      - Not all Btus are equal?
      - Trade energy for materials?
      - Green power?
      - Carbon credits?

Potential new code formats

- Mandatory renewables
  - Strengths
    - Promotes market transformation
  - Weaknesses
    - May not make sense everywhere in a zone
    - Only part of the solution

Potential new code formats

- Capacity constraints
- What are they?
  - Most code provisions are designed to limit the amount of energy consumed by a house
  - Energy constraints are often difficult to enforce
    - Prescriptive requirements are dependent on proper installation and quality control (official lacks time/expertise, builder may not care)
    - Prescriptive requirements don't encourage integrated design
    - Btu/carbon budgets are all about simulation/calculation/rules (i.e., you're actually regulating a large suite of surrogates for Btus)
    - Post-occupancy metering doesn't fit the enforcement paradigm
  - Capacity constraints may solve some of those problems
  - Idea: limit key capacities rather than consumption

Potential new code formats

- Capacity constraints—an example
- Code: Electric panel ≤ X Amps
  - 100% enforceable by unsophisticated official
  - Inspection requires 15 seconds
  - Builder's interest shifts from compliance to design (else the house won't work and the occupants will be unhappy)
  - Effectively and predictably reduces peak load as well
  - Leaves open all efficiency options
- Reality
  - Need to limit several capacities (furnace, A/C, others?)
  - Might discourage certain control options
  - Probably need to be paired with some traditional requirements

Potential new code formats

- Capacity constraints
  - Strengths
    - Re-inverts incentives
    - Enforcement is simplified
    - Required infrastructure is focused on design, not compliance
  - Weaknesses
    - Requires infrastructure that doesn't currently exist
    - Can it be done?
      - Will they really save the desired energy (you're regulating a surrogate again)?
      - Are there enough pinch points?
      - Are the pinch levels consistent enough across climates, house types, etc.?

Summary

- Things are getting more serious
- If DOE (and others) are successful, the IECC will be as good or better than most current beyond-code programs
- Calculating impacts in a way comparable with beyond-code programs is difficult
- Creative changes to the code format and/or enforcement infrastructure will likely be needed
- Development of a currently nonexistent (or at least inadequate) expert infrastructure will likely be needed

Question and Answer Session

Questions will be submitted electronically and answers will be provided verbally

To submit a question, select Q&A on the top bar, click in the top box, type your question, click Ask

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