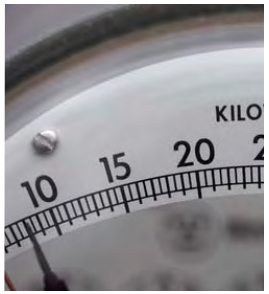
BUILDING ENERGY CODES

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



The Evolving Relationship Between Energy Codes, Beyond-Code Programs, and Home Energy Ratings

RESNET Conference 2010

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Overview

- What's evolved
- What DOE is up to…
  - Current IECC-related activities
  - Other residential code-related activities
  - Related residential energy efficiency activities
- A few notable impacts
- Discussion of potential issues

What's evolved?

- Public interest
- Political will
- Pull at ICC

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
- One major new direction:
  - Existing buildings

Other Codes-Related Activities

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

(Are these really codes related?)

- Yes, if we see them offered as inputs to code developers or alternatives for adoption
- Yes, if their tools have potential application to codes

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

Notable impacts of those changes, cont'd.

- Less distinction between code, beyond-code programs
  - Before:
    - Codes had large "N," captive audience, easy requirements, minimal infrastructure
    - Beyond-code programs had small "N," interested audience, tougher requirements, expert infrastructure
  - Now:
    - Codes has large "N," captive audience, **tougher** requirements, minimal infrastructure
    - Beyond-code expertise will need to move into code, where audience is less interested than typical

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

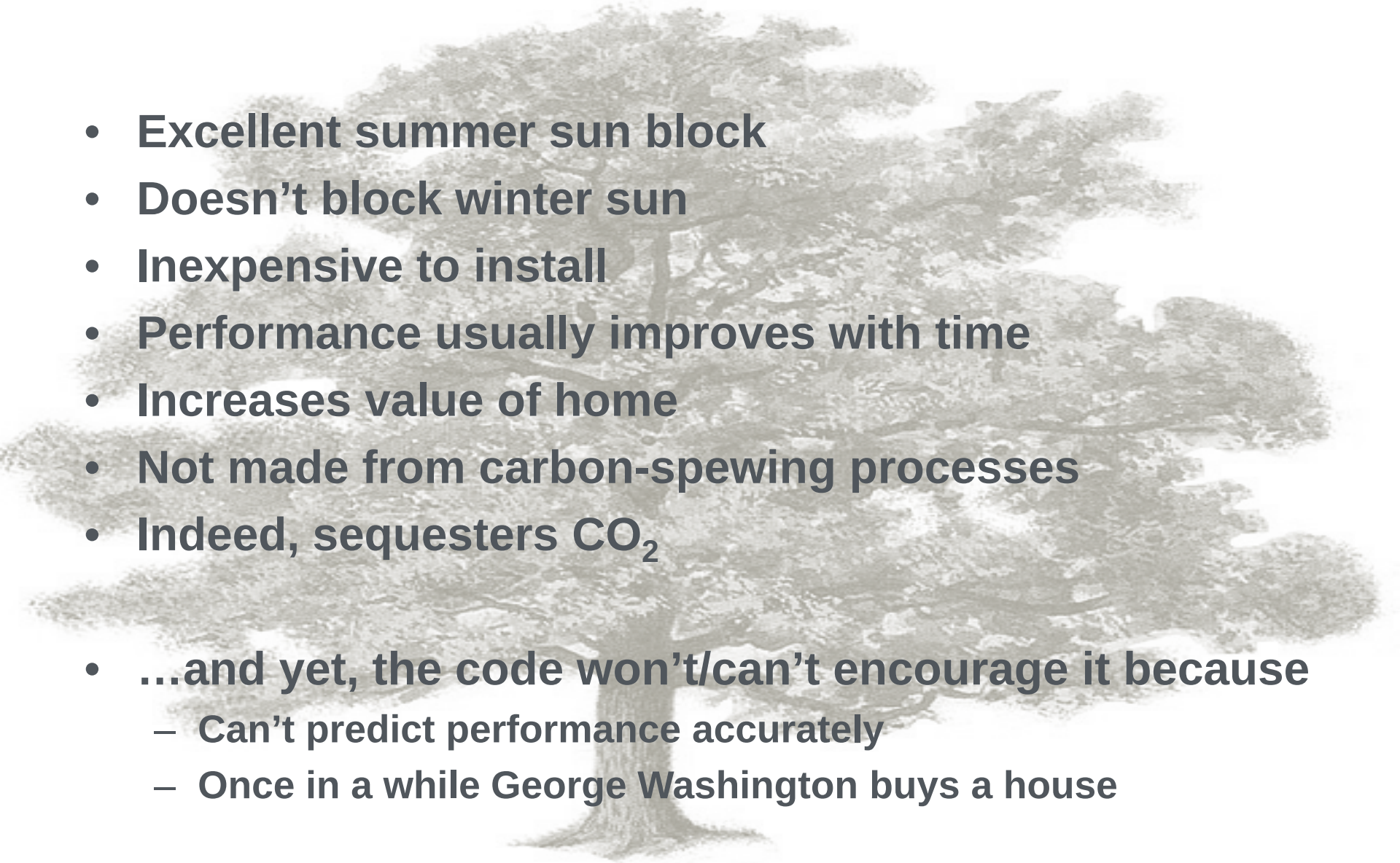
Recent IECC Changes of Note, cont'd.

- 2012 IECC (proposed, approved at 1st hearing)
  - More stringent duct leakage limits
  - Requirement for ducts indoors
  - Mandated whole-house pressure test (with allowance for code official-managed sampling)
  - Requirement for hot water pipe insulation (unless pipes are short/skinny)
  - Some R-value/U-factor improvements
  - (Still) no equipment-envelope performance trade-offs in performance path
  - ~30% better than 2006

Possible Future IECC Changes

- 2015 and beyond – what will it take to achieve 50% improvement ove
  - Orientation restri
  - Requirements se
  - Conversion of op
  - Scope expansion
  - Quality control (re placement, etc.?)
  - Direct incorporati
  - Exploitation of tra 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

POTENTIAL ISSUES

Issue: Equipment Efficiency

- National Appliance Energy Conservation Act of 1987 (NAECA)
  - Preemptively regulates efficiencies of residential-sized equipment
  - Directs DOE to establish minimum efficiencies by rulemaking
  - Restricts how state/local building codes may incorporate high-efficiency equipment
    - At least one package must use NAECA-minimum equipment
    - For each package with high-efficiency equipment, there must be at least one package with equipment not exceeding NAECA-minimum by more than 5%
    - Packages must be one-for-one equivalent (energy or energy cost)
    - Performance baseline must be NAECA-minimum equipment
    - Performance trade-offs must be one-for-one (energy or energy cost)

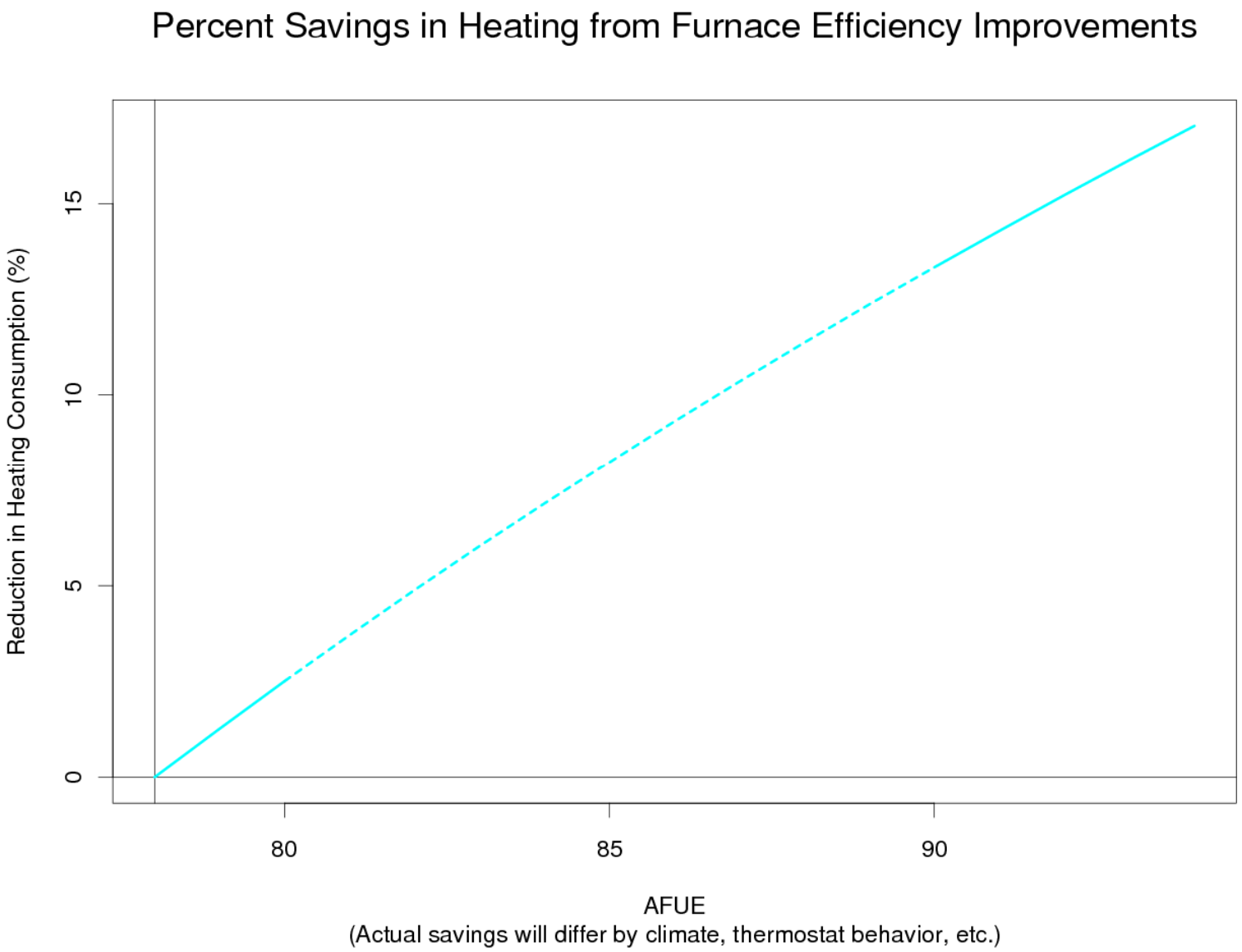
Issue: Equipment Efficiency, cont'd.

- 2009 IECC disallows equipment trade-offs—why?
  - "Why" is not a valid question in the ICC's process
  - However the major arguments are fairly clear…
    - Equipment efficiency is legally outside the scope of the IECC
      - If the code can't regulate it, the code shouldn't give credit for it
      - NAECA minimums haven't kept up with typical practice
      - So, equipment efficiency is a "free rider" bypass
    - Energy saved by high-efficiency equipment is short-lived
      - ~15-20 years versus 30-100 years for envelope
      - Replacement equipment not likely to be influenced by initial equipment
      - So, trading envelope for HVAC efficiency is a net loser
    - Comfort of good envelope is generally better, may induce lower heating and higher cooling setpoints

Issue: Equipment Efficiency, cont'd.

- Implications of an equipment-blind IECC
  - DOE's 30/50% goals may be more ambitious than would be similar goals in a voluntary above-code program

Issue: Equipment Efficiency, cont'd.



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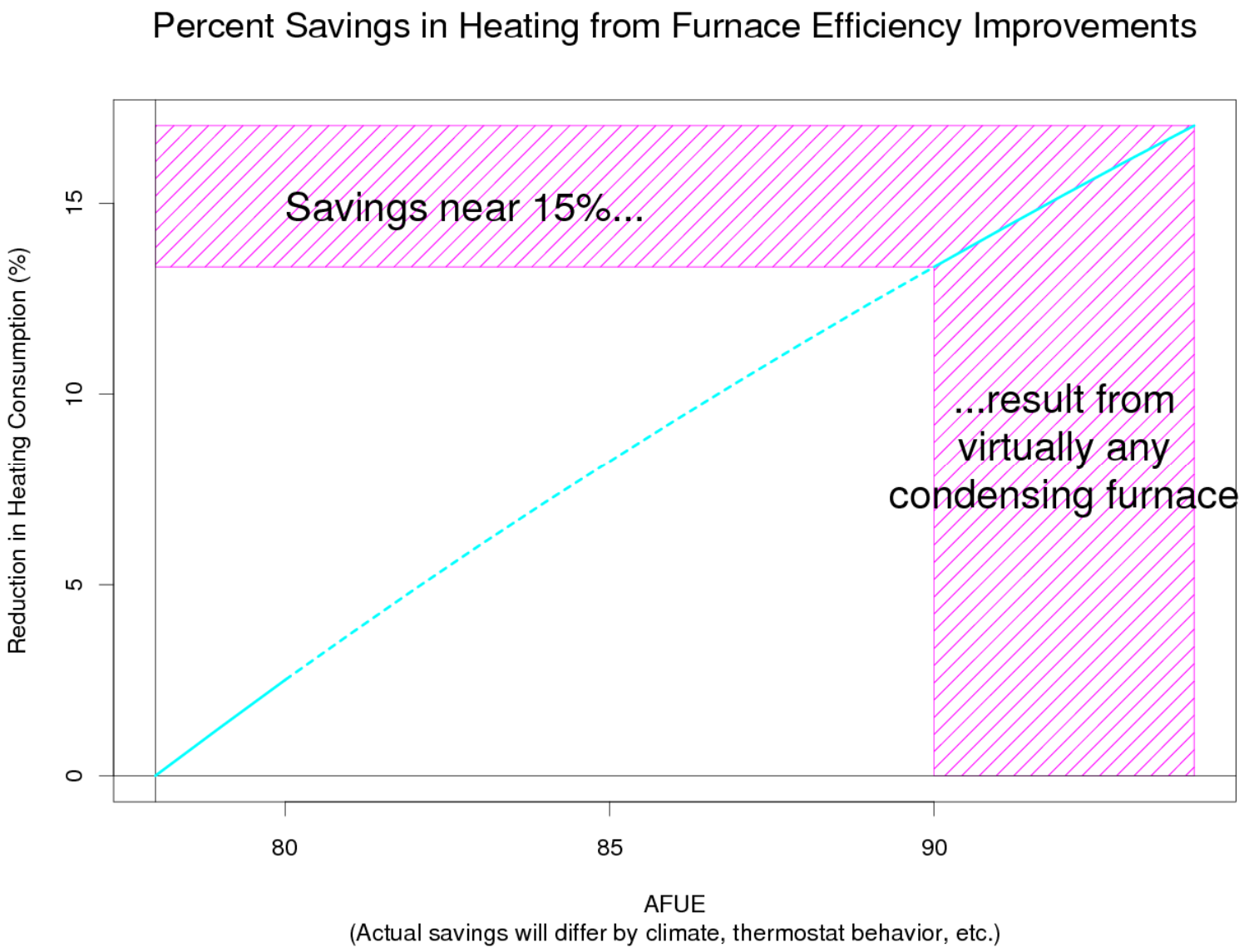
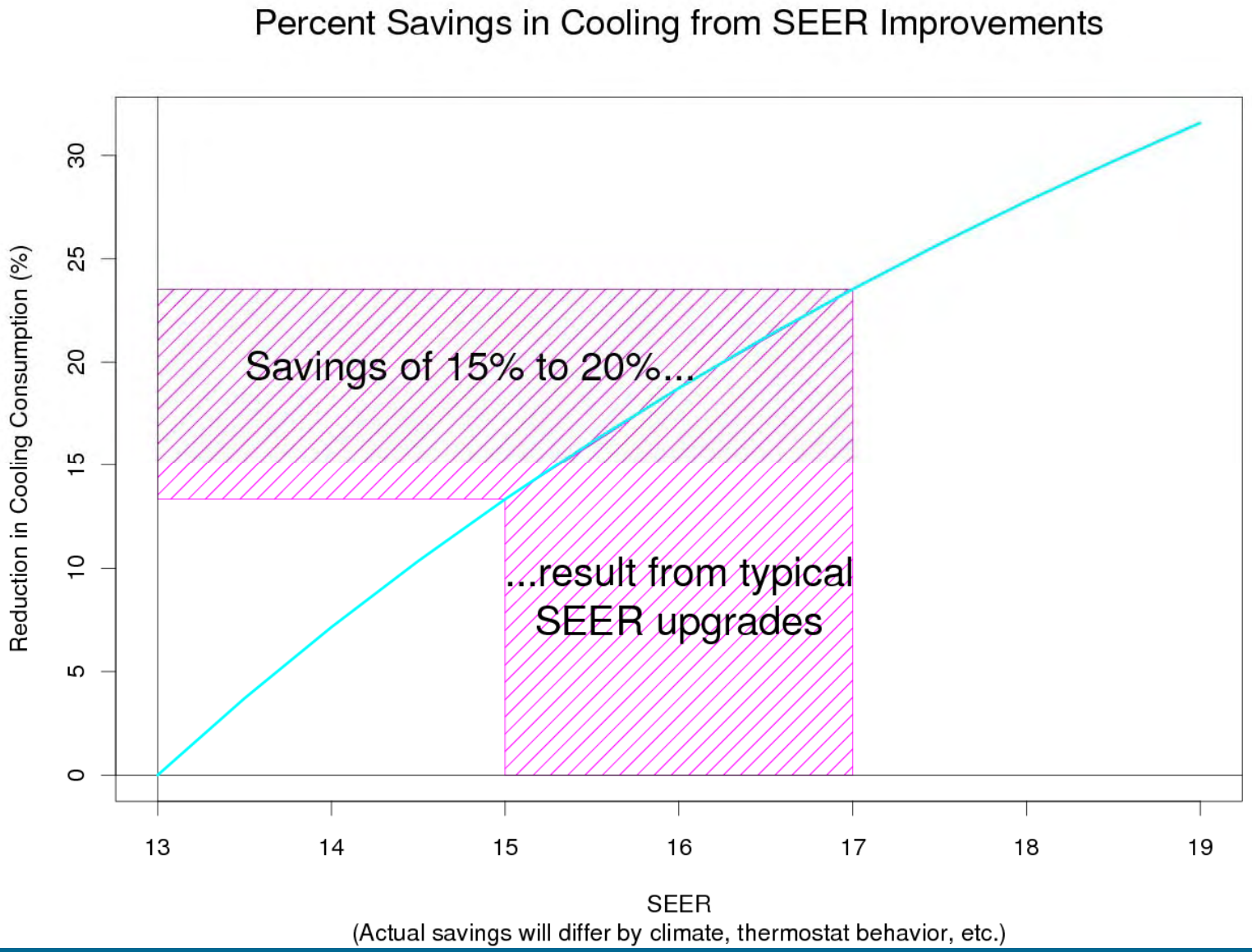


Issue: Equipment Efficiency, cont'd.



Issue: Equipment Efficiency, cont'd.

- Implications of an equipment-blind IECC
  - DOE's 30%/50% goals may be substantially more ambitious than would be similar goals in a voluntary above-code program
    - Equipment is off the table—almost half of the 30% goal
    - Other end uses (appliances, etc.) are also off the table
    - All savings must come from envelope, ducts, pipes
  - Beyond-code program experience not always directly transferrable to codes
  - HERS index (or *E-Scale*) can differ substantially from IECC measure of percent-better

Issue: Scope of Code

- IECC regulates only heating, cooling, and water heating
- And lighting (as of 2009)
- Not covered
  - Dishwashers
  - Refrigerators
  - Ranges & Ovens
  - Washers & Dryers
  - Other plug loads
- DOE's goal: 30% of what?

Issue: Scope of Code, cont'd.

- DOE's goal: 30% of what?
  - Baseline is 2006 IECC, which covers only H, C, WH
  - Does "30% better than the 2006 IECC" mean…
    - Whole-house energy is 30% less?
    - (Heat + Cool + H2O) is 30% less?
    - (Heat + Cool + H2O + Lighting) is 30% less?

      but 2006 IECC had no lighting requirements
- DOE has decided:
  - Code improvements reduce national average energy cost by 30% compared to the energy regulated by the 2006 IECC
  - Therefore, savings from scope expansions (e.g., lighting) are counted in the numerator but not the denominator
  - That's weird, but it provides a stable progress indicator as the scope of the code changes

Issue: Scope of Code, cont'd.

- That's weird—what does it mean?

$$\%better = 100 \times \frac{Energy_{2006} - Energy_{2012}}{EnergyInScope_{2006}}$$

$$\%better = 100 \times \frac{(H + C + WH + L)_{2006} - (H + C + WH + L)_{2012}}{(H + C + WH)_{2006}}$$

- But L_{2006} doesn't exist…

$$\%better = 100 \times \frac{(H + C + WH)_{2006} - (H + C + WH)_{2012} + Lsaved_{06to12}}{(H + C + WH)_{2006}}$$

Issue: Scope of Code, cont'd.

- That's weird…why not just modify the denominator with each scope expansion?
  - ***%better*** as a progress indicator might not increase monotonically
  - a scope expansion doesn't necessarily set the new requirement to be better than the previous average

    (more on that later)

Issue: Scope of Code, cont'd.

- That's weird…are there really any more scope expansions to worry about?
  - Possibly some appliances
  - Possibly some odd things
    - Orientation (not currently in prescriptive path)
    - House size (possibly indirectly)
    - Maybe some QA things (air distribution, refrigerant charge, etc.)
    - Air infiltration and duct leakage, in a sense
- But other than appliances, none of those adds any new end uses to the scope

Issue: Scope of Code, cont'd.

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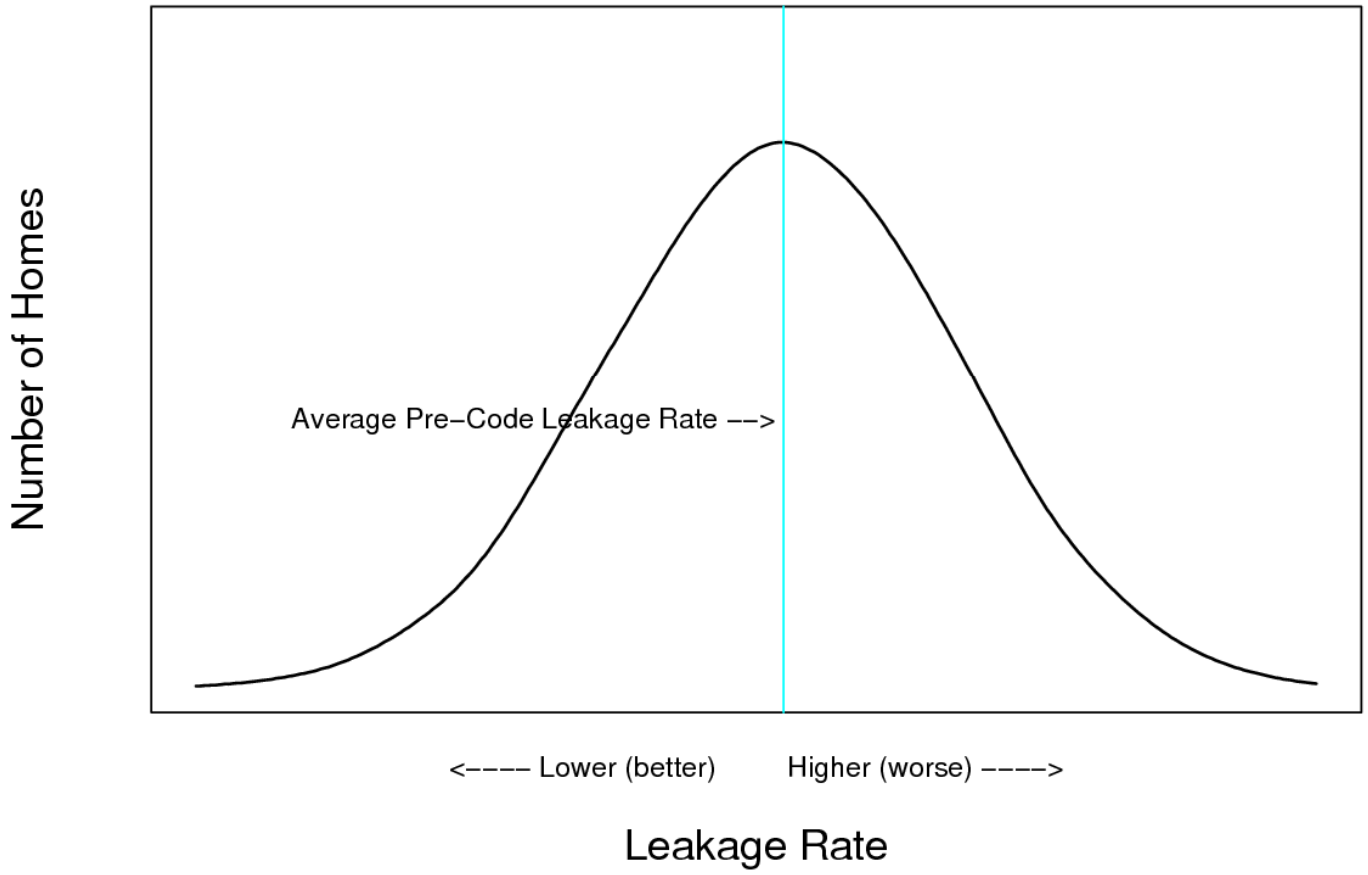
    - Maybe some QA things (air distribution, refrigerant charge, etc.)
    - Air infiltration and duct leakage, in a sense
- Calculating the impact of virtually any measure that was not previously regulated is complicated
  - Air infiltration was previously regulated
  - But not quantifiably or enforceably

Air Leakage as an example…



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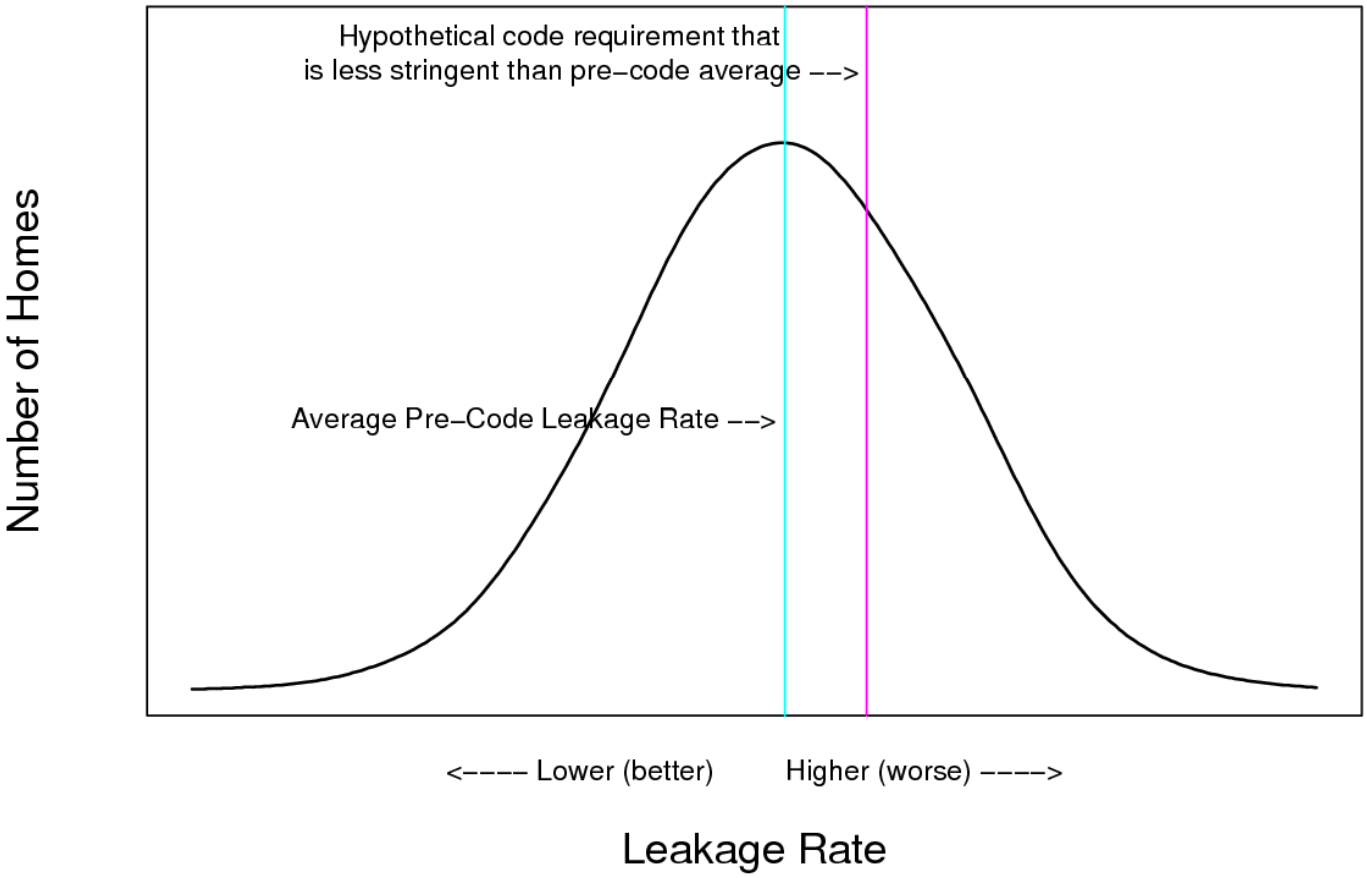

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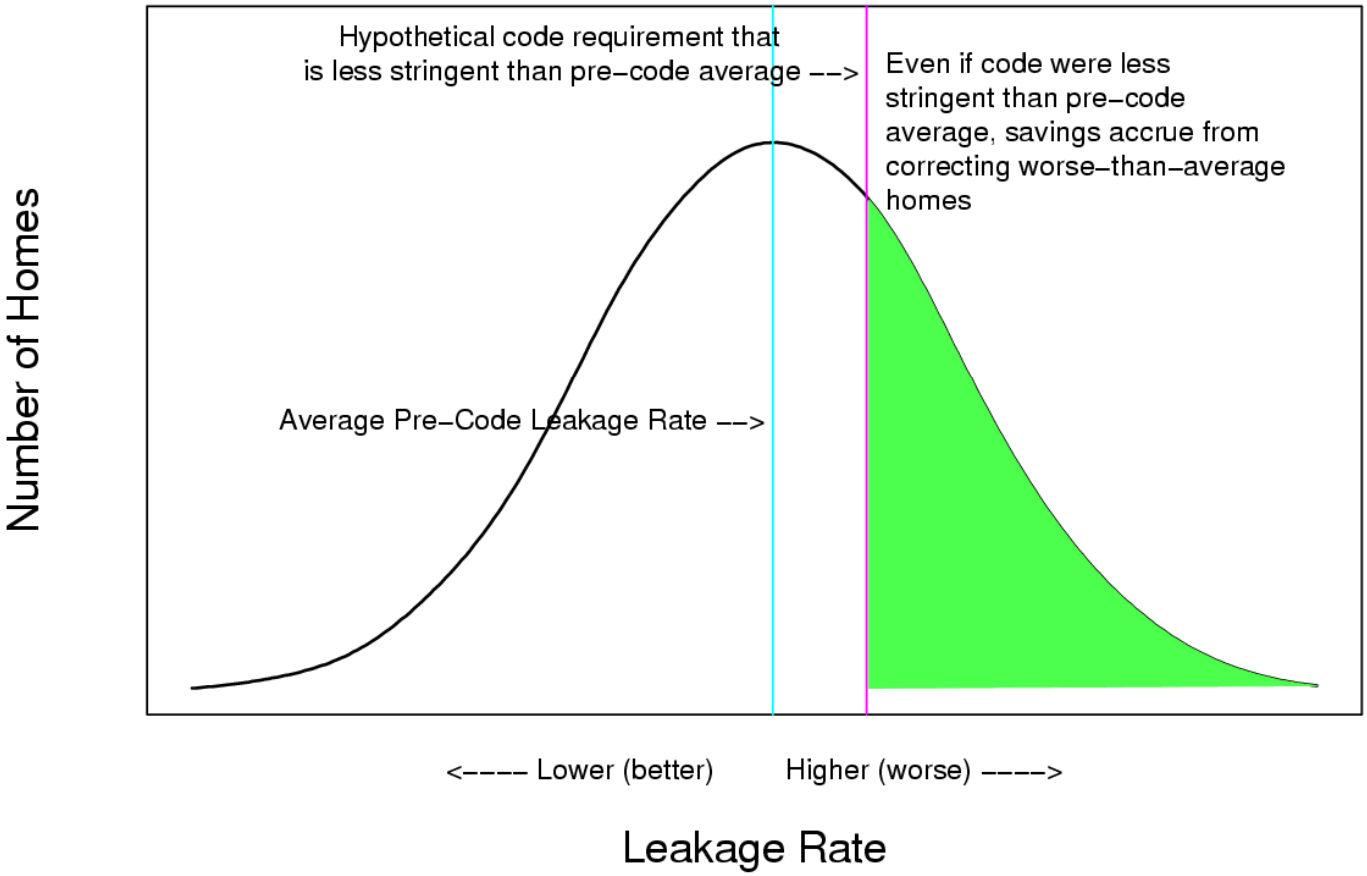

Issue: Scope of Code, cont'd.

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    - Maybe some QA things (air distribution, refrigerant charge, etc.)
    - Air infiltration and duct leakage, in a sense
- 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)

Issue: Sampling

- Many builders are accustomed to Energy Star-style sampling for leakage tests
- Is sampling legally permissible for codes?
  - The code official signs off on a house, not a subdivision
  - Who is liable if a homeowner finds her house substandard?
  - Requires a type of record keeping not common to code offices
- Can sampling adequately regulate the right entities?
  - Does sampling apply to a builder? A subcontractor? A slate of subcontractors? A builder-sub combo?
  - Does sampling apply to a builder? A subdivision? A plan?
- Nevertheless, DOE has proposed allowing code official-managed sampling of envelope leakage

Issue: 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
…				

Issue: Changes to Code Format, cont'd.

- 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 Btu/ft^2 budget ("BEPS")
  - Annual Btu budget (like BEPS, but 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

Issue: Changes to Code Format, cont'd.

- "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

Issue: Changes to Code Format, cont'd.

- "BEPS" (Btu/ft^2*yr budget)
  - Strengths
    - Allows maximum design flexibility to accommodate local conditions
    - Can, in theory, accommodate <u>any</u> 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?)

Issue: Changes to Code Format, cont'd.

- "BEPS absolute" (Btu/yr budget)
  - Strengths
    - Allows design flexibility to accommodate local conditions
    - Can, in theory, accommodate any energy-saving feature
    - Encourages smaller homes
  - Weaknesses
    - Certain larger homes are disallowed almost without recourse
    - May be too lenient on smaller homes
    - Requires infrastructure that is currently inadequate
    - Enforcement is complicated
    - Incentives are inverted
    - Invites new controversies (discriminates against large families?)

Issue: Changes to Code Format, cont'd.

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

Issue: Changes to Code Format, cont'd.

- Post-occupancy metering (with any of the above)
  - Strengths
    - Re-inverts incentives
  - Weaknesses
    - Penalizes (or rewards) builder for occupant's behavior
    - Regulates whom?
    - Penalizes or rewards (whomever) for family size, lifestyle, etc.
    - Requires development and deployment of an energy police force

Issue: Changes to Code Format, cont'd.

- Mandatory renewables
  - Strengths
    - Promotes market transformation
  - Weaknesses
    - Only part of the solution

Issue: Changes to Code Format, cont'd.

- 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

Issue: Changes to Code Format, cont'd.

- 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
  - Might need to be paired with some traditional requirements

Issue: Changes to Code Format, cont'd.

- 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

- 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
- A code that efficient will require development of a currently nonexistent (or at least inadequate) expert infrastructure
- Creative changes to the code format and/or enforcement infrastructure will likely be needed
- Beyond-code expertise, experience, and tools, with some customizations, will be need to be brought to bear on the code compliance/enforcement problem