

# Emerging Approaches to Residential Heating and Air- Conditioning

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# Scope of the Presentation

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- Reducing Loads: the starting point.
  - Envelope & ducts.
  - HVAC system installation.
- Advanced approaches that are on the market today.
  - Air conditioning.
  - Heating.

# Think Systems, not Widgets

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- New Construction: build better, reduce loads.
  - Windows, Infiltration control, Crawl spaces
  - No equipment or ducts in attics.
- Replacement: First, repair the defects.
- All:
  - Get your ducts-in-a-row.
  - Compute loads accurately.
  - Install correctly.

# New Construction Upgrades

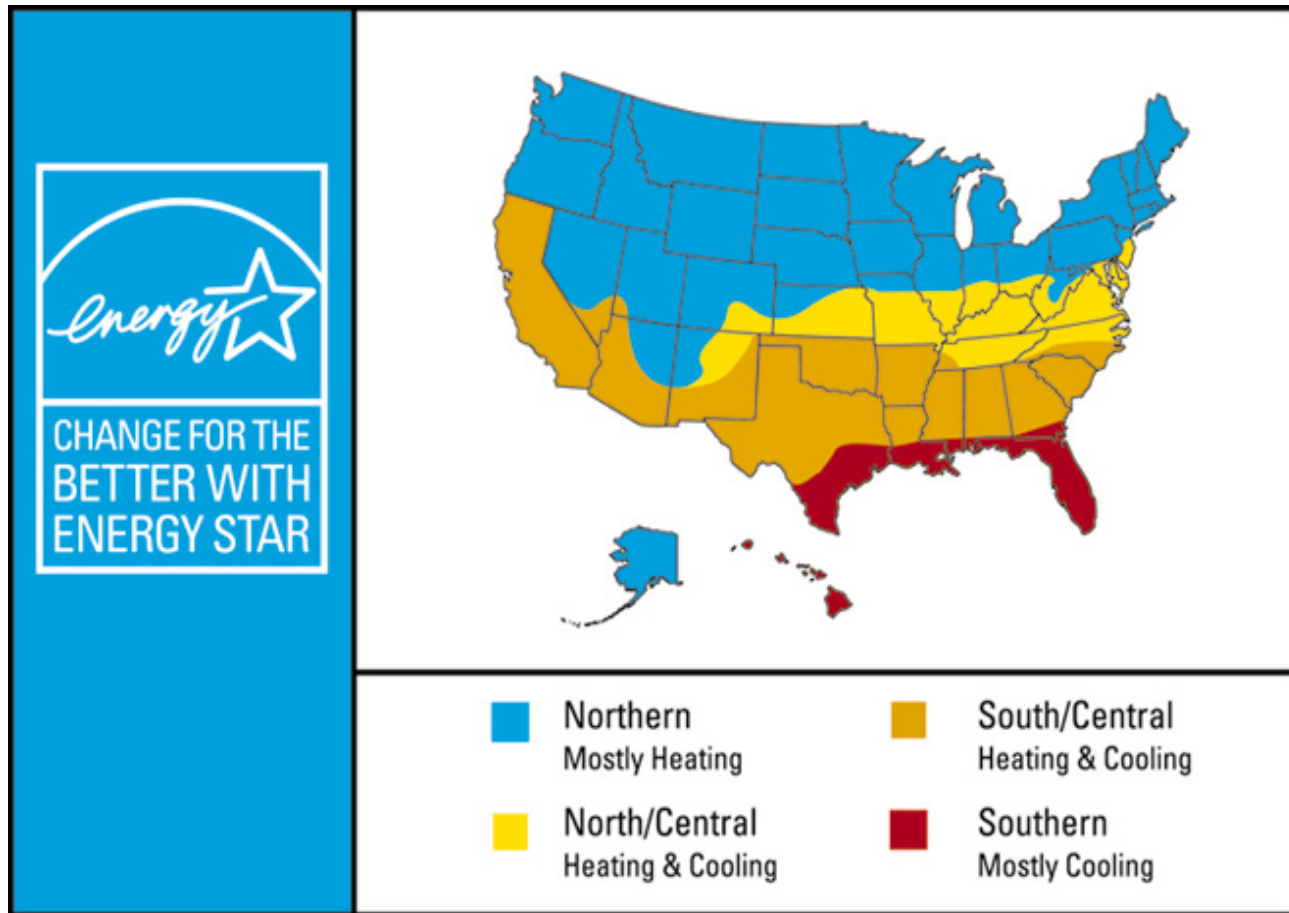
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## Energy Star windows

- Perhaps \$15/window incremental cost
- Save \$45/yr in NC – 2004 tariffs
  - Assume gas heat, std. A/C.
  - Assume 2000 sf, 300 sf windows.
- Reduce load ~1/2 ton in moderate size homes.

# Energy Star Window Regions



# Locating equipment & ducts

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- Inside the thermal envelope.
  - Mechanical closet or room, or even cellar.
- Why keep ducts out of attics:
  - Air leakage, Pressurization problems.
  - Insulation issues.
  - “External static pressure” and flex-duct spaghetti.

# Air Leakage from Air Handlers: Put 'em inside!

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- Air handlers are the high pressure points.
  - Typically ~ 100 pa (0.4 inches water)
- Indoor air handlers:
  - 37% of leakage to outside, inc. 28% of indoor.
- Attic air handlers:
  - 63% to outside, inc. 81% of return leakage.
- Garage air handlers:
  - 56% to outside, inc. 68% of return leakage.

# Rethinking the Crawl-Space

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# Air Conditioners for Mold Growth ☹️

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- Uncontrolled ventilation (duct leaks) guarantees high humidity loads.
- Good dehumidification requires long operating cycles.
- Oversizing guarantees short cycles.
- And how much time does your equipment spend at peak conditions?

# Selling Comfort, Avoiding Pain

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- Sizing: “ACCA Manual J or Better”
- Installation
  - Charge
  - Air-flow and duct issues
    - And who laid out those ducts?
    - And who sealed those ducts?
    - And who insulated those “outdoor” ducts?
    - And who thought the garage was the place for AC?



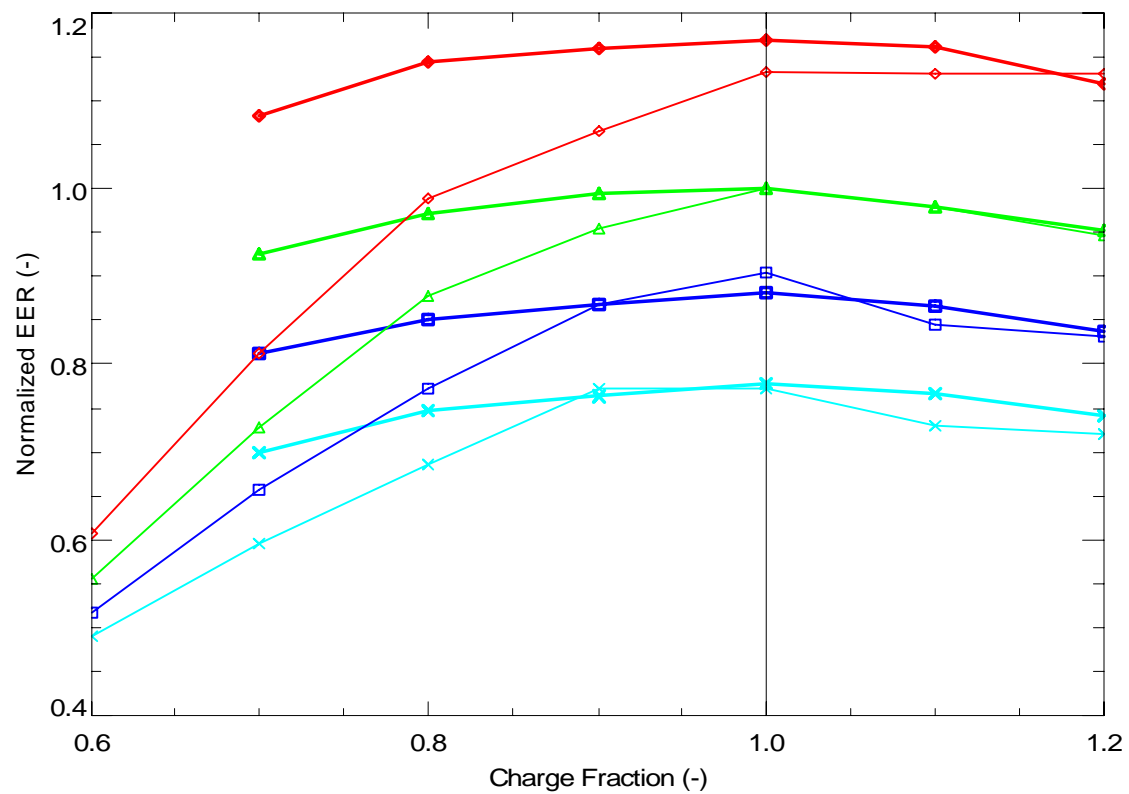
# Charge, Capacity, Efficiency

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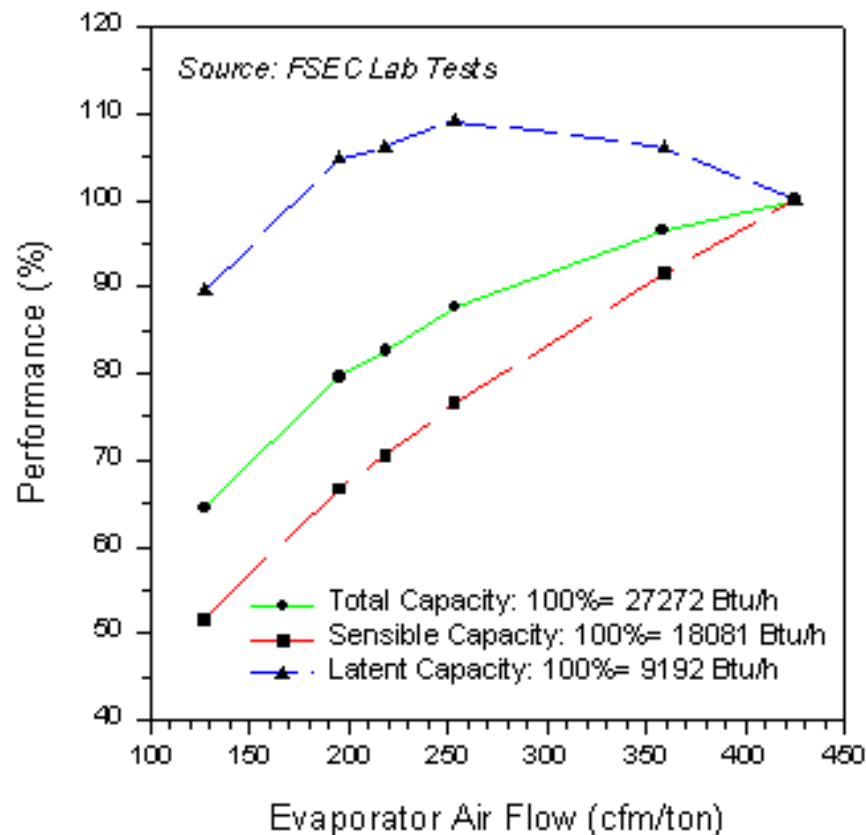
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- If refrigerant charge is off, capacity decreases.
- So does efficiency.
- Less true with “feedback refrigerant metering, AKA “TXVs”

# EER v. Refrigerant Charge



# Efficiency v. Air Flow – Latent and Sensible



**Figure 6** Impact of reduced airflow on cooling capacity

# External Static Pressure ~ Duct Friction

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Capacity Btu/h	ESP now	ESP Proposed?
Up to 28,800	0.10	0.35
29,000 – 42,500	0.15	0.50
43,000 and above	0.20	0.65

# Ratings: the Villain

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- National Standard – One size fits all regions.
- Current work:
  - High Temperature (“Western”) Standard
  - High Humidity (“SE”) Standard
- Modified SEER or
  - Multipoint EER?
  - Air-flow-controlled?

# Furnaces

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- What's to love about non-condensing furnaces (80% AFUE) when gas is >\$1.50/therm?
- Zen and the magic of furnace fans.
  - ECM, PSC, and cfm/w

# Payback for Condensing Furnace, Raleigh, NC (E\* calculator)

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Natural Gas, \$/therm	Simple Payback, years
\$1.00	2.6
\$1.25	2.1
\$1.50	1.8
\$1.75	1.5
\$2.00	1.3

# Are Ratings the Villain here, too?

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- Engineering Problem: Missing AFUEs
  - Not a rating problem, maybe a policy issue.
- Missing in Action: Furnace Electricity Use
  - Very variable, from <2% of site energy to >6% of site energy.
  - High electricity use (fan motor) reduces gas use, but increases A/C electricity use.

# Summary

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- Step 1: Reduce Loads
- Step 2: Equipment and ducts inside the envelope.
- ENERGY STAR is GOOD.
- There is life above ENERGY STAR
  - Higher-performance equipment, by region.
  - Emerging Opportunities not considered here

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