Technical Support for the 2008 Energy Star Windows Revisions

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DRAFT, final version available at:
http://windows.lbl.gov/ESTAR2008

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Technical Support

- Part I: Modeling Assumptions for developing a national database of space heating and cooling energy impacts from windows:
  - Steve Selkowitz
- Part II: A National Energy Savings Model of US Windows Sales:
  - Josh Apte
- Details at: windows.lbl.gov/EStar2008

Simulation Model Background

- Computer Simulations of Window Performance in a Typical House used to assess energy savings potentials from Energy Star program
- Analysis performed in many US climates
- “RESFEN” program utilizes DOE-2 Building Simulation Model;
  - “Typical House”: house parameters and operating parameters
  - Window and window-related parameters
- “Typical House” last updated in 1998 in RESFEN 5
  - New and Existing houses defined separately
  - Characteristics vary with climate

“Typical House” for 2008

- NFRC has been working to update definitions of a “Typical House” over the past decade
- Considered all NFRC 901 recommendations
- Updated assumptions to reflect changes in the building sector or incorporate better information available over the past decade
- Improved some questionable or poorly substantiated modeling assumptions
- Changes in 7 key areas

7 Specific DOE-2 modeling changes:

Impact total energy use
Impact Heating/Cooling Balance

1. ***Building size and type*** - change from a single 2000 ft^2 one-story prototype to two prototypes – a 1700 ft^2 one-story and a two-story prototype with floor areas of 2800 ft^2 for New construction and 2600 ft^2 for Existing construction.

3. ***Building Shell conditions*** – change from 1993 MEC to 2006 IECC for New construction, but no change in insulation levels for Existing construction.

4. ***Infiltration*** – change from 0.00057 ELA (effective leakage area) for all vintages to ELAs of 0.00037 for New and 0.00047 for Existing construction.

Specific DOE-2 modeling changes in seven areas (2)

4. ***Internal gains*** – change from LBNL equation with a large constant and low sensitivity to floor area to an FSEC equation with a smaller constant and greater sensitivity to floor area. Calculated internal loads are similar for a 1700 ft^2 house (57.3 to 56.0 kBtu), with larger differences in a 2600 ft^2 house (64.9 to 72.8 kBtu).

5. ***HVAC System sizing*** - change from a fixed HVAC size irrespective of window properties, to an “auto-sized” HVAC for New construction, but retaining a fixed HVAC size for Existing construction. The rationale is that while builders do size new HVAC installations, it is unrealistic to expect the HVAC system to be replaced during window retrofits.

Specific DOE-2 modeling changes in seven areas (3)

6. ***Natural Ventilation*** – no change in assuming natural ventilation occurs when beneficial between 6 am and 11 pm; the amount of window opening is halved from 25% to 12.5% of total window area, and maximum amount of ventilation halved from 20 to 10 ACH.

7. ***HVAC System efficiencies*** – system efficiencies are increased for both <u>New</u> (AFUEs from 0.78 to 0.80-0.90, and COPs from 2.7 to 3.8) and <u>Existing</u> construction (AFUEs from 0.74 to 0.78, and COPs from 2.4 to 2.7), <u>but</u> offset by higher assumed duct losses (increased from 10% to 12-20% depending on foundation type)

Impacts of changes - **Heating**

- Heating a function of U first, SHGC second (as before)
- Heating energy/sq.ft. of house area lowered significantly from shell changes, less infiltration, use of 2-story homes
  - Other changes less significant
- Heating differences between windows as a function of window U-factor changes are similar (i.e. going from .35 to .30 U-factor saves approximately the same window energy as in the past)
- Increased SHGC reduces heating loads, but not as much as before since window solar gain has lower losses from shell and infiltration to offset

Impacts of changes – **Cooling**

- Cooling a function of SHGC "only" (as before)
- Minor increase in Cooling/sq.ft. of house area
  - Mostly in heating dominated climates
  - Higher Duct losses compensates (sometimes more than compensates) for equip. efficiency gain (new SEER to COP conversion minimizes impact of higher SEER)
  - Two story house characteristics, e.g. less overhang
  - "Swing season" has more cooling – an effect in northern climates

Impacts of changes – **Total Energy**

- Total "Btu" impact of window improvements similar to prior studies
- Higher SHGC products still a benefit in Northern climates, but less than before
  – Heating benefit from increased SHGC drops
  – Cooling liability from increased SHGC rises
- After savings from lower U, additional Northern energy savings potential comes from getting the right SHGC (high or low) for the right application
  – How will Energy STAR, industry accomplish this?

Result: Database of DOE-2 Results

- Raw Simulation Data
  - 98 Climates
  - 40+ windows per climate
  - Gas, Electric Resistance, and HP heating
  - Electric Air Conditioning
- Converted Raw Data to Equations
  - Heating/cooling data regressed for each climate as a function of U and SHGC
  - Regressions form the basis for National Energy Savings Model (next presentation)