

Truly Going to a Systems Engineering Approach – The Expansion of the Rating Method to Account for Lighting, Appliances and On-Site Energy Production

> RESNET Conference March 1, 2005

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Topics of Discussion

- Background
- History
- Guiding Principles
- Expanded HERS Score
- Dave Roberts:
 - Impact on Rating Scores Sensitivity Analysis
 - Massachusetts Expanded vs. Classic Scores
 - REM/Rate Screens
- Questions and Discussion



Background

- HERS Council Technical Guidelines
 - Heating, cooling, hot water
 - No data and limited support for lighting and appliances
- National Home Energy Rating Technical Guidelines
 - NASEO
 - September 1999 adoption
- Mass. Lights and Appliances Study in 2001
- FSEC White Paper in January 2002
- NASEO gave up Guidelines to RESNET in summer 2002
- RESNET Conference sessions on L&A in 2001, 2002, 2003 & 2004
- Pilot tested expanded score, side-by-side with classic score in Massachusetts in 2004



RESNET History

- RESNET solicited comments in 2002
- October 9, 2002 L&A Subcommittee Meeting at EEBA
- November 2002 HERS amendments submitted
- Weekly in 2003 RESNET Standards Drafting Committee reviewed 60+ submitted amendments, including lighting & appliances
- February 2004 Draft amendments posted
- Spring 2004 75 day public comment period
- April November 2004 Standards Drafting Committee reviewed all comments and made adjustments
- Approved by RESNET Board in November 2004 and Standards Revisions Committee in December 2004
- January 2006 New HERS rating standards



Rationale for More Rated Features





Amendment EXP 2004-01

- End-Uses to Include:
 - Heating
 - Cooling
 - Hot water
 - Refrigerator(s)
 - Dishwasher(s)
 - Ventilation fan(s)
 - Light Fixtures
 - On-site power generation



Rating Score Presentation

- Two Scores
 - Classic HERS Score
 - Expanded HERS Score
- All ratings to include Classic Score
- Presentation of Expanded Score is optional, to be determined by:
 - Program sponsor (e.g. utility, EPA, etc.)
 - HERS provider
 - HERS rater (if not specified by either above)



Lighting

- Qualifying Light Fixture Locations:
 - Kitchen, dining room, living room, family room/den, bathroom, hallways, stairs, entrances, bedrooms, garage, utility rooms, home office, all outdoor fixtures mounted on a building or pole;
 - Excludes plug-in lamps, closets, unfinished basement and landscape lighting.
 - Captures ~80% of lighting kWh (various studies)
- Qualifying Light Fixtures:
 - Fluorescent hard-wired (pin-based) lamps w/ballasts (ENERGY STAR fixtures)
 - CFL screw-ins in screw-base fixtures
 - Light fixture controlled by photocell and motion sensor



Lighting Con't

- Counting Light Fixtures:
 - # of Qualifying Fixtures and all light fixtures (for ratio)
 - Assumption of 10% fluorescent lighting in base case
- Lighting Incorporation in Score:
 - Add lighting kWh to Reference and Rated home
 - Consumption added to other end uses and used to determine house score



Appliances - Refrigerator

- 765 kWh/yr. in reference home
- 25 ft³ automatic defrost, side-by-side, through-thedoor ice model
 - Nearly the largest
 - Most popular model
 - Still some room for improvement
- Minimum Federal Standard:
- Gain or loose points depending on kWh rating of rated home refrigerator



Appliances - Dishwasher

If present:

| Bedrooms | Reference kWh/Year | Cycles/Year |
|----------|-----------------------|-------------|
| 1 | 90 | 154 |
| 2 | 126 | 214 |
| 3 | 145 | 247 |
| 4 | 174 296 | |
| 5+ | 203 | 345 |



Mechanical Ventilation in Reference Home

If present:

| Bedrooms | Sq. Ft. | CFM | Annual KWh |
|----------|---------|------|------------|
| 2 | 1,500 | 37.5 | 148 |
| 3 | 2,000 | 50 | 197 |
| 4 | 3,000 | 67.5 | 266 |
| 5 | 4,000 | 85 | 335 |



Appliances - General

- Adjust for internal gains
- Account for increased ventilation loads on heating and cooling energy



Score Calculation

- Based on comparison of design to reference in both cases
- Classic: as-is currently

Score = 100 - (TnML/TRL) * 20) TnML = $nMEUL_{htg} + nMEUL_{clg} + nMEUL_{dhw}$ TRL = $REUL_{htg} + REUL_{clg} + REUL_{dhw}$

• Expanded:

Score = 100 - ((TnML/TRL) * 20) TnML = nMEUL_{htg} + nMEUL_{clg} + nMEUL_{dhw} + $EC_{rated, I\&a}$ TRL = REUL_{htg} + REUL_{clg} + REUL_{dhw} + $EC_{reference, I\&a}$



Score Impacts

- So, how does all of this affect rating scores?
- Dave Roberts:
 - Sensitivity analysis
 - Massachusetts experience with applying the Expanded Score



Annual Light Fixture Usage

Annual Lighting Intensity (kWh/yr-sq.ft.) = (98.38/CFA + 0.1730) * (FL%) + (393.5/CFA + 0.6919) * (1-FL%)

Where:

CFA = Conditioned Floor Area

FL% = ratio of Qualifying Light Fixtures to all light fixtures in Qualifying Light Fixture Locations. Rated home can never have FL% less than 10%.



Lighting Calculation Source & Justification

- Annual lighting energy use normalized for CFA
 - Adopts DOE Building America's benchmark home
 - kWh/yr = 455 + 0.80*CFA
- 90% of annual lighting is incandescent, 10% fluorescent
- 4:1 efficacy (lumens/watt) for fluorescent over incandescent
- 10% of lighting is outdoors (reference & rated homes)
- Reference home has 10% fluorescent lighting



Lighting Calculation Source & Justification Con't

- Rated home usage is based on equation, for example:
 - 50% fluorescent: 0.6081kWh/yr-sq.ft.
 2,000 sq. ft. house: 1,216 kWh/year
 - 100% fluorescent: 0.2432kWh/yr-sq.ft.
 2,000 sq. ft. house: 486 kWh/year
- Internal gains
 - 90% of heat energy subtracted from sensible internal gains
 - 3.413 * 0.9 = 3.07 Btu for each lighting watt



Appliances - Mechanical Ventilation

• Exhaust rate based on ASHRAE 62.2:

 $Q_{fan} = 0.01 A_{floor} + 7.5 (N_{br} + 1)$

where:

Q_{fan}

A_{floor}

N_{br}

- = fan flow rate in cubic feet per minute (cfm).
 - = floor area in square feet.
- = number of bedrooms; not to be less than 1.
- 62.2 requires operation for each hour



Mechanical Ventilation

- If present, reference consumption of .45 watt / cfm
- Annual ventilation energy:
 - kWh/yr. = 0.03942*CFA_r + 29.565 * (N_{br}+1) in reference home.