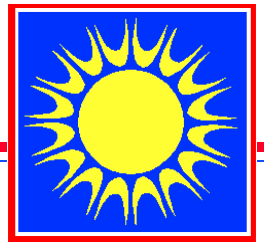

FLORIDA SOLAR ENERGY CENTER

A Research Institute of the University of Central Florida

Lighting, Appliances and PV Energy Production

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Guiding Principles

- The feature has to be one for which a reference level of efficiency can be defined.
- A way must exist to cost-effectively measure the performance efficiency of the feature.

Policy Issues

- Should the basis of the HERS score be locked and never allowed to change?
- How valid is the view that only features covered by an energy code should be rated?
- How valid is the view that the home should be rated and not the occupant and that the rating consider only measures that a builder would install that can not easily be removed when the occupant moves.

Analysis

- EnergyGauge USA used to determine energy uses in HERS Reference home.
- Impact of adding new features to Reference and Rated home.
- Impact of adding PV power to Rated home.
- Considered under a range of climate conditions.

Simulation Data

Energy End Uses from EnergyGauge®

Table A. Comparison of Energy End Uses Across Climate Types

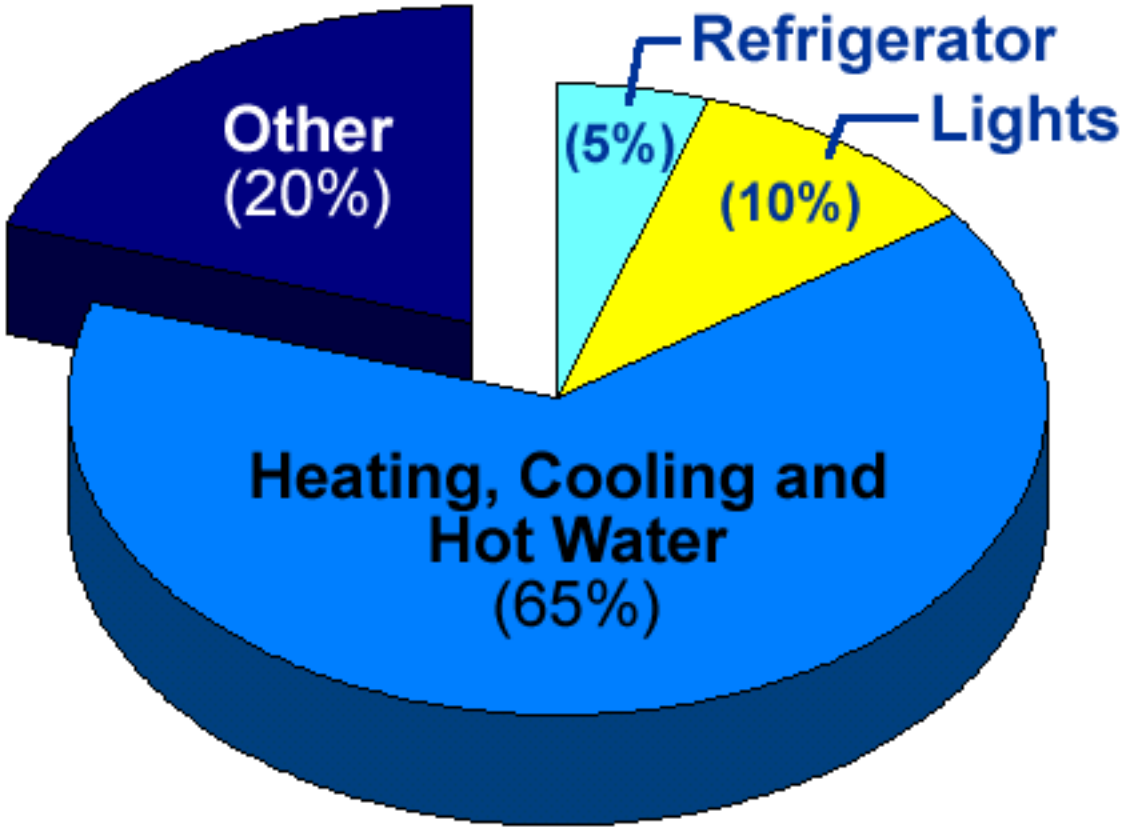
Climate:	Chicago		Miami		Baltimore		San Diego	
End Use:	MBtu*	% Tot	MBtu*	% Tot	MBtu*	% Tot	MBtu*	% Tot
Heating	29.8		0.1		21.8		3.4	
Cooling	4.2		28.5		8.0		1.2	
Hot Water	9.8		9.6		10.6		6.2	
HERS Base	**43.8**	**67%**	**38.1**	**63%**	**40.4**	**65%**	**10.7**	**33%**
Lighting	6.1	9%	6.1	10%	6.1	10%	6.1	19%
Sub Tot	**49.9**	**76%**	**44.3**	**74%**	**46.5**	**75%**	**16.8**	**51%**
Refrigerator	3.2	5%	3.2	5%	3.2	5%	3.2	10%
Sub Tot	**53.2**	**81%**	**47.5**	**79%**	**49.8**	**80%**	**20.1**	**61%**
Dryer	3.0		3.0		3.0		3.0	
Range	1.5		1.5		1.5		1.5	
Other	8.1		8.1		8.1		8.1	
Total	**65.8**	**100%**	**60.2**	**100%**	**62.4**	**100%**	**32.7**	**100%**

* Site energy use for fossil fuel-fired end uses are adjusted to their modern electric equivalent (for full explanation, see section entitled **"Accounting for On-Site PV Power Production in HERS Scores**" that follows later in this paper). Homes located in Chicago and Baltimore assume natural gas heating and hot water and homes located in Miami and San Diego assume all electric equipment.

How Much Expansion?

- **Current:** Heating, cooling and hot water comprise about 65% of home energy use in most climates.
- **New Features:**
  - Lighting is about 10% more in most climates.
  - Refrigerators are about 5% more in most climates.
  - Including both results in coverage of about 80% of home energy use.

Revised HERS Method



Captures 80% of typical energy use.

Counting New Features

New features should be added to both the Reference and the Rated home – the "expanded denominator" method.

- Expands the basis for energy savings in programs (i.e. 30% of what?)
- Enhances consumer information and awareness (covers about 80% of end uses)
- Improves the cost-effectiveness of energy savings (e.g. CFLs are very cost-effective)

Counting Lights

- Hard-wired vs. All lighting?
- Level of accounting detail?
  - Count fixtures and differentiate by use type (bedroom, kitchen, outdoor, etc.)?
    - Variable hours of use by use type
    - Variable luminous intensity by use type
  - Uniform use and luminous intensity?
    - Intensity = Avg. Luminosity x CFA
    - Energy = Intensity x Avg. Efficacy

Lighting Proposal

- Annual lighting density: 0.9 kWh / ft^2-yr
- 90% incandescent / 10%fluorescent
- 10% outdoor lighting
- Luminous efficacy:
  - Incandescent = 15 lumens / watt
  - Fluorescent = 60 lumens / watt
- % of conditioned floor area (CFA) lit by fluorescent (FL%) is the “performance measure”

Lighting Equation

Annual Lighting Intensity(ALI) =

$0.2432 * (FL_{\%}) + 0.9730 * (1\text{-}FL_{\%})$ kWh / yr-ft^2

- If $FL_{\%} = 10\%$ ALI = 0.90 kWh / yr-ft^2
- If $FL_{\%} = 50\%$ ALI = 0.61 kWh / yr-ft^2
- If $FL_{\%} = 100\%$ ALI = 0.24 kWh / yr-ft^2

What Appliances?

Typical Annual End Use Energy

End Use	Annual Energy
Pool Pumps	~3,000 kWh / yr
Lighting	~1,500 kWh / yr
Refrigerator	~950 kWh / yr
Dryer	~900 kWh / yr
Stove / Oven	~450 kWh / yr
Well Pumps	~300 kWh / yr
Washer	~200 kWh / yr
Dishwasher	~150 kWh / yr

PV Power Production

- Applied against rated energy use or total energy use?
  - DOE's Zero Energy Home (ZEH) program.
  - Impact of additional rated features on perceived PV benefit.
- Achieving fuel "parity."
  - Normalization doesn't apply.
  - Electric equivalent.

Scoring Methods

Method 1: PV applied against total use
Method 2: PV applied against H,C & HW

Table B. Comparison of HERS Scores for 3500 kWh/yr PV System

Energy (MBtu)	Chicago	Miami	Baltimore	San Diego
HERS base	43.8	38.1	40.4	10.7
Total	65.8	60.2	62.4	32.7
PV	11.9	11.9	11.9	11.9
Score: Method 1	83.6	84.0	83.8	87.3
Method 2	85.5	86.3	85.9	102.3

Difference is 15 HERS points!

Fuel Type Impacts

There are significant differences between all electric and natural gas home HERS scores unless natural gas use is adjusted.

Climate:	All Electric	N. Gas	Adj.* N.Gas
Baltimore	83.7	82.2	83.8
San Diego	87.3	84.4	86.4

* Site gas use is multiplied by 0.40 to account for modern efficiency of electric power production.

HERS Score Differences

Another view of the data

	Baltimore	San Diego
All Electric	83.7	87.3
N. Gas	82.2	84.4
Difference:	1.5	2.9
All Electric	83.7	87.3
Adj. N. Gas	83.8	86.4
Difference:	-0.1	0.9