

EER and IEER Ratings In HVAC Program Implementation

CEE 2010 Summer Program Meeting
Commercial HVAC Committee Breakout Session 2
June 2, 2010



Today's Topics

- Background: HVAC efficiency ratings
- The new IEER rating
- Using the ratings
- Application to Program Implementation

Air Conditioning Efficiency Ratings

- Standards for ratings set by Air Conditioning, Heating and Refrigeration Institute (AHRI)
- ANSI/AHRI Standard 340/360-2007 is current standard for commercial unitary equipment
- Establishes two ratings for unitary air conditioning
 - Energy Efficiency Rating (EER) – Usually used as the full-load or peak rating
 - Integrated Energy Efficiency Ratio (IEER) – New part-load rating effective 1/1/2010
 - Both ratings are in units of BTU/watt

Energy Efficiency Ratio - EER

- Usually seen as the rating at Standard Conditions
 - 95°F DB and 75°F WB outdoor air temperatures for air-cooled units
 - 80°F DB and 67°F WB return air temperatures
- Reflects the efficiency at design or peak-load conditions
- A good indicator of peak kW savings potential
- Not so good at indicating energy (kWh) savings potential
 - Does not represent how efficient the unit is for over 95% of it's operating time

Integrated Energy Efficiency Ratio - IEER

- Developed by AHRI as an improvement over the old Integrated Part Load Value (IPLV) for unitary equipment
 - Covers all units – even if single-stage
 - Takes into account constant fan usage in commercial applications
 - Uses ambient conditions appropriate for equipment loading
 - Lower load = Lower outdoor air temperature
 - Based on weighted US data for weather and equipment sales volume
 - Includes mechanical cooling operation only – economizers and energy recovery not factored in
- May be a better indicator of energy usage
 - Definitely for the National picture
 - Not necessarily on a regional or utility area level
- Does not reflect peak kW savings potential

IEER – How Is It Determined

IEER is a weighted average of the unit's efficiency at four load points – 100%, 75%, 50% and 25% of full cooling capacity

$$\text{IEER} = (0.020 * A) + (0.617 * B) + (0.238 * C) + (0.125 * D)$$

Where:

A = EER at 100% net capacity at AHRI standard rating conditions

B = EER at 75% net capacity and reduced ambient (81.5° F for air-cooled)

C = EER at 50% net capacity and reduced ambient (68° F for air-cooled)

D = EER at 25% net capacity and reduced ambient (65° F for air-cooled)

How were the four factors developed

- Weather modeling for cities representing 15 US Climate zones

Miami	Memphis	Baltimore	Chicago	Helena
Houston	El Paso	Albuquerque	Boise	Duluth
Phoenix	San Francisco	Salem, OR	Burlington, VT	Fairbanks

- Percent of time in the 4 load bins – 100%, 75%, 50% & 25%
 - Outdoor air temperatures for each load bin
- Sales volume percentage into each of the climate zones
- Three end-use sectors
 - Office – 40%
 - School – 30%
 - Retail – 30%

IEER – How Does It Relate Regionally

- Fairly well for most climate zones – Within +/- 8%

Zone	City	Volume %	Econo	Load Factors - % of Time at Load Level (Weighted Average of Office, School and Retail)					% Delta from USA Wavg
				100%	75%	50%	25%	Average	
				of Design	of Design	of Design	of Design	Load	
1a	Miami	1.181	No	0.8%	84.7%	13.7%	0.8%	71.4%	12.8%
2a	Houston	8.838	No	1.6%	70.2%	20.9%	7.3%	66.5%	5.1%
2b	Phoenix	3.876	Yes	0.6%	70.2%	22.2%	6.9%	66.1%	4.5%
3a	Memphis	8.738	No	8.5%	58.2%	23.4%	9.9%	66.3%	4.8%
3b	El Paso	8.321	Yes	2.3%	75.6%	14.8%	7.3%	68.2%	7.8%
3c	San Francisco	8.678	Yes	0.6%	23.2%	31.0%	45.3%	44.8%	-29.3%
4a	Baltimore	13.671	No	0.4%	55.8%	27.4%	16.5%	60.0%	-5.2%
4b	Albuquerque	1.442	Yes	0.8%	62.2%	28.0%	9.1%	63.7%	0.6%
4c	Salem, OR	2.153	Yes	1.4%	52.9%	28.6%	17.1%	59.7%	-5.8%
5a	Chicago	21.081	Yes	2.1%	68.6%	23.1%	6.2%	66.7%	5.3%
5b	Boise	5.294	Yes	0.9%	70.3%	21.5%	7.2%	66.2%	4.6%
6a	Burlington, VT	10.434	Yes	2.2%	67.8%	20.3%	9.7%	65.6%	3.7%
6b	Helena	2.541	Yes	0.7%	51.7%	36.5%	11.1%	60.5%	-4.4%
7	Duluth	2.334	Yes	1.3%	60.2%	27.4%	11.0%	63.0%	-0.5%
8	Fairbanks	1.420	Yes	0.8%	49.1%	37.5%	12.6%	59.5%	-6.0%
USA Weighted Average				2.02%	61.66%	23.81%	12.50%	63.3%	0.0%

Data from PowerPoint presentation by Dick Lord, Carrier Corp.

How To Calculate Savings With EER & IEER

- General Formula

$$\text{Cooling Capacity} / \text{EER or IEER} / 1000 = \text{kW}$$

- Example for 180,000 BTUH, 12.1 EER unit

$$180,000 / 12.1 / 1000 = 14.88 \text{ kW}$$

- Use EER to calculate demand savings
- To calculate the demand reduction from an 11 EER minimum efficiency unit

$$(180,000 / 11 - 180,000 / 12.1) / 1000 = 1.48 \text{ kW}$$

- May also need to apply coincidence and demand diversity factors to get a system peak demand reduction

How To Calculate Savings With EER & IEER

- Use IEER to calculate energy usage

Cooling Capacity / IEER /1000 x Annual Cooling Hours = kWh

- **Caution** – Annual Cooling Hours is not always the same as EFLH
 - Equivalent Full Load Hours (EFLH) is the hours the unit would have to run at full output to satisfy the annual cooling load. This is the value that used to be used with EER.
 - Annual Cooling Hours is the total hours the unit would have to run at all output levels to satisfy the annual cooling load.
 - Annual Cooling Hours and EFLH will be very close for a single-stage unit, but may differ considerably for multi-stage units.
 - Annual Cooling Hours will almost always be higher than EFLH.

Application To Program Implementation

- Determine if the regional IEER difference is “close enough” to be acceptable
 - Developing a regional IEER might be possible if manufacturers will release the part load EER values (75%, 50% and 25%)
- Develop Annual Cooling Hours values for your region
 - Can be done using energy simulations such as EQuest, EnergyPlus and DOE2
 - Simulate various single and multi-stage equipment scenarios to check for differences
 - A multi-stage unit may have a higher IEER but may run longer and use more energy than expected
 - Annual Cooling Hours will likely vary by facility end use, i.e. retail, schools, offices, etc.

How To Calculate Savings With EER & IEER

- Use IEER to calculate energy usage

Cooling Capacity / IEER /1000 X Annual Cooling Hours = kWh

- **Caution** – Annual Cooling Hours is not always the same as EFLH
 - Equivalent Full Load Hours (EFLH) is the hours the unit would have to run at full output to satisfy the annual cooling load. This is the value that used to be used with EER.
 - Annual Cooling Hours is the total hours the unit would have to run at all output levels to satisfy the annual cooling load.
 - Annual Cooling Hours and EFLH will be very close for a single-stage unit, but may differ considerably for multi-stage units.
 - Annual Cooling Hours will almost always be higher than EFLH.

Questions?

Thank You

Colin Odell
ICF International
codell@icfi.com
203-288-5338