Benchmarks - Ranking Building Energy Intensity

Energy Saving Fact Sheet

Why Benchmark a Building for Energy Use?

The cost of electricity, natural gas, propane, and fuel oil has risen significantly in the last several years. This sharp rise in cost has caused much concern for institutional operating budgets, retail profit potential, and the means for diminishing the energy cost escalation. The efficiency of energy use and subsequent energy cost of a building can be benchmarked, that is, establish an annual energy use reference for comparing to other buildings of similar size, functional use, and operating schedules. This benchmark can also be used to track on a monthly basis the savings generated by the application of several Energy Conservation Measures (Energy Saving Fact Sheet #, ECM Listing) In order to normalize the comparison, geographic regions of the United States are categorized for similar annual weather conditions. Electric power companies track consumption, demand, and billed cost by metered accounts and historically can provide achieved histories back several years. Additionally, heating energy from natural gas, propane, and fuel oil can be traced through billing accounts of quantities and cost as well. With this information it is possible to develop a building benchmark reference for energy use and gauge the potential for savings.

Energy Use and Cost Intensity

Most of North Carolina's 100 Counties are considered Region 4 with the exception of a few northwestern counties in the mountains. This fact sets the energy expectations for heating and cooling based upon the weather extremes of the seasons for Region 4. The Table to the right shows the average benchmark of energy consumption for all energy sources for the stated building use. This would include electricity, natural gas, propane, and fuel oil that might be used for lighting, office equipment, heating and air conditioning, cooking, hot water, etc. The benchmark unit of Energy Use Intensity is defined as follows:

Energy Use Intensity = Annual Building Energy of all sources divided by the gross square footage of the building. This is expressed in the last column as 1000 (k) btu/sf-yr. From the accounting billing information the following example shows the units and conversion factors used to derive these numbers. Similarly, the cost per sf can be estimated.

Building Energy Benchmarks

Averages, Region 4, (One Kwh = 3.41 Kbtu)

Buildings Type/Use	Kbtu/sf-yr Fuels	Kwh/sf-yr Electricity	Kbtu/-sf-yr Total
K-12 Schools 46,000 sf	32.6	10.5	**68.3**
Colleges 650,000 sf	38.9	16.0	**93.4**
Hospitals 500,000 sf	103.6	35.7	**246.8**
Public Assembly 14,200 sf	35.8	9.7	**68.9**
Restaurants 6,000 sf	143	48.4	**308.0**
Large Office 90,000 sf	29.4	16.7	**86.4**
Small Office 28,000 sf	36.4	16.7	**93.4**
Warehouse 27,000 sf	19.2	4.5	**34.5**
Refrig. Whouse 18,000 sf	23.3	28.8	**121.5**
Lodging 35,800 sf	43.8	16.8	**101.1**
Large Retail 32,200	35.8	16.0	**90.7**
Small Retail 9,700 sf	34.9	16.4	**90.8**
Health Care 24,000 sf	60.6	19.2	**118.6**

Work Examples

1,776,246 kwh of electricity was used in the 12 month accounting period for XYZ School; in addition for the same period of time 950 therms of natural gas consumption and 11,284 gallons of fuel oil. The school has 111,000 sf of gross building (s) area. Calculate the Energy Intensity Indexes for the buildings. Compare this to the average and determine the opportunity for energy savings. Given from accounting records that the average cost for the year 2006/07 was: Electricity-$0.065/kwh, Natural Gas - $1.13/therm, LP-$1.62/gal., FO - $1.90/gal. Conversion Factors: 1 therm = 100 kbtus, 1 gallon propane = 91 kbtus, 1 gallon fuel oil = 138 kbtus, 1 kwh = 3.41 kbtus

Energy Use Intensity = 1,776,246 kwh x 3.41 kbtus/kwh + 950 therms x 100 kbtus/therm + 11,284 gals. x 138 kbtus/gal. = 7,709,191 kbtus/111,000 sf = **69.5 kbtus/sf-yr**

Energy Cost Intensity = 1,776,246 kwh x $0.065/kwh + 950 therms x $1.13/therm + 11,284 gals. x $1.90/gals = $138,630/111,000 sf = **$1.25/sf-yr**

Energy Use Intensity (EUI) and Energy Cost Intensity (ECI) Relationships

The equation for Energy Use Intensity is:

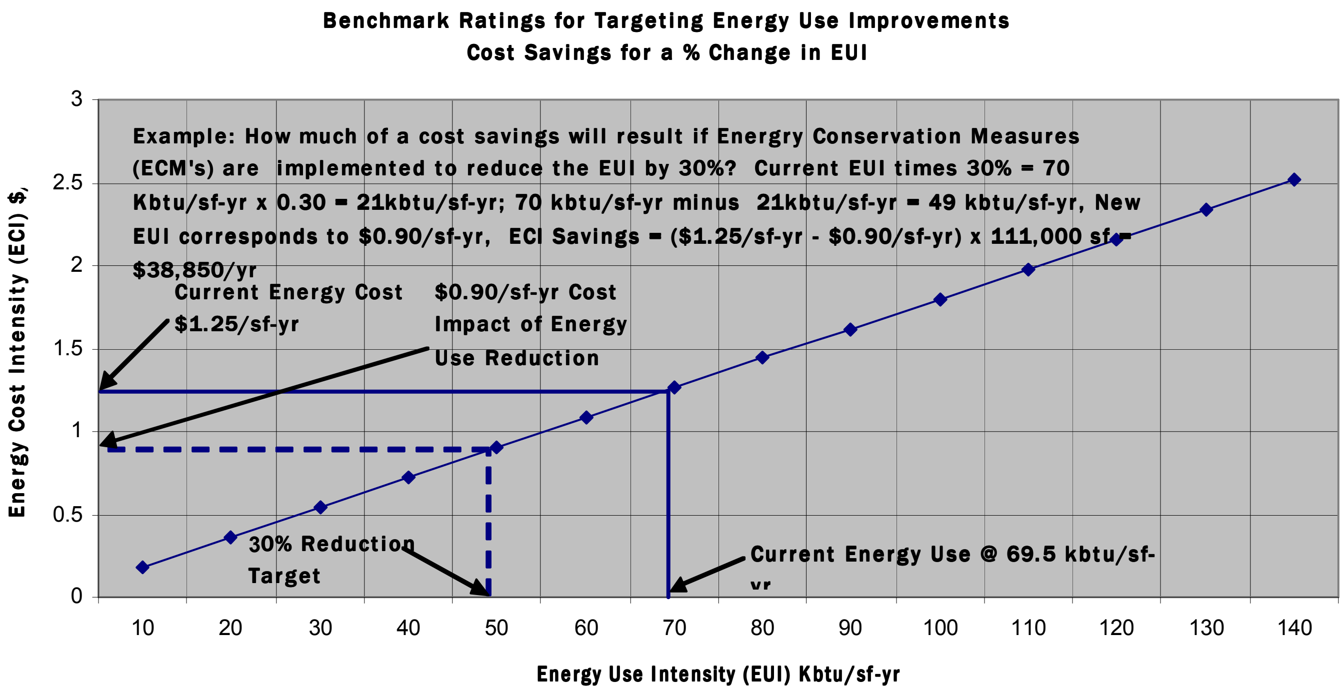
$$\text{EUI (kbtu/sf-yr)} = (3.41 * E + 100 * NG + 138 * FO + 91 * P) \div SF$$

where E is the 12 month electric use for the building in kwh, NG is the therms of Natural Gas, FO is the gallons of fuel oil, and P is the gallons of propane for the same 12 month period, and SF is the gross square footage of the building. If some energy sources are not involved (P or FO) then zero is expected for that component.

The Energy Cost Intensity equation is:

$$\text{ECI (\$/sf-yr)} = (0.065 * E + 1.13 * NG + 1.90 * FO + 1.62 * P) \div SF$$

where the coefficients are the unit cost for the 12 month period as previously described in the worked example. These coefficients will change from year to year or perhaps from month to month as the cost of energy sources fluctuate. If the average EUI benchmark for a building type with the same functional use was lower than the computed benchmark for a given building what is the basis to equate cost savings to reach the lower benchmark, assuming there is no change in the cost or proportion of the energy consumption mix. The graph below was developed from **ECI (new) = ECI/EUI * EUI (new)** The increase/decrease in EUI building benchmark is related to the ECI benchmark by the graph below. A goal set for a reduction in the energy use benchmark will result in a cost savings of the amount shown for constant conditions of the application criteria.



Energy Assessments Require Benchmarks

The first step in making an energy assessment of a building's energy use **is to benchmark the building**. This will allow the visualization of where the building is relative to buildings of like type and function. The EUI (kbtu/sf-yr) margin between the building benchmark and the collective average of all buildings of similar type will provide the potential for Energy Conservation Measure (ECM) applications.

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