

Energy Use Benchmark for the UT-K Campus

Dr. Randy Hudson
Oak Ridge National Laboratory

In developing a campus energy plan, it is useful to understand how energy consumption at the University of Tennessee, Knoxville campus (UT-K), compares to other universities. Unfortunately, there is limited data available to make such a comparison. The Association of Higher Education Facilities Officers (APPA) conducts a biennial survey of cost and staffing at colleges and universities. A part of that survey collects data on the amount of electricity and fossil fuels (e.g., gas, coal, fuel oil) consumed on campus. The most recent comparative data obtained for this paper is from a study by Oak Ridge National Laboratory (ORNL), which used APPA survey data from the 1997-1998 school year.¹

In order to normalize for varying campus sizes, the reported total campus gross building floor area is used to develop an energy performance indicator, the total energy consumed per unit building area.² As used in the ORNL study, the indicator is called the Energy Use Index (EUI) and is expressed in units of thousands of BTUs per square foot of gross floor area. To arrive at the total energy consumed on a campus, the various fuel streams are converted to consistent BTU energy units. To reflect primary fuel and environmental impacts more accurately, the electrical energy consumption is expressed as source energy consumed (i.e., the primary fuel used to generate the electricity) using a generic conversion of 10,280 BTU/kWh.

Performance for UT-K was determined on the same basis using data from a recent campus environmental progress report³ and supplemental data from the Facility Services Department. Two data points were calculated: one consistent with the APPA survey year, 1997-1998, and the other using UT data from the most recent available year, 2005-2006. Although mixing years may introduce some confounding (as other institutions may have experienced similar energy density growth), it seems reasonable to benchmark the most recent UT-K data as well. The resulting EUI values for 1997-98 and 2005-06 were 237.6 and 254.9 thousand BTUs per square foot, respectively.

The statistical analysis of the 1997-1998 APPA survey data for all institutions is shown in Figure 1. The energy performance for UT-K is indicated in the cumulative density function (CDF) plot, shown at the bottom of Figure 1. As shown, energy performance at UT-K, as measured by the EUI, places UT-K in the third quartile across all 175 reported institutions, with 56 percent and 66 percent of institutions having lower EUI values on the basis of 1997-98 and 2005-06 UT data, respectively.

¹ MacDonald, Michael, *Higher Education Energy Performance Indicators 1997-1998*, Oak Ridge National Laboratory, August 2000.

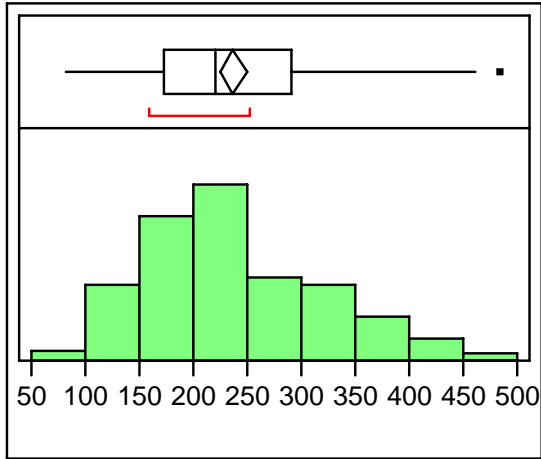
² Other normalization factors have been considered, such as energy use per student. However, due to inconsistent reporting of student head counts by institutions (e.g., full-time, part-time, commuter, on-campus resident), it was felt that energy use per floor area was a more reliable measure.

³ Committee on the Campus Environment, *2005 UTK Environmental Progress Report*, The University of Tennessee, Knoxville, April 2005.

An influence in an institution's energy consumption and performance is the Carnegie classification of the institute. Initially defined by the Carnegie Commission on Higher Education in 1970, the classification framework was developed to support its program of research and policy analysis. The Carnegie Commission classifies The University of Tennessee as a research institution. This is a relevant consideration since, as shown in Figure 2, energy density values (e.g., EUI) are higher for research institutions than for other institutional categories. The statistical behavior of the 1997-98 APPA energy performance data for Carnegie research institutions (a subset of the data in Figure 1) is shown in Figure 3. When considering the subset of Carnegie research institutions, the energy performance of UT-K is in the second quartile, with only 30 percent and 43 percent of institutions having lower EUI values on the basis of 1997-98 and 2005-06 UT data, respectively.

Although UT-K's energy performance, as measured by EUI comparisons, is, in general, close to the median behavior of other educational institutions, energy consumption on the campus continues to increase. As shown in Figure 4, energy consumption as measured by the EUI has increased rather steadily over the last 25 years. The performance within the last ten years, presented in Figure 5, however, hints at a possible leveling of energy density growth (i.e., consumption growth on a normalized square foot basis). Whether this is a permanent change, owing to factors such as the addition/renovation of more energy efficiency buildings on campus, or a merely temporary respite remains to be seen.

**Distribution – All Institutions
EUI (kBtu/sqft)**



Quantiles

100.0%	maximum	485.00
99.5%		485.00
97.5%		421.20
90.0%		355.40
75.0%	quartile	292.00
50.0%	median	221.00
25.0%	quartile	173.00
10.0%		137.00
2.5%		109.40
0.5%		81.00
0.0%	minimum	81.00

Moments

Mean	236.88571
Std Dev	83.44169
Std Err Mean	6.3075989
upper 95% Mean	249.33497
lower 95% Mean	224.43646
N	175

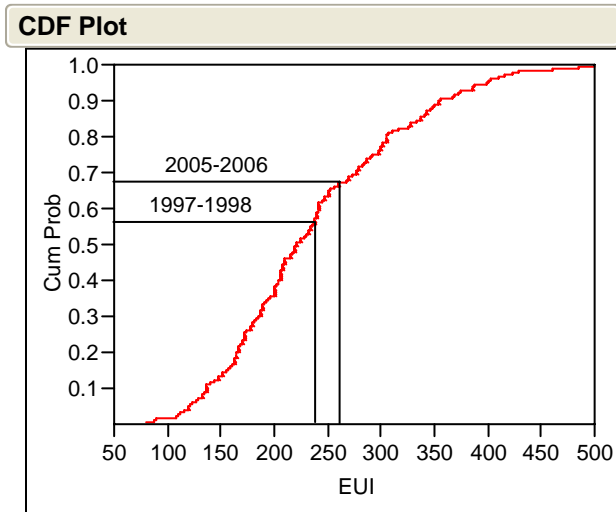


Figure 1. Statistical Analysis of 1997-98 APPA Data for All Institutions

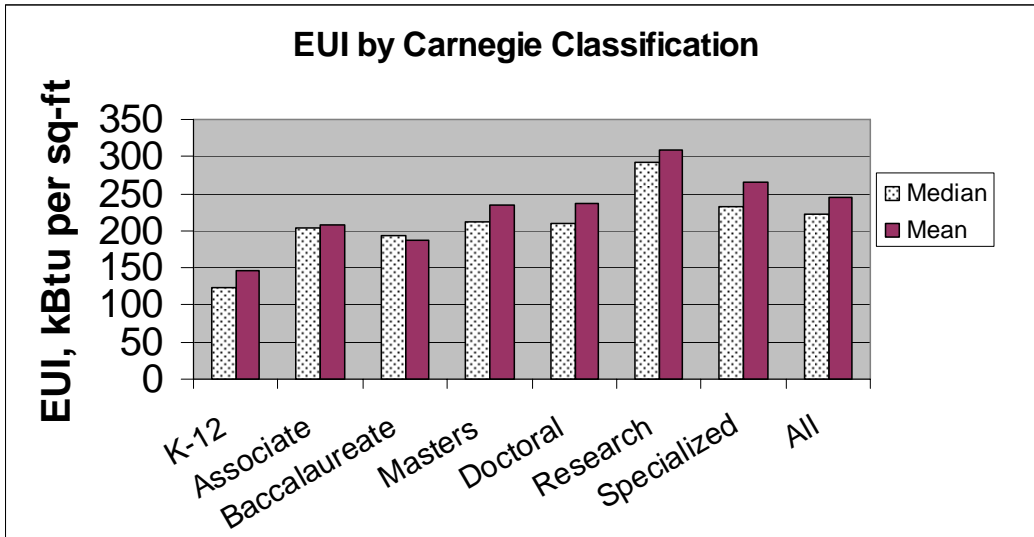
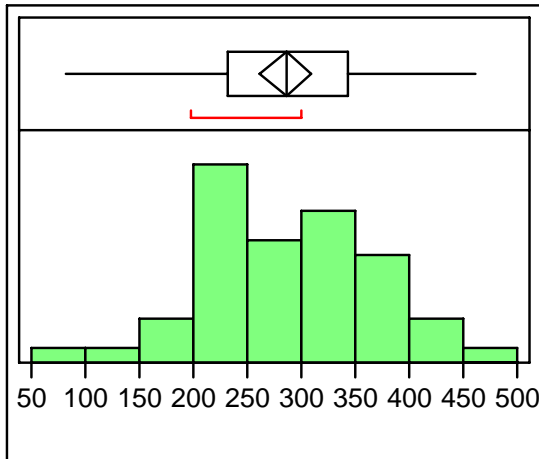


Figure 2. EUI Values by Carnegie Classification

**Distribution for Carnegie Research Institutions
EUI (kBtu/sqft)**



Quantiles

100.0%	maximum	461.00
99.5%		461.00
97.5%		454.60
90.0%		400.00
75.0%	quartile	343.00
50.0%	median	287.00
25.0%	quartile	231.00
10.0%		195.60
2.5%		86.80
0.5%		81.00
0.0%	minimum	81.00

Moments

Mean	286.04255
Std Dev	82.294793
Std Err Mean	12.003929
upper 95% Mean	310.20521
lower 95% Mean	261.8799
N	47

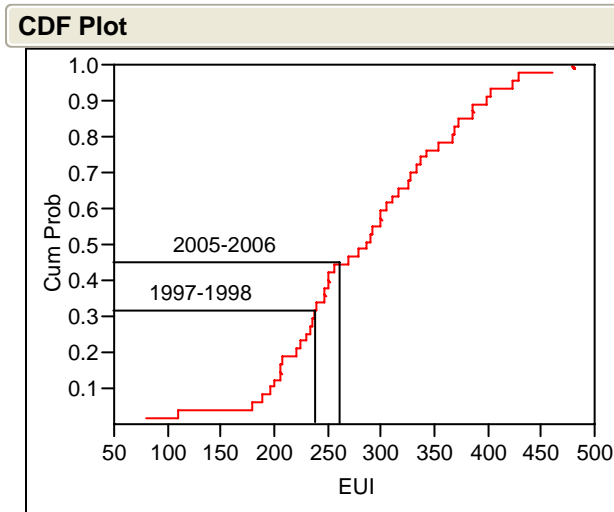


Figure 3. Statistical Analysis of 1997-98 APPA Data for Carnegie Research Institutions

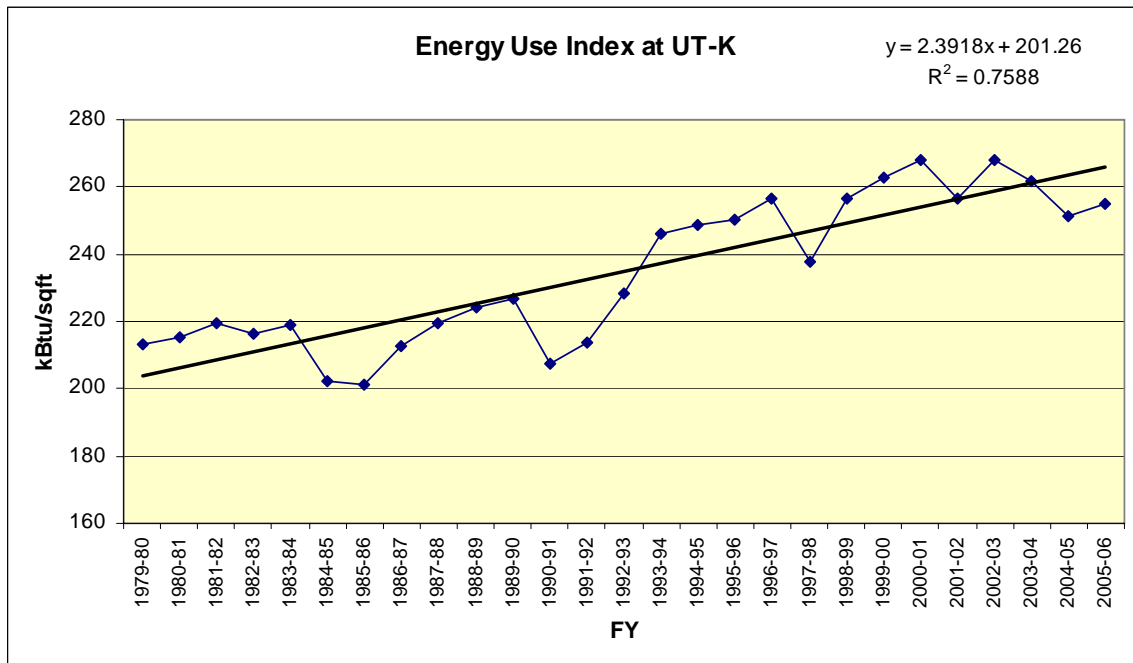


Figure 4. UT-K Energy Consumption As Measured by the EUI

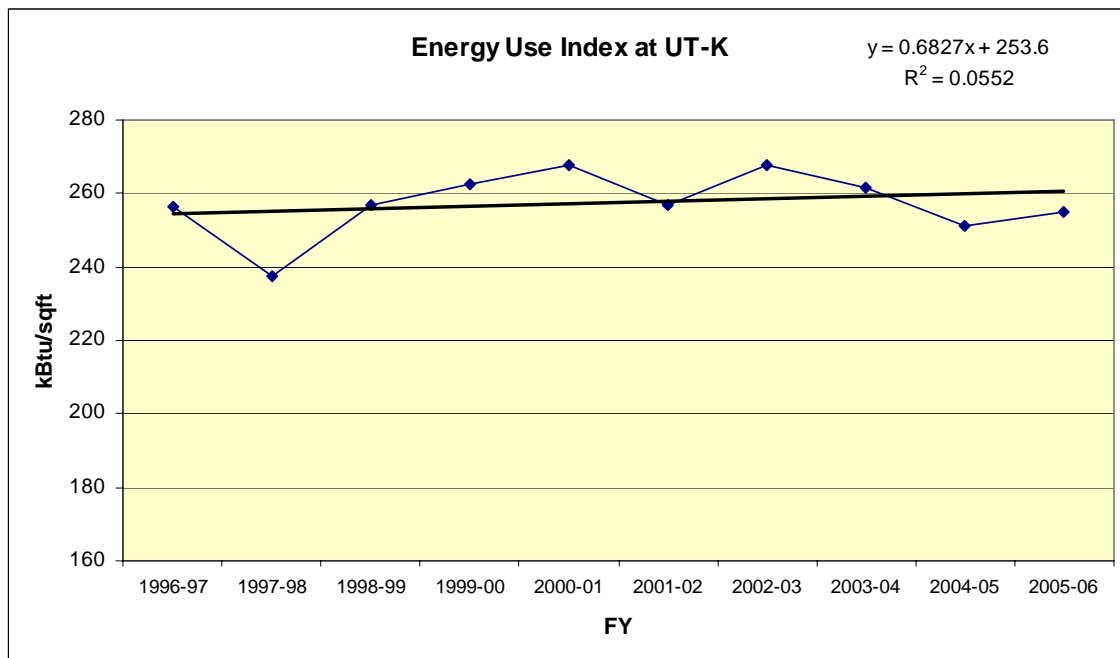


Figure 5. UT-K Energy Consumption As Measured by the EUI for last 10 years