Benchmarking 101

Santee Cooper® POWER

Comparing the energy usage of your building to similar buildings is a simple way to get a rough assessment of building performance. You can also use benchmarking to help set performance targets and monitor progress, and to identify buildings that may need focused effort to reduce energy consumption. Benchmarking is less accurate than an audit, an engineering analysis, or computer modeling of building systems, but it is faster and much less costly.

The Art of Benchmarking

The results of a benchmarking analysis may identify buildings that are energy hogs, but interpreting the data can be challenging. Many factors affect energy usage, including occupancy, fuel choices, energy-using equipment, climate, and building design. Comparing buildings by electricity intensity (annual kilowatt-hours per square foot [ft^2]) can make some buildings appear energy efficient even though they are not. For example, an office building with lots of vacant space will have low energy intensity, but that does not mean it is efficient.

Ideally, you will be able to evaluate benchmarking data by accounting for factors that you can't change as well as those that you can—such as occupancy behavior, operating hours, equipment operation, and equipment choices. Fully assessing the impact of each of these factors on your energy consumption will require in-depth analysis. Once an initial benchmarking analysis is done, a facility manager might decide to invest in an audit and some temporary data loggers to further investigate and monitor a building. If one isn't already in place, adding an interval meter will give you a great data source for benchmarking energy usage at different times of the day.

Selecting a Metric

Comparing buildings based on energy expenditures (annual $/$ft^2$) is useful if the energy prices billed for those facilities are the same. It is advisable to benchmark energy consumption with an energy metric, such as Btu, to remove the distorting effect of varying fuel prices and energy rate structures. You can use Btu or joules to measure all types of fuel consumption individually or as a combined total. Often, kilowatt-hours (kWh) are used to measure electricity, and either therms or cubic meters are used for natural gas. What metric you choose should be based on your objectives. If you would like to promote a simple conservation strategy focused on behavioral changes, you might want to use a very simple measure so that managers of different facilities can easily understand and check their progress.

Dividing building energy consumption by square footage provides an energy intensity measure that allows buildings of different sizes to be compared. Make sure your definition of square footage is consistent with the comparison (benchmark) data. The U.S. Energy Information Administration's Commercial Building Energy Consumption Survey (CBECS) data uses gross square footage, but the Building Owners and Managers Association (BOMA) uses total rented floor space.

You may consider calculating energy intensity relative to some business measure, such as energy per sold guest room in a hotel or energy per student in a school. Also, if your objective is to shed light on what is achievable in terms of energy performance, consider defining your target as 20 to 30 percent less energy-intensive than average.

A cautionary note: lower energy use does not always translate into lower expenditure; that can depend on the fuel and equipment you use. When gas prices are low, some gas-burning equipment can be cheaper to operate than electric alternatives, even though the gas technology may use more energy. For example, stovetop gas burners in a restaurant kitchen give off more waste heat than electric burners but may cost less to operate.

Compared to Whom?

Benchmarking requires that you compare your building performance to data on similar buildings. National or regional data for major commercial sectors is readily available, but there are drawbacks to using such aggregated data. If you compare a 5,000-ft^2 jewelry store's energy usage to the national average for the retail sector, you are in effect comparing it to department stores and big-box pet-food stores. Fortunately, with national data, a large sample tends to minimize the effect of buildings that differ significantly from the average. It also makes it easier to extract the most relevant sample for comparison. For example, you can restrict your sample to lodging buildings that are 100,000 square feet and larger and that use natural gas for space heating. But be careful not to restrict the data by too many factors or you will end up with a sample that is too small to be reliable.

Climate is a big driver of energy consumption in commercial buildings, so benchmarking should rely on regional or local data whenever possible. Several branches of a chain store in a region may be comparable in terms of building size and design, energy-using equipment, occupancy, and operating hours. When you know the data is for similar buildings in the same climate region and with similar operating hours, fairly small differences in energy intensity may indicate a problem.

Data Sources and Benchmarking Tools

There are many tools available to benchmark energy performance. If you want a quick check to prioritize further in-depth analysis, you can build your own spreadsheet and compare results with national or regional data. For more accurate results, you can find free benchmarking software online or purchase software that analyzes billing or meter data.

Energy Star

The Energy Star Portfolio Manager software (available free at www.energystar.gov) can be used to analyze the Office Buildings, Grocery, Education (primary and secondary schools), Hotel, and Hospital sectors. Ranking systems for more building types are being developed, including convenience stores, warehouses, and healthcare buildings. This free tool is built around CBECS data, and it can show you where you stand relative to the demonstrated energy performance of existing buildings during the past several years. By entering your building information, you can compare performance with similar

Benchmarking Step by Step

Before you begin to benchmark your building, you need to clarify your goals.

Step 1: Calculate energy intensity. Choose your measure carefully based on your objectives and the comparison data available. Will you use kWh or Btu, measured per gross square foot or per rented square foot? Gather the data from your utility bills or install your own meter or data recorder. Utility billing cycles can vary from month to month, so you may need to correct for the number of days in each cycle.

Step 2: Select comparison data. Using the same intensity measure as you calculated for your building, compare performance with the national or regional average, similar buildings owned by your organization, or demonstration buildings (ones that are highly energy-efficient). You can also compare your building's recent usage intensity with a historical average.

If you need to convert your units of measure, there are many conversion calculators available on the Internet, such as www.onlineconversion.com. Normalizing the data to correct for weather is more complicated. If the average temperature for the summer months was 10 percent higher than normal, don't expect the energy usage to be 10 percent higher during that time—the relationship is not that direct. Software such as the U.S. Environmental Protection Agency's Energy Star Portfolio Manager can do this calculation for you.

Step 3: Interpret the results. What buildings use the most energy per square foot? Does electricity usage for a particular building stand out? You could graph energy and cost intensity to find which buildings are outliers on both counts. You may also want to compare your building to the CBECS average and top quartile (the lowest energy users) of buildings nationwide in your sector.

buildings in areas with similar weather. The output is a score from 0 to 100, with scores above 75 indicating that the building is in the top quartile in terms of energy performance (the lowest energy-intensive buildings earn the highest points). Buildings that score 75 and above are eligible to apply for an Energy Star building label. It often takes a few tries to fine-tune data entry—accuracy is important! If you have more than 30 buildings, you can send your data in a spreadsheet to Energy Star to enter into the system for you.

Tools for Your Sector

Your trade association may be another place to find energy consumption data that you can use for benchmarking. For example, facility managers for luxury, mid-range, and small or budget hotels in tropical, temperate, and Mediterranean climates can try the www.benchmarkhotel.com online software developed for the International Hotels Environment Initiative. The American Society for Healthcare Engineering has a collaborative initiative with Energy Star called the Healthcare Energy Project (HEP). The HEP assists healthcare organizations in establishing an Energy Star rating and suggests energy-saving opportunities for participating buildings. BOMA publishes "The Exchange Report," an annual report and CD with data on building type, occupancy, and operating expenditures, including energy.

Other Sources

The U.S. Energy Information Administration posts both CBECS tabular data and raw data files on its Web site (www.eia.doe.gov). (See **Figure 1** for an example of that data.) You can see CBECS data for buildings comparable to yours with the Arch Building Energy Reference Tool created by the Lawrence Berkeley National Laboratory (http://poet.lbl.gov/arch) or on a U.S. Department of Energy Web site (1995 data, http://analysis.eren.doe.gov/webcbecs/cbecs.htm). Data from Canada's Commercial and Institutional Building Energy Use Survey is available from the Office of Energy Efficiency of Natural Resources Canada (www.oee.nrcan.gc.ca).

Figure 1: Commercial building benchmark data

The most recently available data from the U.S. Energy Information Administration's Commercial Building Energy Consumption Survey is from 1999. You can use this table for a quick comparison of your building's performance relative to other buildings in your sector, but you'll get more accurate results by using software that normalizes the results for local weather variations.

Type of building	Average annual electricity intensity (kWh/ft^2)	Average annual natural gas intensity (thousand ft^3/ft^2)	Average annual energy intensity (MMBtu/ft^2)
10,000 ft^2 or smaller			
Food service	40.5	177.2	281.1
10,001–100,000 ft^2			
Education	9.1	33.8	75.7
Food sales	39.8	51.5	180.6
Healthcare, outpatient	18.7	33.5	89.2
Lodging	13.1	53.1	104.2
Malls and strip malls	19.8	24.4	84.9
Offices	17.1	30.9	83.1
Religious worship	4.0	22.8	31.8
100,001 ft^2 or larger			
Hospitals	27.3	109.0	225.1
Warehouses	8.5	44.1	65.6

Notes: ft^2 = square foot; kWh = kilowatt-hours; ft^3 = cubic feet; MMBtu = million Btu.

Source: U.S. Energy Information Administration

There are many software products and consulting services available to help benchmark multiple facilities. For example, the consulting firm Jackson Associates maintains its Market Analysis and Information System (www.maisy.com), including its "State Level Database," which has building energy use, building structure, and end-use equipment data. Also, check this Lawrence Berkeley National Laboratory Web site for an array of offerings: http://poet.lbl.gov/cal-arch/links.html. Remember, whether you plan to compare your building's current energy usage against historical data or benchmark against similar buildings, make sure the software you purchase corrects for weather differences.

Benchmarking Works

A healthcare organization operating 2,300 facilities needed to prioritize upgrades to its building systems. Rather than performing a full audit of each building, it scored each property by total energy costs, energy cost per square foot, and energy usage per square foot. The 200 properties that performed worst were given on-site audits. The remaining facilities received less-expensive desktop audits that modeled energy performance based on facility and equipment data. This organization saved time and money by using a simple measure to focus its investments in audits and, ultimately, energy-efficiency upgrades.

In a similar example, the United States Postal Service (USPS) calculated annual energy spending by square foot for 23 facilities and found that costs ranged from 35¢ to $\$15/ft^2$. That simple calculation helped to identify buildings to target with billing audits and efficiency measures. Because the USPS looked for the most costly sites to decide where to spend a limited budget and there was a wide variation in cost intensity, it made sense to benchmark the sites based on spending.

Benchmarking data can also be used to promote awareness of energy consumption among building occupants. For example, a university published monthly energy usage data for the most energy-intensive buildings on campus and challenged occupants to reduce their consumption. If over a six-month period a building's energy usage dropped by more than 10 percent, the relevant department received payment equal to 30 percent of the cost savings. After 18 months, the university cut its annual energy costs by about $300,000!

The Bottom Line

If you have limited funds to spend on energy-efficiency improvements, basic benchmarking can provide you with valuable information to effectively target your energy management efforts so that you get the biggest impact. It can also be an inexpensive mechanism to build awareness and commitment to energy efficiency among building occupants. But remember that benchmarking is imperfect and is only one step in developing your energy management strategy.