Health Care Energy Management Benchmarking

This paper was originally presented at ASHE's 47th Annual Conference, July 2010.

David Stymiest, P.E., FASHE, CHFM, CEM, GBE
Senior Consultant – Compliance and Facilities Management

Nashville, TN
DStymiest@ssr-inc.com

Health Care Energy Management Benchmarking

David Stymiest, P.E., FASHE, CHFM, CEM, GBE
Senior Consultant – Compliance and Facilities Management
Smith Seckman Reid, Inc.
Nashville, TN

Abstract

This paper includes energy benchmarking uses, metrics, tools, operational differences and efficiencies, early benchmarking pitfalls, fuel cost variances, dashboard reporting, multi-year trending analyses, load profiling, utility rates; weather and campus growth impacts on both energy index and utility index, similar/dissimilar facilities, and the pros and cons of the US-DOE CBECS databases. Also included are load factors, peak demand charges, energy intensity, utility programs, supply/demand side management, comparing uses, buildings, campuses and systems.

Much utility/energy usage and cost analysis is based upon locally available information without input from others. When outside input is sought for benchmarking purposes, the ability to compare apples with apples is often severely limited by assumptions and misinformation.

This paper discusses approaches that work well as well as approaches that don't work very well.

Examples include actual benchmarking spreadsheet tools and management presentation documents used in health care facility utility budget discussions, with an emphasis on effectively presenting the results of the benchmarking activities.

What is benchmarking?

Benchmarking defines the current situation. It can be internal, competitive, or functional in nature. Internal benchmarking involves comparing your own facilities, or your own subsidiaries, over time. Internal benchmarking is useful to see changes and improvements, but lacks the "reality check" one can get by comparing your facilities with other similar facilities owned by others. Competitive benchmarking, on the other hand, is used to compare your facilities with the facilities of others within the same industry sector. Thus competitive benchmarking involves comparing your own facilities with other healthcare facilities – this is the reason for the ASHE Energy Survey and other similar surveys. Functional benchmarking involves comparing facilities within your industry against facilities in other industries. It has limited usefulness if trying to determine best practices within healthcare for example.

"Benchmarking is the practice of being humble enough to admit that someone else is better at something and wise enough to learn how to match and even surpass them at it."
– Carla O'Dell, Continuous Journey, April, 1994

Normalizing Benchmarking Metrics

Most energy benchmarking requires that different energy utilization types and fuel sources be converted to a common basis. The most common basis in use is the British Thermal Unit (BTU) and there are numerous conversion factors available for energy types and fuel sources. However not all of them are consistent.

The Energy Star® Energy Units Conversion Table is a commonly used set of conversion factors.[1] Within the higher education facility arena, much college and university facility benchmarking is performed under APPA's auspices. An APPA conversion table was used in at least one major APPA energy survey, the APPA Higher Education Energy Performance survey.[2]

Many of the people doing benchmarking have their own textbooks, reference books, and favorite conversion tables. The author's web search on BTU conversion tables returned 562,000 results with many private BTU conversion tables and many governmental conversion tables. Needless to say consistency is going to be an issue.

The recommended facility energy benchmarking metric is ENERGY INTENSITY, also called ENERGY INDEX, measured in BTU / Sq Ft / Year.

The Energy Intensity or Energy Index does not account for water/sewer costs, and many administrators lump water/sewer costs into the "energy" accounting arena because they represent another utility bill to be paid. Although water/sewer utilization cannot be converted to BTU, the costs of water/sewer use can be included in overall utility costs. Several slides illustrate how water/sewer usage and utility rates can be compared similarly with energy usage and rates, and how their costs can be presented separately and together with the energy usage and rates.

When internal benchmarking is performed (within your own facilities or subsidiaries) it is most commonly done with multi-year trends. Competitive benchmarking (with others in similar facilities) however is most commonly done as a snapshot in time, say with 1 year of data.

Benchmarking normalization is usually performed by region, by weather, by number of days or other calendar metric. The US DOE's Energy Star® process does this level of benchmarking with its use of regional monthly weather data.

Benchmarking should also be related to hospital operational efficiencies, resulting in metrics such as BTU per occupant, utility cost per occupant, utility cost (or BTU) per admission, and utility cost (or BTU) per patient day, and perhaps even water/sewer usage per FTE. All of these metrics should also be considered per square foot, and perhaps even as a percentage of gross revenue for the space(s) being considered. Lastly, consider how the clinical side of the organization benchmarks itself and consider using the same metric.

---

[1] This table is available at the following web URL:
http://www.energystar.gov/ia/business/tools_resources/target_finder/help/Energy_Units_Conversion_Table.htm

[2] This table is available at the following URL:
http://eber.ed.ornl.gov/commercialproducts/CCAS9798.htm

Information needed

Information on demographics is needed for effective facilities benchmarking. What are the demographics of facilities? They include the following, many of which are included in the ASHE Healthcare Energy Survey:

- Gross Sq. Ft.; Net Sq. Ft.; Rentable Sq. Ft. – Although most facility energy benchmarking is done with gross sq. ft. it may be more helpful to consider net sq. ft. or some other metric when looking at water/sewer benchmarking since the water-sewer usage is less determined by the overall building envelope and more by the personnel usage patterns within the space.
- Building ages – this often has an impact on building construction and weatherproofing, which of course will affect energy loss and thus energy use.
- Primary and secondary occupancies within the building or facility; types of uses within the building or facility – it is a well-known fact that operating rooms and intensive care units typically exhibit more energy use per sq. ft. than most other types of patient areas. Laboratory areas (both clinical labs and research spaces) are intensive energy users, as are data centers and some types of procedure rooms.
- Climate type – even within the USA the Energy Star® program recognizes five distinct climate zones as illustrated in one of the slides.
- Setting – is the facility in an urban, suburban or rural setting?
- Operating hours per day, operating hours per week, etc.
- Site type – is it congested, spread out, high rise, etc?
- Ownership – Is the facility for-profit or not-fur-profit? Is the ownership publicly-held, privately-owned, or owned by one of the federal agencies or departments?

Information on the usage and costs for each energy type or fuel are also required for effective benchmarking. These include the most common types - electricity, water, sewer, natural gas, chilled water, hot water, and steam they should also include the less common types such as biomass (gas), biomass (electric), geothermal (used for cooling or heating), solar, wind, fuel cell, and other types.

Early benchmarking pitfalls

Early benchmarking had a difficult time being accepted, and some of the time for good reason. The early pitfalls led to in some cases substantial inconsistencies in the benchmarking data and thus in the benchmarking results and recommendations, among them:

- Some facilities included their open and/or closed parking garages in the benchmarked gross sq. ft. Others did not. Needless to say those facilities had much better energy intensities than the facilities that did not include their garage sq. ft.
- Some facilities included their clinical or biomedical engineering labor with the maintenance and plant operations labor because those services all fell under the same director. Others did not.
- Some facilities included grounds maintenance, whereas others did not.
- Some facilities with central energy plants or central utility plants (CEP) included CEP labor as maintenance. Others that were purchasing district steam and/or district chilled

water instead had a labor advantage; however that benchmark did not necessarily provide fair utility cost comparisons if CEP labor was factored into the internal utility cost structure.
- Some hospitals reported net sq. ft. as gross sq. ft. thus unnecessarily inflating their energy index in the early competitive benchmarking processes.
- Early benchmarking labor data often only included hospital employee labor. Hospitals with higher percentages of outsourced labor were initially designated as "best practice" purely on the basis of the numbers.

Benchmarking uses and benefits

Benchmarking has many uses, among them:

- Tracking utility usage and expenses over time. Purely considering the raw numbers, both BTU (or some variation) and dollars, does not often provide useful information due to the myriad of variables that affect use and costs. Benchmarking that takes into account these variables is much more useful in helping the owner manage the facility.
- Better forecasting of the next fiscal year utility budget. Many of the approaches illustrated in the slides were developed based upon utility usage and cost forecasting experience in hospitals and were used by the author for years to forecast hospital utility budgets accurately, usually within a few percent of the eventual actual usage.
    - Consider weather variances when forecasting energy use.
    - Consider rate and fuel cost variances when forecasting energy costs.
- Knowing how a building's BTU per sq. ft. Energy Index changes, providing documentation of positive results from demand side management initiatives.
- Benchmarking a building's energy use over time, allowing early identification of both positive and negative trends.
- Benchmarking a building's energy use against other buildings, assisting facility management and administration in prioritizing capital investments and determining where to spend limited capital energy conservation funding.
- Using monthly benchmarking results to gauge the results of continuous improvement activities.
- Benchmarking, done well, helps the owner establish a level playing field for both internal and external comparisons.
- When benchmarking is used with an understanding of the variables that effect energy use, it assists facility management in understanding the key energy consumption drivers. It also provides another tool for diagnosing operating problems that drive up energy costs, resulting areas for improvement, and even best practices.

Benchmarking also has many other benefits as well. It assists the facility management in establishing a baseline with which to measure energy conservation progress. Benchmarking helps to provide documentation of continuous improvement in energy performance – and we all know that the benefit of utility cost savings is that they go directly on the fiscal bottom line.

The graphics on the PowerPoint slides are provided to illustrate many concepts related to benchmarking. The following concepts are illustrated:

- Why benchmark for fuel cost variances? This graphic provided by the U.S. Energy Information Administration (EIA) illustrates variations over 20 years in natural gas unit pricing, clearly indicating that simply considering utility costs from year to year can have very limited usefulness.
- Dashboard energy/utility cost reporting is a useful tool for providing both data and illustrations to administration on a monthly basis. One such dashboard and one of its charts are illustrated on two slides.
- Utility usage multi-year trending is useful for many purposes, both to show seasonal weather impacts on usage and also to show both raw and benchmarked data concisely. One chart covers an 8-year span with monthly data points and illustrates the impacts of campus footprint changes during that period. Other charts and the table that provides the data for them illustrate different approaches for showing data for quick understanding during short budget discussions with the CFO.
- Chiller plant energy use analyses can be quickly understood along with the application of both base load chillers and peaking chillers.
- Internal (and external) benchmarking is most effective when the comparisons are apples-to-apples. Getting dissimilar buildings into such a valid comparison can be quite a chore as illustrated generally in one slide.

Load Profiling

Benchmarking with load profiling can be a powerful ally in the war on increasing utility costs. Facilities that are not presently metering for date/time-stamped load profiling should consider that capability for both their main meters and submeters. Many utility customer accounts have time-of-use data available for the customer to download and/or access on the utility's web site. Facilities that are not presently receiving utility time-stamped information should discuss the availability of their data with their utility account representatives.

Time-of-use metering is not new; it has been around since time-of-use rate structures were first established. This metering can often provide time stamped data for load profiling as well. Other sources of data include data loggers, "smart" meters and many varieties of customer submetering devices. Load profiles should be considered for benchmarking not only electricity but also chilled water, steam, and water/sewer.

Load profiles can provide the information that better enables facilities to control their billed demands and avoid large demand charges. One example is where a chiller that trips off line is immediately reset and put back on line. This occurred in one of the author's facilities and the resulting extra campus electrical utility demand charge for that month (due to this event) was over $15,000. We discovered the correlation while investigating the cause of the overly-large demand charge and were able to trace it to that chiller operation. Operating procedures were subsequently changed to avoid similar situations in the future.

The PowerPoint presentation contains several slides that illustrate some of these concepts:

- When hourly data points are available, daily load profile patterns can be examined as illustrated in the Weekdays vs. Weekends slide. The charts on this slide illustrate hourly electrical usage data for 1 year for a large multi-building hospital campus. The darker

areas represent common operating patterns and the lighter single lines near the tops of the charts represent the more extreme daily load profiles on high temperature design days. The lower portions of each chart represent the cooler winter months that required less onsite cooling (this campus generated chilled water from electric chillers.) The two charts entitled "Internal electricity benchmarking" also illustrate another internal benchmarking approach where daily energy usage for a year is plotted against the calendar (to show seasonality) and against outdoor air temperature (to show the temperature-dependent aspect of utility usage.) [3]

- A much simpler presentation is in the next slide, entitled "Typical day load profiles from utility metering data." In this chart, typical daily load profiles were generated from 1 year of 15-minute interval utility metering data. The baseload (winter Sunday) load profile identifies variable activity-independent usage whereas the baseload (summer Sunday) load profile includes the impact of activity-independent cooling on campus loading. The two weekday lines above those Sunday lines illustrate the impact of the hospital processes (or activities) on the winter weekday line and then with the additional impact of cooling of that extra activity. This type of approach assists the facility manager in zeroing in on variations from the operating norm.

Using Benchmarking in Budget Discussions

Benchmarking results can be very useful in quickly making selected points during operating and capital budget discussions. Internal benchmarking can be used to identify the most energy-intensive buildings in a multi-building campus as a way to back up infrastructure renewal and demand side management project budget requests.

- Benchmarking utility "rates" over time can be helpful in explaining long-term budget variances. The term "rates" is provided in quotations because rate structures are often complex entities themselves, and the facility manager needs to determine exactly what values to include and how to describe them.
- Benchmarking weather impacts can be done with average daily temps, or with heating degree days and cooling degree days (HDD and CDD). Refer to the footnote for a detailed discussion from NOAA regarding the use and application of HDD and CDD.[4]
- Hospitals tend to change continuously as footprints expand, are modified, and (sometimes) contract. Benchmarking campus growth over time and factoring this into

[3] "Process for identifying patterns of electric energy effects of proposed changes, and implementing such changes in the facility to conserve energy" United States Patent 5566084, Gregory Cmar, Inventor

[4] "For any individual day, degree days indicate how far that day's average temperature departed from 65 degrees F. HDD's, which measure heating energy demand, indicate how far the average temperature fell below 65 degrees F (since cooler weather means more heating fuel demand). Similarly, CDD's, which measure cooling energy demand, indicate how far the temperature averaged above 65 degrees F. In both cases, smaller values represent less fuel demand, but values below 0 are set equal to 0, because energy demand cannot be negative. Furthermore, since energy demand is cumulative, degree day totals for periods exceeding 1 day are simply the sum of each individual day's degree day total. For example, if some location had a mean temperature of 60 degrees F on day 1 and 80 degrees F on day 2, there would be 5 HDD's for day 1 (65 minus 60) and 0 for day 2 (65 minus 80, set to 0 since degree days cannot be negative). For the day 1 + day 2 period, the HDD total would be 5 + 0 = 5. In contrast, there would be 0 CDD's for day 1 (60 minus 65, reset to 0), 15 CDD's for day 2 (80 minus 65), resulting in a 2-day CDD total of 0 + 15 = 15." This discussion is from the following URL:
http://www.cpc.ncep.noaa.gov/products/predictions/experimental/ddtest/weekass.html

energy use and cost discussions is a helpful way to remove that impact from an analysis of the results of, say, demand side management initiatives.

- Benchmarking past dollar savings (per year) internally is helpful to back up future funding requests. It is also often helpful to show cumulative savings so that the contribution of the facilities department to the hospital bottom line is reinforced.
- The slide entitled "Benchmarking annual changes" illustrates an approach that is effective when rate fluctuations eclipse usage reductions. The chart shows the independent variables usage and rate as well as their combined impacts on cost.
- It is difficult to benchmarking dissimilar facilities as shown in the next series of charts.
- Pure usage and cost numbers by themselves don't often tell whole story, and unfortunately sometimes even showing benchmarked usage and cost values per sq. ft. doesn't tell the whole story either. In facilities where there is ongoing constructions with areas being taken out of service for construction, then added back in at completion and populated with a ramp-up it is sometimes necessary to benchmark with construction changes also shown and taken into account in the presentation as shown in the next series of slides.
- Benchmarking utility rate and utility cost components can be helpful when discussing the impact of fuel charges, for example, or another rate component on bottom line costs.
- The US Department of Energy's Commercial Buildings Energy Consumption Survey (DOE/CBECS) contains energy consumption, energy expenditure, and extensive energy-related bldg characteristics for approximately 7,000 commercial buildings in the USA. However it has limited usefulness for health care benchmarking, primarily because of its limited healthcare sample but also because it is usually several years out of date before being released to the public. CBECS is updated typically every 4 years and there has typically a 2 year delay between data collection and publication, although publication of the 2007 data appears to be lagging behind this historical schedule. The 2003 CBECS end-use consumption data are now available at www.eia.doe.gov/emeu/cbecs/ in XLS, PDF, and HTML table formats. The 2003 CBECS database included only 8 inpatient and 121 outpatient buildings. The CBECS 2007 data publication status (per DOE's website) as of June 1, 2010 was that building interviews were held between 2/08 and 9/08, the Energy Supplier Survey occurred in 2009, and the "2007 CBECS data are currently being processed. A release date is yet to be determined."

ASHE Benchmarking Initiatives

ASHE's Energy Efficiency Commitment (E^2C) Initiative is bearing fruit as well. It involves close cooperation with EPA's ENERGY STAR® program. There are case studies available by climate zones, a Healthcare Energy Guidebook plus other reference resources, an energy toolkit, education, recognition, grants and funding available. As a result of this initiative, more than 2,800 hospitals are using EPA's Portfolio Manager to benchmark their energy performance.

The 2010 ASHE Healthcare Energy Survey is an extremely worthwhile endeavor, and can counter the lack of healthcare buildings that are available for benchmarking through the 2007 CBECS database. The ASHE Healthcare Energy Survey includes anonymous sharing of data with EPA, and ASHE is working with EPA to update the ENERGY STAR® benchmarks for acute care hospitals. The survey includes sophisticated input including:

- Assessing both hospitals and outpatient facilities in either standalone or multiple building campus configurations
- Input for Gross sq. ft., number of beds, number of floors, types of medical equipment, types of services, energy consumption data
- Differentiating between General Medical/Surgical Hospitals, LTAC, CAH, Cancer Centers, Rehab, Psych, outpatient health care facilities, medical office buildings, Primary Care, Ambulatory Surgical Centers, Urgent or Express Care Clinics, BHC, Outpatient Rehab, and Physical Therapy

Going "Green"

Lately it appears that every professional publication in the facilities field has some "Green" topic on its cover. The same observation appears to be valid for Internet-distributed newsletters as well. Readers are urged to implement "Green" principles even if they are not intending to construct LEED® certified projects. It can also be helpful to get LEED® AP certified personnel on project design teams.

The Green Guide for Healthcare (www.gghc.org) according to its website "is a best practices guide for healthy and sustainable building design, construction, and operations for the healthcare industry." It is also worth noting that "Green" is not just about energy use – it is also about sustainability and environmental impact as well.

About the author: David Stymiest has spoken at over a dozen ASHE conferences and dozens of state conferences, written and updated two major ASHE documents, and over 20 magazine articles. Before joining SSR, David was Senior EE for over 10 years for Massachusetts General Hospital and the other hospitals of Partners HealthCare System, Inc. He has spent almost half his 37 year career as an Owner and hospital engineer. He can be reached at *DStymiest@ssr-inc.com*.