Energy Star for Hospitals 2011 Update: Progression or Regression?

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Abstract:
The Energy Star performance rating system for buildings has achieved widespread adoption in the building sector as a standard benchmark for energy performance. In 2011, the U.S. EPA released an updated technical methodology for its Energy Star performance rating system for hospitals, shifting how the score is calculated. The new rating system, similar to the previous rating system, is still a poor metric for benchmarking hospitals and should be used with caution. The aim of this paper is to critique the methodology used in the Energy Star for Hospitals 2011 Update. The paper reviews the changes between the 2001 methodology and 2011 methodology, how Energy Star views usage of different fuel types in its score, and lastly items that did not change in the 2011 hospital methodology update which are still causing confusion amongst Energy Star users and are causing significant error in the Energy Star score calculations.
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1. Introduction

Benchmarks are crucial tools in our society. The term “benchmark” or sometimes “bench mark” has various origins, some of which are related to surveying and some related to cobblers but, no matter its origin, the word is closely connected to the idea of measurement. A measurement is made and all subsequent measurements are compared to the original measurement, or benchmark. Sometimes that measurement is used as a static standard or reference point ad infinitum, but in many cases the benchmark becomes a moving standard which changes over time. When the benchmark is performance related, as performance improves so also must the benchmark improve to be of continued accuracy. The four-minute mile was a good benchmark in 1954 when it was broken by Roger Bannister, but is wholly inadequate to measure the best runners today, who typically run the mile in under three minutes and forty-five seconds.

In the realm of buildings, benchmarks, particularly energy benchmarks, are a relatively new phenomenon. Until the 1970’s, energy in developed countries was widely available and inexpensive, thus there was no great push for buildings to perform with any level of energy efficiency. Indeed, energy efficiency was an alien notion for buildings because there was no real idea, no benchmark whatsoever, of what an energy efficient building looked like to begin with. When there is no benchmark, there is no ability to see how an object, be it a runner or a building, is performing. But the world changed - energy is no longer inexpensive, and buildings are more energy-intensive now than ever before. But a void existed, and the ability to determine if a building was energy efficient or not was non-existent.

Seeking to fill the void in the United States, in 1999 the U.S. Environmental Protection Agency created Energy Star for Buildings, as well as Portfolio Manager, an online benchmarking tool which allowed users to input their utility bills while simultaneously tracking important energy performance metrics for their building, such as the Energy Utilization Intensity (E.U.I.) and Energy Cost Intensity (E.C.I.). Since its inception, Portfolio Manager has also added the ability to track water consumption, as well as greenhouse gas emissions. As of September of 2011, the U.S. EPA reported that over 250,000 buildings had been benchmarked in Portfolio Manager.

The most prominent part of Energy Star Portfolio Manager came with the advent of the Energy Star performance rating system, more colloquially known as the Energy Star score. The Energy Star score has become the golden standard for energy performance; the U.S. Green Building Council, the Green Building Initiative as part of Green Globes, and others have adopted the Energy Star score as part of their rating systems. However, not all building types are eligible for an Energy Star score; presently only fifteen different building types are eligible to be rated for an Energy Star score, as shown in Table 1.

Table 1: Building types eligible for the Energy Star score.

Building Type	Minimum Gross Square Footage (ft^2)
Bank/Financial Institution	≥ 1,000
Courthouse	≥ 5,000
Data Center	N/A
Hospital (General Medical and Surgical)	≥ 20,000
Hotel	≥ 5,000
House of Worship	≥ 1,000
K-12 School	≥ 5,000
Medical Office	≥ 5,000
Municipal Wastewater Treatment Plant	N/A
Office	≥ 5,000
Residence Hall/Dormitory	≥ 5,000
Retail Store	≥ 5,000
Senior Care Facility	≥ 5,000
Supermarket	≥ 5,000
Warehouse	≥ 5,000

The Energy Star score is a 1-100 number generated in Portfolio Manager after eligibility requirements for the respective building have been met (more on that later), specific data related to the building type (e.g. square-footage) have been entered, and a finite amount of utility months (varies dependent upon building type) have been entered into the Portfolio Manager system. The score is meant to benchmark the building, providing an energy efficiency score for the building amongst its peers in a respective building type. A score of 75, for example, is meant to indicate that the building scores amongst the 75^{th} percentile in energy efficiency, and that only 25% of the building population is more energy efficient.

The technical methodology used to generate the score is different for every building type (thus, the grading criteria for a Senior Care Facility is not the same as a Warehouse, thankfully), but each methodology operates in the same manner with three important parts: Dependent Variables, Independent Variables, and Reference Data Set. A description of how the Energy Star score is calculated is shown in Figure 1.

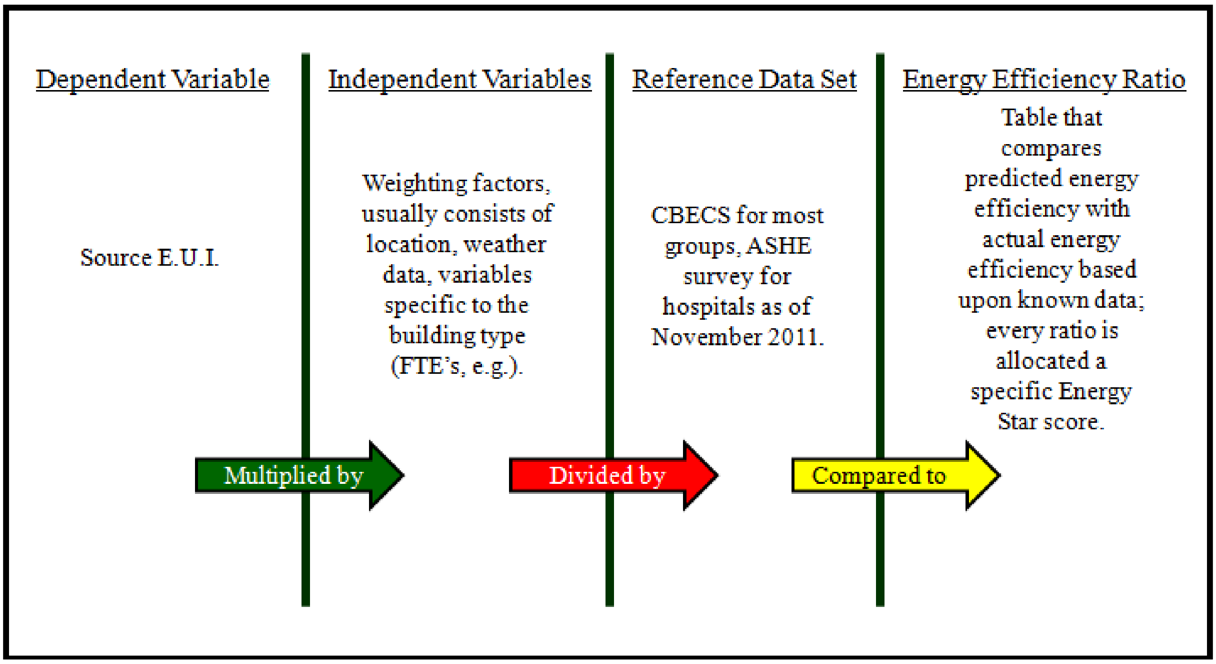

Figure 1: General methodology for calculating the Energy Star score.

More will be discussed on this methodology in later sections, but it should be noted that Energy Star uses Source E.U.I., not Site E.U.I., as its dependent variable. Thus, a multiplying factor is given for each specific fuel type (electricity, natural gas, coal) to create energy equivalence, instead of using the site E.U.I. which does not factor out losses based on transportation or other means. Although losses due to transportation or the grid vary significantly from one utility company to the next, Energy Star does not punish or promote buildings based upon their utility provider, but instead uses a common multiplier for each type of utility, regardless of the provider.

2. Energy Star for Hospitals

The first Energy Star Performance Rating system for Hospitals was released in November of 2001; the scoring system was tweaked slightly in 2007, but otherwise remained the same for the next decade. The second version for Hospitals was released in November of 2011. Since its inception, according to Clark Reed of the EPA, as of December of 2011 over 3600 hospitals had been benchmarked in Portfolio Manager – an astounding 69% of the 5200 community and Department of Defense Hospitals in the United States. A comparison between the two methodologies is shown in Table 2.

Table 2: Overview of Energy Star for Hospitals.

	2001	2011
Reference Data	1997 EPRI Survey	2010 ASHE Survey
Qualifications	3	4
Dependent Variable	Natural Log of Source E.U.I.	Source E.U.I.
Independent Variables	8	4

2.1 Reference Dataset

The most important change between the 2001 methodology and the 2011 methodology is the reference data used to compare all buildings to. The Energy Star score is not based on data entered into Portfolio Manager (which would cause the score to constantly fluctuate based upon the buildings entered), but rather is based on a fixed set of data that does not change with time. The original data was based on a 1995 Electric Power Research Institute Survey; the survey included records for Acute Care/Children's Hospitals (415 records), Cancer Centers/Clinics (4 records), Skilled Nursing Facilities (45 records), Psychiatric Hospitals (10 records), and Rehabilitation Centers (19 records), for a total of 493 records to compare to.

However, by 2010 the survey was already severely outdated, particularly considering the increasing energy intensity rise in hospitals due to electrical equipment. The 2011 methodology uses an American Society for Healthcare Engineering (ASHE) survey from 2010. Although the survey is newer, the sample size is only 39% of the previous methodology as there are only 191 hospitals in the dataset. Post-processing was also done on the data to address biases in the data, such as an over-representation of hospitals in a specific geographic location or by hospital ownership. Statistics from the ASHE survey are shown in Table 3.

Table 3: 2011 Reference Dataset.

Characteristic	ASHE Survey Sample
Sample Size	191
Average Source E.U.I.	485
Average Square Footage	448,061
Average Staffed Beds	197
Average MRI Machines	1
Average FTE Workers	1167

2.2 Qualifications

The qualifications to be considered to receive an Energy Star for Hospitals score were slightly tweaked between the 2001 methodology and the 2011 methodology. The four qualifications for the 2011 methodology are as follows:

1. More than 50% of the gross floor area of all buildings must be used for general medical and surgical services.
2. More than 50% of the licensed beds must provide acute care services.
3. Long-term care hospitals that are certified as acute care hospitals are not eligible because they provide patients with acute care for extended inpatient stays, defined by federal statute as an average of 25 days or more.
4. Ambulatory surgical centers, specialty hospitals, and other types of long-term care facilities should benchmark under the "Other" space type category.

2.3 Dependent Variable

The dependent variable for both the 2001 methodology and the 2011 methodology is still the

Source E.U.I.; however it is no longer calculated in natural log form.

2.4 Independent Variables

Apart from the reference data set, the second biggest change in the 2011 methodology is the selection of the independent variables. A comparison of the two methodologies is shown in Table 4.

Table 4: Independent Variables

2001	2011
Natural log of gross square footage	Number of FTE workers per 1000 square foot
Acute Care/Children's Hospital	Number of staffed beds per 1000 square foot
Tertiary Care	Number of MRI machines per 1000 square foot
Natural log of number of beds	Cooling degree days
Natural log of the maximum number of floors	
Above ground parking facility	
Heating degree days	
Cooling degree days	

As shown, the independent variables have changed drastically. The 2001 independent variables included three (acute care/children’s hospital, tertiary care, above ground parking facility) that were simple yes/no questions; none of these exist in the 2011 methodology. The 2001 methodology also included gross square footage, whereas gross square footage as a standalone variable has been dismissed completely in the 2011 methodology. The 2001 methodology focused on the number of beds total for the hospital, whereas the 2011 dismisses the total number of beds and is only focused on “staffed” beds per 1000 square foot. The number of floors is also no longer used in the 2011 calculation. The biggest deletion from the 2011 methodology though is the complete removal of heating degree days, and cooling degree days are the only instrument of weather considered in the calculation.

The 2011 methodology adds several variables that were not considered in the 2001 methodology, namely the number of full-time equivalent (FTE) workers, the number of staffed beds, and the number of MRI machines in the facility, all averaged out per 1000 square foot. It is interesting to note that gross square footage as a separate variable is not considered, only when it is melded with another variable.

3. Critique

The value of any benchmark correlates directly with its ability for any user to make accurate judgments with its usage. Like a ruler, it must be able to be used quickly to determine if something is four inches in length; if we cannot make this determination, or if the benchmark is difficult to use, the benchmark is of little value. Extra burden lies on performance-based benchmarks (like the example of the four minute mile earlier), because these benchmarks must be updated over time. Thus, the Energy Star for Hospitals performance-rating system has an admittedly very difficult task – the ability to accurately gauge how energy efficient a hospital is compared to its peers. There are four primary categories where I believe the Energy Star for Hospitals 2011 methodology falls short of being a good benchmark: the reference dataset, the independent variables used, the usage of source E.U.I. rather than site

E.U.I., and the guidelines classification for hospitals. I will discuss each of these critiques in the sections below.

3.1 Poor reference dataset quality

The goal of any reference dataset is to use a small amount of data to be indicative of a larger section as a whole. The 2001 methodology reference dataset used a survey that included 493 hospitals, nearly ten percent of the amount of hospitals in the United States. The survey was also available and viewable by the general population and approved to be a good overall representation of acute care hospitals. The 2011 methodology reference dataset on the other hand only uses 191 hospitals, accountable for only 3.7% of hospitals in the United States. The dataset is also currently unavailable to independent third parties for review of the accuracy and completeness of the data, whereas as other data (such as CBECS) is openly available. The EPA has also confessed in its technical methodology for the 2011 methodology that it has biased the data in some fashion, but it does not release the data from the survey nor indicate how the survey has been mathematically biased. All of these points make building confidence in the reference dataset difficult.

3.2 Independent variable selection

The independent variables (weighting factors) for the 2011 methodology were selected by mathematical regression techniques of the reference dataset. These variables were chosen because they showed a direct correlation between their characteristic and energy intensity of the building. However, strange independent variables were chosen as showing correlation with energy intensity, while other variables, which would seem to be obvious selections for independent variables were not chosen.

Ultimately, the efficiency of the hospital is rated according to its energy density, measured in energy used per year per square foot of the building. Thus, energy density is important. It is understandable how MRI machines were selected as an independent variable; MRI machines are electricity intensive machines which usually have their own data rack, require intense cooling, and have tight temperature and humidity requirements. However, other electrical intensive machines, such as PET Scan and CT Scan, were not chosen. Also, the most energy intensive areas of a hospital, operating rooms (which require extraordinarily rigorous temperature and humidity requirements, and use lots of steam-cleaning equipment such as sterilizers and washers), kitchens (which are heavily energy intensive with cooking equipment and fume hoods), gyms or swimming pools, and laundry facilities (which use high-pressure steam for extended periods of time) were not considered – very head-scratching for measuring energy density in buildings.

Inversely, areas that have low density were not necessarily counter-weighted. Some hospitals, due to their unique layout, have a high percentage of medical office space as part of their building or campus. Medical office space is a low density energy space compared to inpatient care areas, and would greatly affect the E.U.I. of any facility.

3.3 Source E.U.I.

One of the interesting things about the Energy Star performance rating system, for hospitals as well as other types of buildings, is its usage of source E.U.I. rather than site E.U.I. as the dependent variable. The reason source E.U.I. is used is the idea of energy equivalence, so as to not punish buildings dependent upon their fuel-type (with the hoped-for ambition of being able compare buildings that use a large amount of natural gas with buildings that use a small amount of natural gas or buildings which are all-electric). However, in spite of its intention, the usage of source E.U.I. appears to in fact punish buildings that use more natural gas than electricity. It does this by using metrics related to electricity rather than natural gas as the independent variables, due to the multiplying factor given to electricity when changing it from site E.U.I. to source E.U.I. As shown above, cooling degree days and MRI machines were selected as independent variables because they showed a high correlation with energy usage with the reference data set. However, both of these items are generally electricity-based consumers. Items that use natural gas usually do not get selected as independent variables (heating degree days was completely dropped from the 2011 methodology), which in effect plays down their significant role. In turn, buildings that have a higher blend rate of natural gas to electricity tend to score lower Energy Star scores than their all-electric or mostly electric brethren.

3.4 Classification confusion

One attribute for the Energy Star for hospitals guideline that went completely unchanged with the updated 2011 methodology is the hospital classification guideline. The guideline is meant to give Portfolio Manager users guidance on how to allocate utilities for hospitals, as well as different metering techniques (such as when a hospital has a data center, parking lot lighting, et al.). However, the classification guideline is quite short and poorly worded which causes confusion when creating using the Portfolio Manager system.

Hospitals come in a variety of shapes and sizes. Some hospitals are encapsulated in one building that is on one electric meter. Some hospitals on the other hand are built in campus-like setups where inpatient care may be in one building, surgery may be in another building, ambulatory care in another, and so on. Each of these buildings may also have drastically different blend rates of different fuel types, and may have parking lot lighting sub-metered (or not) and have data centers sub-metered (or not). However, the classification guideline does not provide clear and accurate information on how hospitals in a variety of different setups are to be entered correctly. This is the biggest deficiency in Portfolio Manager, because improper entry of utility data can greatly increase or decrease the Energy Star score by plus or minus twenty points.

4. Conclusions

Benchmarks are vital tools for our society – they play an important and necessary role to advance our understanding of a variety of characteristics. For many years there had not been a benchmark for building energy efficiency, and Energy Star has valiantly began this process. The Energy Star for hospitals 2011 methodology is a slight improvement over the 2001 methodology, but it is still an inaccurate benchmark for building energy efficiency. The selection of a smaller dataset, the continued usage of strange independent variables while disregarding other independent variables, and the continued confusion over the classification of spaces in Portfolio Manager makes it difficult to have confidence in any Energy Star for Hospitals score generated.

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