Back to School on Energy Benchmarking

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ABSTRACT

Benchmarking school energy performance has received much attention recently as a strategy for understanding and tracking energy intensity (annual energy consumption per square foot) and minimizing energy costs. EPA's National Energy Performance Rating System ("Rating System," formerly known as the ENERGY STAR® Commercial Buildings Program) offers a benchmarking system that enables school building managers and administrators to understand how their buildings perform relative to others and track their performance over time. As more school buildings have recently been analyzed to determine their performance under the Rating System, several counterintuitive results have been observed. A recent study in the Northeast, for example, found that some new, modern, well-ventilated schools scored lower with the Rating System than some older schools with outdated energy systems in the same region. Questions have also been raised about whether geographic or climate biases are present in the Rating System, and whether benchmarking energy intensity is particularly useful or relevant to decision makers in schools. This paper reports on a detailed review of the Rating System as it was applied to a sample of school buildings in New York State. It presents an overview of benchmarking and its importance for schools. It describes the results of two studies, discusses findings related to questions that have been raised about benchmarking schools, and describes efforts by the EPA to resolve some of those issues.

Introduction

Benchmarking is used in many fields. Automobile energy efficiency is measured in miles per gallon, and economic performance is measured through the Gross National Product. Benchmarking has become somewhat of a corporate buzzword in reference to methods for comparing the performance of one operation against others. "The Benchmarking Book" defines benchmarking as "a continuous, systematic process for evaluating the products, services, and work processes of organizations that are recognized as representing best practices for the purpose of organizational management" (Spendolini 1992).

Lately, energy efficiency agencies and utilities have given much attention to benchmarking energy performance in commercial buildings as a strategy for understanding, tracking and minimizing energy costs. Benchmarking can be an excellent tool for characterizing the energy intensity (often measured as annual Btus consumed per square foot) of buildings. It can also be used to track an individual building's performance over time and help monitor or identify opportunities to improve operation and maintenance (O&M) practices. Managers who oversee a number of buildings can use benchmarking results to

rank buildings and identify from those that need some immediate attention or those that perform efficiently. While benchmarking cannot give the same level of detail as a good energy audit or full engineering analysis, for a relatively small investment of time and effort, it can provide a good overall picture of energy use for a given facility. It is an easy and worthwhile first step to understanding energy usage and savings potential.

The concept of benchmarking energy performance in buildings is not new. Early efforts to use benchmarking were hampered, however, because it was not possible to benchmark a building against populations larger than those that the users could define and measure by themselves. This early problem has been resolved by the development of numerous databases of building energy consumption over the past two decades. In the United States, the largest and most widely used commercial building energy use database is the "Commercial Buildings Energy Consumption Survey" ("CBECS"), compiled every four years by the Energy Information Administration ("EIA"). An E-Source publication (Komor 1998) contains an excellent summary of building energy benchmarking and the databases that are typically used.

Overview of the National Energy Performance Rating System[1]

In recent years, the U.S. Environmental Protection Agency ("EPA") has worked aggressively to develop voluntary programs to help energy consumers cut their energy usage, and reduce environmental emissions. Since 1998, the centerpiece of EPA's effort for commercial buildings has been promotion of the EPA National Energy Performance Rating System (Rating System) and the corresponding Portfolio Manager software program. The Rating System scores a building for its energy consumption relative to other similar buildings nationally. Buildings scoring 75 or above, and verified by a Professional Engineer as meeting minimum indoor air and lighting requirements, are eligible for recognition by EPA as a *labeled* building and may receive a bronze plaque for display. The Rating System is currently available for selected types of existing buildings, including office buildings, grocery stores, hotels, hospitals, and K-12 schools. Soon to join this list are convenience stores, healthcare facilities, and warehouses.

Portfolio Manager is an on-line program. It requires relatively few data inputs, including some building attributes such as building size, percent of area that is cooled, presence of cooking, etc. In addition it requires some building operating characteristics, such as weekly hours of use and occupant density. It also requires a minimum of twelve months of energy consumption data. Portfolio Manager generates a score, ranging from 1 to 100, that is a function of the energy intensity of the benchmarked building.[2] The score identifies the percentile of that building relative to all other like buildings nationally. For example, a score of 40 represents that 59% of like-buildings nationally are less energy intensive and 39% are more energy intensive.

To building owners and operators, the score offers a clear and concise means to benchmark their building, providing a means to determine simply whether the energy

[1] The name "National Energy Performance Rating System" was recently introduced by EPA. It has commonly been known as the EPA ENERGY STAR® Commercial Buildings Label Program.

[2] A detailed description of the procedure and models used in calculating benchmark scores is provided at: http://yosemite1.epa.gov/estar/business.nsf/content/multiarea_portfolio_manager.htm?opendocument&pca=Business#eslabel.

performance of a building is good, average, fair or poor. A relative low score may signal opportunities for reducing operating cost through energy efficiency or O&M measures. A relatively high score may indicate the presence of fewer opportunities. The simplicity and clarity of this percentile score therefore enables an efficiency baseline to be established. The score enables operators of multiple properties, particularly over diverse climatic conditions and varying energy costs, to validly compare similar properties for relative energy performance.

Benefits of benchmarking to the building operator include the ability to monitor changes in energy performance over time. By benchmarking successive 12-month windows of energy data, the Rating System can enable utilities, system benefit administrators, and the building operators themselves to demonstrate the impact of energy efficiency activities over time. Equally significant, tracking performance can help in evaluating and tracking results of changes in building maintenance and operations.

Benchmarking Systems and Schools

Because the public pays for the energy use in schools, there is a lot of interest in understanding and cutting school energy waste. Educational buildings account for 11.5 percent of direct commercial sector energy consumption and 10 percent of commercial sector carbon emissions. Moreover, energy costs in many schools are second only to salaries and account for approximately 20 percent of facilities' operation and maintenance costs (Thorne, 2000). The U.S. Department of Energy estimates that smarter energy management in schools could reduce energy consumption by as much as 25 percent and cut school energy costs nationally by more than $1 billion annually (Thorne 2000). Benchmarking is proving to be a useful tool to help begin this process. One of the keys to cutting school energy costs is motivating school decision-makers. EPA relies on the rating system to help motivate decision-makers and market energy efficiency to schools.

The Buildings Technology Center of Oak Ridge National Laboratory has developed a methodology to benchmark various building types, including K-12 schools. With their approach, the energy performance of whole buildings can be benchmarked against a population either defined by the user or within regional census divisions, as defined by CBECS. Lawrence Berkeley National Laboratory has also developed some tools for commercial building energy benchmarking. They have assembled a good set of links to commercial building energy benchmarking web sites that can be found at: http://poet.lbl.gov/cal-arch/links/.

The LEED™ (Leadership in Energy Environmental Design) Green Building Rating System from the United States Green Building Council offers another approach to rating overall building performance. As the EPA Rating System evaluates energy performance of existing buildings, LEED evaluates the environmental performance of new buildings from a "whole building" perspective. Energy efficiency and renewable energy constitute one of five broad categories of what constitutes a LEED Certified building. LEED is different from the EPA Rating System, however, in that LEED is point-based, rather than statistically based. LEED is not a means to quantifiably compare buildings. In a recent development, the United States Green Building Council has piloted LEED-EB, a methodology to benchmark the environmental performance of existing buildings. For benchmarking energy performance, this new tool utilizes EPA's Rating System translated into a point-based rating.

Relative to other benchmarking tools, the EPA's Rating System is unique as a nationally based, ready-to-use tool for comparing the overall energy performance of schools and other building types. Within four months after the Rating System was first made available on the web, over 90 schools in seven states had qualified for the ENERGY STAR® schools label.

Research Undertaken on Northeast School Buildings

With the growth in interest in benchmarking and the wide promotion of EPA's Rating System, several projects have recently studied school buildings' energy performance with the goal of understanding how to best measure and communicate the energy efficiency of existing school buildings. At the same time, concerns arose within the energy efficiency industry regarding the accuracy or validity of the Rating System, particularly in its application to schools. Concerns included: a potential bias against schools in colder climates and against oil-heated schools; inadequate accounting for amenities in schools by the Rating System; and, limited usefulness of the benchmark score for facility managers and decision-makers.

This paper describes the findings of two recent projects that examined energy usage and building performance in a sample of schools in New York State. The research was aimed at answering some of the concerns and providing input to future program design and/or modification.

NYSERDA/RLW Schools Study

On behalf of the New York State Energy Research and Development Authority (NYSERDA), RLW Analytics, Inc. examined the potential to target high-energy use schools for efficiency improvements. RLW used the Rating System as a first screen to identify candidates. The project involved collecting basic building information through telephone surveys with school administrators, collecting some energy use data directly from utilities and determining benchmarking scores by inputting data into Portfolio Manager using a data import template provided by the EPA.

The initial intent was to benchmark 500 private schools in the Consolidated Edison service territory and then target the 50 most energy inefficient schools for direct follow up outreach. Follow up outreach included on-site visits. The purpose of these was to present NYSERDA's funding and technical support opportunities to schools in need, as well as to conduct a preliminary walkthrough audit where the visiting consultant would identify and analyze potential energy savings opportunities for the school.

Around the time of project conception, NYSERDA was named by the New York State Public Service Commission to administer a statewide public benefits fund. As a result, the project was expanded to also include 500 upstate New York schools. As a first step in this project RLW conducted baseline surveys of 234 schools, which included some questions on building and operating characteristics. In the second phase of the research project, school data were collected, entered into an import template, and then forwarded to EPA to be benchmarked through Portfolio Manager. These results were subsequently screened to remove outliers and the remaining schools were ranked according to their respective benchmark score.

The process of screening to remove outliers and verify the validity of the information from the sample of downstate and upstate schools revealed many questions about the validity of the data for the downstate, parochial schools. Due to the substantial number of schools with data outside the ranges expected in the downstate sample, these schools were removed from further consideration in this paper as the authors felt there were too many remaining questions about the validity of both the size (square footage) of the schools, and whether or not the energy consumption data was complete and accurate. Concerns about the data validity were based on the fact that a number of schools in the New York City region are not stand-alone buildings, but instead may occupy a portion of a larger building with other tenants. This causes complications due to electric and/or gas meters serving portions of the building different from the reported school building area, as well as some cases where the school has its heat provided by the central building systems so that accurate energy use data are hard to verify. These concerns were not present for the 453 upstate schools, which had a distribution of energy intensities that relatively closely tracked the national and regional data from CBECS. Thus, for the purpose of this paper the examination of the NYSERDA/RLW study was restricted to the upstate sample of schools.

After the benchmarking task was completed, fifty of the lowest-scoring upstate schools were then recruited for on-site visits. Through several visits and initial phone calls to some of these schools, it was discovered that that some of the low scores were for schools in large suburban school districts that serve mid- and upper-level income populations. In short, the results were counterintuitive, as one might expect that modern schools would perform well with respect to energy efficiency. In fact, many of these schools were recently constructed (within 20 years), had modern lighting and HVAC systems, and had already been upgraded through an existing energy performance contract.

After RLW completed the project, a closer look at the data revealed certain common features of these large suburban school districts:

- Extensive athletic and program facilities
- Frequent after-hour and weekend community events and adult education
- The school gymnasium and auditorium had large dedicated HVAC systems, and were used for many events beyond the regular school day
- There is extensive computer use in the school: PC labs, CAD design workshops, digital design classes and classroom computers; in addition, these labs and classroom spaces tended to have dedicated, around the clock air conditioning
- Some schools had TV and radio studios and work centers

This project was one of the first to utilize the import template and the K-12 version of the software extensively. Subsequently EPA has made a number of improvements to the import template. The Rating System currently includes procedures to control for the energy impacts of some features of schools, such as extensive computer use and after-hour use of the buildings. However, after this project was completed it became apparent that collecting and incorporating all the data needed for each of these schools for a more accurate benchmark score is a task that was definitely beyond the limits of this project. Difficulties were experienced in collecting operating data via telephone surveys and subsequently entering it into the import template.

Experienced custodians. RLW also found another interesting ancillary aspect that might positively affect school scores. Visits or phone calls to small school districts in rural parts of New York State revealed that each of their school buildings tended to be maintained by staff that had longer tenures than their peers in urban school districts. This translated into a better understanding of the history and general operating efficiencies for each building. For example, RLW found from a visit to a small suburban school district in the Syracuse area that there was one maintenance person assigned to each building. Each of these staff members have spent about 8 to 12 years (and in one case, about 25 years) employed by the school district, with a majority of time in the same building. The net result was that, although most of the buildings were built between 1930 and 1960, their operating systems were well maintained and cared for. It appeared that these schools had garnered low scores based on the age of their HVAC systems and building envelope, but would have likely scored lower if they were not maintained and operated well. The common denominator in this case was that the staff members knew their facilities well, cared about how they operated, and strived to best maintain the aged systems these buildings have. This was similar to practices found in other smaller suburban and rural school districts visited in central New York.

NEEP Schools Study

Northeast Energy Efficiency Partnerships, Inc. (NEEP) began a project in early 2001 to investigate the value of the Rating System to public utilities and other public benefits administrators. One purpose of this project was to explore the concerns expressed by some utilities that the EPA Rating System didn't work well for schools, particularly in colder climates and with oil heat.

A private performance contracting energy services company (ESCO) was willing to provide data to NEEP to perform a review of the schools for two districts where efficiency projects had been completed over a year earlier. The districts were chosen by the ESCO in part because they were among the few in New York that had not participated in a lighting efficiency program offered by the utilities or the New York State Power Authority during the past decade and therefore they were likely to still have significant energy efficiency opportunities. Moreover, these two districts had not been studied as part of the NYSERDA/RLW project.

One school district is relatively large, suburban and considered one of the more progressive around the upstate metropolitan area that it serves. All seven of the schools in this district are heated with natural gas. The other school district is located in a medium sized suburban city in the New York City metropolitan region. Most of its 14 school buildings are heated with oil.

Figure 1 shows a summary of the 21 school buildings showing the characteristics, energy consumption, and resulting Rating System scores.

The in-depth reviews of these schools provided interesting anecdotes that reveal some of the strengths, weaknesses, and sensitivities of the Rating System. The effects from two of these anecdotes are described below.

Ventilation. A single action – increasing make up air ventilation – in one oil-heated elementary school was taken in early 2000 to comply with applicable regulations and to improve the indoor environment. It caused the benchmark score to drop by almost 50%

Table 1. NEEP Schools Study, Rating System Inputs and Results

Building	Floor space (sq. ft.)	Year Built	Op. hrs. per week	No. students	Cooking present	Percent air con-ditioned	Mos. used per year	Heating fuel	Source energy intensity (kBtu/SF)	Rating System Score
District "A"										
Elementary School 1	60,374	1972	41	544	No	0	10	N. gas	50.7	61
Elementary School 2	250,241	1952	46	2203	Yes	0	10	N. gas	67.0	46
Elementary School 3	121,320	1966	40	1094	Yes	0	10	N. gas	74.5	51
Elementary School 4	57,410	1972	41	574	No	0	10	N. gas	48.4	65
Elementary School 5	212,320	1965	43	1192	Yes	0	10	N. gas	78.4	49
Secondary School 1	233,805	1969	38	1686	Yes	100	12	N. gas	56.7	57
Secondary School 2	135,640	1964	37	1106	Yes	0	12	N. gas	79.2	42
District "B"										
Elementary School 1	54,000	1912	35	502	No	0	10	Oil	83.7	53
Elementary School 2	110,600	1912	35	778	Yes	0	10	Oil	122.6	9
Elementary School 3	77,100	1897	35	685	No	0	10	N. gas	86.9	38
Elementary School 4	51,000	1950	35	517	No	0	10	Oil	79.1	59
Elementary School 5	66,100	1954	35	419	No	0	10	Oil	101.5	23
Elementary School 6	91,000	1971	35	768	No	90	12	Oil	88.6	39
Elementary School 7	83,100	1924	35	426	No	28	10	Mix	76.2	30
Elementary School 8	64,600	1936	35	555	No	0	10	Oil	56.2	65
Elementary School 9	60,000	1928	35	402	No	0	10	Oil	115.7	16
Elementary School 10	129,800	1925	35	697	No	0	10	Oil	76.5	26
Elementary School 11	59,600	1968	35	372	No	90	12	N. gas	73.7	46
Elementary School 12	71,000	1931	35	549	No	0	10	Oil	90.5	30
Secondary School 1	409,400	1962	37	2474	Yes	90	12	Oil	69.3	58
Secondary School 2	67,000	1924	35	576	No	0	10	Oil	99.8	30

within one year as shown in Figure 1. This example illustrates a perceived problem or counterintuitive feature of the Rating System. Increasing ventilation increases energy intensity of a building yet improves the school's learning environment.

Maintenance. In another oil-heated elementary school, an experienced custodian retired in late 1999 and was replaced by a rookie with no incentive or interest in maintaining the energy efficiency of the school. Within 12 months, the benchmark score dropped by almost one quartile as a result. This example, shown in Figure 2, illustrates that one of the strengths of the Rating System model is its sensitivity to changes in energy intensity related to operation and maintenance changes.

Data Analysis of NYSERDA and NEEP schools

In order to study the concerns that had been raised by various practitioners about potential biases in the Rating System, a detailed analysis of the data collected in both of the studies described above has been performed to determine the significance of the issues raised.

Much more complete data on the energy consumption were available for the 21 schools that NEEP had studied in detail. These were added to the upstate NYSERDA/RLW

dataset for the purpose of analyzing the validity of the perceived concerns. A summary of the performance rating scores for the combined set of upstate New York and NEEP (474 total) schools studied appears in Table 2 and graphically in Figure 3.

Figure 1. National Energy Performance Rating System Score History, District "B," Elementary School 10, Change in Ventilation

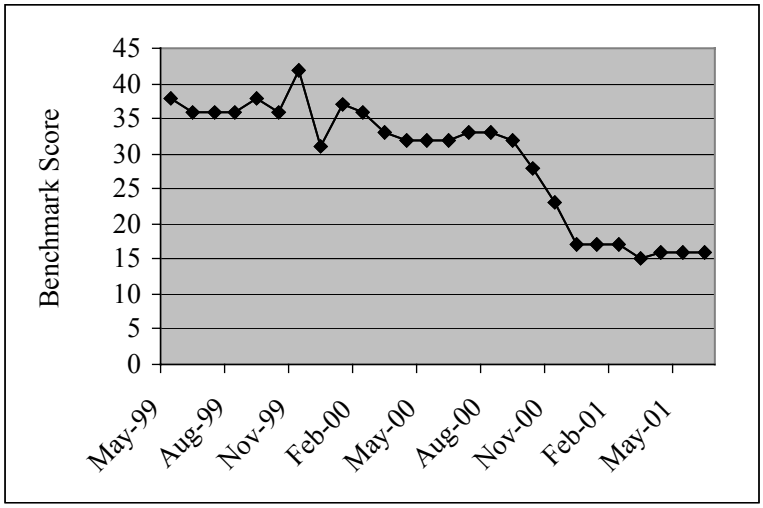
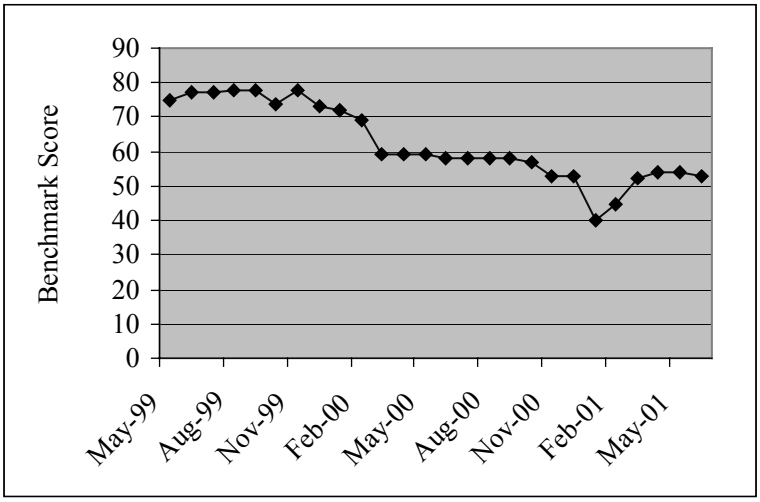


Figure 2. National Energy Performance Rating System Score History, District "B," Elementary School 1, Change in Maintenance



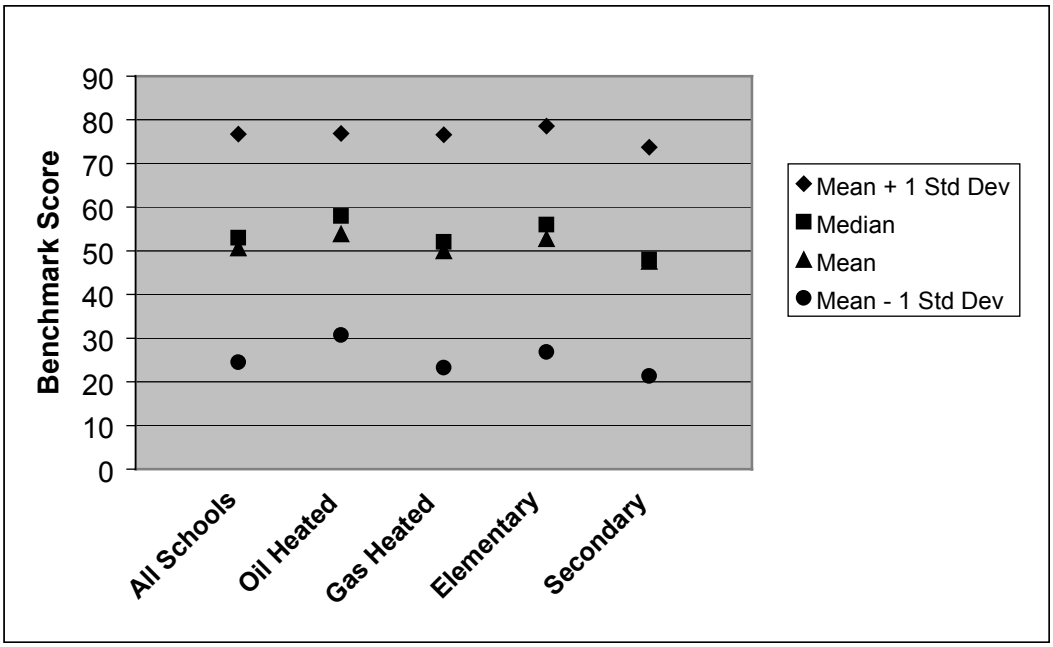
The mean performance rating score of 50.6 demonstrates that for this substantial sample, the average energy consumption of the schools comes in right at the 50th percentile, as should be the case. Further, this summary of the data shows that there is no bias against oil-heated schools; they score on average slightly higher than gas heated schools. There are several potential explanations for this: the sample may be comprised of more old, technologically simple schools that heat with oil, or it may be that many of them are located

in less urban areas where gas is not available and where there is often less turnover of the building operating staff.

Table 2. National Energy Performance Rating System Scores for New York Schools

	N	Mean	Median	Std. Dev.
Oil Heated Schools	85	53.8	58	23.1
Gas Heated Schools	398	49.9	52	26.7
Elementary Schools	277	52.7	56	25.9
Secondary Schools	197	47.5	48	26.2
All Schools	474	50.6	53	26.1

Figure 3. Descriptive Statistics, National Energy Performance Rating System Scores for Schools



The data show that on average, secondary schools are more energy intensive than elementary schools, because these schools typically have more functions and amenities, such as swimming pools, clubrooms, vocational classrooms, and computer centers.

Issues

A detailed review of the data from the two studies shows that most of the concerns and issues raised regarding the validity of the Rating System when applied to K-12 schools are not significant issues. There are, however, a few remaining issues that EPA plans to address, and other perceived issues that need further work to best advance the use of the EPA National Energy Performance Rating System for schools.

The issues can be broken down into two principal groups. One includes issues that have been studied and found not to be relevant to the technical validity of the Rating System; the second group of issues includes technical weaknesses or concerns that need further study

and will be considered by EPA for future enhancements to the Rating System. Many of the perceived concerns about the technical validity are due to shortcomings in the CBECS data, some of which will be clarified after the detailed energy consumption data from the 1999 CBECS survey (referred to as the "CBECS microdata") are released for analysis.

Issues not relevant to the technical validity of the rating system

- **Geographic/climate bias**. Some have expressed concerns about possible climate or geographic biases in the way that the benchmark scores are calculated, potentially penalizing schools in some parts of the country and making it more difficult to achieve the ENERGY STAR® Label. The review of the combined NYSERDA and NEEP datasets does not support the claims of bias, as confirmed by the mean score of 50.6 for the large dataset. When the rating system is updated, after 1999 CBECS microdata are released, it will be worth another review to verify this.
- **Bias against oil heated schools**. There had been perceptions that schools heated with oil would generally score low in the Rating System. Again, the combined NYSERDA and NEEP data analysis does not support any bias. The distribution of energy intensities of oil and gas schools found in the two studies is similar to the national distribution as found in CBECS, and is not skewed in favor of either primary heating fuel source, and can therefore be considered "fuel neutral."

Concerns that need further study. A different set of issues includes technical weaknesses or concerns that need further study and will be considered by EPA for future enhancements to the Rating System, some of which can be (or already have been) addressed by clarifying the eligibility criteria and/or guidance to prospective participants.

- **Mechanical ventilation**. Obviously, good indoor air quality (IAQ) is critically important for providing a good learning environment. However, providing substantial amounts of outdoor air into the conditioned space requires significant energy use both for conditioning the outdoor air that is introduced into the space, as well as the fan energy used to transport the air. The NEEP review showed that the presence of a mechanical ventilation system could have a large negative impact on the Rating System benchmark score.

  Initially, EPA's guidance to professional engineers in validating a building score states that generally, buildings are required to be mechanically ventilated to meet ASHRAE Standard 62, which is established as the minimum standard level for a building to qualify. (A school could score in the top quartile through the Rating System, yet not meet all applicable ventilation and IAQ requirements to qualify for the ENERGY STAR® Label). However, the adequacy of ventilation and resulting IAQ is largely left up to the validating engineer's discretion. The current version of EPA's guidance on ventilation is more explicit than earlier versions. A cursory review of the EPA's registry of ENERGY STAR® labeled schools from the Northeast region of the country labeled prior to the current guidance suggests that a portion are older buildings that most likely do not have adequate mechanical ventilation systems in place.

While it is plausible that operable windows can allow for adequate ventilation in the absence of any major indoor air pollutant sources within older schools, these buildings have very different energy profiles than newer buildings that were designed and built with modern mechanical ventilation systems. There is a need for more study and finer segmentation of the datasets used for comparison to be certain that buildings in intensive heating climates are not penalized in their benchmark score for having appropriate ventilation systems in place and being used. It is expected that the 1999 CBECS microdata will provide some new insight into this issue, and additional modeling on the effect of mechanical ventilation's effect on the benchmark score would be very useful.

- **Differing levels of amenities in schools**. Schools have very different levels of services that they provide. For example, the technologies and energy systems in a modern high school are very different from those in an 80-year-old elementary school. These different systems and the amenities provided affect the energy intensity of the school building. The more services a school provides, the higher the likelihood the school will receive a lower score. The Rating System has algorithms that correct for certain major energy using amenities, such as computer data centers and the presence of air conditioning. EPA plans to add additional algorithms to account for swimming pools and possibly other major equipment. It is open to discussion, however, whether the definition of these variables alone captures the inherent differences in energy consumption between schools with and without substantial amenities.

Other issues. In addition to the issues discussed so far, there are some not related to the technical validity of the EPA Rating System. They are important, however, because they have an effect on how the tool is perceived by potential practitioners. The following issues need to be conveyed so that decision-makers can understand the value and limitations of the tool:

- **Results are sometimes counterintuitive**. As was noted in the analysis of the schools studied by NYSERDA/RLW and NEEP, the benchmarking results can be counterintuitive. One example is where an old, seemingly inefficient school can receive a higher score than a modern school with many energy efficient technologies included in the design. This can easily occur due to differences in the schools' energy using systems. An old school may be heated with an old, gravity steam boiler, and not have any mechanical ventilation, and will therefore have a much lower energy intensity as there are no fans or pumps circulating air or heating media around the building. This kind of building will have low energy use intensity, and will therefore receive a higher score than a more modern school. Technically, this is completely correct, however, this affects acceptance of the tool by some within the schools community, as there is an expectation that modern schools with the latest energy efficiency technologies designed in should receive a good score.
- **Relevance of benchmark score to other metrics**. For a school decision maker or service provider to set priorities as to which are the best targets for reducing energy costs, other performance measures, such as energy cost per square foot, or site energy use per square foot, might provide more relevant information than the Rating System

score. For example, performance contractors often screen potential projects by a quick scan of the energy cost per square foot in determining investment priorities. While the Rating System score is a relevant measure for comparison and benchmarking, these other metrics can also be complementary and valuable to many decision makers.

Summary

There is tremendous value in benchmarking, using the EPA Rating System for tracking building energy performance and identifying problems so that they can be corrected. As illustrated by some of the anecdotal evidence obtained from an analysis of New York State schools, the tool is most useful when it is used periodically to make performance changes visible.

Some of the issues that were explored in a review of the data on New York schools were perceived rather than actual problems with the K-12 Rating System. It is likely that the way the system evolved over the past couple of years contributed to perceived problems. For example, under the initial guidance to the validating engineer, old schools that would not have met the intended requirements for adequate mechanical ventilation may have qualified for the ENERGY STAR® Label. Over the past year and a half the building eligibility criteria have also been refined by EPA. Many of the issues that have lead to perceived technical weaknesses of the system have been clarified, and as the above analysis demonstrates, should no longer be considered issues. Most of the remaining, outstanding technical issues should be clarified after release of 1999 CBECS data and EPA's updates to the software tool after that.

In addition to continuing to build upon the CBECS database and improve the Rating System, it is important to keep the community of school decision-makers and the energy efficiency community informed about the improvements to the model, and to provide examples of benefits and uses of the benchmarking system.

Conclusions

Benchmarking is a strategy that has merit for schools. School decision-makers must be motivated to incorporate energy efficiency into planned construction and renovation projects and to invest time and resources to improve energy performance. Using the National Energy Performance Rating System's Portfolio Manager, local and regional players can demonstrate the potential for energy savings in their facilities. The growing number of case studies showing how schools around the country have successfully implemented energy efficiency projects can help convince decision-makers that efficiency upgrades are worthwhile and achievable.

The Rating System is a tool that has numerous strengths as a benchmarking system for schools. As demonstrated in some of the anecdotes from schools in New York, it is very effective in documenting changes in a building's performance over time. Moreover, the fact that it is a nationally based, ready-to-use system makes it an important resource for many energy efficiency and other school programs.

Continued research on school benchmarking is important. As this paper illustrates, research can help to dispel erroneous perceptions about the Rating System. In addition,

research is useful to identify areas for potential improvement. It is important to communicate the uses, limitations, and advances as this tool develops to help ensure the success of the National Energy Performance Rating System.

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