Melrose Veteran Memorial Middle School

An Analysis of Energy Performance

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Objective

This report describes the findings from an analysis of Melrose Veterans Memorial Middle School (Veterans) and offers recommendations for improving the school's energy performance. This section is written primarily for the benefit of the school. Veterans is listed as GS-6 in the full school report. Please reference the figures in the full report for more information.

Summary

Based on energy use during the period August 2007 – July 2007, Veterans' energy intensity per ft^2 is much better than average when compared to all 6 middle schools included in this study. Veterans' ENERGY STAR® score of 74 is also much better than the average, making it one of the better performing schools in the study. These results are shown in Figure 1, which compares annual energy

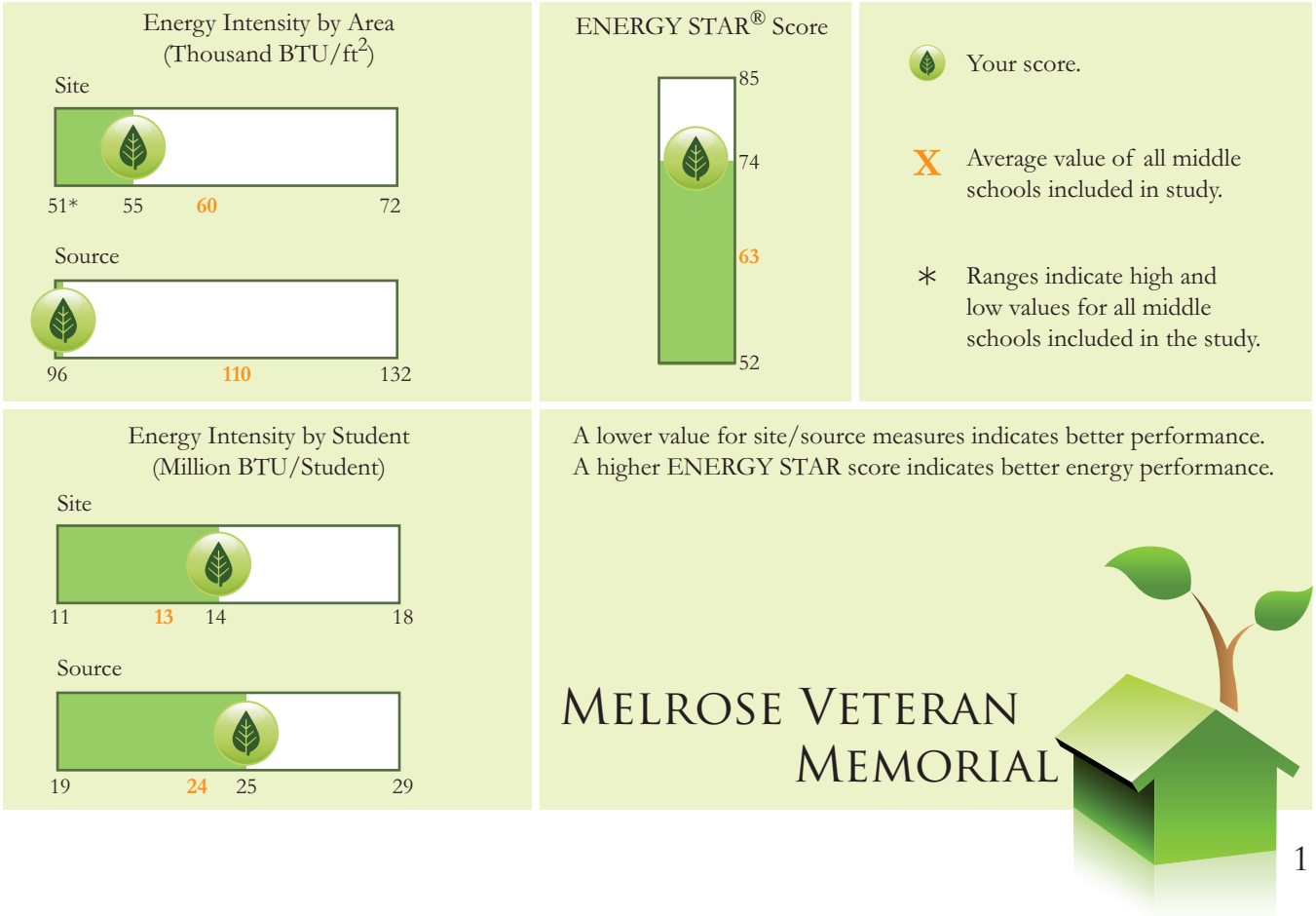
Definitions

British thermal unit (BTU): A standard unit for measuring the quantity of heat needed to raise the temperature of 1 pound of water by 1 degree Fahrenheit at or near 39.2 degrees Fahrenheit.

Site Energy: The energy consumed at a building location or other end–use site.

Source Energy: The total amount of raw fuel that is burned to create heat and electricity to operate the building. This incorporates all transmission, delivery, and production losses. For more information visit: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_benchmark_comm_bldgs.

Figure 1. How does your school compare to other new Massachusetts Middle Schools?



Melrose Veteran Memorial

Table 1. School Description

Benchmarking Report Card	
School	Veterans Memorial - Melrose
Location	350 Lynn Fells Parkway Melrose, MA 02176
Space Attributes	
Floor Area (ft^2)	215,100
Number of Students	831
Number of PCs	450
Operating Hours/Week	91
Metrics Based on Utility Bills January 2006 – December 2006	
Total kWh/year	1,328,250
Total therms/year	73,176
Water Use (cubic feet)/year	131,295
Square feet/student	259
Annual kWh/student	1598
Annual therms/student	88.1
Annual Site BTU/student (million)	14
Annual Source BTU/student (million)	25
Annual Energy Intensity Metrics	
Portfolio Manager ENERGY STAR benchmarking rating	74
Site Energy Intensity (Thousand BTU/ft^2)	55
Source Energy Intensity (Thousand BTU/ft^2)	96
Average Utility Rates 2007 – 2008	
Electric: ($/kWh)	0.15
Gas: ($/therm)	1.55
Water: ($/cf)	0.094

use at Veterans with annual energy use at other new middle schools built in Massachusetts. The data used in this analysis covers the first year of operation of the school. Building occupation began in September 2007, with staff present in the building in late August. All of the schools in this study were constructed between 2001- 2006.

This report also compares Veterans energy use, derived primarily from the school's energy bills, to (1) the energy use forecast by a pre-construction building design model, and (2) a base-case model that simulated the school's energy use if it had been built to just meet the minimum requirements of the Massachusetts Energy Code.[1] After reviewing the energy models and conducting a brief site investigation, we found that the school is using about 10% less electricity over code, but is using 3% more gas than it would if built to just meet the energy code. Improved operational practices, identified in the Conclusions and Recommendations section of this report, could improve electrical savings to 10% better than code. Ongoing operational tracking using the existing Energy Management System (EMS) could yield additional natural gas savings. Table 1 highlights school building characteristics, and energy metrics based on Veterans' utility bills.

Methodology

The first step in this study was to compare actual energy use to modeled energy use for each school. When we undertook this comparison, we found that the assumptions used by the pre-construction models to predict energy use differed in important ways from how the buildings were actually constructed and how their equipment functioned and was operated. We then conducted a high-level review of each school's as-built plans and briefly inspected the school during a site visit. While we did not intend for our inspection to function as a comprehensive energy audit, we did discover several patterns across all schools in the study that might yield additional savings and that explain in part where predicted and

1 Massachusetts State Building Code, Energy Conservation, Chapter 13.

actual energy use differs. The methodology used to analyze and compare each school is consistent with the methodology used in the full post-occupancy report and can be found there in section 2.

Modeled and Actual Energy Usage Comparison

The code model, as-designed model, and actual energy use are shown in Table 2. Before adjustments, electricity use and gas use at Veterans was better than the code model.

The as-designed model originally estimated total *source* energy savings of 28% over the code model. However, as noted above, energy models typically address "regulated" loads such as indoor lighting, heating and cooling, and ventilation, and do not consider "unregulated" loads for computers, external lighting and kitchen equipment. Because additional unregulated loads are not generally included in the models, some modelers suggest that actual energy use at a site can be as much as 50% higher than model results. Table 3 details the adjustments made to the model for this school.

With these adjustments and the contributions of emergency generation accounted for, the electricity bills are 10% better than the code model. Electricity savings accrue from occupancy sensors that control lighting and lower lighting density (W/ft^2) than required by the code or the as-designed model documented. Outdoor lighting schedules currently run from dusk until 10:00 pm, which also accounts for electricity savings greater than schools that leave their outdoor lights on overnight. Turning off PCs or putting them in sleep mode, in addition to other measures, can save an additional 129,150 kWh per year, increasing electricity savings to 19% better than the code model.

We similarly adjusted gas use to account for the actual footprint of the building and the local weather. Combining the adjusted value with estimated gas use for the kitchen yields a code value of 70,845 therms/year; the actual use is 3% higher than the code model.

As shown in Tables 3 and 4, adjusting the code and as-designed models gives a truer picture of building performance. When compared to code model, gas use appears to be high, but it is important to note

Table 2: Site Energy: Comparisson of Energy Bills with Unadjusted Models

Annual Use	Code Model	As Designed Model	Projected Savings Better than Code Model	Actual (1/07 - 12/07)
Electricity (kWh)	1,370,268	1,028,209	25%	1,328,250
Natural Gas (therms)	77,683	51,395	34%	73,176

Table 3: Adjustments to Models to Fully Represent Actual Electricity Use (kWh)

	Code Model	As Designed Model	Actual (8/07 – 7/08)	Savings
Annual Use (kWh)	**1,370,268**	**1,028,209**	**1,288,000**	
Back-up Generator			5,000	
Footprint	32	24		
Transformers	33,919	33,919		
Plug Load	1,631	1,631		
Outdoor lighting	28,580	28,580		
Interior lighting	-24,234	-67,510		
Kitchen Equipment	72,288	72,288		
Total (kWh) Total (kWh) with Savings[2]	**1,482,484**	**1,097,141**	**1,293,000** **1,204,100**	**10%** **19%**

2 Total (kWh) with Savings refers to potential savings that could be achieved by implementing the recommendations found in the Conclusion and Recommendation section of this report.

Table 4: Adjustments to Models to Fully Represent Actual Gas Use (therms/year)

	Code Model	As-designed Model	Actual Use (8/07 – 7/08)	Savings
Annual Use (therms)	**77,683**	**51,395**	**73,176**	
Footprint	2	1		
Weather (HDD)	-2,799	-1,852		
Kitchen Equipment	-4,041	-4,041		
Total	**70,845**	**45,504**	**73,176**	**-3%**

that Veterans gas usage is better than average when compared to other middle schools in this study. Two factors contribute to the appearance of high gas usage: 1) the annual BTU/ft^2 in the code model is among the lowest for all schools except those with heat pumps. 2) The energy data analyzed in this report are taken from the first year the building was occupied. Schools usually improve after one year of operation as facility staff get used to equipment and are able to optimize the EMS. It is likely that gas performance will improve in the second and third year of operation.

After adjustments for both gas and electricity, Veterans shows energy savings of 6% better than code; however, when compared to other middle schools, their site and source energy use is better than average.

ENERGY STAR Portfolio Manager Score

The U.S. Environmental Protection Agency (EPA) ENERGY STAR Portfolio Manager Tool we used to benchmark the school yielded a score of 74, better than the median score of 50 and just short of the 75 required for ENERGY STAR recognition. When considering the ENERGY STAR score, it is important to note that the energy data analyzed with this tool reflects the first year of building occupancy. Building operations during the first year do not always reflect a typical year of energy usage. Additionally, the benchmarking tool is an approximate fit of a national database and doesn't take into account a school's precise operation and equipment.

Conclusions and Recommendations

1. Veterans could save 129,000 kWh of electricity a year, yielding an annual cost savings of $19,350 based on a rate of $0.15 kWh. A large portion of this savings would come from addressing nighttime plug load. We recognize that some of the following recommendations may have been implemented since the on-site visit. These recommendations address savings opportunities specific to Veterans, but also useful for all schools:

   - Plug load power management is a low- or no-cost measure that can provide potential savings. While some computers and monitors are shut down at night, programming all computers to sleep settings can provide savings. Free help is available from the EPA at http://www.energystar.gov/powermanagement. EPA contractors can answer technical questions about implementing these settings and about various options for keeping sleeping PCs up to date with security and other software patches. By contacting EPA, a quick conference call can save time researching various solutions and provide lessons learned from dozens of information technology departments.

   - Additional savings could be achieved by turning off or reducing the use of kitchen equipment otherwise unnecessarily left on. This recommendation is applicable to all schools.

2. The following observations and recommendations address EMS settings at Veterans:

   - The EMS trending feature, which is not currently used, could help the facility staff recognize potential energy savings opportunities and adjust building operations to realize those savings. The trending feature shows energy use over a period of time and high periods of use can be identified and addressed. Similarly, utility interval data is available from utility companies by special request. Accessing this information can also provide insight on active loads during unoccupied hours.

   - Based on a review of the EMS, temperature set backs in unoccupied zones were set to 65º F at night and 72º F during occupied hours during the day. These settings could be adjusted to be more in line with standard configurations and with the model assumption of 60º F at night and 70º F during the day. Our experience studying schools across the state and elsewhere shows that optimizing outdoor air damper settings and ventilation schedules can provide additional savings.

   - Veterans' gas usage is slightly better than average compared to other middle schools analyzed in this study. Gas usage is expected to improve during the second and third year of building operation, but optimizing the EMS to control set points, scheduling, outdoor air dampers, and ventilation could further increase the thermal savings.

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The full report Massachusetts Green Schools: Post-occupancy Study of Energy Efficiency can be found at www.masstech.org/greenschools.