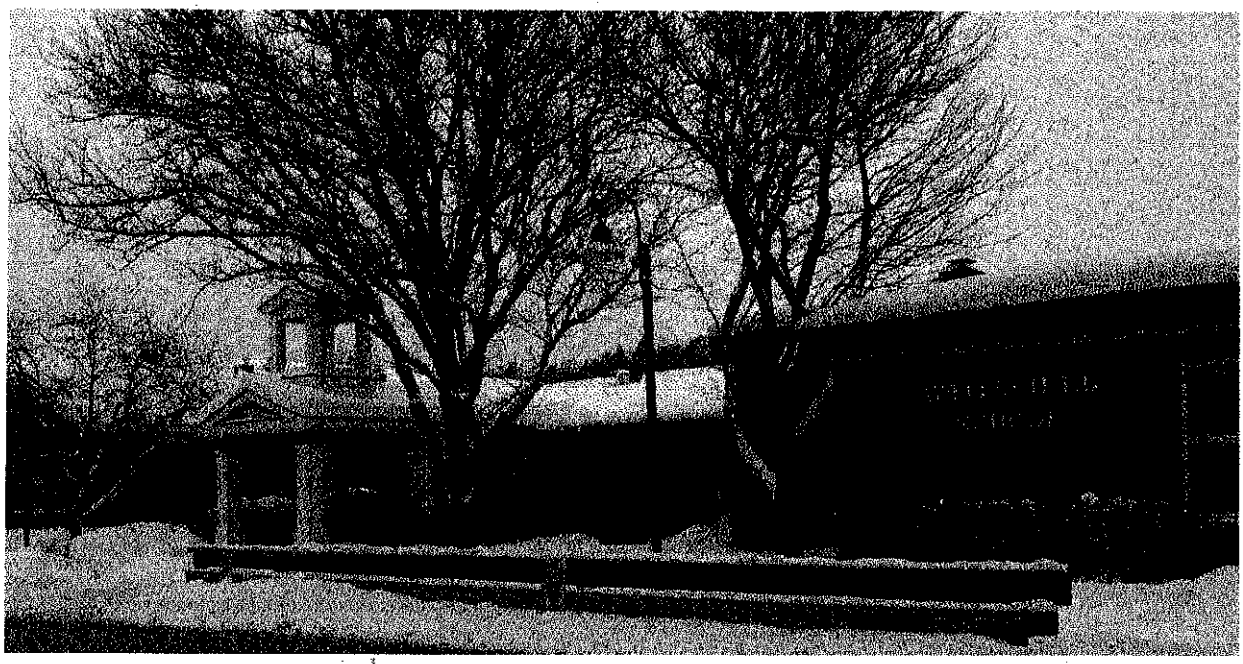

Waitsfield School

Energy Assessment Report

Date of Site Visit: February 10, 2015

Present at Site Visit:

Joe Robinson, Maintenance Director
Kaiya Korb, Principal
Norm Etkind, SEMP

Vermont Superintendents Association - - School Energy Management Program

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EXECUTIVE SUMMARY

The primary goal of the building's energy using systems is to create an indoor environment that supports the school's educational and community purposes. Adequate lighting, heating and ventilation are essential to meeting this goal. This report outlines steps that can be taken to use energy in an efficient manner to achieve energy savings while complementing, not compromising the educational environment.

The Waitsfield School has done a good job of reducing their fuel and electricity use since my last visit. It is nice to see the improvements that have been made.

The new building automation system for the original wing of the building needs some fine tuning and correction to work in an optimal fashion. CO2 settings and minimal outside air intake during occupied times need correction.

A return air system should be installed to make ventilation work better in the area of the building served by unit ventilators. Adding additional building areas to computer control when budget allows would be helpful.

There is a need to more reliably ventilate classrooms in the area of the building served by the energy recovery ventilation system.

A conversion to pellets to utilize a less expensive renewable fuel may want to be considered by school administrators.

It is recommended that the school create a Facility Operating Plan for the building using the template available on the VSA-SEMP website.

You will also be getting a checklist derived from this report that can be a useful guide as you work to improve your energy efficiency.

These are some of the major items, there are many other ways to save energy and money outlined in this report.

REPORT FORMAT

This report begins with a discussion of the school's energy use. Then the report continues with a system by system discussion of specific observations and recommendations for action steps that can be taken to improve the building's physical plant and how it is managed. Many ideas are presented. Some are simple and can be implemented without delay and some will need serious consideration and funding. Some of the recommended measures are already being implemented. They are included here to help as a guide going forward. Not all the measures will be deemed appropriate by school facility staff and administration that may be aware of particular constraints. The report then continues with some additional information that may be useful to school administrators and staff.

In a follow-up email you will also receive a checklist of recommended measures that you can use as a tool as you work to make your building more energy efficient.

Recommendations are separated into O&Ms and ECMs as described below:

ACTION STEPS - OPERATIONS, MAINTENANCE, AND BEHAVIOR (O&Ms) – In some ways the operational savings are the most important ones you can achieve because of their no-to-low cost, low risk, easy implementation, and their positive impact on the learning environment. Many small changes in the way the building is used can add up to big energy savings. Schools tend to have good operational saving opportunities because they are only active for a portion of the day, week and year. A good operating strategy takes advantage of this fact to only use most energy using devices when the building is occupied.

In order to maximize the benefits of proper energy management, all parties need to be on board with the program. This starts with administration and principals to teachers to students to staff. While all parties can help, someone has to have the key responsibility for the energy management function and the time to perform it. Savings from good energy management will more than compensate for the cost of this person's time.

Note: Most schools have fairly complex and interactive building systems. Setting changes should be made in small incremental steps to ensure that there are no adverse impacts and to lessen the perceived effects on the building's occupants.

ACTION STEPS - ENERGY CONSERVATION MEASURES (ECM) – These are the more capital intensive projects. For many of these measures, the savings will be able to amortize the cost of borrowing to complete the measure, especially when there are available incentives. However, at times the reasons for performing these measures, in addition to energy use and cost savings, include maintenance savings, need for scheduled replacement (end of useful life), aesthetics, and obsolescence. Some of these measures

may not have an attractive payback but are essential for maintaining the building's value as a community asset and for proper operations.

At times, a school may choose to reduce energy use or add renewables as an end in itself, independent of financial considerations. It is important to be clear on what the goals are when considering these improvements.

A general discussion of the costs and savings for different types of measures can be found in the section titled, "Relative Cost Effectiveness of Energy Conservation Measures"

GENERAL

GENERAL ACTION STEPS – O&M

1) It is important for the person responsible for managing the building to understand its energy use. The manager should get copies of all electric and fuel bills and track them. At a minimum, fuel tanks should be checked at the beginning and end of each heating season to determine usage.
2) The spreadsheets on electrical use that were sent to you with this report should be kept updated to determine trends in usage and analyze anomalies. Contact can be made to the appropriate representative of the electric utility to make sure that the school is on the correct rate structure based on its usage. You can also register for online access to your account at GMP and get information on when the building reaches peak demand and other useful data.
3) Direct Digital Control (DDC) Systems often have trending log capabilities where the performance of the HVAC systems over time can be tracked. It is important to review the logs to see that the systems are performing as designed.
4) Documents that are critical to long-term facility management can get misplaced, damaged, or lost. Scanning them into computers or taking digital pictures of important plans can help prevent the loss of this valuable information. Often a local architectural firm or copy center (at a cost of about a dollar a page) can scan full sized building plans and create a digital version that you can use both to preserve the documents and as a reference tool.
5) It is best practice for the building manager to visit the building at night after all staff has left to see what building systems are still operating. Almost all systems should be off (some exceptions are exit lights, refrigeration, certain computer servers and heat on night setback).

BASIC BUILDING DESCRIPTION

This is a one-story building built in 1961 with additions in 1980 and 1991. Building size is reported as 22,000 square feet. The building serves 156 students in grades PK-6. Basic construction is slab on grade with wood and metal framing, roof trusses and brick exterior.

BUILDING ENERGY USE

DISCUSSION

Energy use at Waitsfield is below average. Electrical use has declined by 30% since 2008-2009. There are some anomalies with ventilation not being fully utilized. When this is corrected electricity and fuel use will increase but not significantly.

FUEL

The school uses #2 oil as its main fuel. Oil use last year was 5,780 gallons or .26 gallons per square foot per year. Average Vermont school usage is .34 gallons per square foot. Usage will vary based on hours of building occupancy, whether meals are cooked on site and many other factors relating to equipment and how the building is operated.

The school has a 3,000 gallon underground oil storage tank.

ELECTRICITY

The school used 89,501 kWh of electricity for the last twelve months or 4.1 kWh per square foot per year. This is down from 128,407 in 2008-2009. Average school usage in Vermont is 5.4 kWh per square foot.

Maximum electrical demand for the past twelve months was 30 kW. Demand is based on the highest 15 minute draw any time during the month. There are also ratchet penalties where maximum demand any month will affect your bill for the remainder of the year. Typically about one third to one half the energy portion of the bill (demand plus usage) are demand charges.

Almost all schools establish their peak demand between 10 AM and 2 PM. This is because of the addition of kitchen electrical loads to the other building loads. Because you are charged for the peak demand, strategies to avoid major discretionary uses during this period will save money and are included in this report.

I have attached an Excel spreadsheet that shows your electrical energy use and demand for the past several years. Use the tab at the bottom to access the graph. It is a good idea to keep this spreadsheet updated with new bills to keep track of electrical use trends and to determine if there are unusual events that may need attention.

DOMESTIC HOT WATER

Domestic hot water is produced by a stand-alone electric hot water heater outside the heating season and by the main boilers using an indirect fired tank with a heat transfer coil during heating periods.

KITCHEN APPLIANCES

Kitchen appliances use electricity.

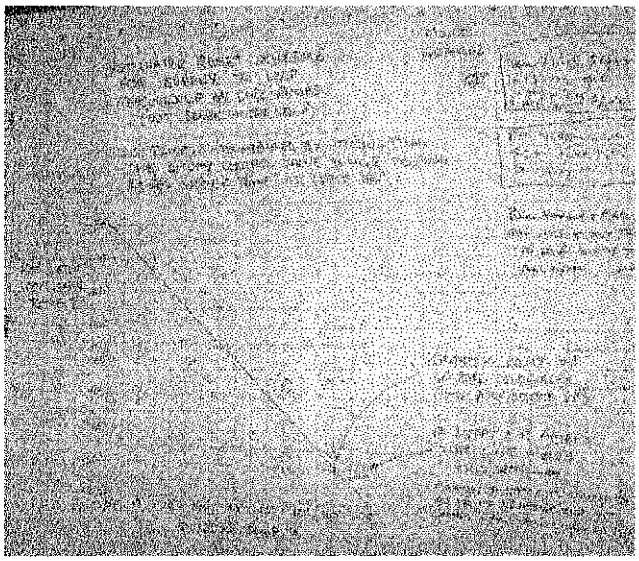
HVAC SYSTEMS – HEAT

SITE VISIT OBSERVATIONS

1) The building is heated with two Weil McLain 943 MBtu oil fired boilers.
2) There is an automatic outside temperature reset for the heating loop.
3) There is an automatic outside temperature cutoff for the circulators.
4) There is no automatic outside temperature cutoff for the boiler.
5) Heat distribution is via forced hot water.
6) There is no glycol in the system.

DISCUSSION

There are instructions on how to adjust the boiler loop temperature included on the chart posted on the wall. Because there were issues maintaining proper temperature in some areas, the loop temperature should be raised. Most schools have the boiler temperature operating at 180 degrees when outside air temperature hits zero degrees.



1 - Outside Air Temperature Loop Reset Chart

ACTION STEPS - OPERATIONS, MAINTENANCE, AND BEHAVIOR (O&M'S)

1) Circulators and fans often have grease fittings that need periodic attention and belts that need adjustment and replacement. Also, some have bearings that need to be re-packed on a regular basis.
2) A boiler room log should be kept to record maintenance work that has been performed such as motor and circulator replacement, tuning of boilers, damper replacement or repair, belt changes, etc. This log will help to ensure that needed maintenance has taken place and to be able to identify problem areas (i.e. – frequent circulator changes).

3) Boilers should be serviced and tuned at least once a year to ensure efficient performance and reliability.

4) Operating fluid in hot water boilers should be tested annually to ensure that anti-freeze levels (for freeze protected systems) are adequate and that rust inhibitors, pH levels and conductivity are within acceptable ranges. Dissolved oxygen should also be checked. A school recently had to re-tube a new large boiler due to a dissolved oxygen problem. Here is a link that discusses the issue: http://cleanboiler.org/Eff_Improve/Operations/Deaerator.asp . Be sure to only use heating system grade anti-freeze if adding to your system.

5) Often both boilers do not need to be kept to temperature when one is not needed.

6) Combustion air dampers should be checked for adequacy and proper operation on a regular basis.

7) Heat coils should be thoroughly cleaned once a year to allow for good heat transfer. They often need to be pressure washed or cleaned with compressed air to make sure that the coils are free from dirt or obstructions.

8) Baseboard radiation should generally be cleaned annually or as needed. A small layer of dirt or dust can significantly reduce heat transfer.

9) Unit ventilators and baseboard radiation need good air flow to operate efficiently. Obstructions should be removed.

10) To help resolve complaints about heating temperatures, it is helpful to use a temperature chart recorder. This gives a visual printout of temperatures in the space over a twenty four hour period. One type can be found at
    a) http://www.omega.com/ppt/pptsc.asp?ref=CT88&Nav=tems07 (This is not an endorsement of this particular product or vender.)

11) If it is determined that there are problems maintaining proper heat in a given area the following steps should be taken:
    a) Make sure that the room is set for the correct temperature at the computer or thermostat.
    b) Check the actual temperature in the room vs. the setting and readings at the computer or thermostat.
    c) Make sure that the zone valve is opening and closing properly.
    d) Check hot water supply temperature to make sure it is adequate.
    e) Check ventilation air supply temperature. If too high it will be too warm in the room, if too low, an uncomfortable draft may result and the room may have difficulty in reaching temperature setpoint. Most schools set their supply air temperature between 65 and 67 degrees.

POTENTIAL ENERGY CONSERVATION MEASURES (ECMS)

1) Motors

(a) When replacing larger motors consider upgrading to more efficient ones. Here's some more info on how to decide on efficient motors: http://www.motorsmatter.org/tools/index.asp

(b) Variable frequency drives (VFDs) for circulators allow for energy savings by reducing motor speeds. They can be controlled automatically for maximum effect. Circulator VFDs generally monitor water pressure and adjust the speed accordingly, ramping up when more zones are open. The VFD can be a separate device or it can be built into the circulator itself. A circulator motor going at half speed uses one eighth the amount of power. Efficiency Vermont will provide significant incentives for this measure. This measure needs careful consideration by an expert to ensure that savings are achieved and the systems will function correctly with the VFDs. This article helps to explain some of the issues: http://www.facilitiesnet.com/hvac/article/Analyze-VFD-Variable-Frequency-Drive-Retrofit-Applications-To-Ensure-Savings--14674?source=BOMhomepage-01/2014# For more technical information on VFDs go here: http://www.motorsmatter.org/resources/asds.html Some VFDs are integrated into the circulator. For information on Efficiency Vermont incentives and info on these circulators go here: http://www.efficiencyvermont.com/for-our-partners/Contractor-Supplier-Installer-Partners/High-Performance-Circulator-Pumps

2) Efficiency Vermont's rebate form for HVAC is here: http://www.efficiencyvermont.com/docs/for_my_business/rebate_forms/HVACRebateForm.pdf

3) The contractor that maintains your boilers can usually advise if an upgrade to your burner would be cost-effective.

4) Your boilers were installed in 1991. They are twenty four years old and near the end of their useful life. While they are still operating effectively, replacement should be part of a long-term capital plan for the facility. Careful consideration of fuel options, both fossil and renewable should be undertaken at time of replacement.

HVAC - VENTILATION SYSTEM

SITE VISIT OBSERVATIONS

1) The gym has a dedicated ventilation system that takes in outside air, pre-heats it, and supplies it to the space.

2) Older classrooms use unit ventilators that take outside air directly into the unit. There is an outside grille and dampers in the ventilators. There was an apparent issue because of a lack of a return or exhaust duct. There were issues on how the units are set to operate - - more in the controls section.

3) Newer classrooms have heat recovery ventilators located in the attic space. This air is not tempered but there are high ceilings that allow for more air mixing. They are not always used in cold weather.
4) Office area has a heat recovery ventilator that was not in use.
5) Bathroom ventilation fans operate with the light switch or are on with the occupied cycle.
6) There are ceiling fans in the classrooms.
7) Carbon Dioxide - This is a gas we all exhale (not to be confused with the dangerous carbon monoxide). While elevated levels of CO2 are usually not dangerous in itself, the level of carbon dioxide in an occupied space is a good indication of how well your ventilation system is working. Other contaminants in the air are the more serious health issue. Many studies have shown increased absenteeism, illnesses and poor student performance when CO2 levels are too high. The CO2 level should be kept below about 1100 ppm (parts per million). At the same time, low levels of CO2 can be an indication of over-ventilation which should also be avoided due to the cost of heating makeup air and because it can result in very low relative humidity. All CO2 readings taken were within acceptable limits. CO2 readings above 1100 ppm were found in:
    a. Tom Young's room - - 1460 ppm
    b. Liz Belknap's room - - 1235 ppm.
    c. Anne Beattie's room - - 1418 ppm.
8) Filters are changed four times a year.

DISCUSSION

Ventilation systems can use a considerable amount of energy but they are necessary to create a healthy school environment that is conducive to learning. With the right equipment that is properly managed and maintained, the energy costs will be minimized. Ventilation systems need to operate when the space is being used. The optimal strategy is to provide all the ventilation necessary, but no more than is needed.

ACTION STEPS - OPERATIONS, MAINTENANCE, AND BEHAVIOR (O&M'S)

1) Ventilation systems need to operate whenever the space is occupied. So, the new classrooms should have their systems operating even in cold weather. By increasing the loop temperature, it should be easier to maintain proper temperature in these rooms. If supply air temperature is too low and is causing a problem, you may need to add a heating coil to these air handlers.
2) Most schools change the air filters three or four times a year like you do at Waitsfield. Some filters that are in heavy use areas or where the intake can be fouled by outside

contaminants may need more frequent changes. Manufacturer's recommendations should be followed for these changes. In general, pleated filters with a MERV rating of 6 or greater are recommended.

3) Energy recovery ventilators need filters on both the incoming and exhaust air to prevent the heat transfer medium from becoming dirty and inefficient.

4) Outside air dampers should be checked at least annually for proper operation and sealing. If computer controlled, the physical damper setting needs to be checked vs. the computer reported setting.

5) Putting streamers on the supply air registers is recommended as a way to easily determine that the ventilation is operating when it should. Without these, it can be hard to tell if the system is on and shuts down correctly during the un-occupied cycle. This is also a good way to convince occupants that fresh air is being supplied and windows do not need to be opened during the heating season.

6) Carbon dioxide sensors typically need to be calibrated on a five year cycle according to what the school was told.

POTENTIAL ENERGY CONSERVATION MEASURES (ECMS)

1) The issue of exhaust or return air for the unit vents should be explored and this should be added if necessary.

2) Heat/energy recovery ventilation - - these systems use exhaust air to pre-heat incoming air and reduce energy costs. This is typically a cost effective improvement when replacing equipment.

3) Ceiling fans
   a) These quiet fans in classrooms do not affect temperature but the air movement aids in comfort during hot days and their use allows for higher temperature settings if the space is air conditioned. The fans should be set to blow air down in summer. There is not much benefit in most classrooms during the heating season. If used in winter in classrooms the fan should be set to move air upwards.
   b) In high applications like gymnasiums the ceiling fans can help move the hotter air from near the ceiling to the "people zone" in winter. They should not be used in these applications during the summer.
   c) If acquiring ceiling fans, specify Energy Star rated ones.

HVAC - CONTROLS

SITE VISIT OBSERVATIONS

1) There is a Direct Digital Control (DDC) system for some of the newer systems in the older section of the building.
2) There is only one pneumatic thermostat left in operation.
3) Occupied cycle is from 6:30 AM to 2:30 PM.
4) The temperature sets back 10 degrees during unoccupied times.
5) Minimum setting on the unit vents is zero% open. This results in a quick rise in CO2 and then a large influx of ventilation air.
6) Gym CO2 setpoint is at 1600 ppm.
7) There are no VFDs (variable frequency drives).

2 - - Chart showing rise in CO2 levels

DISCUSSION

Some of the settings on the control computer do not result in good performance of ventilation. See recommendations below.

ACTION STEPS - OPERATIONS, MAINTENANCE, AND BEHAVIOR (O&M'S)

1) There was some question about proper operational sequencing for some HVAC controls. People charged with operation of the building's HVAC systems had some questions about the way they are designed to be operated. I suggest having the controls contractor in to explain the workings of all the systems and how to adjust them to the building operator and having this presentation recorded on DVD for future reference and to be incorporated into a Facility Operating Plan. For sophisticated DDC systems it may be useful to have the school's IT professional attend this presentation because they may be able to help with issues going forward.
2) The unit vents should always have a minimum flow of outside air when the space is occupied. This should prevent that quick rise in CO2 as shown on the chart.
3) The gym setting of 1600 ppm exceeds levels established by ASHRAE. This should max out at 1100 ppm.
4) In a recently constructed building or for recently installed systems consider copying the "Sequence of Operations" section from the specifications, framing them, and putting them on the wall in the area where the controls are. This section of the document delineates the original design intent for operation of the HVAC systems.
5) Tweaking of controls for optimum performance of the heating and ventilation systems is an important conservation strategy. The goal is to provide all the heat and ventilation necessary but no more than that. Again, it is best to make incremental adjustments to make sure no problems are created. Savings in heating costs alone from reduction of

ventilation times for oil heated systems are about $200 a year for each reduction of 1000 cfm for one hour per day.

a) Lowering the setback temperatures for nights and weekends and reducing the on-time for ventilation to match occupied times will reduce energy use. Systems should also be set to go to unoccupied schedule for weekends, vacation periods, snow days etc. Most schools have the ventilation come on when students arrive and shut off when most of them leave, generally from about 7 AM to 3 PM.

b) Heating systems usually set back around 3 PM and come on around 6 AM. Some schools may need a longer pre-heat period, especially after a week-end or vacation period. Most schools set back temperatures ten to fifteen degrees for the unoccupied cycle during the winter and further during the shoulder seasons. During frigid outbreaks, when temperatures drop down to the 20-30 below range, many schools will not set back as far to make sure there are no problems.

c) The best facility managers have learned how far they can set back temperatures based on the time of year and the weather and are constantly adjusting their temperature setpoints and hours of operation accordingly to maximize the energy savings while ensuring that the building can be brought back to temperature when students arrive. This assumes that the building operator has sufficient time available to properly manage the building's systems. This is not always the case.

4) If possible, consolidate after-hours use of the facility so only certain areas of the building will need to be kept in the occupied cycle during after school hours.
5) Many schools have certain heating elements that are not controlled by the central system. These are typically found in hallways and entryways. Often these should be set at the night setback temperature to avoid having them conflict with the night setback hours. Usually these areas can be kept cooler because they are not used for classroom work.
6) If people tamper with common area thermostat setpoints, lockboxes should be installed.
7) Occupants of rooms with manual thermostats should turn the heat down at the end of the day.
8) Most types of thermostats need to be calibrated periodically to maintain accuracy.
9) While it is recommended to remove the air compressor (below), until such time as this is done the condenser coils need cleaning.

POTENTIAL ENERGY CONSERVATION MEASURES (ECMS)

1) It is unfortunate that one of the thermostats was missed when you converted from pneumatic controls. This should be rectified and the air compressor removed.

2) When budgets allow, it would be good to add additional areas on to the new control system.

3) Ventilation systems, including unit ventilators, can also be controlled by occupancy sensors.

4) Economizer cycle (or night purge) - - Controls can allow for free night cooling during summer months to reduce overheating, known as an economizer cycle. A typical scenario for schools during hot days in May, June, August and September would be that the ventilation system is shut off at the end of the day when the building goes into the unoccupied cycle. Temperature at that point is likely to be very warm. When the building begins its occupied cycle in the morning some fresh air will be brought in by the ventilation system and begin cooling the space. However, the ventilation air heats up quickly with outside temperature (and is sometimes brought in off the hot roof). This will continue throughout the day and warm the space making it uncomfortable.

   Instead, with proper controls the system can work like this; for a period during the night, sensors will monitor indoor and outdoor temperature. The system will bring in cooler night air (as long as it is available) until a certain setpoint, say 65 degrees is reached. The ventilation system at night will only operate to maintain this indoor temperature. Some care needs to be exercised or more sophisticated enthalpy controls put in place to prevent night air from being introduced into the building when outside humidity levels are very high.

5) It is essential to use the services of a competent, independent, building commissioning entity to ensure that the new systems will be properly designed and installed. While it would seem that this would not be necessary when you have good design engineers and contractors, with the complexity of modern systems it has been shown that using commissioning agents reduces problems and overall costs. The services of the commissioning agent should be secured at the early stages of developing the project.

6) Once controls are upgraded, I recommend having the controls contractor review all the controls and their proper settings, functioning, and methods of adjustment with building staff. It is advisable to have this review recorded on DVD for future reference and staff. Training and creation of the DVD should be included as part of the control upgrade contract.

7) While it is advisable to provide room occupants with control over their temperature, this control should be limited. Most thermostats in use in schools now allow for room occupants to control the temperature only plus or minus two degrees from the standard 70 degree setpoint.

DOMESTIC HOT WATER (DHW)

DISCUSSION

Having the boilers create DHW while in operation backed up by the electric unit is a reasonable approach for this school .

ACTION STEPS - OPERATIONS, MAINTENANCE, AND BEHAVIOR (O&M'S)

1) The Vermont Department of Health recommends that DHW tanks maintain a temperature of 140 degrees to help prevent contamination by Legionella bacteria.
2) Be careful to shut off the electric hot water heaters at their disconnect when not in use for seasonal systems.

POTENTIAL ENERGY CONSERVATION MEASURES (ECMS)

1) Electric hot water heaters can be replaced with heat pump hot water heaters that use about half the electricity. This option should be considered at time of replacement. Efficiency Vermont currently has rebates that bring the cost down to about the same as a regular electric unit. More info here:

   https://www.efficiencyvermont.com/For-My-Home/ways-to-save-and-rebates/water-heaters/heat-pump-water-heaters
2) DHW Circulation pumps can be put on timers to shut them down at night and on weekends when the building is unoccupied.
3) An aquastat can also be provided to shut down the DHW circulator when the return water temperature is high enough.

KITCHEN

SITE VISIT OBSERVATIONS

1) Food is prepared elsewhere and the kitchen is used for warming only.
2) There is a range hood with on/off switch.
3) There is a residential style dishwasher and some refrigeration units.

ACTION STEPS - OPERATIONS, MAINTENANCE, AND BEHAVIOR (O&M'S)

1) Range hood fans can usually be placed on an hourly timer so that they are not inadvertently left running when not needed.
2) All refrigeration evaporator and condenser coils should have their fins straightened and be cleaned periodically.
3) Gaskets on refrigeration devices should be inspected a few times a year and gaskets replaced as necessary to ensure proper seal. Latches also need adjustment at times.

4) Fix any leaks at faucets and other water connections to save water and reduce water heating, treatment and pumping costs.

POTENTIAL ENERGY CONSERVATION MEASURES (ECMS)

1) This site: http://www.fishnick.com/ - - the Food Service Technology Center, is a great resource for determining efficient commercial kitchen equipment options.
2) You may want to consider changing to a propane stove to reduce electrical demand charges when replacing the existing electric stove.

ELECTRICAL - LIGHTING

SITE VISIT OBSERVATIONS

1) The gym uses efficient T-8 fluorescent lighting.
2) Classrooms use High Performance T-8 fluorescent lighting.
3) Some miscellaneous lighting is incandescent.
4) Exit lights are fluorescent and LED.
5) Occupancy sensors are used in the classrooms.
6) Outside lighting is metal halide controlled by a timer.

DISCUSSION

The school has reduced their lighting load considerably over the years.

ACTION STEPS - OPERATIONS, MAINTENANCE, AND BEHAVIOR (O&M'S)

1) While it's easy to say that lights should be turned off when not in use, it is harder to get people to do it. Some schools have appointed students to be lighting monitors for extra credit. They tour the school to make sure unused lights are turned off.
2) The situation in areas covered with occupancy sensors is more complicated. The sensors are typically designed to shut lights off 15 minutes after people leave the room. They have this lag time to prevent frequent on/off cycles that would reduce bulb life. However, if the room will be unoccupied for longer than 15 minutes, the light switch can be shut off to save that energy.
3) Those little signs on light switches advising people to shut them off when not needed do help. Some schools have had students engage in a design competition for these signs.

4) Some schools unnecessarily have maintenance staff turn all the lights on in the building when they arrive. This results in some lights being left on for hours before they are needed. Consider having people turning lights on when they are needed instead.
5) Timers that are used to control outside lights need adjustment seasonally (unless they utilize astronomical clocks) or after power outages. Consider replacing these with units with battery backups (and then change the batteries annually as part of a PM schedule).
6) Night janitors should shut lights off in areas they are not currently working in to reduce energy use.
7) When repainting hallways, use of lighter colors will allow for reduced need for light from fixtures.
8) Light fixtures should be cleaned annually and yellowed or broken diffusers replaced.

POTENTIAL ENERGY CONSERVATION MEASURES (ECMS)

Most lighting measures have a quick payback that is assisted by the Efficiency Vermont rebate.

1) When changing T-8 ballasts, high performance ones should be used. Efficiency Vermont has rebate forms to help pay for this upgrade.
2) Gym lighting
    a) Gym lights should be put on occupancy sensors. Many schools do this now and report excellent results.
5) Occupancy Sensors
    a) Areas that receive intermittent use such as teacher prep areas and bathrooms (if they have sufficient connected load) are good candidates for occupancy sensors to control the lighting.
    b) Some schools also use occupancy sensors to control hallway lighting with good results.
    c) Efficiency Vermont offers $30 per wall-mounted or fixture mounted occupancy sensors and $75 per remote-mounted occupancy sensor with a minimum load of 150 watts. Note: motion sensors should be set at 30 minutes delay if instant start ballasts are used. A shorter delay time can be used if you have program start ballasts.
6) Some miscellaneous lighting using incandescent bulbs should be replaced with compact fluorescents (CFLs) or LEDs. Use only brand name units to ensure savings and longevity.
7) Exit lights should all be converted to LEDs. This change has a quick payback and EVT will provide incentives to help pay the cost.
8) Outside metal halide lights can be replaced with LEDs to save energy, improve lighting quality, and reduce maintenance costs.

9) Smart light – current EVT incentives for efficient lighting can be found here: http://www.efficiencyvermont.com/docs/for_my_business/lighting_programs/SMARTLIGHT.pdf?utm_medium=email&utm_campaign=Lighting+eNews+June+2013&utm_content=Lighting+eNews+June+2013+CID_12b09dbf10decfa93a3aac242255e0a6&utm_source=Campaign%20Monitor&utm_term=two-page%20handout

ELECTRICAL - PLUG LOADS

SITE VISIT OBSERVATIONS

2) There are some small refrigerators in classrooms.
3) There are microwaves and coffeemakers in use.
4) There is a kiln that typically draws 10 kW.
5) There are heat tapes in use to prevent icing from the roof.
6) School buses are not kept on-site overnight.

DISCUSSION

Many individual savings from plug load management are small, but with so many plug loads in a typical school, they add up to a significant sum.

ACTION STEPS - OPERATIONS, MAINTENANCE, AND BEHAVIOR (O&M'S)

1) Small refrigerators in classrooms – schools have used a variety of strategies to address the issue of refrigerators in classrooms. Some of these small units can use as much electricity as a full sized EnergyStar rated unit. Sometimes they are necessary for program reasons. This can be a sensitive subject with teachers so discretion as to whether it is worth addressing is an important issue. Here is a range of strategies that other schools have used:
   a) Ban the use of them and provide a central energy efficient refrigerator that teachers can use. There is often some push back on this. However, most schools that have instituted this ban have not reported significant negative consequences.
   b) Allow teachers to have them but charge them a monthly fee to cover the electrical cost (some schools charge anywhere from $6 - $20 per month for this). Actual usage of these units can be determined by use of the "Kill A Watt" meters.
   c) Require teachers to take them home for the summer and long breaks. This avoids usage during those months and prevents the school from having to clean them out. Also, they don't always come back.
   d) Require that the small refrigerators be EnergyStar rated (this ensures that they

are energy efficient).

e) Require written permission from the principal after explaining why the unit is needed. The unit itself must also be approved by maintenance after checking its condition.

2) Microwave ovens are not substantial energy users. Some facility managers require that they inspect and approve any that are brought into the school because of safety issues.

3) Coffee Makers - - there are several different kinds. Some retain the coffee in insulated carafes and don't use a lot of energy. Some use considerable energy all the time because they have heating elements that are always on. Policy makers can require the low energy use ones for people that want to have them. Timers can be placed on the coffee makers that maintain heat constantly to shut them off after use, at night, on week-ends, and during break periods.

4) Other miscellaneous loads - - such items as lava lamps, chargers for cell phones and other equipment including televisions, LCD projectors, and audio equipment all use power. Some schools require permission from administration when any outside energy using items are to be added to the classrooms or other areas. All of these devices should be put on power strips and shut off when not needed and for unoccupied periods. These loads, commonly referred to as "phantom" or "vampire" loads, are small but there are many of them and they add up to being a significant element in the school's energy use.

5) Kilns - - these units overall do not use that much electricity because they aren't used that frequently. However, they can have a costly impact on demand charges. Most schools are billed separately for their maximum electrical demand (this is the highest 15 minute use during the whole month). This is a hefty charge and can have year round impacts. Extra demand charges from just one kiln can cost as much as an extra $1000 a year. There is no impact on demand if the kiln is used outside of when the school would otherwise reach their peak usage. Specific information on when the school reaches its peak demand can usually be obtained from your utility. Most schools with kitchens hit their peak demand between 10 AM and 2 PM. If it is possible to use the kiln only outside those hours, you won't have to pay this charge.

6) Computers and copiers - -

a) Computers should have their software activated to allow them to enter their "sleep" modes when not used for a short period of time. Most computers have this software as part of their basic systems. If they do not, free software can be downloaded from the Energy Star website http://www.energystar.gov/index.cfm?c=power_mgt.pr_pm_wizard .

b) The switch on the computer monitor allows for the monitor itself to be turned off when it will not be used for a period of time. A monitor in sleep mode typically still draws power. While the savings from each monitor will not be great, many schools have dozens or even hundreds of units in use.

c) Computers and their related equipment should be shut down at night and if not used for extended periods of time (an exception may be a server that may be needed during off hours). A power strip that shuts down the computer and all related equipment makes sense. This saves energy and also helps to protect the equipment from damaging power spikes and lightning.

d) Some schools use centralized shut down systems to control all the computers on the network.

e) There are several different types of surge protectors or power strips that shut off power automatically to some of the outlets when either there is no occupancy or when the computer goes to sleep mode. Some are called "Smart Strips" and another type is "WattStopper". These units allow the basic computer to keep functioning while the rest of the system goes to sleep when no one is present. We don't endorse a particular brand but you may want to check into these options.

f) Copiers, printers and peripheral equipment should also be shut down at night.

g) Some schools have attached rain gutter material to the back of the tables used for computers. They then lay the wiring and power strips where they are easily accessible and off the floor to allow for easier cleaning.

8) The use of the heat tapes should be carefully controlled to prevent them being on when not needed.

BUILDING ENVELOPE

DISCUSSION

There were no problems reported or observed with the building envelope.

ACTION STEPS - OPERATIONS, MAINTENANCE, AND BEHAVIOR (O&M'S)

1) Window locks should be utilized to make sure that windows are sealed to their weatherstripping.

2) Leaks in the roofing and other areas of the building envelope should be fixed promptly to maintain the integrity of the insulation and prevent mold problems.

3) Maximize the benefit of window shades. On the north side of the building the shades should be open during occupancy to get the full benefit of natural lighting. On other sides of the building they may need to be used to provide shade from direct sunlight at times. At night or when the building is unoccupied, all shades should be closed during the heating season.

4) Door closers on exterior doors may need adjustment to make sure they close and seal properly against the weather-stripping.

SUMMER SHUT DOWN

When the school or large areas of it will not be used for an extended period many systems can be turned off. Think of it this way; if the entire building were shut down, what would need to be turned back on during this period? Everything else should be left off. Items to consider (some are covered elsewhere as well).

1) Computers and peripheral equipment- - if it is okay with the technical people, teachers should unplug the computers and peripherals on the last day of school. This shuts them all down, saves energy, and helps prevent losses due to lightning or power surges.
2) Walk-in coolers, refrigerators, ice makers and similar equipment – these should be cleaned out and turned off for the summer.
3) Television/VCRs - - unplug them. When just turned off these units still use power. Over the summer they use about 23 kWh each. You also reduce the chance of lightning or other damage. Same holds true for LCD projectors, Smart Boards, and any other energy using equipment.
4) Ventilation systems - - these can usually be left off except as needed to help with drying after cleaning carpets etc. Care needs to be taken to help control mold and prevent bringing in moist humid air. Many schools use dehumidifiers and fans to dry their cleaning areas and leave their central ventilation system off. There are times when the outside air is so humid that it will not help dry areas appreciably and may increase problems with humidity in the school.
5) Heating equipment - - boilers should be shut down for the summer. It is recommended that they be fired up once a month to drive off any moisture in the system. Circulators should also be shut off.

WATER USE

Water leaks or running toilets can result in increased energy use as well as wasted water. Regular inspections and a good work order system to quickly repair leaks yields good savings. Saving water reduces the need for pumping energy and water treatment for most schools. For schools on municipal systems, reducing water use results in lower water and sewer bills.

Information on how to save on water use and get rated equipment can be found at this website: http://www.epa.gov/WaterSense/

EFFICIENCY VERMONT (EVT)

1) Efficiency Vermont can provide incentives for the electrical measures discussed above. They have several new programs (described below). If you want to proceed with some of these measures please contact me and I will help get an EVT project manager assigned. They can do an analysis that will provide annual savings estimates and simple payback calculations. This data is typically needed to generate momentum to get money allocated in the budget.
2) If you are proceeding piecemeal with some measures, EVT has prescriptive forms on their

website (http://www.efficiencyvermont.com/pages/Business/RebateCenter/) that cover lighting, occupancy sensors, efficient three phase motors, VFDs, HVAC equipment, and refrigeration equipment. Recently they have added incentives for boiler replacement. You can use these forms to get rebates on projects you are executing yourself. Please insert VSA-SEMP in the lower right hand corner of the last page where it asks for "tracking number".

3) EVT has created a brochure about school lighting issues. It can be found here: http://www.efficiencyvermont.com/docs/for_my_business/k-12/EVT_SchoolLightingBrochure_FINAL.pdf

4) EVT can be contacted to get up to date information 888-921-5990.

RENEWABLES

While some of these systems will not meet a rigorous cost effectiveness test without grant support, there are many reasons why schools may opt for renewable systems. There is educational value to these systems and future fossil fuel costs may escalate dramatically, improving their cost effectiveness. These systems also help move the school to operating on a more sustainable basis.

1) Solar Hot Water - - schools can utilize solar domestic hot water systems however the cost effectiveness is not as attractive as in a residence. This is because schools typically do not operate in summer when solar hot water systems are most productive. Some schools with summer programs have a small, residential size solar hot water system that they are happy with.

2) Solar Electric (photovoltaic or PV) systems – Waitsfield ES is already involved in a group net metered photovoltaic agreement.

3) Wood Pellets - - most schools including Waitsfield can utilize a wood pellet system that would connect to your main heating distribution system. Pellets would typically be stored in an outside silo and would feed automatically to the boiler. Alternatively, some manufacturers utilize self-contained units that are placed outside the building in proximity to the boiler room. The containers include pellet storage and the pellet boiler which are pre-plumbed and wired. The hot water feed is then incorporated into the building's existing distribution system. There are newer, more efficient and better operating systems now available. Also, some pellet suppliers are willing to enter into long-term contracts with schools to stabilize pricing. Efficiency Vermont has some (minor) incentives available for these systems. Additional grant funding may be available. A more complete feasibility analysis can be performed if requested. Large schools may consider wood chip systems that have a higher capital cost and a lower fuel cost.

FACILITY OPERATING PLAN AND WORK ORDER SYSTEM

Facility Operating Plan - -A written plan that lays out the key modes of building operation is important for administrators and staff and is a key document when there is a turnover in facility staff. This plan should include maintenance schedules for the main building systems, operating

schedules for ventilation and setback temperatures and other important information about the building's systems. SEMP has worked with some of Vermont's most experienced facility managers to create templates that schools can use for this purpose. Two templates can be found on our website. The first is the best, most thorough one to use. The second one has some material removed and is targeted to smaller schools. There are complete instructions on using these MS WORD files and a link for a Google Docs version:

http://www.vtvsa.org/files/FOP%20Template%20Final.doc

http://www.vtvsa.org/files/FOP%20-%20Small%20School%20Web.doc

Work Order System - - people responsible for managing school facilities have many bosses. It seems that every one in the building can accost the manager asking for any number of special considerations to get their project done. Facility managers want to be helpful and accommodate these requests, but they often prevent the manager from properly setting priorities and getting their needed work done in a timely manner. Also, these hallway encounters sometimes result in requests that are inadvertently lost. Instituting a work order system can address these problems. The systems can be as simple as a box with written request forms conveniently located in the hallway. This works well for some small schools.

Larger schools may want to have a computerized system so that requests can be automatically logged, prioritized and tracked. Some schools use free Google Forms to set the system up and track the requests, set priorities, and follow the response in a spreadsheet format. School personnel can directly enter their requests into the system.

Whatever the system used, over time when building occupants realize that the way they will get the needed work done is by using the system, it will be successful in easing staff time.

FACILITY OPERATOR TRAINING

It is important that the people responsible for maintaining a facility keep up with the many requirements of their job. Here are some training opportunities:

1) Building Operator Certification course information and schedule is found here: http://www.theboc.info/ Several Vermont facility managers have taken this course and found it beneficial.

2) The Annual Vermont Custodial/Maintenance Workers Association, School Plant Operation and Maintenance Conference is held annually in June at Hartford High School, in White River Junction. When we get close to that date you can find the registration brochure at www.vscma.org . This is inexpensive and a "must attend" event.

3) VSA-SEMP has performed day-long training on the use of the Facility Operating Plan template, which includes information on best management practices. More training on this and other subjects will likely be held in the coming months. Contact SEMP if you want to get on the mailing list for these trainings.

4) Also, facility managers meet periodically to get updated on best practices. Please let me know if there is someone that should be added to the facility manager's mailing list.

CAPITAL PLAN

For proper building maintenance, schools should have both a short term and a long term capital plan. At some point, upgrades will be needed to keep the building safe, comfortable and efficient. Items that affect energy use, such as windows, roofing, boilers etc. should be included in this long term capital plan.

ENERGY SAVING PROGRAM

A school-wide program to improve energy efficiency and conservation can be both educational and pay significant monetary dividends. Annual energy cost savings of 10% - 20% are achievable with a concerted effort. These programs begin with establishing an energy use baseline. Energy teams comprised of students, teachers, and building staff are formed and begin their work. With students engaged, they will help evaluate potential energy saving measures and help ensure lights are turned off when not needed etc. Some schools have also given a financial incentive to staff if energy savings goals are achieved.

On the general subject of how to develop an energy saving project in your school, see the EVT guide "Making the Grade" which outlines a step-by step approach to developing a project in your school:

http://www.efficiencyvermont.com/for_my_business/solutions_for_me/K_12_schools/general_info/publications_and_resources.aspx

TOWN ENERGY COMMITTEES

These can be an ally as you work to improve the energy efficiency of your buildings. A listing of town energy committees can be found here: https://www.facebook.com/VTEnergyNetwork

ENERGY POLICY

Some school boards have adopted an energy policy to help guide school personnel. This is a useful document to help support energy efficiency efforts. A model policy that was created by SEMP and Vermont School Boards Association can be found on their website:
http://www.vtvsba.org/policy/e10.pdf

ENERGY STAR

Appliances are rated by the Energy Star system to ensure that they are energy efficient. It is helpful to adopt a policy to acquire only Energy Star rated equipment. For more information, visit the Energy Star website at www.energystar.gov .

ENERGY MANAGER

Someone at the school should be designated as "Energy Manager". It would be this person's

responsibility to continually tweak the building's systems to achieve maximum efficiency. Building staff very often already have too full a plate to pay attention to the detail of maximizing the efficiency of the buildings. Someone can be hired and trained to fulfill this role or this scope could be added (along with hours) to a part time position. The savings could more than pay for the cost of this person's time.

OTHER RESOURCES

1) An excellent manual entitled "School Operations and Maintenance: Best Practices for Controlling Energy Costs - - A Guidebook for K-12 School System Business Officers and Facilities Managers" can be obtained as a free download http://www1.eere.energy.gov/femp/pdfs/omguide_complete.pdf

2) Vermont School Board Insurance Trust (VSBIT) Their Physical Plant Consultant will visit schools and advise them on a whole range of facility management issues including cleaning programs, indoor air quality, playground safety, work order systems, managing contractors, grounds maintenance etc. Contact VSBIT at 223-5040 and/or check out their website at www.vsbit.org where they have many resources for schools.

3) The Vermont Energy Education Program (VEEP) offers a variety of hands-on/minds-on learning experiences about energy and our environment for Vermont teachers and their students in grades 3 - 12. For an overview of VEEP's programs visit www.veep.org. For further information use the "contact us" form at VEEP's website.

4) The "Kill A Watt" device is a great educational tool that gives readings on kWh, volts, amps etc. for plug loads. It can be obtained from many sources found on the internet and elsewhere for around $25. You plug it into an outlet and then plug items into it to get the readings.

5) The CHPS Best Practices Manual for Operations and Maintenance of schools can be found along with a good many other publications of interest to schools at this address - - http://www.chps.net/manual/index.htm#BPM .

6) If considering the purchase of more efficient kitchen appliances, this site is very helpful: http://www.fishnick.com/

FUNDING OPTIONS

Below is a summary of funding sources and strategies to help pay for energy retrofit programs:

ENVISION GRANTS

This is a small ($1,000 - $5,000) grant program to help schools improve indoor air quality. Help with planning for retrofit of ventilation systems, installation of environmentally friendly materials etc. are eligible. Contact Chris Zuidema at 865-7762. Email: Christopher.zuidema@ahs.state.vt.us .

COMMUNITY FACILITIES GRANTS

Schools are eligible for funding under this USDA Rural Development Program. General information can be obtained at: http://www.rurdev.usda.gov/HAD-CF_Loans.html and

http://www.rurdev.usda.gov/HAD-CF_Grants.html

A listing of town eligibility can be found at:

http://www.rurdev.usda.gov/SupportDocuments/VT2010Census.pdf suggest first checking for eligibility so you don't waste your time if your community will not be able to get support. Maximum percentage grant is 75% (but few towns are eligible for this high percentage). Contact the state reps shown on the website for more information. Typically, the maximum grant amount is $50,000 but the particulars of this program can be different from the general info on the website and higher grant amounts are possible sometimes.

BONDING AND MUNICIPAL LEASING

School districts can obtain project funds either by bonding or by obtaining a municipal lease. They both carry somewhat similar (low, tax exempt) interest rates (although you should always be clear on the total interest, fees, and terms). Recent rates for a ten year term are about 3.5% and 4.5% for a twenty year term (there are other bonding options, see below).

The source for school districts to obtain bond funding is primarily the Vermont Municipal Bond Bank www.vtbondagency.org . Most school business managers are familiar with the bonding mechanism.

For many energy projects, you can enter into a municipal lease that generally has you pay an annual amount for the use of the equipment and obtain ownership of the equipment at the end of the lease period. A "non-appropriations clause" is included in the agreement that gives the leasing company the right to remove the collateralized equipment in the event of non-payment of the lease. If certain criteria are met, the school district does not need to include the lease amount as "debt" and will not need a vote of the electorate to enter into this agreement. Check with your counsel to clarify exactly how the law applies and what these criteria may be for your project.

For smaller projects and for smaller school districts that don't generally have a CPA performed audit, leasing may be a better option. For more information about these options, I suggest you contact Bob Giroux at the bond bank – 223-2717.

SOLAR HOT WATER, WIND AND ELECTRICITY

There is an incentive program for the installation of solar domestic hot water systems, wind systems and photovoltaics for schools. This program is administered by the Renewable Energy Resource Center at Vermont Energy Investment Corporation (http://rerc-vt.org/) .

QZAB PROGRAM

Qualified Zone Academy Bond - - this program provides tax credits to the issuer of the bond for the school district. The net result is that the school can get an interest free loan for their project. There are income based eligibility criteria, many hoops to go through and not much (if any) money left in this program. For general information go to www.qzab.org . For specific information contact the Vermont Agency of Education.

EVERGREEN FUND

This is a program of Green Mountain Power that provides schools in their territory with zero interest loans and easy, on-bill financing. It is administered through Efficiency Vermont and is designed for "approved projects" that save electricity. The program is designed to have savings cover the debt service. Contact Efficiency Vermont for more information.

A district vote is usually required to access this loan money.

AUTHORITY TO BORROW

Based on a statute change last session, school boards can seek authority from the district voters to incur debt for cost effective energy improvements without getting specific voter authorization for each project. See 16 VSA Chapter 562 (11).

http://www.leg.state.vt.us/statutes/fullsection.cfm?Title=16&Chapter=009&Section=00562

OTHER

RELATIVE COST EFFECTIVENESS OF ENERGY CONSERVATION MEASURES (ECMS)

The return on investment for the Energy Conservation Measures varies greatly depending on the type of improvement and the building specific cost and savings of each. There is significant variability depending on your exact situation. The numbers given below are just rules of thumb to help understand the relative savings that can typically be achieved from these measures. This does not take the place of an actual evaluation based on your particular set of facts.

The criterion for cost effectiveness used is generally Return on Investment or ROI. This is simply arrived at by dividing one by the simple payback in years. For example, a four year payback will give you 1 divided by 4 = .25 or 25%. Use of ROI gives a better idea of the return so that it can be compared to the returns people get from other investments. These numbers are given without taking into account available incentives from Efficiency Vermont and other sources that improve the financial calculation for the schools.

1) Improving Operations - - these are the most cost effective measures because they require little if any expense and they can generate substantial savings. Typically these measures pay back in as little as a month to a year.

2) Lighting - - many lighting upgrades will provide return on investment (ROI) in the 25-33% range.

3) Controls - - certain control measures, short of new system installation, can have ROI in the 20-30% range.

4) Other recommended electrical measures can also have an ROI in the 20-30% range.

5) Upgrading of central control systems usually will have a 7-10% ROI, depending on the types of systems and options (and the extent of problems with the existing system). Many systems need to be replaced due to obsolescence and difficulty in maintaining older systems.

6) **Infiltration** - - comprehensive weather-stripping and sealing of envelope penetrations can generally pay back with about a 10 - 20% ROI.

7) **Window replacements** usually have a ROI of 5% -10% or less due to the high cost of window replacement. However, windows often need replacement due to maintenance, functional, and obsolescence issues.

8) Adding **insulation** to completed walls usually has a long payback yielding an ROI of less than 5%. Upgrading wall insulation is generally undertaken as part of a larger renovation project. Adding insulation to an accessible attic will have a better payback depending on the amount of existing insulation.

9) **Solar domestic hot water** systems will pay back in the greater than 20 year timeframe, primarily because most schools do not operate in summer when the solar hot water systems are most productive.

10) **Photovoltaic (solar electric or PV) systems** - - Based on the latest information from the VT Renewable Energy Incentive Program, PV for schools, when considered without subsidy or special rates, generally fail a life cycle cost test when full operating costs and benefits are included. Estimates for operating costs vary widely. Costs include cleaning, foliage control, annual maintenance, repairs, insurance, and replacement of the inverter (expected life +/- 10 years). Cost effectiveness to the school after taking grants and special rates into account will vary greatly. Schools should clarify their motivation if considering PV systems verses other energy investments that may yield better savings in CO2 or $. It should be noted that a small PV system will yield the same educational benefits as a larger system would. However, many of the proposals that schools are receiving are not based on schools owning the systems. They are from third parties that have a financial proposal whose risks and benefits have to be carefully weighed by the school.

11) The return on investment of a conversion to **wood pellets** from oil or propane can be a viable option for many schools depending on several site specific parameters. The fuel cost of natural gas and pellets is roughly the same so there would be no savings for a conversion from natural gas. The feasibility and cost of the system should be ascertained in each particular case to determine whether the bottom line is favorable. At the current

time, most schools that have a suitable site will save about a third of your fuel cost by using pellets. Part of a life cycle cost evaluation of these systems takes into account potential fuel price increases in the future.

12) Fully automated **wood chip heating systems** are cost effective only for very large schools that use fuel oil or propane. Site specific evaluation is necessary to determine whether this is a viable option.

Life Cycle Cost - - For larger capital investments, the best way to compare options is the use of Life Cycle Cost Analysis (LCCA) methodology. This analysis takes into account many factors including; expected life of the measures, replacement/salvage value, maintenance costs, future fuel costs and a discount rate to bring all the numbers back to a present value of the measure. Then the present (today's) values of the different options can be compared in the best "apples to apples" comparison.

DISCLAIMER

Recommendations for improvements are made based upon experience with other similar schools and general engineering practices. Before implementing significant changes to your building(s), a more in-depth analysis by competent professionals is generally needed to maximize benefits and help ensure that the changes will not result in any problems for the school or its occupants.

FINAL NOTE

I see a large quantity of schools. At times I may make a mistake in describing an element of your building or neglect to include an important feature. I apologize in advance in case this may have occurred with your facility. Please let me know if this happened so I can correct my report accordingly.

ABOUT VSA-SEMP

The Vermont Superintendents Association's School Energy Management Program (VSA-SEMP) began its operations in 1993 and has provided both public and private K-12 schools support for their energy reduction programs continuously since then. VSA is a private non-profit association of Vermont school superintendents. VSA-SEMP is not a state run program. The program receives funding from a variety of sources to be able to provide site assessments and advice on renewables at no charge to the school. The major program funder is Efficiency Vermont. The Vermont Public Service Department supports work on renewables. The US Forest Service through a grant to Vermont Department of Forest, Parks and Recreation

supports additional work on biomass. The High Meadows Fund has also assisted the program in the past.

From December 2005 thru December 2014 the Program Director has audited 450 school buildings at 321 schools in Vermont and generated 316 reports.

GLOSSARY OF ENERGY TERMS USED IN THIS REPORT

ASHRAE - - American Society of Heating, Refrigeration and Air Conditioner Engineers - - they provide codes and standards for most building systems.

Aquastat - - this device is inserted into the plumbing to sense water temperature and activate a switch based on its temperature setting.

Block-Heaters - - these are typically used on diesel school buses to help ensure they start and to reduce the amount of time needed to heat up.

Btu – British Thermal Unit - - This is a unit of energy - - roughly equivalent to the heat generated by a burning wooden match - - technically, a Btu is the amount of heat it takes to raise a pound of water by one degree F.

Carbon Dioxide - - CO2 - - this is a non-toxic component of air we breathe and exhale. When we take in air we utilize a portion of the oxygen and exhale additional carbon dioxide. Because CO2 levels are a good indication of how many people are in a space it can be used for automatic control of ventilation systems. CO2 levels are also used to determine the effectiveness of ventilation systems.

CFM – Cubic Feet Per Minute - - this is a measure of air being moved by the ventilation system.

Circulators - - these are motors and pumps that force hot water through a building. They may be on domestic hot water or heating systems.

Compact Fluorescent Lights (CFLs) - - these are fluorescent lights designed to screw into a regular incandescent fixture.

Condenser - - this is the component of a refrigeration system that releases heat through a coil or grid to condense the refrigerant.

DDC – Direct Digital Control - - or computer control of building systems. A central computer can control all heating, electrical and ventilation systems in a building.

Domestic Hot Water (DHW) - - this is hot water used for general purposes such as cleaning, hand washing etc. as opposed to hot water used for heating.

EPA – Environmental Protection Administration - - the EPA administers the EnergyStar rating system.

Facility Operating Plan (FOP) - - this document outlines key building systems and how they are to be operated.

Fluorescent Lighting - - these lights utilize a transformer (called a ballast) and a sealed bulb to excite mercury vapor. The excited mercury atoms produce short-wave ultraviolet light that then causes a phosphor to fluoresce, producing visible light. Fluorescent lights are more efficient and last longer than incandescent.

Fuel Oil - #2 - - this is the most commonly used fuel at Vermont schools. Btu content is 138,200 per gallon.

HVAC - - Heating, Ventilation, Air-Conditioning - - this is a general term that covers all those systems. It is used whether or not air conditioning is a big factor.

Incandescent Lights - - these use a filament inside an evacuated glass enclosure. Most of the energy is released as heat instead of light.

Indirect Tank or Indirect Fired Tank - - this is generally an insulated water tank that is heated from an independent source such as an oil boiler or a solar system using a heat transfer coil in the tank. Usually the two water systems are separate.

Infiltration - - essentially air leakage through gaps in the building envelope and around windows and doors.

kW – kilo-Watt = one thousand Watts - - this is a unit of power or demand. Ten one-hundred Watt bulbs on at the same time will result in a demand or draw of 1 kW. On the electric bill it is the highest 15 minute draw on the power system any time during the month. Most schools are charged separately for kW demand and kWh (usage). This is a significant charge and there are often "ratchet penalties" where you are charged a percentage year-round based on your maximum demand.

kWh – kilo-Watt-hour - - this is a unit of electrical energy or usage. A kWh is 1,000 Watt-hours or the amount of electricity 10-100 Watt light bulbs will use in an hour. A kWh used on site will yield 3,412 Btus.

LED - - Light Emitting Diode - - this form of lighting uses semiconductor diodes to create light. These bulbs have exceptionally long life and other advantages.

Life-Cycle Cost (LCC) - - a method of calculating the full cost of a system over its expected useful life. This is typically brought back to present value to be able to compare the value of different systems or options. LCC can include factors for fuel escalation, maintenance, replacement, residual value, useful life, and the cost of money.

MERV Rating - - for air filters - - Minimum Efficiency Reporting Value - - a rating of the effectiveness in removing particles from the filtered air.

Metal Halide lighting - - this is typically used in schools in high applications (such as gyms). This lighting needs a warm-up period making it difficult to shut down for short periods.

MBtu - - thousand Btus.

MMBtu - - Million Btus. Boilers are often rated in these units.

Occupancy Sensor - - these detect the presence of people through some combination of infra-red, ultra-sonic or microwave detection. They are typically used to control lighting or mechanical systems.

Occupied Cycle - - this is the period of time when the school is typically occupied by students. Heating, ventilation, and other systems can be modified for lower use outside these hours.

Outside Temperature Cutoff - - this is a boiler control that monitors outside temperature and will automatically turn off circulators and/or boilers when the outside temperature is high enough that they are not needed.

Outside Air Dampers - - these are mechanical devices that allow outside air into a ducted system. They open or close depending on demand for outside air, in response to controls. Outside air is used both to provide fresh air and, at times, cooling.

Outside Temperature Reset - - a boiler control that monitors outside temperature and automatically adjusts boiler temperature. This reduces boiler temperature when heating demand is low and saves energy.

Payback or Simple Payback - - this is a basic form of figuring cost effectiveness. It is calculated by simply dividing the cost of a measure by the annual savings. Its advantage is its simplicity. Its disadvantage is that it doesn't take into account many other factors like the life of the system, periodic maintenance, cost of money, or fuel escalations.

Photocells - - these detect light and are generally used to turn lights on at dark (and sometimes to shut lights off when there is adequate light from fenestration).

PM – Preventive Maintenance - - these are recurring measures taken to properly maintain systems and prevent problems.

Power Factor - - this is a measure of how efficiently the building electrical systems utilize power. In inductive loads like motors and transformers the voltage leads the current. This can result in inefficient use of the electrical distribution system both within the facility and for the power company. Due to this dynamic, power companies penalize building owners if the power factor is outside a certain range. Bills should be monitored to ensure that you are not getting this penalty.

Power Strips - - these are multi-outlet strips that have a shut-off switch. They are typically used for computer and peripheral equipment and may incorporate surge protection.

Pneumatic Control Systems- - these systems use air to control components of the heating and ventilation systems. They utilize an air compressor (typically in the boiler room) and air piping to thermostats and actuators.

R-Value - - this is a measure of the resistance to heat flow. It is used to rate insulation.

Square Footage - - this is the meant to be the size of the heated space. This number is used for rough calculations of energy use per square foot which is a means of comparing energy use at different schools.

T-12, T-8, T-5 - - this is a measure of the diameter of a fluorescent tube. The number refers to the number of eighths of an inch (T-8 is one inch diameter). Typically, the smaller diameter bulbs are more efficient.

Temperature Setback - - reducing the building temperature during unoccupied hours. Setting back the temperature by ten degrees (typical of most schools) can save, on average, 25% of the heat loss by conduction through the building envelope.

Transformers - - these are used to change electrical voltage from the high values used to get the power to the building to the lower values that are utilized by the building's equipment. Some transformers are pole mounted, some are mounted on pads outside the building and there are some inside the building, usually near the electrical panels.

Unit Ventilators - - these are typically located in classrooms. They provide heating, fresh air, and also operate in a cooling mode to bring in extra outside air to help cool a space when needed.

VFD - - variable frequency drive - - the speed of a motor can be efficiently controlled using this device. There are times when a motor doesn't have to operate at full speed. Due to the cube rule, a motor going at half speed uses only $1/8^{th}$ of the power. These can be automatically controlled based on demand.

Ventilation - - fresh air supplied to the building typically by a forced air system. Fresh air is essential to create a healthy school environment that is conducive for learning. The basic ASHRAE requirement is for 15 cubic feet of outside air per person per minute for classrooms (unless a demand system is in place).