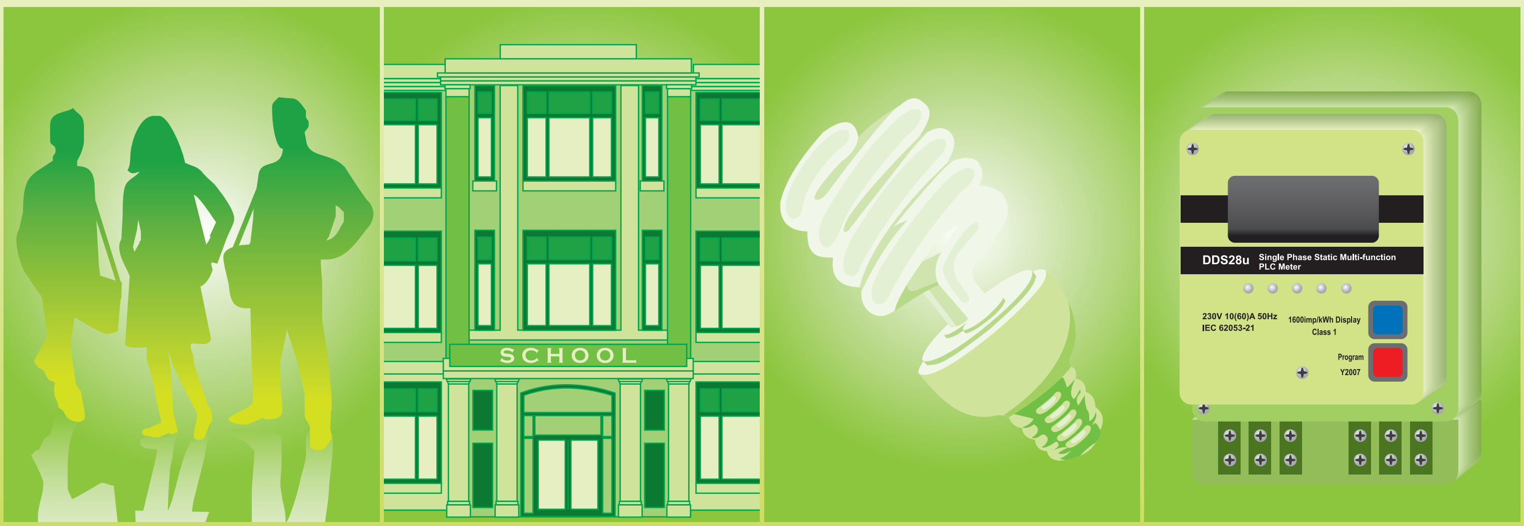
Energy Management
IN YOUR SCHOOL



ENERGY IS LIFE
BEE
CONSERVE IT
Bureau of Energy Efficiency

British High Commission
New Delhi

ICF
INTERNATIONAL

Energy Management

In your SCHOOL

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ENERGY IS LIFE ऊर्जा कार्यकुशलता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)
BEE
CONSERVE IT **BUREAU OF ENERGY EFFICIENCY**
(Government of India, Ministry of Power)

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Director General

FORWARD

The current electricity consumption in the commercial buildings sector in India is about 8% of the total electricity supplied by utilities. The electricity demand in commercial buildings is growing annually by 11-12% due to demands for providing international level comforts and facilities. This presents a challenge to ensure that energy growth in commercial building does not become unmanageable, but at the same time, also presents an opportunity to influence and address energy management issues in various commercial buildings and facilities.

Educational institutions are often overlooked as a contributor to energy intensive operations in India within the commercial buildings sector. Energy costs form one of the more manageable costs within a school's budget and can be managed effectively. Resultant cost and energy savings will go a long way in reducing energy use within the sector and provides a venue for re-investment within schools.

A review of international experience and several energy audit studies conducted in India indicate that schools can effectively reduce 5-20% of energy use. This "Guidebook for Managing Energy Use in Your School" developed by ICF International with the help of funding support from Strategic Programme Fund, Low Carbon High Growth Programme managed by the British High Commission in India, makes a concerted attempt to support the growing education industry in India in achieving improved energy performances. This guidebook aims to highlight several opportunities to create and implement an energy management plan within schools. Topics include the steps that are required to develop and implement an energy management plan, how to identify energy opportunities and how to evaluate costs and paybacks.

I am sure that the school administration and staff would find this document very useful, and that it would facilitate the process for achieving improved energy performances in school buildings.

(Ajay Mathur)
Director General
Bureau of Energy Efficiency, New Delhi

New Delhi, the 25th March, 2009

स्वहित एवं राष्ट्रहित में ऊर्जा बचाएँ   Save Energy for Benefit of Self and Nation
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Why Manage Energy Use

UNDERSTANDING THE INDIAN ENERGY CONTEXT

The Indian energy requirements are likely to grow at a much higher rate than the world growth rate of 2%. India has limited energy reserves and therefore it will need to increase its energy efficiency, in addition to reevaluating its existing building stock. Existing buildings offer one of the greatest potentials in contributing to energy conservation and if not evaluated also provide the greatest challenge of being energy hogs. This book highlights a methodology for implementing energy management in educational institution buildings.

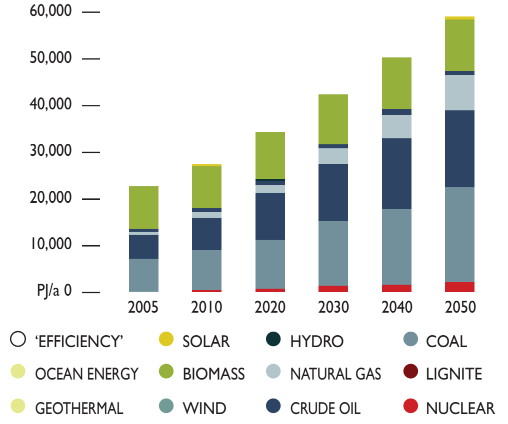


Figure 1 – Understanding the Indian Energy Consumption Scenario

ENERGY USE IN SCHOOLS

Schools are constantly faced with optimizing limited budgets to ensure maximum payback for students, teachers and their facilities. Rising energy costs associated with additional expenditure for replacing equipment adds strain to an already compact budget.

Energy maintenance is often overlooked in school buildings as the associated costs are relatively lower compared to other expenses. Schools can effectively reduce energy use, garner energy savings, and extend equipment lifetime through effectively implementing an energy management program.

Implementing an energy management program can save anywhere between 5-20% on energy bills. This will help improve your bottom line and holds down operating costs. An operations and maintenance based program can be relatively low in cost and still yield effective payback.

Managing Energy Use in Your Hospitals

- Initiate an Energy Management Program
- Determine Efficiency Targets
- Conduct Energy Assessments
- Identify Energy Savings Opportunities
- Calculating Costs and Paybacks
- Implement Measures
- Monitor Performance

Controlling costs is a key to profitability allowing your school to route resultant savings toward fulfilling other requirements including purchasing additional amenities, staff salary increases, etc.

IMPROVED LEARNING ENVIRONMENT

In addition to optimizing energy and saving costs, schools offer a critical platform for creating a better environment that includes favorable light, sound, and temperature, which can help students learn better. In many cases, improving these attributes can also reduce energy use. A research captured in Greening America's Schools: Costs and Benefits, highlights 17 studies that demonstrate productivity increases of 2% to more than 25% from improved indoor air quality, acoustically designed indoor environments, and high-performance lighting systems. Some of these studies show that day lighting, which uses the sun to produce high-quality, glare-free lighting, can improve academic performance by as much as 20%. Quality lighting systems include a combination of day lighting and energy-efficient electric lighting systems. These complement each other by reducing visual strain and providing better lighting quality. Advanced, energy-efficient heating and cooling systems create cleaner, healthier indoor environments that lower student and staff absentee rates and improve teacher retention. This translates into higher test scores and lower staff costs. For example, Ash Creek Intermediate School in Oregon has reduced absenteeism

(compared to the previous facility) by 15%. Lower construction and operating costs also signify responsible stewardship of public funds. This translates into greater community support for school construction financing. Schools that incorporate energy efficiency and renewable energy technologies make a strong statement about the importance of protecting the environment. They also provide hands-on opportunities for students and visitors to learn about these technologies and about the importance of energy conservation.

HOW TO MANAGE ENERGY USE

Energy management helps improve your bottom line and holds down operating costs. Energy costs typically represent a high proportion of a school's variable or "manageable" costs and expenses. On average, energy costs represent 16% of a school's "controllable" costs. As a result, in this era of tight budgeting, energy cost management has the potential of becoming a major source of flexible expenditure. (Adapted from "Schools and Energy Efficiency – Reducing Costs and Creating Better Learning Environments")

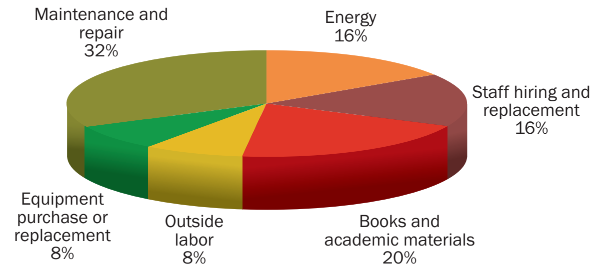
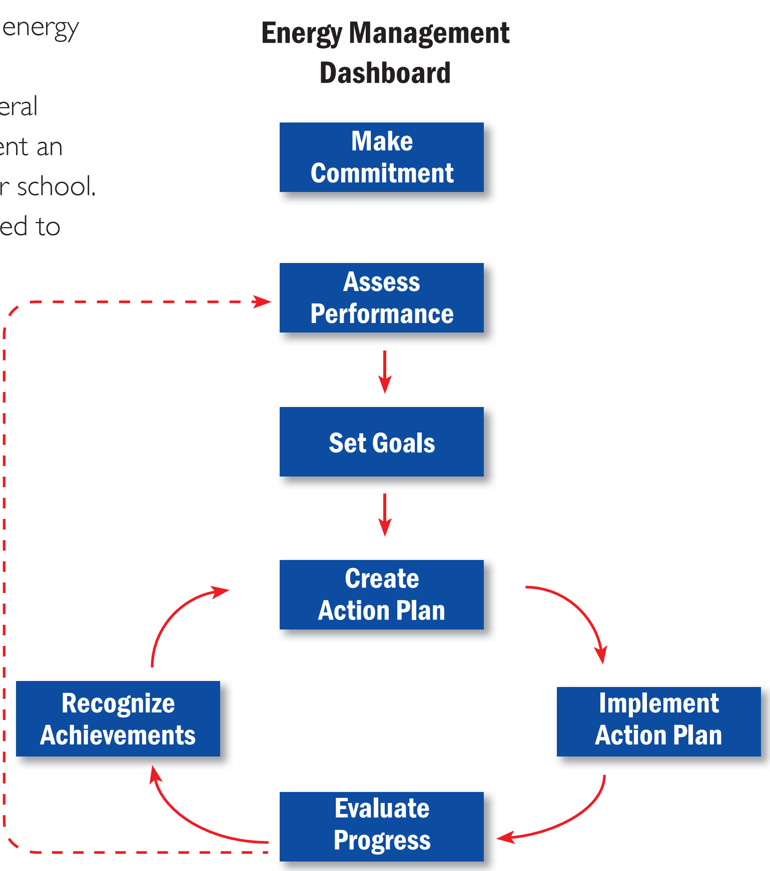


Figure 2 – Controlling Costs – A Typical US Example Source: "Schools and Energy Efficiency – Reducing Costs and Creating Better Learning Environments"

There are numerous ways by which energy can be managed within your school. This guidebook aims to highlight several opportunities to create and implement an energy management plan within your school. Topics include what steps are required to develop and implement a management plan, how to identify energy opportunities and how to evaluate costs and paybacks.



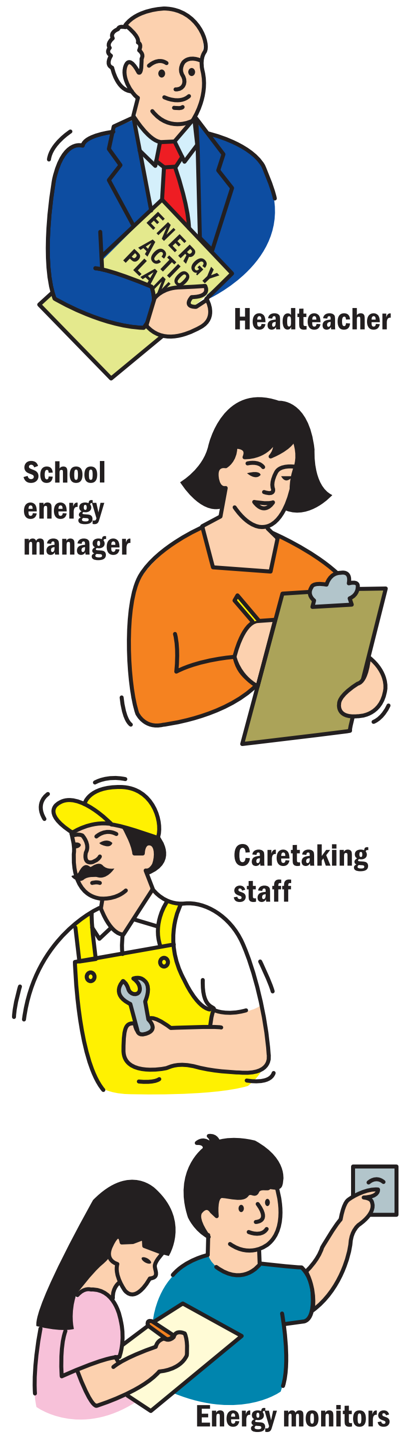
Initiating An Energy Management Programme

"Good school buildings contribute to good education just as bad school buildings interfere with it.

Studies demonstrate the relationship between school infrastructure and student achievement, but this relationship is not straightforward, and a myriad of other variables go into making good schools. In other words, school infrastructure contributes to but does not decide the quality of a school. As such, infrastructure is not distinct from other issues of school reform or educational excellence; rather, school infrastructure decisions are a central component of whole-school reform." (Source: Planning Guide for Maintaining School Facilities, National Forum on Education Statistics and Association of School Business Officials International, p.14, February 2003.)

Before any energy management program can be developed a dedicated staff team is required to ensure that accurate objectives are set and the right people will implement the plan. In schools, a dedicated O&M team is generally not an integral part of the organizational structure; therefore it will be an important first step to identify who could play this role. This could be a roster based effort.

Understand existing energy use situation.
The first step in implementing an energy management program is to understand the existing energy use scenario within the school facilities. Details on deriving an energy baseline and determining efficiency levels within your school facilities are elucidated in the next chapter – "Determining Efficiency Targets".



Identify a core team. The next step in initiating an energy management team is establishing a team of staff members who will play an integral role in the program. Identifying key staff members who will be involved in energy management activities and those responsible for overseeing the program is imperative for success. An effective team should include the school owner or members from the management group, the staff in charge of school facilities, several teachers to raise awareness among the student body on importance of energy management, and someone who understands finance. The school can also choose to include select students to raise morale and motivate students to “do their part” in efficient energy use. Commitment from the school administration and/or management and their involvement is vital to providing focus to energy management operations. Their attitude toward energy savings sets the pace for increased efficiency. Also, designate a mid level or upper level employee as “Energy Manager” to monitor energy saving activities and projects daily.

Once the team is selected organize an introductory session to start laying the groundwork for the program.

Identify and set specific objectives. Identifying the program goals and objectives helps establish a standard of comparison for success and also lays the path toward achieving desired results. For example, if you want to save 25% over the next 1-3 years you should consider the following –

- Have you defined the 25% as reduced consumption of energy or as reduced cost?
- What is the base you will measure against?
- How and when will the measurement be made?

Receive input from your team and plan workable goals and objectives to establish a baseline for your efforts. Use this phase to also identify related budget factors to achieve goals.

Develop a plan. Create an action plan to define the implementation of the pre-determined energy management goals and objectives. This plan will outline steps toward achieving desired results, delegate responsibilities, identify budget limitations and set targets for energy saving opportunities.

Communicate plan. Once the plan is established the success of the energy management program depends on the effectiveness of communicating it to the involved staff members and other individuals including students, parents, etc. Use the plan to delegate responsibilities to key staff from facilities and other involved staff members. Ensure that it is easy to understand and everyone shares the common goals and objectives of the program. Regular updates on program and visual tools to share progress are effective ways of building momentum within staff members.

Important Questions to Consider While Creating an Operations and Maintenance (O&M) Plan

- What tools and information do staffs currently have to effectively manage energy costs?
- What is the current status of O&M practices in my school?
- Would changes in facility O&M practices likely produce significant operating savings?
- Would senior administrators actively support an O&M effort?
- What local resources may be available to assist?
- Monitor Performance

Implement measures and monitor performance. Implementing identified measures and their monitoring with respect to associated results is imperative for the program. Without regular monitoring of program it will be difficult to evaluate any savings. Follow up is also required to ensure that measures have been implemented properly.

Motivate staff members. The key to keeping stakeholders onboard with your energy management plan is having a reward and celebrating successes. Don't wait until the end of a two year program to announce results. Have regular milestones and incentives to meet them. Make people feel part of the program's success and it will take on a life of its own. Create an environment where people work together to get things done and enjoy the rewards of achieving success on a regular basis.

Determining
Efficiency Targets

According to the United States Environmental Protection Agency's ENERGY STAR program, the least efficient schools use three times more energy than the best energy performers. Energy costs are influenced by numerous variables that need to be taken into consideration while determining efficiency targets.

Before determining targets, a successful O&M program must clearly address the organizational issues likely to be encountered. An essential element of designing and implementing a successful O&M effort is anticipating and planning for the pitfalls likely to occur. Many of the barriers are a variation of two major themes; 1) the limited internal availability and distribution of complete, accurate and timely information with respect to energy cost, facility performance and staff maintenance and operational practices; and 2) the lack of clear leadership in energy management objectives and an associated under-investment in the staff resources and training necessary for effectively managing facility operating costs and reducing life cycle costs of school buildings. (Adapted from School Operations and Maintenance: Best Practices for Controlling Energy Costs)

Once these are recorded, the next step is to understand the factors that relate directly to the bottom line of energy costs - operating expenses, annual revenue etc. Operating expenses is one of the significant "constant" variables to be considered while determining savings objectives. Others like occupancy rate, cost of materials and supplies, will fluctuate based on external factors.

Operating expenses are largely influenced by actions you can take and on average, the cost of energy accounts for 3% to 5% of the total operating expense. Figure 3 below highlights select variables that will determine your efficiency targets.

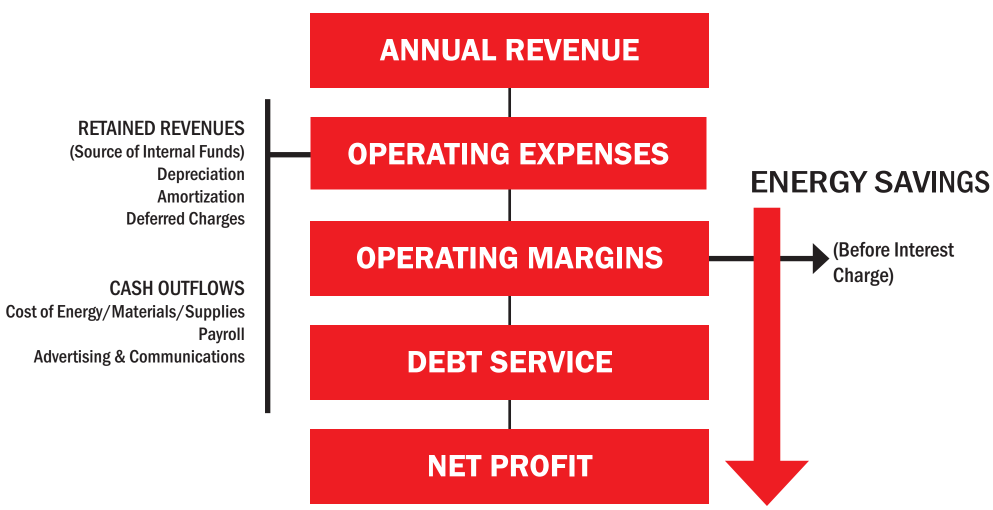


Figure 3 – Factors involved in establishing profitability for a school
Source: "Managing Energy in Your Hotel"

Where Is Energy Being Used

While studying the factors affecting energy costs within school facilities a key step is studying where energy is being utilized within your school. Identifying areas of high and low energy use will help you target key areas for improvement and also areas that will provide maximum returns. Figure 4 below highlights K–12 energy consumption by end use in the U.S based on data from the U.S. Energy Information Administration.

Similar graphs can be constructed for your school by analyzing your energy bills. Understanding the school's energy use will help you establish a baseline from which you can determine a suitable and more importantly an achievable efficiency target that can be reached through implementation of energy management best practices.

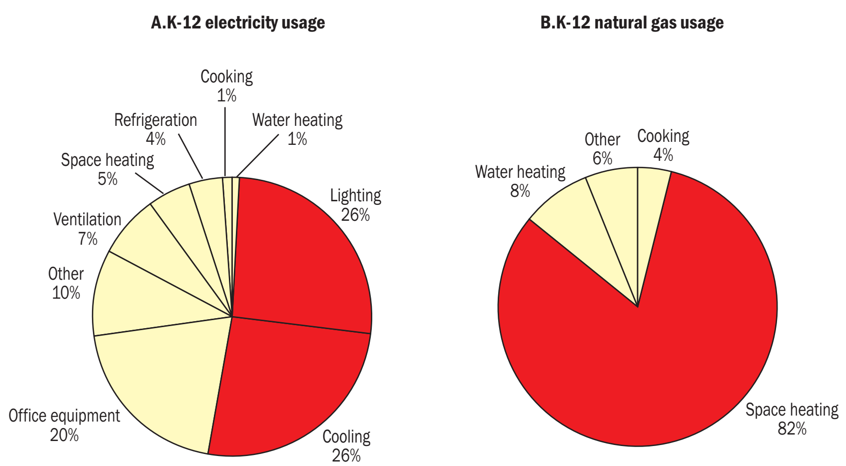


Figure 4 –K–12 energy consumption by end use in the U.S.
Source - Managing Energy Costs in Schools (http://www.esource.com/BEA/demo/PDF/CEA_schools.pdf)

Conducting
Energy Assessments

An energy assessment is an essential component of a successful energy management program. This will help you identify the present energy use situation within the school facilities and flag energy costs. Energy saving opportunities can be identified based on the assessment report. The assessment will also help you develop a baseline for future comparisons of program success by comparing energy use before program implementation and after.

Schools can conduct either a basic **walk-through energy assessment** or a more detailed **energy analysis audit.** Schools also have the option of carrying out the assessment as a first step to identify existing energy saving opportunities and implement the results followed by a more detailed analysis audit to derive more detailed measures for savings including capital intensive energy saving opportunities.

This guide focuses on the walk-through energy assessment process as a means for schools to delve immediately into saving energy and improving their bottom line through less capital intensive measures. Schools are encouraged if they desire to follow the implementation of these measures with a more detailed audit to garner additional savings.

Performing A Walk-Through Assessment

Often 25% of a commercial building's energy consumption is wasted due to specific management practices. Simple adjustments to management and operation practices can result in savings for your school. For example, adjusting the Building Automation Systems (BAS) to more effectively control your lighting can result in significant savings.

A walk-through assessment is the easiest and least expensive means of identifying and evaluating energy use in your school building providing you with a tangible sense of current building conditions and staff operations and maintenance practices. Since people have a major affect on how energy is used, this assessment pays particular attention to identifying habits and procedures that can be adopted to use energy more efficiently. Basic information about the systems in your school is also collected during this process.

The point of a walkthrough survey is NOT to take measurements or conduct technical equipment testing. The objective is to produce a quick snapshot of the highlights of how the building is being operated and maintained with respect to energy use. Although a variety of useful building survey protocols are available from consultants and government agencies, the primary information of importance is the following (adapted from "School Operations and Maintenance: Best Practices for Controlling Energy Costs")

- Building use and occupancy schedules;
- Shutdown procedures during unoccupied periods;
- Status of control strategies for major equipments and systems in the building;
- Classroom lighting levels and fixture control;
- Heating and cooling system efficiency and maintenance practices;

- Condition of water or air distribution systems;
- Temperature control and setbacks;
- Condition of building envelope, windows and weather-stripping;
- Identification of prominent problems (indoor air quality etc.);
- Control of computers, vending machines and other plug in loads;
- Assessment of staff expertise.

The first step in this assessment is to examine energy use and associated costs across systems within your school. Utilize your operations and maintenance staff to assist in this process. Provided in the following pages are –

1. Energy Planning Ledger – assist you with highlighting required information to initiate the assessment
2. Questionnaire for the Operations and Maintenance (O&M) Staff at specific school(s) energy policy and building
3. Walk-Through Assessment Checklist – assist you with identification of energy saving improvements that can be easily implemented.

Use all these sheets while walking through your school building and recording information on energy use. The sheets can be modified to suit existing systems in your school buildings.

Energy Planning Ledger

How much energy does your school use? Ask to see your school's energy bills for the previous year or two.

Acquire school electricity bills for a 12 month period and use them to fill out the ledger provided below If bills are paid on a monthly basis, combine bill amounts for three consecutive months to make up for a quarter of the year.

School Building Statistics

Carpet Area Sq. Ft. ______________________________

Air conditioned Area Sq. Ft. ______________________________

Number of Floors: ______________________________

Building Age: ______________________________

Energy Source

Electricity: ____________________________________ % of total cost

Gas: ____________________________________ % of total cost

Total electricity use per quarter ________________________

Total cost per quarter ________________________

Number of billing days ________________________

Number of students and teachers at your school ________________________

Billing periods (from-to)	No of Days	Electricity cost for each period * ($)	Electricity consumed / period* (KWh= kilowatt hour)
		(C)Total cost for year $	(D)Total energy usage for year_______KWh

** If gas is also used for energy in your school, the table provided above can be modified to include gas readings.*

With this information you can determine the past:

Daily Use of Energy
Total use per quarter / number of billing days (kWh/day) ____________________

Personal Daily Use of Energy
Daily use / size of school population (kWh/person/day) ____________________

Daily cost
Total cost per quarter / number of billing days ($/day) ____________________

Personal daily Cost
Daily cost / size of school population ($/person) ____________________

Hot Water Uses: ____

Predominant Type of Indoor Lighting: ______________________

Predominant Type of Outdoor Lighting: ______________________

School Operation Hours: ___________________________________

This ledger will help you ascertain an energy use baseline that will allow you to measure the success of your energy management program at regular intervals.

Questions For O&M Staff At Specific School(s) Energy Policy And Building

Questions for O&M Staff at Specific School(s) Energy Policy and Building

Operations Procedures

1. Is there any specific kind of standard building operating and maintenance procedure in your building?

2. What maintenance records do you keep? Of particular interest are the testing and maintenance of air-conditioners and other major building systems.

3. What was the date of your last assessment of energy use or other important actions related to energy conservation?

Building Energy Information

4. Are annual energy costs at your school increasing or decreasing? What are the reasons for these changes?

5. Are you provided with the monthly energy consumption or billing information for your school?

6. If yes, how do you use this information?

7. Do you know how energy costs at your school compare to costs in other similar schools?

School Condition and Operations

8. What are the major problems in respect to the condition of equipments and appliances in your school? (Poor maintenance, staffing etc.)

9. How are maintenance decisions made? How does the administration plan, track or schedule maintenance activities at individual schools, particularly for large systems such as air-conditioning systems?

10. Are you aware of any recommendations for changes in O&M practices that have been made in energy audits or other sources?

11. Do you have any recommendations for reducing energy costs at your school?

12. Does your school have a computerized energy management system (EMS)? Is it working effectively? Which building systems does it control? Does your staff know how to operate it effectively?

13. Can you briefly describe night time, vacation and weekend shutdown procedures currently in place in your school? Is there a written procedure available?

14. What are the current thermostat settings and night time temperature setbacks?

15. Are teachers, students and staff careful about turning off computers and other equipment when not in use?

O&M Staff Training

16. What training has been provided to your schools custodial or maintenance staff that is relevant to reducing energy costs in your school?

17. Can you identify any specific training needs that would enhance staff's ability to manage energy costs?

Walk Through Assessment Checklist

CHECK LIST	ACTION LIST	OBSERVA-TIONS
	HEATING & COOLING	
Window and Split ACs -		
	OPERATION ° Control operating hours of AC unit- use manual control, timers, automatic controls. ° Keep doors and windows closed when using the AC. ° Ensure that thermostat settings are not set too high or too low - aim for 24-25°C in winter and 22-23°C in summer. ° Locate AC on shady side of building away from direct sunlight where possible. ° Avoid frequent opening of doors/windows of the room.	
	MAINTENANCE ° Regularly replace or clean the filter and have a mechanic clean the evaporator and condenser coils ° Clean and replace thermostat regularly. ° If your compressor doesn't work properly, call a service person immediately. ° Any AC noise needs to be checked by a mechanic.	

Fans –		
	OPERATION ° General classrooms require 2-4 ceiling fans ° Ceiling fans should have a head clearance of 600–900 mm for safety ° Metal blades are the most effective ° Units should be mounted clear of existing light fittings to avoid annoying flicker	
	MAINTENANCE ° Turn off the fan when the room is not in use. ° Inspect the fan each year. ° Clean the fans every month or two. ° Dust the areas surrounding the ceiling fan.	
HVAC -		
Check temperature and humidity levels in various areas: - Class Rooms - Conference Rooms - Staff Rooms - Lab Areas - Auditoriums - Dining rooms - Corridors - Lobby	**OPERATION** ° Monitor outside air use ° Avoid heating and cooling at the same time ° Use modular, localized heating/cooling units where possible ° Control system by time-of-use when possible for public areas ° Use ceiling fans to increase comfort ° Shut off chiller during winter if possible.	

Check ductwork and airflow Check condition of windows and doors Check refrigerant levels.	**MAINTENANCE** ° Seal ductwork leaks ° Clean filters and allow free air-flow to grills ° Seal unused building openings ° Install vinyl curtains in loading areas ° Weather-strip doors and windows, caulk cracks ° Insulate: doors, pipes, ductwork ° Cover and lock thermostats and ventilation controls in public areas to prevent unauthorized adjustments ° Clean boilers, chillers and condenser coils regularly, straighten fans.	
Check thermostat readings Check availability of passive solar	**PROCEDURES** ° Do not heat/cool in low traffic areas, hallways or unoccupied rooms/floors ° Adjust building temperature by season: lower in winter / higher in summer ° Utilize available passive solar heat during cooler months by opening blinds and drapes ° Close doors to outside and unheated or un-cooled areas ° Use ventilation only when required ° Establish routine maintenance procedures ° Plan occupancy so guests are assigned in same area of school ° Have facilities staff close draperies and adjust thermostat to acceptable level in unoccupied area or rooms.	

<table>
<tr><th colspan="3">LIGHTING</th></tr>
<tr><td>Check when lights are being used.

Check lighting levels.</td><td>OPERATION
° Use automated lighting Controls
- Timers
o Outside lighting
o Playgrounds
o Parking lots
o Restricted-access areas
- Motion sensors
o Rest rooms
o Principal & senior staff offices
o Low-traffic areas
- Dimmers
o Auditoriums
o Meeting rooms
- De-energize fixtures/ballasts not in use
- Reduce lighting to minimum acceptable level for safety/security
o Parking areas
o Canteen
o Corridors</td><td></td></tr>
<tr><td>Check cleanliness and condition of lamps and fixtures

Check accessibility of switches</td><td>MAINTENANCE
° Clean lamps for maximum illumination
° Repair broken fixtures
° Replace non-working lamps/bulbs
° Install lowest acceptable wattage bulb
° Install energy-efficient ballasts
° Add reflectors to existing lighting
° Label panels and switches so lighting can be monitored and controls can be accessed</td><td></td></tr>
<tr><td>Check how lights are being used</td><td>PROCEDURES
° Turn off lights not being used
° Use task lighting in place of area lighting where possible</td><td></td></tr>
</table>

Importance Of Data Collection & Use

The data must be complete and accurate because it will be used for analysis and goal setting. Consider the following when collecting energy use data:

- Determine appropriate level of detail — the level and scope of data collection will vary from school to school. Some may choose to collect data from sub meters on individual processes while others may only look at a utility bill.
- Account for all energy sources — inventory all energy purchased and generated on-site (electricity, gas, steam, waste fuels) in physical units (kWh, mMBtu, Mcf, lbs of steam, etc.) and on a cost basis.
- Document all energy uses — for the sources identified above, assemble energy bills, meter readings, and other use data.

Energy data may reside in the accounting department, be held centrally or at each facility, or can be acquired by contacting the appropriate utilities or energy service providers. Gather at least two years of monthly data or a more frequent interval if available. Use the most recent data available.

" Figure 5- Students Making Presentations on School Energy Use
Source – "School Energy Audit"

Collect facility and operational data — To be able to normalize and benchmark, it may be necessary to collect non-energy related data for all facilities and operations, such as building size, operating hours, etc.

Another important factor to consider is the use of energy data collected and the awareness generated on the associated operations and maintenance programs. It is vital that the school administrations, staff and students are educated on both the programs and the data collected.

Schools have effectively used outreach strategies including periodic program newsletters, school board presentations, and websites. Data collected can also be displayed in posters across the school buildings in staff rooms, corridors, libraries and labs. Regular updates through short presentations on energy use to staff and students during morning assembly are also an effective tool. Examples of outreach strategies are highlighted in figure 5 above and figure 6 below.

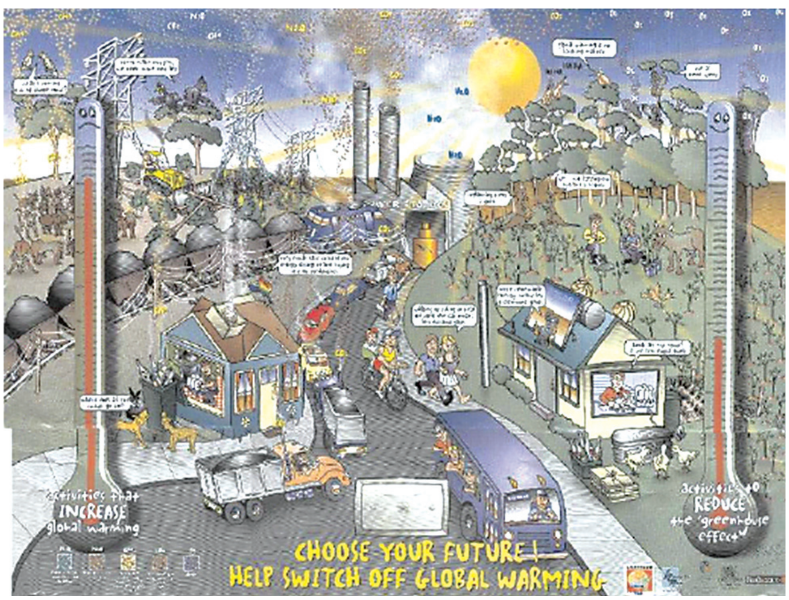


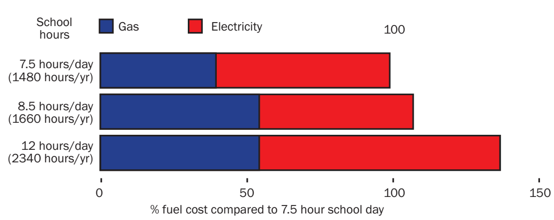
Figure 6 - Example of Poster on Energy Use
Source – "School Energy Audit" - Wetlands Environmental Education Centre
Compiled from resources developed by Observatory Hill EEC

An operations and maintenance program devoid of visibility and effective use of data collected will affect support levels from staff, students and the administration. Regular data use will also ensure that the energy use practices carried out match the mission goals outlined at the offset of the program.

Identifying
Energy Saving Opportunities

Identifying Energy saving opportunities is a key step of an energy management program, the opportunities should be identified in the following steps, the first and foremost focus should be to address all maintenance issues, the next is to focus on exploring appropriate changes in the operations, third should be to look at system improvements, part and whole and the fourth and the last focus should be to evaluate replacement options. This flow of evaluation also aligns with the low and no-cost measures first and then looks at capital investment.

Energy management in school facilities varies from other regular commercial buildings due to factors like funding, operation hours, limited infrastructure, etc. For example figure 7 below indicates the effect of extended school operation hours on fuel costs.



" Figure 7 - The effect of extended hours on fuel costs Source – "Energy Savings in Schools

Schools should look at their individual systems based on the type of facilities they manage and the services they offer to identify areas for maximum savings.

A UK guidebook on schools suggests the following generic distribution of energy costs across systems –

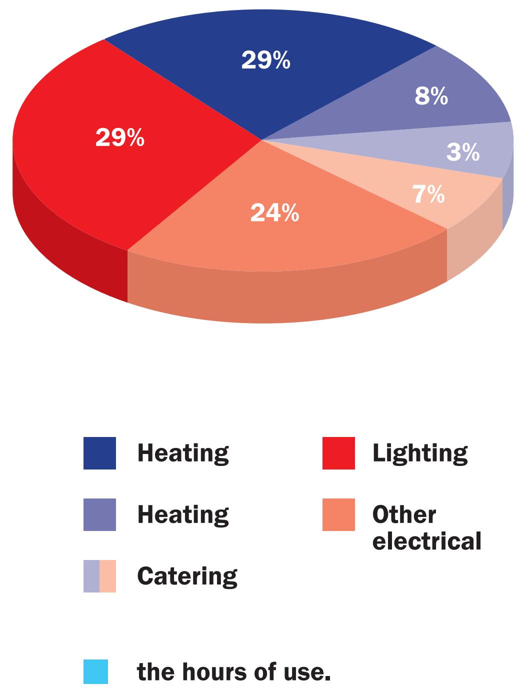


Figure 8- Typical distribution of energy costs : blue tints – fossil fuels, red tints – electricity (1992 figures adjusted to reflect 1997 figures Source – "Energy Savings in Schools"

Figure 8 above indicates the higher potential for savings in areas like lighting and heating due to the associated higher costs.

Lighting

The lighting system is the most visible energy user in the building accounting for nearly 50% of the electric bill at times. Savings from lighting efficiency are some of the most rewarding to achieve because most are easy to make and cost little or nothing.

Identifying Savings Opportunities within your Lighting Systems

The main lighting systems at a school consist of classroom and office lighting, external security lighting, gym lighting, and, exit and emergency lighting. Begin your lighting improvement project by determining how much light is really needed in the various areas of the school and its surroundings. Areas where people are walking as opposed to seated or working require very different lighting levels, but all too often are lit to the same high levels.

Do a walk-through of the facility looking at the existing lighting in each area and the area's lighting needs. It's a good idea to use a light meter (lighting suppliers often lend them). You can then compare your present lighting levels to recommended levels for the tasks being performed.

RECOMMENDED LIGHTING LEVELS FOR SCHOOLS

AREA	FOOTCANDLES	TYPE OF LIGHTING
Classrooms-general	50-75	Fluorescent
Classrooms-art	50-75	Fluorescent
Classrooms-computer	50-75	Fluorescent (indirect)
Classrooms-drafting	75-100	Fluorescent
Classrooms-sewing 7	5-100	Fluorescent (task lighting)
Labs-general	50-75	Fluorescent
Labs-demonstrations	100-150	Fluorescent (task lighting)
Auditorium seating areas	10-15	Fluorescent
Auditorium concerts on stage	50-75	Fluorescent
Kitchens	50-75	Fluorescent
Cashiers	20-30	Fluorescent (task lighting)
Dishwashing areas	20-30	Fluorescent
Dining areas	10-20	Fluorescent
Corridors & stairwells-elem	10-15	Fluorescent
Corridors & stairwells-middle	20-30	Fluorescent
Corridors & stairwells-high	20-30	Fluorescent
Gymnasiums	20-30	Metal Halide/Fluorescent
Media centers	50-75	Fluorescent
Offices	75-100	Fluorescent
Teacher workrooms	30-50	Fluorescent
Conference rooms	30-50	Fluorescent
Washrooms	20-30	Fluorescent
Building exteriors/parking lots	1-2	Sodium/Metal Halide

As you walk through the school building, also note the type of lighting present. One of the keys to improved lighting efficiency is using the most efficient light source to produce light. Incandescent bulbs are least efficient and have the shortest lives, but have the advantage of low first cost, good color rendition and easy installation. Fluorescents are popular in general because they are 4 to 5 times more efficient and have 10 times the life expectancy of incandescent.

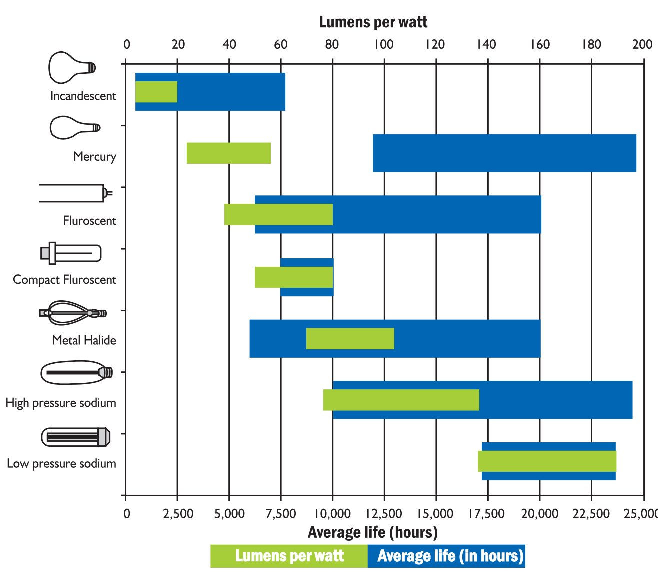
High Intensity Discharge (HID) lamps, which were once used almost exclusively outdoors because of their poor color rendition, are more and more being brought indoors in color-corrected versions due to their extremely high efficiency and long life.

First, Do Things That are Free

- Remove unnecessary lamps. Because a number of schools were designed and built in an era when energy efficiency was not a high priority, lighting levels often are higher than necessary. But be careful. If you remove lamps near windows, make sure there will still be enough light on overcast days or at night.

- Make sure lights are turned off when an area is unoccupied. For the most part in schools, that means getting staff and students on-board with the program.

- Use switch plate covers reminding people to turn lights off when leaving an area. In public places, staff and students



are hesitant to turn lights off without "permission," so signage is important. Wind-up timers, time clocks and occupancy sensors can help get lights off when they are not needed.

- Keep the fixtures clean to be sure you are getting all the light for which you are paying. Cleaning fixtures and reflectors can compensate for reduced light levels from de-lamping.

- Consider group re-lamping, which means changing all the lamps at once rather than as they burn out. Light output from lamps decreases as they age, so replacing them in a group assures you get full light output, and the practice can reduce the maintenance costs associated with lamp replacement by half.

Low -Cost and Low - Investment Projects

After doing the no-cost projects, consider modifying the lighting system. Many projects require only a small investment. Before investing, calculate the payback period and, for large expense projects, consider life cycle costs to see if the project will be a good investment. And, try an improvement in a small area before committing to major changes.

A. Retrofitting signs is one of the quickest payback projects in many schools. The idea of replacing conventional signs with energy-efficient compact fluorescent ones has been widely promoted over the past ten years. Instead of incandescent light bulbs that last a few months, compact fluorescent exit signs require only about 12 watts and generally last two years in continuous use.

Converting to LED signs has become more popular. The light emitting diode, or LED meets electrical code requirements in most applications, uses minimal amounts of electricity and lasts up to 50 years. LED's are winners for cost savings and avoiding the inconvenience of replacing lamps.

S. N.	Cost Description	LED Lights	Incandescent Bulbs
1.	Lifespan	60,000 Hr.	800 Hr.
2.	Number of bulbs used in 60,000 hours	1	75
3.	Cost	INR 1000.0	INR 10.0
4.	Power dissipation	4 Watt	20 Watt
5.	Power savings per year*	140.0 kWh	-
6.	Lifetime power savings	960.0 kWh	-
7.	Cost saving per year	INR 490.0	-
8.	Lifetime cost saving	INR 3360.0	-
7.	Payback period	2-years	-

** With one bulb in use for 24 hours and 365 days in a year. The power cost is INR 3.50/kWh.*

B. Retrofitting Corridor Fixtures if applicable are also a quick payback project in schools. Attractive fixtures that house compact fluorescent lamps with color rendition similar to that of an incandescent are available. In most cases, no one will notice the difference.

C. Installation of more Efficient Lamps is one of the most effective ways to make lighting more energy efficient. Here are some of the best examples:

Replace Incandescent Lights with Compact Fluorescents

The standard incandescent light bulb may seem inexpensive, but it is not a bargain. Not only is it extremely inefficient, less than 10%, it also has a very short life, which means it must be replaced frequently. One of the great advances in lighting technology is the compact fluorescent lamp. Developed as a replacement for the common incandescent light bulb, the super energy efficient compact fluorescent is a spiral or miniature U-shaped fluorescent tube and ballast. Screw-in or pin holder compact fluorescents fit many of the fixtures where you previously used incandescent light bulbs.

This makes it possible to replace an incandescent (15 lumens/watt, 800 hours life) with a more efficient and long lasting fluorescent lamp (70 lumens/watt, 6000 hours life).

Consider that you can replace a 60-watt incandescent with a 15 watt compact fluorescent that will last 10 times as long and will deliver about the same amount of light for one quarter the energy. Compact fluorescents are more expensive than incandescent, but they will more than pay for themselves with savings in electricity, lamp replacement and labor costs. Payback is quickest when they are installed in fixtures that are used for many hours each day.

Compact fluorescents are available in a wide variety of styles to suit most lighting needs, with reflectors and extenders that can make them fit and work well in many fixture types.

They come either as one-piece screwing units that include the ballast or as modular units where the tube can be separated from the ballast when the lamp burns out. The compact fluorescent tubes have lifetimes of 10,000 hours, while the ballasts last 4 or 5 times that long.

Compact fluorescents can be used outdoors when they are protected by an enclosure. However, they have some cold limitations. For instance, they are dimmer for a short time when they start, until they get up to their operating temperature and may not start at all when it is very cold. Using an enclosed light fixture helps. Ask your supplier which would be the best option for your outside needs.

Fluorescent Ceiling Lights

Since some lighting systems in schools are fluorescent, let's look at what can be done to improve their efficiency. There are four primary options –

1) Install lower wattage or more efficient lamps - When selecting new, more efficient fluorescent lamps, make sure they are compatible with the existing ballasts, although it may be cost-effective to replace the ballast as well. While some of the replacement lamps may yield slightly less light, this may be acceptable since in many areas you may have more light than you need. Furthermore, when clean new lamps are installed, and the diffuser and reflecting surfaces of the fixture are cleaned, there may be an increase in light output even with lower wattage.

2) Replace the ballasts - Replacing existing magnetic ballasts is often one of the most cost effective energy improvements. For instance, installing an electronic ballast can reduce the energy consumption of a fixture with two 34-watt lamps from about 74 watts to about 59 watts, a 20% drop, with no reduction in light output.

3) Replace the fixtures - Fixture retrofits can involve changing out the ballast, replacing yellowed or hazy lenses, diffusers, and globes with new ones that will remain brighter and transmit more light, and installing reflectors that "bounce" more light out of the fixtures. New lenses and reflectors may enable you to use fewer or lower wattage lamps and still achieve acceptable lighting levels.

4) Rewiring or installing more efficient controls can be an effective investment, with a fast return.

D. Educate and Motivate Staff and Students.

Invariably, there are lights, computers, and other electronic equipment left on by staff and students who forget to shut down their workspace. Both security and cleaning staff in addition to teachers and students can play an integral role in energy management by assisting in overall savings.

Form a student energy patrol to ensure lights are out when rooms are empty (check classrooms, the cafeteria, the auditorium, etc.). Encourage all staff members to turn off lights through signage and other modes of communication.

E. Some Other Tips

Control Outdoor Lighting. Some schools have lights that are left on all the time for code compliance or to meet safety and security needs. While meeting code requirements, use only lighting necessary to do the job. It is recommended that the outside lighting should also be fitted with timers. Different timing should be set for summer and winter months. The alternative lights can be switched off after 11.30 pm. It is also recommended to create zones of every third lamp, and have each zone turn on 30 minutes apart, and turn off 30 minutes apart, instead of all at once.

Rewiring. If your present switches don't give you enough control to turn off unneeded lights, you should consider rewiring and installing additional switches or dimmers.

Occupancy sensors. In public areas where staff and students forget to turn lights off, an occupancy sensor may be the answer. These easy-to-install motion detecting devices turn lights on and off automatically in a space such as a restroom, storage area or stockroom. A sensor can be mounted on the wall where a light switch would normally go or can be installed in the ceiling or high on a wall. Occupancy sensors are activated when they detect motion, heat or both. Energy savings from sensors is greater the more hours the lights are off and the more watts controlled by the sensor. Savings from 20% to 40% are possible and even greater savings are possible when spaces are infrequently used. Consider installing occupancy sensors in the following:

staff rooms, conference rooms, student locker rooms, restrooms, stockrooms, and storage areas. While providing the sensors in toilets it is important to note that WC areas should be kept out of the circuit to avoid inconvenience to the guests.

Use Task Lighting. Install desk lamps for close work at office desks and staff room desks. This type of task lighting puts light where it is needed, when it is needed, and may permit ceiling lighting levels to be lowered.

Use Day lighting. Day lighting is the practice of using free light from the sun during the day to supplement or even eliminate purchased light. Taking advantage of day lighting may require installation of blinds or shades to control heat gain and glare. Combining this with rewiring and installation of switches will enable you to save money by turning off lights when they are not needed.

Cooling

Save on energy costs without sacrificing comfort. It's expensive to heat and cool school buildings, but indoor temperatures must be comfortable so teachers can concentrate on teaching and kids can concentrate on learning. Using fans can make people feel degrees cooler, at much less cost than air conditioning. (Adapted from the Alliance to Save Energy tips for schools)

Schools in India primarily use fans, split air conditioners (ACs), and/or window units to cool their buildings.

USING FANS

Fans produce a cooling effect by moving air over the skin. Although they do not reduce actual room temperatures or humidity levels, fans can often provide an adequate level of comfort and provide the cheapest method of cooling. In winter (if applicable), ceiling fans redistribute the warm air that collects near the ceiling to the lower part of the space for comfort.

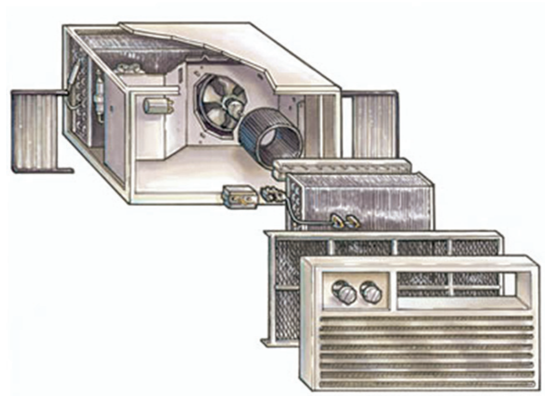
Use the "Fans" checklists provided in this guidebook (can be found in the section "Conducting Energy Assessments") during your walk-through of the facility to garner tips on efficient use of the system.

Ceiling Fan

USING WINDOW UNITS AND/OR SPLIT AIR CONDITIONERS (ACs)

Window units and split ACs comprise options provided under the realm of domestic refrigerative air conditioners. Here the compressor is located separately to a cooling head that is usually mounted on a wall or ceiling inside the building. The compressor can be in a less obtrusive outside location, provides for quieter operation and is connected to the cooling head by insulated pipes.

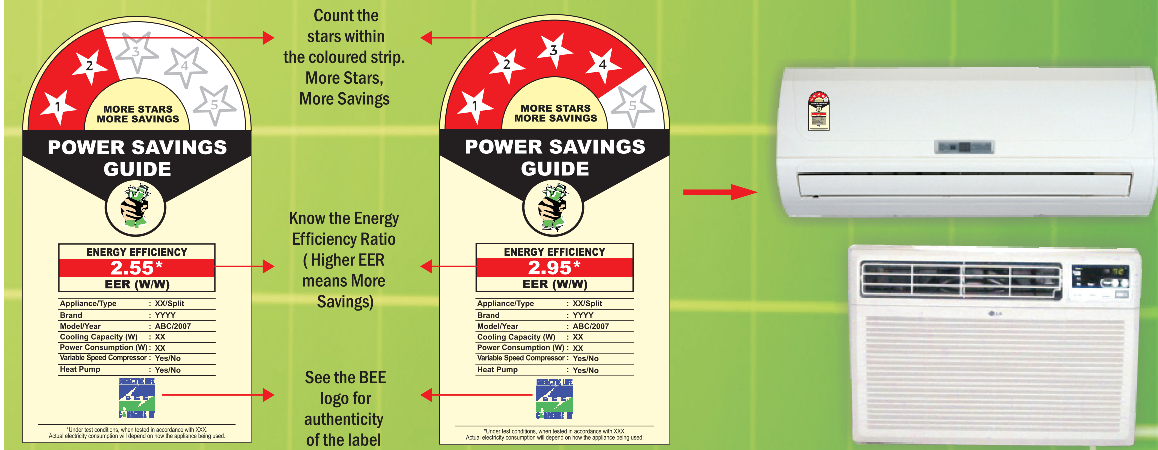
Refrigerative air conditioners are sized in kW according to the rate at which they can transfer heat. This rating of an air conditioner's cooling ability is usually 2 to 2.5 times the electrical power required for their operation. The correct size of an air conditioning system depends on many factors including: building construction, level of insulation, shading of windows, room size, number of people in the room and their activity and the presence of other heat generating sources such as computers and lights. A north-facing General Purpose Classroom measuring 7.2 m x 7.2 m with 25 students and three computers would require about 9 kW of cooling. It should be noted however that the largest domestic type air conditioner available is rated at about 7.5 kW. (Adapted from "Guide to School Cooling – Resources for School Energy Managers")



Window AC

When buying an air-conditioner (window or split unit), always buy BEE labeled air conditioners having rating between 3 to 5 stars. Use the table given in the picture in the following page to choose the AC unit for your school.

Labels For ACs



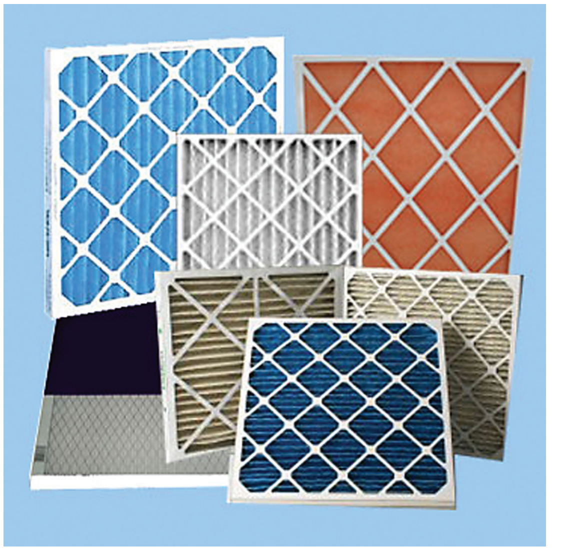
Energy and Cost saving for 4500 KCal/Hrs Windows Air conditioner at different Star Rating

Star Rating	Maximum Cooling Capacity (Watts)	Minimum Energy Efficiency Ratio (EER)	Input Power (Watts)	Units consumption /Day (kWh) (approx.)	Per Unit Charge (Rs.) (approx.)	Total Cost per month (Rs.)	Total Saving (w.r.t No star) Every year (Rs.)
No Star	5200	2.20	2364	18.91	4.00	2269	0
1 (One)	5200	2.30	2261	18.09	4.00	2170	987
2 (Two)	5200	2.50	2080	16.64	4.00	1997	2723
3 (Three)	5200	2.70	1926	15.41	4.00	1849	4202
4 (Four)	5200	2.90	1793	14.34	4.00	1721	5477
5 (Five)	5200	3.10	1677	13.42	4.00	1610	6588

A. Keep System Off During Unoccupied Times. The best time to save money in an area of the school is when no one is there. All too often energy is being wasted heating or cooling the air when nobody is there. Making matters more complicated, your occupancy hours are different for the various parts of the school building, like when there is a program in the auditorium. Temperature can only be controlled for individual areas when there are separate heating or cooling units, zones, or thermostats.

B. Replace/Clean Filters & Coils. It's one of the simplest of the conservation measures, and it's often overlooked. Take time to check that there are filters in place and see that coils and filters are cleaned and changed regularly. Filters and coils are the two most critical elements in any cooling system depending on whether they utilize window units, split air conditioners and/or HVAC systems. They are where the mechanical system interacts most directly with the environment it is trying to impact. It does not take much dirt and dust to degrade thermal transfer across the coils, and as filters get dirtier, air delivery to spaces and fan energy required to deliver air will suffer. Very aggressive cleaning schedules for coils and filters are always a part of the maintenance regime for buildings. It is very common to observe dirty filters and coils even when maintenance staff reports an aggressive approach. Often, teams will rely on pressure drop alarms in the BAS system to signal the need for filter cleaning. Our experience in the field indicates that this is not a proactive approach associated with capturing available low-cost savings.

Ensure that the school has regular maintenance schedules for their cooling systems and for cleaning of coils and filters. It is recommended that the coils and filters be cleaned very aggressively and on schedule (preferably every month). Close inspection of coils and filters on a periodic basis will be the best initial indication as more aggressive schedules are set. The amount of dirt on the coils and filters



Examples of Filters

can easily be determined by wiping the surface with a finger or clean cloth. As this measure is less popular with maintenance staff, motivation and oversight are required, which might result in a checklist that appoints a responsible staff person to ensure on time completion. Replaceable filters can be cleaned in batches to reduce labor associated with this measure, and pre-filters can be considered depending on local condition. Where coils and filters are difficult to access, it is important to document the process, appoint specific staff who can learn to do the job efficiently, and evolve cleaning techniques that are appropriate to the challenge. For example, if coils and filters are in terminal units above high end conference space, frequent cleaning with a liquid chemical solution may not be feasible compared to brushing, vacuuming, and forcing compressed air through the coils. The goal is to look at current conditions and practices and come up with a reasonable definition of an aggressive, sustainable approach.

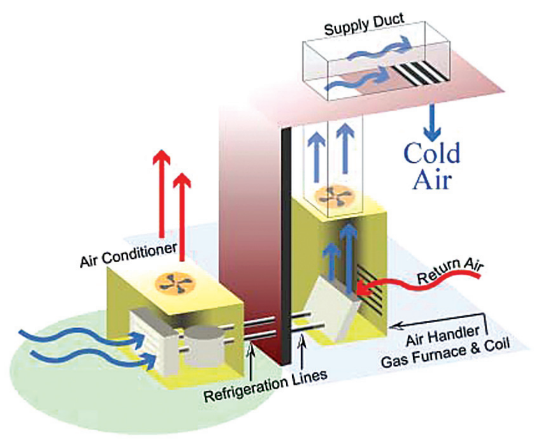
The estimated savings for this measure are difficult to calculate but with past experience it has been observed that this practice can save between 10-20 % of electricity use every year as very clean coils and filters are a fundamental part of excellent HVAC performance and should not be treated as an option to be weighed against others.

C. Adjust Temperature Set Points in the Units. Different sections of the school building have different expectations for interior temperatures associated with seasonal climatic temperature conditions. About 1°C reduction in interior temperature settings during the winter months (October to February) can save as much as 5% in energy costs during these months. By carefully selecting seasonal set points that meet but do not exceed comfort expectations, considerable energy can be saved and guest satisfaction can be maximized.

D. Plan Ahead. People rarely plan for an equipment failure, and when one occurs you will be under pressure to get it up and running right away. This makes it difficult to shop and plan for energy efficient replacements. So, prepare in advance for likely units that may fail, particularly in student areas, and check on the price and availability of efficient units. HVAC systems last a long time, so your school will live with the replacement for many years to come.

Using an HVAC System

Select schools in India have an HVAC system in place for cooling. Depending on usage finding savings of 20% or higher are quite often possible through more efficient operation and maintenance of the HVAC system. Much of the savings will come from simple things you can do yourself like keeping the system off when it is not needed, or operating it less by changing temperature settings. The remainder of the potential savings comes from making the system more efficient.



Use the HVAC checklists provided in this guidebook (can be found in the section "Conducting Energy Assessments") during your walk-through of the facility to garner tips on efficient use of the system. These include –

A. Put Locking Covers on Thermostats if Applicable. Determine a reasonable setting and cover programmed thermostats in public areas with tamper-proof covers or look into replacing them altogether with ones that hold a fixed setting. Make sure to also check the accuracy of thermostats. At a time when your heating or cooling system has the school at a stable temperature, walk through with an accurate thermometer and see if the thermostats are accurately recording the temperature. If the thermostat says it is 21°C and the actual temperature in the space is 23°C, the heating system may be running more than necessary.

B. Inspect and Repair Duct Leaks. In air distribution systems, take a look at the duct system as part of your energy check-up. Over the years, these systems deteriorate and can even get stepped on and damaged by contractors and technicians working in the area. Fix broken joints and other leaks, and be sure they are insulated if they run through unconditioned space.

There are plenty of ways to get your students involved to assist with this –

- Have students determine areas of energy loss by using "draft meters" made from plastic wrap and pencils to study where drafts are coming in.
- Avoid infiltration in conditioned spaces - Have students help replace insulation and stuff energy loss "holes" through innovative measures, such as making translucent window quilts to hang in classrooms and "insulation snakes" to put at the bottom of doors and windows.
- Work with facility staff to install permanent weather stripping, caulking, and insulation.

Building Envelope

Careful consideration should be given to the use of natural and passive methods of cooling. It is more efficient and effective to stop heat entering a building rather than having to remove heat to lower internal temperatures.

While it consumes no energy itself, the school building envelope has a large influence on a major energy consumer, the air-conditioning system. The envelope consists of the buildings outside walls, its roof, windows, doors, and floors. It is the barrier or filter between the inside conditioned space and the outdoors.

When it operates effectively, your buildings will require less energy. From an energy perspective, its purpose is to minimize heat loss and gains. While there are some easy improvements, like fixing broken windows or leaky doors, many building envelope projects require large investments and become difficult to justify on a return on investment basis.

The roof and walls, windows and doors are the most obvious places to look for energy losses. The five critical areas for building envelope energy improvements are:

Infiltration is air leaking through openings or cracks around building components. It is one of the easiest losses to locate and fix.

Poor insulation lets heat leak into or out of the building, primarily through the walls and roof.

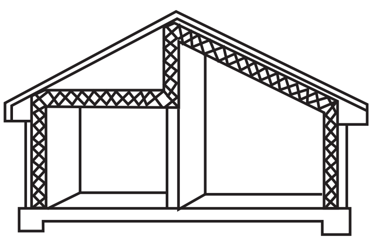
Single pane windows have extremely low resistance to heat loss or gain.

Lack of shading increases solar loads in the summer and increases air conditioning costs.

The HVAC equipment allows losses through piping, ductwork, stacks, dampers and rooftop units.

Here are the most important things you can do to improve the building envelope:

A. Infiltration. Find and seal leaks. This is most easily done on a day when there is a large difference between inside and outside temperature. This can also be done by using fans to create a pressure differential between the indoor and outdoor areas. You should be able to walk around the facility and look for cracks and feel for drafts. Ask employees where they feel drafts. The worst culprits are around windows and door frames, and any area where dissimilar building materials meet, like where a metal door frame meets mortar around brick. Start fixing the largest and easiest to fix leaks. Use high quality caulk to fill small gaps, and use materials like glass fiber insulation to fill larger openings.



Tighten window and door frames and install weather-stripping to reduce air leaks. Replace broken windows, and adjust any automatic door openers/closers to ensure they close quickly and completely. If your facility has window air conditioners, cover them in the off-season and make sure they are sealed tightly in the window frames.

In some instances, a vestibule, where two sets of doors create an air lock, can dramatically reduce air flows related to people entering and leaving the school. They are especially beneficial when there are lots of door openings, particularly in windy locations. Adding a vestibule can be cost prohibitive, but you may be able to create a low-cost version by adding another set of doors inside the external doors.

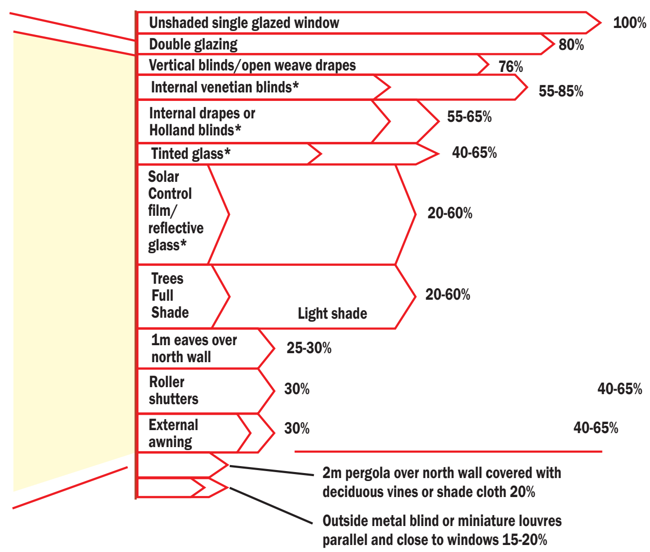
B. Poor insulation. Add insulation to reduce heat flow through the building components. The place to begin is assessing what is there now. If there is none, the most cost-effective place to begin is probably the roof, then the walls and floors. Because these measures often require a large investment, you may want to consult with an energy specialist to run a building simulation and estimate savings.

C. Window Treatment. While they are beautiful to look at, windows are virtually thermal holes in the building envelope. Consider that a wall might have a resistance to heat flow, or R-value, of 19. A single pane window has an R-value of less than 1, almost 20 times less resistance to heat flow!

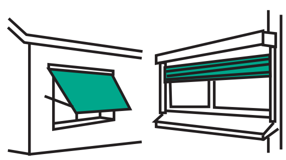
Double panes (R-2) and triple panes (R-3) do improve the situation, they double or triple the window's R-value, but by comparison to even a wall, this is not much of a heat flow barrier. Often the best you can do with windows is covering them with shades or curtains that increase their resistance to heat flow.

Other options include applying reflective films to windows to reduce glare and heat transfer. These films have the disadvantage of reducing natural light and solar heating in cooler months.

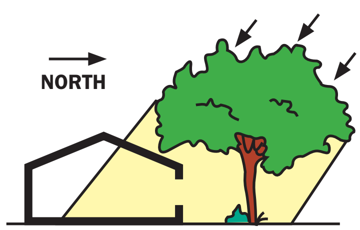
Effectiveness of various window treatments

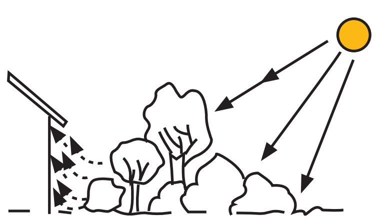


**Effectiveness is reduced as the colour darkens.*



Shading awnings and shutter reduce radiant heat passing through windows





From School Cooling, Ministry of Education (Schools Division) Victoria, 1986. Reproduced with permission of the Department of Education, Employment and Training (DT&T).

D. Shading. Reducing heat gain through windows can reduce cooling costs, but can also increase occupant comfort. Particularly in warm climates, protecting windows from the sun can have a big impact. The first principle of shading is begin as far from the building as practical and move in. That means planting deciduous shade trees or building trellises for vines to create summer shade. Deciduous vegetation is best because it drops its leaves in winter when the extra solar gain is appreciated. Awnings are also an option.

Hot Water

Water heating in schools is needed for public restrooms, janitorial work, cafeteria, locker room showers, and occasionally swimming pools. Schools are now adapting to solar water heater systems to maximize energy savings and reduce dependence on boiler systems. Solar water heater systems have proven to be effective in schools due to their limited hours of operation.

Here are some basic thumb rules to follow during assessing requirements to install a SWHS –

The primary requirement for installation of Solar Water Heating System is a shadow free area with clear access to the South sky.

Total no. of collectors per 1000 liters:

	N. India & Hilly Regions.	Rest of India.
For 60°C	10	8
For 70°C	12	10
For 80°C	15	12

Flat/Roof Area required for installing SWHS
- Each solar collector measuring 2m x 1m requires 3.5 sqm of flat surface inclusive of hot water storage tank and interconnecting piping.

For every **1000 liters of water heated from room temperature (25°C) to 80°C, approximate equivalent energy savings per day** are as follows (Source – "Driving Towards Energy Independence" – TATA BP Solar):

Electricity: 45 Units
Diesel: 5.3 Liters

The table provided below provides a comparison snapshot of savings based on the selected SWHS capacity -

Table1 - Comparison Snapshot of Savings Based on the Selected SWHS Capacity (Source – "Driving Towards Energy Independence" – TATA BP Solar)

Capacity lpd	Total no. of collectors	Area - 800C Sqm	Elec Savings (Units/day)	Savings/Yr (@Rs5/Unit)	Savings/Yr (Diesel)
1000	10	35	45	67,500	52,500
2000	20	70	90	135,000	105,000
3000	30	105	135	202,500	157,500
4000	40	140	180	270,000	210,000
5000	50	175	225	337,500	262,500
6000	60	210	270	405,000	315,000
7000	70	245	315	472,500	367,500
8000	80	280	360	540,000	420,000
9000	90	315	405	607,500	472,500
10000	100	350	450	675,000	525,000
15000	150	525	675	1,012,500	787,500
20000	200	700	900	1,350,000	1,050,000
25000	250	875	1125	1,687,500	1,312,500
30000	300	1050	1350	2,025,000	1,575,000

** Approximated*

Irrespective of the heating system utilized in your school, listed below are some inexpensive and easy measures that can reduce your water heating costs.

B. Reduce Hot Water Use. Install flow restrictors and aerators in sink faucets. Don't install them in areas like janitor's closets where they are used for filling buckets where filling speed is important. Install low-flow showerheads to reduce hot water usage. Some showerheads, particularly older ones, have flow rates of more than 5 gallons per minute, while low-flow models are half that amount. Check the flow rates in the showers by turning on the shower to a normal flow rate and timing how long it takes to fill a gallon bucket. Install self-closing faucets in public restrooms.

C. Reduce Heat Loss. If the tank is warm to the touch, it is losing valuable heat to the surroundings 24 hours a day and needs a tank wrap or blanket. Blankets are inexpensive and easy to install, and are readily available at hardware stores. Also insulate the exposed hot water piping, and repair or replace any existing insulation.

D. Label Faucets. Remind staff, students, and visitors of your conservation effort by posting labels asking them to "Please turn off the water." If continuously running water is a problem, install self-closing faucets where you push down on a lever for 10 to 15 seconds of water flow. Also, occupancy sensing controls typically consisting of a photo cell and solenoids can be installed above sinks to control water flow.

E. Maintain the System. Fix hot water leaks. Check and adjust the fuel-fired systems to be sure they are burning properly. Have a service technician check it out and clean it once a year. Drain any sediment from the bottom of tank water heaters by letting a little water out until it runs clear. When left to accumulate, the sediment forms a layer of insulation at the bottom of the tank, where with fuel-fired systems; heat transfer is trying to take place.

Integrating Energy Management Into A School's Culture

In addition to improving systems, a successful energy management program needs to be imbibed into the school culture. There is a significant human factor involved in all operations and maintenance programs.

New staff energy management training:
Any new staff member across departments must be introduced to the school's energy management culture. Developing a brief energy management training will help instill energy management as a department-wide value and teach staff how to use energy more efficiently in their respective areas. Reinforcing this orientation training with regular energy management seminars, brochures, or other visibility will ensure that the initial training stays with staff.

Educating new and existing students on importance of energy management:
Motivating students to participate in an energy management program is crucial to the success of any related activity. Student orientation can be conducted for both existing and new students. Existing students can be reached out to through the inclusion of energy savings programs as an extra curricular activity. "Student Patrols" can be formed where higher grade students work with elementary students to patrol school premises and identify areas for energy savings. Developing a brief introduction to the schools' energy management program is also essential for incoming students (depending on their grade level) and their parents.

Tracking and reporting energy consumption to all staff and students: Tracking and recording energy consumption throughout the school building(s) at regular intervals (monthly) can serve as a tool for reinforcing the importance of energy management, since consumption spikes in energy and water use can be more quickly identified and resolved while tracking weekly/monthly use.

Creating a culture of continuous improvement: Make energy efficiency an integral part of your staff and student culture. Encouraging leadership and visibility, tracking energy use and offering incentives will help. These aspects are described in more detail below.

a. Tracking – All efficiency efforts at the staff or student level should be recorded, tracked over time, and evaluated. A transparent data-driven program will allow participants to see their individual and collective impact on energy performance and encourage them to actively participate in charting the impact of their activities.

b. Visibility – A simple method like using a dedicated whiteboard to track daily energy data could be useful. A whiteboard that is centrally located can be used to record energy data and any factors that may influence energy use, as well as strategies to reduce energy consumption.

c. Incentives – The recognition of staff and student commitment to energy efficiency can have a strong impact on participation. The recognition can be formal or informal, ranging from something as simple as offering participants free CFL lights as a reward for reducing energy consumption by a certain percentage, to providing certificates for identifying major energy savings and process improvements.

Calculating
Costs And Payback

Evaluation and calculating costs and payback period form the lifeline for an energy management program. Cost savings are a driving factor behind the longevity and success of the program. Associated savings can be used to improve the program or re-invested within the school for enhancing other services. For example, cost savings are invested in additional facilities for the school. Understanding the payback period also helps school administrative authorities assess the viability of the measures to be implemented. Please note that the payback option is primarily used as a basic calculation for each measure implemented. Determining cost effectiveness of large investments over time would require a life cycle cost or monthly flow calculations.

There are many ways associated with calculating costs and payback period. This guidebook focuses on the **"simple payback"** method, which is one of the least complicated ways to evaluate the value.

Simple Payback Method

The following calculation method and calculator has been adapted from the energy management guide "Managing Energy in Your Hotel". The calculator can be modified to include variables specific to your school.

The simple payback method involves calculating the simple payback by dividing the cost of the improvement by the annual energy savings. The result is the number of years to payback the investment from the energy savings.

This method comprises of a basic calculation and is utilized primarily for low investment measures. It doesn't take into account the time value of money, energy cost changes, tax effects if any, nor the expected life of the equipment. Please note that to make the ratio as accurate as possible, remember to subtract any rebates from the initial cost of the measure and deduct any required operating costs from the annual energy savings.

$$\textbf{Simple Payback} = \frac{\text{Cost of Measure (minus any rebates)}}{\text{Annual Energy Savings (minus any operating expenses)}}$$

Example: If installing a time clock costs INR 2,000 and saves INR 4,000 annually on energy costs, it has a 0.5 years or 6 months payback.

$$\textbf{Payback} = \frac{\text{INR 2,000}}{\text{INR 4,000/year}} = \frac{1}{2} \text{ years}$$

ELECTRIC ENERGY IMPROVEMENT PAYBACK CALCULATOR

Cost For Implementing Measures

Cost of Materials INR ________________________ ,

Cost of Labor INR ________________________ ,

Cost of Training INR ________________________ ,

Total Cost of Energy Saving Measures INR ________________________ **(A)**

Electric Usage Savings

Complete the following calculations for each measure determine your total Rupee savings and compute your payback.

Details	Old	New
(B) Watts		
(C) Hours/day		
(D) Watt-Hours/day (Multiply B & C)		
(E) Days/year		
(F) Watt-Hours/year (Multiply D & E)		
(G) Total Kilo-watt-hour (kWh)/year (F/1000)		
(H) Annual kWh Savings [(G – Old) – (G – New)]		

Annual Electricity Cost Savings

Annual kWh Savings INR ________________________ **(H)**

Times Electricity Cost/kWh x INR ________________________

Total Energy Savings INR ________________________ **(I)**

Less any incremental O & M Costs INR ________________________ **(J)**

Total Savings INR ________________________ **(K)**

Simple Payback In Years

$$\text{Simple Payback} = \frac{\text{Total Cost of Energy Saving Measure}}{\text{Total Savings}}$$

Energy-Efficiency

Measures List

An energy efficiency checklist is provided below as a template that can be modified and used by your school. This is included to provide a quick overview of measures that you can consider for the various systems in your school.

1.0 Envelope

- Reduce Heat Losses-Ceiling/roof
  - Better Ceiling/Roof Insulation
  - Use Light-Colored Roof Surfaces
- Reduce Heat Losses-Walls/floors
- Use Light Colored Exterior Surfaces
- Thermal Mass/Passive Solar Heating
- Reduce Heat Losses-Windows/Doors
  - Install Additional Glazing Layer
  - Use Special Coatings or Gases
    - Heat mirror
    - low-e coatings
    - Argon gas window fill
- Reduce Heat Gain--Windows/Doors
  - Install Exterior Shading
  - Install Interior Shading
  - Use Tinted or Reflective Coatings or Films
  - Optimize Window Sizing and Orientation
- Reduce Infiltration
  - Caulk and Weather strip Doors and Windows
  - Install Air-Lock Vestibule System or Revolving Doors

2.0 Lighting

- Reduce Lighting Required
  - Utilize Task Lighting
  - Lighting Controls
    - Selective switching
    - Programmable timing control
    - Occupancy sensors
    - Energy management system
  - Use Light-Colored Interior Wall Finishes
- Install More Energy-Efficient Lighting System
  - Use High-Efficiency Fixtures
    - HID fixtures in selected locations
    - Efficient exit signs
    - Self-ballasted compact fluorescents
  - Use Efficient Exterior Fixtures
    - High-pressure sodium HID fixtures
    - Metal halide fixtures
  - Use High-Efficiency Ballast
    - Electromagnetic
- Use Day lighting
  - Install Dimming Controls
  - Architectural Modifications

3.0 HVAC Systems

- Air Distribution Systems
  - Reduce Energy Losses
    - Increase duct insulation
    - Install air-to-air heat recovery
    - Runaround loop heat recovery
    - Reduce System Flow Rates
    - Airflow and fan speed reduction

    - VAV system to reduce fan energy use
    - Variable speed drive motor for VAV
  - o Reduce System Resistance
    - High-efficiency filters
    - Improve design and balance of duct system
  - o Reduce Ventilation Loads
    - Reduce ventilation rate to minimum
    - Install local ventilation and makeup air hoods
  - o Air Destratification
    - Enclosed high-velocity fan
    - Open propeller fans
    - Ductwork system with centrifugal or vane axial fans

3.1 Water Distribution

- Reduce System Flow Rates
  - o Primary/secondary pumping with variable speed motors
  - o Isolate off-line equipment in parallel piping circuits
  - o Time control or interlocks on circulating pumps
- Reduce System Resistance
  - o Install booster pumps

3.2 Cooling Plant

- Select More Efficient Cooling System
  - o Use evaporative cooling
  - o Use cooling tower instead of air-cooled system
- Improve Cooling Efficiency
  - o Optimize chiller efficiency with temperature controls
  - o Use multiple chillers and optimization controls
  - o Increase chilled water design temperature
  - o Optimize cooling tower flow controls
- Increase Condensing Efficiency
  - o Lower condenser water design temperature
  - o Reset controls on water temperature
  - o Tube-brush cleaning system
  - o Chemical washing system
- Improve Part-Load Performance
  - o Select chillers based on Integrated Part Load Value (IPLV)

4.0 Water Heating

- Reduce Water Heating Loads
  - o Use solar water heating system
- Reduce System Losses
  - o Increase Insulation on Hot Water Pipes
  - o Increase Insulation on Water Storage Tanks

5.0 Power Systems

- Reduce Power System Losses
  - o Correct Power Factors
  - o Install Energy-Efficient Transformers
- Install Energy-Efficient Motors
  - o High-Efficiency Motors
  - o Variable Speed Motors
  - o Optimize Motor Sizing

6.0 Refrigerators

- Improve efficiency
  - o Buy BEE labeled energy efficient refrigerators

Glossary

Air Handling Unit (AHU):

Equipment that distributes conditioned air.

Ambient Temperature:

Outside air temperature.

Ballast:

A device used with fluorescent and other types of gaseous discharge lamps to aid starting and limit current flow and to provide voltage control at proper design levels. Can be magnetic or electronic.

British Thermal Unit (BTU):

Equal to the amount of heat energy necessary to raise the temperature of one pound of water one degree Fahrenheit. One Btu is about equal to the amount of heat given off by a wooden match.

Building Envelope:

The elements of a building which enclose conditioned spaces through which thermal energy may be transferred to or from the exterior.

Caulking:

A flexible material used to seal up cracks or spaces in a structure.

Coefficient Of Utilization:

The ratio of lumens on a work plane to lumens emitted by lamps.

Comfort Zone:

Average: The range of effective temperatures over which the majority (50 percent or more) of adults feel comfortable. Extreme: The range of effective temperatures over which one or more adults feel comfortable.

Conversion Factors:

1 Watt = 3.413 Btu/hr
1 kW = 3,413 Btu/hr
746 Watts = 1 HP (Motor)
1 Gal. Oil = 140,000 Btu
1 Lb. Coal = 12,500 Btu
1 Therm of Natural Gas = 100,000 Btu
1 Cu. ft. of Natural Gas = 1,000 Btu
1 Cu. ft. of Propane Gas = 2,500 Btu
1 Lb. of Propane Gas = 21,500 Btu
1 Ton refrigeration = 12,000 Btu/1 hr

Degree Day:

The degree day value for any given day is the difference between 65°F and the mean daily temperature. Example: for a mean daily temperature of 50°F, the degree days are 65 minus 50 or 15 degree days.

Energy Audit:

Any survey of a building, business or complex that reviews energy-using equipment or behavior.

Energy Conservation Measure (Ecm):

A permanent change made to a conditioned building after completion of operation and maintenance measures which will result in energy savings.

Energy Efficiency Ratio (EER):

The ratio of net cooling capacity in Btu/hr to total rate of electric input in watts under designated operating conditions.

Foot Candles (FC):

Energy of light at a distance of 1 ft. from a standard (sperm oil) candle.

Glazing:

Another term for glass in windows.

Horsepower (HP):

British unit of power, 1 HP = 746 W or 42.408 Btu per minute.

Insulation:

A material used to minimize heat losses from a given space.

Kilowatt Hour (Kwh):

A unit of energy equal to that expended by one kilowatt in one hour = 3,414 site Btus and 11,600 source Btus.

Infiltration:

The process by which outdoor air leaks into a building by natural forces through cracks around doors and windows, etc. (usually undesirable). Usually caused by the pressure effects of wind and/or the effect of differences in the indoor and outdoor air density.

Lumen:

Unit of light energy or output (luminous flux).

Makeup Air:

Outdoor air that is brought into a building to compensate for air removed by exhaust fans or other methods.

Multizone System:

An HVAC system that heats and cools several zones each with different load requirements from a single, central unit. A thermostat in each zone controls dampers at the unit that mix the hot and cold air to meet the varying load requirements of the zone involved.

Photo Cell:

A device sensitive to light which is now commonly used to turn on and off the lights at dusk and dawn.

Pneumatic:

Operated by air pressure.

Power:

Power is the time rate of doing work. In connection with the

transmission of energy of all types, power refers to the rate at which

energy is transmitted. In customary units it is measured in watts (W),

British Thermal Units per hour (Btu/hr), or Horsepower (HP).

Refrigeration, Ton Of:

Equivalent to the removal of heat at a rate of 200 Btu per minute, 12,000 Btu/hour, or 288,000 Btu/day.

Resistance (R-Value):

Term used to measure insulation material resistance to the flow of heat in units of square feet per hour.

Retrofit:

The improvement of existing buildings to make them more energy efficient.

Setback:

Reducing the level of heat required from the conditioning system to the lowest practical point especially during periods where the room activities or occupation allows.

Simple Payback (SPB):

Time required for an investment to pay for itself. The cost of the retrofit measure divided by the annual energy cost savings in Rs/year.

Single Zone System:

An HVAC system that supplies one level of heating or cooling to a zone or area controlled by one thermostat. The system may be installed within or remote from the space it serves, either with or without air distribution ductwork.

Thermal Barrier:

A strip of nonconducting material, such as wood, vinyl, or foam rubber, separating the inside and outside surfaces to stop conduction of heat or cold to the outside.

Ventilation:

The process of supplying or removing air, by natural or mechanical means to or from any place. Such air may or may not have been conditioned.

Weatherstripping:

Metal, plastic or felt strips designed to seal between windows and door frames to prevent air infiltration.

Zone:

A space or group of spaces within a building with heating and/or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device.

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