SCHOOLS MANUAL FOR THE SOLAR AND ENERGY EFFICIENCY IN QUEENSLAND STATE SCHOOLS PROGRAM

QUEENSLAND STATE SCHOOLS

Prepared for Education Queensland

If all financially viable energy efficiency initiatives were implemented in EQ schools, energy use could reduce by nearly 35%.

ENERGY EFFICIENCY IN QUEENSLAND

OVERVIEW:

This manual was written to assist Education Queensland in the implementation and operation of the Solar and Energy Efficiency for Queensland State Schools Program. It aims to identify a lighting efficiency strategy for Queensland State Schools and classify energy saving initiatives that could be undertaken cost effectively at the school. The document will provide lighting initiatives and retrofit options aimed at achieving energy savings along with the identification of other technological and behavior related energy savings initiatives.

Furthermore, it was identified that there was a need to provide appropriate policies and procedures which are integral to the success of the energy efficiency initiatives in schools through;

- Education and communication of appropriate benchmarking information across the schools to allow rigorous comparisons to other similar schools,
- Providing schools with a suitable energy benchmark point to move forward from.
- Providing schools with the ability to manage their energy and environmental reporting demands.

To achieve the project goal of improving the energy efficiency in State Schools, several electrical services within schools were investigated including; lighting, air conditioning and electrical appliances.

Based on the outcomes of these investigations, several opportunities were identified which would improve energy efficiency, consequently reducing electricity costs.

As identified by EnSight, there are six technological and behaviour change opportunities for energy efficiency in schools; lighting, computers, air conditioning, water heating, refrigeration and standby power. Improved practices can also reduce energy use, particularly in relation to computers and electric urns.

KEY FINDINGS:

In order to obtain a comprehensive understanding of the energy breakdown of State Schools across Queensland, energy assessments were conducted in 10 State Schools. These schools differ in size and composition however three main themes emerged;

1.Primary Schools in South East Queensland consume the least amount of energy.
2.High Schools in South East Queensland consume significantly more energy than primary schools.
3.Cool Schools consume significant more, than non-cool schools.

C O N T E N T S

ENERGY SAVINGS INITIATIVES

OVERVIEW:

In order to obtain a comprehensive understanding of the energy breakdown of State Schools across Queensland, energy assessments have been conducted in 10 Queensland State Schools.

Four main schools energy use categories were identified including;

1.Non air conditioned Primary Schools
2.Air conditioned Primary Schools
3.Non air conditioned High Schools
4.Air conditioned High Schools

Furthermore, six main energy services within schools were identified as having potential energy savings including;

1.Lighting
2.Computers
3.Air Conditioning & Ventilation
4.Water Heating
5.Refrigeration & Water Cooling
6.Standby Power

Many energy saving initiatives exist for schools and can be categorised into technical improvements and practice based improvements. Technical improvements require the installation or improvement of an existing energy service by a qualified professional, whereas practice improvements can be undertaken by students, teachers and staff.

The following pages present these technical and practice based improvements for each of the 6 main energy services.

Page 9 offers some suggestions on how the provided improvements may be implemented in a school.

FLOURESCENT LIGHTING

AIR CONDITIONING

COMPUTERS

WATER HEATING

REFRIGERATION

ENERGY SERVICE - SCHOOL LIGHTING

LIGHTING ENERGY SYSTEMS	
Description	**Lighting Energy Service**
Potential Lighting Energy Savings (as a percentage of total school energy use)	8.1 %

LIGHTING MYTH:

Myth: It takes more energy to start up a fluorescent light than it does to keep it running.

Fact: This myth refers to the older technology fluorescent fittings. With modern technology lamps, this is no longer an issue - one hour turned off is an hour of energy saved.

OVERVIEW:

Four main lighting types were found in Queensland State Schools including;

1.Fluorescent tube lighting - consisting of a fluorescent lamp with a diffuser to spread the light. Diffusers can be plastic or metal.

2.Incandescent or Compact Fluorescent Lighting (CFL's).

3.Surface Mounted/suspended High Bay –identified by their metal fittings and often found in gymnasiums and auditoriums.

4.Outdoor or other use lighting including, exterior security lighting and amenities lighting.

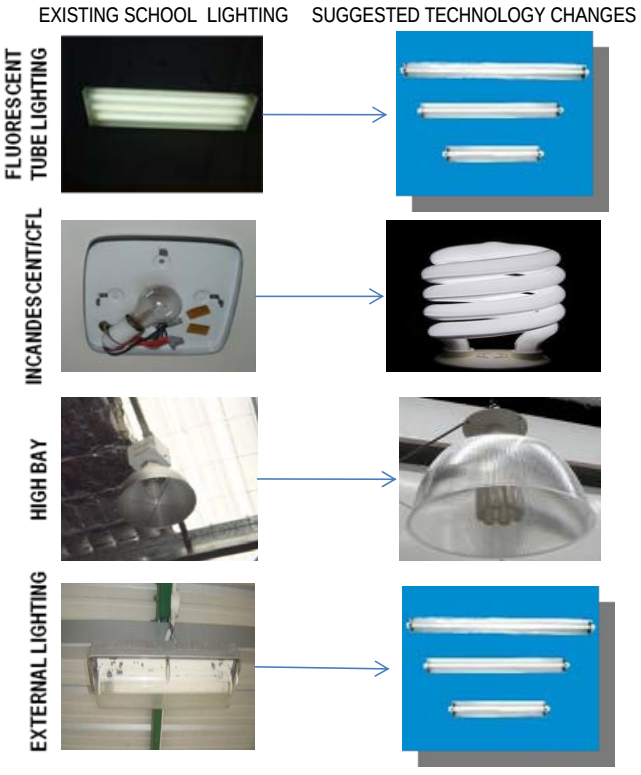
ENERGY SAVINGS INITIATIVES:

TECHNOLOGY CHANGES:

1. Replace T12 (40 watt) or T8 (36 watt) fluorescent lamp fittings with an efficient T5 (28 watt) – providing an energy saving of 30% or 22% respectively.
2. Replace incandescent light bulbs with CFL alternative;

Inefficient Incandescent Bulb	Efficient CFL Replacement	Percent of Energy Saved
25 Watts	7 Watts	72%
40 Watts	8-10 Watts	78%
60 Watts	11-13 Watts	80%
75 Watts	15-16 Watts	79%
100 Watts	18-20 Watts	81%
150 Watts	28 Watts	81%

3. Replace existing Mercury Vapour Metal Halides (400 watts) with an efficient CFL replacement lamp (215 watts) – providing an energy saving of 46%.
4. Replace existing security, amenities or outdoor fluorescent T8 (18 watts) tubes with efficient T5 retrofit (12 watts).



ENERGY SAVINGS INITIATIVES:

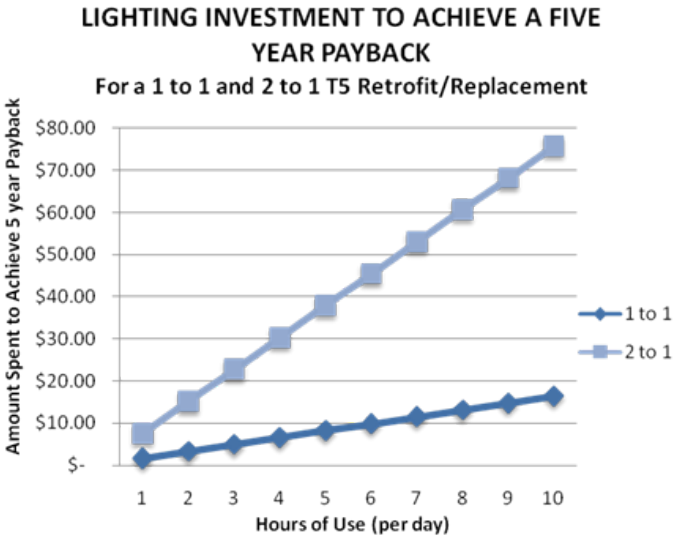
PRACTICE CHANGES:

- Turning off lights during times when the room is not occupied.

CLASSROOM GLA LIGHTING PRACTICES		
Behavioural Energy Savings Possibility	**Energy Saving per light (kWh/yr)**	**GHG Savings per light (kg/yr)**
Turning off lighting in GLA over morning tea and lunch breaks.	19.8	20.6
Note: These values assume a double T8 light fitting.		

LIGHTING INVESTMENT TO ACHIEVE A 5 YEAR PAYBACK:

The graph below illustrates the feasible amount of money that can be spent on lamps in a classroom to provide a 5 year payback, determined by the number of hours the lights are used a day.



ENERGY SERVICES - COMPUTERS

ENERGY SYSTEMS - COMPUTERS	
Description	**Computer Energy Service**
Potential Computer Energy Savings (as a percentage of total school energy use)	9.4%

COMPUTER MYTH:

Myth: Completely turning off a computer every day reduces its life by damaging the hard drive.

Fact: Old computers were not made to be turned on and off constantly, however new computers (within the last 15 years) are designed to be turned off whilst not in use.

OVERVIEW:

Personal computers were determined to consist of two main types;
1.Computer tower with a Cathode-Ray Tube (CRT) monitor.
2.Computer tower with a Liquid Crystal Display (LCD) monitor.

There are two main types of computer power and operational management in schools consisting of;
1.User controlled systems – where staff or students are responsible for turning computers on and off.
2.Automated network systems – such as the Azurus system, which automatically turns pc's on and off at the beginning and end of each day.

Personal computers were located in the Library, administration areas, classrooms and computer labs, where the operation of the computers differed in relation to the service area.

- ***Library Computers:*** were on from 8am – 4pm Monday to Friday and shutdown at all other times. Correspondence with Librarians revealed that they were responsible for shutting down all computers at the end of each day, which was common practice across all schools.
- ***Administration Computers:*** were subject to the operational variability of administration staff, as there was no clear policy or practice to turn off pc's. It was discovered that approximately 30% were left on after school hours.
- ***Active classrooms:*** operational times were governed by demand and teachers operating behaviour.
- ***Computer labs:*** the use of the computers was governed by class timetables and teachers operational behaviour. They were used on average 75% of the week, where around 70% of the pc's were in use at a given time and approximately 30% were shut-down by conscious students. Otherwise, pc's were generally left running while labs were unoccupied. I.T staff advised that lab pc's can be remotely shut down, however logging data showed that this was not a consistent practice with the majority of labs having computers left on overnight. This can be expected as the I.T staff are required to manually shut down computers.

Computer	Power Consumption	Standby Power Consumption
Tower	70 Watts	3.0 Watts
CRT	40-60 Watts	1.0 Watts
LCD	30 Watts	0.5 Watts

COMPUTER TOWER WITH CRT MONITOR

COMPUTER TOWER WITH LCD MONITOR

ENERGY SAVINGS INITIATIVES:

PRACTICES CHANGES:

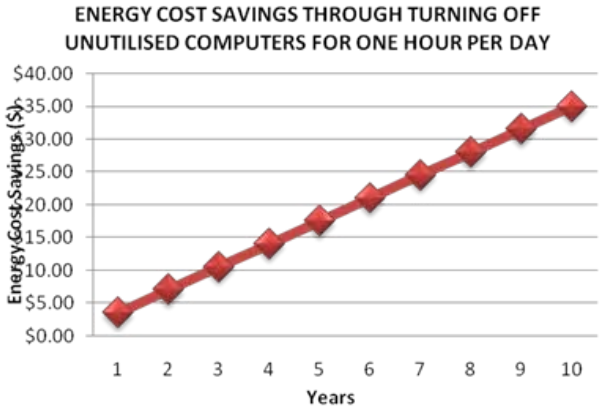
1. Educate students and staff to shutdown computer towers and switch monitors off when not in use.
2. Educate and provide access to allow switching of all computers off at the power point after hours and on holidays to avoid the 3 watt off-mode standby power draw – a computer room with 24 computers which are all turned off (but not unplugged at the wall) consumes 72 watts.

COMPUTER PRACTICE CHANGES		
Behavioural Energy Savings Possibility	**Energy Saving per computer (kWh/yr)**	**GHG Savings per computer (kg/yr)**
Turn off an unutilised computer for one hour every day.	22.8	25.6

Simply multiply the number of computers in your classroom by the above values to calculate the energy and greenhouse gas savings.

ENERGY COST SAVINGS – COMPUTERS

The graph below illustrates the cumulative energy cost savings over 10 years when an utilised computer is turned off for one hour every day.



ENERGY SERVICES – AIR CONDITIONING & VENTILATION

AIR CONDITIONING ENERGY SYSTEMS

Description	Air Conditioning Energy Service
Potential Air Conditioning Energy Savings (as a percentage of total school energy use)	4.4%

AIR CONDITIONING MYTH:

Myth: Air conditioning should be used as soon as the temperature becomes uncomfortable.

Fact: Fans are a good way to decrease temperature initially in a room as they circulate the air and air movement within a room makes the ambient temperature feel 2-3^{o}C cooler.

OVERVIEW:

Air conditioning systems consist of 4 main types including;
1.Thru-wall or thru-window systems – individual room air conditioners which can be cooling or reverse cycle systems to heat and cool a space.
2.Split systems – Consist of a 'head' component inside the room and an external compressor system to circulate the air. They can be cooling or reverse cycle systems to heat and cool a space.
3.Evaporative Coolers – systems which use cool water to refrigerate the air. A large fan is used to blow air over damp filters which are connected to the plumbing.
4.In ceiling ducted air conditioning – systems which have an external component and a ducted ceiling component to cool large spaces.

ENERGY SAVINGS INITIATIVES:

TECHNOLOGY CHANGES:

1. Where feasible, install 2 hour timer switches on air conditioners.
2. When installing new air conditioning systems (or at a time when an old air conditioner fails) it is recommended that heat recovery wheels are installed.
3. When installing external compressor units avoid installation in areas that have direct exposure to the sun, where possible shade or provide shading for these units. Compressors use up to 10 % less energy to cool the air when located in the shade than in direct sunlight.
4. When procuring a new air conditioning system, ensure highly efficient systems are employed by choosing the highest energy star rated appliances (see http://www.energyrating.gov.au/acmenu.html for more information).

EXISTING AIR CONDITIONERS

SPLIT SYSTEM

CEILING CASSETTES

THRU-WINDOW A/C

ENERGY EFFICIENCY INITATIVES

HEAT WHEEL

TIMER SWITCH

SHADED COMPRESSORS

ENERGY SAVINGS INITIATIVES:

6. Where possible, install insulation into roofs and ceilings to minimize heat gain from external surfaces.
7. Ensure that all doors and windows are well sealed to prevent the migration of warm outside air into the air conditioned space.
8. Install room occupancy based controller on all air conditioners.

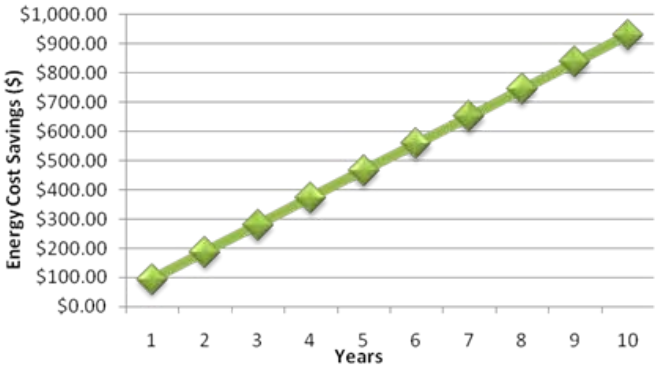
PRACTICE CHANGES:

- Ensure that air conditioners are set to 24^{o}C year round (or the highest temperature it can be in summer and the lowest temperature it can be in winter).
- Ensure that all windows and doors are closed properly before turning on the air conditioning.
- Turn off air conditioners & fans during lunch times and break periods.

AIR CONDITIONING PRACTICE CHANGES

Behavioural Energy Savings Possibility	Energy Saving per Air Conditioner (kWh/yr)	GHG Savings per Air Conditioner (kg/yr)
Turn off air conditioners during morning tea and lunch breaks.	600	630

ENERGY COST SAVINGS THROUGH BEHAVIOURAL CHANGES IN PER AIR CONDITIONER



ENERGY SERVICES – WATER HEATING

WATER HEATING ENERGY SYSTEMS

Description	Water Heating Energy Service
Potential Water Heating Energy Savings (as a percentage of total school energy use)	1.3%

WATER HEATING MYTH:

Myth: Hot water is needed for disinfection and hygiene purposes throughout the school.

Fact: The temperature of water delivered to a tap is 40-50ºC, however the temperature required for disinfection and hygiene purposes is 77ºC.

OVERVIEW:

Two forms of hot water systems were present in schools;
1.Electric storage: an insulated tank of water is kept at a preset temperature (typically 60-80°C) by one or more electric resistance elements. These come on when the tank temperature drops below the thermostat set point or in accordance with off-peak timing settings, as occurs when hot water is drawn off and replaced by cold water, or heat is lost by conduction through the tank walls and the pipe connections.
2.Electric Instantaneous Boiler: an electric element heats the incoming cold water as required, with storage capacities of 1.5, 3, 5, 7.5 and 15 litres.

Hot water in primary schools and secondary schools must have water delivery temperatures set to 45°C or below to reduce the risk of scolding (excluding kitchen sinks and laundry tubs often found in Home Economics buildings). Contrary to conventional attitudes, hot water does not provide disinfection when used at these temperatures. One of the main issues is that low quality detergents are not very effective with cold water. However, if quality detergents are used, cleaning with cold water is as effective as hot water cleaning.

ENERGY SAVINGS INITIATIVES:

TECHNOLOGY CHANGES:

1. Implement a smart plug in power point timer set to turn Zip boilers on at 7am and turn off at 4pm so hot water is only produced when it is needed.

2. Implement DIN Rail digital timer on the switchboard to necessary water heaters, set to turn the water heater on 6am Monday morning and turn it off Friday afternoon at 4pm for electric storage water heaters.

3. Implement flow restrictors on taps and showers which service hot water. This limits the amount of water being required and consequently, the amount of water required to be heated.

EXISTING HOT WATER SYSTEMS

RHEEM 50L WATER HEATING

5L ELECTRIC INSTANTANEOUS BOILER

ENERGY SAVINGS INITIATIVES

PLUG IN POWERPOINT TIMER

DIN RAIL TIMER

ENERGY SAVINGS INITIATIVES:

PRACTICE CHANGES:

- Ensure dishwashers & washing machines are not used until completely full.

- Disconnect unused/unnecessary electric storage water heaters (i.e. those not in use for hygiene purposes such as in general purpose classrooms).

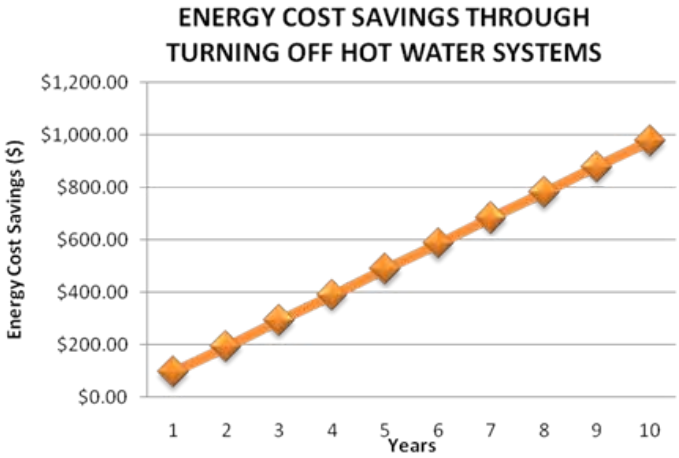
- Ensure that electric storage and electric instantaneous boilers remain off during holiday periods.

WATER HEATING PRACTICE CHANGES

Behavioural Energy Savings Possibility	Energy Saving per Water Heater (kWh/yr)	GHG Savings per Water Heater (kg/yr)
Turn off existing unused/unnecessary hot water systems in schools.	630	665

ENERGY COST SAVINGS – WATER HEATING

The graph below illustrates the cumulative energy cost savings over 10 years for one unused/unnecessary hot water system when switched off.



ENERGY SERVICES - REFRIGERATION

REFRIGERATION ENERGY SYSTEMS	
Description	**Refrigeration Energy Service**
Potential Refrigeration Energy Savings (as a percentage of total school energy use)	25%

REFRIGERATION MYTH:

Myth: Turning off a fridge over the weekend will damage its motor.

Fact: Motors are developed to be turned off on an intermittent basis with substantial energy savings accruing to refrigerators which are switched off over weekends.

OVERVIEW:

Refrigerators varied in size from 40L bar fridges to 4m x 4m cold rooms. It was observed that in many instances the refrigerators were substantially underutilised and the technology used by all of the devices could be substantially improved. The operation of refrigerators was subject to the staff responsible for the appliance. Four main forms of refrigeration were found in Queensland State Schools including;

1.Fridges: consisting of;
•Bar Fridge – 40L, 50L, 110L and 140L
•Fridges – 182L, 390L and 450L
•Display Fridge – one or two door display fridge
2.Freezers: consisting of;
•Chest Freezer – 800L
•Upright Freezer – 310L, 360L and 390L
3.Fridge-Freezer Combinations: consisted of a 300L upright fridge freezer
4.Cold Rooms; 4 x 4m cold room

There were many fridges and freezers used throughout the schools inefficiently, where they only contained small amounts of food items. This identified an opportunity to reduce their number by emptying any unused/unnecessary fridges .

ENERGY SAVINGS INITIATIVES:

TECHNOLOGY CHANGES:

1. Purchase 6 star rated refrigerators when replacing appliances.
2. Install split compressor systems for display fridges and cold rooms so that the units rejected heat is not expelled into the extended working environment.
3. Install a rack compressor system sharing a common manifold of refrigerant gas to supply all display fridges in the cold room as one system.
4. Install digital controls in cold rooms and refrigerator systems.

EXISTING REFRIGERATORS

2 DOOR DISPLAY FRIDGE

BAR FRIDGE

CHEST FREEZER

FRIDGE-FREEZER

ENERGY SAVINGS INITIATIVES:

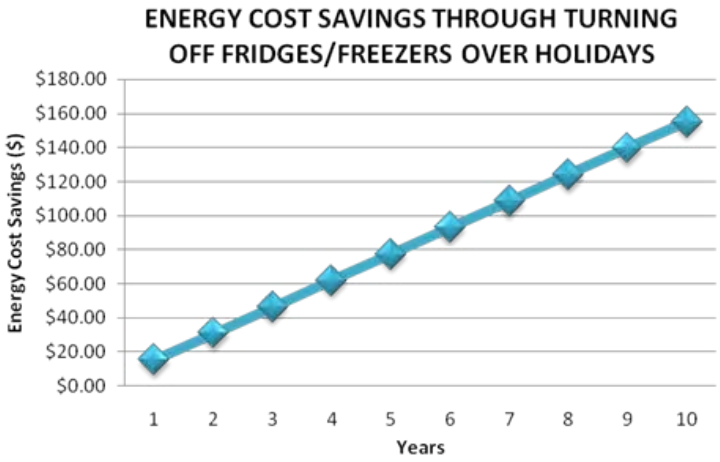
PRACTICE CHANGES:

- Empty (and if required relocate all food stuffs to single fridge/freezer) and turn off appliances during holiday periods.
- Ensure that chest freezers do not have a build up of ice. Ice is an insulator and thus, a buildup of ice requires more energy to cool the items.
- Disconnect the mullein door heaters if they are used as display fridges.

REFRIGERATION PRACTICE CHANGES		
Behavioural Energy Savings Possibility	**Energy Saving per fridge/freezer (kWh/yr)**	**GHG Savings per fridge/freezer (kg/yr)**
Turning off fridges/freezers over the holiday period.	100	105

ENERGY COST SAVINGS – REFRIGERATION

The graph below illustrates the cumulative energy cost savings over 10 years for fridge/freezer when they are turned off over the holiday periods.



ENERGY SERVICES – STANDBY POWER

STANDBY ENERGY SYSTEMS	
Description	**Standby Energy Service**
Potential Standby Energy Savings (as a percentage of total school energy use)	0.2%

STANDBY MYTH:

Myth: Standby power use is very low and leaving items on leads to insignificant energy use.

Fact: There are large quantities of items within schools which have standby power draw. Combined, the unnecessary energy use amounts to an average of 2,000kWh/yr which is $300.00 or 2,095kg of CO_2.

OVERVIEW:

Standby power refers to the electric power consumed by electronic appliances while they are switched off or in a standby mode. Some such devices offer remote controls (e.g. digital data projectors) and digital clock features to the user (e.g. digital microwaves), while other devices, such as power adapters for laptop computers and other electronic devices, consume power without offering any features.

Items with standby draw present within schools include;
- Large printers & copiers
- Small USB printers
- Digital microwaves
- Stereo's
- PA systems
- Digital Data Projectors
- and other miscellaneous standby items including fax machines, DVD's. TV's, VCR's, scanners, and paper shredders.

LARGE PRINTER/COPIER

SMALL USB PRINTER

DIGITAL MICROWAVE

STEREO SYSTEMS

TV/VCR/DVD

DATA PROJECTOR

PAPER SHREDDER

FAX MACHINE

FLAT BED SCANNER

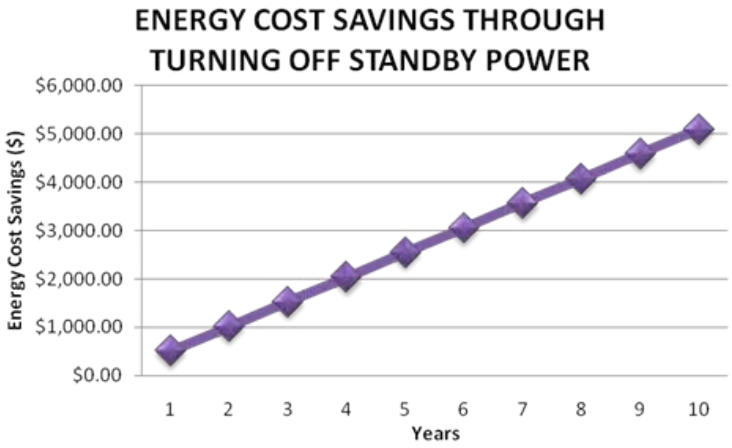
ENERGY SAVINGS INITIATIVES:

PRACTICE CHANGES:

STANDBY PRACTICES CHANGES		
Behavioural Energy Savings Possibility	**Energy Saving per Item Unit (kWh/yr)**	**GHG Savings per Item Unit (kg/yr)**
Turn off large copiers and printers after hours.	1,390	1,456
Turn off small USB printers after hours.	725	759
Unplug digital microwaves when not in use.	185	194
Turn off stereo & PA systems when not in use.	481	503
Turn off other standby power when not in use.	503	527

ENERGY COST SAVINGS – STANDBY POWER

The graph below illustrates the cumulative energy cost savings over 10 years for turning off items with standby power draw.



IMPLEMENTING INITIATIVES

OVERVIEW:

This section offers some suggestions on how each of the provided improvements may be implemented within a school.

LIGHTING:

Technology Changes:

Any changes of fluorescent tubes, incandescent bulbs, metal halide lamps or security, amenity or outdoor lighting can be performed by the school janitor or maintenance staff.

Practice Changes:

Turning off lights – Students could be empowered with the responsibility to turn lights off at recess and lunch and incentives given to those who best achieve this practice. In-class energy display meters could be used to compare the daily lighting and weekly energy use with the ambition to reduce energy use to as low as possible.

COMPUTERS:

Practice Changes:

Students could be empowered with the responsibility to turn computers off when they finish using them and when the computers will be inactive for an extended period of time, e.g. recess & lunch. At the end of each day and before weekends and holidays, students could be empowered with the responsibility to switch all computers off at the power point to avoid standby power draw. In-class energy display meters could be used to compare the daily and weekly computer energy use with the ambition to reduce energy use to as low as possible.

AIR CONDITIONING & VENTILATION:

Technology Changes:

Where technical air conditioning improvements are sought, qualified professionals should be engaged. However, the school should request that the air conditioning experts comply with the recommended air conditioning changes as shown on page 5. The janitor or maintenance staff could install weather stripping on all relevant doors and windows to prevent the migration of warm outside air into rooms. They could also construct a shading structure to shade compressors that are subject to direct sunlight to improve air conditioner efficiency.

Practice Changes:

Students could be empowered with the responsibility to turn air conditioners off at recess and lunch and incentives given to those who best achieve this practice. In-class energy display meters could be used to compare the daily and weekly air conditioning and ventilation energy use with the ambition to reduce energy use to as low as possible. This process would include ensuring all windows and doors are shut when air conditioners are in use and that air conditioner thermostats are as high as comfort permits.

WATER HEATING:

Technology Changes:

Install smart 7-day plug timers on all Zip Boilers and Urns to ensure that unnecessary water heating doesn't occur. Staff would need to be aware of the maintenance requirements for such timers as their internal clocks can alter, which jeopardises their effectiveness and leads to them being overwritten or removed. A professional plumber can install flow restrictors on appropriate taps and showers to reduce hot water use if not already completed.

An electrician could be engaged to install a 7-day DIN rail timer on hot water systems to eliminate unnecessary water heating. Staff would need to be familiar with the requirements to adjust these timers in the case that their internal clocks are altered.

Practice Changes:

Engage a qualified electrician to disconnect any unused/unnecessary water heaters. Ensure that the water is emptied from these systems and water flow is disconnected.

Where possible, switch hot water systems off at the meter box during holiday periods and empty the water from these systems to avoid stagnation.

REFRIGERATION & WATER COOLERS:

Technology Changes:

A procurement policy could be initiated in the school that ensures that high star rated appliances are sourced when new refrigeration units are purchased. Where technical refrigeration improvements are sought qualified professionals should be engaged. However, the school should request that the refrigeration experts comply with the recommended refrigeration changes as shown on page 7.

Practice Changes:

Students and staff could be empowered with the responsibility to empty and turn off fridges and freezers (and if required relocate all food stuffs to a single fridge/freezer) during holiday periods. When refrigeration units frost up, staff could be empowered with the responsibility to thaw them. An appropriate technician should be engaged to disconnect mullein door heaters .

STANDBY POWER:

Practice Changes:

Staff and students could be empowered with the responsibility to fully turn off/unplug the following items after hours or when they are not in use:

- Large printers & copiers
- Small USB printers
- Digital microwaves
- Stereo's
- PA systems
- Digital Data Projectors
- and other miscellaneous standby items including fax machines, DVD's. TV's, VCR's, scanners, and paper shredders.

ENERGY SAVERS:

Energy efficiency within schools can have two benefits:

1. Reduce energy use and curb greenhouse gas emissions,
2. Instil an energy conscious culture within the future generations of the country.

A means to achieve the second of these two benefits could be enlisting in the Energy Wise Program which recruits students to keep a watchful eye on energy use within the school and switch off appliances when they are not needed. This could be done at the classroom level or the school level. At the classroom level, recruited students could turn off lights, computers, air conditioners, fans and appliances with standby at recess and lunch and before the end of the day. At the school level, students could be recruited to scan the school on a Friday afternoon and on the last day before holidays to turn off all computers, Zip Boilers, Urns, appliances with standby power and other energy consuming items that are not required to be on during these times. This may also include switching all fridges and freezers off prior to holidays and moving any food stuffs to a central fridge to be returned at the beginning of the term.