wattwize
www.wattwize.ca

TEACHER Guide

A PROGRAM BY

eco spark
Formerly Citizens' Environment Watch

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Wattwize: Teacher Guide

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The 2010-2011 Wattwize Program and You

The *Wattwize:* Teacher Guide is designed to accompany EcoSpark's *Wattwize* program and should be used in conjunction with **www.ecospark.ca/wattwize**. This guide includes contextual information, instructions, suggestions, and the handouts you will need for a successful electricity conservation project. For elementary classes, alternate versions of the handouts are available at **www.ecospark.ca/wattwize** - as are editable copies.

The *Wattwize* program runs in the Greater Toronto Area (GTA) – Durham, Peel, Toronto, and York regions. It is designed to foster student experiential learning and create tangible results in electricity conservation. The program provides continual support for students and teachers who are committed to reducing their school's electricity consumption.
The FREE program for participating GTA schools consists of:

- An EcoSpark-facilitated introductory in-class workshop
- Student-facilitated electricity audits (using energy meters – 3 provided by EcoSpark)
- An EcoSpark-facilitated Electricity Conservation Plan Creation Workshop for EcoTeams and Environment Clubs
- Teacher- and student-facilitated electricity conservation plan creation
- Teacher- and student-facilitated conservation plan implementation
- Continual remote support available from EcoSpark for implementing schools
- The chance to submit conservation plans and results into the Conservation Champions competition to win monetary prizes to help your school's conservation efforts

Schools not in the GTA can participate too!

Although EcoSpark is unable to facilitate workshops at your school, schools outside of the GTA can still use this teacher guide to run an electricity conservation unit with their class, or program with their EcoTeam or Environment Club. Just follow the steps in this guide! EcoSpark also has a presentation that you can use in place of the EcoSpark-facilitated introductory workshop. You can find this at **www.ecospark.ca/wattwize**. You can also submit your electricity conservation plan to the Conservation Champions contest to win a monetary prize!

If you are a teacher within the GTA and would like to participate in the whole Wattwize program contact EcoSpark:
E-mail: wattwize@ecospark.ca
Tel: 647-258-3280

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Welcome to *Wattwize*

Wattwize is an experiential learning program which helps students develop skills and knowledge about electricity conservation. The program is designed to be student-led with the teacher and EcoSpark staff playing an advisory role. Whenever possible students are encouraged to take the lead and show initiative.

You'll accomplish real results with *Wattwize*

Full completion of the program will result in real world changes:

- Reducing electricity consumption and thus the GHG emissions of your school
- Reducing electricity consumption and thus the non-emissions environmental impacts of your school
- Reducing the electricity consumption in students' homes
- Reducing the electricity bill of your school

Wattwize is a simple **6 step** process:

STEP 1: Introductory Workshops
Led by EcoSpark staff (if at a GTA school) or by a teacher through EcoSpark-created presentations, the workshops outline the current situation of electricity production in Ontario, the need for conservation, and how to conduct an electricity audit.

STEP 2: School Electricity Audit
In this student-led activity, students use energy meters and EcoSpark electricity audit worksheets to map and measure the electricity consumption of their school.

STEP 3: Conservation Plan Creation
Facilitated by EcoSpark (if group is a GTA EcoTeam) or by the teacher, students discuss ways that they can reduce electricity consumption at their school; then create an electricity conservation plan.

STEP 4: Conservation Plan Implementation
Students implement their plan at their school.

STEP 5: Measure and Reflect on Your Success
Students calculate their plan's impact; discuss any external factors that would have influenced electricity consumption; and think of improvements and ways forward.

STEP 6: Conservation Champions Submission
Students submit their results or electricity conservation plan for the chance to win a monetary prize to put towards future conservation efforts.

Wattwize and the Ontario Curriculum

The Ontario curriculum is conducive for integrating ecological literacy into most courses. At EcoSpark we recommend (but do not limit) *Wattwize* for the following courses:

Grade 5 **Science and Technology**
Conservation of Energy and Resources

Grade 6 **Science and Technology**
Electricity and Electrical Devices

Grade 9 **Geography** (CGC1D / CGC1P)
Human-Environment Interactions

Grade 9 **Science** (SNC1D / SNC1P)
Physics: The Characteristics of Electricity / Electrical Applications

Grade 11 **Environmental Science** (SVN3M / SVN3E)
Conservation of Energy

Grade 11 **Physics** (SPH3U)
Energy and Society

Grade 12 **Physics** (SPH4C)
Electricity and Magnetism

Grade 12 **Environment and Resource Management** (CGR4M / CGR4E)
Human-Environment Interactions

For a list of course expectations that can be met through the *Wattwize* program visit: www.ecospark.ca/wattwize.

NOTE: For elementary school classes and EcoTeams, the handouts in this guide might be too advanced. Therefore, elementary versions are available at www.ecospark.ca/wattwize. The program should be facilitated in the same manner, however.

Wattwize and the EcoSchools Program

The EcoSchools program has an optional annual certification program for elementary and secondary schools committed to ecological literacy and environmental action. It encourages schools to work within six areas:

1. Leadership and Teamwork
2. Energy Conservation
3. School Ground Greening
4. Waste Minimization
5. Ecological Literacy
6. Environmental Stewardship

The *Wattwize* program is designed to help EcoSchool EcoTeams to excel within the Energy Conservation area of the program. It is for this reason that *Wattwize* facilitates Electricity Conservation Plan Creation Workshops and regular follow-up with EcoTeams in particular.

ONTARIO ecoschools

Handy Background Information for Teachers

The information within this section is important background information to provide you with context for your electricity conservation project. Some of the information will also be presented in the *Wattwize* Introductory Workshops, and is included in the available online presentation (dependent upon grade). Much of the information in this section might also supply ideas for potential student research projects or preceding discussions.

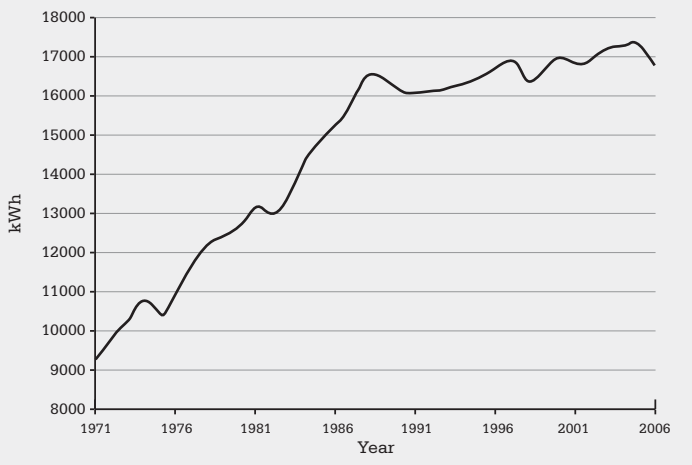
Canadian and Global Energy Consumption

Canada uses a lot of **energy**. The country used 8,475 peta-joules in 2005 in homes, cars, businesses, farms, schools, etc.[1] Not many countries consume more energy per person than Canada (SEE BOX 1).

GRAPH 1 illustrates how this energy is used between the various sectors. Schools fall within the Commercial/ Institutional sector – a sector responsible for 14% of Canada's energy use. Within this sector elementary and secondary schools use 11% of the energy (114,789,224 GJ).[2] This means that schools are a significant energy user.

The energy sources that schools mainly use are: **electricity** and **natural gas**. Canada produces a lot of electricity. In fact, Canada ranks 6th in the world in terms of electricity production – producing 628,083 gigawatt-hours in 2005.[3] Canada also consumes relatively more *per person* – that is, Canadians over-consume. Canadians consumed 16,753.07 kilowatt hours per person in 2006.[4] Only Iceland, Norway, and Finland use more per person.

GRAPH 2: Electricity Consumption (per capita) in Canada 1971-2006 (kWh)



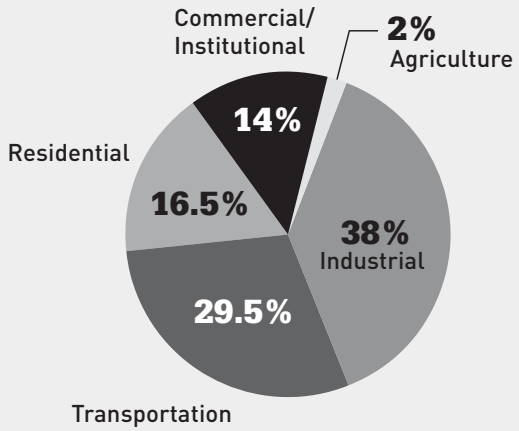
World Bank (2009)

BOX 1: Global Electricity Comparisons

Students can compare different countries' total energy and electricity use per capita through an interactive map at: www.ecospark.ca/wattwize

They can also view changes over time of:
* *Energy consumption per capita*
* *Electricity consumption per capita*
by following the links above or visiting:
www.gapminder.org

GRAPH 1: Energy Use by Sector (2005)



Natural Resources Canada (2009)

BOX 2: Measuring Electricity

You'll see various units used to discuss electricity amounts. Here's a quick key to help you:

TWh (terrawatt-hour) = Wh x 10^{12}

GWh (gigawatt-hour) = Wh x 10^{9}

MWh (megawatt-hour) = Wh x 10^{6}

KWh (kilowatt-hour) = Wh x 10^{3}

In *Wattwize* we will only use Wh and kWh.

Electricity Generation and the Environment

Using vast amounts of electricity can have a negative impact on the environment. **How much impact it has on the environment depends upon the electricity generation source.**

When producing electricity we often produce **Greenhouse Gases** (GHGs) by burning **fossil fuels**. GHGs are harmful to humans and the environment, since they contribute to air pollution and climate change. In fact, anthropogenic – human induced – sources of GHGs are the main contributors to **climate change**.

In Canada, GHGs are of a particular concern to many people given that we produce a lot of them. In 2007, Canada released 747,041,000,000 kg of GHGs.[5] Because of this Canada is failing to meet its commitments to the Kyoto Protocol (SEE BOX 3). Electricity conservation is not the only way to reduce Canada's GHGs but it is an important component.

GHG's are not electricity generation's only negative environmental impact. The forms this impact can take depends upon the electricity generation method – or the source. **How we produce electricity makes a difference to the type and level of impact on the environment.**

See TABLE 1 for a brief look at various environmental impacts of electricity production. See BOXES 4, 5, 6 AND 7 for a slightly more in depth look at certain electricity sources' impact on the environment.

BOX 3: Canada and the Kyoto Protocol

The Kyoto Protocol is a binding agreement made in 1997 between industrialized countries (Annex A countries) to reduce greenhouse gases. Participating countries agreed to set binding emission reduction targets, as well as carbon sinks, and other mechanisms to reduce GHGs. These targets amounted to an average of 5% reductions on 1990 levels.

Opposite to commitments made under the Kyoto Protocol, Canada's emissions have risen since 1990. Canada's Kyoto pledge was to reduce emissions to 6% below 1990 levels by 2012. According to 2009 records (using 2007 data) Canada emits 26.2% more than 1990 levels.[5]

To learn more about the Kyoto Protocol visit:
www.davidsuzuki.org/Climate_Change/Kyoto

http://unfccc.int/files/press/backgrounders/application/pdf/fact_sheet_the_kyoto_protocol.pdf

To read the actual Kyoto Protocol visit:
http://unfccc.int/resource/docs/convkp/kpeng.pdf

TABLE 1: Environmental Impacts of Electricity Production

Technology	Renewable?	Environmental Impacts
Nuclear	No	Extraction Process; Waste; Thermal Discharge; High Water Demand
Gas	No	Medium GHG; Extraction Process, Thermal Discharge; Water Demand
Oil	No	High GHG; Extraction Process; Waste; Thermal Discharge; Water Demand
Coal	No	High GHG; Extraction Process; Waste; Thermal Discharge; High Water Demand
Geothermal	Yes	Some Water Impact; Some Waste
Wind	Yes	Bird Injuries and Fatalities; Noise
Hydro	Yes	Water Impact; Large Impact on People/Fish /Animals
Solar PV	Yes	Extraction Process for Manufacturing
Tidal	Yes	Unknown
Wave	Yes	Unknown

For more detailed chart see: http://www.electricity.ca

BOX 4: Focus on Wind

Pro:
1) Electricity production does not produce GHGs
2) Renewable
3) Low impact overall

Con:
1) Intermittent and limited to windy areas
2) Bird injuries and fatalities reported
3) Many people do not like the look of the turbines

For more information check-out:
www.canwea.ca/wind-energy/windfacts_e.php

www.re.pembina.org/docs/web-eng-wind-factsheet.pdf

www.pollutionprobe.org/Reports/renewableenergyprimer.pdf

BOX 5: Focus on Nuclear

Pro:
1) Electricity production does not produce GHGs
2) Non-intermittent

Con:
1) Expensive!
2) Potentially dangerous
3) Fuel intensive
4) Invasive uranium extraction process
5) Disposal of waste is dangerous
6) Large water use and thermal discharge

For more information check-out:
www.davidsuzuki.org/Climate_Change/Energy/Nuclear.asp

www.centreforenergy.com/aboutenergy/nuclear

www.ontariosgreenfuture.ca/myths.pdf

www.cbc.ca/canada/story/2009/08/19/f-nuclear-waste-storage-options.html

BOX 6: Focus on Hydro

Pro:
1) Electricity production does not produce GHGs
2) Renewable
3) Non-intermittent

Con:
1) Large projects can destroy thousands of km^2 of habitat (flooding, sedimentation, mercury contamination)
2) Projects can displace and interfere with local people (eg: James Bay and Three Gorges Dam projects)

Smaller, more local projects can have a lesser environmental and social impact if monitored adequately.

For more information check-out:
www.davidsuzuki.org/Climate_Change/Energy/Renewables/hydropower.asp

http://archives.cbc.ca/society/native_issues/topics/94/

www.pollutionprobe.org/Reports/renewableenergyprimer.pdf

http://re.pembina.org/sources/hydro-power

BOX 7: Focus on Coal

Pro:
1) Non-intermittent
2) Cheap
3) Quick to build

Con:
1) Large quantities of GHG emissions
2) Emits mercury
3) Extraction can be a destructive force
4) Large water use and thermal discharge

For more information check-out:
www.davidsuzuki.org/Climate_Change/Energy/Fossilfuels/coal.asp

http://therealnews.com/t2/index.php?option=com_content&task=view&id=360

www.worldcoal.org/coal-the-environment/coal-use-the-environment/

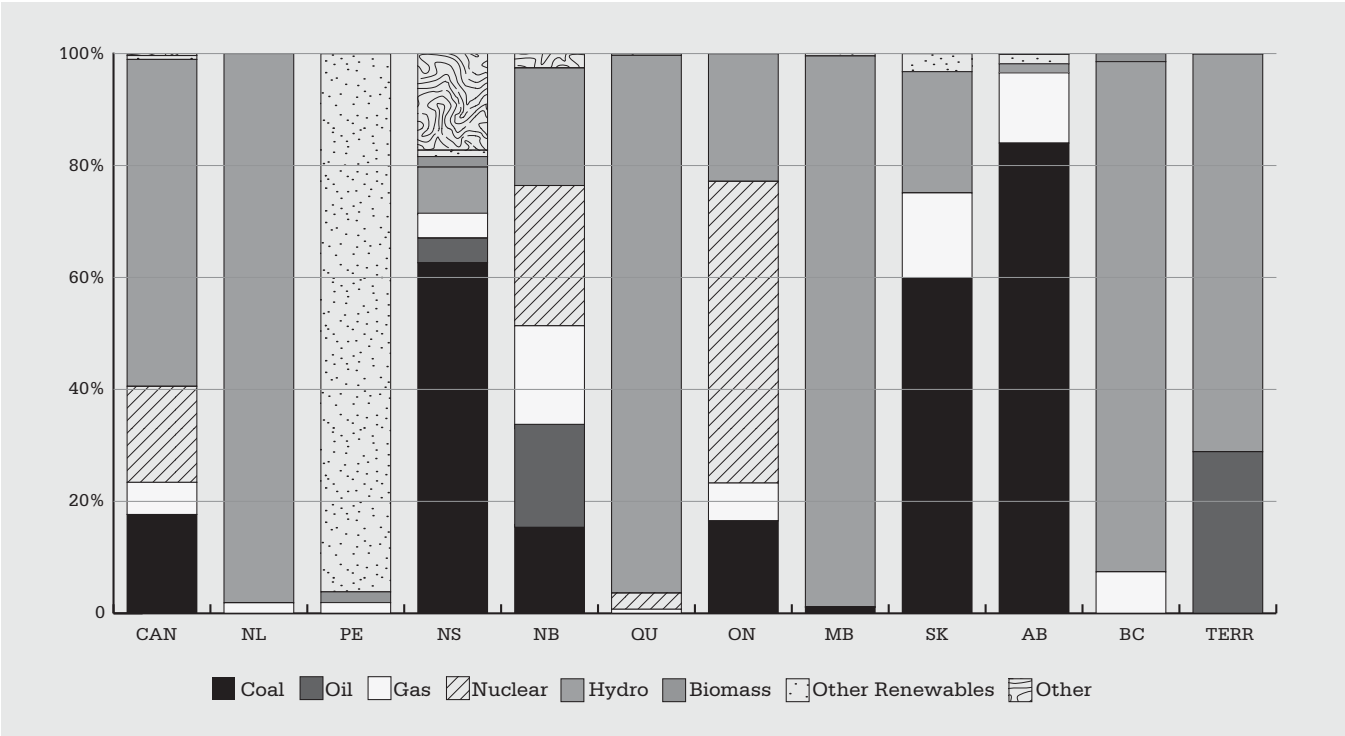
www.enviroliteracy.org/article.php/1122.html

For more electricity generation types see www.ecospark.ca/wattwize

Electricity Generation in Canada and Ontario

In Canada, our electricity mainly comes from Hydro (58%), Nuclear (17%), and Coal (18%). Each of these generation sources has their own impact on the environment.

GRAPH 3: Electricity Generation/Type (%), (2006)

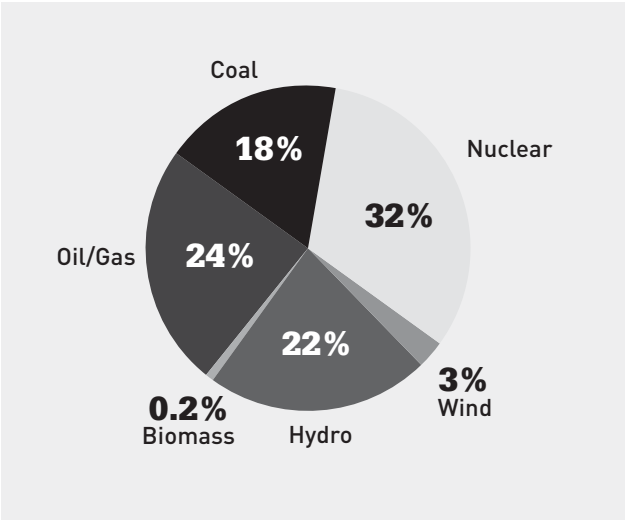


Environment Canada (2008)

Like all provinces, how Ontario generates its power differs from the Canadian average. In Ontario, over half (54%) of the electricity generated in 2006 was produced by nuclear power plants. GRAPH 3, which uses 2006 numbers, shows that the remainder was mostly produced by Coal (17%), Hydro (23%), and Gas (7%).

GRAPH 4 shows Ontario's generation (by type) for 2009. It is evident that the numbers are changing for Ontario. Part of this is the provincial government's plan to phase out coal by 2012 (which constituted 27% of generation in 2000); and to increase gas and renewable electricity generation. This is having an effect on GHG emissions, **but is this enough?**

GRAPH 4: ON Electricity Generation per Type (%), 2009



IESO (2009)

Electricity Generation and Calculating GHG Emissions

In the *Wattwize* program (depending upon grade) we are going to want to calculate the GHG emissions of our electricity consumption – though this is not the only effect of electricity consumption. To do this we will need to know the "electricity intensity" or the "emission factor." These numbers estimate the rate of release of CO_2 equivalents due to electricity consumption **(SEE BOX 8).** Because each province produces electricity in different ways, the emissions factors vary. The higher the factor the higher the GHGs emitted through electricity generation. It is for this reason that there is a correlation between **GRAPH 3** and **TABLE 2**.

The information here will be explained in the *Wattwize*: *Introductory Workshop*.

To calculate GHGs emitted through a certain electric-powered action use the formula below:

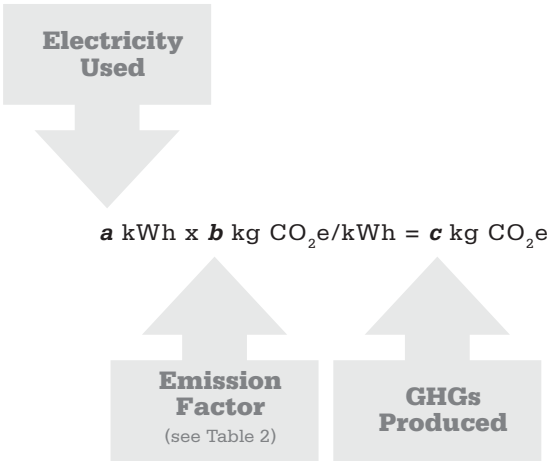


TABLE 2: Canadian and Provincial Emission Factors

	kg CO_2 eq/kWh
Canada	0.205
NL	0.015
PE	0.192
NS	0.549
NB	0.366
QC	0.006
ON	0.180
MB	0.010
SK	0.810
AB	0.930
BC	0.020
YT, NT, NU	0.080

Environment Canada (2008)

BOX 8: What is CO_2e?

CO_2 Equivalent is a unit used to represent all GHGs emitted by an action. It allows various gasses to be compared. Non-CO_2 gases are converted into their CO_2 equivalent according to their impact on the environment.

For example:
1 kg methane (CH_4) = 25 kg CO_2e

EXAMPLE 1

Dr. Norman Bethune C.I. (Toronto, ON) used 76,190 kWh of electricity in September 2008. To calculate the consequent GHGs we do the following:

a kWh x ***b*** kg CO_2e/kWh = ***c*** kg CO_2e
a = 76190 kWh
b = 0.180 kg CO_2e/kWh

76190 kWh x 0.180kg CO_2e/kWh = **13,714.2 kg CO_2e**

EXAMPLE 2

If this had occurred in Quebec, the following would be the result:

a = 76190 kWh
b = 0.006 kg CO2e/kWh

76190 kWh x 0.006 kg CO_2e/kWh = **457.14 kg CO_2e**

But remember: GHG emissions are not the only environmental impact of electricity consumption!

Making GHGs Tangible for Students

Once students have calculated GHG emissions it is important to help them understand what these numbers mean. To do this it is important to put the numbers into everyday terms. Below you will find a simple formula to help *estimate* an example equivalency. Visit www.ecospark.ca/wattwize for more potential equivalency calculations.

Younger grades can also use the online calculators available on the *Wattwize* website: www.ecospark.ca/wattwize.

Comparing GHGs to Trees

Comparing GHGs produced or saved to the number of trees needed to absorb that CO_2 **in a year** will help students to tangibly comprehend the GHGs caused by their electricity consumption.

According to the UNEP an average tree absorbs 12 kg CO_2 **per year.**[6] We can therefore calculate the number of trees it would take to balance those emissions with the following calculation:

d kg CO2 ÷ 12 kg CO_2 = # trees needed to balance CO_2 emissions within one year

EXAMPLE

Dr. Norman Bethune C.I. indirectly produced 13,714.2 kg CO_2e in September 2008

To calculate how many trees they would need to balance this amount:
d kg CO2 ÷ 12 kg CO2 } ***d*** = 13,714.2 kg CO2e

13,714.2 kg CO_2e ÷ 12 kg CO_2 = **1,143 trees needed to balance Dr. Norman Bethune C.I.'s September 2008 CO_2 emissions within one year**

Possible summary statement: 1,143 trees breathing for a year are needed to absorb the emissions produced in September by Dr. Norman Bethune C.I.

BOX 9: Converting Kg to Tonnes

Some resources that your students might find measure GHGs in tonnes.

To convert tonnes to kilograms:
b tonnes x 1000 = *c* kg

To convert kilograms to tonnes:
b kg ÷1000 = *c* tonnes

Remember to visit www.ecospark.ca/wattwize to find more equivalency calculations.

Step 1: Introductory Workshops – *(2 classes)*

If your school is located within the GTA you can book an EcoSpark-facilitated introductory workshop by visiting **www.ecospark.ca/wattwize**. If it is not within the GTA you can download the presentations from the website.

There are presentations available for elementary and secondary schools (two for each). The presentations will cover much of the information summarized in the "Handy Background Infomation for Teachers" section of this guidebook (especially in the secondary school presentations), and introduce students to energy meters and electricity audits.

INTRODUCTORY WORKSHOP 1: Teacher-facilitated

This workshop is to provide background information for students (in a class rather than an EcoTeam) on electricity generation. A pre-made presentation is available on the *Wattwize* website, but teachers can design their own and make assignments on electricity generation types, etc. Topics to cover include:

- An overview of electricity generation types
- Environmental impacts of different electricity generation types

INTRODUCTORY WORKSHOP 2: **EcoSpark-facilitated**

This workshop is designed as an introduction to the electricity audit and examines the how and why of the audit. Topics covered include:

- An overview of electricity use in Canada
- An overview of electricity generation in Canada and Ontario
- Calculating GHG emissions of electricity use
- Understanding GHG emissions in tangible ways
- Preparing for the electricity audit

For Workshop 2 you will need:

- energy meters (EcoSpark will provide some, if needed; if the presentation is to be teacher-facilitated outside of the GTA, see **BOX 12**).
- Print outs of **HANDOUT #2** for every two students

BOX 10: Watts versus Watt-Hours

How we measure power and energy are very important concepts in the *Wattwize* program. Many people confuse Watts (W) and Watt-Hours (Wh).

In short, Watts are the units used to measure **power** (the rate at which energy is used); whilst Watt-Hours are the units used to measure **energy used**.

By measuring the Watts an appliance uses with your energy meter, you are measuring the rate at which it uses electrical energy.

We like to compare power (W) to speed (km/h) and energy (Wh) to distance (km).

Example:
If a laptop uses energy at a rate of 26W, it will use 26 Wh in an hour; 52Wh in two hours; and 13Wh in half an hour.

BOX 11: Using Your Energy Meters

Wattwize Introductory Workshop 2 and the online presentation will demonstrate how to use Energy Meters. Here is a quick guide:

1. Plug in the Energy Meter.
Outlet ← Energy Meter ← Appliance

2. Set the Energy Meter to measure Watts (W) – that is, the "power draw" of the appliance.

3. Turn the appliance on and measure the Watts at various different levels of activity.
Eg. For a computer measure:
Watts during high activity
Watts whilst on, but idle
Watts whilst on stand-by
Watts with monitor off but computer on, etc.

4. Turn off the appliance and measure the "phantom load" of the appliance (see BOX 14).

Step 2: School Electricity Audit – *(approx. 3 classes)*

An electricity audit is an assessment of the electricity consumption in (and outside of) a building. By conducting one in your school you will be able to pinpoint ways to reduce electricity consumption: mainly through behavioural and appliance changes – but you can also recommend infrastructure changes too.

Here are the steps:

A. Understanding Total School Electricity Consumption

Students need to use HANDOUT # 1 to record your school's general information and its electricity consumption information. You will need to provide them with some of this information.

How you determine your school's electricity consumption will depend upon your school board. Some school boards can be contacted directly to access this information; others have the information available online. SEE BOX 13.

An alternative method for accessing this information is to ask your school custodian or principal to gain access to the school electricity meter. Record the time and meter reading. Then return at the same time the next week to record the meter reading again. From that you can determine the amount of electricity used in a week. For help on reading the meter and for helpful handouts see: **www.ecospark.ca/wattwize.**

Remember to work out the GHG emissions produced and to determine the equivalents! You can calculate the equivalents with your class (SEE PAGES 7-8) or use the calculator at **www.ecospark.ca/wattwize.**

BOX 12: Accessing Energy Meters

You will need energy meters to complete the audit. For a class of 30, 10 energy meters are recommended.

For participating schools within the GTA energy meters are available from EcoSpark (amount varies in each year). For other methods of obtaining energy meters visit **www.ecospark.ca/wattwize**

BOX 13: Board-Specific Access to Monthly School Electricity Consumption

Toronto District School Board
Access monthly TDSB electricity information by going to **www.ecoschools.ca**. Click "School Energy Reports" and follow the links.

Durham Catholic District School Board
Contact *Facilities Services* (905-576-6150) for information and a graph showing electricity data.

York Catholic District School Board
Schools participating in the Eco Champion Program, can obtain live electricity consumption data through their school's intranet on the Eco Champion site. Non-participating schools can request historical data through the Eco Champion website.

Other Ontario School Boards:
The Ministry of Education Energy Conservation Initiative has begun a Utility Consumption Database, which will be fully functional by Fall 2011! You will be able to check your electricity and gas consumption online. Many boards will have access to the database in 2010. Contact your board's Facilities Services department to obtain information about accessing the database.

All schools should also be able to contact their board's Facility Services for access to the utility bill.

Electricity Audit Start Date:

Handout #1
General School Energy Information

GENERAL SCHOOL INFORMATION

School Name

Address

Year School Built **Size (sq metres)** **Current Student Population**

ELECTRICITY CONSUMPTION

Average Monthly Electricity Use **Monthly GHG's Emitted** (due to electricity consumed) [kg]:

{Remember for Ontario: GHGs emitted = kWh of electricity consumed × 0.180 kg CO_2e/kWh or use the online calculator!}

Number of Trees Needed to absorb CO_2 in a year:

{Remember: Number of Trees Needed = GHGs emitted (kg) ÷ 12 kg CO_2}

OTHER ENERGY USAGE

Heating Type

Water Heating Type

Cooling Type

OTHER IMPORTANT INFORMATION

(Upgrades, Special Infrastructure [Solar/Wind], # Portables, etc.):

Why is this information important for your audit?

Various factors determine the energy efficiency and consumption of your school. For example, older schools may have less efficient furnaces and insulation, while newer schools may be designed to allow passive solar heating and cooling, which reduces the use of electricity and fuel to heat and cool the school.

You will need Energy Meters to complete this section! See BOX 12.

B. Completing the School Electricity Audit

The electricity audit is an important step in understanding how your school uses electricity. The information that students will gather here is important for making their electricity conservation plan.

First, split your class into groups. Each group should then be assigned a zone so that the group/class can audit the entire school together (or the sections of your school being audited). We recommend three students to a group. Each group will then be able to audit the appliances and infrastructure in their assigned zone.

Each group will need several copies of **HANDOUT #2** and **HANDOUT #3**. They should use separate sheets for each room they audit. Remember that elementary school audit sheets are available at **www.ecospark.ca/wattwize.**

How to fill out Handout #2: Electrical Appliance Audit:

The purpose of **HANDOUT #2** is to help students determine the electricity used by each appliance.

Below is an example for a laptop computer. When filling-out a form students can fill-in the first two columns first and then the later columns back in the classroom.

= (Power Draw) × (Hours a Week in Use for Mode)

Add together "Total Electricity Used in One Week in kWh" for all modes

= (Total Electricity Used / Week) × 0.18*

* This number is for Ontario only.
For other provinces see Table 2.

Appliance /Mode	Power Draw (Watts)	Hours a Week IN USE for Mode	Total Electricity Used in One Week for Mode	Total Electricity Used in One Week for Mode in kWh	Total Electricity Use in One Week per Appliance	# of Appliances in Classroom	Total Electricity Used by Appliance Type per Week	Consequent GHG Emissions per Week
APPLIANCE: Laptop Computer								
Mode 1: Normal	20 W	15 hrs	300 Wh	0.3 kWh	0.63 kWh	2	1.26 kWh	0.23 kg CO_2e
Mode 2: Low Power	6 W	30 hrs	180 Wh	0.18 kWh				
Phantom Load:	2 W	75 hrs	150 Wh	0.15 kWh				

Determine from the Energy Meter

= (Total Electricity Used in One Week for Mode) ÷ 1000

= (Total Electricity Use in One Week) × (# Appliances)

BOX 14: Phantom Load

"Phantom Load" is the amount of electricity used by an appliance when it is turned off. This is an important concept within electricity audits because it essentially measures the amount of energy that is being used when we are not even using the appliance! It can be seen as a measurement of pure waste.

Date:

Handout #2
Electrical Appliance Audit

Group Members | School Zone | Room

Using your energy meters, fill-out the table below for all of the appliances in your zone/classroom. Use as many sheets as you need. **Remember to measure each of the appliance's modes!**

Appliance /Mode	Power Draw (Watts)	Hours a Week IN USE for Mode	Total Electricity Used in One Week for Mode	Total Electricity Used in One Week for Mode in kWh	Total Electricity Use in One Week per Appliance	# of Appliances in Classroom	Total Electricity Used by Appliance Type per Week	Consequent GHG Emissions per Week
APPLIANCE:								
Mode 1:	W	hrs	Wh	kWh				
Mode 2:	W	hrs	Wh	kWh				
Mode 3:	W	hrs	Wh	kWh	kWh		kWh	kg CO_2e
Phantom Load:	W	hrs	Wh	kWh				
APPLIANCE:								
Mode 1:	W	hrs	Wh	kWh				
Mode 2:	W	hrs	Wh	kWh	kWh		kWh	kg CO_2e
Phantom Load:	W	hrs	Wh	kWh				
APPLIANCE:								
Mode 1:	W	hrs	Wh	kWh				
Mode 2:	W	hrs	Wh	kWh	kWh		kWh	kg CO_2e
Phantom Load:	W	hrs	Wh	kWh				
						ZONE TOTAL		

List the Appliances which were ON when you audited the room:

How to fill-out Handout #3: Infrastructure Audit:

HANDOUT #3 will help students to observe aspects of your school's infrastructure which have an impact on electricity consumption. Their observations here will help them produce an effective conservation plan.

For example, students might recognize that there are many, many lights in the gymnasium and that these lights are not turned off when the gym is vacant. This can lead to recommendations regarding remote sensor lights, etc.

BOX 15: Calculating Electricity Consumption of Your Lights

You can calculate the electricity use for each zone's lights if you know the watts of each light and the estimated time turned on.

A light electricity consumption calculator is coming in 2010 to **www.ecospark.ca/wattwize.**

BOX 16: Calculating Costs

To calculate the dollar cost of your electricity usage visit **www.ecospark.ca/wattwize** for help.

Below is an example Handout #3:

LIGHTS	
Type:	Fluorescent Tubes - 23W
Number:	32 (4 rows of 8)
How many per switch?	16 (two switches)
Switched off when room unoccupied?	No - left on at lunch time
Other observations:	Also two 60W lamps in room (never on)
WINDOWS/ INSULATION	
Number:	4 large windows
Direction facing:	South-facing
Windows left open/closed	closed
Curtains left open/closed	Closed half of the time
Drafts?	No drafts
Direct or partial sunlight?	Sunlight blocked by trees in summer
Other observations:	
HEATING AND COOLING	
Heating or Cooling Type (eg. AC):	AC unit in one window and electric heaters
Temperature observations:	Seems hot
Ventilation observations:	Can't feel any air circulation through vents
Other observations:	All heaters are turned on

Handout #3
Infrastructure Audit

Date		School Zone	
Group Members		Room	

LIGHTS
Type:
Number:
How many per switch?
Switched off when room unoccupied?
Other observations:

WINDOWS/ INSULATION
Number:
Direction facing:
Windows left open/closed:
Curtains left open/closed:
Drafts?
Direct or partial sunlight?
Other observations:

HEATING AND COOLING
Heating or Cooling Type (eg. AC):
Temperature observations:
Ventilation observations:
Other observations:

Step 3: Electricity Conservation Plan Creation – *(approx. 3 classes)*

Once students have collected as much information about their zone as possible it is time to help them determine appropriate actions to conserve electricity in their school. The conservation plan is an important component of the *Wattwize* program. It empowers students to take an active leadership role in their school and contributes to real-world GHG emissions reductions!

If you are working with a secondary school EcoTeam or environment club, EcoSpark staff can facilitate a Conservation Plan Creation Workshop with your group at this stage.

The following activities can be done as a class or in groups consisting of members from each zone group.

A. Analyzing the Data from Each Zone

Use **HANDOUT #4** to help students discuss:

- What appliances are using the most electricity?
- Where is electricity being wasted? Which zones?

NEED IDEAS FOR ELECTRICITY CONSERVATION?

Check-out **www.ecospark.ca/wattwize** for completed plans and useful links.

B. Determining Conservation Strategies

In preparation for this activity remind students about the three factors that affect school electricity use: appliances, behaviours, and infrastructure.

Use **HANDOUT #5** to help students discuss:

- What are your priority areas?
- What are the possible strategies to reduce electricity waste in these areas?
- What are the most feasible strategies to implement?

Then, using **HANDOUT #6**, have students pick 4-5 strategies and determine the potential electricity and consequent GHG emissions savings. **HANDOUT #6** is handy to determine your priorities – where are the biggest savings?

C. Writing the Conservation Plan

Once your students have created a list of feasible conservation strategies it is time to make a final decision on a manageable number of them to implement.

Using **HANDOUT #7** as a guide, have your class or each group write a conservation plan. In this plan they should:

- compile their data from the electricity audit;
- create an electricity reduction goal;
- outline the strategies to be implemented in detail (less than 5);
- outline any recommendations which cannot be implemented by the students (eg. Infrastructural changes and other changes that were deemed unfeasible).

One conservation plan per school can be submitted to the Conservation Champions contest in order to win a cash prize to help fund conservation efforts. See **STEP 6** (page 24).

Handout #4
Analyzing Electricity Consumption

School | Start Date

Group Members

In **classrooms**, we noticed electricity was wasted and energy was lost because...

In the **gymnasium** and **library**, electricity was wasted and energy was lost because...

In **offices** and **hallways**, electricity was wasted and energy was lost because...

In **washrooms** and **changing rooms**, electricity was wasted and energy was lost because...

In **cafeteria** and **kitchens**, electricity was wasted and energy was lost because...

In other areas of the school, electricity was wasted and energy was lost because...

The following problems should be our **priorities** when making a conservation plan:

Date:

Student Name:

Handout #5: Determining Conservation Strategies

Use this table to brainstorm actions that you might take to conserve electricity in some of the areas which you highlighted in **HANDOUT #4**.

Zone	Electricity Wasting Behaviour/Appliance/ Infrastructure	Goal	Actions to Be Taken	Resources		Timeline	Feasible Task? (Yes/No)
				Materials	People		
(example) Geography	Lights left on at lunchtime in classrooms	Lights on only when needed	Create "lights-OFF" posters	Recycled paper, computer ink	- Principal for permission to hang posters - 1 designer - 5 posterers	Nov. 5th, make posters Nov 8th (Lunchtime) put up posters	Yes

This table modeled after: http://www.ontarioecoschools.org/forms&resources/downloads/form_energy_action_plan.pdf

Handout #6: Determining Electricity Reductions

Date:

Student Name:

Use the table below to calculate the electricity savings of your proposed conservation strategies.

Conservation Action	Estimated Electricity Reductions per Week (Wh)	Estimated Electricity Reductions per Week (kWh)	Estimated Electricity Reductions per Month (kWh)	Estimated GHG Emissions Saved per Month
(example) Turn computer monitors off in lab at lunchtime	40W × 10 monitors × 1 hour × 5 days = 2,000 Wh	2000 Wh / 1000 = 2 kWh	2 kWh × 4 weeks = 8 kWh	8 kWh × 0.18 = 1.44 kg CO_2e
		TOTAL		

Handout #7
Writing A Conservation Plan

Electricity Conservation Plan

Develop an electricity conservation plan for your school. Below are the sections which you will need to include in your plan. A good plan should be thoughtful and should aim to implement only as many strategies as you think are feasible.

Sample Electricity Conservation Plans are available online at www.ecospark.ca/wattwize

1. Introduction and Background

Include information about your school, your class or group, and your reasons for undertaking this project.

2. Electricity Audit Data

Include a summary of the data collected during your electricity audit. Use the information collected on **HANDOUTS #1, #2, #3,** and **#4.**

3. Electricity Conservation Goals

Discuss your MAJOR goals, e.g. to reduce school electricity use by 5%. To determine this look at **HANDOUT #6** at the savings you have estimated.

4. Electricity Conservation Strategies

List the specific strategies (or "actions") that you will pursue to conserve electricity in your school. It is best to limit yourself to less than 5 strategies to make sure you do them all well. Use **HANDOUT #5** and **#6** to help you choose. You may want to organize your thoughts in a chart. Remember to estimate how much electricity each activity will save. Also, don't forget to include a timeline and a list of roles!

5. Recommendations

List and discuss other actions that can be pursued at a later time. They might be unfeasible now, but what about if you had unlimited time and resources? These can include infrastructural changes such as renewable energy projects, and the purchasing of new appliances. Use **HANDOUT #5** to help you.

Step 4: Implementing the Conservation Plan – *(time varies)*

So your students have made their plan(s). It is now time to implement them!

If your class created plans in groups you will first have to decide which plan to implement – or which elements of various plans. You might want to consider having class presentations and a vote (or consensus decision process) to decide.

The plan you have made will have a greater effect the longer you implement it. That is, if you continue to make announcements, put up posters and to monitor (etc.) you'll see better results. You might also want to adjust your strategies as time passes.

If you are working with a class (rather than an EcoTeam) you will have limited class time available and your class will eventually end. There are several ways to ensure implementation continues for as long as possible though:

- get your schools' EcoTeam or Environment Club involved;
- encourage students to continue the project on their own;
- encourage students to join the EcoTeam;
- although the conservation plan is made, have implementation as an ongoing assignment;
- or once the course ends ensure continued implementation by encouraging other teachers and classes to integrate *Wattwize* into their course.

While you are implementing your conservation plans contact EcoSpark staff for any support you need at: **wattwize@ecospark.ca.** Also, visit **www.ecospark.ca/wattwize** for other ways to keep the *Wattwize* community up-to-date on your project.

Step 5: Measure and Reflect on Your Success – *(1 class)*

After implementing your plan (or a part of it), it's time to reflect on the results of the plan to date. Students will measure the results, reflect on their accuracy, and evaluate the plan. They can use **HANDOUT #8** to do this.

If you are working with an EcoTeam or Environment Club you could do this step several times to continuously improve your conservation plan.

To help students prepare for this section of the program you will need to provide them with a new measurement of the electricity consumed. You should use the same method (i.e. school board or school meter) and time duration (i.e. a week or a month) as you used for the first measurement. If possible supply the students with (or a resource to find) a comparison between the most recent month and the corresponding month from the year before. For example, supply them with March 2009 and March 2010 figures to compare. This will hopefully, eliminate some of the external factors which can skew comparisons between different months/weeks (i.e. April to June comparisons).

Using HANDOUT #8 students will (either in groups or as a class):

1. Discuss the two electricity consumption measurements – their difference or similarity
2. Think through external factors that affect electricity consumption, including:
   - Weather
   - Construction
   - Differences in weekend permit use, etc.
3. Think of other ways to measure their impact. You might want to try to apply these tools too (surveys etc.)
4. Think of improvements to their plan
5. And finally, think of ways to go forward

Extensions:

1. Have students think about who makes big decisions about electricity at their school – or who makes decisions about where that electricity comes from (i.e. the generation source). Then have them write a letter to these decision-makers about electricity conservation initiatives and electricity generation.
2. How might students apply what they learnt in their home? Have students complete a home energy audit.
3. Elementary classes can do a reflection piece on what they have learnt.
4. How might students teach their community what they have learnt?

Handout #8

Reflections And Next Steps

Date:

Student Name:

It's time to reflect on your conservation efforts!

1. Check your school's current electricity consumption for this month, and compare it to that in last year's corresponding month. What was it? Has it increased or decreased?

2. What external factors might have influenced this consumption?

3. Success is not a number! Brainstorm other ways your group can measure success.

4. What elements of your conservation plan worked or didn't work in your opinion?

5. What changes or new initiatives would you implement if you had the chance to do it again?

6. How could you extend your project? How could you ensure that your school improves its electricity conservation in the future?

Step 6: Submitting Your Electricity Conservation Plan and Results to the Conservation Champions Contest

Congratulations! You have almost completed your electricity conservation project!

There is only one thing left to do: submit your class or EcoTeam's electricity conservation plan and **HANDOUT #8** to EcoSpark's Conservation Champions Contest for the chance to win a monetary prize! We judge entries based on their plan, results, results-analysis, and conclusions.

Check www.ecospark.ca/wattwize for the next deadlines

E-mail submissions to:
wattwize@ecospark.ca

Send submissions via Snail-Mail to:
Conservation Champions Contest
EcoSpark
147 Spadina Ave, Suite 204
Toronto, ON
M5V 2L7

If you are from a school outside of the GTA we would still love to see your electricity conservation plans, results, and reflections. Please send them to us at the above address.

Endnotes

[1] Natural Resources Canada (2009). *Improving Energy Performance in Canada – Report to Parliament Under the Energy Efficiency Act For the Fiscal Year 2007-2008*. Available at: http://oee.nrcan.gc.ca/publications/statistics/parliament07-08/chapter1.cfm?attr=0

[2] Natural Resources Canada (2007). *Commercial and Institutional Consumption of Energy Survey, Summary Report – June 2007*. Available at: http://oee.nrcan.gc.ca/Publications/statistics/cices06/chapter1.cfm?attr=0

[3] Canadian Energy Research Institute (2008). *Comparative Life Cycle Assessment (LCA) of Base Load Electricity Generation in Ontario*. Available at: http://www.cna.ca/english/pdf/studies/ceri/CERI-ComparativeLCA.pdf

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[5] UNFCC (2009). National Greenhouse Gas Inventory Data for the Period 1990-2007. Available at: http://unfccc.int/resource/docs/2009/sbi/eng/12.pdf

[6] UNEP (2009). *Plant for the Planet*. Available at: http://www.unep.org/billiontreecampaign/FactsFigures/FastFacts/index.asp

eco spark

Formerly Citizens' Environment Watch

EcoSpark empowers people to take an active role in restoring and sustaining their local environment. We educate communities and give them the tools for monitoring and influencing positive change.

EcoSpark was founded in 1996 as Citizens' Environment Watch (CEW) and became EcoSpark in 2010.

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