CURRICULUM-UNIT PLAN

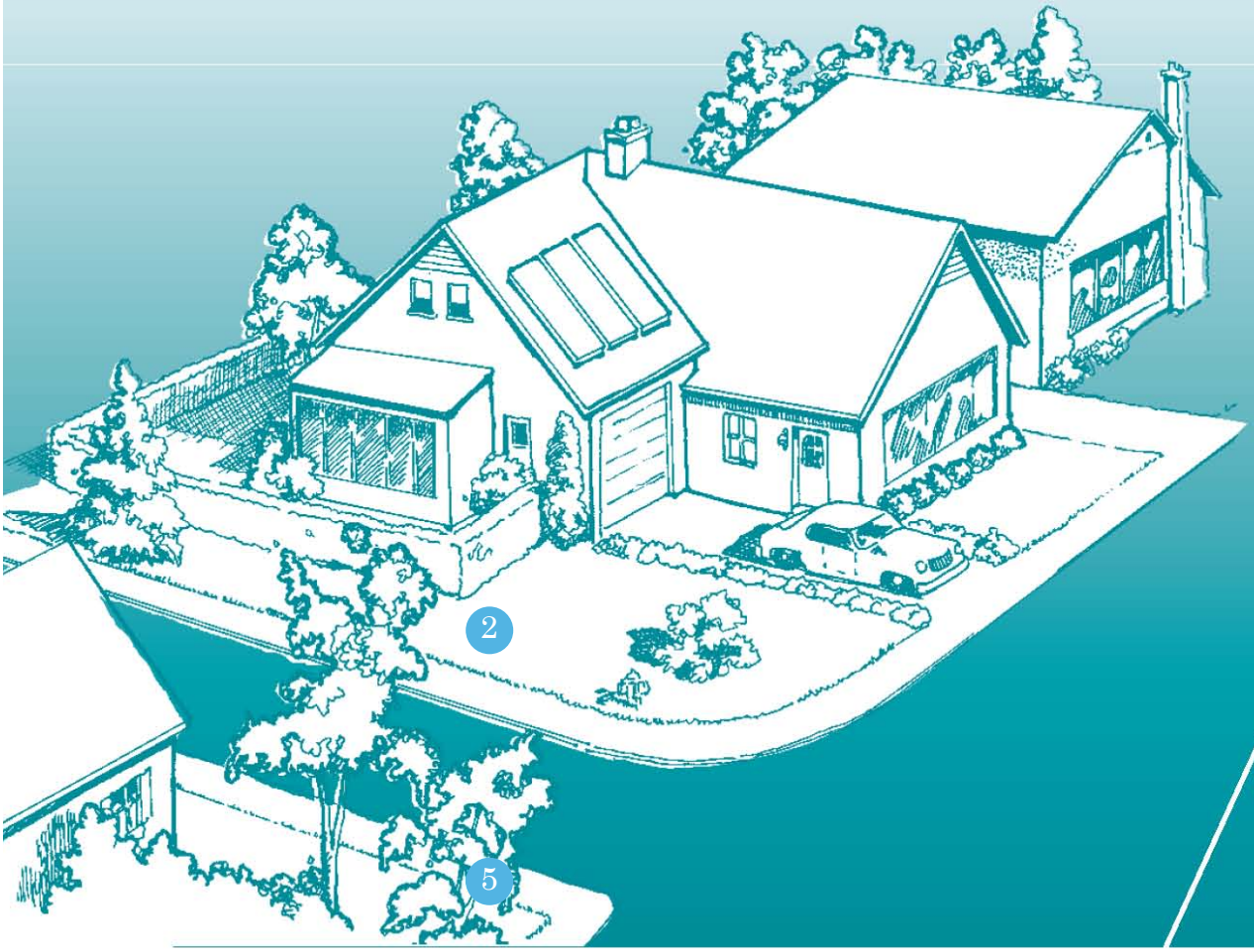
Green Energy Education

I.N.S.P.I.R.E.

Implementing New Sustainable Program in Rewnewal

Limestone District School Board (Kingston)

[Date]



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Unit Lesson Plan:

Energy Conservation: Renewable Alternatives for Sustainable Future

GRADE LEVEL: 11
COURSE NAME : Biology University
UNIT TITLE: Environmental Conservation in Biology
STUDENT ACTIVITY: Independent Study Project (ISP)
TIME REQUIRED: Minimal 5 days (45 min per lesson)

Unit Overview:

This unit in environmental conservation biology requires students to research and critically evaluate the impact of non-renewable resources and the green sustainable energy and resources as replacements. Students will review and compare the different types of non-renewable and renewable resources on earth and develop a deeper understanding of their properties, efficiency and applications. They will gain insight from various perspectives of resource depletion and its impact globally to locally. They will specifically learn about a particular renewable energy, solar power in solar panels, which will become the focus of their independent study project.

Curriculum Connections:

- Ontario Grade 11, *Species and Biodiversity: Habitat, Species and Conservation*
- Ontario Grade 11, *Diversity of Living Things: Habitat, Species and Conservation*

Unit Lesson Outline:

Day 1: Lesson I-Introduction to Environmental Conservation Biology
Day 2: Lesson II-Conservation Issues and Depletion of Non-Renewable Resources
Day 3: Lesson III-Alternative Renewable Energy Sources and Sustainable Practices and Solutions
Day 4: Lesson IV-Solar Energy and Solar Panels
Day 5: Field Trip and Interactive Learning

Related Subjects:

- Environmental Studies
- Geography
- Chemistry
- Physics
- Technological studies
- Social sciences and humanities
- Political sciences

Unit Topics:

1. Non-renewable and Renewable Resources
2. Conservation Issues
3. Global Warming
4. Sustainability
5. Habitat Loss
6. Biodiversity Values
7. Solar Power and Solar Panel Technology

Unit Overall Expectations:

By the end of this unit, students will:

- Demonstrate an understanding of factors that influence the sustainability of the natural environment and evaluate their importance
- Examine how various factors influence and feedback in the relationships between organisms, natural environment and human development
- Explain why it is important to be aware of the impact of human activities on the natural environment and biodiversity perspectives
- Analyze from a variety of perspectives, the risks and benefits to society and the environment of applying scientific knowledge of conservation issues or introducing a particular technology (e.g. examine the effect of alternative resources)

Unit Content Standards:

Students are expected to:

- Write effectively for a variety of purposes and audiences.
- Use writing to communicate effectively
- Apply technology for creativity and innovation
- Incorporate technology for communication and collaboration
- Use technology for critical thinking, problem solving and decision-making

Curriculum-Framing Questions:

Essential Question:

- How can we minimize our impact on earth

Unit Questions:

- What is the current impact of non-renewable resources?
- How can we reduce the reliance on non-renewable resources and increase the usage of sustainable resources?
- What are some of the renewable resources available on the market and their properties, efficiency and applications?
- How will renewable resources and sustainable practices benefit us in the long-term?

Schedule/Advanced Organizer:

1. Introduction: Activity or Discussion
2. Background Content
3. Question & Answer
4. Assessment and Feedback
5. Homework

Final Summative Evaluation:

- Independent Study Project (ISP): choose one of the three options provide, including artistic, creation and research.

Day 1: Lesson I-Introduction to Environmental Conservation Biology

Lesson Expectations:

- **Developing Skills of Inquiry and Communication:** Examine various human activities and determine which human development/activities consume the most energy, and how changing patterns of behaviour can reduce the total amount of energy consumed.

- **Relating Science to Technology, Society, and the Environment:** identify some current environmental issues and conservation concerns and integrate information from the video to evaluate the short-term and long-term environmental effects.

Instructions:

- Teachers will show a video called: "The Story of Stuff"
- Teachers will conduct a debrief session to discuss and reflect this video with students
- Students will be given the chance to ask questions after the video

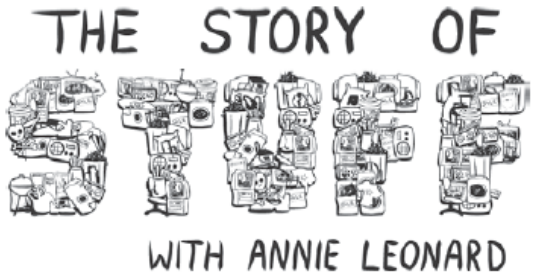
Teacher Resources:

- "The Story of Stuff" (video): http://www.storyofstuff.com/
- A 20-minute animation of the consumerist society, narrated by Anne Leonard

Key Questions:

1. What are the five stages that form the material economy?
2. What are some of the main problems associated with the material economy
3. In what ways can we reduce our impact on the environment with respect to consumer goods and the process of production?

Background Content:



- Every step of the material economy system interacts with the world
- Extraction, production, distribution, consumption and disposal are the five main steps that make up the material economy
- The world becoming depleted of resources-1/3 of the planet's natural resources have been depleted in the last thirty years.
- To produce goods, toxic chemicals are mixed in with natural resource.
    - People are constantly exposed to increasing amount of toxins and we are not exactly certain of its effects (direct or synergistic).
- To increase distribution, corporation and businesses will increase revenues by lowering prices to maximize sales which mean that more products need to be produced to satisfy the demands.
    - To be able to sell products for a low price, workers at the other stages of the material economy are paid low wages
- Continual consumption is encouraged by planned obsolescence and perceived obsolescence.
    - 99% of the consumer goods that we use have a lifespan of about 6 months.
- Eventually consumer goods are disposed of and this will pollute air, land water and have affects on climate change.
    - On average, each person in the United States create 4.5 lbs of garbage each day
    - Sometimes, countries will even export their garbage elsewhere.

Teaching/Learning Strategies:

Accommodations:

- visual cues (video)
- re-activating prior learning and especially after watching the video, teachers should initiate discussion and reflection questions to engage students to connect concepts and knowledge from previous classes and other subjects
- create a classroom environment that is conducive to learning (limited noise/distractions)

Differentiated Instructions:

- handouts about video and questions
- write on the board (chalk and talk), class discussion and individual work

Assessment:

- Students will write a short 1-page personal reflection on the video and can discuss some of the issues raised by the video or class discussion questions
- Develop an action plan that student will commit to for the next six months

Day 2: Lesson II-Conservation Issues and Depletion of Non-Renewable Resources in a Global Context

Lesson Expectations:

- **Understanding Basic Concepts:** Define, with examples when appropriate, terms such as: non-renewable resources, conventional energy sources, conservation, global energy crisis, nuclear power, fossil fuels. Name and describe technologies created in response to dwindling non-renewable energy resources (e.g. windmills, solar panels, electric cars etc.)

- **Developing Skills of Inquiry and Communication:** gather and analyze some data from research to evaluate the non-renewable energy sources and how they contribute to some conservation problems.

- **Relating Science to Technology, Society, and the Environment:** Evaluate the environmental impact of various non-renewable energy resources in both global and local contexts

Teaching/Learning Strategies:

General Accommodations:

- students who have trouble focusing during classroom activities would be given special responsibilities to keep focused (ex: a student could act as the mediator or lead during class discussion)
- use of an advanced organizer
- use of handouts and examples
- make sure the classroom environment is conducive to learning: minimize noise, have an effective seating arrangement, etc.

Differentiated Instructions:

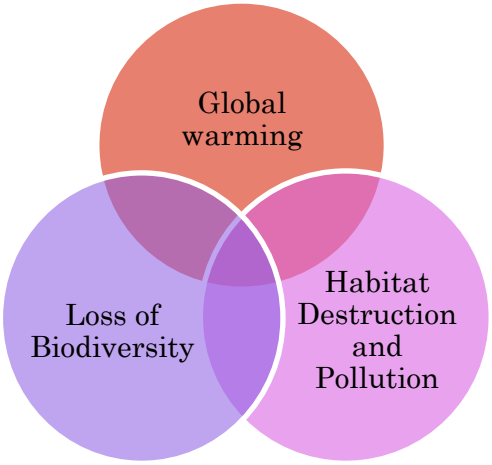
- visual cues (handouts)
- auditory cues (oral speak from teacher)
- practice (the game is a chance to use what they just learned)
- group structures (class discussions, small group work)
- using something of interest to them: the class discussion or debate

Lesson Assessment:

- in groups, students will explore the different types of non-renewable resources in depth from various aspects, including social, political, economical, environmental, biological and chemical.
- Present one aspect and discuss the impact of non-renewable resources on this.

Background Content:

The Problem:



Everything that we use is produced from some form of non-renewable resource. We have grown extremely dependent on these resources to provide us with material goods as well as energy. However, the usage of these resources has many negative global impacts and we are also running out of it. Global impacts include problems such as: habitat destruction, pollution, global warming, acid rain and loss of biodiversity.

Why should we care about these problems:

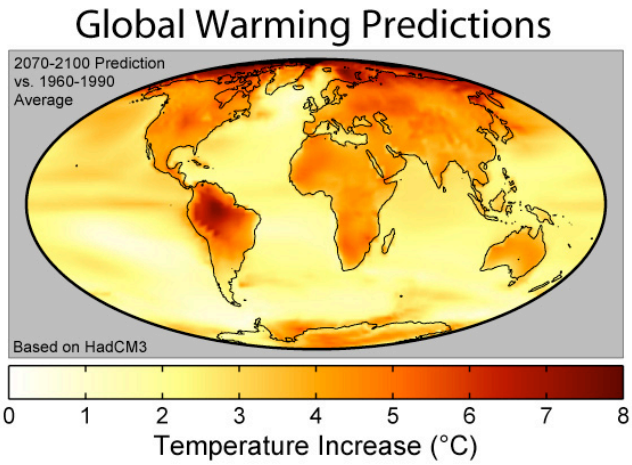
1.Human Value Perspective:
- I. Utilitarian value-resources are direct use to humans
- II. Intrinsic value-inherent value of biodiversity

2.Economic Perspective:
- I. Long-term benefit >>> cost
- II. Government rebate incentives
  - promotes social welfare and environmental initiatives
  - two programs currently running: 1) ecoENERGY[1] 2) Ontario Home Energy[2]

Related Energy Conservation Problems:

1) Global Warming:

Greenhouse gases (such as carbon dioxide) create a blanket in the atmosphere which prevent the reflection of solar radiation out of the atmosphere and thus increasing the Earth's surface temperature.



http://opinionsandexpressions.files.wordpress.com /2009/10/global_warming_predictions_map.jpg

- 400,000 sq miles of Arctic ice have melted in last 30 years (size of Texas)[3]
- Temperature and carbon dioxide increases (surface temperatures are expected to increase 2-4°C)[4]
- Extreme weather, scarcity of water, melted arctic ice caps, sea level rises shift man species' home range or completely destroy home ranges (in the case of Arctic and Antarctica). See case study of arctic ice melt and its effect on polar bears.[10]

Related Energy Conservation Problems:

2) Pollution[5]:

Through usage of fossil fuels, lots of CO_2 is emitted into the atmosphere, which create a warming affect. This contributes directly to the greenhouse gases and global warming. Also, pollution has hazardous to many animals: turtles that think plastic bags are jellyfish, animals getting stuck in garbage and drowning etc.

An increase in pollution means that there is an increase in the density of fine particle matter (PM). This has potential health risks for humans. Correlations studies have shown that long-term exposure to these elements was strongly associated with mortality due to cardiac problems. Even a fine PM density of 10-$\mu g/m^3$ can increases in mortality risk 8%-18%.[6]

I. **Acid rain:** pollutants from combusting of fossil fuels are transported through the atmosphere and deposited as acid precipitation[5]
   - Damage to plants, forests, crops, aquatics and all the biodiversity that occupies these habitats and space
   - Deterioration of materials
   - Increased erosion and loosened soil

II. Stratospheric ozone depletion[5]:
   - Thinning of the ozone as a result of fossil-fuel use. Thinning of this layer can lead to increased levels of damaging UV radiation which can increase risks of various types of cancer.

3) Loss of Biodiversity[7]:

Biodiversity is everywhere, both on land and in water. It includes all organisms, from microscopic bacteria to more complex plants and animals. Current inventories of species, though useful, remain incomplete and insufficient for providing an accurate picture of the extent and distribution of all components of biodiversity.

As more non-renewable resources are discovered and are extracted from various locations, species from that region are heavily affected by this alternation in their habitats and ecological organizations in terms of resources, food web and physical aspects of their environment. 15-37% of plant and animal species that global warming will wipe out by 2050.

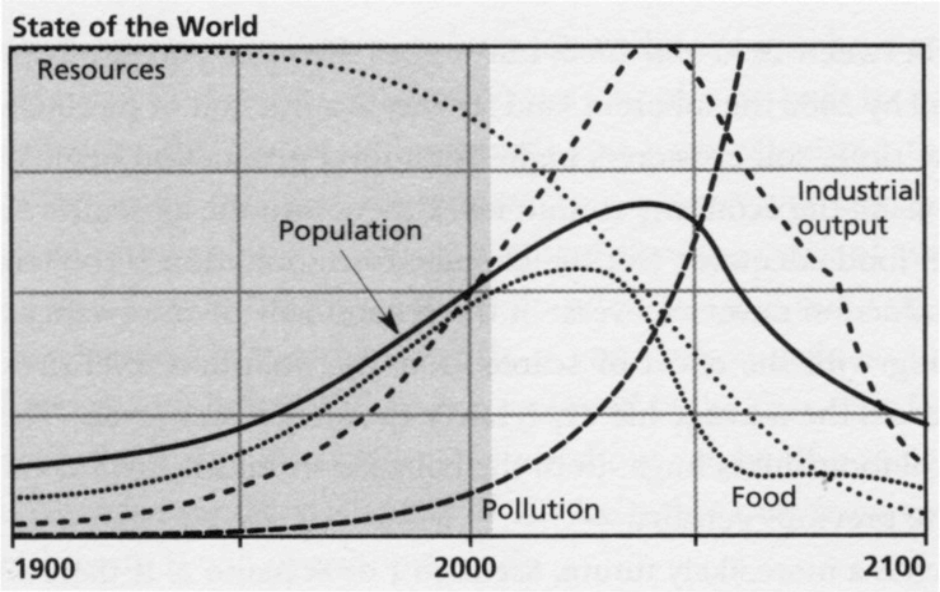
Major Species Affected by Energy Conservation Problems[8]:
- Polar bears
- Fish, salmon
- Coral reefs
- Birds and waterfowl
- Humans

4) Habitat Destruction:

In order to extract resources there is much damage what it is extracted from. Also after mining, most areas are left in their damaged state and nothing can survive on such terrain. Also, oil spills are common near drilling areas and cause a great hazard for individuals.[9]

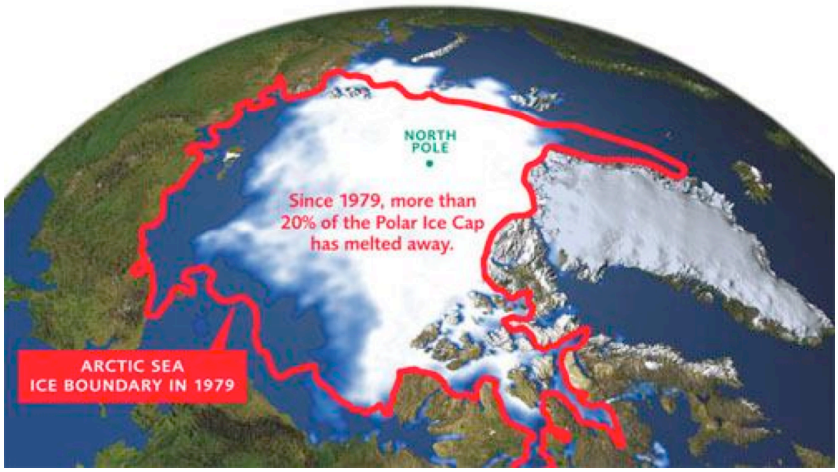
Example: Canada's Hudson Bay, a long-term study confirmed that polar bears are losing weight and bearing fewer cubs as their icy habitat melted away

Current State of the World: A graphical representation



Case Study: Decrease in Arctic Polar Ice Cap

- A clear retreat of the boundary of Polar Ice Cap from 1979 is shown in diagram and this is equivalent to the size of Texas, US.
- Continued melting of the ice cap is predicted and this will impact on the species that inhabit the Northern Hemisphere.[3]



Day 3: Lesson III-Alternative Renewable Energy Sources and Sustainable Practices and Solutions

Lesson Expectations:

- **Understanding Basic Concepts:** Define, with examples when appropriate, terms such as: renewable resources, alternative energy sources, solar energy, wind power, geothermal, hydropower, biofuels, byproducts. Compare and contrast conventional and alternative energy sources with respect to criteria such as availability, renewability, coast and environmental impact

- **Developing Skills of Inquiry and Communication:** evaluate arguments for the use of renewable and sustainable energy resources and technology, based on its advantages and disadvantages (e.g. production of greenhouse gases from fossil fuels is reduced but production of other wastes may be present)

- **Relating Science to Technology, Society, and the Environment:** Evaluate the environmental impact of various non-renewable energy resources in both global and local contexts

Key Questions:

- Give several examples of renewable energy. Why are they considered "renewable"?
- What are some of the advantages of renewable energy over non-renewable energy?
- Can you describe any examples of how renewable energy is being used in your region?

Teaching/Learning Strategies:

Accommodations:
- Teacher encourage students to be open-minded and contribute to discussion and bring in new ideas and concerns
- teacher observes the students in their independent work and discretely help students who are struggling

Differentiated Instructions:
- visual cues (handouts for experiment instructions and summary notes)
- auditory cues and ask questions to guide discussion and understanding
- group structures (class discussions, small group work)
- use elements of interest: video clips, visuals, and examples

Background Content:

Introduction to Renewable Energy[11,12]:

Renewable energy on the other hand quickly replaces itself and is usually available in a never-ending supply. Renewable energy comes from the natural flow of sunlight, wind, or water around the Earth. With the help of special collectors, we can capture some of this energy and put it to use in our homes and businesses. As long as sunlight, water and wind continue to flow and trees and other plants continue to grow, we have access to a ready of supply of energy.

Importance of Renewable Energy[17]:

i. Clean Air
ii. Protecting Global Climates
iii. Protecting Wildlife and Landscapes
iv. Unlimited Supplies-Sustainable Solution
v. Jobs and the Economy

Types of Renewable Resources:

1. Geothermal[12]:

- Extracting heat (from hot water, steam or gas) stored in the Earth to produce electricity and heat
- The plants used to convert heat to usable forms or to electricity do not require much space and is self-sustaining.
- The heated liquid that is extracted carries a mixture of gases which contribute to global warming and acid rain (carbon dioxide, hydrogen sulfide, methane and ammonia). It may also contain traces of toxic chemicals such as mercury and arsenic

Courtesy of The National Renewable Energy Laboratory (NREL)

2. Hydropower[12]:

- Electricity and mechanical power is derived from the force of moving energy
- Little maintenance is required
- Water power is generally available as needed, as long as the generator is placed in an area with adequate water flow, typically in major rivers.
- Can impact fish populations since they may need to migrate through these turbines
- Turbines may also be impacted by droughts
- Has the potential to affect water quality and flow. Plants may cause low oxygen levels in water which is critical to the survival of any water species

Biofuels/Bioenergy[12]:

- Biofuels are various types of biomass which come in three forms
  - Solid- wood, crops, garbage
    Liquid-ethanol
  - Gaseous-methane and carbon dioxide (ie captured from landfills or livestock manure management systems)
- Burning biofuels produces less sulfur oxides and carbon monoxide.
  - Believe that there is a lower net carbon dioxide emissions since
  - Non-renewable resources are required to move the machinery to harvest crops used for biofuels
  - Land, water and other resources that are used to grow these crops can put towards growing crops for food

Solar Energy[12]:

- For billions of years, the sun has poured out huge amounts of energy in several forms, including light, heat, radio waves, and even x-rays.
- Solar collectors and modules are designed to capture some of the sun's energy and change it from radiation into more usable forms such as heat or electricity.
- Sunlight is an excellent source of heat and electricity, the two most important forms of energy we consume.
- There are two types of solar technologies: solar thermal and solar photovoltaics

Wind power[12]:

- Used for electricity or for mechanical power
- Can generate electricity in remote locations (mountains and deserts)
- Requires lots free space in order to build them up
- Problem with wind farm on Wolfe Island is the fact that many bats are killed due to the negative pressure that builds up on the other side of the blades. Bats do not avoid these blades and as they fly through the negative pressure area their lungs explode because of the pressure differences.
- Can potentially be very unreliable if the area does not receive a sufficient amount of wind and therefore cannot support a wind farm
- Some wind turbines are extremely loud and can make the noise of a small jet engine

Local Kingston Connection:

A Green Future for Kingston:

Kingston Facts[13]:

- Kingston ranked 3rd Best Place to live in Canada in 2009
- Kingston ranked 1st in Canada for Science and Engineering
- Kingston is expected to the greenest city in Canada

It starts with an Idea[13]:

- Innovation Park at Queen's University invites innovative companies interested in collaborating in key technology clusters:
  - Advanced materials
  - Alternative energy
  - Environmental technologies
- Learn more at: www.innovationpark.ca

Everbrite Solar Company[13]:

- Everbrite Solar announced plans to build a $500-million manufacturing plant in Kingston, initially employing 300 people
- The robotics-drive, ultraclean facility will turn out "thin-film" solar modules which will be less expensive, more efficient and sleeker than most panels currently on the market.
- Everbrite settled on Kingston because of the technological expertise that already exists with Queen's, St. Lawrence College and RMC.
- The company and the university are also negotiating the construction of a $25-million experimental solar panel manufacturing research center.

Wolfe Island-$475-MILLION WIND FARM[13]

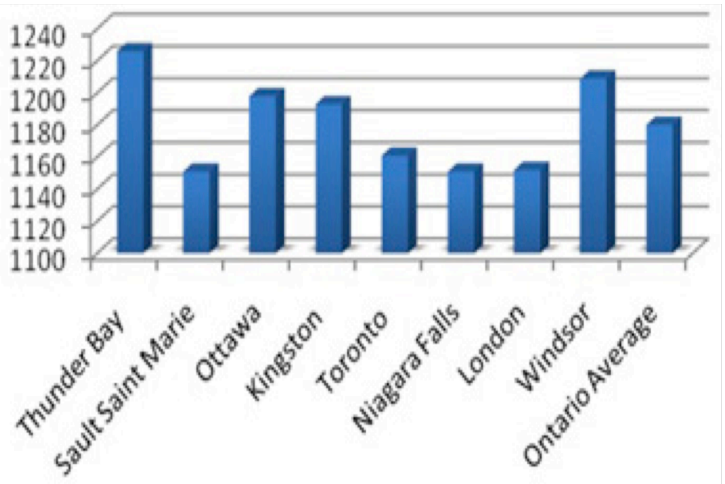
86 gigantic wind turbines were installed along the west end of Wolfe Island. The $475-million wind farm built and operated by Canadian Hydro Developers Inc. will churn out an anticipated 594 gigawatt hours of clean and sustainable electricity annually.

Supplementary Information: Kingston's Past Green Accomplishment

Kingston Hydro[13]:

- 2009 recipient of the Electricity Distributors Association's Environmental Excellence Award
- for its work to enable and facilitate distributed electricity generation within the Kingston community and throughout the province.
- Distributed electricity generation refers to electricity supplied directly to electricity distribution system, typically from renewable or low-impact energy sources.
- reduced emissions intensity of Ontario's electricity supply, lowers electricity transmission and distribution losses

City	kWh/year
Thunder Bay	1226
Sault Saint Marie	1151
Ottawa	1198
Kingston	**1193**
Toronto	1161
Niagara Falls	1151
London	1152
Windsor	1209



•Power Purchase Rate 80.2 cents / kWh

Source: Natural Resources Canada, PV Potential and Solar Resource Maps of Canada

Kingston Hydro's accomplishments include[13]:

- Development of metering, protection, and financial settlement protocols for a wide range of renewable and low-impact electricity generation installations.
- Connection of 10 solar and wind power facilities ranging in size from 0.4 to 30kW, and one large 15MW natural gas combined heat and power plant since 2006.
- Development of an innovative financial incentive for generators to help reduce Kingston Hydro's peak electricity consumption

Since 2007, distributed generators within Kingston Hydro's service have[13]:

- Provided 15,060 kW of renewable and/or low-impact electrical generation capacity to Kingston, representing a local investment of over $25 million.
- Kept over $3 million within the Kingston economy through sales of locally generated electricity to Kingston Hydro.
- **www.utilitieskingston.com**

Assessment: Energy Debate

Goal:
To investigate the economic and environmental advantages and disadvantages of the major renewable energy sources.

Background:

Economic Perspective-Natural Resources

Human populations use resources in the environment to maintain and improve their existence. Humans use many natural systems as resources. Natural systems have the capacity to reuse waste but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologically. Discuss how the us

Social and Environmental Perspective-Values of Biodiversity and Effort to Change

Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans. Do we care about maintaining the environment and is it worth the effort to do this? Look at the values of biodiversity and its social impact in renewable resources.

Instructions:
In this debate, students will learn about various types of energy sources, then are assigned to represent the different energy sources. Students will work cooperatively and develop arguments on their chosen topics/resources over the others.

Time: Short 15-minute debate for each group

Procedure:
1. Step 1-Preparation
2. Step 2-Introduce your topic to the class
3. Step 3-Debate
4. Step 4-Debrief and Reflection

The Ultimate Source of Energy:

Hydroelectric: heat from the sun evaporates water, which falls as rain in high places, then flows down to the dam and drives turbines.

Wind: winds are created by temperature differences caused by heating from sun.

Wave: driven by the wind.

Solar: light is turned directly into useful energy.

Biomass: (plant material e.g. wood). Plants turn carbon dioxide and water into carbohydrates (a chemical store of energy) using light energy to drive the process.

Fossil fuels: petrol, gas and oil are simply biomass that has been subject to great pressures underground for thousands of years.

Exceptions to the rule:

Nuclear power (a bit scary), **tidal power** (driven by the moon), **geothermal** (hot rocks underground) and **nuclear fusion** (like in the sun but a bit tricky to arrange on earth)

Day 4: Lesson IV-Introduction to Solar Energy and Solar Panels

Lesson Expectations:

- **Understanding Basic Concepts:** Define, with examples when appropriate, terms such as: solar energy, solar panels, solar cars, solar photovoltaic, solar thermal, evacuated tubes, flat panels. Understand the different types of solar panels and its main properties, efficiency, and application.

- **Developing Skills of Inquiry and Communication:** Analyze and discuss the various aspects of solar panels and examine that from various perspectives, social, economical, biological and technical. Able to connect these aspects and communicate its pros and cons.

- **Relating Science to Technology, Society, and the Environment:** Evaluate the suitability of solar energy and solar panels and analyze the costs and benefits to society of this alternative energy system and assess the impact of their use on both local and global scales.

Materials and Equipment:

- Solar panel models (flat panel and evacuated tubes)
- Thermometer to measure efficiency
- Materials used to contribute solar panels

Teaching/Learning Strategies:

Accommodations:

- Teacher encourage students to be bring ideas to class and generate questions
- teacher observes students in class and experiments and provide feedback and individual help as needed.

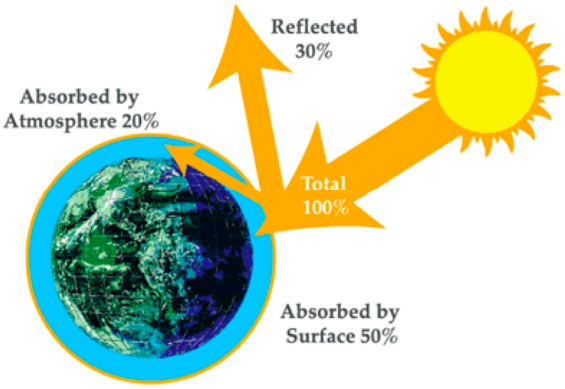
Differentiated Instructions:

- visual cues (handouts for experiment instructions and summary notes)
- auditory cues-describe the experiment orally
- bring in samples of solar products (models and smaller versions)

Formative Evaluation:

- Conduct experiment(s) on solar evacuated tubes in class with a partner or two.
- Record preliminary results and graph these
- Write a formal lab report and answer the questions listed in instruction sheet

Background Content:



Introduction to Solar Power

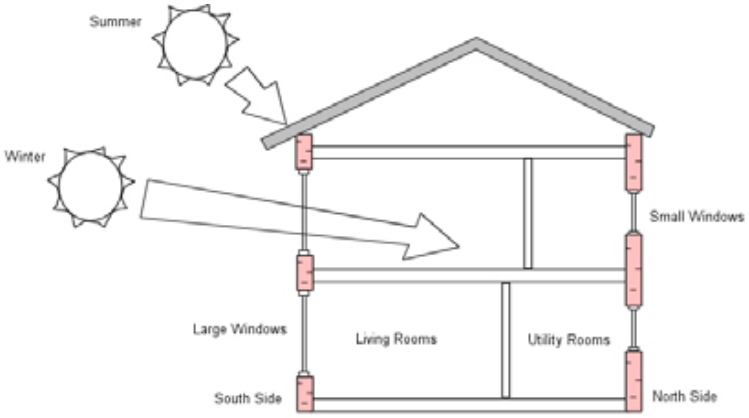
The Sun[14]:
The sun is a blazing globe of hot gases fuelled by nuclear fusion - where small atoms are squeezed together at great pressure to make heavier atoms with the release of massive amounts of energy.

The energy from the sun is radiated out in all directions as light. Much of the energy striking the earth is reflected back into space by the atmosphere. Every single second, the Earth receives over 173,000Tw energy from the sun. At sea level, the peak solar irradiation energy strength is 1Kw/m^2. This is enough to provide energy for daily uses for everybody on the Earth.

Using Sunligh[14]:
Although most forms of energy have the sun as their ultimate source, solar energy generally refers to methods of collecting light and turning it directly into a useful form of energy.

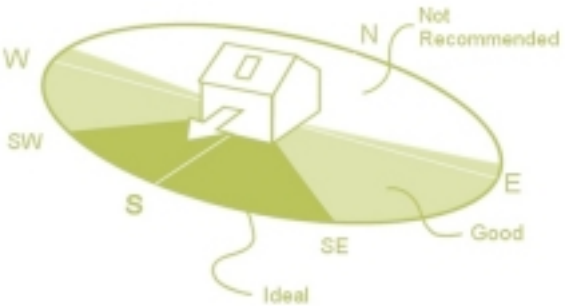
Thoughtful design can improve this figure further with very little, if any, increase in the cost of building the property[15]:

- Orienting the house so that the more often used rooms face south
- larger windows on the south side, smaller on the north;
- using building materials that store heat by adding "thermal mass" to the house
- lay out housing so that buildings do not over shadow each other.



Orientation

The effect of tilt angle and orientation[15]:
The position that maximizes the energy collected by a solar panel is facing south and tilted at an angle of 35 degrees from the horizontal.



Two main forms of solar energy generation:

1. Solar Thermal
2. Solar Photovoltaics (PV)
3. Combined Heat and Power (CHP)

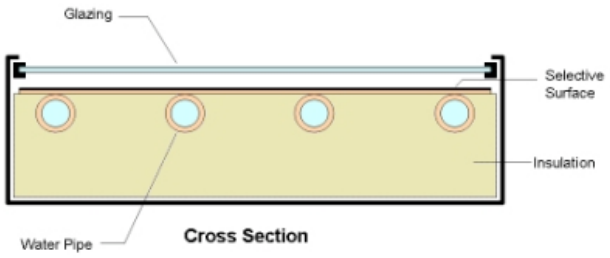
Background Content: (Cont.)

1. Solar Thermal[15]

A solar panel (also called solar collector), is a system that absorbs light and warms up, with a heat transfer fluid flowing through to transport the heat energy to meet the energy demands of water heating in various settings. The solar panel is located where it will get good light levels, often on the roof of the building, and a pump circulates heat transfer fluid (water, or water mixed with antifreeze) through the panel. One typical household solar water heater can save 1,000m^3 of natural gas or equivalent amount of energy in other forms, reducing 0.7 tonnes of greenhouse gases emissions per unit per year.

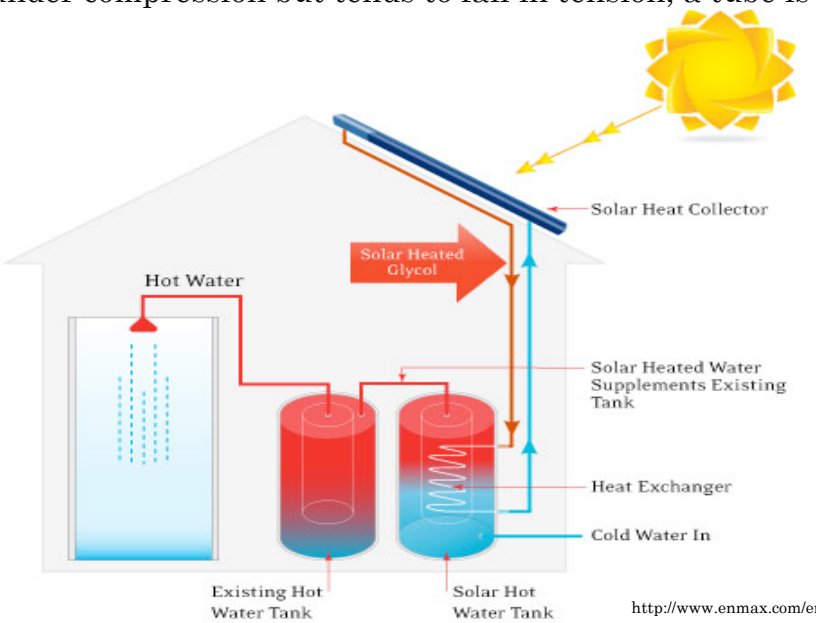
Types of Solar Thermal Panels[15]:

I. **Flat Plate Solar Panels:**
- The flat plate solar collector consists of a black surface arranged beneath a transparent cover, and insulated to the rear and sides. A heat transfer fluid (often water or glycol solution, sometimes air) is circulated through the panel to transport the heat collected away to where it can be used.



http://www.viridiansolar.co.uk/Technology%202%20Different%20types%20of%20Solar%20Panel.htm

II. **Evacuated Tube Solar Panels**
- Like in a thermos flask, a vacuum can be excellent thermal insulation. It reduces heat transfer by convection to zero. Conduction is not significantly altered under the level of vacuum typically used, but air is already a poor conductor.
- the vacuum is held in a glass container (to let light through). Since glass is very strong under compression but tends to fail in tension, a tube is ideal to use.



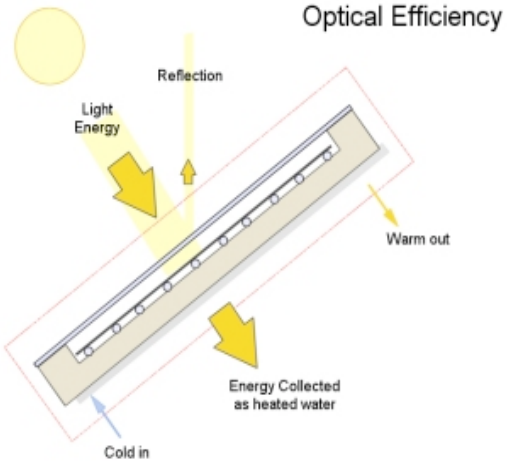
http://www.enmax.com/energy/res/greenmax/technology/default.htm

Background Content: (Cont.)

1. Solar Thermal (cont.)

Solar Efficiency:

Not all of light energy landing on a solar panel will be turned into useful heat. The ratio of the light energy that passes through transparent cover and is absorbed at the black surface to the light energy landing on the panel gives a measurement called "optical efficiency".



Future Development:

- Solar energy storage has been created so that during night time or low solar radiation time, solar energy can still be used[16].
    - Made possible by directing thermal energy from solar radiation into a salt container which stores this heat
    - This thermal energy from the salts will slowly dissipate during low radiation times and can recharge during the next high radiation time

Current Development and Applications on Market[14]:

I. Residentials
    - Solar energy systems for houses in domestic hot water
    - GTA led the way in residential installations

II. Commercials
    - Restaurants-use hot water for dish washing
    - Car Wash Stations-both at gas stations and independent ones

III. Swimming Pools
    - heat up large pools both indoors and outdoors

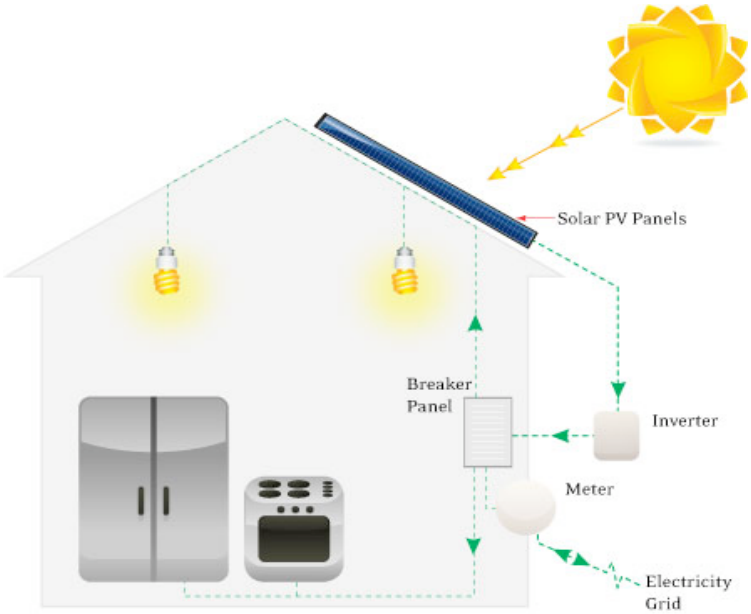
IV. Schools and Institutions
    - Toronto District School Board has started installing solar panels on roofs in some elementary and secondary schools

2. Solar Photovoltaics

Definition[16]:
Photovoltaic (PV) technology converts sunlight directly into electricity. A semi-conductor material in the panel produces a direct current when light lands on it. The direct current is converted to alternating current (AC) for use in the house or for export to the electricity grid.

PV Advantages[17]:

- Green, clean and unlimited energy
- provides a technologically feasible solution to the current environmental challenges created by current reliance on fossil fuel-based electrical power generation
- PV energy production, which is a large net energy producer and thus CO_2 emission reducer
- an environmentally beneficial and sustainable method of maintaining an energy intensive standard of living.



http://www.enmax.com/energy/res/greenmax/technology/default.htm

Current Development:

- has extremely limited deployment, making up far less than one percent of the global electricity generation due primarily to economics
- costs of PV-generated electricity expected to decline as production continues to climb and benefits from economies of scale
- As the world's politicians better understand the threat posed by climate destabilization it is likely that more countries will levy additional charges on electricity generation

Future Development[19]:

- New materials, such as silicon (Si) wires can be used instead of the traditional panel waters (1)
- Si wires uses 99% less material
- Absorption of peak wavelength has greatly increased to 96%, and boosting
- overall conversion efficiency to 89% (twenty times what it use to be)

Requirement[19]:

- PV requires more roof area, but unlike solar heating where the household demand places a limit on the energy saving, excess electrical energy can be exported, so the only technical limit on energy production is the area available for installation.

Background Content: (Cont.)

3. Combined Heat and Power (CHP)[20]

This system is one that uses solar energy to provide thermal heat as well as electricity. By combing the two systems, it can greatly increase the efficiency of the PV system.

Current Development:
More efficient combined heat and thermal (CHP) system are now in place so that 85% of energy is converted into thermal energy and 25% of radiation converted into electricity (5)

Overall Benefits of Solar Technology:

1. Sustainability
    a. Clean, renewable and green (decrease greenhouse gas emissions)
    b. Generate power where it's used
    c. Offset Peak Demand
    d. Reduces land use
    e. Glycol-free systems-safe and maintenance free

2. Technology Efficiency
    - Currently efficient to heat up water for homes, commercial uses and schools
    - PVs are not as efficient and are working towards improvement

3. Affordable: Green=Free
    a. Solar panels costs from $3000-6000
    b. Both federal and provincial government provide rebate support
    c. Decreased payback time
    d. Sun's energy ALWAYS free

Lesson Assessment:

Students, in groups should discuss and answer the questions below:

- How does this technology work? How could this energy source be used?
- What are some examples of its current use?
- What are apparent environmental impacts associated with this?
- Are there hidden environmental and social costs?
- Do the costs of this technology make it prohibitive for common use? Why or why not?

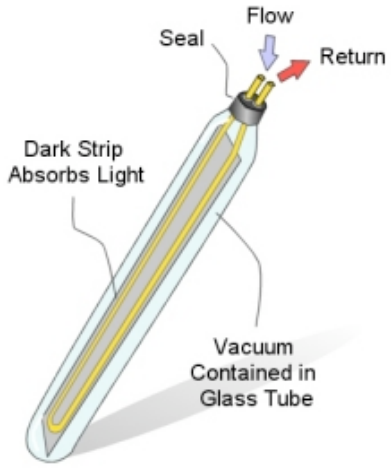
For Teachers:

- Teachers should facilitate the discussion
- Ask open-ended questions
- Encourage as many students to participate as possible
- Promote critical thinking and creativity

Solar Panel Experiment: Measuring the Efficiency of Evacuated Tubes

Purpose:

- To examine one type of solar thermal technology, the solar evacuated tubes, in depths
- To determine the efficiency of evacuated tubes by taking periodic measurements throughout the day and record these in a table for analysis



Time Required:

- 1 day (with one measurement per hour)

Materials:

- Solar evacuated tubes, thermometer, data record table chart paper, pencil

Methods:

1. Examine the anatomy of an evacuated solar tube and understand its properties and functions in depth. Draw a diagram in your notebook.
2. Take this evacuated tube and connect it to a thermometer where you will be taking the readings of temperature of the tube throughout the day.
3. Observe the weather and surrounding of the experiment site and note your observations in details (including location, estimated temperature, sky coverage and placement of your solar evacuated tube).
4. Place the solar evacuated tube outside and choose a clearing with visible sunlight. You should place it towards southwest where the solar radiation is maximized.
5. Visit the site of experiment periodically (once per hour) and record the temperature reading from thermometer. Make a table of this data and graph the results.

Observations:

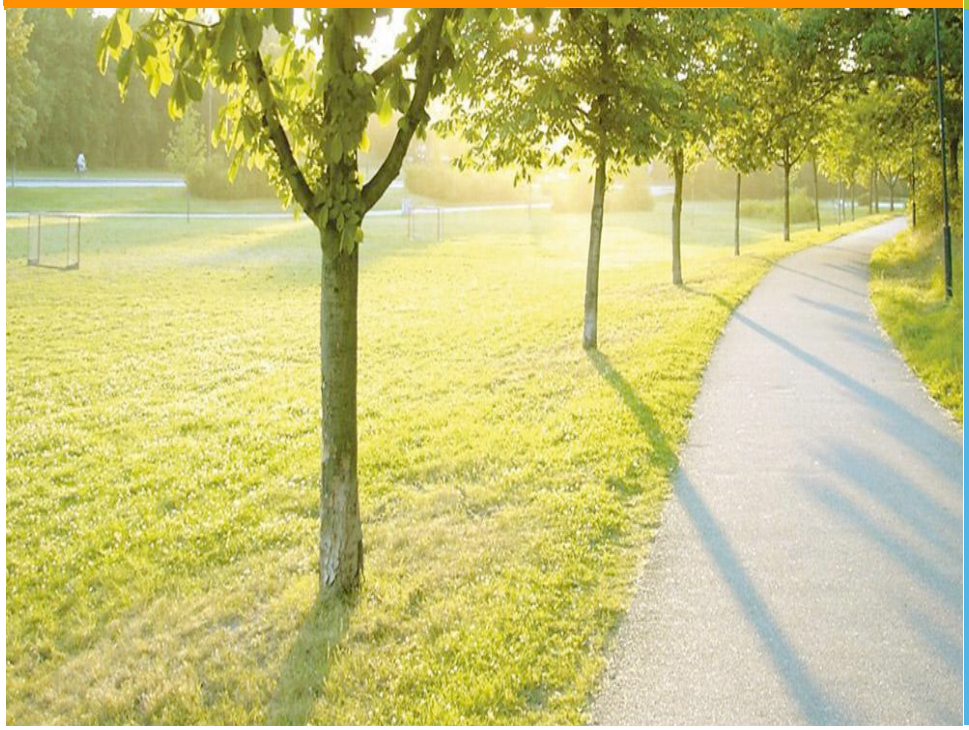
- Make a table of this data and describe your results in words
- Graph the results with appropriate tool.

Questions:

- Is there a pattern or trend in your table of results? If so, what kind of trend do you observe and predict it to be?
- What is the average temperature that the evacuated tube has reach, when was it maximum and minimum?

Assessment:

- Write a scientific report on this experiment



Grade 11-Environmental Conservation Biology
Independent Study Project (ISP)

Overview:

Global warming, rising sea levels, destruction of habitats, and loss of biodiversity are some major problems as a result of using non-renewable resources on earth. Our world is changing at an alarming rate and the changes can be scary and overwhelming. Based on what you have already learned in class, you will be investigating the alternative energy source and technology, solar energy and solar panels, in greater depths. You will be given some choices for your ISP.

Purpose:

- To provide students with the opportunity to creatively examine solar energy and solar panels and connect that to current social values and demands.
- To allow students to develop research skills and communication skills
- To encourage students to make the connection between curriculum and its application to the world.

Curriculum Expectations:

- Describe the solar panel technology and understand its pros and cons
- Connection between solar energy and other aspects of the current development
- Demonstrate an understanding of the importance, applications and future research on the field of sustainability and renewable energy resources with an emphasis on solar energy.

ISP Instructions:

You will choose **ONE** of the following options. All options contain some background research and knowledge acquired from class.

1. **Artistic Option:**
   For this option you will identify one or two major themes and/or social issues present using solar energy and solar panels. You will need to select a specific target audience and explain why you have choose that. Art is loosely defined for this component; you may create: a multi-media presentation, a piece of visual art, a poem, a song, an interpretive dance, etc. You must seek teacher-approval on your choice of artwork.

   In addition to your piece of art, you will write a 2-page reflection which identifies your theme and/or social issue and discuss its importance with reference to the society and the future in biology and environmental conservation. You will be expected to include some local sources and initiatives. Use MLA format for all citations from all sources.

2. **Research-based Option:**
   For this option you will perform research (using journal literatures, both books, mazagines, and online sources) on various aspects of solar technology. You can focus on the technical, social, political, economical and biological perspective of solar panels and provide a short scientific background introducing renewable resources and solar panels. A few potential topics are:

   a. How does the implementation of solar panel impact the society and its economy?
   b. How will the solar technology benefit the environment and help in the conservation effort in the long-term?
   c. What is the current developmental stage in solar panels and where do we anticipate this technology to provide and improve in the future?

   - Based on your research, you will write a 5-6 page essay using the MLA format.Finding both current and historical newspaper articles. You will also include a summary of your research following the MLA format.
   - Based on your research you will make a 3-5 minute presentation to your classmates. This presentation may be either entirely oral or a combination of oral and power point.

   Although certain guidelines have been mentioned above, what you choose to research and how you will present it is up to you. Teacher-approval of your choice required.

3. **Creation Option:**
   For this option you will create something which connects to the application of solar panels. Some examples are: sustainable house or solar car. In order to complete this option, you will need to research and create your final product. Again, teacher-approval should be sought. Submit a summary of your research (2-3 pages) following the MLA format.

Seminar Evaluation Form

Student Name: _____
Seminar Topic: _____

Criteria	*Level 1 (50-59)*	*Level 2 (60-69)*	*Level 3 (70-79)*	*Level 4 (80-100)*	*Marks*
Introduction	topic is mentioned	topic and some of the subtopics are stated	topic and all subtopics are stated	topic and all subtopics are stated in proper order	
Knowledge of Topic	limited knowledge of topic with little accuracy	some knowledge of topic with a degree of accuracy	standard knowledge of topic, usually accurate info	detailed knowledge of topic with consistently accurate info	
Support of Ideas	limited connection made between evidence, subtopics & topic	some connection made between evidence, subtopics topic	usually connection made between evidence, subtopics & topic	consistent connection made between evidence, subtopics & topic	
Organization	unclear agenda with illogical sequencing & unhelpful handout	scant agenda & handout with somewhat useful handout	clear, logical agenda is usually shown / followed with useful handout	clear, logical, thorough agenda is shown & followed combined w/ very useful handout	
Conclusion	little summary of subtopics	topic and some subtopics summarized	topic and all subtopics summarized	topic all subtopics summarized in proper order	
Creativity / Enthusiasm	little colour or variety used & no smiles	somewhat bored, with some variety & colour	usually smiling, appropriately dressed, variety	unique, colourful, stimulating seminar with extra effort	
Use of Time / Pace	seminar is too short/long and moves too quickly/slow	sometimes seminar moves too quickly / slowly and at times is off topic	starts / finishes on time covering relevant info	starts / finishes on time covering relevant info in an interesting manner	
Discussion	little discussion generated from closed-ended, repetitive questions	some discussion generated from somewhat relevant questions that require superficial thought	three relevant questions generate discussion that requires thought	three relevant, open-ended questions generate much discussion, insight, analysis & evaluation	
Totals					

Additional Comments:

_____

_____

_____

_____

Essay Evaluation Form

Student(s) Name(s): _____

Essay Topic: _____

Criteria	*Level 1 (50-59)*	*Level 2 (60-69)*	*Level 3 (70-79)*	*Level 4 (80-100)*	*Marks*
Introduction / Thesis	-weak introduction of topic, thesis & subtopics -thesis is weak and lacks an arguable position	-adequate introduction that states topic , thesis and some of the subtopics - thesis is somewhat clear and arguable	-proficient introduction that states topic, thesis, and all subtopics in proper order - thesis is a clear and arguable statement of position	-exceptional introduction that grabs interest of reader and states topic, thesis, and all subtopics in proper order - thesis is exceptionally clear, arguable, well developed, and a definitive statement	
Quality of Information / Evidence	-limited information on topic with lack of research, details or historically accurate evidence	-some aspects of paper is researched with some accurate evidence from limited sources	-paper is well researched in detail with accurate & critical evidence from a variety of sources	-paper is exceptionally researched, extremely detailed and historically accurate with critical evidence from a wide variety of sources	
Organization / Development of Ideas	-paper lacks clear and logical development of ideas with weak transition b/w ideas and paragraphs	-somewhat clear and logical development of subtopics with adequate transitions b/w paragraphs	-clear and logical subtopic order that supports thesis with good transitions b/w paragraphs	-exceptionally clear, logical, mature, and thorough development of subtopics that support thesis with excellent transition b/w paragraphs	
Conclusion	-lack of summary of topic, thesis & subtopics with weak concluding ideas	-adequate summary of topic, thesis and some subtopics with some final concluding ideas	-good summary of topic, thesis and all subtopics with clear concluding ideas	-excellent summary of topic (with no new information), thesis & all subtopics in proper order with concluding ideas that leave an impact on reader	
Language Conventions	- inconsistent grammar, spelling and paragraphing throughout paper	-paper has some errors in grammar, spelling and paragraphing	-paper is clear, with mostly proper grammar, spelling and paragraphing	-paper is very concise, clear, with consistently proper grammar, spelling and paragraphing	
Bibliography	-lack of proper format and limited details with many sources missing or incomplete	-some errors in MLA format with most sources shown and a variety of sources	-mostly proper MLA format used in alphabetical order with all sources shown and a variety of sources	-proper, detailed MLA format always used in alphabetical order with all sources shown and a wide variety of sources	
Comments:				Total:	

Day 5: Field Trip and Interactive Learning

Learning Outcome:

- Students will observe solar panels installed on Goodwin Hall
- They will examine its physical components and learn about its technical functions
- Students will learn about how these solar panels supply energy for the building

Schedule/Advanced Organizer:

1) Tour Integrated Learning Center (ILC) and Goodwin Hall (booking required in advance)
    a. This provides a chance to see some of the solar technology that is already in place
    b. Have an understanding of the types of impact from these technology
2) Listen to guest speaker(s) give a talk on sustainability and renewable resource, with an emphasis on solar energy
3) Examine some current projects and solar car

Key Questions:

1. What are some of the important factors that need to take into consideration before installing solar panels?
2. How does this technology work and how well does it work in this building?

Teaching/Learning Strategies:

- Research accessibility of the building prior to field trip. Provide both visual and auditory aids during the trip for students.

Activity Assessment:

- Have students note down three interesting facts that they learnt about solar technology from the field trip and its current relevance.
- Write a 2-3 pages of reflection from the visit

Goodwin Hall

Queen's University
25 Union Street
Kingston, ON

Introduction:

Goodwin Hall houses Queen's Departments of Mining Engineering and the School of Computing.

Solar Panels:

A 20 kilowatt solar array was placed on Goodwin Hall, in June 2002. It was constructed as a learning, teaching, and research tool for Applied Science students, and it generates enough power to run five family homes.

Solar Power Supply:

The array feeds its power into Walter Light Hall, Goodwin Hall, and the Integrated Learning Centre (Beamish Munro Hall). These buildings are located around Goodwin.

Additional Resources for Teachers

1. Renewable Resource sources: This website provides a list of general websites concerning different types of renewable resoureces http://www.teachers.ash.org.au/jmresources/energy/renewable.html

2. Solar Panel Information-this provides some more background information about fitting solar panels into a residential unit. http://www.solarpanelinfo.com/

3. Worldwatch Institute- Vision for a Sustainable World: "Worldwatch focuses on the 21st-century challenges of climate change, resource degradation, population growth and poverty by developing and disseminating solid data and innovative strategies for achieving a sustainable society" http://www.worldwatch.org/

4. Conservation Interanational: This website provides information on various conservation projects to maintain biodiversity in threatened ecosystem. It also provides connections between some of the problems of global warming to biodiversity. http://www.conservation.org/discover/Pages/about_us.aspx

Reference:

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