



ENERGY LESSON PLAN

Solar Panels and Their Impact on the Environment

Background

Solar photovoltaic (PV) cells convert the sun's energy directly into electricity. Although sunlight is a clean, renewable energy source, the solar panels themselves have an effect on the environment. Solar panels contain silicon and rare or precious metals such as silver, tellurium, and indium. Not only that, but solar panels and their working parts also often include hazardous substances such as cadmium. Making a silicon-based solar cell uses a lot of energy. Unfortunately, the source of that energy is often coal, which is a dirty way to create electricity because it emits a lot of carbon dioxide (CO₂), particulates, mercury, and other harmful greenhouse gases into the atmosphere.

1. Restriction of Hazardous Substances

According to **Waste from Electrical and Electronic Equipment (WEEE)**, an estimated 90% of electronic waste ends up in landfills around the world. The **United Nations Environmental Programme** estimates that 64 million individuals in developing nations make a living foraging electronic waste. **Restriction of Hazardous Substances (RoHS)** originated in the European Union in 2002. RoHS is a regulation that restricts the amount of hazardous materials in electronics in order to protect the environment and workers' health and safety. RoHS limits the concentration of substances such as lead, mercury, and cadmium.

Solar photovoltaic panels first became popular in the 1980s, powering common objects such as calculators, watches, radios, etc. (**Sunlight Electric**). Panels made before RoHS was introduced in 2002 contain a larger amount of hazardous materials than those manufactured after that time, so it is imperative that those first generation solar panels are disposed of responsibly when they stop working.

Did you know?

Saskatchewan captured only 28% of the mercury emitted by our coal-fired power plants in 2003. By 2014, SaskPower was capturing 45% of the mercury from the province's coal-fired electric power generation plants, which complies with the Canada-wide standards for mercury emissions, however there is still clear room for improvement. In 2014, 357kg of mercury was emitted from Saskatchewan's coal-fired power generation plants.

Source: Canadian Council of Ministers of the Environment, **Canada-Wide Standards for Mercury Emissions from Coal-Fired Electric Power Generation Plants**

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2. Silicon Valley Toxics Coalition

The **Silicon Valley Toxics Coalition** (SVTC) formed in 1982 to tackle occupational illnesses and water pollution in the Silicon Valley, a global hub of electronic manufacturing facilities. Today, SVTC continues to research the effects of the production of electronics on human health and the environment. Through advocacy and awareness, SVTC has been a leader in promoting producer responsibility in the production of electronics, including the solar PV industry.

SVTC has created a way to measure sustainability in the solar industry. The **Solar Scorecard** awards points to solar PV manufacturers according to their performance in twelve different areas. Companies are ranked based on their use of chemicals, water, conflict minerals, energy, toxic metals, etc.

Setting A Local Example



The **SES Solar Co-operative Ltd.** is Saskatchewan's first renewable energy co-op. When choosing an installer, they utilize the Solar Scorecard and RoHS to help the Board of Directors compare the environmental impact of various panels.

Objective

The goal of this lesson plan is to analyze the effects of solar PV technology on the environment and human health by taking a closer look at workers' rights and the disposal of solar PV components. As consumers, we need to be both knowledgeable and responsible enough to demand environmentally, socially, and economically feasible solar panels.

Procedure

1. Encourage the students to research a number of media articles that focus on solar panels' environmental impact, or read one together.

Suggested Readings

- National Geographic: [How Green Are Those Solar Panels, Really?](#)
- The Globe and Mail: [The darker side of solar power](#)
- The Guardian: [Are solar panels the next e-waste?](#)
- Silicon Valley Toxics Coalition: [Toward a Just and Sustainable Solar Energy Industry](#)
- United Nations Environmental Programme: [Illegally Traded and Dumped E-Waste Worth up to \\$19 Billion Annually Poses Risks to Health, Deprives Countries of Resources, Says UNEP Report](#)



2. Show the students the following chart substances banned under RoHS.

Substances Restricted Under RoHS		
Source: http://www.rohsguide.com/rohs-substances.htm		
Lead	Pb	< 1000 ppm
Mercury	Hg	< 100 ppm
Cadmium	Cd	< 100 ppm
Hexavalent Chromium	CrVI	< 1000 ppm
Polybrominated Biphenyls	PBB	< 1000 ppm
Polybrominated Diphenyl Ethers	PBDE	< 1000 ppm
Phthalates	DEHP	< 1000 ppm
	BBP	< 1000 ppm
	DBP	< 1000 ppm
	DIBP	< 1000 ppm

Did you know?

Compact fluorescent light bulbs contain a small amount of mercury. Each swirly bulb has about 3-5mg of mercury in it. Old mercury thermometers contained about 500 mg of mercury.

Source: Environmental Health Perspectives, **Mercury: Cleanup for Broken CFLs**

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3. Have the students research different metals used to make solar panels. Take notes about each metal using the chart (attached below).

Resource: [Royal Society of Chemistry's interactive periodic table](#)

4. Divide the students into groups of four or five. Each group will represent one of the following stakeholders in the renewable energy sector:
- A business that has twenty-five-year-old solar panels on its roof
 - A local installation company
 - A recycling company
 - SaskPower
 - A solar panel manufacturer

Explain that solar panels have a lifespan of approximately twenty-five years. This means that the first generation of solar panels are nearing the end of their life. As solar panels and their associated technology begin to stop working, it is important that they are recycled, reused and/or disposed of properly.

5. Read the following:

In 1998, an elderly couple installed ground-mounted solar panels on their farm. Today, the couple are 84 and 85-years-old. As their solar photovoltaic cells near the end of their lifespan, the couple is concerned about how they will dispose of the panels in a safe and responsible way.



6. In their assigned groups, the students' task is to design a business that will ensure the proper management of retired solar photovoltaic cells in Saskatchewan. Remind the students to keep rare and precious elements in mind.



METAL	NATURAL ABUNDANCE	USES	TOXICITY	VALUE
Silver				
Tellurium				
Indium				
Indium tin oxide				



METAL	NATURAL ABUNDANCE	USES	TOXICITY	VALUE
Selenium				
Copper indium gallium selenide (CIGS)				
Amorphous silicon				
Cadmium				



Curriculum Connections

Science 9: CE9.4 Critique impacts of past, current, and possible future methods of small and large scale electrical energy production and distribution in Saskatchewan.

Science 10: SCI10-CD1 Assess the implications of human actions on the local and global climate and the sustainability of ecosystems.

Environmental Science 20: ES20-HP1 Investigate technologies and processes used for mitigating and managing resource use, waste generation and pollution associated with a growing human population.