Solar Schools
for British Columbia

A collection of lessons to assist teachers and students with their exploration of solar energy

SolarBC
Join the Solar Revolution

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Breakthroughs and Barriers

Timeline game of inventions and obstacles

What will happen

Students explore the significance of solar inventions and predict what they think will happen next, what they'd like to see happen and identify what might influence those outcomes.

Students will

- Learn about inventions that aided the progress of solar energy;
- Understand how certain events in history have aided and interfered with the progress of solar energy technology;
- Predict how history and current circumstances will affect the future of solar energy technology;
- Understand that inventions are merely one aspect of implementation; that there are numerous other factors such as politics, legislation, supply, demand and activism that impact the amount of solar energy in use.

Total Time 1½ - 2 hours	Establish what students know	Activity	Debrief what students learned	What next
	10 - 15 minutes	45 - 60 minutes	20 - 25 minutes	20 minutes

Who invented solar energy

What you need to know

Many factors combine to affect the development and implementation of technology. Some of the notable points along the timeline of solar energy technology have been selected for the lesson. These could easily be substituted or enhanced to shift the emphasis to feature political, scientific, social, or legislative events, or a combination of these.

What might surprise you

- There is some evidence that ancient cultures across the globe have used glass and polished metals to concentrate the heat and light of the sun. This concept has been around so long that the Justinian Code of 6th Century A.D. decreed that every individual had "Sun Rights".
  Source: http://www.xtimeline.com/evt/view.aspx?id=194766
- 85% of the households in Israel use solar thermal systems, saving about two million barrels of oil a year, one of the highest per capita rates
  Source: Israeli Section of the International Solar Energy Society
- Over 30 million Chinese households have solar water heating systems where they cost approximately $200, about 80% less expensive than in Western countries. Efficient evacuated tubes which allow heaters to function even under gray skies and at temperatures well below freezing are credited with this growing popularity in China.
  Source: Energy-Hungry China Warms to Solar Water Heaters *Reuters*

WildBC

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What you need

- Patent application form – one per student
- For each student group:
  - Solar thermal timeline
  - Solar thermal student cards
- For optional activity:
  - Solar photovoltaic (PV) timeline
  - Solar photovoltaic student cards

Establish what students know

1. As a class, discuss what it means to invent something and the role of a patent.
2. Ask students, "Who invented solar energy and when was it discovered?"
3. Introduce the idea that natural systems use the sun and have been doing so, long before people lived on Earth. Discuss the idea of 'nature' as the inventor.
4. Have them complete the patent application form on behalf of 'nature' for the invention of the sun.
5. Read the statement below and ask students to comment on how this relates to nature's uses of solar energy.

   > "Solar technology isn't new. Its history dates back to the 7th Century B.C. In those early days, the sun's heat was used with glass and mirrors to light fires."
   >
   > Source: US Dept of Energy www1.eere.energy.gov/solar/pdfs/solar_timeline.pdf

Main Activity

What you do

Part A

1. Introduce this activity with a bridging statement such as, "By exploring the events that have hindered or helped the progress of solar energy technology since it was first used, we can form conclusions about the role of solar energy, today and in the future, in people's lives."
2. Explain to students that they will be working with a solar technology timeline. You may choose to build on prior student knowledge by demonstrating how to work though the steps of the lesson using the solar photovoltaic timeline and then assigning students to use the solar thermal timeline with a small group. Conversely, you may wish to simply provide students with the instructions and materials and have the groups construct the solar thermal timeline on their own.
3. Explain that students will be matching a series of event cards to the year they think the event occurred. If students need assistance in developing the time line, have them begin by sorting the events into these three categories:
   - recently;
   - when our parents were kids;
   - when our grandparents were kids.

4. Group the students and distribute the solar thermal timeline cards. Have the students create the timeline. Once students have placed all their cards, distribute the actual solar thermal timeline to check their answers.
5. Have students discuss the following:
   - What trends do you see?
   - What was the most surprising?
   - What do you think will come next on the solar thermal timeline?

Part B

1. Select one group to bring their timeline to the front of the room and stand holding the cards in correct chronological order.
2. Invite students to select one event and move it to a different place in the timeline.
3. As a group discuss how this would have changed the progress of solar technology development. Summarize and record one 'if/then' statement for the changes that would have occurred.
4. Replace the card in the correct location in the timeline. Repeat for a different card in the timeline.
5. Discuss how discoveries and progress in technological development build upon each other.

Debrief what students learned

Have students create a record of their solar energy discoveries. This could be within an existing journal, notebook or have them design their own graphic organizer. Encourage them to use both a visual and descriptive features within their work. Assign all or some of the following questions.

- What do you think is the most significant event to help solar thermal energy? Explain why you think this?
- What do you think is the most significant event to hinder solar thermal energy? Explain why you think this?
- If you could alter the course of history and influence the progress of solar energy what would you change and why?
- What do you expect will happen next? What makes you think that?
- How would you like this timeline to look in ten years? Why would you like it to look like that? What changes would this have brought to our lives?
- What do you think needs to happen to reach these milestones?

Assessment

- Formative: Can students explain what inventions aided the progress of solar energy? Can they accurately describe how the progress of solar energy was impacted by certain events in history? How well did students record their discoveries about solar energy?
- Summative: Challenge students to identify how they would use the timeline to:
  a. Lobby government
  b. Support a social marketing campaign
  c. Educate elementary students

Extensions

- Take a piece of history and bring it to life. Have the student groups research one event in solar thermal history and present what they discover to the class.
- Create a new timeline game for solar thermal technology. Have student groups research and determine other events in the development of solar energy capture and create their own timeline and set of timeline cards. Students then challenge the other groups to complete their time line.
- Watch an inspiring video featuring an inventor who invented solar plastic at: http://www.youtube.com/watch?v=9yxktvSF4_4

Check out

Links

- The History of Solar. A comprehensive list useful as a reference tool for details associated with solar history up to 2001 http://www1.eere.energy.gov/solar/pdfs/solar_timeline.pdf
- Timeline of solar energy http://www.xtimeline.com/timeline/History-of-Solar-Power
- Timeline of solar cells http://www.xtimeline.com/timeline/Timeline-of-Solar-Cells
- Photovoltaic Timeline http://tonto.eia.doe.gov/kids/energy.cfm?page=tl_photovoltaic
- California Solar Centre: History of solar energy http://www.californiasolarcenter.org/history_pv.html
- Solar thermal http://www.californiasolarcenter.org/history_solarthermal.html
- Passive solar http://www.californiasolarcenter.org/history_passive.html

Video

- Look who invented solar plastic at: http://www.youtube.com/watch?v=9yxktvSF4_4

Poster

- Student-friendly 10-page summary of the history of solar energy http://www.californiasolarcenter.org/pdfs/rahus/Panels_1-10_poster.pdf

Brochure

- Understanding solar electricity http://www.californiasolarcenter.org/pdfs/rahus/SolarElectricity_3.pdf

student worksheet

Patent Application

Inventor: Nature

Assignee:

(Whoever is applying on behalf of the inventor)

Patent Title: Sun

Abstract (a summary of the invention) It is known to....

Specification (description of the invention and its usefulness)

1. It is common that this tool....
2. What makes this invention unique is....
3. This invention is better than other similar inventions because it...

Claims (specific ways it works) When this invention is used as...

1. a thing, it can....
2. a process or a way of doing things, it can....

Drawings

Your application must include a drawing whenever the invention can be shown by one.

- Your drawing must show every feature of the invention defined by the claims.

Check out a real patent application in Canada
http://www.cipo.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/engwr01088.html

Timeline of Solar Photovoltaic (PV)

		WHAT HAPPENED?	HOW DID IT IMPACT?
1	1870s	An electrical current could be started in selenium solely by exposing it to light.	This proved that a solid material could change light into electricity without heat or without moving parts.
2	1880s	A solar cell was created using selenium on a thin layer of gold.	It was the first solar device but it had less than 1% efficiency.
3	Early 1950s	A silicon solar cell that was efficient than the existing solar cells made from selenium was discovered.	Solar cells could convert enough of the sun's energy into power to run everyday electrical equipment.
4	1956	A one-watt solar cell costs almost $300 per watt while a commercial power plant produced a watt for 50 cents.	The only demand for silicon solar cells came from radio and toy manufacturers to power miniature ships in wading pools, propellers of model DC-4's, and beach radios.
5	Late 1950s	The Cold War encouraged the development of technology.	The Military saw solar cells as the ideal power source for a top-secret project: earth-orbiting satellites.
6	1960s	The Space Race.	Cost was not a factor. Manufacturers worried more about size, efficiency and durability: the cost of the launch, and the continuing operation of equipment once in space.
7	1970s	A less costly solar cell was created by using a poorer grade of silicon and packaging the cells with cheaper materials.	This brought the price down from $100 a watt to $20 per watt. Solar cells could now compete with other energy sources, in situations where people needed electricity distant from power lines.
8	1979	The Energy Crisis.	This caused a groundswell of public interest in solar energy use.
9	1980s	Individual homes in parts of the world without electricity now had power.	Solar cells proved effective where access to other forms of power was limited.

		WHAT HAPPENED?	HOW DID THAT IMPACT?
10	1990s	Tubular octagons of crystalline silicon were made from a die.	This eliminated much of the expense of producing solar cells.
11	2004	California Governor Arnold Schwarzenegger proposed Solar Roofs Initiative for one million solar roofs in California by 2017.	This got a lot of attention and created media attention and interest in solar.
12	2005	Organic solar cells made of plastic are developed.	While traditional solar panels are made of silicon, which is expensive, brittle and shatters like glass, these are relatively inexpensive, flexible, can be wrapped around structures or even applied like paint.
13	2006	A new process of printing a fine layer of semiconductor directly onto glass, metal and other building materials was developed.	New skyscrapers can be solar energy-ready as they're constructed.
14	2007	Photographic technology to align trough mirrors was invented. Also: Efficiency of solar panels reaches 42.8%	It shows how the mirrors should be aligned. Once the mirrors are aligned, the energy savings start and the alignment ensures maximum efficiency during the life of the plant.
15	2008	Thin-film solar panels roll off the assembly line, as if from a printing press.	This process offers a light and extremely inexpensive option to silicon panels that need to be baked in batches.

There has been a rapid rate of advancement in recent years. Here's what some BC industry experts think.

Between 2005 and 2009, some of the most significant advances in solar energy include the first solar thermal system which feds into the district utility line in North Vancouver, a solar heat recovery hybrid system and the first solar-geothermal hybrid system installations in Canada. Susan Huber, Swiss Solar Tech Ltd.

Between 2005 and 2009, the most significant advance in solar energy was when the demand for solar silicon surpassed the demand for microchip silicon. This meant that the solar industry began to drive the refinement process for silicon and was a large enough market to get silicon made to its standard rather than the microchip standard (which is purer). This resulted in cost savings for the solar industry. Simon Boone, Generation Solar

Student Cards

2004	Late 1950s
1880s	1960s
2008	1970's
1980s	1979

Student Cards

A solar cell was created using selenium on a thin layer of gold.	The Cold War used any technology that was available.
California Governor Arnold Schwarzenegger proposed Solar Roofs Initiative for one million solar roofs in California by 2017.	Thin-film solar panels roll off the assembly line, as if from a printing press.
Individual homes in parts of the world without electricity now had power.	The Energy Crisis
A less costly solar cell was created by using a poorer grade of silicon and packaging the cells with cheaper materials.	The Space Race

Timeline of Solar Thermal

		WHAT HAPPENED?	HOW DID IT IMPACT?
1	1767	Swiss Scientist Horace de Saussure invented the world's first solar collector, or 'hot box".	This prototype for solar collectors introduced the idea and the possibilities.
2	1890s	Clarence Kemp of Baltimore patented a way to combine the old practice of exposing metal tanks to the sun with the scientific principle of the hot box, thereby increasing the tanks' capability to collect and retain solar heat. A Bed & Breakfast in Atlanta, Georgia, featured solar hot water with 10 roof-top panels to heat three 105-gallon storage tanks in the basement.	This was the world's first commercial solar hot water heater. Kemp originally marketed his invention to eastern gentlemen whose wives had gone off with their maids to summer at some resort, leaving their husbands to fend for themselves. The solar water heater, Kemp advertised, would simplify housekeeping duties for this class of men already burdened by their wives and domestic staff's absence and unaccustomed to such work as lighting the gas furnace or stove to heat water.
3	1900s	William J. Bailey patented a solar water heater that had two parts: a heating element exposed to the sun and an insulated storage unit in the house.	This revolutionized the business because his system, called the Day and Night, provided hotter water for longer periods. In just nine years his company sold more than 4,000 Day and Night Solar Hot Water Heaters.
4	1920s	Because people tend to rely on expensive imported coal or wood for fuel, many found solar a cheaper alternative. The huge discoveries of natural gas in Los Angeles basin during the 1920s and 1930s killed the local solar water heater industry.	
5	1940s	More than half the population of Florida heated its water with the sun. After World War II,	This brought Florida's once flourishing solar water heater industry to a screeching halt.

		WHAT HAPPENED?	HOW DID IT IMPACT?
		the cost of electricity declined. Florida Power and Light offered electric water heaters at bargain prices.	
6	1950s	There was a fuel shortage in the new Israeli state, and the government forbade heating water between 10 pm and 6 am The first commercial manufacturer of solar water heating was in Israel.	This encouraged people to look at solar technology for another option.
7	1970s	President Jimmy Carter put a large solar system on the White House.	It sent a message to people that solar was a good idea.
8	1980s	The price of oil dropped and the Israeli government did not want people returning to old energy habits as happened in the rest of the world. Israel passed a law requiring the installation of solar water heaters in all new homes (except high towers with insufficient roof area). Technical performance, life expectancy and ease of use were improved.	Over 40,000 were installed and still function a quarter of a century later. Today, more than 90% of Israeli households own solar water heaters. Designs became so successful that they came with a 25-year warranty
9	1997s	Australia has a variety of incentives (national and state) and regulations (state) for solar water heating systems.	The number of solar installations increases with incentives.
10	2006	Spain became the second country in the world (after Israel) to require the installation of solar water heating systems.	As countries adopt policies like this, installing systems like this will become more common,

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Susan Huber, Swiss Solar Tech Ltd

Student Cards- Solar Thermal

1767	1940s
1890s	1970s
1900s	1997
1930s	2006

Student Cards- Solar Thermal

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