



PEEL

People for Energy and
Environmental Literacy

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Renewable Energy 101

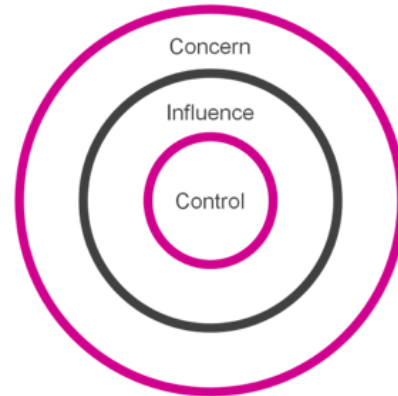
2018

Lesson 4 – Advanced Level

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Circle of Concern, Control and Influence

- **Circle of concern** - things we may not have direct control over.
- **Circle of influence** - things that I can influence and others can do something.
- **Circle of control** - things I can actually do



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It can be easy for kids to become overwhelmed by the issue of climate change. Using the circle of control, influence and concern helps students to discern what they can affect.

This lesson is focused on the circle of concern.

Introduction to Alberta's Renewable Energy

- The Year of Cheap Wind Power - Year End Review Part 1
 - https://www.youtube.com/watch?v=Z9tzFHdz_HM
 - 4 minute video of green energy in Alberta



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Show the class this video as an introduction to green energy. This video highlights the low cost of renewable energy. David Dodge, from Green Energy Future,s is an industry expert here in Alberta.

To show the video, click on the link on this slide while in PRESENTATION MODE.



Types of Energy

Renewable energy and non-renewable energy



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Types of Renewable Energy



Natural Resources Canada definition:

"Renewable energy is derived from natural processes that are replenished at a rate that is equal or faster than the rate at which they are consumed"



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Renewable energy: Energy that comes from a source that is not depleted when used.
Current renewable sources include: wind, solar, hydro, geothermal, and biomass

Types of Non-Renewable Energy



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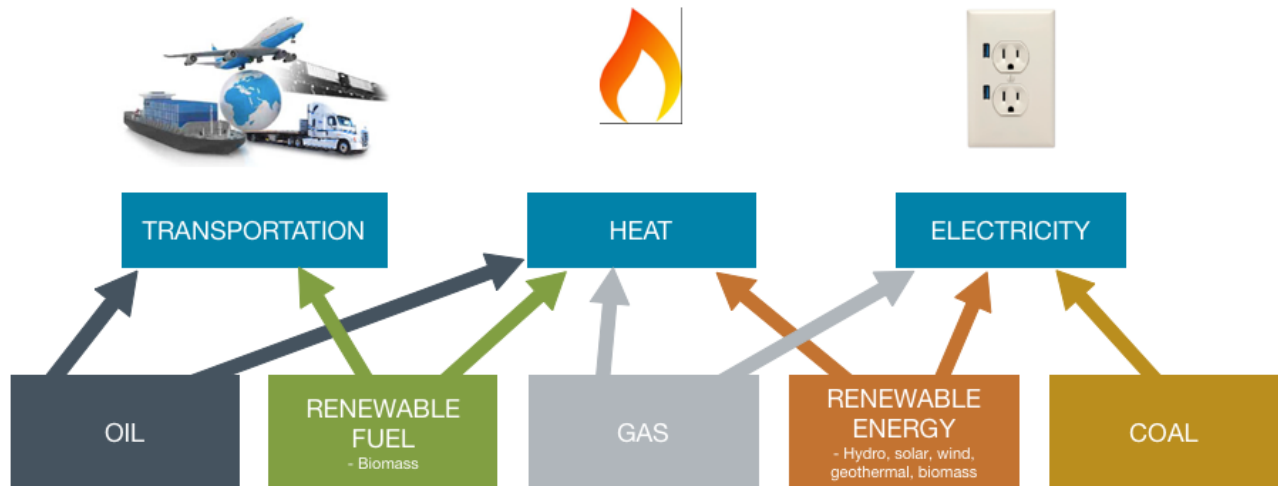
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Non-Renewable Energy: An energy source that will not be replaced naturally within our life time, if ever. Examples include: coal, oil, nuclear, and natural gas

Alberta is a producer of coal and coal power

Uses of Energy



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The three primary uses of energy are:

- Transportation (how we get to different locations)
- Heat (how we keep buildings and homes warm)
- Electricity (how we power electronics and appliances)

We can make energy from these sources:

- Oil
- Renewable Fuel (Biomass)
- Gas
- Renewable Energy
- Coal

Majority of the types of renewable energy (hydropower, solar, wind and geothermal energy) are used for electricity generation. Biomass is a special kind of renewable energy because it can also be used for transportation.

Transportation fuels are primarily from oil, and biomass.

Heat is from gas, primarily in Alberta, or biomass

Electricity is from gas, coal and renewable energy

What kind of skills are needed to develop a renewable energy facility?

- Engineers – Mechanical, Electrical, Civil, Structural, Wind Power
- Geologists, Geotechnical Specialists
- Construction Specialists
- Project Managers
- Administrators, Bookkeepers
- Contract Administrators
- Computer Specialists
- Construction Workers
- Biologists
- Archaeologists
- Traditional Land Study Specialists
- Lawyers
- Communications Specialists
- Artists
- Land Specialists
- Stakeholder Consultation Specialists
- Electricians



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This is a list of all the specialists that have a role in the development of a renewable energy facility. There are many different fields of work that come together throughout the different phases of the project. This list should show students that there are many jobs available if a career in the renewable industry is of interest.

Additionally, during the construction of a power facility, there is a large demand for construction workers, as well as permanent operation positions.



Wind Energy 101



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Windmills and Wind Turbines

- They may seem the same, but they are very **different**

WINDMILLS

- Uses the winds energy to **grind grain**, and **pump water**
- Has typically multiple blades (4 or more)



WIND TURBINES

- Uses the winds energy to generate **electricity**
- Has typically only 3 blades



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There is a lot of confusion between windmills and wind turbines, and it is a common mistake. Although wind turbines are modeled after windmills, which have been around for centuries, they both serve very different purposes. See the comparison above to understand the difference. Wind turbines are also significantly larger in size (as high as 200m!).

For centuries, humans have used the wind to power their activities. Windmills and sailboats have helped us in our lives.

Windmills are used to grind grain and pump water.
Wind turbines produce electricity.

What is Wind Energy?

- Wind energy generation is the conversion of the **kinetic energy** in wind to **electrical energy**



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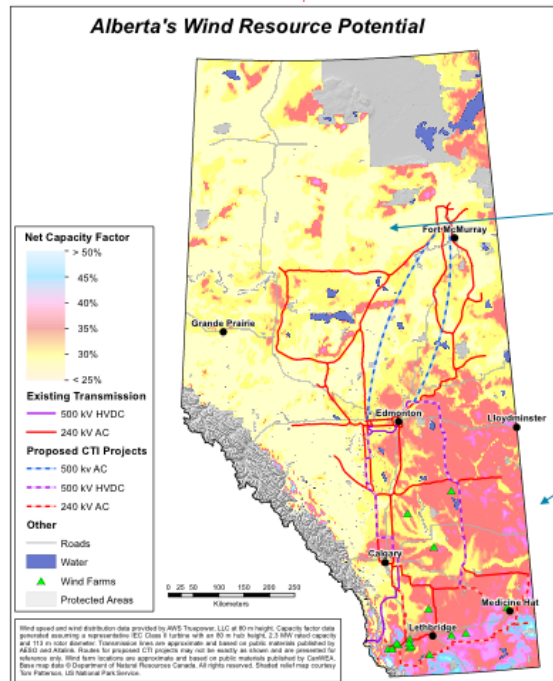
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Wind energy is one of the five types of renewable energy generation. Wind is considered a renewable energy source because there will always be wind blowing, which means there will always be an opportunity to generate electricity.

A **wind turbine** is used to convert the energy found in wind to electrical energy that can be used by us.

Wind Resource in Alberta



Lower Wind Resource

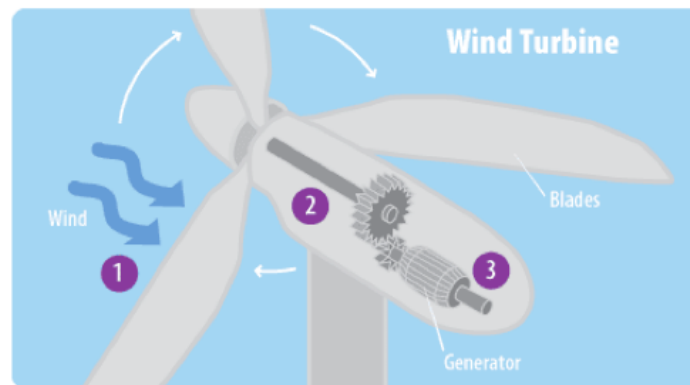
Higher Wind Resource

This is Alberta's wind resource.

Areas in red, pink and blue mean there is lots of wind! This map shows that most of Alberta has a strong wind resource from Edmonton south. Historically, wind has been build in the very south but now we understand the resource is much bigger.

How does a wind turbine work?

- The turbine blades housed in the rotor hub turn the **rotor shaft**
- The shaft spins a **generator** to produce electricity



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This picture shows how the force of wind is used to turn the turbine blades (you can think of turbine blades like airplane wings). Inside the **nacelle**, is where the generator is located, which is a key component to generating electricity. The generator is what converts the mechanical energy to electrical energy.

This picture is from:

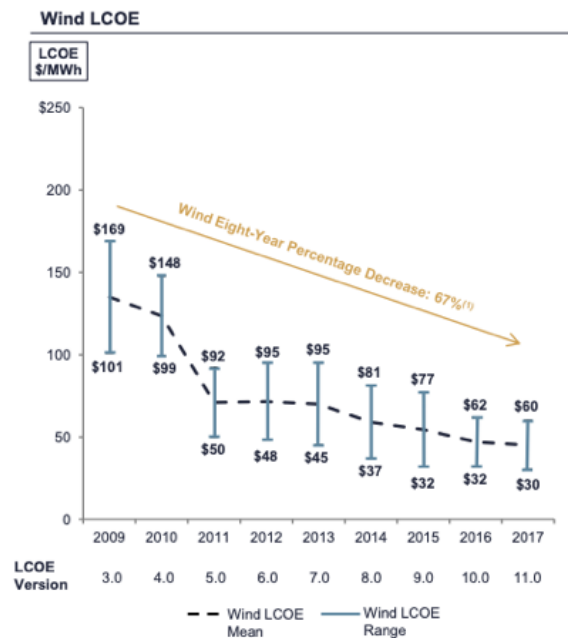
<https://archive.epa.gov/climatechange/kids/solutions/technologies/wind.html>

This animation by the US Government shows how all the components in the nacelle work. Take a look at it for a more in detailed explanation of how a turbine works:

<https://www.energy.gov/maps/how-does-wind-turbine-work>

Wind Power Costs
are one-third of
what they were
20 years ago.

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<https://www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf>

Here is a graph of the cost of wind. Look at how the cost had decreased since 2009. Wind energy is becoming more and more affordable every year!

Largest Wind Farm in Alberta – 300 MW!



- Blackspring Ridge is currently the largest operating wind farm in Alberta
- Located near Vulcan, Alberta.
- It is owned and operated by EDF Renewables and Enbridge

www.edf-re.ca



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Blackspring Ridge (built in 2014) is the largest operating wind farm in Alberta. It is owned and operated by EDF Renewables. The wind farm generates 300 MW of energy. There is a total of 166 turbines and they are over 100 metres tall from ground to blade tip!

This wind farm is located 1 hour north of Lethbridge.

Pros and Cons of Wind Energy

PROS

- Lowest cost of power in Alberta
- No greenhouse gas emissions during the life cycle
- No water usage
- No air quality impacts
- Clean fuel source
- Can be built on existing agricultural lands

CONS

- Winds does not blow all the time (Variable)
- Environmental impacts on birds and bats
- Low employment compared to thermal power



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Here are some pros and cons associated to the development of a wind farm. Can you think of any others?

Pros:

- Wind is cost effective, which means that the cost to generate electricity is affordable.
- There are no emissions directly related to the generation of electricity from wind. This includes greenhouse gases and no air quality contaminants such as particulates, NOx and SOx.
- Agricultural lands can be used for development. This means the land can be used for dual purpose!

Cons:

- It is not windy all the time, which means that wind turbines won't make electricity when there is no wind (wind is resource dependent) This is considered a variable resource
- Wind power requires about 1 person for every 10 turbines.



Solar Energy



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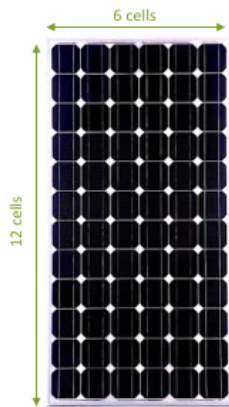
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Solar PV Terminology

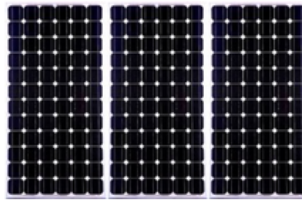


One **solar cell**



One **solar module**

There are 72 solar cells in this module



Multiple modules form a panel



Solar Array

Multiple panels form an array



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Solar panels and solar modules are sometimes used interchangeably, but there is a key difference. The term panel means multiple modules connected together. An array is when the panels are connected to a power source. An array is made of multiple panels, or modules connected together.

AMAZING SOLAR RESOURCE

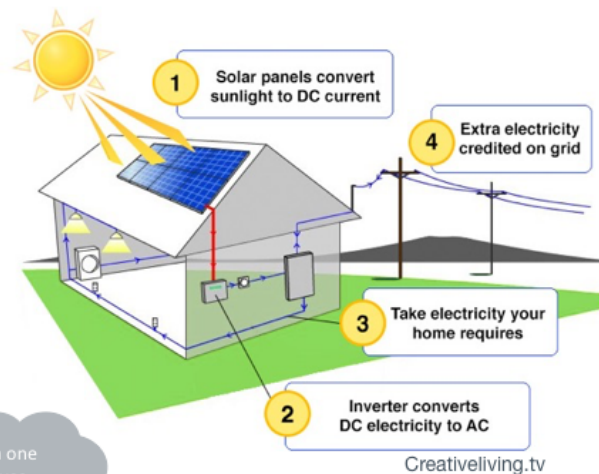
- Alberta has an amazing solar resource.
- It's really sunny here and we have mostly cloud free days!



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What is Solar Energy?

- **Solar photovoltaics (PV)** converts energy from the sun to electricity
- **Solar thermal** uses heat from the sun to heat a home and hot water
- Solar is one of the few renewable energy sources that can be installed on a house for direct use
 - This electricity produced from solar PV can also be sold back to the grid!



Did you know: In one hour, the sun gives off enough energy to power the whole world for a year!

Creativeliving.tv



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Solar energy converts the energy from the sun to electrical energy. Solar Photovoltaic occurs by the photovoltaic effect (see the next slide)

Solar energy is a renewable energy source that is commonly seen at the consumer level. If you install solar on your home, you can directly generate electricity to power your house. Any extra energy you produce can be sold to the grid. This will reduce your energy bill at the end of the month.

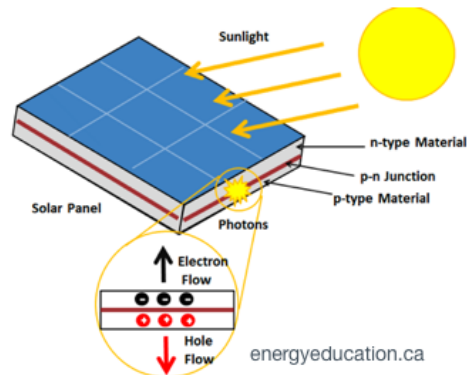
Solar thermal is another alternative. This is used for heating and cooling a home.

Did you know: In one hour, the sun gives off enough energy to power the whole world for a year!

This is how much potential the sun has, however, we are not taking full advantage of the potential yet.

How does a solar module work?

- **Photovoltaic effect:** a process that occurs between two metals in which a voltage or electric current is generated in a photovoltaic cell due to exposure to light.
- Light from the sun excites electrons in a solar cell to generate a current. The current flows into wires to generate electricity.



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Solar photovoltaics work through the photovoltaic effect. When light hits materials like silicon, the electrons in the material get excited and electricity starts to flow (an electric current is generated).

The electricity is gathered with conducting material into wires that flows onto a grid.

A solar cell is made of n-type material, and p-type material. N-type is electron rich (negatively charged), and p-type is electron poor (positively charged). When sunlight hits the face of a solar cell, the electrons get excited and begin to flow from the p-type material to the n-type material. This creates a charge difference and an electric current is formed.

For more information, read this webpage:

https://energyeducation.ca/encyclopedia/Photovoltaic_effect



Largest PV System in Western Canada

This is a 17 MW_{DC} PV system located in Brooks, Alberta



The is currently the largest solar farm in western Canada, located in Alberta.

Elemental Energy is the developer, owner and operator of the solar farm, which became operational in 2017.

Solar Cost
Has Reduced
by 86% since
2009

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<https://www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf>

Similar to the cost of wind, the cost of solar is also going down. Since 2009, we have seen an 86% decrease in the price of solar. Solar is more affordable than ever!

Pros and Cons of Solar Energy

PROS

- There is a large solar resource
- Low environmental impact
- Quiet
- No GHG emissions during production
- No or little water usage during operations
- No air quality emissions
- Easy to predict the production levels
- Easy to install in urban environments

CONS

- Weather conditions can impact production
 - Cloud cover, snow cover, nighttime
- Energy generation can only occur in the day



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Here are some pros and cons to solar energy. Can you think of any more?

Pros:

- There is a ton of resource— if the sun is shining, electricity can be generated
- Little environmental disruption is required to build a solar farm (i.e., large holes in the ground are not required, and there is relatively little land used)

Cons:

- Similar to wind, solar is resource dependent. If there is no sun shining, electricity cannot be produced. Clouds, snow and nighttime restrict when electricity can be generated by solar panels
- Solar is restricted to production during the day.



Hydropower



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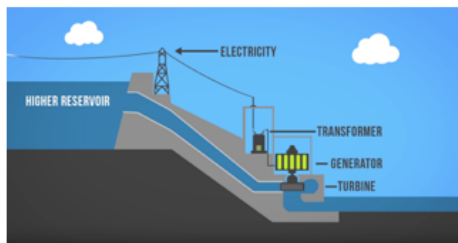
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Types of Hydropower

LARGE SCALE HYDROPOWER

- Uses a dam to control the flow of water to produce electricity when needed
- A higher reservoir stores the water



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RUN-OF-THE-RIVER HYDROPOWER

- Generation is dependent on the flow of the river (lots of production variability)
- No reservoirs to store water (smaller footprint)
- Less power produced than large scale hydropower



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Source: Hydro YouTube video (Student Energy)

This is the two main types of hydro power. Lesson 7 goes into more detail on the different types of hydropower and how they work.

What is Hydropower?

- “Hydro” means “water” in Greek
 - *Hydropower* means power that is generated from the flow of water
- The power from water was historically used to grind grain (Ancient Egyptians), and saw wood (Americans).
- Today, turbines are spun by the water, which then generates power.
 - Hydropower is based around the concept of **potential and kinetic energy**
- There are two types: **large scale hydro and run-of-the-river (small hydro)**

Did you know: There are 475 hydropower generating stations in Canada! We rank #2 in hydropower generation!
energybc.ca



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Hydropower is also called hydroelectricity.

This is a very powerful source of generation used widely around the world.

In the past, water flow was used to grind grain and saw wood. Today, the same concept is used to generate electricity.

The main concept associated to hydropower is the conversion between potential and kinetic energy as water flow changes height above ground.

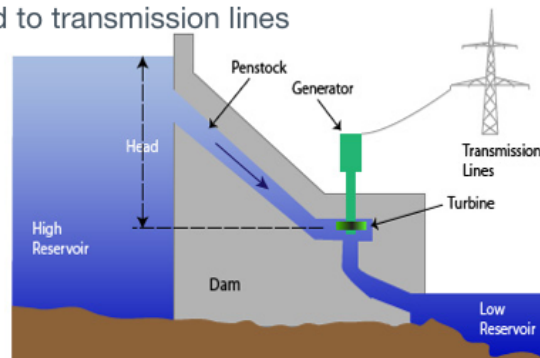
Check out this site for more information:

<http://www.energybc.ca/largehydro.html>

<http://www.energybc.ca/runofriver.html>

How Hydropower Works

- Hydropower is the most common renewable energy source in the world
- Water is released from a height, and flows through a penstock
- The water turns a turbine
- A generator is powered
- Electricity is delivered to transmission lines



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Here is a high level view of how hydropower works.

Water is stored in a high reservoir, where it's energy exists as potential energy.

When the water is released, the potential energy is converted to kinetic energy.

The flowing water turns a turbine, which powers a generator.

The generator produces electricity and delivers to transmission lines.

Hydropower in Alberta

- Canada's primary source of renewable energy production comes from hydropower, however, there is significantly less hydropower facilities in Alberta compared to other provinces.
- In the 1950's half of Alberta energy was produced from hydropower
 - Currently, hydropower makes up about 6% of Alberta's energy profile ^[1]
- Alberta has a significant amount of remaining capacity totaling to over 11,500 MW ^[2]



- Horseshoe Hydroelectric Dam located near Kananaskis
 - First large scale hydropower facility built in 1911
 - Owned and operated by TransAlta Corporation

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Hydropower generation is a main source of energy for many countries. For example, China uses a significant amount of hydropower to meet its energy demands. Alberta does not have a lot of large hydro power installments. There is a significant amount of potential capacity, most of which is unused. Alberta's main source of energy generation has historically been from coal.

In the 1950's nearly half of Alberta's power generation was from hydropower. This shifted when coal came on the market. Today, hydropower makes up close to 6% of the Alberta's power demand.

The picture on this slide is of the Horseshoe Hydroelectric Dam near Seebe, Alberta. The hydropower facility is owned by TransAlta, and was build in 1911. This is the first large-scale hydroelectric facility in Alberta.^[3]

Watch this video to see the hydroelectric dam in action:
<https://www.youtube.com/watch?v=f3PRJ7ld5tA>

Source:

^[1] <https://albertapowermarket.com/2017/05/23/unlocking-albertas-hydro-potential-to-generate-clean-dependable-electricity-for-alberta/>

^[2] <http://www.history.alberta.ca/energyheritage/energy/hydro->

power/hydroelectricity-in-alberta-today.aspx

^[3] <http://www.history.alberta.ca/energyheritage/energy/hydro-power/early-alberta-hydro-history/horseshoe-dam-hydroelectric-plant.aspx>

Pros and Cons of Hydropower

	Large Scale Hydropower	Run-of-the-river
Pros	<ul style="list-style-type: none"> • Renewable source • Low emissions • Can provide baseload power • Dispatchable • Long lifetime • Low operating cost 	<ul style="list-style-type: none"> • Renewable source • Low emissions • Can provide baseload power • Long lifetime • Low environmental impact compared to large scale hydropower • Low operating cost
Cons	<ul style="list-style-type: none"> • Can have a large impact on the environment • Takes over 10 years to develop and built the project • High upfront capital cost • Some greenhouse gas emissions 	<ul style="list-style-type: none"> • Costly • Less flexibility in production than large scale • Energy production is not consistent throughout the year – usually most is in the spring



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Advantages:

- Renewable – the ‘fuel’ doesn’t get used up
- It doesn’t produce any pollution or CO2
- Hydroelectricity plants with ‘reservoirs’ are very flexible – as long as the water is there, they can turn on and off. They can provide power during the busiest times of day and store water during times when we use less energy
 - They have the ability of providing **baseload power** and can **ramp up and ramp down**.
- The oldest power station in Alberta is 102 years old and it is still running.
Hydropower plants have very long lifetimes

Disadvantages:

- It takes a long time and a lot of money to build compared to other types of power generation
- Large scale hydropower have a big impact on their surrounding environment when they are built;
- Run-of-the-river has a smaller impact on the environment than large scale hydropower but they don’t have the flexibility in production
- Production from hydro facilities is usually highest in the spring and lowest in the winter
 - Why do you think that is? **Freshet** is when river water levels increase from the melting of snow.



Geothermal Power



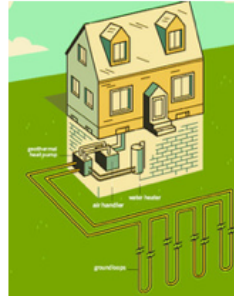
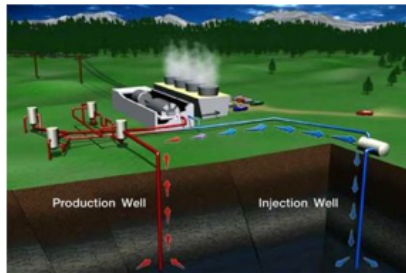
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What is Geothermal Energy and Ground Source Heat?

- **Geothermal energy** generates electricity from **hot reservoirs** of water below the Earth's surface
 - There are three types of technology: dry steam, flash steam and binary cycle
- **Ground source heat** is a temperature regulator in buildings. It uses the earth for heating a cooling in the winter and summer months.



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Geothermal refers to pulling heat from the earth for energy or heating/cooling purposes. There are two types:

- Geothermal energy
- Ground source heat

In general, geothermal energy is used for electricity production. This works by pulling steam or hot water from the Earth's reservoirs. Steam is used to turn a turbine and generator unit to produce electricity.

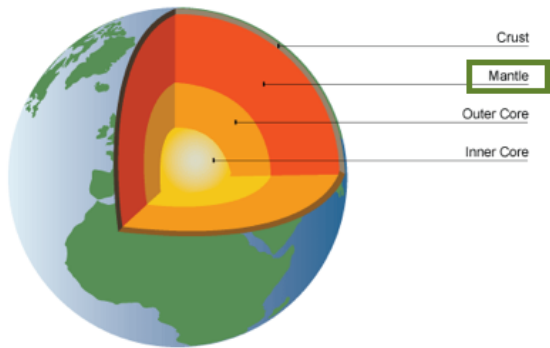
Ground source heat is a temperature regulator. It provides heating a cooling solutions for homes and small buildings. Water in pipes cycles through a closed system. While in the ground, heat from the Earth warms the water for use in the building.

<https://www.cangea.ca/geothermal-101.html>

Scroll down on this page until you find the video insert. This page also has lots of easy to read text on geothermal.

How Geothermal Energy Works

- Two wells are drilled into the ground to access the hot reservoirs in the Earth (mantle layer)



- A **production well** pulls hot water or steam from the reservoirs
- An **injection well** returns the cooled water or condensed steam back to the reservoir to be renewed



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A geothermal energy facility is comprised of two wells, which are used for extracting and injecting hot water or steam to and from the earth. There are three main types of geothermal energy technology, all of which use steam to turn a turbine and produce electricity.

The three types of geothermal technology are:

1. Dry steam geothermal
2. Flash steam geothermal
3. Binary cycle geothermal

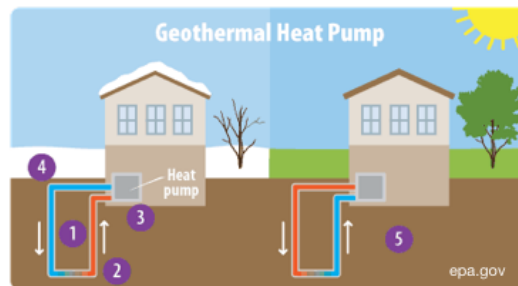
We will explore these technologies more in Lesson 8.

If students wish to learn more, you can show them this video, which is all about geothermal in Canada:

<https://www.cangea.ca/geothermal-101.html>

How Ground Source Heat Pumps Work

- Ground source heat pumps cycle water through a closed loop
- While in the ground, the water heats up
- In the winter, closed loop ground source heat pumps pull **hot** water from the ground
- In the summer, closed loop ground source heat pumps pull **cold** water from the ground



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Ground source heat pumps are closed loop systems that are used for heating purpose in homes and small buildings. They are capable of heating and cooling a home in the winter and summer months, respectively.

This is an energy efficient option to use as it does not use coal, had has no direct emissions.

Geothermal in Alberta

- There are not many geothermal energy facilities in Alberta, however, there are some under development
- The Banff Hot Springs are an example of recreational use of geothermal energy



www.banfflakelouise.com



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In Alberta, heat from the earth is commonly used for recreational purposes. For example, hot springs in Banff and Jasper pull naturally occurring hot water from the earth to make pools the public can enjoy.

Pros and Cons of Geothermal Energy

PROS

- Sustainable energy source for electricity and heating
- Baseload energy source
- Heating and cooling solutions year round for small buildings
- Small environmental footprint

CONS

- Small risk of earthquakes if well drilling is not properly executed
- High upfront costs
- Currently no geothermal power production in Alberta
- Requires specific temperatures to be able to generate power.
- Location specific



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Here are some pros and cons associated to geothermal energy production. Can you think of any more?

Pros:

- Geothermal energy is not resource dependent like the other renewable sources we explored. Heat from the earth is available on demand, at any time of the day and year. This means that geothermal energy can use as a baseload energy source, to meet energy demands
- Geothermal energy is a sustainable heating alternative to coal
- There are very small emission in comparison to other energy sources.

Cons:

- Improper drilling of wells can lead to small earthquakes
- Expensive to build
- Very location dependent, as not every location has high temperatures in the earth's mantle

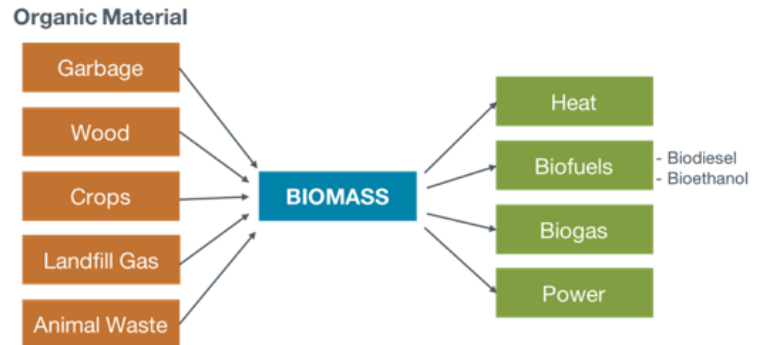
Check out this webpage for more information on the pros and cons.
<http://energyinformative.org/geothermal-energy-pros-and-cons/>

Biomass



What is Biomass?

- Biomass is **organic material** from plants and animals
 - Wood, crops, seaweeds, animal wastes
- Biomass can be converted to biofuels or biogas, which can be used as fuels
 - This is a renewable fuel



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Biomass uses organic matter to generate power, biofuels, biogases, and heating solutions. The organic materials typically used are:

- garbage (i.e., municipal waste)
- wood (the most common source)
- crops
- landfill gas
- animal waste

These sources are called feedstock.

Depending on the conversion process used, some feedstocks are better suited than others.

How Biomass Works

- The energy in biomass comes from the stored energy that organic matter absorbs from the sun (**photosynthesis**)
- Biomass is converted to a more useable state for energy production
- 6 Biomass Conversion Process:
 - Combustion
 - Fermentation
 - Trans-esterification
 - Anaerobic digestion
 - Gasification
 - Pyrolysis

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There are many ways to generate energy from biomass. These are called conversion processes, and include the following:

- Combustion
- Fermentation
- Trans-esterification
- Anaerobic digestion
- Gasification
- Pyrolysis

Through each of these processes, energy is made.

The most common type of biomass conversion is combustion, which is the burning of material. In Lesson 9, we will explore each of these processes in more detail.

Biomass in Alberta

- Biomass has been around for many years
 - It was used in stove-heated homes and in centralized power generation
- In 1880, Peter Prince burned the wood waste by-products from sawmills to fuel a steam power electric generator at the sawmill. He also sold this electricity to the City of Calgary to power street lights.
- There are currently 9 Biomass power facilities in Alberta
 - Athabasca, Grande Prairie (3), Dapp, Hinton, Peace River, Drayton Valley, Whitecourt



This is an old wood burning stove that was used to heat small homes



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Biomass is an energy source that has been used for many years.

Wood was most commonly used to heat homes when electric furnaces did not exist.

Wood is still used today as a feedstock. Wood waste at saw mills is commonly used to heat facilities to offset their energy usage for heating. Wood can also be used to generate electricity.

Source: <http://history.alberta.ca/energyheritage/energy/alternative-energy/biomass/biomass-in-modern-alberta-history.aspx>

Pros and Cons of Biomass Energy

PROS

- Carbon neutral life cycle
- Widely available in Alberta (not site specific like other sources)
- Biomass comes in many forms
- Not location specific
- Great method of waste management for wood waste and municipal solid waste.

CONS

- Air Quality emissions
- Uses water to generate power
- Not very cost effective since they are usually smaller scale.



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Here are some pros and cons associated to biomass energy. Can you think of any more?

Pros:

- Biomass is an alternative heating source to coal
- The entire process (from obtaining the fuel source to producing electricity) has net zero carbon emissions.
 - Uptake of carbon by trees offsets the emissions during operation
- Biomass facilities are not site specific, or dependent on the location of the resource (although closer is better)
- There are many different types of fuel sources available for biomass
- Can serve as waste management practices

Cons:

- Air quality emissions from combustion of wood waste resulting in particulates
- Uses fossil fuel to transport the waste to the power generation facility.
- Tends to be smaller scale facilities in Alberta and therefore higher costs.



Electricity in Alberta today



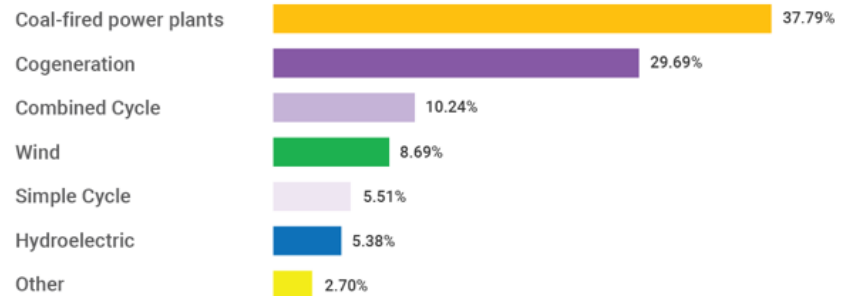
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Alberta's Current Electricity Generation Profile

Where does Alberta's power come from?



- This is Alberta's current energy generation as of March 2018
- 83.2% of Alberta's electricity is from fossil fuels
 - 37.8% of our generation comes from coal-fired power plants

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Graph source:

<https://www.aeso.ca/aeso/electricity-in-alberta/>

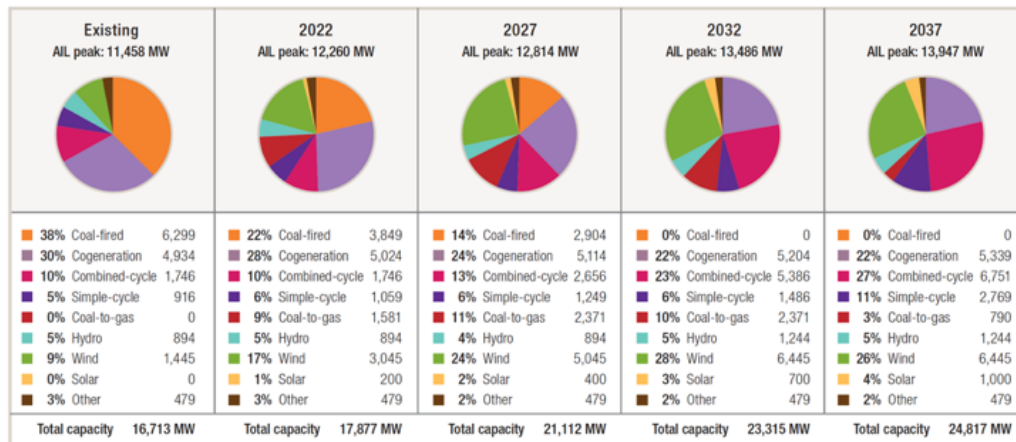
This data is up-to-date as of March 2018. Courtesy of AESO

The graph here shows students a visual of where our energy comes from. A large portion of our energy comes from coal. Coal will be phased out completely in Alberta by 2030, and 5,000 MW of renewables will be installed (30% of Alberta's generation will come from renewables by 2030). This will result in a large change in the generation profile in the years to come.

You may notice that there is no solar, biomass or geothermal on the graph. This is because there are very few of these facilities in Alberta. These have therefore all been combined under "Other"

Thought question: How do you think our energy generation profile will look in 10 years?

Future Electricity Generation in Alberta – Source: AESO



*Future capacity as of the end of year; existing capacity includes under-construction projects.



Reference: www.aeso.ca/download/listedfiles/AESO-2017-Long-term-Outlook.pdf

The Alberta Electric System Operator (**AESO**) **2017** Long-term Outlook. (**2017 LTO**) describes Alberta's expected electricity demand over the next 20 years.

Coal power is reduced to zero by 2030.

Wind power increases from 9% in 2017 to 26% in 2037

Solar power increases from almost 0% to 4% in 2037.

By 2037, the Alberta electricity will have 63% of our electricity coming from fossil fuel. This is down from 83.2% in 2018.

Coal Phase Out

- Alberta currently has 18 coal facilities
- By 2030, Alberta will have zero pollution from coal-fired electricity
 - 12 facilities will be phased out by 2030
- Some coal facilities will be converted to natural gas.
- Along with the coal phase out, 5,000 MW of renewable energy generation will be installed
 - That's 30% of Alberta's energy demand!



In the past couple of years, there has been more movement towards sustainable energy production in Alberta and Canada.

Alberta's main source of electricity generation comes from coal. We have 18 operating coal facilities across the province.

In 2017, Alberta announced its goal to have all coal facilities reach a target of zero emissions by 2030. This can occur through a variety of solutions (can you think of any from Lesson 3?). 12 of the 18 coal facilities will be decommissioned by 2030.

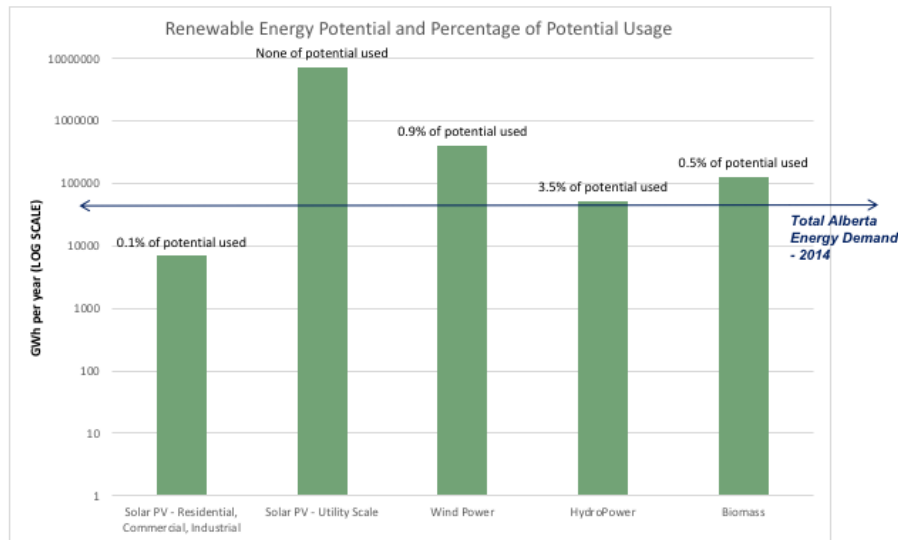
In addition to the phase out, Alberta plans to install 5,000 MW of renewable energy generation, which will meet 30% of Alberta's energy demand.

Source:

<https://www.energy.alberta.ca/AU/electricity/AboutElec/Documents/Elec101.pdf>

<https://www.alberta.ca/climate-coal-electricity.aspx>

Alberta's Renewable Energy Resource



- Alberta has more renewable energy resource than it could possibly use, however it is an undeveloped and unused energy source. Our RE is of high quality and geographically diverse.



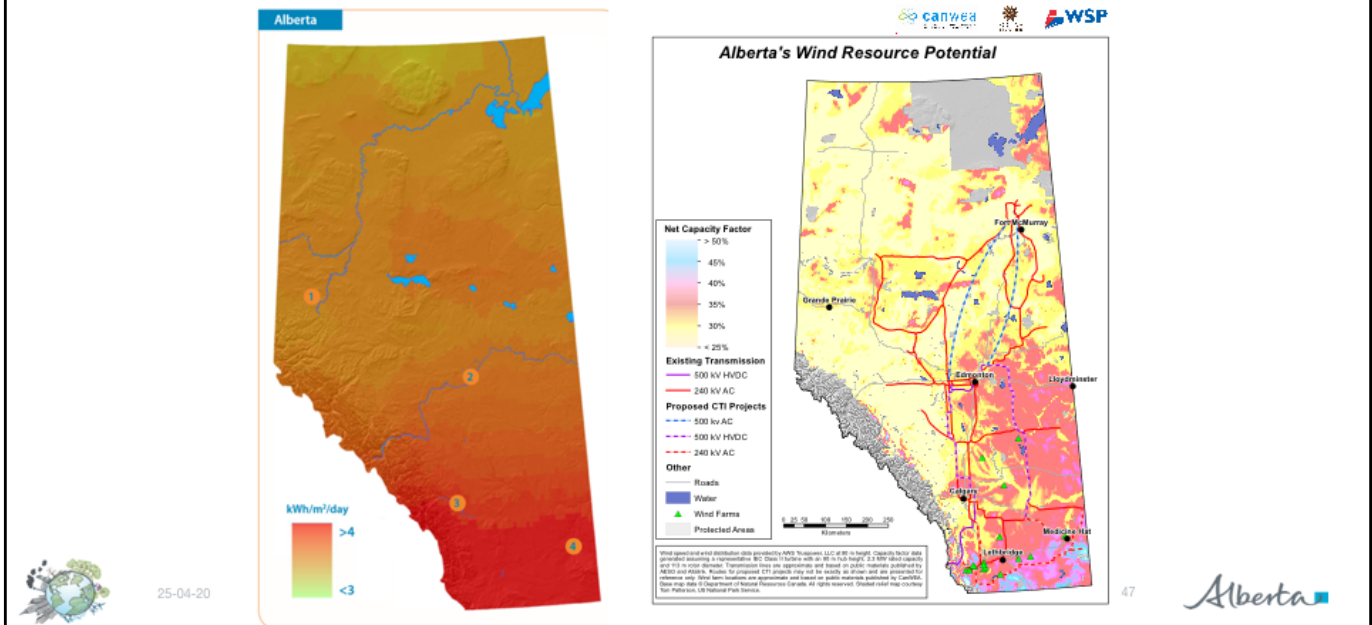
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This figure is from 2014. It illustrates Alberta's potential production (in GWh), if all the potential resource is used. However, as mentioned on the graph, very little of Alberta's potential is used. This means that there is a lot of growth potential in Alberta. Alberta has many opportunities to become more green!

Solar and Wind Resource Potential in Alberta



Supplemental to the last slides, this is Alberta's current resource potential for solar and wind. Southern Alberta has high resource for both wind and solar! In fact, Alberta's solar is world class!

Wind:

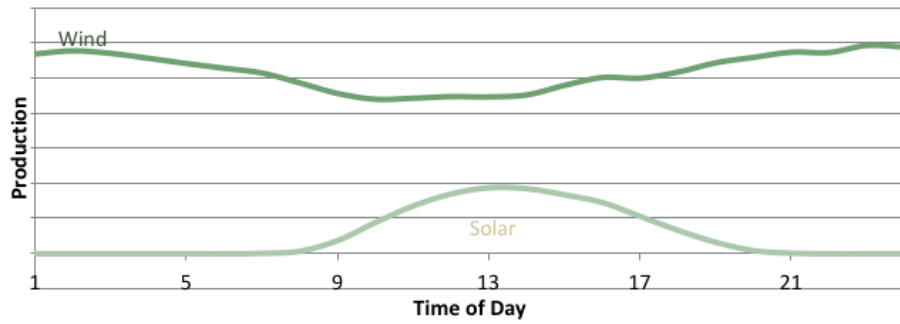
Areas in red, pink and blue have high wind power potential. This map shows that most of Alberta has a strong wind resource from Edmonton south. Historically, wind has been build in the very south but now we understand the resource is much bigger.

Solar:

The solar resource is strong in all of Alberta. The south is marginally better than the north. The colder climate is better for solar module performance.

Production Profile

- In Alberta, wind and solar are a natural complement to each other.



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This figure shows that when wind is at its peak generation, solar is at its lowest, and vice versa. This means that throughout a single day, there is continuous energy generation (note, this is highly weather dependent).

Wind power in Alberta is winter and nighttime peaking.

Solar power is summer and daytime peaking.

This means that at these times, the most power is produced from the renewable energy sources.



Quiz!



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Label the following as renewable or non-renewable

- | | |
|------------|----------------|
| A. Biomass | E. Hydro |
| B. Solar | F. Oil |
| C. Nuclear | G. Natural Gas |
| D. Wind | H. Geothermal |
| E. Coal | |



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Answer:

- A. Biomass – Renewable
- B. Solar – Renewable
- C. Nuclear – Alternative or Non-Renewable
- D. Wind – Renewable
- E. Coal – Non-Renewable
- F. Hydro – Renewable
- G. Oil – Non-Renewable
- H. Natural Gas – Non-Renewable
- I. Geothermal – Renewable

What year will Alberta have 30% of its generation from renewable energy?

- A. 2020
- B. 2025
- C. 2030
- D. 2040
- E. 2055



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Answer: C. 2030

Where does Alberta have the **highest** solar and wind potential, respectively?

- A. Northern, Southern
- B. Southern, Southern/Central
- C. Central, Northern
- D. Northern, Central
- E. None of the above



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Answer: B. Southern, southern/central

True or False: Wind and Solar are NOT complimentary to each other.

- A. True
- B. False



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Answer: False

Match each of the following to the correct energy conversion. (_____ energy to electrical energy)

TECHNOLOGY

1. Wind Turbines
2. Solar Panels
3. Hydropower Facility
4. Geothermal Power
5. Biomass Power

RESOURCE

- A. Organic matter
- B. Water
- C. Hot steam
- D. Sunlight
- E. Wind



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Answer:

1. Wind Turbines
2. Solar Panels
3. Hydropower Facility
4. Geothermal Power
5. Biomass Power

- E. Wind
- D. Sunlight
- B. Water
- C. Hot steam
- A. Organic matter



ACTIVITY!



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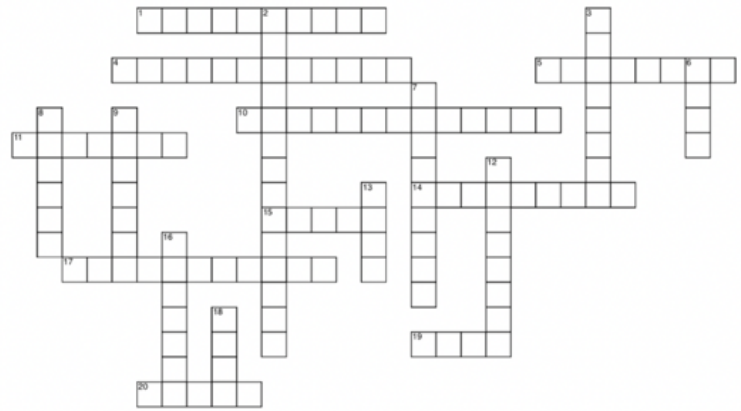
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Renewable Energy Word Search and Crossword



RENEWABLE ENERGY CROSSWORD



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Have students complete the word search and/or crossword puzzle to learn some renewable energy terminology!

GreenLearning.ca Additional Resources

- Re-Energy: <http://www.greenlearning.ca/programs/re-energy/>



BASIC



If you would like to learn more about this topic, visit the links above.



THANK YOU!

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