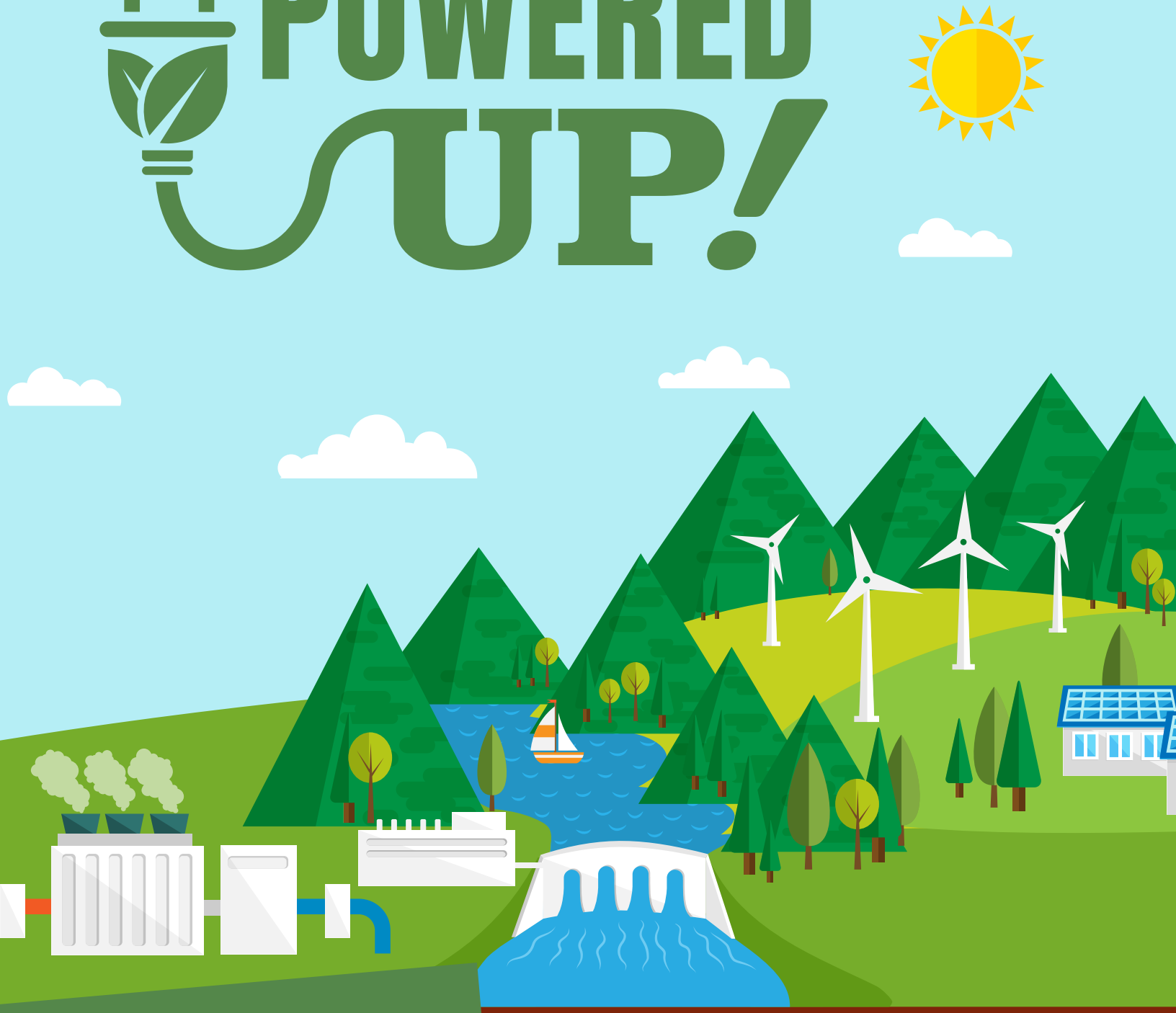
POWERED UP!



Activity Book

CANADA

Acknowledgements

Powered Up! offers youth across Canada the opportunity to learn about the Affordable and Clean Energy United Nations Sustainable Development Goal, and their personal role in supporting sustainability. This unique learn-at-home program would not be possible without the dedicated support of our partners.

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YOUTH ADVISORY PANEL

We would also like to thank the advisory panel that assisted in the content development and review of this resource. We appreciate their support of 4-H Canada's initiatives and 'Learn To Do By Doing' programming.

Brett Rumpel, 4-H Canada Youth Advisory Committee

Written by Melina Found
Designed by Em Dash Design, Montreal

Funded by the Government of Canada | Canada

Table of Contents

You'll notice there are links to videos and other information throughout this activity guide. Please download the digital Powered Up! Activity Book for easy access to these links!

Download and learn more at 4-h-canada.ca/powered-up

Introduction

Hello!

We're thrilled that you are joining us for Powered Up!, an initiative for youth across Canada, 4-H members, families, and clubs! This is an opportunity for you to learn about an interesting topic, participate in hands-on activities (including making S'mores with the power of the sun!) and have some 4-H fun in your own home.

This initiative is part of **4-H Canada's Science & Technology Leadership Development Pillar**, which supports engaging youth in the science and technology world. Youth can explore their ideas, learn about career opportunities related to STEM, and expand their minds through experiential, inquiry-based learning.

In this activity book and the accompanying activity kit, you will find everything you need to know about alternative and clean energy, along with hands-on activities! Our hope is that you will achieve the following learning goals:

- Understand alternative, affordable, and clean energy and why it is important.
- Learn about the Sustainable Development Goals, and their impact on the world.
- Identify actions you can take to support clean energy in your home, community, country, and around the world.
- Develop skills that help you identify different energy sources and what makes them clean.
- Become a clean energy champion by creating awareness about this issue.

This activity kit contains:

- Powered Up! Activity Book
- Affordable and Clean Energy info sheet
- Supplies to explore energy activities, including:
  - » Mini generator
  - » LED lights
  - » Battery and cap
  - » Solar oven supplies
    - Box
    - Black paper
    - Oven mitt
    - Wooden skewer

We wanted to grow the opportunity for youth to get involved in 4-H programming by making this kit available across Canada to 4-H members, families, and even youth who aren't yet members! For those of you who may not be familiar with 4-H, we believe in nurturing responsible, caring and contributing leaders who are committed to positively impacting their communities. We provide hands-on learning for youth across the country thanks to the support of volunteer leaders. To learn more about us, check out our programs at **4-h-canada.ca**!

We can't wait to see what you learn, generate, and spark! Take a minute to share it with us by tagging **@4hcanada** on Instagram, Facebook, or Twitter.

Happy 'Learn To Do By Doing'!

The 4-H Canada Team

What are the Sustainable Development Goals?

EXPLORE THE 17 SDGs
You can learn more about what the 17 goals are at sdgs.un.org

The **Sustainable Development Goals (SDGs)** are a set of 17 global goals developed by the United Nations. The United Nations is an international organization that encourages nations to protect peace and security, and work well together. The SDGs are a global call to action, with the support of 193 nations, including Canada. Each nation is working to achieve these 17 goals which deal with poverty, health, education, and the environment.

When setting a goal, it is always valuable to look to the future. The United Nations did just this by asking, "What will it look like when these goals are achieved? How long will it take?" So, in 2015, the United Nations developed these goals and laid out what they wanted the world to look like in 2030.

Sustainable – something that can last and not run out. These goals are trying to achieve a sustainable world, where basic needs of all people are met, and the health of our environment is not in danger of being used up or damaged.

SPARKING IDEAS

What is a long-term goal you've achieved for yourself? Maybe, it was to develop a new habit or achieve something that is important to you. How did you work toward that goal? Did you take little steps, or was it a big effort all at once? How did you know when you achieved it? Consider the SMART template for setting your own goals!

Specific	Measurable	Achievable	Realistic	Timely
S	**M**	**A**	**R**	**T**
G	O	A	L	S
What do you want to do?	**How will you know when you've reached it?**	**Is it in your power to accomplish it?**	**Can you realistically achieve it?**	**When exactly do you want to accomplish it?**

In Powered Up! we are focusing on SDG 7, **Affordable and Clean Energy**. This SDG has the goal to make sure everyone has access to clean energy. Energy that people can afford, that they can rely on, and that comes from an energy source that is sustainable.

ENSURE ACCESS TO AFFORDABLE, RELIABLE, SUSTAINABLE AND MODERN ENERGY FOR ALL

There have been big steps forward on this goal in terms of bringing electricity to more people around the world and providing access to clean energy options. But we still have a lot more to do:[1]

- 789 million people still don't have access to electricity.
- 2.8 billion people are unable to cook with clean energy sources, which means they breathe in smoke when they cook every day.
- Only 17% of our energy comes from renewable sources.

THE POWER OF OUR PLEDGE

Who can be a **global citizen**? Anyone, including you! A global citizen is someone who is aware of global issues and wants to make the world a better place for everyone. And just like the 4-H Pledge, it is someone who commits their Head, Heart, Hands and Health to their community, country, and the world.

You might find some of these numbers surprising as all Canadians have access to electricity and clean cooking options that don't make a lot of smoke when we're cooking.[2] As a global citizen, it is important to be aware that not everyone has the same resources that we do. This means that in Canada, we might be more focused on achieving the SDG 7 goal of energy that is affordable and sustainable, but in other countries, the focus might be on increasing access to electricity or supporting cleaner and safer energy sources to cook with. When each country does their part, while also working together to achieve this goal, everyone wins!

This goal is also closely linked to climate change – using unsustainable energy sources like gas, oil, and coal produces greenhouse gases, which cause global temperatures to rise. Energy is the main cause of climate change, **producing around 60% of total global greenhouse gas emissions**. If we want to stop climate change, we also need to work on clean energy and using more sustainable sources.

CHARGING STATION

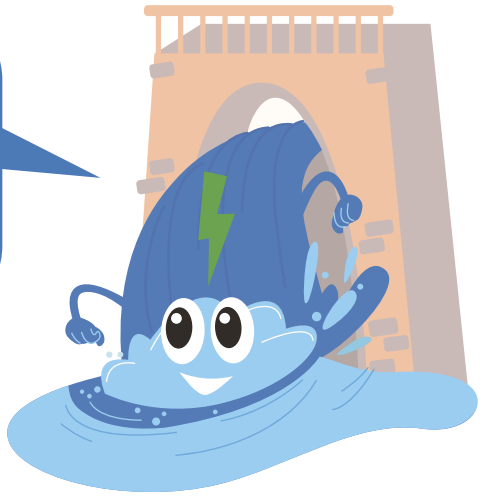
Access to clean and reliable energy is a global issue. Check out this awesome interactive map where you can track the progress of SDG 7, and even look up an individual country for specific details. What do you notice when you look around the world? Which countries have access to electricity, clean cooking, or renewable energy? Which ones do not? Which counties have made progress on using more renewable energy? Which ones have not?

trackingsdg7.esmap.org

SPARKING IDEAS

Want to learn even more? Check out this article from UN-Energy about SDG 7, including more details about sustainable energy, news, and tracking the goal:

un-energy.org/newsdg7



7 AFFORDABLE AND CLEAN ENERGY

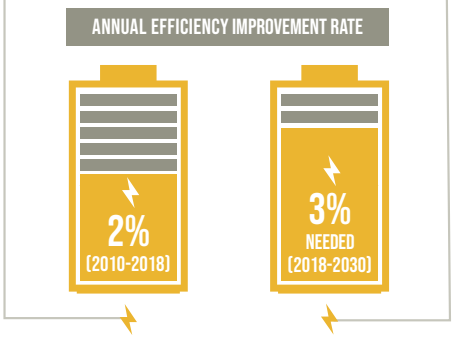
ENSURE ACCESS TO AFFORDABLE, RELIABLE, SUSTAINABLE AND MODERN ENERGY FOR ALL

ONE THIRD OF THE WORLD'S POPULATION USE DANGEROUS AND INEFFICIENT COOKING SYSTEMS (2019)

759 MILLION PEOPLE LACK ACCESS TO ELECTRICITY

3 OUT OF 4 OF THEM LIVE IN SUB-SAHARAN AFRICA (2019)

ENERGY EFFICIENCY IMPROVEMENT RATE NEEDS ACCELERATION



ACCELERATED ACTION ON MODERN RENEWABLE ENERGY IS NEEDED – ESPECIALLY IN HEATING AND TRANSPORT SECTORS

MODERN RENEWABLE SHARE OF TOTAL FINAL ENERGY CONSUMPTION (2018)

Powering Up – The Basics of Alternative and Clean Energy

When learning about SDG 7 on Affordable and Clean Energy, a great place to start is understanding energy itself! Energy is what powers things – from your phone, to a bus, to the lights in your home.

Energy cannot be created or destroyed – it is one of the laws of the universe! Instead, we can change energy into different forms. A campfire turns the energy in wood into heat and light energy. A battery turns the electric energy it stores into light energy when turning on a flashlight. A car engine turns the energy stored in gas into mechanical energy by burning the gas, powering the engine, and making the wheels turn. Energy is all around us, and it is important to learn about the different types of energy, how we use energy in our daily lives, and why sustainable energy sources are key to successfully reaching SDG 7.

Let's start with some of the basic words and terms we'll be using:

GENERATOR – a machine that takes one type of energy and turns it into electricity. Generators are often found in power stations.

CLEAN ENERGY – energy that when generated, doesn't release harmful exhaust into the air. We're using this term to talk about clean energy for cooking, like electricity or solar instead of wood, coal, or charcoal - which create smoke when they burn that is dangerous for people to breathe in.

SUSTAINABLE ENERGY – energy sources that can last, and won't run out like coal, oil, or gas.

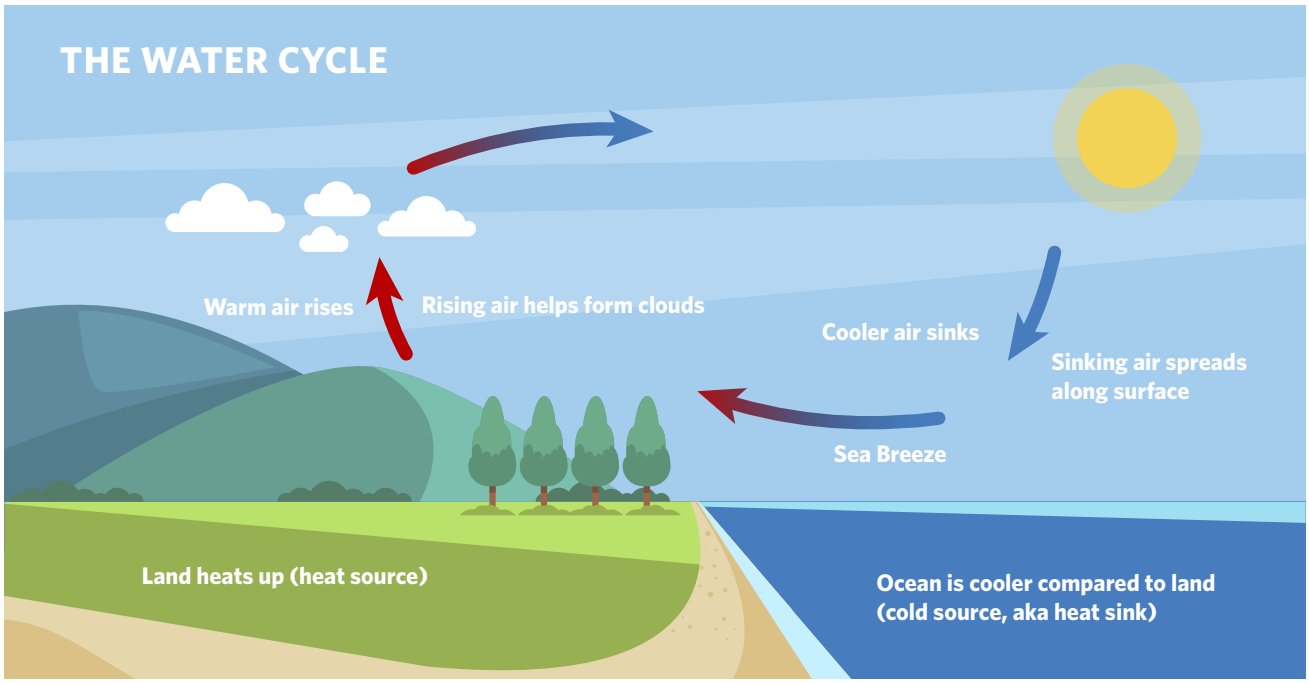
POWER GRID – the network that delivers electricity to all our homes, businesses, and communities. The electricity can be generated in different ways, and the power grid brings it to where it is used.

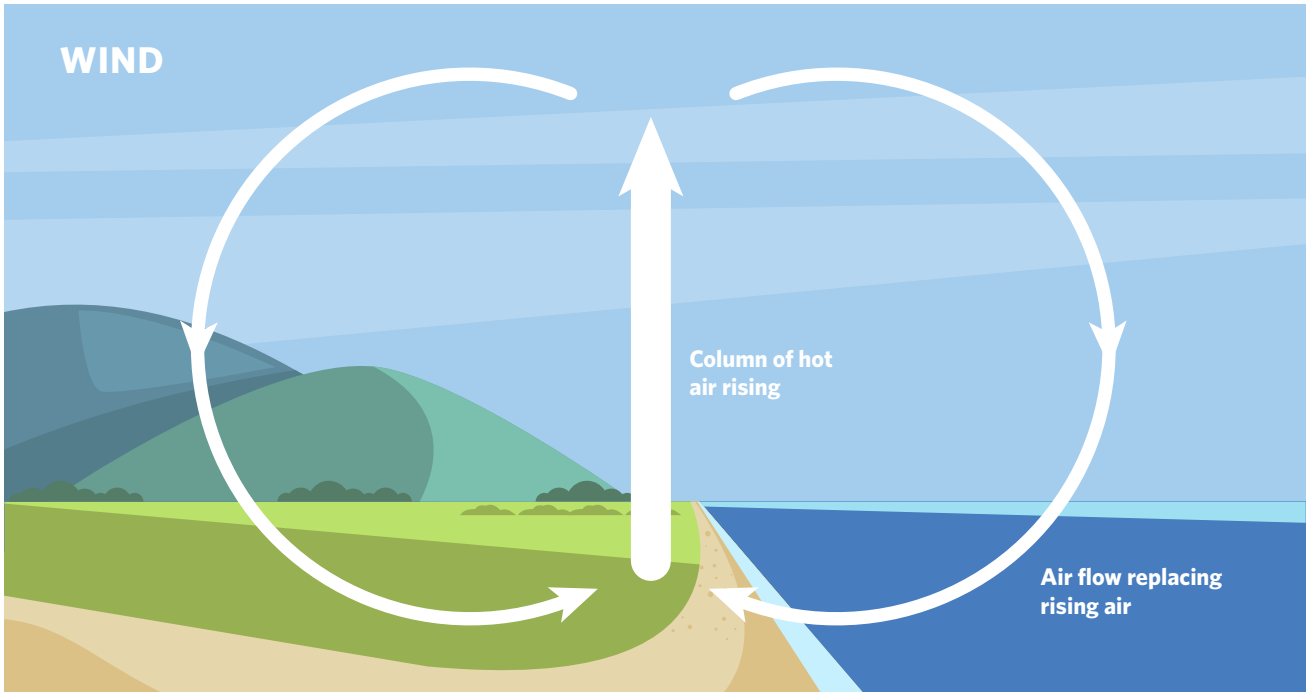
WIND

Wind energy has been used for a very long time, with old windmills being used to grind grain into flour and even pump water.

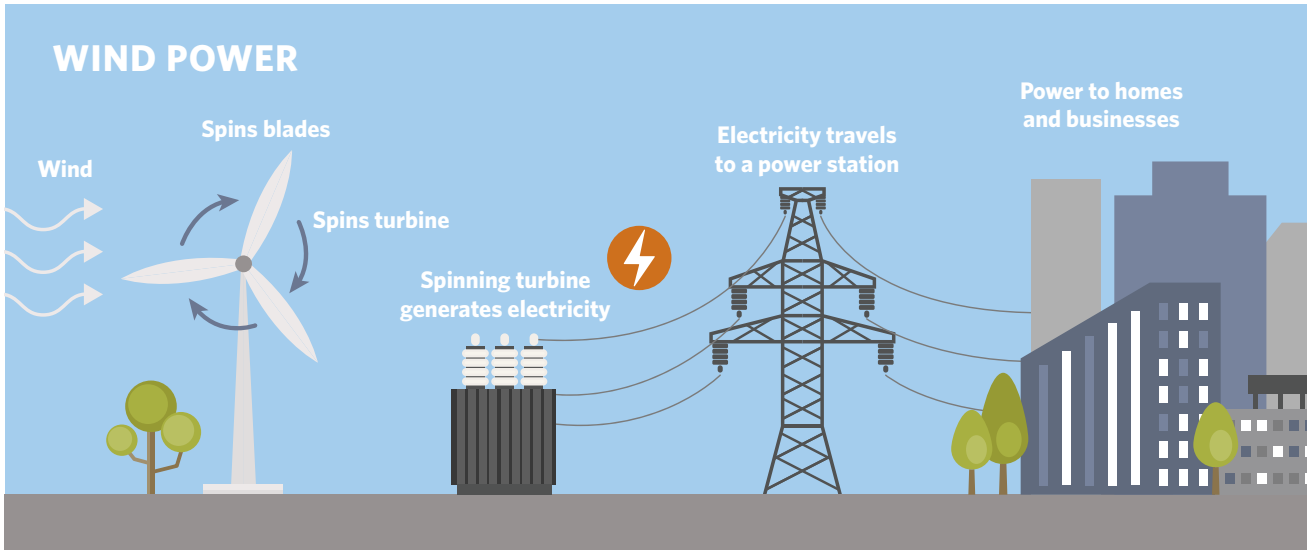
You may never have thought about it before, but what causes wind? It's actually the sun! The sun's rays heat water, ice, and even moisture in the ground, and cause it to get hot and evaporate. When water evaporates – changing from a liquid into a gas – it rises. You can see this when you boil a pot of water, or a kettle – the steam rises into the air. Now, imagine that effect on the scale of the whole Earth! Water evaporating into the air moves up into the sky, creating movement as air rushes in to fill the space left behind. When the water in the air gets cold again, it turns back into a liquid, and falls back down to the ground as rain or snow. This downward movement also creates movement as air rushes in to fill the space left behind. So, because of the sun's energy, we get water heating up, rising as it evaporates, and then cooling and falling back down to Earth. This cycle is also known as the water cycle, and it is what creates wind.

Powered Up!


THE WATER CYCLE
Warm air rises
Rising air helps form clouds
Cooler air sinks
Sinking air spreads along surface
Sea Breeze
Land heats up (heat source)
Ocean is cooler compared to land (cold source, aka heat sink)


WIND
Column of hot air rising
Air flow replacing rising air

When wind blows, you can see and feel the energy! You can see leaves dance in the wind, feel it pushing back against you when you're out for a walk, sometimes it's so strong it can blow down entire trees! Wind has a lot of energy in it, but how do we use that energy for the things we need? We capture the energy in wind by using wind turbines – tall metal fans that spin, turning wind energy into electricity.



Today's wind turbines are made of metal, high in the sky. They are placed in areas where the wind is strongest, so the most energy can be generated. They also have advanced monitoring systems – powering down when the wind isn't strong enough to generate electricity and turning on to meet our energy needs at peak times. As long as there is wind blowing, sustainable energy can be captured!

Positives of wind energy:

- It is a sustainable energy source – as long as the wind blows, you can generate electricity!
- Wind turbines can be placed in different locations where the wind is strongest. They can be placed in fields, along mountains, and even in the ocean!
- Wind turbines are becoming more efficient as technology improves.

Things to be aware of:

- It takes a lot of materials and energy to produce wind turbines.
- It isn't always windy, so it isn't a constant energy source. Wind energy needs to be part of a system that includes other forms of energy generation.
- Wind turbines can cause harm to some wildlife (e.g. birds, bats), so more research needs to happen to protect these animals.

SOLAR

Solar energy is becoming more and more popular, and technological advancements help us transfer the sun's rays into electrical energy. We've all felt the sun's energy when we've been outside on a sunny day – we can feel the energy as heat. This energy is used by plants to grow, it creates our climate, lights our days, and you could say it powers all life!

There are two ways we can harness solar energy:

THERMAL ENERGY

Have you ever noticed how a dark coloured door, railing, or even mailbox gets hot to the touch in the summer? Darker coloured objects absorb thermal energy or heat from the sun, causing them to warm up. We can use this energy by passing water through black pipes that are in the sunlight, warming the water as it flows through. Water, more than most substances, takes a lot of energy to heat up, so by using the power of the sun, we can use the sustainable thermal energy to raise the temperature of water for uses around our homes and businesses.

Thermal energy depends on the weather and won't always get water as hot as it gets from a hot water tank. But by increasing the water temperature in the black tubes with solar thermal power and then using just a bit more energy from a hot water tank to finish heating it up, we're using less electricity overall!

PHOTOVOLTAIC ENERGY

These are the solar panels you see – they're on calculators, on the roofs of homes and buildings, and sometimes cover entire fields! These panels are made up of thin crystals that absorb the photons, or energy from the sun, causing the particles in the crystals to turn that energy into electricity. That electricity then travels down wires into a battery, or travels to a power plant to use directly on the power grid.

They generate more energy when it is sunny, so this type of energy depends on the weather. There is technology that helps tilt the solar panels to be at the best angle, and some panels even follow the sun throughout the day. The cost of these panels is still high, and the efficiency, or how much solar energy they can turn into electricity, still needs improvement - but as long as the sun is shining, there is sustainable energy we can use!

A total of 173,000 terawatts (trillions of watts) of solar energy hits the Earth each minute. That's more than 10,000 times the world's total energy use![3] If we can capture even a small piece of this energy, we will be able generate enough energy for everyone.

Note: Watts are units of energy and are how we measure it. Just like we measure distance in centimeters, metres, kilometres, etc., we measure energy in watts. For example, a lightbulb requires 40 to 60 watts to turn on for one hour. An LED lightbulb takes 7 to 10 watts to turn on for one hour.

Positives of solar energy:

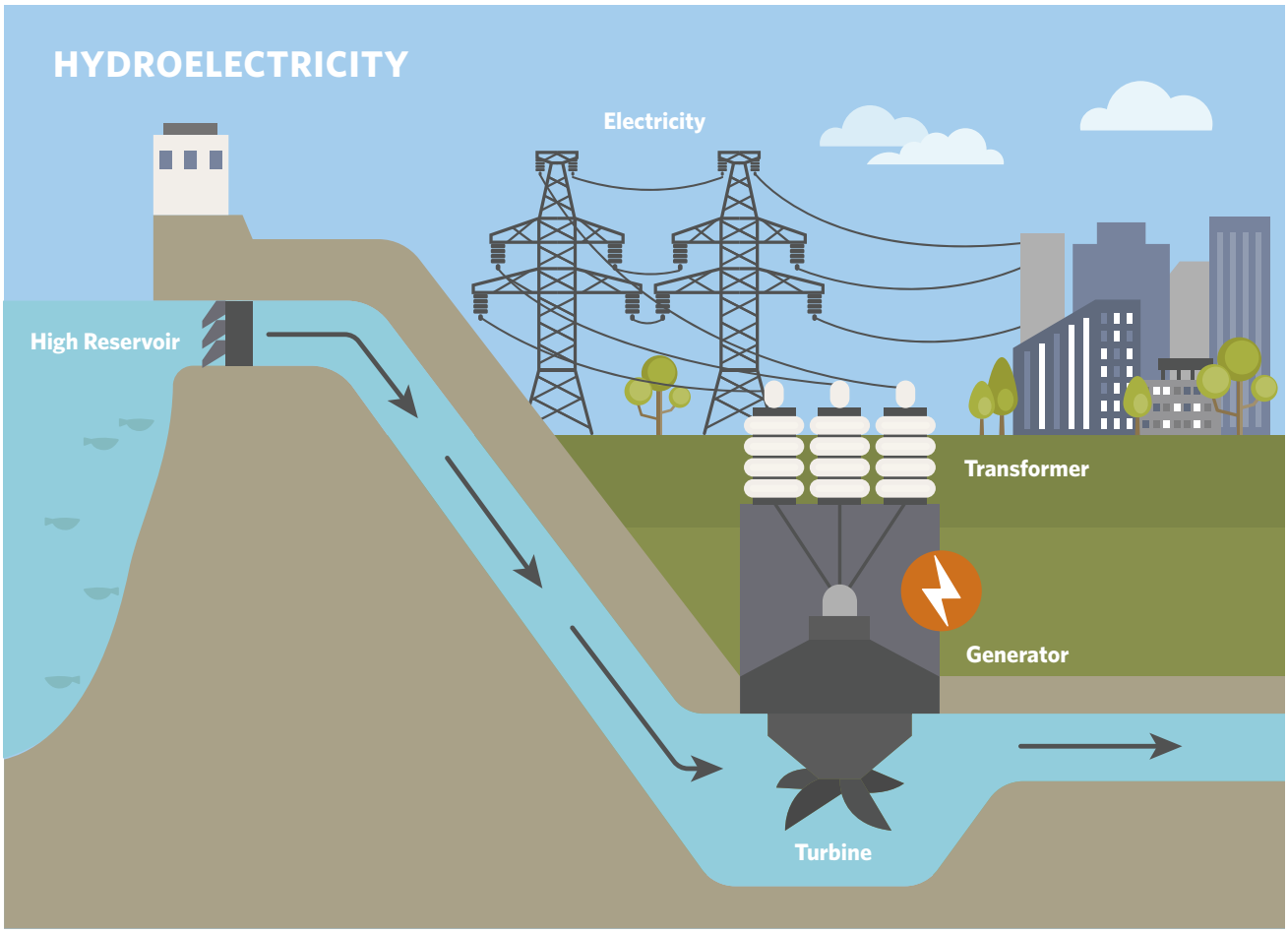
- The earth receives more than enough energy from the sun to power the world's current needs.
- It can generate energy even when it is cold or cloudy (just not as much).
- Solar panels can be set up on individual homes, and on top of businesses – small scale to large scale.

Things to be aware of:

- We need to find better ways of recycling solar panels when they stop working.
- It takes a lot of materials and energy to produce solar panels.
- They can be expensive for individual people to buy.

HYDROELECTRICITY

Close your eyes and imagine the intensity of a rushing waterfall. The rumbling sound, the rushing water, and the weight of it falling down... there is energy here! Hydroelectricity, or the power of water, is generated when water flows from a high point to a low point. The flowing water is passed through a turbine, spinning it, and generating electricity.



POWER UP

Canada is the third largest hydroelectric energy producer in the world.[4] Hydro makes up 59.6% of Canada's electricity generation.[5]

Positives of hydroelectricity:

- Large amounts of energy can be generated – it is the most commonly use renewable energy source in the world.[6]
- Doesn't have 'down time' like solar and wind – as long as water is flowing, it can generate electricity.
- Over the lifetime of a hydroelectric dam, it produces energy for less money than nuclear or fossil fuel power plants.[7]

Things to be aware of:

- Hydroelectric dams need to be built in the right area, and there are limited spots to build them.
- When a dam is built, it blocks the water and floods the area above the dam. This can damage the surrounding environment, and even force people to move.
- Dams can block migration routes for fish and other wildlife, so research needs to be done to reduce harm.

GLOBAL SNAPSHOTS

Costa Rica

Covered with mountains and volcanoes and with ocean coast on both sides, the small country of Costa Rica has produced 95-98% of its electricity from renewable energy sources over the past four years.[8]

Look it up! Do some research and learn about clean energy in this country.

What are the main types of energy used in this country?

.....

.....

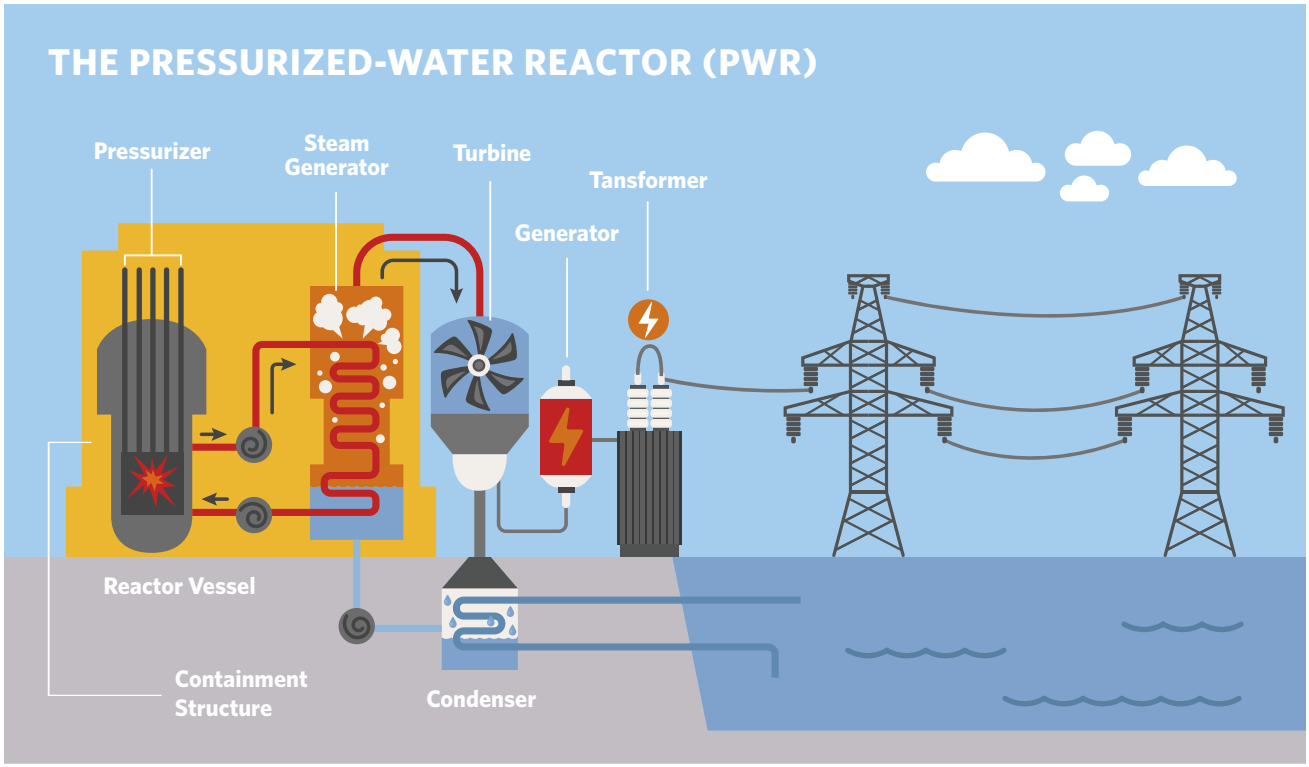
What is something Canada could learn from this country?

.....

.....

NUCLEAR

Nuclear energy is different from the other types of energy we've talked about because its energy comes from a chemical reaction. It is called nuclear fission and is a process where an element called uranium (which exists naturally in the Earth's crust) is split. Splitting atoms of uranium releases a lot of energy, which heats up the water in the power station, producing steam, and spinning a turbine which generates electricity.



This source of power is important because it can produce a large amount of energy fairly easily, helping us meet our energy needs. That said, it also requires planning to protect our environment – once the uranium has been used, it is radioactive and isn't safe. Radioactivity lasts for thousands of years, so we need to safely store the used uranium, which means there is a limit to how much nuclear waste we can manage.

Positives of nuclear energy:

- It is a reliable source of energy because it can be generated at any time (unlike solar and wind), and it produces large amounts of energy with a small amount of fuel.
- The cost of electricity produced from nuclear energy is relatively cheap.[9]
- Nuclear reactors don't produce CO_2 or other greenhouse gases, which contribute to climate change.

Things to be aware of:

- The waste from nuclear energy generation is radioactive and needs to be handled and stored safely.
- Nuclear power generators are expensive to build.
- The mining of nuclear material – uranium – has environmental impacts.
- Nuclear energy generation requires lots of water to cool the reaction. This water absorbs the heat, and is then pumped back into waterways, causing them to warm over time and affecting the aquatic ecosystem.

Using nuclear energy to provide the power we need to create other energy innovations (e.g. more efficient solar panels, making the steel needed to build wind turbines, etc.) is a way for nuclear energy to support affordable and sustainable energy goals.

GEOTHERMAL

You've probably seen videos or pictures of volcanoes exploding and lava flowing – there is an incredible amount of heat energy beneath our feet! Below the Earth's crust, the layer of ground that we all live on, are layers of melted rock. When this bubbles up close to the surface, we can use that heat to generate geothermal energy – which means Earth (geo) heat energy (thermal). Running pipes of water close to this heat makes the water evaporate and turn into steam. The steam is used to spin turbines, which then generate electricity.

GLOBAL SNAPSHOTS

Iceland

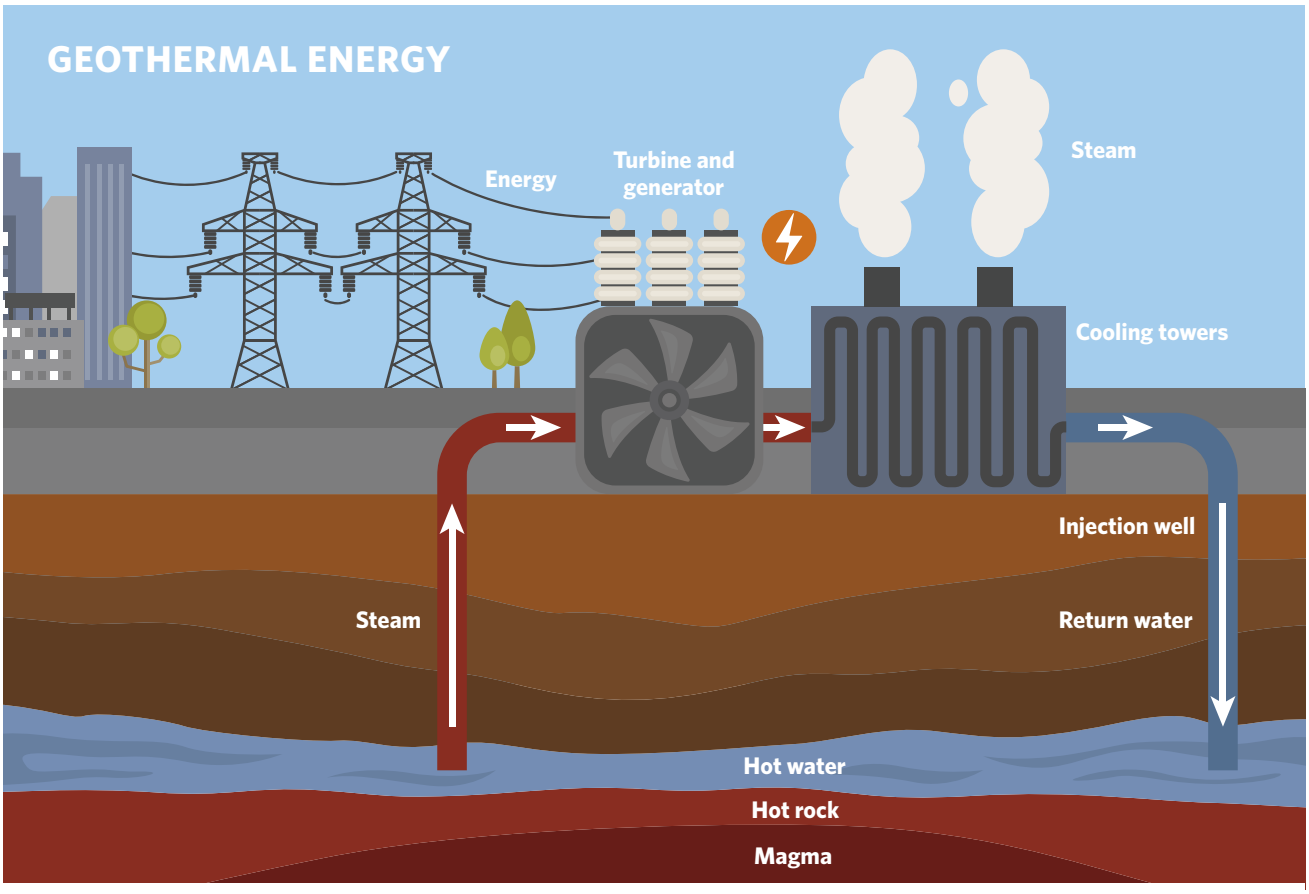
This tiny island country packs huge power! Iceland has a lot of volcanic activity, so heat from the Earth's core is close to the surface. They use this heat to turn water into steam; the steam spins the turbines, which generate electricity.

Look it up! Do some research and learn about clean energy in this country.

What are the main types of energy used in this country?

What is something Canada could learn from this country?

Even cooler (or warmer, in this case) is the fact that we can generate geothermal energy almost anywhere. The ground is hottest near areas with volcanic activity, but even the ground outside your home holds heat that radiates up from the Earth's core. Some buildings and homes run pipes below the frost layer, where the soil never freezes. The constant temperature of the ground means that in the winter it warms the water in the pipes, which can then be used to heat buildings. In the summer, when the ground is cooler than the outside air temperature, the water in the pipes stays cool which can be used to cool down buildings.



Positives of geothermal energy:

- Renewable energy source, coming from the heat of the earth.
- Always available to generate power (unlike solar or wind) because the earth is always giving off heat.
- Through research, we are learning about more places where geothermal energy could be generated, increasing the amount of energy we can produce.

Things to be aware of:

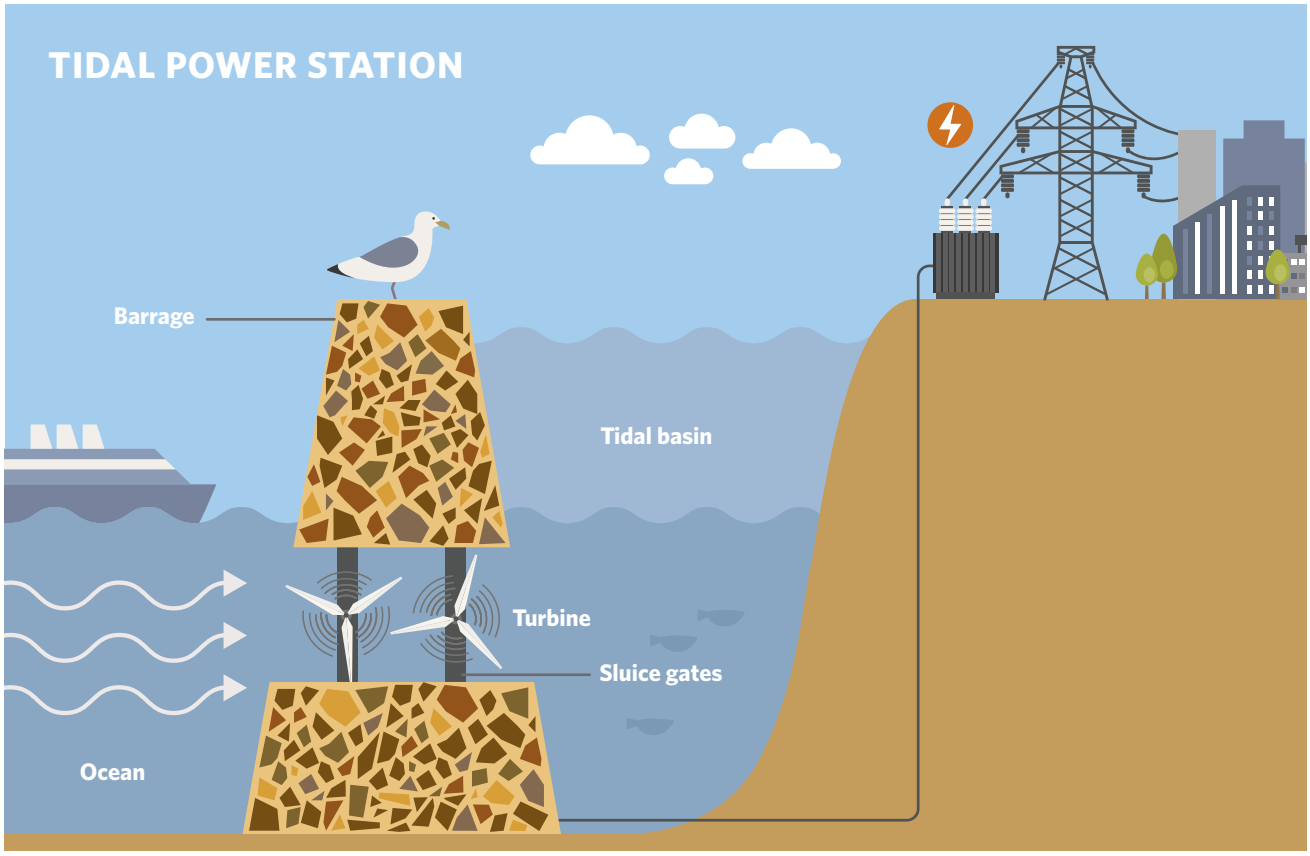
- Geothermal power plants can only be built in specific locations, where the magma is close the surface.
- The digging to build geothermal infrastructure can release greenhouse gases from under the earth's crust.
- Geothermal plants can be very expensive to build.

TIDAL

If you've ever seen the ocean – either in person, on TV, or in a movie – you've likely watched waves crashing on the shore. If you came back later in the day, you might notice that the waves have moved up or down the shoreline. This is caused by the tide, which causes the oceans to rise and fall twice a day. Our tides are caused by the moon, as it orbits around the Earth. The pull of gravity from the moon causes the oceans to rise and then fall... and in that movement of water is energy!

Underwater turbines, which spin when water passes through them, are placed along coasts that experience large tidal energy – big rises and big falls. As the water flows through the turbines, they spin, generating electricity.

There is still a lot of research to be done on this type of energy source. It may not be good for ocean ecosystems, and the cost of the technology is still very high. There will always be tides, so it is a sustainable energy source, but this is our opportunity to learn more about whether we can do it in an environmentally friendly and affordable way.



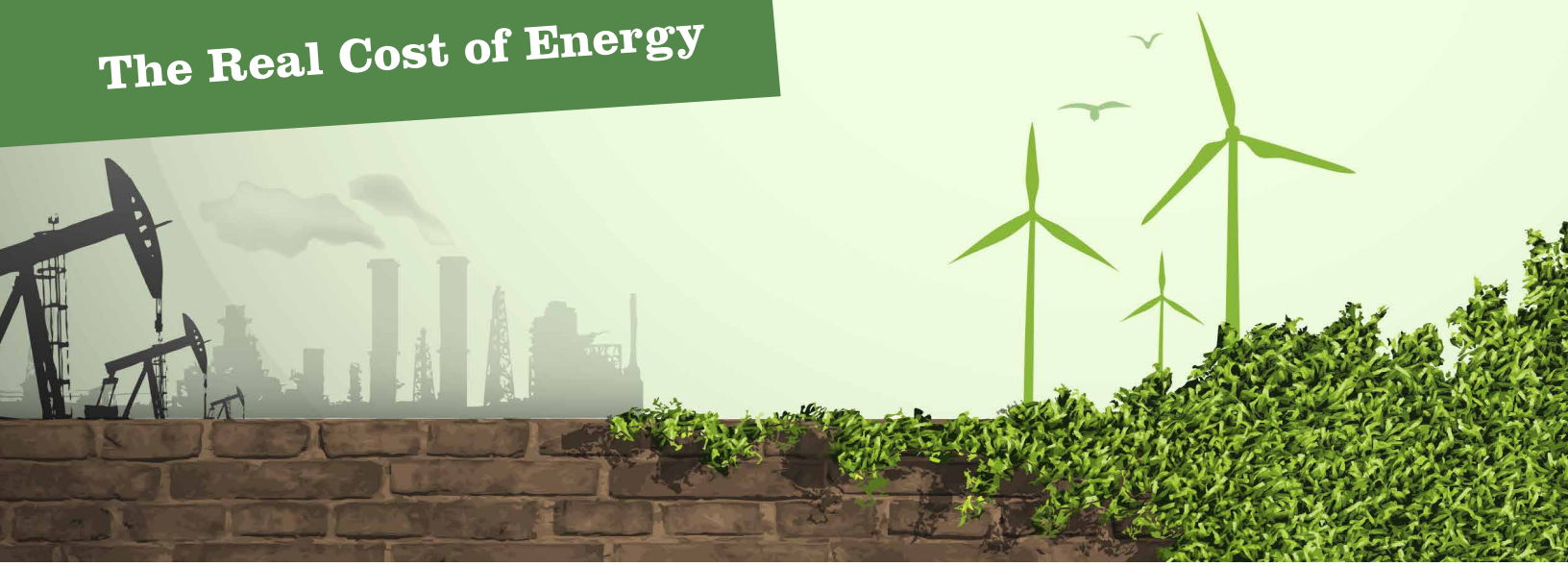
Positives of tidal energy:

- It can generate reliable energy, as the tides go in and out every day.
- No greenhouse gases are produced.
- Tidal energy generates a lot of energy.

Things to be aware of:

- Tidal energy generators are very expensive to build.
- There are limited locations where tidal generators can be built.
- More research is needed to understand the effects of these power generators on ocean ecosystems.

The Real Cost of Energy



After learning about the different types of alternative energy sources, it is important to understand the impact of using unsustainable fuels. Traditionally, a lot of our energy came from burning coal, gas, and oil. These energy sources give us lots of energy when we burn them, so we use them for everything from heating our homes to fuel in our vehicles. Unfortunately, there are two main problems with continuing to rely on unsustainable fuels:

1. Once they're used up... they're gone! It takes millions of years for gas, oil, and coal to be created, and because the global demand for energy is increasing, we're currently using up these energy sources faster than they form.
2. When they are burned, they create greenhouse gases like carbon dioxide and methane, which contribute to climate change by trapping heat in our atmosphere, increasing global temperatures.

GLOBAL SNAPSHOTS

Morocco

The Noor Power Plant in Morocco is the world's largest concentrated solar power plant. When it is complete, the project will power more than half of Morocco's electricity needs each year.[10]

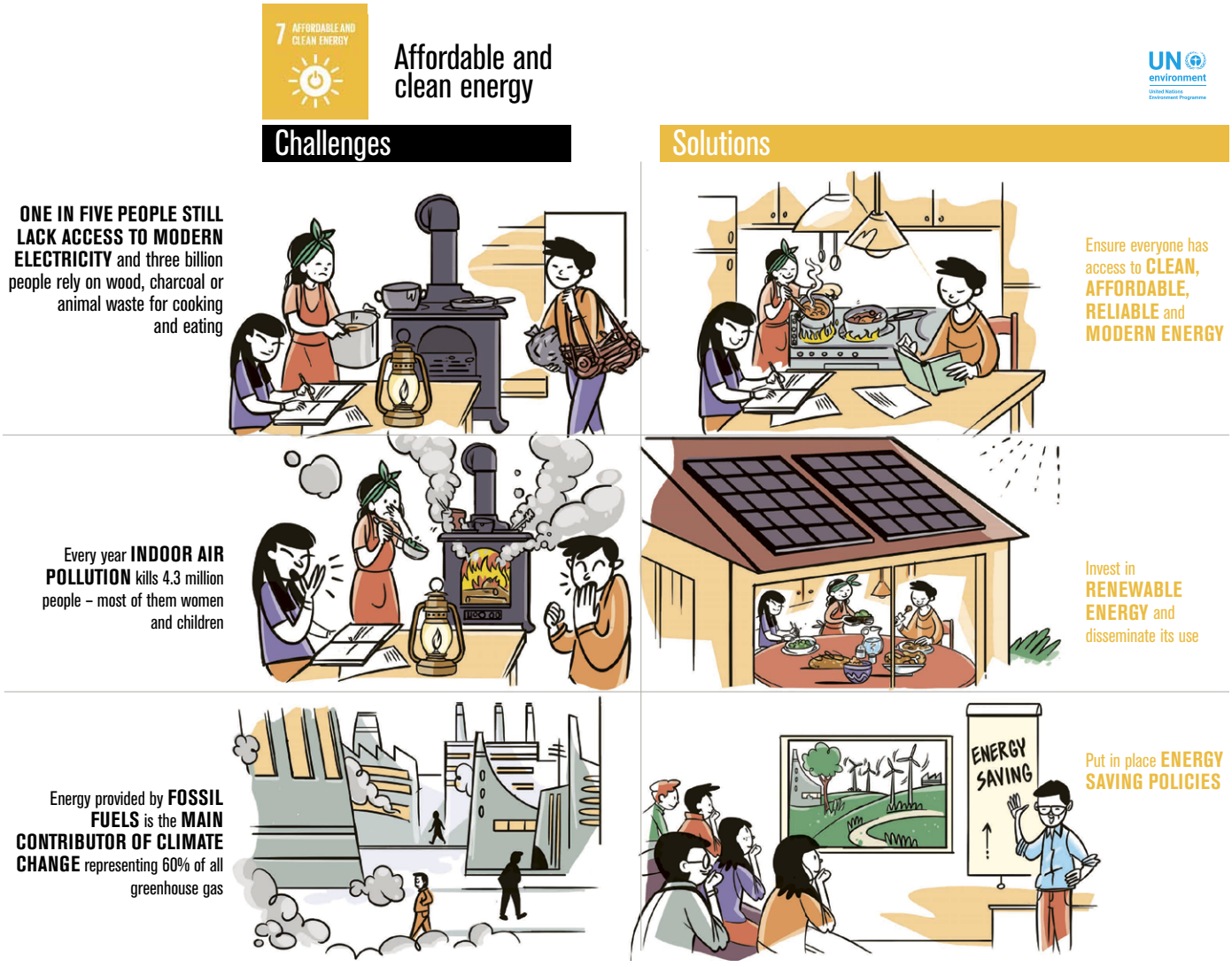
Look it up! Do some research and learn about clean energy in this country.

What are the main types of energy used in this country?

What is something Canada could learn from this country?

3. When it comes to clean energy for cooking, 3 billion people rely on wood, coal, charcoal, or animal waste for cooking and heating. When burned, these create greenhouses gases, and fumes that are harmful to breathe in. Indoor air pollution from using fuels for household energy caused 4.3 million deaths in 2012, with women and girls accounting for 6 out of every 10 of these deaths. This is why clean cooking is so important for the health and wellbeing of people around the world.

By learning more about why it is important for us to use clean energy, we can work to move away from energy sources that are non-renewable and not clean. There is a big cost to the environment, the global climate, and to people's health if we don't. Working to achieve SDG 7 and making sure everyone has access to energy that is safe and sustainable is a key step in protecting each other and our planet.



Energy for the Future

Reducing the amount of energy we use and shifting to generate as much of our energy as possible from clean, sustainable sources is what we need to protect the future of our planet. There are lots of ways to achieve this goal, and the way we discover new solutions is through innovation.

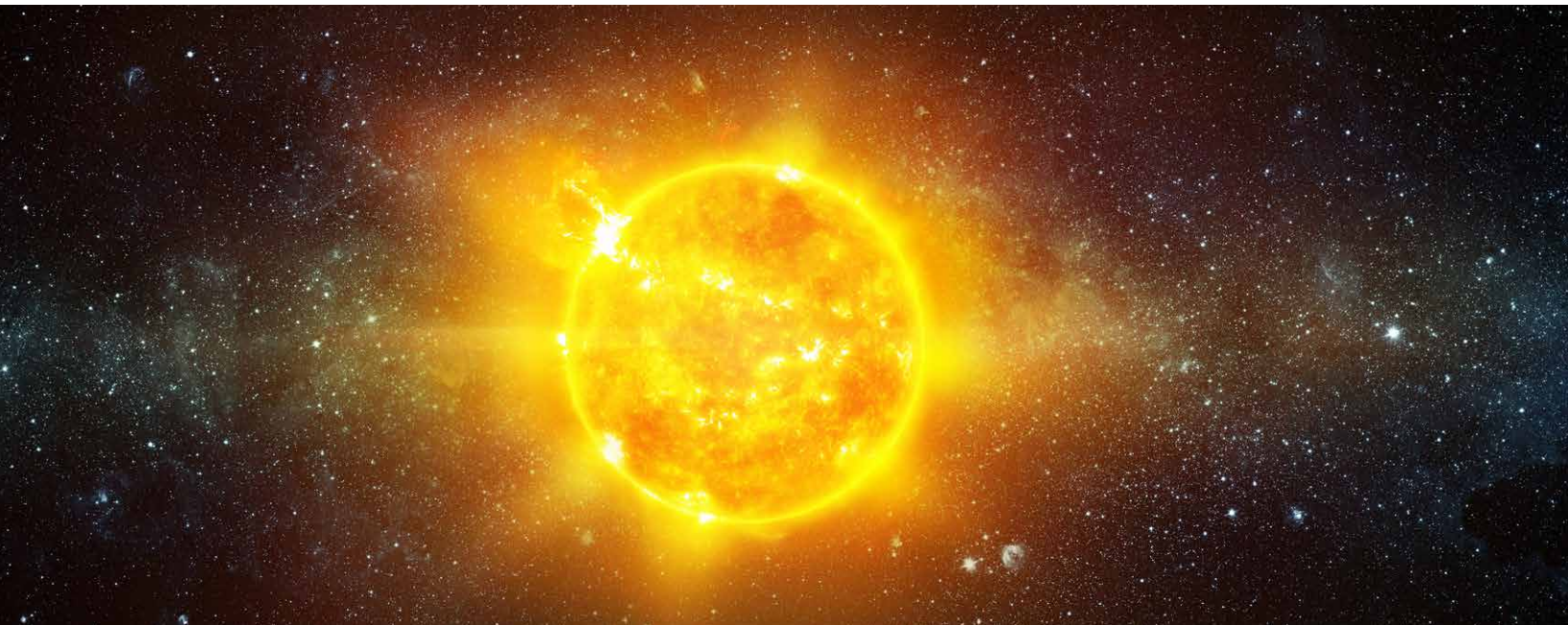
Innovation is creating something new, or changing something that already exists, to meet a want or need. If we want to increase our use of sustainable energy, we need to innovate new ways of meeting our energy needs.

NUCLEAR FUSION

We talked about nuclear energy earlier, but this is a different kind of chemical reaction. It is the same way the sun's energy is generated, through a process called nuclear fusion. As you can see from any picture of the sun, the reaction is intense! So intense, that we're still figuring out how to create these reactions and capture the energy they create. If we're able to innovate a way to harness this energy, we will be able to produce huge amounts of energy with very little fuel. In theory only a few grams of this nuclear material could produce enough energy to support the energy needs of one person in a developed country for 60 years.[11] A solution has not yet been discovered, with some researchers and scientists saying it may never be possible. But this is the role of science and technology, using them to discover new things about the world we live in and solve issues.

SOLAR ENERGY

Solar energy has made big advancements, becoming more efficient and cheaper to produce every year.[12] Some of the ways solar could change in the future is by becoming part of new developments – homes and other buildings are starting to be built with roof supports to allow solar energy to be generated. Solar panels are also becoming thinner and even flexible, so they can be applied as a film or thin coating on vehicles, buildings, bridges and more. Imagine everything that is outside turning the sunlight that touches it into electricity! We still have a long way to go with solar energy, but innovations in science and technology will continue to help us be more sustainable in our energy use.



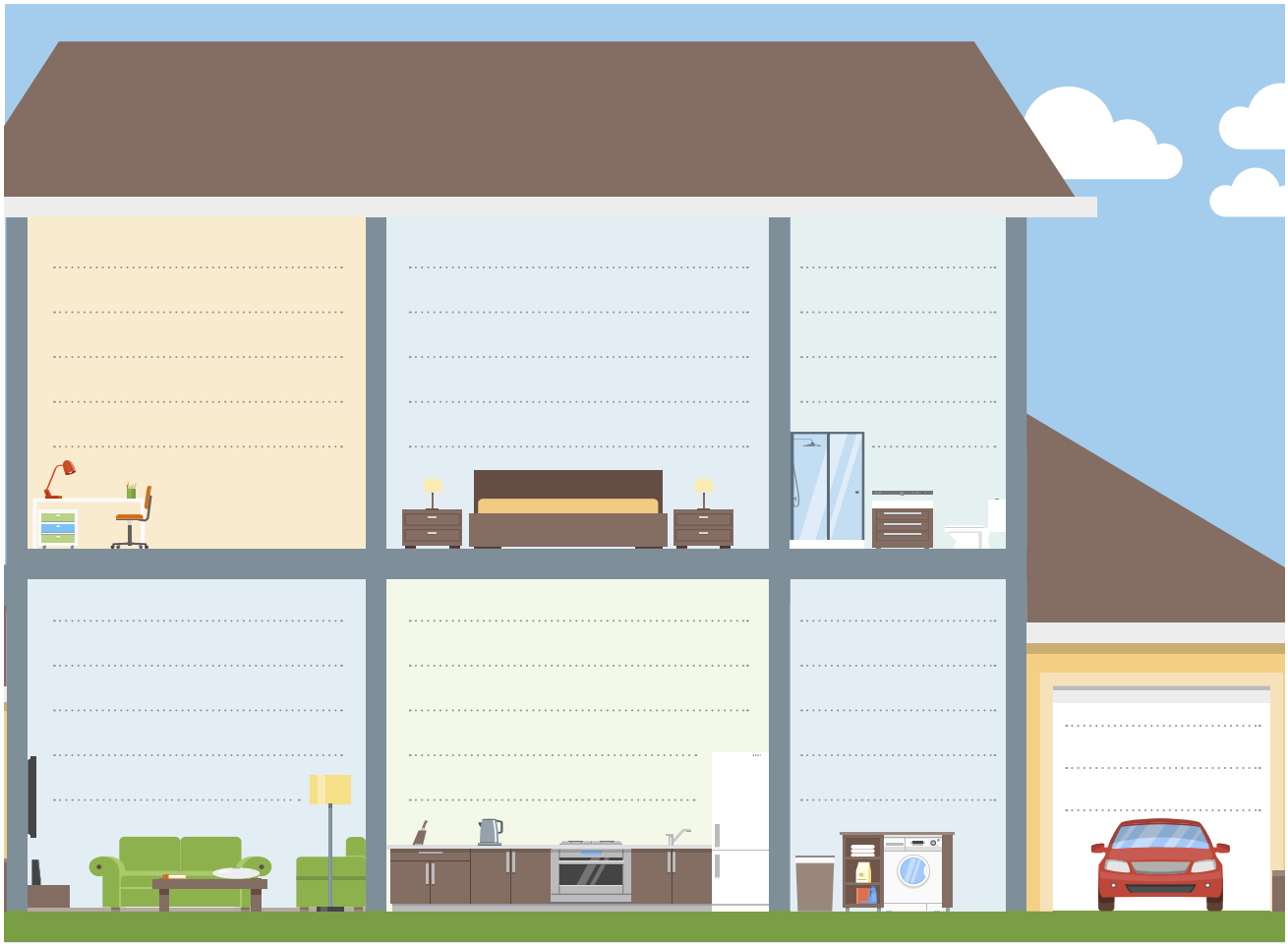
WHAT COULD THE FUTURE OF ENERGY LOOK LIKE?

Take some time to brainstorm what your dream power station would look like. Let your imagination run wild – there are no limits! What would you use as fuel? How would we collect the fuel? How would you transport the energy? What colour would it be? Would you be able to see it? Taste it? Smell it? Have fun with it and imagine a world where we could generate power from seaweed, or treadmills in gyms, or draining bathtubs!

My Energy Footprint

We're surrounded by things that use energy... and that's okay! These are things that make our lives easier, safer, more connected, and fun. They can power how we eat, how we get around, how we learn, or how we talk with friends and family. But it is important to be aware of all the things that use energy, so we can be more mindful about using them, not leaving them on too long, maybe using them less, or finding greener energy alternatives.

Go through your home and write down at least three things that use energy in each room. Try not to repeat any (e.g. if you write down "lights" in one room, try not to write it for any other room):



We've also learned about different types of energy. Can you spot them in your home? Go through this checklist and see what types of energy you use – and add in a few items of your own! This will help you better recognize the world of energy around you.

TYPE OF ENERGY	ITEMS
Electricity	☐ Fridge ☐ Oven ☐ Toaster ☐ Kettle ☐ Microwave ☐ TV ☐ Phone ☐ Computer ☐ Lights other: ....
Solar	☐ Calculator ☐ Plants growing ☐ Solar powered lights/outdoor lamps ☐ Clothesline other: ....
Wind	☐ Fan ☐ Hairdryer ☐ Lawn ornaments ☐ Wind chimes ☐ Flag other: ....
Gas, oil, propane	☐ Vehicle ☐ BBQ ☐ Lawn mower ☐ Snow blower ☐ Gas or oil furnace ☐ Gas stove other: ....
Other:	Electricity bill – talk to your family about where your electricity comes from. You might need to do a bit of research! It could be generated by hydroelectricity, nuclear, or another energy source. ....

Powered Up!

As you go through your home, you'll quickly realize that there are hundreds of things in your home that use energy! Was there anything plugged in or turned on that didn't need to be? Pick three of the things you found and write them down below. Then do a search online for how much energy that item uses each day. Finally, figure out how many hours it would take you to spend the same energy biking – the results might surprise you!

Item that uses energy	How much energy does it use per day? (Units can be watts, or kwatts, which is 1000 watts)	What is that equal to in the energy it takes to bike? (100 watts = 1 hour of biking)
Example: Fridge (newer model)	180 watts/day	Almost two hours of biking/day

SPARKING CHANGE

Sustainable energy use is a big goal, and one the whole world needs to work on together. But on a personal level, you can play a part in achieving it with the actions you take in your own life. Check out these things that we can all do to reduce our energy use and become more sustainable:

- Bike or walk when you can.
- Be more light-aware and turn off lights when you leave a room.
- Start a timer! How quickly can you shower? Shorter showers not only use less water, but less energy is needed to heat the water. Make sure you're still getting clean, but see if you can be quicker in the shower!
- Energy use is highest during the day. Shift your energy use, like charging your phone, or running the dishwasher until after 7 p.m.
- Investigate which items in your home still require batteries. If you're not already, try using rechargeable batteries.

I-SPY ENERGY GAME

After going through your home and noticing all the things that use energy, play a game with your family or friends. Play traditional I-Spy – where someone picks something in the room and the rest of group ask Yes/No questions about what it could be – but only pick things that use energy. Try to be sneaky! Maybe something small and hard to think of, like a watch. Maybe something so obvious that people overlook it, like a thermostat. Get creative and see if people can figure out what you're spying!

- Reduce is the most important of step of Reduce, Reuse, Recycle, because if we reduce how much we buy or use, less energy is needed to make those things in the first place. Think about things you could reduce in your life, and for the things you do use - how could you reuse them to give them an even longer life?

- Talk to your family about changes you can make around the home:
  - » Lower the thermostat one or two degrees in the winter; raise it one or two degrees in the summer.
  - » Does your family have a smart thermostat? Talk to your parents about how to program it and get the most efficiency out it!
  - » Buy LED lightbulbs – they use much less energy than traditional lightbulbs.
  - » Buy local – it takes a lot of energy to order things online, have them individually packaged, and dropped off at your home. See what items could be grouped together and purchased at a local store.

To build upon what you are learning and exploring with this activity book, check out these past 4-H resources from different provinces across Canada, available for download at 👉 **4-h-learns.org**:

- Building Blocks Engineering – 4-H Ontario
- Explore Energy & the Environment – 4-H Manitoba
- Adventures in STEM – 4-H Ontario
- And many more!

And if you're looking to learn about the other SDGs, check out the other 4-H at Home resources for more activities and awesome information:

- My Plate and the Planet – learn about sustainable agriculture and food security, and where the food on your plate comes from.
- Dig into Soil – learn the importance of soils by getting your hands dirty and exploring the world beneath our feet.

Get these resources and more at 👉 **4-h-canada.ca/4-h-at-home**

ACTIVITY 1

GENERATION STATION - LIGHT IT UP!

After learning about different types of clean energy, this is your chance to test it out for yourself. With the mini turbine in your activity kit, you can experiment using wind and water to spin the fan, which spins the generator, producing power, and turns on the LED light.

MINI TURBINE

CHARGING STATION

Want to see what different clean energy generation plants look like? Check out this virtual tour for more information about sustainable energy, and an up-close look at a wind farm and solar farm.

youtu.be/CKZaBg1xkxs

Wind

Just like a wind turbine, your mini turbine can spin in the wind and generate electricity. You can try blowing into the fan... it will be enough energy to spin it, but probably not enough to turn the light on. You need more power! If it is a windy day, take it outside, and point the fan into the wind. If it isn't windy enough, use a hair dryer, ideally one with a cool air setting. (If it doesn't have a cool setting you may want to wear an oven mitt while you hold the mini turbine and blow the hair dryer at the fan.) As the fan spins, it converts the wind energy into electricity, lighting up the LED!

What happens to the light if you turn the fan away from the wind? What happens if you turn the fan, so it is still catching the wind, but pointing up? What happens if you carefully add longer paper fins to the fan?

My observations:

Water

Just like a hydroelectric power generator, your mini turbine can be moved by flowing water to generate electricity. Turn on a tap so there is a gentle stream of water. Holding the plastic generator, put the fan into the stream of water. **Keep the plastic generator out of the water as it's not completely waterproof!** Watch the fan as it moves and the light turns on. You might need to adjust the flow of water to get the fan spinning fast enough. As the fan spins, it converts the flowing water energy into electricity, lighting up the LED! This kind of energy is seen in hydroelectric dams (water falling down over a turbine), and in tidal energy (as water moves towards the shore and pulls away from it).

What happens if the water slows down, or speeds up? Does changing the angle of the fan change the brightness of the light?

My observations:

Steam

We talked about how a lot of energy is created by turning water into steam, and using steam to turn a turbine, generating electricity. While this mini turbine is just like the big ones that run off steam, it is not safe to try as it would be too hot and would need to be under pressure. Instead, you can see the energy of steam, and how it rises, the next time you boil a kettle – imagine that movement of steam turning a fan to generate electricity. If you have an oven-top kettle you can even *hear* the energy in steam – when it is boiling, it will whistle as the hot steam blasts through the spout.

SPARKING IDEAS

Are you interested in finding solutions to issues? Do you have questions about how the world works and want to find answers? Check out the **4-H Canada Science Fair** – a program for 4-H members where you can discover and innovate with your very own STEM project. We've had members do projects on environmental issues, agricultural innovations, even baseball! Your project can be related to any topic you're passionate about, as you explore the science and technology behind it!

ACTIVITY 2

SQUISHY CIRCUITS

Did you know that you can turn on a lightbulb with... playdough?! Squishy Circuits was created in the Playful Learning Lab at the University of St. Thomas in Minnesota by Dr. AnnMarie Thomas, an educator and researcher passionate about making science and technology fun! She and her team came up with this awesome, hands-on experiment where you can take playdough and turn it into an electrical circuit. You can check out her TED Talk here: youtu.be/5M3Dow20KIM

What will you create?

Materials:

- Playdough – salty and sugary
  - » If you already have store-bought playdough, you can use it as the salty playdough and just make the sugary one.
- LED lights
- 9V battery with cap on

SAFETY: It is important to always be safe with electricity, so follow the instructions carefully. **Only put the wires into playdough.** If you have the wires directly touching the ends of the LED, it will burn out the light!

Playdough Recipe

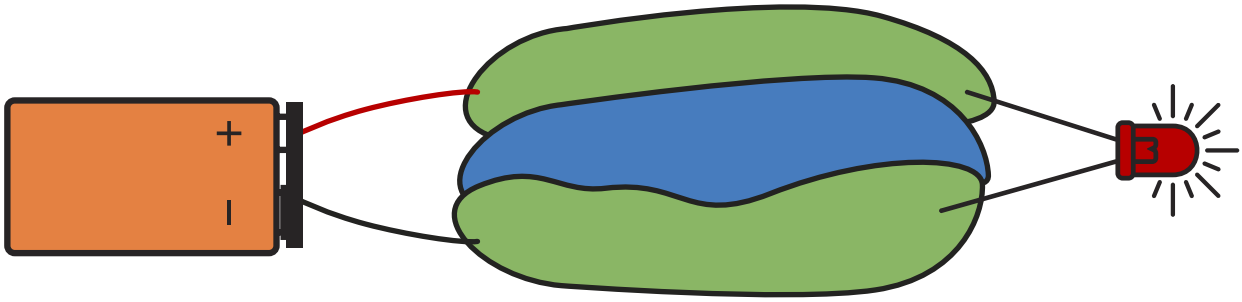
SALTY PLAYDOUGH:	SUGARY PLAYDOUGH:
2 cups flour **~ 1 cup warm water** **1 cup salt** **2 tablespoons vegetable oil** **1 tablespoon cream of tartar** (optional, for improved elasticity) **Food colouring**	**2 cups flour** **~ 1 cup warm water** **1 cup sugar** **2 tablespoons vegetable oil** **1 tablespoon cream of tartar** (optional, for improved elasticity) **Food colouring** (different colour from salty playdough)
1. Mix all of the ingredients together (start with less water and add more as needed) and stir over low heat. The dough will begin to thicken and clump. 2. When the dough pulls away from the sides and clumps in the centre, remove the pan from heat and allow the dough to cool enough to handle. 3. Once cool, knead the dough to create a uniform consistency. The dough should be stretchy and smooth.	1. Mix all of the ingredients together (start with less water and add more as needed) and stir over low heat. The dough will begin to thicken and clump. 2. When the dough pulls away from the sides and clumps in the centre, remove the pan from heat and allow the dough to cool enough to handle. 3. Once cool, knead the dough to create a uniform consistency. The dough should be stretchy and smooth.

If kept in a sealed container, playdough should last for months.

Instructions:

- After making the two types of playdough, set up all the materials on a clean work surface.
- First, we're going to make a simple circuit. You can think of a circuit like a racetrack or loop – it must start at the battery and have an unbroken pathway to come back to the battery:

1. Roll out two rolls of salty playdough. Put a roll of sugary dough in between them.
2. Stick the red wire into one end of the first roll of salty dough.
3. Stick the black wire into the end of the second roll of salty dough.
4. Connect the two rolls with the ends of the LED. Make sure the two rolls of salty playdough aren't touching each other – only touching the sugary dough.
5. The light should come on! (If it doesn't turn on, try flipping the LED around, so the ends of the LED go into the opposite piece of playdough.)



- Now it's up to you! Try having fun with it and create a different kind of circuit. Maybe you use more LEDs – what happens when you do? What if you make the rolls longer, or shorter? Can you shape the rolls into a design? What happens if you try to make the same circuit just using sugary dough?

Check out more Squishy Circuit designs here: **squishycircuits.com/collections/projects**

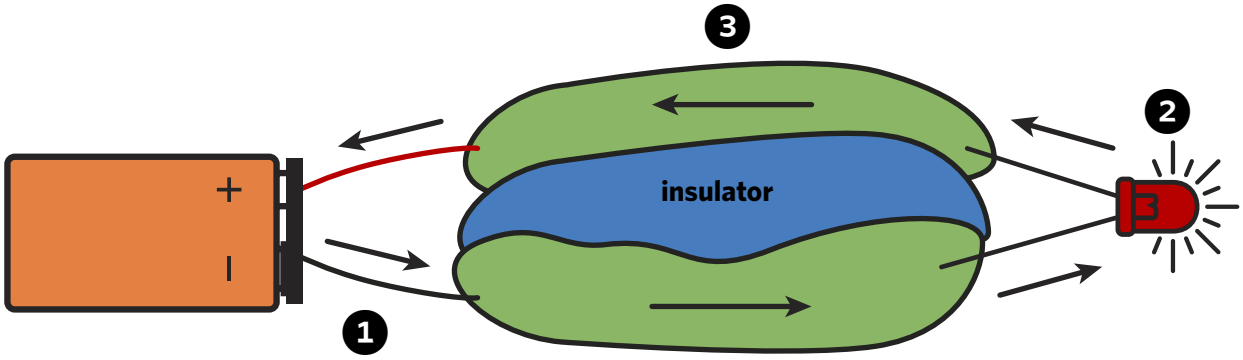
POWER UP

Take your circuit even further! You can look online to find a number of different add-ons, like spinning motors, light sensors, noise makers, even minicomputers like a MakeyMakey or Raspberry Pi. Use your imagination, dream up something cool, and have fun creating!

Powered Up!

Why does this work?

The salt in the dough acts as a **conductor**, which means it allows electricity to pass through it. The electricity flows from the battery into the first roll of salty playdough ❶. As we mentioned above, the electricity has to flow back to the battery in order to complete the circuit, so the electricity goes through the LED ❷ and back to the battery through the second roll of salty playdough ❸. This electricity, flowing through the LED is what turns the light on! The sugary dough acts as an **insulator**, which means it does not let electricity pass through it. It keeps the two rolls of salty dough separate, forcing the electricity to go through the LED to complete the loop. You can test what happens if the two salty rolls touch...what did you observe? With nothing between them, nothing is forcing the electricity to pass through the LED, so the electricity only goes through the salty playdough (this is called a short circuit). [1314]



GLOBAL SNAPSHOTS

Scotland

Scotland is known for its wet, harsh weather, but this contributes to the perfect conditions for the third largest off-shore wind farm in the world![13] The power from these wind turbines contributes to Scotland generating 97.4% of their electricity from renewable sources.[14]

Look it up! Do some research and learn about clean energy in this country.

What are the main types of energy used in this country?

.....

.....

What is something Canada could learn from this country?

.....

.....

ACTIVITY 3

SUPER SOLAR S'MORES!

One of the big parts of SDG 7 is clean cooking – and this is your chance to cook up something delicious, only using the power of the sun! We've talked about solar energy, and how we can harness the heat and light that comes from the sun. Building your own solar oven will give you a chance to see that power up close, while making a tasty treat.

Materials:

- Box that this initiative came in, or a pizza box
- Tin foil
- Glue or tape (optional)
- Newspaper
- Black paper
- Plastic wrap
- S'mores ingredients – graham crackers, marshmallows, chocolate
- Oven safe pan, or pie tin
- Wooden skewer
- Thermometer (optional)
- Oven mitts

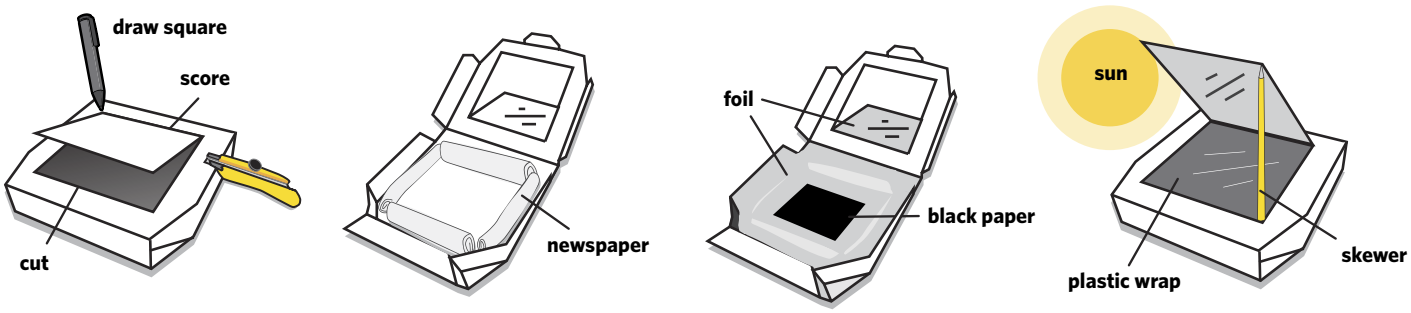
Note: Cooking in a solar oven takes longer than a normal oven, so don't expect instant results. Keep an eye on the temperature and your food as it cooks. This activity works best on a sunny day.

Solar ovens are used around the world as a clean energy option for cooking food. People use them camping, in remote places without electricity, or as a free, clean energy option that is safer to cook with than burning wood or coal. If you want to learn more about the potential of solar ovens and how important they can be when it comes to ensuring clean cooking is available to everyone around the world, check out this video: youtu.be/Ofn7jqPDTeY

Powered Up!

Instructions:

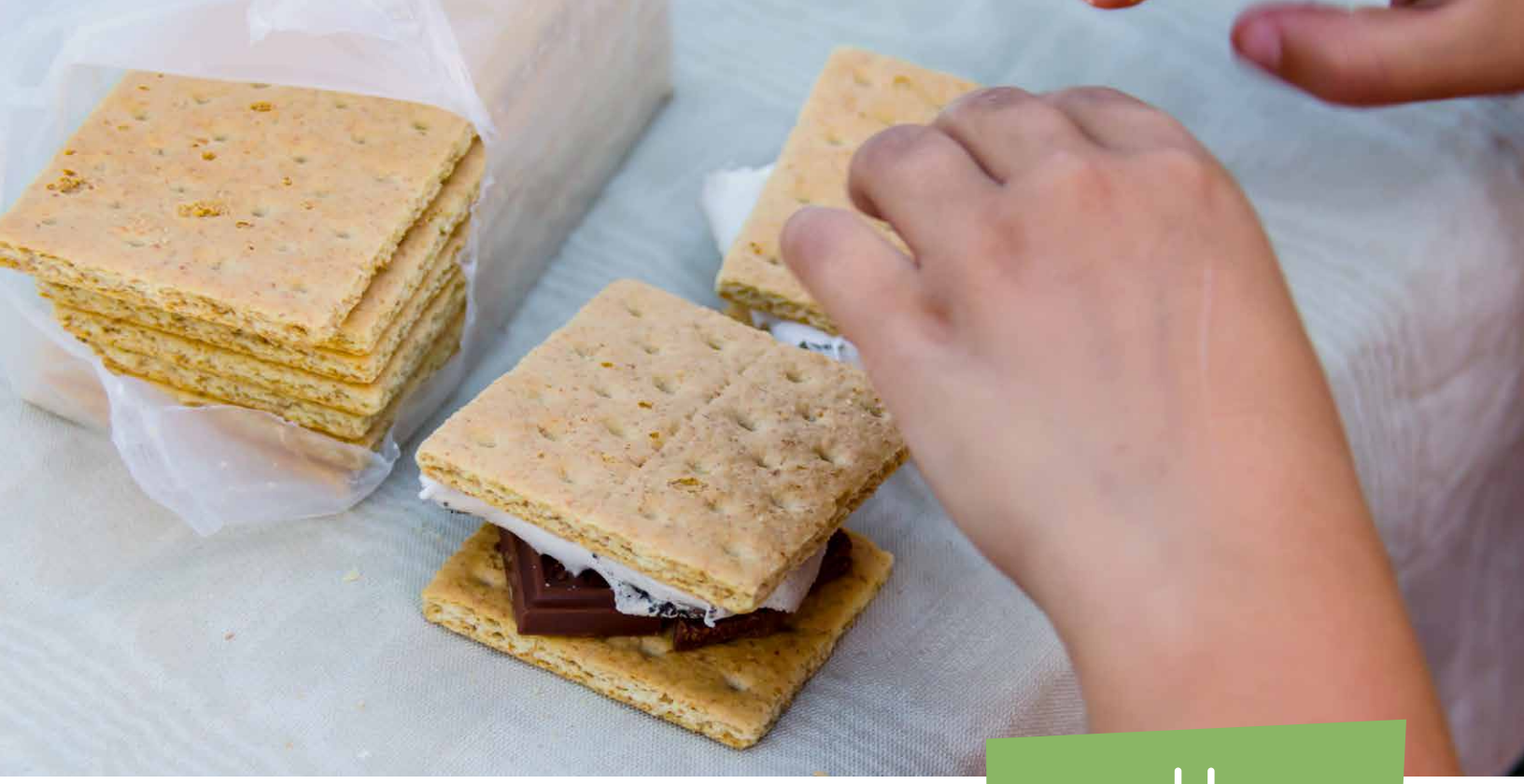
1. Take the box and close the lid. Draw a square on the lid, about 10cm in from the edges. Carefully cut three of the sides of the square – this will be the flap you use to reflect the light into the oven.
2. Around the inside edges of the bottom of the box, tightly roll up tubes of newspaper (taped to help keep the shape), putting one on each side. This will act as insulation, keeping the heat in the oven.
3. Lay the tin foil down on the inside of the box, including up the sides. Glue or fold the tin foil to the inside of the flap you created. There should now be tin foil on the top and bottom of the inside of the box. The tin foil will reflect the sun's rays, helping to trap the heat in the box.
4. On the bottom of the box, right below the flap opening, place the black paper. Because it is black, it will absorb the heat, helping to cook the food.
5. Close the box, but lift the flap. With the flap open, cover the opening with plastic wrap. This will allow the sun's rays to reflect into the box, but the plastic wrap will keep the oven space closed.
6. Place your solar oven outside, in full sun, to get warm as you prepare your snack.



7. Now you can put together your S'mores! Take a graham cracker, put chocolate chips or some squares from a chocolate bar on it, and then top it with a large marshmallow. Make as many of these as you'd like and arrange them on an oven-safe pan or pie tin that will fit into the solar oven.

SAFETY: When cooking, even with a solar oven, it's good to have adult supervision. Talk with your parents/guardians before getting started.

8. Put the pan of S'mores inside the box, in the middle, on top of the black paper, and close the lid.
9. Lift up the flap and tape the wooden skewer to it or stick it through the cardboard. This will act like a kickstand, keeping the reflective flap open. Position the oven, with the flap propped open, at the best angle and direction to reflect as much light as possible into the oven. You'll see the light reflect off the tin foil – try some different angles and positions until you see the brightest amount of light reflected down into the oven.
10. Carefully stick the pointy end of the thermometer through the plastic wrap, but not into the food. You'll use this to check on the rising temperature of the oven (optional, if you have a thermometer).



11. Looking through the plastic wrap, check on your snack every 10 minutes or so. It will probably take about 30 minutes to cook and melt the chocolate, but it could be longer depending on the weather that day. Check on the thermometer to see the temperature rise as your oven captures the energy from the sun (optional).

12. When the chocolate is melted, open the oven, and using oven mitts, carefully remove the pan. Share your snack with friends and family and enjoy!

POWER UP

You can also use your solar oven to make nachos or mini pizzas!

If you'd like to follow along with video instructions, check out this video. We've simplified our instructions, but this is still a helpful demonstration: **youtu.be/xZJmz_tF4NU**

Nature-powered Nachos – tortilla chips, salsa, cheese, plus anything else you like on nachos - beans, onion, hot peppers. Put some tortilla chips on an oven-safe pan. Layer on the toppings, cover with cheese, and put into the solar oven. Wait for the cheese to melt and enjoy with some sour cream and guacamole!

Sunshine Pizzas – English muffins, bagels, pita or naan bread as a base, tomato sauce, cheese, your favourite pizza toppings. Spread the tomato sauce on your pizza base, cover with shredded cheese and top with a variety of pizza toppings. Put it into the solar oven and wait for the cheese to melt. Cut into slices, and enjoy with a salad.

Want to discover other recipes you can make in your solar oven? Look up solar oven recipes online!

Be a Clean Energy Champion!

With everything you've learned about SDG 7 – Affordable and Clean Energy, this is your chance to share it with your friends, family, and the world! This is a global issue, and we all have a part to play in raising awareness and encouraging others to make sustainable energy choices in our homes, communities, countries, and around the world!

YOUNG PEOPLE MAKING THINGS HAPPEN

GIVE THESE SOME THOUGHT

What was the most interesting thing you learned from Powered Up!?

What was something that surprised you as you went through the guide and activities?

How has your understanding and thoughts about clean and sustainable energy changed?

What is something you have done to reduce your energy use?

What is one thing about sustainable energy you could work to improve in your own life?

NOW TAKE ACTION – CHALLENGE YOURSELF TO MAKE A BIG IMPACT!

- Post on social media. If you have an account, share:
  - » What you've learned!
  - » The amount of energy used by common everyday items.
  - » The steps you're taking to reduce your energy footprint.
  - » Invite others to join you in learning more, making sustainable energy choices, reducing their energy use, and discussing the ways they can make a difference!
  - » And remember, we love to hear from you and support your learning, so share your posts with us by tagging **@4hcanada** on Instagram, Facebook, or Twitter.
- Talk to your friends and family about what you've learned, include them in these activities, or encourage them to read this resource too!
- Post a sign in your window, or on your lawn, encouraging others to support SDG 7 - Affordable and Clean Energy.
- Volunteer with a local green energy organization and see what can be improved in your own community.
- Reach out to your local politicians – community, provincial, federal – and ask them what they are doing to support SDG 7. No matter which political party they are part of, they should be able to give you an answer!
- Your own idea of how to make change:

Reflection

You have just completed a series of activities about affordable and clean energy, and we hope you feel like you've achieved the goals we mentioned in the beginning! When we learn and do something new, one of the key steps is to reflect at the end of it all. How did it go? What was your favourite part? What surprised you? What did you achieve? What would you do differently next time?

Consider the following questions and see how they link up to the skills you've developed in Powered Up!

REFLECTION QUESTIONS	OUTCOMES
How have you advocated for clean and affordable energy or supported others in their learning?	*Leadership development*
What skills have you learned by going through these activities?	*Skill mastery*
What positive change can you make by supporting the Affordable and Clean Energy SDG?	*Positive values*
What responsibility do you feel you have when it comes to achieving SDG 7?	*Responsibility*

What goals have you set for yourself to try and reduce your energy use, or support cleaner energy?

Planning and decision making

How will you make your mark as a member of your community, and as a global citizen?

Sense of purpose

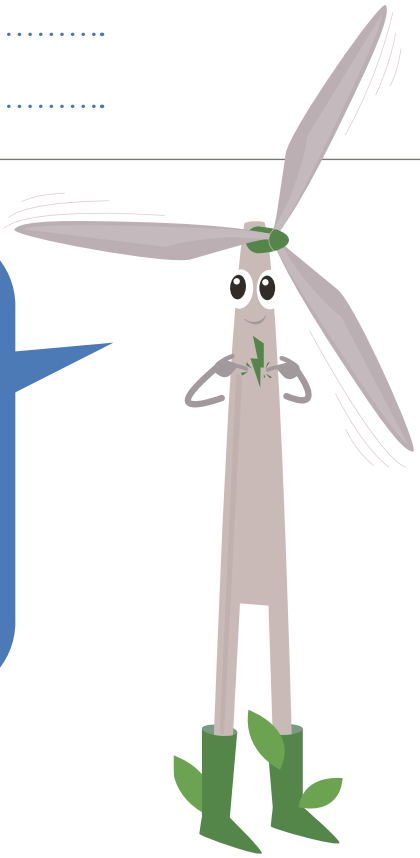
What was the most fun part of this kit? What was something you learned in a hands-on way? Did anyone help you with your learning – acknowledge them here.

Learn To Do By Doing

Fun

Supportive adults

Thank you for joining 4-H Canada, and youth across the country, in learning more about sustainable energy, gaining skills, and having fun with science and technology as you explored Powered Up! We look forward to seeing what you've accomplished (remember to share it with us by tagging **@4hcanada** on Instagram, Facebook, or Twitter!) and hope you'll try out some of the other opportunities available through 4-H Canada!



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