

DESIGNING A BRIGHTER FUTURE

UNIT 2: RENEWABLE VITALITY

Planet Earth is facing an energy crisis owing to an escalation in global energy demand, continued dependence on fossil-based fuels for energy generation and transportation, and an increase in world population, exceeding seven billion people and rising steadily (Coyle & Simmons, 2014, p. 1).

This unit allows students to explore non-renewable and renewable forms of energy, as well as look into the energy history and future of Canada's provinces and territories. Students will then have the opportunity to assess the renewable energy sources that can be further capitalized in our country.

CURRICULUM CONNECTIONS

This unit is linked to elementary science and technology curricula, particularly in grades 5 to 7 where there is a focus on energy forms and their environmental impacts. The unit is also linked to secondary science curricula, particularly in grades 10 and 11, where there is a focus on energy and climate change. The activities can also be introduced into geography courses.

LEARNING OUTCOMES

- Explain the basic principles of renewable and non-renewable energy production
- Analyze energy trends in Canada's provinces and territories
- Describe the environmental impacts of various energy forms
- Analyze the forms of energy in a community and explain why one source is preferred over another (secondary level)

SUGGESTED TIME: 4 HOURS





INTRODUCTION AND BACKGROUND INFORMATION

Energy is everywhere! We can "hear energy (sound), feel energy (wind), taste energy (food) and see energy (light)"¹. From renewable sources such as water, wind and sun, and non-renewable sources such as coal, oil and natural gas, we have access to electricity and heat².

Renewable energy forms

"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"³. In 2017, approximately 17% of domestic energy use in Canada was in the form of renewables², including:

- Solar energy: Capturing the energy from the sun's rays to produce electricity^{2,4}.
- Wind energy: Using the wind to generate electricity^{2,4}.
Currently, wind energy accounts for 4% of Canada's electricity generation, but it is experiencing strong growth in the country².
- Biomass: Living organisms and their by-products, such as vegetable oils, wood, corn and animal waste, can be used to produce electricity and heat^{2,5}.
- Geothermal energy: Since the Earth's core is very hot, we can take that thermal energy and use it for heating or convert it into electricity^{2,4,5}.
- Hydropower: The natural motion of water (kinetic energy) can turn turbine blades, which drives a generator and eventually produces electricity⁵. Hydropower accounts for 60% of Canada's electricity generation².
- Marine energy: the kinetic and potential energy of tides, ocean waves and river currents "can be used to drive turbines and produce electricity"⁶.



Photovoltaic roof tile
Artifact # 2010.0091.001
Ingenium National Collection

Non-renewable forms of energy

"Non-renewable energy is generated from finite resources that will eventually deplete or become too expensive or too environmentally damaging to retrieve"⁷.

- Fossil fuels: Includes coal, oil and natural gas. Under heat and pressure, plant and animal matter buried in sedimentary rocks is gradually transformed into hydrocarbons (or fossil fuels)⁸.
- Nuclear: Uranium is a radioactive metal. During the fission (or breaking) of uranium atoms, heat is generated, which can be used to generate electricity. Nuclear energy provides more than 60% of Ontario's electricity needs. In addition to fission, we can fuse (or assemble) atomic nuclei. Despite the need for more research, nuclear fusion is seen as a solution to our energy problems⁵.

For more Canadian energy highlights, we invite you to visit the "Let's Talk Energy" website and peruse the site's infographics below, which details the current situation in the provinces and territories. <https://energy.techno-science.ca/doc/resources/Infographic-1-Energy-Facts-EN.pdf>

¹ Kolenbrander et al., 2019, para. 5

² Natural Resources Canada [NRCAN], 2020

³ NRCAN, 2020, para. 1

⁴ NRCAN, 2019

⁵ Let's Talk Energy, 2020

⁶ NRCAN, 2017, para. 1

⁷ NRCAN, 2009, para. 2

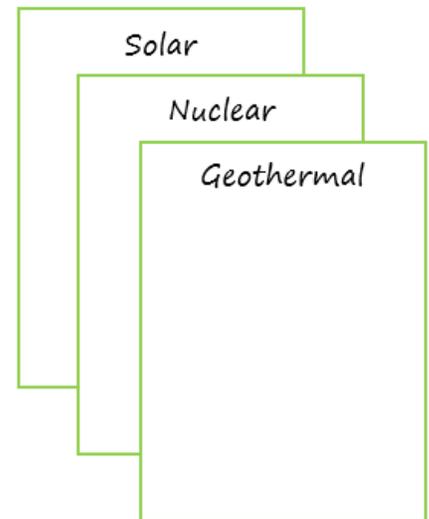
⁸ NRCAN, 2015



RECOMMENDED PROCESS

1. Carousel of energy forms

- Obtain 8 sheets of large format paper. Label each sheet with a title: wind, solar, biomass, geothermal, hydro, nuclear, marine, fossil fuels (natural gas, coal, oil).
- Place the posters in different areas of the classroom.
- Students work individually or in small groups (2 to 3 students) depending on your preferences.
- Place one student or a student group at each poster and ask them to write or draw what they know about this form of energy.
- After approximately one minute, students rotate and move to a new poster.
- Continue the rotation until each group has had an opportunity to give an overview of each energy form.
- Once the carousel has been completed, invite students to share some of their knowledge with the class. This provides an opportunity to ask some questions, to clarify certain elements and assess their prior knowledge.



2. Initiate a mini research project (if applicable)

- If you see that there are gaps in their knowledge, we recommend that you undertake a lesson or mini research project to ensure that students can explain the basic principles of renewable and non-renewable forms of energy, as well as their advantages and disadvantages.

3. Analyzing Canada's energy history

- Students will then assess Canada's energy history with the National Energy Board's interactive site.
- Students, in groups of 2 or 3, can analyze changes in one province or territory and look at Canada as a whole⁹.
- Next, discuss the future of Canada's provinces and territories as it pertains to certain forms of energy (e.g., renewable versus non-renewable energy) (National Energy Board, 2019). Ask questions such as: will we continue to favour non-renewable sources, such as fossil fuels, in the future? What impact do non-renewables have on our environment?

National Energy Board Interactive Site

<http://apps2.cer-rec.gc.ca/dvs/?dataset=oct2017&page=viz3&province=all&scenario=reference&sources=hydro,solarWindGeothermal,coal,naturalGas,bio,nuclear,oilProducts&unit=petajoules&viewBy=province&year=2005>

4. Further exploring the energy crisis

- Present the problem of the energy crisis. To do so, you can watch a documentary, such as "Before the Flood" or read a report/article that will make students aware of our environmental reality.

⁹ National Energy Board, 2019



5. Conduct an online survey and a class discussion

- Use a website, such as "Poll Everywhere" that allows you to launch an online survey that addresses the questions below. Once students have answered a question, discuss it and add relevant information.
 - o Does our energy consumption affect the environment and climate change?
 - o Is there a need to focus on renewable energy?
 - o In your lifetime, what initiatives have been taken to reduce energy consumption?
 - Examples of answers: solar panels on houses, hybrid cars, etc.
 - Present case studies of people who are trying to raise public awareness about energy consumption and the energy crisis. Examples of world leaders are provided in Appendix 1.
 - o In contrast, have you noticed people or organizations that are harming the environment?
 - During the discussion, you may wish to report on political leaders who have made decisions that are detrimental to our environment.
 - o What actions could you take to reduce your energy consumption?



CUMULATIVE PROJECT BY GRADE LEVEL

To end this series of activities on the forms of energy, you can introduce different projects according to grade levels.

Grades 4 to 8

A young trailblazer

- Students can act as reporters to showcase a young person who is a trailblazer for the environment. They must find a person under the age of 25 who is trying to effect changes to preserve the environment, and then write an article about them and their work. How did this person develop their passion for the environment? What are they trying to do and how are they going about this? Etc.
- Afterwards, you can post the stories around the classroom or ask students to introduce their trailblazer to the class.

Grades 9+

Become a political leader

- Students will act as political leaders to make informed decisions about the energy used and produced in their community. During the project, students will be asked to choose a Canadian community, answer the following questions, and submit a report that explains their reasoning.
 - o What form(s) of energy will you support in your community? Please consider the environmental impact, availability, efficiency, and cost of this form of energy in your chosen location. Students should include calculations of the energy required and produced in their community and the cost of this energy.
 - o Did you choose a mix of energy forms for your community? Why is this the case?
 - o What are the disadvantages of your solution? How can you mitigate them?

DIG DEEPER – HIGH SCHOOL PROJECT

The project initiated by the secondary students could also ask students to consider the following points:

- Will there be a need for an energy storage facility?
- Will there be sufficient energy production during peak hours?
- What will be done if there is a significant increase in energy demand in the community?
- Consider the difference in energy production by season¹⁰.

Independent Electricity System Operator

Visit their site for hourly data (including peak hours) on energy consumption and production in Ontario.

<http://www.ieso.ca/>

¹⁰ Mooney et al., 2019



ASSESSMENT

Diagnostic

During the carousel and the discussion on energy forms, teachers can take note of students' prior knowledge. Alternatively, the posters can be kept for post-course evaluation.

Formative

During class discussions, staff can assess students' reflections (e.g., on the advantages and disadvantages of renewable and non-renewable forms of energy, and the environmental impacts of energy production). Teachers can also assess the mini research project on energy forms. In addition, when teachers ask students questions about provincial and territorial energy trends, they can note the depth of students' analysis. Finally, while students are working on their final project, record their insights and progress.

Summative

Evaluate the students' final project. For elementary students, evaluate their report on an environmental trailblazer. For high school students acting as political leaders, teachers can evaluate the quality of the explanation and the data that support their energy recommendations. Teachers could ask students to present their research project to the class or to submit a formal report (Mooney et al., 2019).



APPENDIX 1 - AGENTS OF CHANGE

Many people, regardless of age, ethnicity, or socio-economic status, are trying to raise public awareness about energy use and the energy crisis. Take for example, Eden Full Goh, a young Canadian woman who, while in high school, created a device called the SunSaluter. This device allows a solar panel to follow the sun to capture more energy and produce up to 30% more electricity. The SunSaluter was successful and is now distributed in many parts of the world that are without energy¹¹.

There are many excellent examples of people trying to make a difference in our environment. Learn about the work of change agents such as these.

WOMEN IN STEM

CHARITY WANJIKU

Empowering with Power

Wanjiku's aim is to alleviate energy poverty in Africa. Her company Strauss Energy Ltd., designs and develops innovative solar panels that also act as building materials.

Ingenium is committed to encouraging and empowering women and girls in science, technology, engineering, and math. Learn more at ingeniumcanada.org/womeninstem/

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HOMeward BOUND

Mother Nature Needs Her Daughters

Homeward Bound rallies scientists to join the climate change fight. Their all-female expeditions to the Antarctic champion collaboration, connection, and leadership in science.

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HIND AL-ABADLEH

Cracking the Chemistry of Climate Change

Professor Al-Abadleh's air pollution expertise won her the Fulbright Canadian Research Chair in Climate Change. She explores fundamental questions about the chemistry of air pollution, especially ground-level ozone and inhalable microscopic particles.

Ingenium is committed to encouraging and empowering women and girls in science, technology, engineering, and math. Learn more at ingeniumcanada.org/womeninstem/

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You can find more details about these pioneers in their field at <https://womeninstem.ingeniumcanada.org/>. We also recommend exploring the posters of: Hind Al-Abadleh and Hayley Todesco.

¹¹ Ingenium, 2020



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