**Lesson 9:How Can Changes in the Electricity Sector Reduce Carbon Emissions (2nd Half)?**

In the first class the students learnt about project DrawDown, analyzed a table of data from that source, and started exploring the solutions. This exploration is continued in this lesson and ends with the students considering what they can do to reduce climate change.

**Part 4: Examining and Comparing Non-Monetary Aspects**

1. Suppose you don’t care as much about what it costs, and just want to choose the solutions that will remove the most carbon dioxide.

1. Which four solutions can remove the most carbon dioxide?

**Onshore Wind 100, Utility Solar PV 80, Distributed Solar PV 50, Concentrated Solar 20**

Notice how the two underlined solutions are also top money savers from part 3 #1e.

1. What do they have in common?

These all involve producing electricity from wind and sun.

1. Which of the four solutions is the most economical and which is the least economical? Consider the savings and the savings per gigaton of CO2.

**Concentrated Solar** is the least economical because it does not save money! It will cost $900 billion. The other 3 save a similar amount of money over the 30 years: $10,000, $14,000 and $18,000 billion dollars.

The savings per gigaton of CO2, show that the two photovoltaic solutions are more economical per gigaton of CO2.

The answers are given in billions of USD/gigaton of CO2.

**Utility PV** 18000/80 = 225 **Distributed PV** = 10000/50 = 200 **Onshore Wind** = 7000/100 =70

It looks like the two photovoltaic solutions are basically tied for first place, because they save more money per gigaton of CO2 than the other solutions.

2. The top 4 solutions can reduce CO2 emissions by 250 gigatons over the thirty years. Should we bother with the other fifteen solutions? Why or why not? Include numbers.

We should because we need to do everything we can to slow CO2 emissions. If you add up all the other contributions you will see that they can remove another 108 gigatons, which is significant compared to the 250 gigatons of the top four solutions. This shows how many small solutions can combine to have a significant effect.

3. Consider the next 3 solutions that remove the most CO2.

1. What are they and what do they have in common?

The values are given in billions of USD/gigaton of CO2.

**Insulation 17, LED Lighting 15, Building Automation Systems 12.**

(Note: **Building Automation Systems** is like a **Smart Thermostat** for a huge building or building complex.)

These three solutions reduce the need for electricity through retrofitting buildings.

These numbers show how effective **‘reducing’** the need for electrical energy can be.

1. How do the initial costs compare for these three solutions? What about the long term savings?

As we have seen, switching to **LED Lighting** will save money - even for the “Initial Costs”. In contrast, **Insulation** and **Building Automation Systems** are costly to implement. However, they also result in large savings in the long term.

1. What is the **Canada** **Greener Homes** program and how does it encourage the adoption of these solutions?

**Greener Homes** is a federal program that provides grants to eligible homeowners for retrofits such as home insulation, windows and doors, smart thermostats, heat pumps and solar panels. These grants reduce the initial costs and encourage more people to implement the changes.

<https://natural-resources.canada.ca/energy-efficiency/homes/canada-greener-homes-initiative/canada-greener-homes-grant/greener-homes-grant-ontario/24835>

4. What are the next 6 most significant reducers of CO2? How can the government encourage the adoption of these solutions? What are municipal, provincial and federal governments doing already? Try searching with questions like “How is the Ontario government encouraging the use of electric cars.”

In order they are: **Electric Vehicles** and **Solar Hot Water (9 gigatons)**, then **Geothermal** and **Smart Thermostat (8 gigatons)**, then **Heat Pumps** and **Waste to Energy (6 gigatons)**.

|  | **Municipal** | **Provincial** | **Federal** |
| --- | --- | --- | --- |
| **Electric Vehicles** |  |  |  |
| **Solar Hot Water** |  |  |  |
| **Geothermal** |  |  |  |
| **Smart Thermostat** |  |  |  |
| **Heat Pumps** |  |  |  |
| **Waste to Energy** |  |  |  |

**Electric Vehicles**:

If you do the recommended search, you find <https://news.ontario.ca/en/release/1003146/ontario-expands-electric-vehicle-charging-stations> where you learn that they are building charging stations and have introduced a new electricity price plan that lets you charge your car overnight more cheaply. This may be to your benefit if you usually drive during the day and charge your car at night.

If you search but change ‘Ontario’ to ‘Canada’, you find this site <https://www.eiu.com/n/canadas-federal-government-imposes-2035-ev-mandate/> that points out that by 2035 all new cars sold in Canada must be electric, and they will provide a rebate of $5,000 to purchase a car now. It also mentions the lack of charging stations and this site <https://natural-resources.canada.ca/energy-efficiency/transportation-alternative-fuels/zero-emission-vehicle-infrastructure-program/21876> describes how they are providing funding to solve this problem.

If you change ‘Canada’ to ‘Toronto’ you find this site <https://www.toronto.ca/services-payments/water-environment/environmentally-friendly-city-initiatives/reports-plans-policies-research/electric-vehicles/> which describes how they are building charging stations on the street and at Green P parking spots, providing public education to encourage people to switch, and purchasing electric buses for the TTC. Instead of Toronto, your students should use the city closest to them.

**Heat Pumps, Smart Thermostats and Solar Hot Water:**We have already seen how the first two are given financial support through the federal **Greener Homes** program. It would be easy to add **Solar Hot Water** to this program.

If you search for what Ontario is doing you get this <https://news.ontario.ca/en/release/1002324/ontario-launches-clean-home-heating-initiative> and learn that Ontario has a program, the **Clean Home Heating Initiative**, to encourage switching to heat pump. It is only available in three cities.

If you search for what Ottawa is doing you get this <https://hydroottawa.com/en/blog/why-everyones-talking-about-heat-pumps> and find that Ottawa is doing not doing much directly, but instead is educating and encouraging and directing people to the federal and provincial programs. They also have a program that provides loans for up to $125,000 through the [Better Homes Ottawa Loan Program](https://betterhomesottawa.ca/rebate-and-incentive-programs/better-homes-loan-program/).

**Geothermal**: If you search for ‘what geothermal energy is being developed in Canada’ you get <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2023/market-snapshot-geothermal-power-stable-low-carbon-what-is-potential-canada.html> and find that most geothermal energy is used for heating and that there is only one Geothermal generating plant in Canada. The federal government and some provinces are providing money for research.

**Waste to Energy:**  A search for this leads to <https://www.cbc.ca/news/canada/calgary/varme-energy-from-waste-alberta-1.6622299> which describes the various facilities installed across Canada. These will have been the result of municipal and/or provincial support. Some burn the waste to turn water into steam to generate electricity and some use the waste to produce fuels (like methane) that can replace fossil fuels. A project in Alberta hopes to also capture carbon emissions. However, Project Drawdown says “ We consider waste-to-energy a “transition solution.” It can reduce greenhouse gas emissions, but social and environmental costs are high. It can help move us away from fossil fuels in the near term, but is not part of a clean energy future.

**Part 5. Other Aspects and Conclusion**

1. There are three different solutions involving ‘**Wind**’ generation.

1. The most significant two solutions are **Offshore** and **Onshore**. How and why are their numbers for CO2 reduction and implementation costs so different?

**Onshore** has much more potential than **Offshore** (100 Gigatons vs. 10 Gigatons). This is because the offshore must be built near the shore where it is not too deep. There is much more space on land than there is shallow water just offshore. (This is like the difference between perimeter and area.)

**Onshore** initial costs are also much lower. The values in billions of dollars per gigaton are 1500/100 = **15** vs. 690/10= **69**. Onshore is cheaper because it is easier to build structures and provide maintenance on land than out in the water. However, the long-term savings are the same! This is becauseoffshore winds are stronger and more dependable.

1. What is the **Ontario Offshore Wind Moratorium** and what effect is it having on Ontario?

In 2011 the provincial government said they would not allow any offshore wind generation. Many groups are arguing that this needs to be changed. “The cost of wind power has fallen dramatically due to improvements in technology... and Great Lakes wind power is the best way to decarbonize our economy and to lower our electricity rates.”

“But Ontario, which [halted the construction of renewable energy generation when Premier Doug Ford was elected in 2018](https://www.google.com/search?client=safari&rls=en&q=electricity+emissions+surge+400+per+cent+marco+chowno+ved&ie=UTF-8&oe=UTF-8), has instead opted for new nuclear and methane gas plants. A [carbon intensive](https://www.thestar.com/news/canada/2022/12/15/why-ontarios-new-plan-for-a-greener-electricity-grid-puts-it-on-a-collision-course-with-ottawa.html), moving away from net-zero. Ontario’s grid was 96 per cent carbon free in 2017. Last year (2022), it was 89 per cent carbon free, according to data from the Independent Electricity System Operator.” ”Offshore wind could produce electricity at 14.2 cents per kilowatt hour, less than 60 per cent of the 24.3 cents that energy from new nuclear plants would cost, according to the report. There’s also the question of construction timelines. While wind farms can be built in 12 months, nuclear plants take 10 to 15 years to complete, the report said.”

<https://www.thestar.com/news/canada/could-offshore-wind-in-the-great-lakes-provide-the-cheap-clean-power-ontario-needs/article_b3445fa3-3abe-5798-80ac-2a73b11e616c.html>

Note: Methane is usually called ‘natural gas’. This is a greenwashing term. It suggests that the gas is good for us. It is fossil fuel that we have to stop burning..

2. There are four solutions involving ‘**Solar**’.

1. Describe how they differ in production and transmission.

**Solar Hot Water** does not involve electricity. It replaces the need for electricity or fossil fuels by using light from the sun to heat water directly.

**Concentrated Solar** uses mirrors to focus sunlight to heat a fluid and drive a turbine to generate electricity. These are huge, expensive projects.

The two solutions involving **Solar Photovoltaics** involve the same technology but at different scales. The **Distributed** version involves small installations like a solar panel on a house, and the energy is used where it is generated. The **Utility Scale** version involves huge arrays of solar panels in a field which then has to be transmitted to be used elsewhere.

1. What can governments do to increase the implementation of these solutions?

We have already seen how **Solar Photovoltaics on home roofs** are included in the Greener Homes program and how **Solar Hot Water** can be added easily.

**Concentrated Solar** is probably not a great solution in Canada because we are rather far north where the solar radiation is weaker.

**Utility Scale Solar Photovoltaics** can be encouraged by government investment and regulations at every level.

At one time Ontario was a world leader. When the Sarnia Photovoltaic Power Plant opened in 2010, it was the largest in the world. In 2018, the new Ontario government stopped supporting new solar and wind projects and even spent a huge amount of money dismantling a wind project. <https://www.cbc.ca/news/canada/toronto/doug-ford-green-energy-wind-turbines-cancelled-230-million-1.5364815>

3. Look at a variety of different solutions. What are four very different **co-benefits** to the solutions?

Reduce air pollution. Reduce the ‘heat island’ effect in cities. Save money. Stimulate local economies. Provide new job opportunities in design, construction, installation.

4. Project Drawdown’s plan calls for all of these solutions to be implemented (plus 72 more in other sectors). Which three would you choose to start with? Be prepared to justify your choices.

This question is similar to the very first question in this lesson. However, they now have more information and understanding. There is no right answer. It is an opportunity for students to consider what aspects are more important. Give them time to discuss in small groups and then the full class and then maybe have a vote.

Three really strong contenders are Electric Vehicles, Distributed Photovoltaics and Utility Scale Photovoltaics. Their data is highlighted in green for more boxes than the other solutions.

| Distributed Solar PhotoV | 50 | 400 | 10,000 | 8 | 200 |
| --- | --- | --- | --- | --- | --- |
| Electric Vehicles | 9 | -600 | 14,000 | -67 | 1556 |

| Utility Scale Solar PhotoV. | 80 | -800 | 18,000 | -10 | 225 |
| --- | --- | --- | --- | --- | --- |

Furthermore, the batteries needed in the Electric Vehicles can provide storage for the electrical energy generated by the Distributed Photovoltaics.

5. There is a lot that individuals can do to support these climate solutions. You might be able to influence your family, school, place of worship or other community group to adopt some of these solutions. Which of these solutions might be adopted?

They can access government programs and insulate the buildings, add solar panels, replace lights with LEDs, get a smart thermostat, buy an electric car, install a green or white roof, install a heat pump and a solar hot water heater.

6. The solutions that were not mentioned in the previous questions will be ones that require government support and leadership. When you are older, you can vote. What can you do now to encourage your government to adopt these solutions?

Get involved in elections by putting up signs, delivering pamphlets, and making donations. Up to **75%** of these donations are returned when you do your income tax.

Get involved outside elections by going to rallies, making large banners, doing street theatre, signing petitions, writing or talking to representatives, talking to people, posting on social media and writing letters to the editor of newspapers. Keep up-to-date on changes in policies and climate change science by reading from and listening to dependable sources.

It is hard to have an influence and to keep up efforts unless you work with others. There are many climate activist groups that students could join. These groups provide information about the issues and ways to provide pressure to governments and businesses. Some examples are

1) **Ontario Clean Air Alliance OCAA**<https://www.cleanairalliance.org/>

2) **Citizens’ Climate Lobby CLL**<https://citizensclimatelobby.org/>

3) **Environmental Defence**<https://environmentaldefence.ca/>

5) **350.org**<https://350.org/>