**Lesson 8: How Can Changes in the Electricity Sector Reduce Carbon Emissions?**

# Part 1: Introduction to Project Drawdown

# Project Drawdown is a huge resource and the students will take two classes to explore one part of it. The first class requires a fair amount of instruction from the teacher, but the second half has the students working mostly independently in small groups.

Project Drawdown is a highly regarded, up-to-date resource about the solutions that already exist to slow down climate change. You can read a review of the project

here <https://www.climateandcapitalmedia.com/project-drawdown-there-is-still-hope-to-halt-climate-change/>

and here <https://earth.org/project-drawdown/#:~:text=Founded%20in%202014%20by%20Author,climate%20solutions%20on%20the%20planet>.

Project Drawdown was promoted during the Perimeter Institute’s on-line course for teachers on Climate Change which we recommend highly. It will walk you through the materials and the science and provide a chance to connect with other teachers. You can sign up here <https://perimeterinstitute.ca/teacher-courses>

In this lesson, the **first level answers that we may expect from students are in blue**. More detailed and nuanced information is provided for the teacher in **red**.

# Introduction: Watch Drawdown Roadmap Unit 5 <https://www.youtube.com/embed/xSvQYMH3FJw?start=28&end=258>

# Time 0:28-4:18. This video gives an introduction to what Project Drawdown is about and sets a very positive tone. It shows that electricity is responsible for 22% of the problem. The website has a huge amount of information in a variety of forms. This lesson looks at the electricity sector in detail, using information from their solutions library. The lesson also provides an opportunity to learn or practice skills in spreadsheet use.

# 1. For this exercise, we will be using information from Project Drawdown which “reviews and analyzes practices and technologies that can reduce greenhouse gas concentrations in Earth’s atmosphere and also are currently available, growing in scale, financially viable, able to have a net positive impact, and quantifiable.” Their goal is to show how we can ‘draw down’ carbon emissions and then ‘draw down’ the amount of carbon dioxide we have already added into the atmosphere. Which of the five criteria in bold above, do you think is the most important in choosing the best solutions to reduce climate change? Why?

Give students a chance to discuss this in small groups. Don’t expect to get a clear answer or even a general consensus, because all of these aspects are important. This question is meant to get students talking and thinking about what is important when evaluating different solutions and recognize that there are competing ways to evaluate the solutions.

Solutions should be ‘**currently available’** because we need to change things now and we can’t wait around for new technologies, nor should we put too much money and hope into unproven potential new solutions. For example, fusion has been touted as a perfect solution to provide clean energy but it is not going to be ready for decades - if ever.

**Growing in scale** is also important. If a solution cannot be scaled up easily, it will have little effect on the global problem. You won’t find the traditional large-scale hydro power projects that we already have because there is not much room to grow - most of the good sources are already in use. However, small local hydro power projects are included because this is a new technology and so there are more locations available.

**Financially viable** is also very important. If it is too expensive to implement, then it is not worth considering as a solution. Solutions that can save money are even better and most of the solutions in Project Drawdown do save money in the long run.

**Net positive impact** refers to aspects other than reduction of GHGs, i.e., ecological degradation and health impacts. Each solution on the website includes a description of **co-benefits**. According to the glossary, co-benefits “are benefits of climate solutions that extend beyond their ability to reduce emissions or store carbon (e.g., benefits to public health, water quality, biodiversity, advancing human rights, jobs).”

The solution needs to be **quantifiable** in order to compare solutions. This means that governments and businesses can prioritize efforts, and make sure that the solutions add up to what is needed to slow, stop and possibly reverse climate change.

2. In this lesson you are going to focus on reducing carbon emissions that are associated with the **Electricity Sector.** Your teacher will provide you with a table of 19 solutions which you will analyse. Details about the solutions can be found at <https://drawdown.org/solutions/table-of-solutions>. There is a lot of information provided, perhaps more than you need. Let’s look at one example, **Green and Cool Roofs**. <https://drawdown.org/solutions/green-and-cool-roofs>

Note: The table of 19 solutions was generated using Project Drawdown’s Electricity Sector. Some of the solutions from this sector were removed because they did not have numbers (Utility Scale Storage, Distributed Energy Storage, Grid Flexibility, Microgrid, and Building Retrofitting, Net Zero Buildings). Some items were removed because they had a very small effect and/or were harder to understand. Electric vehicles are included in Project Drawdown’s Transportation Sector, but they are added here because they will be a familiar solution to students.

1. Look at the **Heading**, **Introduction,** and the first two paragraphs of the **Discussion.** Compare **green roofs** and **cool roofs**. How are they similar? How are they different?

**Similar**: They both prevent the house from warming as much in the summer, which will reduce the energy needed for air conditioning. They both prevent the **urban heat island effect**, which makes heat waves worse in cities. Note: The urban heat island effect was covered in the previous lesson.

**Different**:   
Green roofs are roofs with vegetation which insulate, encourage transpiration, and slow water run-off. However, they require stronger roofs than normal

Cool roofs are building roofs covered with light-reflecting materials or paints. Cool roofs are cheaper than green roofs. However, they will also cool the building in the winter, which may significantly increase the need for heating.

Project Drawdown does not mention the effect of solar panels on the roof to heat water or generate electricity.

1. Look at the three data ranges to the right on the webpage. What is the average value of each, rounded to the nearest power of ten? What do these numbers represent?

These numbers are not measurements but projected values calculated from their models. Each value has a range, depending on whether the aim is to keep the temperature increase to 2 oC by 2100 or 1.5 oC. In this lesson we will look at the mid-range values to keep things simple.

The green/cool roofs solution can ‘remove’ (prevent the emission of) **1** gigaton of CO2 world-wide during the years 2020-2050. Its start-up costs will be $**700** billion dollars US. However, over this time period there will be a net savings of $**400** billion.

1. Look at the **Co-benefits**. What are they?

Both green and cool roofs can reduce the urban heat island effect and therefore reduce the risk of heat related illnesses and deaths.

Green roofs can provide green spaces which can promote mental well-being, reduce stress, create a connection with nature, leading to a healthier and happier living environment.

3. The solutions for reducing carbon emissions associated with the electricity sector can be divided into three main strategies. The first is to generate ‘green’ electricity using processes that don’t emit carbon dioxide. The second is to reduce the need for electricity, through more efficient use of electrical energy. The third is to electrify devices that traditionally use fossil fuels. This last strategy will increase electricity use, but will reduce fossil fuel use if the first strategy has been implemented. Look at the table provided and highlight the names in the first column with the appropriate colour according to which strategy they fit in.

Provide each student or small group with a [version of the tabl](https://docs.google.com/spreadsheets/d/10QPMa0AKEEEeMhrH1fjIVfJkJV1h6MBA/edit?usp=sharing&ouid=101667036856908674610&rtpof=true&sd=true)e, with the first four columns filled in. The correct answers are provided in the [teacher version of the table](https://docs.google.com/spreadsheets/d/1bj9bTE6BaOyy__Mrt-e8C8tFjfs_vQQ0/edit?usp=sharing&ouid=101667036856908674610&rtpof=true&sd=true). students should be able to do most of the highlighting without going to the website for more information.

Note: This table was prepared in the fall of 2023. If you are using it after a couple of years, you should check with the Project Drawdown website to see if the numbers have changed significantly and update the table.

**Part 2: Preparing the Data Table using Spreadsheet Tools**

The ability to use a spreadsheet is a very powerful skill which the students will be able to use in many situations in the future and it is recommended that you use this opportunity to teach the skills or provide an opportunity to practice them if they have already learnt them. However, if you don’t have the time, or the equipment to do the spreadsheet analysis, you can have the students do the calculations and highlighting by hand. If so, provide the students with some of the fifth and sixth columns filled in so the calculations do not take up too much time and provide them with a paper version of the table.

1. It will be useful to know the total values for the first three columns. Use a formula to calculate these numbers and enter them in a new row at the bottom.   
Click on the cell below the last entry for CO2 removed. Type **‘=sum(‘** andclick, hold down and drag to select the data values and then type ‘**)**’ and hit ‘**Enter**’. You can do the same for the next two columns or you can just grab the dark corner at the bottom right of the new cell and drag it across two columns.

2. It will be useful to know the cost and savings per amount of CO2 removed. Use a spreadsheet formula to calculate these values for the fifth and sixth columns.

They need to type “**=C2/B2**” in the first cell or type ‘**=**’ click on the cell **C2**, type’**/**’ and then click on the cell **B2**. Next hit enter and check that the answer seems correct. Then click on the box at the bottom right corner of the cell and drag down. Repeat these steps to calculate the values for the last column using “**D2/B2**”.

3. It will be useful to know which strategies are really good or really poor in each of the five columns. Highlight the best few in green and the worst few in red for each measurement using **conditional formatting**. Note: ‘A few’ can be anywhere from 3 to 5.

If you don’t have time to teach conditional formatting, you can just have them highlight the cells by hand.

To do conditional formatting in Google sheets for the second column, you select all the cells in column 2, except for the top cell which is the name and not data. From the menu at the top select **Format** and then **Conditional formatting**. On the right look for ‘**Format cells if …**’ and select ‘**greater than**’ and then ’**5’**. This highlights too many cells. Changing the ‘**5’** to ‘**19**’ highlights 4 cells. Select **Done**. Then choose ‘**add another rule’**, and this time choose ‘**less than 4**’ and in ‘**formatting style**’ choose the red highlight.

Note: This is easier to do in Excel, where you can simply ask it to highlight the top 4.

Repeat the process for the other four columns. The green highlight should always be for the best choices, so for the next column it will be if the costs are less than some amount.

**Part 3: Examining and Comparing the Costs of the Different Solutions**

The students should work through the rest of the lesson in small groups. The teacher should circulate among the groups to monitor progress, help with problems, and have students explain what they have found and what they think.

1. Three of the solutions are especially important because the “Initial Cost”, as defined by Project Drawdown, is negative! They have defined “Initial Cost” to be how much you will need to spend on the hardware and installation over the thirty year period (2020-2050). These three solutions will cost less to purchase and install than the traditional technologies they replace.

1. What are these three solutions and what is each being compared to?

**LED lights** are compared to incandescent bulbs, **electric cars** to gas-powered cars, and **Utility Scale Solar Voltaics** to a gas-powered generating plant.

1. In 2018 LED lights cost ten times as much as incandescent lights; $10 vs. $1. To convince people to switch, the Ontario government gave purchasers a $3 rebate if they bought an LED bulb. They don’t give these rebates anymore. Why? Do an internet search to find out how the costs compare now. What are the other benefits of LED lights?

They cost around $3 now instead of $10. They last 50 times longer than an incandescent bulb so you rarely need to replace them. They use much less electricity and therefore cost less to run.

1. In 2018 electric cars cost around $36,000 compared to $18,000 for a comparable gas-powered car. To convince people to switch, the Ontario government gave a rebate $10,000 to people who bought an electric car. The Ontario government doesn’t give these rebates anymore, but the federal government gives a $5,000 rebate. Do an internet search to find out how the costs compare now. What are the other benefits of electric cars?

In 2023, the Equinox is $30,000 USD for the electric version and $26,600 USD for the gas version. Like all electric vehicles, the car will need less maintenance and the electricity to power it will cost less than the gasoline used by its combustion engine equivalent. <https://www.nytimes.com/2023/02/10/business/electric-vehicles-price-cost.html>

1. According to Project Drawdown, a large solar farm will be cheaper than a gas-powered plant in the future. In fact, it is already the case! Find a quote from a source online that confirms this. Make sure you look for a source that is up-to-date.

Here is one example. “The rapidly falling cost of constructing renewables has been making them more [competitive with fossil fuels](https://www.thestar.com/news/canada/2023/02/01/russias-invasion-of-ukraine-was-expected-to-stifle-the-global-move-to-green-energy-then-something-else-happened.html) for years. (Since 2010, the price of solar is down 88% and wind 68%.) The researchers were surprised, however, to discover renewables are now so inexpensive that even when they’re paired with battery storage, they’re still cheaper than gas plants.”

<https://www.thestar.com/news/canada/ontario-s-new-gas-plants-will-cost-more-than-wind-and-solar-report-says-so/article_a641298d-0272-55b2-830a-abe767e0b49e.html>

The present (2023) Ontario government is preparing to build new gas-powered plants and expand existing ones. Why? For more information about why this is a bad idea read. [https://thoughtleadership.rbc.com/power-shift-how-ontario-can-cut-its-450b-electricity-bill/#:~:text=Ontario%20faces%20a%20%24450%2Dbillion,cut%20or%20 eliminate%20their%20 emissions](https://thoughtleadership.rbc.com/power-shift-how-ontario-can-cut-its-450b-electricity-bill/#:~:text=Ontario%20faces%20a%20%24450%2Dbillion,cut%20or%20eliminate%20their%20emissions). The gas powered plants are bad for climate change, local air quality and they will cost more. This report from the Royal Bank of Canada says that it will be cheaper to expand wind and solar and to reduce the need for more electricity with heat pumps, insulation, smart thermostats etc.

1. Instead of looking at “Initial Costs”, you could look at what will save money in the long run, from 2020-2050. Which four solutions from the table will save the most money over the thirty years?

**Insulation** $20,000 **Utility Scale Solar PV** $18,000 **Electric Vehicles** $14,000 **Dist. Solar PV** $10,000

Note how the two underlined solutions are also the cheapest in “Initial Costs”.

1. Many critics of solutions to climate change say that the solutions will cost too much and that they will destroy the economy. Does this table of data support that argument? Explain.

If you look at the initial costs, it looks like implementing all of these solutions is going to cost a lot of money - $4,460 billion dollars. However, if you look at the total savings over the three decades you see that they generate savings of $82,490 billion dollars. All of these solutions save money in the long run except for three – **Concentrated Solar**, **Micro Wind** and **Waste to Energy**.