

Political Affairs

# Carbon, Capture, Utilisation and Storage in Canada

August 15, 2024

**Onsum Woo**

---

Climate change is an issue that affects all areas of the globe, putting everyone under threat. Time and time again, we have failed to reduce our Carbon dioxide (CO<sub>2</sub>) emissions by continuously using fossil fuels. The increasing concentration of CO<sub>2</sub> in the atmosphere raises global temperature because the heat from sunlight is trapped on earth instead of dissipating into outer space. The higher global temperature is causing more natural disasters, burning forests, rising sea levels, melting glaciers, as well as food and water insecurity. What we are doing is not enough and we must make drastic changes to prevent irreversible damage.

The 2015 United Nations Climate Change Conference (COP21) in Paris saw 196 parties sign the United Nations Framework Convention on Climate Change (Paris Agreement) (Report of the Conference of the Parties on Its Twenty-first Session, 2016, p. 13). This aims to hold global warming below 2 degrees Celsius, ideally at less than 1.5 degrees Celsius (Report of the Conference of the Parties on Its Twenty-first Session, 2016, p. 2). To help meet the Paris Agreement, Canada pledged to achieve net-zero emissions by 2050, to “avert the worst impacts of climate change” (Service Canada, n.d.). This is a very important part

of the current government’s policy agenda reinforced by the mandate letter for the Minister of Environment and Climate Change states that they must “[adopt] additional measures to achieve net zero emissions by 2050” (Prime Minister of Canada - Premier Ministre Du Canada, 2021).

To reach net zero emissions by 2050, there have been efforts to replace the energy produced by oil and gas with renewable energy, which includes wind power, solar power, and bioenergy (Scarlat et al., 2015, p. 971). However, CO<sub>2</sub> emissions are still rising, leading to the question: Should Canada encourage and invest in Carbon, Capture, Utilisation and Storage (CCUS) or focus on cutting carbon emissions? CCUS is an approach used to capture CO<sub>2</sub> from the source of generation, such as electrical power plants, to remove CO<sub>2</sub> from the atmosphere. The extracted CO<sub>2</sub> is used in products or stored with innovative techniques (Norhasyima & Mahlia, 2018). There have been countless debates on the use of CCUS with some arguing that it is necessary to save our world from climate damage and some arguing that investing in carbon capture delays the transition to renewable energy and promotes the

continued use of fossil fuels (Smit et al., 2014).

To avoid catastrophic climate damage, Canada must invest in Carbon Capture Utilisation and Storage but should not neglect the importance of reducing CO<sub>2</sub> emissions from fossil fuels in order to achieve net zero emissions by 2050. Canada relies significantly on natural resources industries that typically generate significant amounts of CO<sub>2</sub> emissions. To reach net zero emissions, the best plan is to eliminate the majority of the CO<sub>2</sub> emissions. However, without a major disruption in economic growth, Canada cannot transition fast enough to clean energy to achieve net zero emissions by 2050 by using the CO<sub>2</sub> emission reduction strategy alone. With oil, gas and coal industries making significant contributions to the Canadian economy, businesses, the general public and governments are not willing to sacrifice their competitive advantage to replace the fossil fuel industry. Therefore, the most promising solution to resolve climate change is to implement CCUS quickly despite the technological, logistic, commercial and financial challenges.

### **How effective is the application of CCUS?**

There are many different methods applied to CCUS. Each method contributes different degrees of carbon reduction. However, CCUS is incredibly important to “[reach] net zero [and it would] be virtually impossible without carbon capture utilisation and storage” according to the International Energy Agency report on CCUS in Clean Energy Transitions (n.d). Carbon capture

and storage (CCS) by replacing fossil fuels with a biomass-produced energy source would contribute to a 25 percent reduction in CO<sub>2</sub> emissions by 2100 (AR5 Climate Change 2014: Mitigation of Climate Change, 2014).

### **How can Carbon be Stored?**

Looking at just CCS, the International Energy Agency estimates that limiting a temperature increase to 2 degrees can be done with the storage of 100 billion tonnes of CO<sub>2</sub> by 2060. Unfortunately, as of 2019, the active CCS projects can only capture and store 40 million tonnes of CO<sub>2</sub> a year based on the projects in operation (Global Status of CSS Targeting Climate Change, 2019). CCS is a way to store CO<sub>2</sub> deep underground in porous rock formations such as saline aquifers, depleted oil and gas reservoirs, and coal beds that can't be mined. This drastically reduces the impact of fossil fuel generated CO<sub>2</sub> (Cormos et al., 2018). There is still a small possibility of leakage. However, research suggests that it is minimal. Even though there is still a minute amount of leakage from the porous formation, the research provided data indicates that the storage formation (reservoirs) can keep CO<sub>2</sub> indefinitely with more than 99.8% of the CO<sub>2</sub> stored for well over 10 000 years (Alcalde et al., 2018).

The Report by researchers at E4Tech and Imperial college estimated that there are 70 billion tonnes of storage capacity in England and 10 trillion tonnes in the US, this shows there is a large number of storage sites to support the extensive adoption of CCS (Energy Revolution: A Global Outlook, 2018).

The world has the capacity to store CO<sub>2</sub> to combat the effects of climate change. Governments and companies must ramp up CCS projects in the next ten years to prevent the temperature increase to 2 degrees.

### **How can Carbon be Utilised?**

Carbon Capture Utilisation Technologies do not allow for long-term storage of CO<sub>2</sub> and it will eventually be emitted back into the atmosphere. This is due to the eventual breakdown of the CO<sub>2</sub>-embedded material used in products, which ultimately disintegrates and releases the CO<sub>2</sub> back into the atmosphere. However, it is still beneficial as it reduces fossil fuel emissions by using the captured CO<sub>2</sub> to substitute some typical fossil carbon sources, such as carbon black. Additionally, it can also bridge the transformation towards renewable energy, fuel sources, and materials (Bruhn et al., 2016). CO<sub>2</sub> utilization can be profitable in the future as there are more product applications, an economy of scale and improved or novel technologies.

CO<sub>2</sub> can be used as a fuel source when mixed with hydrogen to support transportation infrastructure. It can also be used to create methanol, fertilizer and polymers to build long-lasting buildings and cars (Hepburn et al., 2019). By using microalgae, CO<sub>2</sub> can also be recycled into biomass, which can be used to produce bioenergy, such as biofuels and electricity (Singh & Dhar, 2019). Making concrete is typically a major source of greenhouse gas emissions and is commonly used in building roads, homes and pipes. By injecting CO<sub>2</sub> into the concrete, it can improve the strength

of concrete while reducing the carbon footprint of producing concrete (Skocek et al., 2020). Enhanced oil recovery can improve oil production by injecting captured CO<sub>2</sub> into oil reservoirs to decrease the oil viscosity (Farajzadeh et al., 2020). These are all considered conventional utilization pathways as they are industrial utilization approaches.

There are also non-conventional utilization pathways, which are biological utilization approaches. One way this can be done is through enhanced weathering. This speeds up the natural weathering process by using finely grounded rocks, such as Basalt, with more surface area to absorb the CO<sub>2</sub>. The exposure of CO<sub>2</sub> to the rock transforms it into compounds that lock in the CO<sub>2</sub>. These compounds can prevent ocean acidification when it eventually washes into oceans (Bach et al., 2019). Forestry techniques can also be used, such as afforestation and reforestation, to store and capture CO<sub>2</sub>. According to the IPCC (2005), when sustainably managed, it can be a strategy to “maximise climate mitigation outcomes over unmanaged forests” (Hepburn et al., 2019, p. 15-16). In fact, there can be 70 to 520 mt CO<sub>2</sub> stored in wood products from these forestry techniques (Hepburn et al., 2019, p. 15-16). Carbon can also be stored in the soil through “growing cover crops, leaving crop residues to decay in situ, applying manure or compost, using low- or no-till systems, and using other land management techniques optimising soil structure and organic matter input” (Hepburn et al., 2019, p. 16). By changing land management techniques, they can improve yields by approx. 0.9% with an increase in soil carbon stocks.

Finally, the formation of Biochar (carbon captured from the atmosphere by plants and transformed into a stable form of carbon that looks like charcoal powder) helps the CO<sub>2</sub> stay in the soil, thus reducing the amount of CO<sub>2</sub> in the atmosphere. It can also improve crop yields by 10% since it acts as a fertiliser for plants due to its porous structure (Hepburn et al., 2019, p. 17). Each of these carbon utilization techniques has varying potential depending on cost and how much CO<sub>2</sub> can be used.

### **Should there be a focus on replacing the fossil fuel industry?**

There are two ways to greatly reduce CO<sub>2</sub> emissions. We could drastically change our lifestyle so that our daily activities do not produce much CO<sub>2</sub>. We can also replace the majority of fossil fuels consumed with renewable energy sources. Based on the experience of the past 50 years, we have not been able to drastically change our lifestyles to combat climate change, with atmospheric CO<sub>2</sub> continuously increasing from 320 ppm to 415 ppm (Climate Change: Atmospheric Carbon Dioxide, n.d.). The sacrifices needed to combat climate change, such as using public transportation, reduced consumerism and living in smaller homes do not seem to be desirable to the majority of the western world.

There are some individuals who argue against the utilization of CCUS. There is a belief that the investment in CCUS will slow down the transition to renewable energy and instead continue the dependency on the oil and gas industry (Canadians, 2022). Although this thinking has some merit, it is

impractical to massively deploy green energy when most of the economy and infrastructure are associated with fossil fuels. Simultaneously, people are reluctant to accept the cost of transition. Furthermore, with the deployment of CCUS, there is a negating effect that can offset the damage of existing carbon dioxide in our atmosphere (Zappa et al., 2019).

There is also an argument that CCUS can have health, safety and environmental concerns for communities with the rupture of pipelines (Canadians, 2022). However, according to Doctor & Palmer, “pipelines [used to transport CO<sub>2</sub>]... have an established and good safety record” (2005). Pipelines have commonly carried natural gas and oil across the country and CO<sub>2</sub> pipelines are not new and are known as the most economical and safest way to transport CO<sub>2</sub> from where it was captured to a storage location or where it is being used (Doctor & Palmer, 2005).

### **Impact on the Economy:**

The recent announcement by the Canadian government to invest \$319 million over seven years into the research and development of CCUS encourages companies to develop strategies to store and utilize CO<sub>2</sub> (Energy Innovation Program - Carbon Capture, Utilisation and Storage RD&D Call, n.d.). Additionally, the carbon tax on CO<sub>2</sub> emissions also discourages businesses from polluting the atmosphere and incentivises the use of CCUS (Bruhn et al., 2016). CCU can also have its own incentives without government intervention. Using biochar can cut costs for farmers by

reducing the need for fertiliser. Though biochar is currently extremely costly, the increased production can help cut down costs and many large companies that have committed to an accelerated net-zero trajectory are buying this expensive product (Hepburn et al., 2019). Similarly, the cement industry has been able to strengthen concrete by injecting CO<sub>2</sub> into its products. This produces stronger concrete that allows the concrete producer to use less cement, which offsets the costs of purchasing the CO<sub>2</sub> Concrete technologies, making it cost-neutral (Skocek et al., 2020).

By implementing large-scale CCUS projects, there will be increased employment opportunities, increased development of CCUS technologies, and promoted economic development. Chen and Jiang (2022) believe that “central and local governments should strengthen policy incentives . . . increase financial investment, and form a sustainable incentive environment to provide momentum for the industry and even the whole society’s carbon neutral journey” (p. 8).

### **Policy-Related Elements:**

The first large-scale CCUS project called the Weyburn project was launched in 2000, followed by the Midale Project in 2005 (Carbon Capture and Storage: Canada’s Technology Demonstration Leadership, 2013). In the past couple of years, the Canadian government has moved quickly to develop the CCUS industry in Canada by implementing a number of policies. As part of the 2021 budget, the government announced the investment of \$319 million

“over seven years, into research, development, and demonstrations to advance the commercial viability of CCUS technologies” (Carbon Capture, Utilisation, and Storage, n.d.). Additionally, in the 2022 budget, a refundable investment tax credit was announced to encourage the industry to move quickly towards lower emissions (Chapter 3: Climate and Energy Security | Budget 2022, n.d.). Both of these announced policies provide considerable funding to enhance CCUS, the substantive policy instrument used.

We are all impacted by our changing climate, but the CCUS policy would significantly reduce the impact. The state actors related to this policy are the Government of Canada, more specifically, Natural Resources Canada (Carbon Capture, Utilisation, and Storage, n.d.). There are also many non-state actors that have advocated for or against the policies put in place. Interest groups such as the Council of Canadians and a group of 400 climate scientists and academics have put out letters to our governing officials urging them to decide against the use of CCUS (Canadians, 2022; Scientists Want Ottawa to Scrap Carbon Capture Tax Credit, 2022). Companies chasing the CCUS Market such as Canadian Natural Resources Limited, Enhance Energy Inc, and Suncor Energy Inc are non-state actors that could influence the government’s policy decision and benefit from it.

The government has communicated this policy clearly and effectively by putting out press releases and policy briefs to successfully implement CCUS technologies

throughout Canada (Natural Resources Canada, 2022; Carbon Capture, Utilisation, and Storage, n.d.). Because of the recent investment into CCUS in Canada, there are no long-term statistics available. However, the initial data on these programs and policies are promising in reducing carbon in the atmosphere and improving the technologies (AR5 Climate Change 2014: Mitigation of Climate Change, 2014).

Based on the analysis, it is found that the total elimination of CO<sub>2</sub> emissions by reducing consumption and replacing fossil fuel with green energy sources is the ideal solution to maintain a stable atmospheric temperature for the issue of global warming. However, the general public is unwilling to give up the comfort, convenience and economic benefit provided by fossil fuels.

### References:

Alcalde, J., Flude, S., Wilkinson, M., Johnson, G., Edlmann, K., Bond, C. E., Scott, V., Gilfillan, S. M. V., Ogaya, X., & Haszeldine, R. S. (2018). Estimating geological CO<sub>2</sub> storage security to deliver on climate mitigation. *Nature Communications*, 9(1). <https://doi.org/10.1038/s41467-018-04423-1>

AR5 Climate Change 2014: Mitigation of Climate Change. (2014). IPCC. <https://www.ipcc.ch/report/ar5/wg3/>

Furthermore, rapid conversion to renewable energy is costly and it would cause major disruption to the economy. Studies based on socio-political, economic and scientific perspectives demonstrate that the Canadian Government's investment in the research and development of CCUS is the right approach to achieving net zero emissions by 2050. The investment attracts businesses to move quickly to find and develop technologies in CCUS to reduce our climate impact. "There is historical precedent for global infrastructural change that begins with the most accessible and economical methods, gradually improving to the most sustainable." (Vitillo et al., 2022). The policy of providing investment into CCUS is a start to a global infrastructure change in moving towards halting the global temperature rise and a greener environment.

Bach, L. T., Gill, S. J., Rickaby, R. E. M., Gore, S., & Renforth, P. (2019). CO<sub>2</sub> Removal With Enhanced Weathering and Ocean Alkalinity Enhancement: Potential Risks and Co-benefits for Marine Pelagic Ecosystems. *Frontiers in Climate*, 1. <https://doi.org/10.3389/fclim.2019.00007>

Bruhn, T., Naims, H., & Olfe-Kräutlein, B. (2016). Separating the debate on CO<sub>2</sub> utilisation from carbon capture and storage. *Environmental Science & Policy*, 60, 38–43. <https://doi.org/10.1016/j.envsci.2016.03.001>

Canadians, C. O. (2022, October 6). *Carbon capture is not a climate solution*. The Council

of Canadians.  
<https://canadians.org/media/carbon-capture-not-climate-solution/>

*Carbon Capture and Storage: Canada's Technology Demonstration Leadership.* (2013). NRCAN.  
[https://www.nrcan.gc.ca/sites/nrcan/files/energy/files/pdf/11-1416\\_eng\\_acc.pdf](https://www.nrcan.gc.ca/sites/nrcan/files/energy/files/pdf/11-1416_eng_acc.pdf)

*Carbon capture, utilisation, and storage.* (n.d.). <https://www.nrcan.gc.ca/our-natural-resources/energy-sources-distribution/carbon-capture-utilization-and-storage/4275>

*CCUS in Clean Energy Transitions – Analysis.* (n.d.). IEA.  
<https://www.iea.org/reports/ccus-in-clean-energy-transitions>

*Chapter 3: Climate and Energy Security | Budget 2022.* (n.d.).  
<https://www.budget.gc.ca/2022/report-rapport/chap3-en.html>

Chen, D., & Jiang, M. (2022). Assessing the Socio-Economic Effects of Carbon Capture, Utility and Storage Investment From the Perspective of Carbon Neutrality in China. *Earth's Future*, 10(4).  
<https://doi.org/10.1029/2021ef002523>

*Climate Change: Atmospheric Carbon Dioxide.* (n.d.). NOAA Climate.gov.  
<https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide>

Concrete needs to lose its colossal carbon footprint. (2021). *Nature*, 597(7878), 593–

594. <https://doi.org/10.1038/d41586-021-02612-5>

Cormos, A. M., Dinca, C., Petrescu, L., Andreea Chisalita, D., Szima, S., & Cormos, C. C. (2018). Carbon capture and utilisation technologies applied to energy conversion systems and other energy-intensive industrial applications. *Fuel*, 211, 883–890.  
<https://doi.org/10.1016/j.fuel.2017.09.104>

Doctor, R., & Palmer, A. (2005). *IPCC Special Report on Carbon Dioxide Capture and Storage.* IPCC.  
[https://www.ipcc.ch/site/assets/uploads/2018/03/srccs\\_chapter4-1.pdf](https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_chapter4-1.pdf)

*Energy Innovation Program - Carbon capture, utilization and storage RD&D Call.* (n.d.). <https://www.nrcan.gc.ca/science-and-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program/energy-innovation-program-carbon-capture-utilization-and-storage-stream/23815>

*Energy Revolution: A Global Outlook.* (2018). DRAX. <https://www.drax.com/wp-content/uploads/2018/12/Energy-Revolution-Global-Outlook-Report-Final-Dec-2018-COP24.pdf>

Farajzadeh, R., Eftekhari, A., Dafnomilis, G., Lake, L., & Bruining, J. (2020). On the sustainability of CO<sub>2</sub> storage through CO<sub>2</sub> – Enhanced oil recovery. *Applied Energy*, 261, 114467.  
<https://doi.org/10.1016/j.apenergy.2019.114467>

*Global Status of CSS Targeting Climate Change*. (2019). Global CCS Institute. [https://www.globalccsinstitute.com/wp-content/uploads/2019/12/GCC\\_GLOBAL\\_STATUS\\_REPORT\\_2019.pdf](https://www.globalccsinstitute.com/wp-content/uploads/2019/12/GCC_GLOBAL_STATUS_REPORT_2019.pdf)

Hepburn, C., Adlen, E., Beddington, J., Carter, E. A., Fuss, S., Mac Dowell, N., Minx, J. C., Smith, P., & Williams, C. K. (2019). The technological and economic prospects for CO<sub>2</sub> utilisation and removal. *Nature*, 575(7781), 87–97. <https://doi.org/10.1038/s41586-019-1681-6>

Leung, D. Y., Caramanna, G., & Maroto-Valer, M. M. (2014). An overview of current status of carbon dioxide capture and storage technologies. *Renewable and Sustainable Energy Reviews*, 39, 426–443. <https://doi.org/10.1016/j.rser.2014.07.093>

Natural Resources Canada. (2022, July 11). *Canada Opens Call for Carbon Capture Research, Development and Demonstration Projects*. Canada.ca. <https://www.canada.ca/en/natural-resources-canada/news/2022/07/canada-opens-call-for-carbon-capture-research-development-and-demonstration-projects.html>

Norhasyima, R., & Mahlia, T. (2018). Advances in CO<sub>2</sub> utilisation technology: A patent landscape review. *Journal of CO<sub>2</sub> Utilisation*, 26, 323–335. <https://doi.org/10.1016/j.jcou.2018.05.022>

*Prime Minister of Canada - Premier ministre du Canada*. (2021, December 16). Prime Minister of Canada. <https://pm.gc.ca/en/mandate-letters/2021/12/16/minister-environment-and-climate-change-mandate-letter>

*Report of the Conference of the Parties on its twenty-first session*. (2016, January 29). UNFCCC. <https://unfccc.int/resource/docs/2015/cop21/eng/10.pdf>

Scarlat, N., Dallemand, J. F., Monforti-Ferrario, F., Banja, M., & Motola, V. (2015). Renewable energy policy framework and bioenergy contribution in the European Union – An overview from National Renewable Energy Action Plans and Progress Reports. *Renewable and Sustainable Energy Reviews*, 51, 969–985. <https://doi.org/10.1016/j.rser.2015.06.062>

*Scientists want Ottawa to scrap carbon capture tax credit*. (2022). CBC News. <https://www.cbc.ca/news/science/carbon-capture-tax-credit-1.6321458>

Service Canada. (n.d.). *Net-Zero Emissions by 2050 - Canada.ca*. <https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html>

Singh, J., & Dhar, D. W. (2019). Overview of Carbon Capture Technology: Microalgal Biorefinery Concept and State-of-the-Art. *Frontiers in Marine Science*, 6. <https://doi.org/10.3389/fmars.2019.00029>

Skocek, J., Zajac, M., & Ben Haha, M. (2020). Carbon Capture and Utilisation by

mineralization of cement pastes derived from recycled concrete. *Scientific Reports*, 10(1). <https://doi.org/10.1038/s41598-020-62503-z>

Smit, B., Park, A. H. A., & Gadikota, G. (2014). The Grand Challenges in Carbon Capture, Utilisation, and Storage. *Frontiers in Energy Research*, 2. <https://doi.org/10.3389/fenrg.2014.00055>

Vitillo, J. G., Eisaman, M. D., Aradóttir, E. S., Passarini, F., Wang, T., & Sheehan, S. W. (2022). The role of carbon capture, utilisation, and storage for economic pathways that limit global warming to below 1.5°C. *IScience*, 25(5), 104237. <https://doi.org/10.1016/j.isci.2022.104237>

Zappa, W., Junginger, M., & van den Broek, M. (2019). Is a 100% renewable European power system feasible by 2050? *Applied Energy*, 233–234, 1027–1050. <https://doi.org/10.1016/j.apenergy.2018.08.109>