Carbon Capture: Overview

Introduction

Although the industrial accumulation of greenhouse gases in the atmosphere and the resulting changes to Earth's climate were topics of concern throughout the late twentieth century, the first decades of the twenty-first century saw increased emphasis on the urgent need to reduce emissions of gases such as carbon dioxide, which were contributing to rising sea levels, increasingly frequent extreme weather events, and other manifestations of global climate change. Efforts to reduce emissions often focused specifically on preventing greenhouse gases from being produced in large quantities to begin with, for instance by transitioning from fossil fuels to renewable energy sources such as solar power. Some countries, however, also sought to decrease carbon dioxide emissions through the use of carbon capture, utilization, and storage (CCUS) technologies able to capture carbon dioxide, either from the air or directly from the facility that was producing the emissions. The captured carbon dioxide could subsequently be stored, typically underground in a process also known as carbon sequestration, or could be used in any of a number of products or processes.

In Canada, carbon capture had, by the early 2020s, become one of several key components of the Canadian government's emissions-reduction plan, which set the goals of reducing emissions by at least 40 per cent from 2005 levels by 2030 and reaching the state of net-zero emissions by 2050. Alongside various green energy initiatives, the government sought to spur investment in CCUS and in 2021 announced plans to introduce a tax credit that would encourage investment in that field and promote the construction of new carbon capture facilities in the country. Supporters of increased investment in CCUS technology identify carbon capture as a valuable facet of Canada's overall approach to emissions reduction and further note that implementing such technology would benefit Canada's economy and workforce. Critics, however, argue that carbon capture is an ineffective technology and that the government's focus on CCUS would ultimately divert resources from more proven methods of reducing emissions, such as transitioning away from fossil fuels.

Understanding the Discussion

Blue hydrogen: Hydrogen produced from natural gas, of which carbon dioxide is a by-product.

Canadian Net-Zero Emissions Accountability Act: 2021 legislation requiring the Canadian government to develop a 2030 Emissions Reduction Plan as well as further reduction targets and reduction plans for the period between 2030 and 2050.

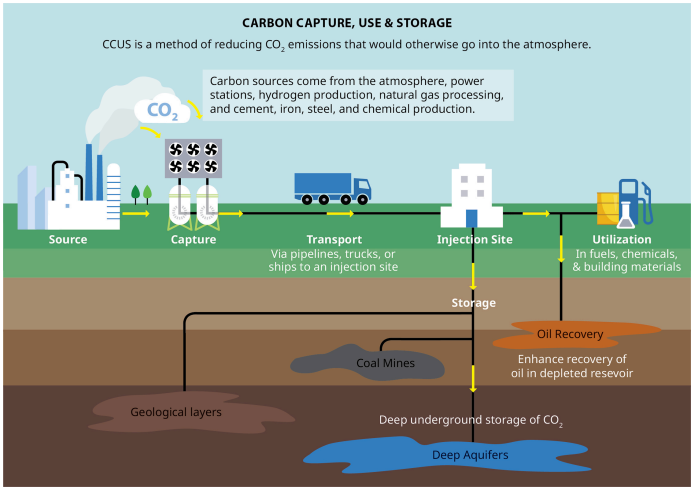
Carbon capture, utilization, and storage (CCUS): A broad term that encompasses a variety of different means of capturing, using, and sequestering emissions of the greenhouse gas carbon dioxide.

Direct air capture (DAC): A form of carbon capture in which carbon dioxide is removed directly from the air.

Enhanced oil recovery (EOR): A method of oil extraction in which carbon dioxide may be injected into an oil reservoir to increase the amount of oil being extracted.

Greenhouse gas: A gas that, after entering Earth's atmosphere, traps heat in the atmosphere and thus contributes to global warming and climate change; common greenhouse gases include carbon dioxide and methane.

Net Zero by 2050: A global roadmap report for achieving net-zero emissions issued by the International Energy Agency in 2021.



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History

The term carbon capture is often used as a catchall term for the broader concepts of carbon capture, utilization, and storage (CCUS) or carbon capture and storage (CCS), fields that encompass a variety of different technologies and processes

for capturing, reusing, and storing—or sequestering—emissions of the greenhouse gas carbon dioxide. After rising into Earth's atmosphere, greenhouse gases trap heat within the atmosphere, creating a so-called greenhouse effect. The greenhouse effect leads to rising global temperatures, a phenomenon sometimes referred to as global warming, which in turn contribute to changes in weather patterns, increases in the frequency of extreme weather events, and droughts. Increases in global temperatures also cause the melting of ice caps and glaciers, which contributes to rising sea levels and the loss of coastal land, among other detriments to human, animal, and plant life on Earth.

Several different gases are considered greenhouse gases, including methane and hydrofluorocarbons. The most common greenhouse gas, however, is carbon dioxide, a gas that is naturally produced through human and animal respiration but is also produced in unnaturally large quantities through the burning of fossil fuels such as oil, natural gas, and coal. In keeping with the widespread industrialization that began taking place in some areas as early as the eighteenth century, global carbon dioxide emissions produced per year rose substantially by the twentieth century, increasing from 6 billion metric tons of emissions in 1950 to 25.23 billion metric tons in 2000, according to the data company Statista. By the end of 2010, annual emissions had risen further to 33.34 billion metric tons. Canada was responsible for 559 million metric tons of carbon dioxide emissions at that time—with substantial emissions coming from the energy and transportation sectors—and ranked among the world's top ten countries in carbon dioxide emissions.

Concerned about the ramifications of global climate change, governments, non-governmental organizations, and researchers around the world worked throughout the late twentieth and early twenty-first centuries to determine means of reducing greenhouse gas emissions and slowing the process of global warming. While many bodies focused primarily on reducing emissions by decreasing the use of fossil fuels, others identified carbon capture as a potential means of removing existing carbon dioxide directly from the air in a process known as direct air capture (DAC) or preventing newly produced emissions from entering the atmosphere by storing or repurposing them. In the latter approach, carbon dioxide produced by facilities such as power-generating plants can be captured from the very facility that is producing them and subsequently processed or transported elsewhere. Carbon dioxide captured using carbon capture technology can be stored, for instance in an underground cavern, or used to manufacture a variety of products, including plastics and carbonated drinks. Gas gathered through carbon capture can also be used in enhanced oil recovery (EOR), an oil extraction process in which carbon dioxide may be injected into an oil reservoir to increase the amount of oil being extracted. When the facilities in which the emissions are captured are geographically separated from the facilities where they will be processed or stored, the carbon dioxide may be transported via pipelines, which must be carefully constructed and maintained to prevent the gas from escaping. Other less common forms of transportation, typically for smaller amounts, can include shipping, trucking, or rail; these methods also lead to emissions during the transportation phase.

During the first decades of the twenty-first century, Natural Resources Canada categorized CCUS initiatives as either commercial projects, demonstration projects, or smaller pilot projects and feasibility studies. The first major commercial carbon capture project in the country, the Weyburn project, began operations in Saskatchewan in 2000. In addition to the Weyburn project (later known as the Weyburn-Midale project), which focused on capturing carbon dioxide for use in EOR, Canada became home to several large-scale demonstration projects over the next two decades, all exploring varying applications of carbon capture technology. The Boundary Dam project in Saskatchewan, for instance, was dedicated to capturing emissions produced by the coal-fired Boundary Dam power station; this was first demonstrated upon operations starting in 2014. The Quest CCS facility in Alberta, first online in 2015 and operated by Shell, focused on capturing emissions from the production of blue hydrogen, hydrogen that is produced from natural gas in a process that also produces carbon dioxide as a by-product. The Alberta Carbon Trunk Line, operated by Enhance Energy starting in 2020, focused on capturing carbon dioxide and delivering the gas to both EOR and storage facilities.

Global carbon dioxide emissions decreased substantially amid the first year of the coronavirus disease 2019 (COVID-19) pandemic, with Statista reporting a fall from 36.7 billion metric tons in 2019 to 34.81 billion metric tons in 2020, a decrease attributed, in part, to reductions in travel and some disrupted or limited industrial processes. Canada's carbon dioxide emissions likewise decreased in 2020, falling to 536 million metric tons. However, global emissions returned to at least near-2019 levels in 2021, a phenomenon that for some organizations and policymakers emphasized the importance of achieving a lasting reduction in emissions. In May 2021, the International Energy Agency (IEA) published *Net Zero by 2050*, a global roadmap report outlining the steps countries around the world would need to take to achieve net-zero emissions by the year 2050, a crucial milestone in the fight against global climate change. Among other points, the IEA stated that many countries' existing emissions-reduction goals were insufficient and recommended that governments make further investments not only in renewable energy projects but also in carbon capture technology, which the organization identified as a key means of limiting the emissions produced by industry.

Carbon Capture Today

In June 2021, the Canadian Net-Zero Emissions Accountability Act became law in Canada and mandated the creation of a 2030 Emissions Reduction Plan, with the goal of reducing emissions by between 40 and 45 per cent of their 2005 level by that year. The act additionally mandated that the government develop further reduction targets and plans for the period between 2030 and 2050, with the goal of reaching net-zero greenhouse gas emissions by the latter year. To that end, and in accordance

with recommendations set forth by bodies such as the IEA, the federal government as a whole and departments such as Natural Resources Canada committed to a multi-faceted, transparent emissions-reduction strategy that would encompass investments in renewable energy, hydrogen-based technology, and CCUS, among other technologies.

Seeking to promote further development and investment in carbon capture technology, the Canadian government went on to propose the creation of a tax credit that would apply to certain investments in CCUS. A consultation period was held between June and December 2021, during which experts and members of the public were able to submit feedback on the proposed tax credit and the CCUS projects to which it would apply. While the efficacy and potential ramifications of carbon capture technology had been subjects of debate in Canada prior to 2021, the announcement of the proposed tax credit and the subsequent consultation period spurred further debate among researchers, industry leaders, policymakers, and advocacy groups, many of whom held opposing views on whether further investment in CCUS was desirable. Proponents of the technology identify carbon capture as a key component of Canada's plan to reduce emissions and assert both its economic benefits and relative ease of implementation, while those opposed to or critical of further investment argue that carbon capture is a distraction from more effective technologies ensuring the phasing out of fossil fuels and would ultimately prove detrimental. Amid the continuing debate, the Canadian government planned to move forward with the proposed tax credit in 2022 in the hope of spurring further development within the CCUS industry. According to early 2022 media reports, plans had already been conceived for the building of new carbon capture and storage hubs in areas such as Alberta.

About the Author

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