THE SOLUTION SET

CARBON CAPTURE AND DIRECT AIR CAPTURE

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The mission of the Energy Future Forum is to develop practical measures that help Canada meet or exceed its 2030 emissions targets on the way to a net zero future, and that strengthen an innovative economy, deepen shared prosperity and enhance national unity.

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INTRODUCTION

One thing is clear. Canada must drastically reduce the amount of CO2 it emits into the atmosphere. The question is how? Specifically, what are the most effective means to achieve the goal of a 30 per cent reduction in emissions by 2030 on the way to a net zero carbon emitting economy by 2050, while maintaining a strong economy? And how will the energy industry make its contribution?

Even amidst the COVID-19 crisis, climate change has remained the context for policy decisions to support the economy. It was continually invoked by critics of special measures for the hard-pressed oil and gas industry. In announcing a package focused on environmental issues and workers, Prime Minister Justin Trudeau said, “Just because we’re in a health crisis doesn’t mean we can neglect the environmental crisis.”

In a post-COVID-19 world when the economy has recovered, there’s little to suggest any fundamental changes from the government’s climate change agenda or the importance public opinion places on the matter. As the conversation returns to normal, the role of carbon capture is posed to reclaim an important place at the table. Many people see carbon capture use and storage (CCUS) as a way to reduce, or in some cases even eliminate, the greenhouse gas (GHG) emissions from large industrial emitters. As such, CCUS is positioned as a crucial global tool in the mitigation of carbon emissions, as is the related process of direct air capture (DAC), which involves extracting CO2 directly from the air, storing it deep underground and returning the decarbonized air to the environment. In both cases, Canada has the potential to claim the mantle of a global leader, helping us to narrow our emissions gap and create exportable knowledge and technology. But to do it will require a renewed commitment by government and the energy sector to capitalize on the opportunity.

BACKGROUND

In 2018, the Intergovernmental Panel on Climate Change (IPCC) issued a special report focusing on the differences in climate change impacts from holding the global temperature increase to 1.5 degrees centigrade, compared to 2 degrees or more. The report, completed by 91 authors and reviewers from 40 countries, set out four pathways that could limit the increase to 1.5 degrees.

In three of the four pathways, carbon capture use and storage was part of mitigation measures holding back the temperature increases. The IPCC concluded that necessary reductions in CO2 can be achieved through combinations of new and existing technologies that would include carbon capture.[1] The global deployment of carbon capture technology would be crucial in reducing emissions from coal-fired power plants and other large CO2 industrial emitters.

The findings were consistent with an earlier and more specific IPCC study on carbon capture and storage from 2005. That report identified a broad range of measures required to address climate change—energy efficiency improvements, the switch to less carbon-intensive fuels, nuclear power, renewable energy sources, enhancement of biological sinks, and the reduction of non-CO2 greenhouse gas emissions. It went on to state that carbon capture:

> **"has the potential to reduce overall mitigation costs and increase flexibility in achieving greenhouse gas emissions reductions."**

With CCUS at the time in its early stages of development, the report also identified several factors that will determine its effectiveness. "The widespread application of CCUS would depend on technical maturity, costs, overall potential, diffusion and transfer of the technology to developing countries and their capacity to apply the technology, regulatory aspects, environmental issues and public perception," the report stated.[2]

Similarly, in 2009 the Pembina Institute gave its provisional support to carbon capture, which it viewed "as one of a number of technologies that can contribute to reducing greenhouse gas emissions on a scale required to combat dangerous climate change." Pembina conditioned its support on several factors. They included: a "massive scale-up" of energy efficiency and renewable energy production; application of CCUS in appropriate regional contexts; a "fair distribution" of investment so that "polluters quickly shouldering the full cost of CCUS deployment"; and, a strong CCUS regulatory framework.[3]

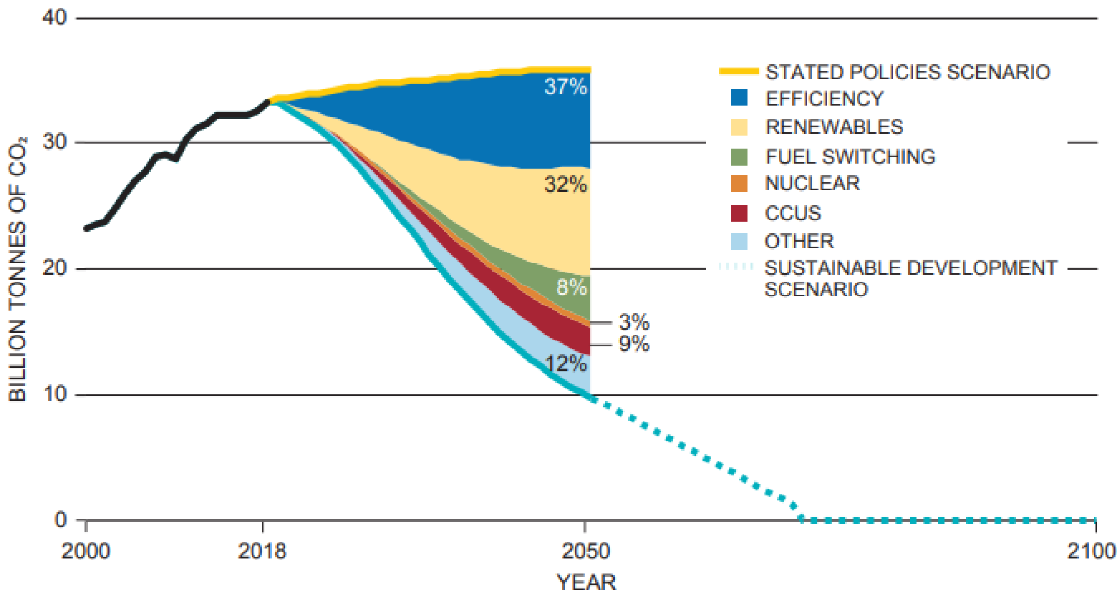
More recently, in 2018, Canada's Generation Energy Council, composed of environmentalists and energy industry figures, cited carbon capture use and storage as having long-term potential to "significantly reduce the carbon emissions arising from fossil fuel use at industrial sites." The report added that the "next generation of these technologies has potential to be employed at a smaller scale and at a broader range of industrial facilities than is economically viable with current technology."

Currently, there are 51 large-scale CCUS facilities globally. Of those, 19 are in operation, four are in construction and 28 in various stages of development. Leading the way in terms of CCUS are the Americas, with 24 facilities in operation or development, followed by 12 in Europe, 12 in the Asia Pacific region, and three in the Middle East. According to a 2019 Global CCS Institute report, an estimated 2,000 large-scale CCUS facilities capturing more than 2,000 Mtpa of CO2—in 2019 CO2 emissions globally totaled 33 gigatonnes—will be needed if there's any hope of achieving global climate targets.

"Over the last 20 years, the role of carbon capture and storage has evolved from 'nice to have', to 'necessary' and now, CCUS is inevitable," says Sally Denson, a professor of energy engineering, co-director of the Precourt Institute for Energy and director of the Global Climate and Energy Research Project at Stanford University.

As the graph indicates, the International Energy Agency forecasts that a healthy nine per cent of the global emissions reduction by 2050 will be through CCUS.

Global Emissions Projections, IEA Stated Policies and Sustainable Development Scenario, 2019



Source: Based on data from International Energy Agency, World Energy Outlook 2019.

CANADA AND CARBON CAPTURE

There are three major post-combustion carbon capture plants operating in Canada. One is a facility at SaskPower's coal-fired Boundary Dam 3 in southeastern Saskatchewan. When it began operating in 2014, the facility ranked as the first commercial, large-scale power station in the world to use post-combustion carbon capture and storage. The majority of captured carbon produced by power generation is used for enhanced oil recovery (EOR) purposes, with the remaining stored deep underground. Another is the Quest plant near Edmonton that operates as part of Shell's Upgrader. The Quest project deploys technology to capture CO2 produced at the Scotford Upgrader and to compress, transport, and inject the CO2 for permanent storage in an underground saline formation. Third is the Alberta Carbon Trunk Line project which began in 2011 and, when completed this year, will be the backbone for CO2 capture and transmission from industrial sources to be used for enhanced oil recovery. Carbon capture technology can potentially have broad application across many heavy emitting industries, such as steel, chemical, cement, fertilizer and pulp and paper.

However, multiple issues—technological, political, environmental and economic—confront CCUS and impede its widespread application. Questions abound about how to finance the significant upfront capital costs as well as the ultimate demand for the captured carbon. Some also fear that CO2 stored underground could eventually leak into the atmosphere.

In spite of those challenges, new approaches to carbon capture are being developed that can build Canada's profile as a global leader. Direct air capture technology uses a chemical scrubbing process to remove CO2 directly from the outside air. The objective is to reduce "legacy" emissions—the estimated 750 billion tonnes of CO2 that have been emitted into the atmosphere over hundreds of years. The World Resources Institute (WRI) notes that the majority of climate models indicate several billion tons of CO2 will have to be removed from the atmosphere every year through to 2050.

> **"With an adequate price on carbon emissions or subsidies for carbon removal, it would be economic to use direct air capture to pull CO2 from the atmosphere and simply store it underground," the WRI argues.[4] A study in Nature Communications found that "Direct Air Carbon Capture and Storage (DACCS) offers an alternative negative emissions technology (NET) option…Deploying DACCS significantly reduces mitigation costs, and it complements rather than substitutes other NETs."[5]**

Last year, Occidental Petroleum announced plans to draw half a million tons of carbon dioxide out of the atmosphere each year with "direct air capture" technology. Occidental will then pump that CO2 into its oil fields in Texas, where it will ease the flow of trapped oil, thereby increasing production. The pumped CO2 will remain stored underground. Occidental is working with Squamish, B.C. based Carbon Engineering, a global pioneer in direct air capture technology. Carbon Engineering investors include Bill Gates, Murray Edwards, Ed Whittingham, BHP, Chevron Technology Ventures, Oxy Low Carbon Ventures, LLC, Bethel Lands Corporation Ltd, Carbon Order, First Round Capital, Lowercase Capital, Rusheen Capital Management, LLC, Starlight Ventures, and Thomvest Asset Management.

Although based in Canada, a major global oil producing nation, Carbon Engineering is hard-pressed to find customers here. The challenge is not lack of interest, but lack of policy development and commitment by governments. What's needed is to make Canada competitive and a global leader in direct air capture technology development and application. Carbon Engineering's founder, chief scientist and board member David Keith, a Canadian who teaches applied physics at Harvard University, has said that the need to address the problem of legacy emissions is self-evident. "Even if we could halt human carbon emissions today, the climate risks they pose would persist for millennia—assuming that we must rely only on natural processes…it is therefore in our interest to have a means to reduce atmospheric CO2 concentrations in order to manage the long-run risks of climate change," says Keith. [6]

KEY CONSIDERATIONS

Following are several factors that need to be considered as part of assessing the role and merits of CCUS and DAC as part of the climate change policy toolkit.

Cost

The application of the post-combustion technology to capture carbon is not cheap. Having said that, while cost is clearly a factor, carbon capture is not uncompetitive with the costs of other decarbonization options. The more critical issue is related to scale. CCUS needs to be applied to large projects, which require significant regulatory and policy efforts for them to proceed. The carbon capture use and storage facility in Saskatchewan cost $1.5 billion. It has the capacity to capture up to 90 per cent of carbon from the coal-generating plant post-combustion. The original coal-fired power facility was opened in 1959 and has gone through three upgrades over its life span, the most recent in 2013. In 2018 it captured a total of 625,996 tonnes of CO2, which represents only 0.8 per cent of Saskatchewan's annual GHG emissions of 77mt. The operation was available that year for 69 per cent of the time because of an 84-day outage after damage from a severe thunderstorm and another 285 hours from two separate boiler leaks unrelated to carbon capture.[7]

The significant majority of CO2 captured at the Boundary Dam power station is sold to Cenovus Energy as part of its enhanced oil recovery project in nearby oil fields. It pumps the waste CO2 back down its depleted wells, to recover oil not available using traditional techniques. The price SaskPower receives for the CO2 is not publicly available. It is estimated to be about $25 a tonne. Based on the amount and some estimates of a minimum carbon price of $55 a tonne needed for CCUS to make financial sense for coal powered units, SaskPower is obviously losing money using CCUS.

However, Corwyn Bruce, vice-president of technical services at the International CCS Knowledge Centre, predicts the cost of CCUS will become significantly cheaper, more efficient and integrate well with renewable energy.

> **"As with any second-generation technology, cost reductions are expected," Bruce says.**

Having said that, SaskPower has shelved plans to add CCUS capacity to two of its other coal generators and instead plans to join the many North American utilities using abundant natural gas to replace the burning of "conventional" (ie non CCUS) coal power by 2030 in its units not fitted with carbon capture technology.

The total capital cost for the Quest plant in Alberta to become operational was $790 million, with annual operating costs of about $33 million and lifecycle capital and operating costs of $1.3 billion. The project received funding of $745 million from what was at the time the Alberta government's $2-billion Carbon Capture and Storage Fund. In 2017, Quest surpassed two million tonnes of CO2 captured from its Scotford Upgrader, which was injected underground. The injected CO2 was recognized by the Global Carbon Capture and Storage Institute (GCCSI) as setting a record for the most CO2 sequestered in a calendar year by a single facility.[8]

Cost is a fundamental issue that has slowed the adoption of CCUS technology. In 2014, the late Jim Prentice, who was to become Alberta premier, said he would cancel further plans for the province to invest in carbon capture and storage, calling it "a science experiment."[9] Citing high costs, Alberta ultimately wound down its $2 billion fund for CCUS investments after it had made the investment in Quest.

The high relative costs associated with carbon capture are consistent with the well-documented technology path that regularly sees a point emerge where massive cost reductions occur. This has been the case for renewable energy sources, such as wind and solar. Still, when it comes to private utility operators, CCUS must compete against today's historically low natural gas prices. For coal-fired thermal plants, the option to replace coal with natural gas, with its much lower GHG emission levels, currently renders CCUS investment an inefficient use of capital. As noted, carbon capture struggles with the absence of a significant price on carbon. Industry officials indicate that a carbon price of at least $55 per tonne, ranging up to $100 depending on whether the source fuel is coal or natural gas, is required to create enough incentive for coal power producers and other heavy industrial emitters to consider CCUS as a financially viable means to reduce GHG emissions. According to industry sources, the costs of carbon capture for the oil sands, whether in situ or mining operations, are roughly equivalent.

In a December 2019 study, the U.S. National Petroleum Council assessed the costs to capture, transport and store 850-point sources of emissions comprising 80 per cent (approximately 2Gt) of all stationary U.S. CO2 sources. It said that clarifying existing tax policy and regulations "could activate an additional 25-40 million tons a year of CCUS, doubling existing U.S. capacity within the next five to seven years." To put that in context, in 2017 total GHG emissions in the U.S. were 5,743 million metric tonnes.[10] The study called for approximately $50 billion in investment over that timeframe. It called on Congress to appropriate $15 billion of new research and development funding over the next 10 years to advance new and emerging technologies and demonstration of existing technologies, which has not happened, and to clarify existing tax incentives to ensure CCUS qualified, which is under way.

The 45Q incentive is a section of the U.S. tax code that provides a performance-based tax credit for carbon capture projects that can be claimed when an eligible project has:

- securely stored the captured carbon dioxide (CO2) in geologic formations, such as oil fields and saline formations; or
- beneficially used captured CO2 or its precursor carbon monoxide (CO) as a feedstock to produce fuels, chemicals, and products such as concrete in a way that results in emissions reductions as defined by federal requirements.

There is also a bill before Congress that proposes an increased credit for CO2 sequestration for direct air capture facilities. Today the U.S. has established itself as a leader in CCUS, with 10 facilities in the U.S. capturing more than 25 mt of CO2. Recently, the U.S. Department of Energy also selected nine facilities for Front-End Engineering Design (FEED) study support. Industry sources say that more than two dozen facilities could potentially be announced once the Internal Revenue Service finalizes the guidance and rule for the 45Q tax credit.[11]

Canada, through policy neglect and weak staying power, is widely seen to have lost the leadership position it previously enjoyed in carbon capture, much to the chagrin of many participants in PPF's Energy Future Forum.

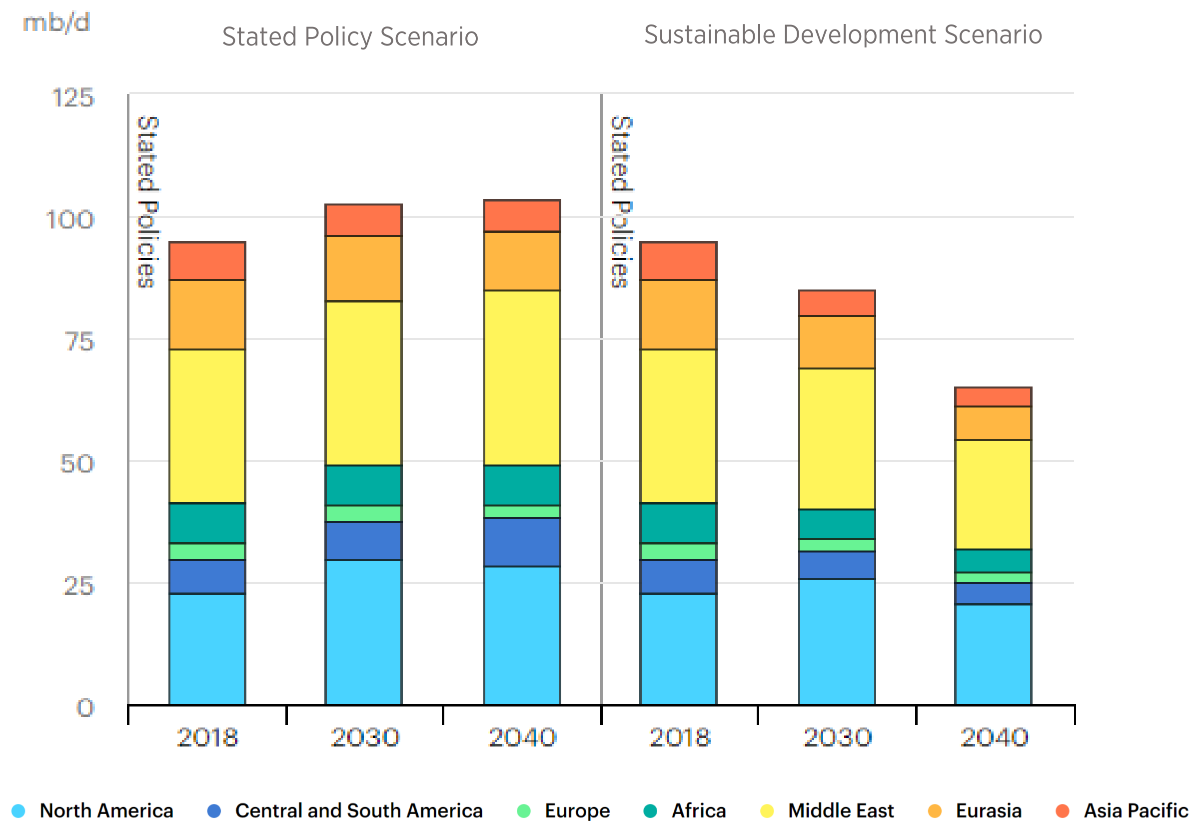
A Means to Produce more Oil

In a policy environment where the ultimate objective is to transition away from an emission-dependent economy, CCUS proponents offer it up as a means to increase oil production through enhanced oil recovery (EOR) while reducing emissions. For many, the idea of increased fossil fuel production as a positive represents a counter-intuitive proposition. With growing pressure to drastically reduce dependence on fossil fuels and move to zero-emission sources, some consider enhancing oil recovery by injecting captured carbon into depleted oil reservoirs as inconsistent with stated climate goals. Their argument is simply that policy should not be encouraging additional oil production at a time when society needs to transition to eventually a net-zero economy. But, as Jennifer Wilcox of the Kleinman Center for Energy Policy at the University of Pennsylvania notes, what matters is net carbon removal, which can be achieved through EOR.[12]

Against that is a (pre-COVID-19) analysis by the International Energy Agency (IEA) of oil demand trends. As shown below, while growth in global demand has slowed, it will not begin declining until 2040. Then again, the IEA also has a second so-called Sustainable Development Scenario, which sets out a much different picture. It points to a rapid transition with demand for oil peaking and beginning to decline in the early 2020s. Even in the second case, though, oil in 2040 continues to represent at least two-thirds of its peak demand. Recently, we've had a sneak preview of the chaos created by such a big bite out of demand that occurs suddenly. Many Canadian producers believe they can stay in business through this period by being competitive on costs and carbon. Committing to a cleaner oil pathway necessitates CCUS as part of the mix.

Otherwise, Canada will simply become an importer of the greenhouse gas emissions of other countries rather than an exporter of our own, hopefully, cleaner petroleum. Just as we are a price taker, so we would become an emissions taker, giving up in the process any influence on reducing carbon intensities.

Oil Production by Region and Scenario 2018-2040



IEA, World Energy Outlook 2019

Wise Investment?

This raises the question of whether the large-scale public and private investment required by CCUS would prove an efficient and effective use of public resources in terms of climate change and energy priorities. In its report, the U.S. National Petroleum Council proposes $680 billion cumulative investment in CCUS over the next 25 years. Corresponding figures are not available for Canada—although all such figures now would have to be looked at through the lens of the COVID-19 crisis, which might mean fewer available investment dollars or, conversely, the need for more technology-based and job-producing infrastructure investments. There are choices here of how to spend our post-COVID recovery dollars in terms of bolstering existing economic activity versus backing fresh cleantech businesses. The answer may well be both.

Canada as a Global Leader

The CCUS and DAC options can also be considered more broadly than the central issues of the effects they can have on meeting emissions targets. They also need to be judged from the perspective of Canada positioning itself as a global leader in climate change solutions. In 2014, SaskPower's Boundary Dam was the first power station in the world to successfully use post-combustion carbon capture technology.[13] As an early adopter of carbon capture, Canada attracted considerable international attention from nations looking at ways to reduce their GHG emissions. This led to the creation of the International CCS Knowledge Centre in Regina, a joint venture of Bhp Billiton Ltd and the Government of Saskatchewan. Some of that initial momentum has been lost as cost issues and the availability of cheap natural gas has made the economics of CCUS less attractive to utilities. On the other hand, the public policy environment has also dramatically changed in the intervening years. With Canada seeking a path to net zero emissions by 2050, carbon capture is considered by many as an indispensable measure in the climate change toolkit.

The other factor to recognize is that the U.S., despite its withdrawal from the Paris Agreement, has identified carbon capture as a crucial dimension in addressing climate change. The December 2019 report by the National Petroleum Council setting out what it called "a roadmap to at-scale development of carbon capture, use and storage" noted the country leads with 80 per cent of the world's carbon capture capacity. Facing the possibility of 25-30 per cent growth in the global demand for energy by 2040, the report states

> **"carbon capture, use, and storage (CCUS), including transport, will be an essential element in the portfolio of solutions needed to take on this dual challenge of supplying energy while addressing the risks of climate change."[14]**

Another nation that recognizes the importance of carbon capture is Norway. In 2018 the Norwegian government initiated a full-scale carbon capture and storage initiative. Two capture projects are part of the pre-engineering project, one is a cement factory and the other a waste-to-energy plant. Both facilities plan to capture around 400,000 tons of CO2 annually, an amount equivalent to removing 60,000 cars from the road for a year.[15] A partner with Norway in developing CCUS as part of its Northern Lights project is Total Energy, which has allocated 10 per cent of its overall research and development budget to carbon capture.[16] Total Energy is also a partner in both the Fort Hills and Surmont oil sands projects in Alberta.

The question is whether Canada can use CCUS and DAC to help achieve its GHG reduction goals and play a prominent role in solving the global challenge of CO2 emissions from coal power generation and oil production. If Canada is to regain its leadership role it would be able to create export capabilities from investment in carbon capture. To put the potential market in perspective, from 1990 to 2018 China increased its coal consumption from 0.99 billion tons to 4.64 billion tons. In 2018, coal made up 59 percent of China's energy use. Since 2011, China has consumed more coal than the rest of the world combined. China's industrial sector is by far the largest consumer of coal. In 2017, the industrial sector accounted for around two thirds of China's total energy consumption and consumed about 95 percent of the country's coal.[17] Then there is the rapidly growing economy of India, which the IEA forecasts will double energy demand by 2040 and triple electricity consumption.[18]

Governments need to make a policy decision soon whether they want to use their procurement power to help Canadian-based firms, such as Carbon Engineering and Carbon Cure, which sequesters CO2 into concrete, graduate into global leaders in carbon capture technology.

Policy Options

If Canada is to achieve its net zero objective, clearly it will be through a medley of measures that includes Carbon Capture Storage and Usage. Canada used to be the leader in an area that demands great amounts of capital upfront while operators learned and improved processes. There is good reason to believe that what has been true for solar and wind can be so for carbon capture and direct air capture technology Should it be deemed that an export opportunity exists for Canada to assume a global leadership position, a critical step in that direction would be creating the incentives to make CCUS and DAC financially viable options for heavy emitters. If recovering its lost lead is to be a policy goal, Canada will have to be competitive with the United States, which introduced its 45Q performance-based federal tax credit in 2018. The credit is worth $10 per metric tonne for use of the carbon to enhance oil recovery. That will ramp up to $35 by 2024. A $50 a tonne tax credit will be available for companies doing carbon capture and storage in geologic formations or in qualified structures, such as saline aquifers. A similar Canadian policy would provide the necessary incentive for greater carbon capture and use in Canada's energy producing and energy-intensive industries.

Another crucial policy instrument to be considered going forward in advancing carbon capture technology is procurement. It can be a powerful incentive to drive towards reduced emissions. In the U.S. and several Asian nations, procurement policies at the local and municipal levels include emissions standards in their purchasing decisions. A similar approach in Canada by the federal government would help our nation regain a leadership role in the emerging carbon capture global reality.

The CO2 reduction benefits of CCUS and DAC are clear and measurable. It is technology that cannot be ignored if Canada is to begin achieving its climate goals.

[1] Intergovernmental Panel on Climate Change (2018). Special Report, Global Warming of 1.5 C., p.15.

[2] Intergovernmental Panel on Climate Change (2005). Carbon Capture and Storage, p.3.

[3] The Pembina Institute, (2009). Perspective on Carbon Capture and Storage, February 2009.

[4] Mulligan, D. and Lashof, D. (2019). A CO2 Direct Air Capture Plant Will Help Extract Oil in Texas. Could This Actually Be Good for the Climate? World Resources Institute, July 31, 2019. https://www.wri.org/blog/2019/07/co2-direct-air-capture-plant-will-help-extract-oil-texas-could-actually-be-good-climate

[5] Realmonte, G., Drouet, L., Gambhir, A., Glynn, J., Hawkes, A., Koberle, A.C., and Tavoni, M. (2019). An inter-model assessment of the role of direct air capture in deep mitigation pathways. Nature Communications, 10, Article number: 3277. https://www.nature.com/articles/s41467-019-10842-5)

[6] Hopecky, A. (2019). David Keith's Carbon Removal Moonshot, The Canadian scientist built a world-class emissions capture project in Squamish. But don't misunderstand his aim. The Tyee. https://thetyee.ca/Analysis/2019/08/16/David-Keith-Carbon-Removal-Moonshot/

[7] International Energy Agency (2019). Canada: Boundary Dam power station had a good year for carbon capture: Saskpower.

[8] Quest Carbon Capture and Storage Project (2017). Annual Summary Report, Alberta Department of Energy.

[9] Wood, J. (2014). Prentice dismisses carbon capture as 'science experiment'. Calgary Herald. July 10, 2014. https://calgaryherald.com/news/prentice-dismisses-carbon-capture-as-science-experimentvideo

[10] Center for Climate and Energy Solutions, (2019) Climate Basics--Energy Emissions Data: U.S. Emissions. https://www.c2es.org/content/u-s-emissions/. https://www.c2es.org/content/u-s-emissions/

[11] Page, B. (2020). US leads new wave of carbon capture and storage deployment, The Hill, Jan. 5, 2020.

[12] Wilcox, J. (2020). The Essential Role of Negative Emissions in Getting to Carbon Neutral. Kleinman Center for Energy Policy. https://kleinmanenergy.upenn.edu/policy-digests/essential-role-negative-emissions-getting-carbon-neutral

[13] SaskPower, Our Power Future/Infrastructure Projects, Boundary Dam Carbon Capture Project. https://www.saskpower.com/Our-Power-Future/Infrastructure-Projects/Carbon-Capture-and-Storage/Boundary-Dam-Carbon-Capture-Project

[14] National Petroleum Council, (2019). Meeting the Dual Challenge, A Roadmap to At-Scale Deployment of Carbon Capture, Use, and Storage. www.dualchallenge.npc.org

[15] Fortum (2018). A full-scale carbon capture and storage (CCS) project initiated in Norway. https://www.fortum.com/media/2018/11/full-scale-carbon-capture-and-storage-ccs-project-initiated-norway

[16] Nevicato, D., Jeanbart, J. (2020) Our CCUS Project: "Northern Lights"; Research & Development, Total. https://www.ep.total.com/en/innovations/research-development/total-invests-heavily-carbon-capture-utilization-and-storage-ccus

[17] ChinaPower (2020). The export and application of Canada's CCUS expertise can be a crucial part of the global climate change strategy. https://chinapower.csis.org/energy-footprint/ The export and application of Canada's CCUS expertise can be a crucial part of the global climate change strategy.

[18] Birol, F., (2020). India's rise on the global energy scene. International Energy Agency. https://www.iea.org/commentaries/indias-rise-on-the-global-energy-scene

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