INCENTIVIZING LARGE-SCALE CCS IN CANADA

A WHITE PAPER

OCTOBER 2020

INTERNATIONAL CCS KNOWLEDGE CENTRE

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This white paper was written by contributing researchers from the International CCS Knowledge Centre and RSM Canada. The biographies for lead authors, Beth (Hardy) Valiaho, Alex Kotsopoulos, and Michael Morrison can be found on page 35.

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EXECUTIVE SUMMARY

Analysis by the International Energy Agency has determined that deployment of carbon capture technology is critical to achieve mid-century global carbon reduction goals and temperature targets. Currently, Canada is not on track to meet its Paris Agreement targets to reduce its greenhouse gas (GHG) emissions by 30% below 2005 levels by 2030. Additionally, in December 2019, the country announced a target to achieve net-zero emissions by 2050. To meet its substantial emissions reduction commitments, a combination of the right policies, significant investments, and continued innovation in all areas including carbon capture and storage (CCS) will be required.

CCS is an emissions reduction process designed to prevent large amounts of CO_2 from being released into the atmosphere. Considered a necessary clean energy technology to reduce industry-driven GHGs, CCS is a three-step process consisting of CO_2 capture, transportation, and utilization and/or storage.

Canada's record as a large-scale CCS leader dates back to 1999, but to achieve its ambitious emissions reduction goals, there needs to be accelerated progress in the commercial-scale deployment of CCS across a wide variety of applications. To that point, Canadian companies realize that government mechanisms are needed to enable commercial CCS which could include a range of complimentary options such as certainty in CO_2 value, a level playing field with alternative low-carbon technologies, and front-end development support to drive down costs and make capital investment competitive.

CCS incentives are a key answer to this challenge. Already governments around the world are employing a range of policy tools and incentives including tax credits and direct government grants to address roadblocks and challenges to promote CCS projects. In the US, the expanded 45Q tax credit is regarded by many as a game-changer and is the primary reason for the significant increase in CCS deployment; while the European Union focuses more on direct government grants, including preferential loans rather than tax credits.

What should Canada do? Which avenues in the Canadian tax system can best assist industry in increasing deployment of CCS? And, should grant programs be leveraged as a mechanism to fund and promote CCS development in the country?

The benefits of deploying CCS are substantial for the country. From helping Canada achieve its emissions reductions to spurring economic growth, boosting productivity, and supporting the diversification of Western Canada's economy, CCS technology plays a vital part in creating an economically sustainable route to deep emissions cuts.

This White Paper highlights what pathways in the Canadian tax system could likely open doors for industry to have kickstart support that results in increased deployment of CCS while aligning with the continued development of the Pan-Canadian Framework on Clean Growth and Climate Change.

Opportunities for the government to consider are best articulated within the report. In order of recommended approach they include:

- Option 1: A refundable capital tax credit provided in advance of construction of CCS facilities to the company who will be capturing their emissions.
- Option 2: A tax credit focused on expenditures during the study and design phase of a CCS project that would allow certainty for investment and offset capital costs of construction.
- Option 3: A production tax credit, similar to that of the 45Q CCS incentive in the United States, to address competitiveness issues.

The economic impact related to the development of CCS projects is substantial. The basic premise behind economic impact analysis is that spending in one industry generates additional spending (i.e. multiplier effects) in other industries and potentially even in the same industry. With Canada seeking projects that boost economic growth while also mitigating climate impacts, CCS projects are a proven and near-term investment opportunity that can see direct, indirect and induced jobs coupled with large emission reductions.

The economic impact analysis provided in this report shows that the construction and development of three CCS projects would generate $2.7 billion (B) in GDP across Canada and support over 6,100 jobs over the construction horizon. A high degree of these economic impacts are viewed as being incremental given current levels of unemployment in regions where these projects would be developed. With just three large-scale CCS projects, Canada's GHG emissions could be reduced at those facilities beyond 90% totalling an emissions reduction anywhere from 1.5 million tonnes (Mt) to over 5Mt annually depending on the size of the facilities.

All opportunities to reduce emissions and stimulate the economy are required to meet the Paris Agreement. CCS is not on track across the array of climate mitigation options, and this White Paper looks to add background and a basis for Canada to consider how to incent further large-scale CCS deployment. Given the high job creation capacity, the variety of construction products and equipment necessary to tackle large projects, the increased GDP opportunities, and the large CO_2 emissions reduction potential, CCS can be a key component in building back better.

ABOUT
THE INTERNATIONAL CCS KNOWLEDGE CENTRE

The International CCS Knowledge Centre (Knowledge Centre) is dedicated to advancing the understanding and use of large-scale carbon capture and storage (CCS) as a means of managing greenhouse gas (GHG) emissions. The Knowledge Centre is unique in that it houses experts who were instrumental in the development and operations of the Boundary Dam 3 CCS Facility.

Understanding the full-chain realities and complexities of a deployed world-leading project, the Knowledge Centre offers insight into practical deployment considerations. The Knowledge Centre places a high value on information and expertise that is permitted to be broadly shared with multiple parties. This promotes research, innovation, and deployment by reducing the cost and risk associated with new CCS projects domestically and around the world.

With hands-on guidance, our technical advice for planning, design, construction, and operation of large-scale applications of CCS is applicable directly to project developers. This practical form of cooperation acts to ensure potential CCS facilities save time and effort in developing workable projects. Such experienced-based decision making can avoid costly delays or allow projects to proceed. By promoting and contributing to the technical advancement and cost reductions of second-generation CCS, organizations are better positioned to de-risk investment decisions.

The team actively engages financiers and decision makers to ensure high-level information on CCS is conveyed with political, economic, and other broad considerations. We are experts that can be relied on to aid in developing roadmaps for CCS considerations and providing strategic and business case advice along the path to deployment.

The International CCS Knowledge Centre was founded in 2016 as a non-profit organization by BHP and SaskPower, with its head office in Regina, Saskatchewan.

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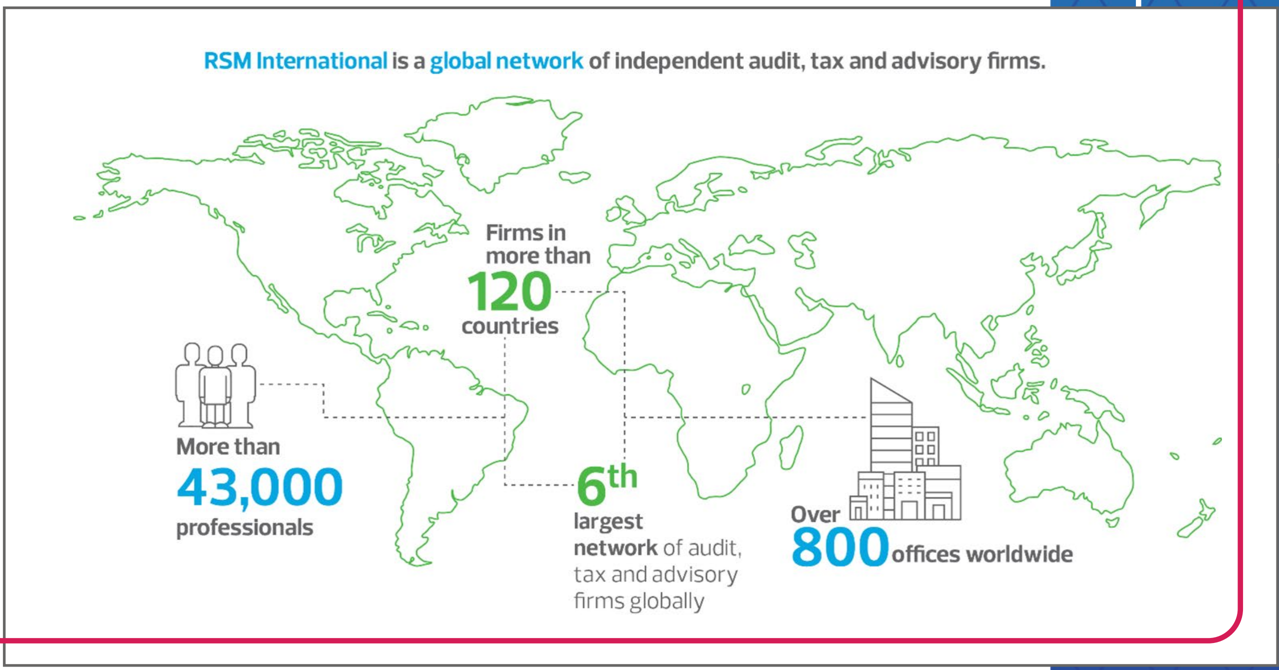
ABOUT
RSM CANADA

RSM's purpose is to deliver the power of being understood to our clients, colleagues and communities through world-class audit, tax and consulting services focused on middle market businesses. The clients we serve are the engine of global commerce and economic growth, and we are focused on developing leading professionals and services to meet their evolving needs in today's ever-changing business environment.

RSM Canada LLP provides public accounting services and is the Canadian member firm of RSM International, a global network of independent audit, tax and consulting firms with more than 43,000 people in over 120 countries. Our team comprises 69 partners and over 600 people nationally in four office locations spanning Ontario and Alberta. We serve clients in various industries, including finance & insurance, energy, oil and gas, manufacturing, private equity, real estate and construction, technology, business and professional services, and government, health care and education.



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INTRODUCTION

BACKGROUND AND CONTEXT

According to Climate Action Tracker, Canada's efforts are "insufficient" and "not consistent with holding warming to below 2°C, let alone limiting it to 1.5°C" as required under the Paris Agreement. The country, currently, is not on track to meet its Paris Agreement targets to reduce its greenhouse gas (GHG) emissions by 30% below 2005 levels by 2030.[1] The right policies with significant investments in clean energy and greening of industrial processes are essential to the achievement of emissions reduction goals. To meet this challenge, and for Canada to meet its goal of "net-zero" emissions by 2050, the country will require a wide range of strategies, including continued innovation in carbon capture and storage (CCS).[2]

With the foresight to make decisions to invest in large-scale CCS, Canada is known as a pioneer in the understanding of this clean technology and its potential for generating substantial emissions reductions (see a detailed overview of these projects below.) These early-mover projects in Canada not only assumed the risks and costs associated with the learning curve seen by first-mover projects, they are contributing valuable global leadership based on the gained experience in operations and subsequent lessons learned.

While advances toward second-generation CCS show the potential for a sharp decline in capital costs, there still remains – for many regions and industries – a need for kickstart incentives to ensure that opportunities to use CCS to reduce large amounts of emissions are maximized.[3] It is important that there are value streams and business cases to support successful deployment of CCS - and that they tie into sustainability and environmental policies.

One-time grants for first-of-a-kind projects have been utilized in Canada for both the Shell Quest and Boundary Dam CCS projects. Federal dollars have supported the shared infrastructure of the Alberta Carbon Trunk Line. Such funding opportunities will hopefully remain available for new sectors entering into first-of-a-kind projects – like cement or other manufacturing. Today's investments to advance large-scale CCS projects will allow for an acceleration of a proven, reliable, and deployable technology that is a key component in the suite of technologies required to meet climate goals.

However, if direct government injections of support are no longer available or are not guaranteed, it raises a key question: what happens to the next projects? While it is imperative for sectors to transition from a reliance solely on government grants to industry uptake, government support remains crucial. This coupled with policy certainty is a necessary next step to aid in the cost hurdles of deployment until costs are reduced with scalable iterations.

Meeting Paris Agreement targets will require Canada advancing further leadership in CCS in the near term. A current incentive called 45Q in the United States (US) is also acting to drive advanced engineering and design studies for CCS, spurring interest from almost 30 projects. Tax credits have a history of acting as effective environmental levers, such as the past success with production tax credits for wind-power uptake in the US. With a steadfast drive to reduce emissions, incentive opportunities for CCS are drawing attention from global governments to examine if such grant-like incentives have potential.

If Canada wants to remain a leader in CCS deployment, it may need to consider opportunities to enhance the economic equation of project development, ensuring that early years of operation have enough clout and financial backing to get industry over the front-end, capital-intensive hurdle.

A carbon price may assist in the long run, but companies undoubtedly face large monetary risks, primarily in the first three to five years when developing CCS. These risks present a stumbling block for getting economics working for decision-makers and investors. Addressing this gap will generate significant economic impacts across Canada, but particularly in Western Canada, where most CCS projects may be initiated to help Canada achieve its GHG emissions reductions.

This *White Paper on Carbon Capture and Storage Incentives Options for Canada* intends to highlight what pathways in the Canadian tax system may open doors for industry to have kickstart CCS support. This kickstart support aims to increase deployment of CCS while aligning with the continued development of the *Pan-Canadian Framework on Clean Growth and Climate Change*.

PAPER OBJECTIVES

This paper will begin with an overview of the climate commitments Canada has made under the Paris Agreement and highlight some of the measures it has taken to reduce emissions – including the role of CCS. It will then explore the current status of CCS in Canada - outlining what CCS actually is, identifying its benefits to climate mitigation, and providing a timeline for the projects and investments (and their challenges) in CCS in Canada to date. The paper then outlines what policy options are available based on jurisdictional review and recommends the ideal incentive scenarios for Canada. It concludes by outlining the economic impact that incenting CCS projects in Canada can have on the greater economy.

WHY WE PARTNERED ON THIS JOINT REPORT

The global economy has been hit hard by the pandemic, and Canada feels the impact of economic downturn. Extraordinary monetary and fiscal policy measures have fortunately staved off a much deeper economic contraction and financial crisis, and as a result, the Canadian economy is recovering strongly. Canada's deficit for this fiscal year is expected to be $343B or approximate 16% of GDP – the largest since WWII.[4] Other economists suggest that the deficit could be $200B next fiscal year, which is historically, an extremely large figure. The path to economic growth will take time.[5]

The federal government has indicated that now is not the time for austerity. The recent Speech from the Throne signaled a number of additional measures intended to tackle the Corona virus and provide income support to Canadians during the pandemic.[6] But it also looks post-pandemic indicating measures intended to facilitate Canada's transition to a lower carbon economy and infrastructure spending. The upcoming series of budgets will likely be some of the most expansive in Canada's history.

Prioritizing investments to improve Canada's productivity will become increasingly important. One way to address the deficit is to grow, and the key is productivity growth. Increased public and private sector investment is critical to improving labour productivity and can be done in a low-carbon fashion. Investments in CCS projects should be viewed in a similar light.

The International CCS Knowledge Centre and RSM Canada have partnered on this study to facilitate a discussion regarding CCS and its role in Canada's economy because of the breadth of experience of each organization respectively. In addition to improving productivity and lowering Canada's GHG emissions, CCS can play an important role in supporting regional economic development, the diversification of Western Canada's economy, improving the competitiveness of Canada's oil and gas and other sectors, and support small and medium sized businesses – the lifeblood of the Canadian economy.

SETTING THE STAGE

CANADA'S GHG EMISSIONS REDUCTION TARGETS

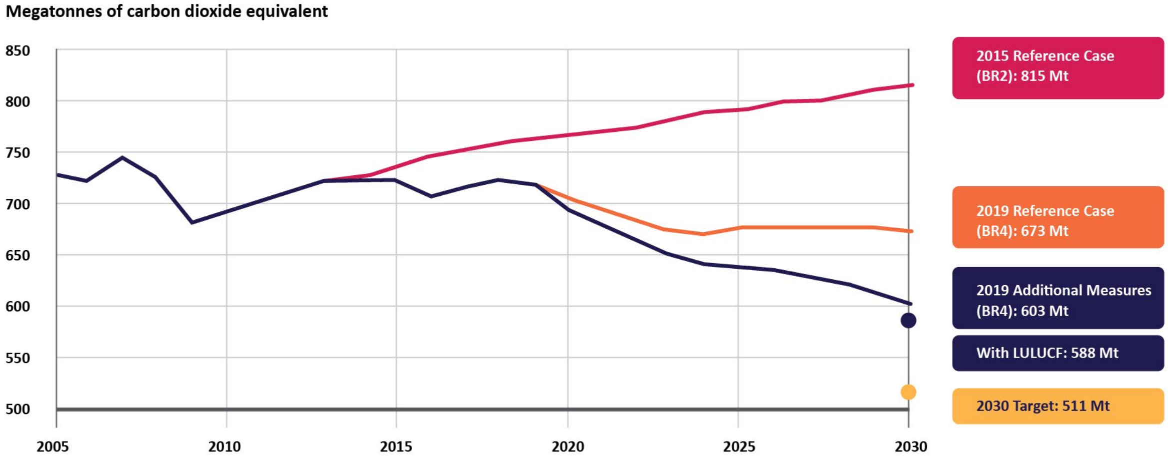
Canada's GHG emissions target aims for an annual 511 million tonnes (Mt) of carbon dioxide (CO_2) by 2030. This is also Canada's international goal under the Paris Agreement. The Paris Agreement seeks to strengthen the global response to climate change, reaffirms the goal of limiting global temperature increase to well below 2 degrees Celsius (°C), while pursuing efforts to limit the increase to 1.5°C.[7] In order to do so, large-scale, emissions-intensive, industrial and power generation processes must be significantly decarbonized.

Canada targets a 30% reduction in GHGs below its 2005 levels. Currently, Canada continues to hold its GHGs at approximately the same level as 2005, (730Mt CO_2 per year), but without climate action, the CO_2 emissions level is projected to climb to an annual rate of 815Mt by 2030.[8] In response, Canada adopted its *Pan-Canadian Framework on Clean Growth and Climate Change* in December 2016.[9] This framework is built on four pillars: pricing carbon pollution; complementary actions to reduce emissions across the economy; adaptation and climate resilience; and clean technology, innovation, and jobs.

Determined to meet or beat its commitment to the Paris Agreement, Canada announced in December 2019, a target to achieve net-zero emissions by 2050 which would include setting legally-binding, five-year emissions-reduction milestones.[10] By including measures that were put in place and acted on by governments, consumers and businesses, Canada adapted its annual emissions projections for 2030 to 673Mt CO_2.[11]

Canada then put forward an additional scenario that adds policies and measures currently under development and yet to be fully implemented; credits through the Western Climate Initiative; and the contribution from the land use, land use change and forestry (LULUCF) sector. This further reduced the projection rate to 603Mt CO_2 and then again (with LULUCF), to 588Mt CO_2.[12]

FIGURE 1: Historical Greenhouse Gas Emissions and Projections, Canada, 2005 to 2030



Source: Environment and Climate Change Canada (2020)

This graph summarizes GHG projections from 2005 to 2030 comparing scenarios in the 2015 reference case in the Second Biennial Report (BR2) and the 2019 reference case in the Fourth Biennial report (BR4) with additional measures and LULUCF.[13]

CANADIAN CLIMATE POLICIES

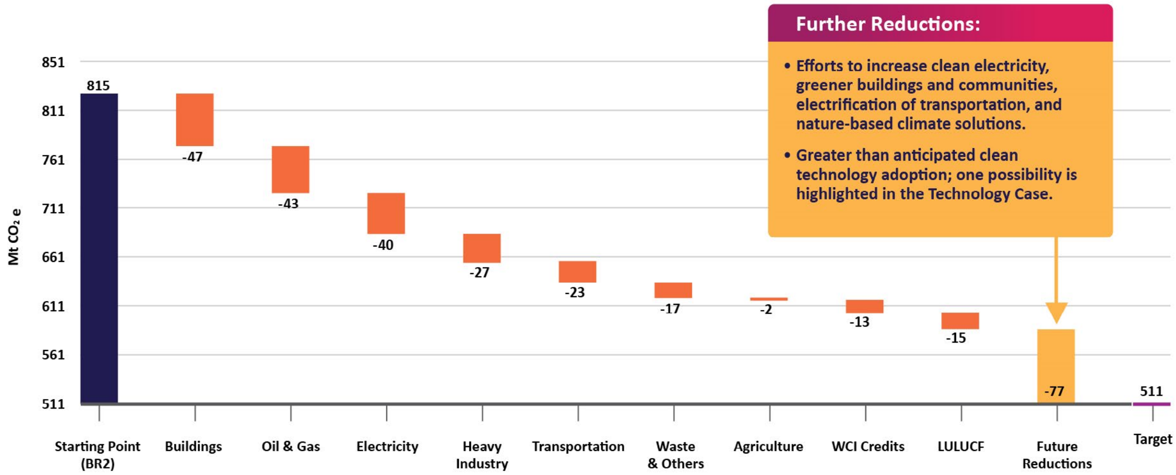
It is not the intent of this paper to analyze Canada's emission reduction policies. However, understanding the current realities is important. Since its adoption in 2016, the *Pan-Canadian Framework* has implemented measures including:[¤]

- New regulations introduced to reduce methane emissions from the oil and gas sector, reduce GHG emissions from heavy-duty vehicles, and accelerate the phase-out of emissions from coal-fired electricity
- A price placed on carbon pollution across Canada
- $60B invested to reduce emissions, drive clean growth, build resilience, and protect the environment
- A Low Carbon Economy Fund established to finance emissions reduction projects in provinces and territories
- A suite of programs launched to build Canada's resilience to a changing climate, including establishing the Canadian Centre for Climate Services to improve access to authoritative climate science and information.

[¤] Further summaries of policies and measures that Canada and its provincial governments have taken with respect to GHG emissions are detailed in the Fourth Biennial (BR4) filed by Canada with United Nations Framework Convention on Climate Change (UNFCCC).

Canada will need to implement additional measures to achieve or exceed Canada's 2030 Paris Agreement target and to work toward its goal of net-zero emissions by 2050. Identified priority areas include clean electricity generation, greener buildings and communities, the electrification of transportation, and nature-based climate solutions. Canada has yet to formally announce commitments to further specific measures, though has articulated anticipated progress by sector.[14] This includes a Canadian Energy Strategy which seeks to ensure efficient use of Canada's energy resources in a manner compatible with a low-carbon future using collaborative efforts.[15]

FIGURE 2: Progress to Canada's 2030 Emissions Targets (2015-2019)



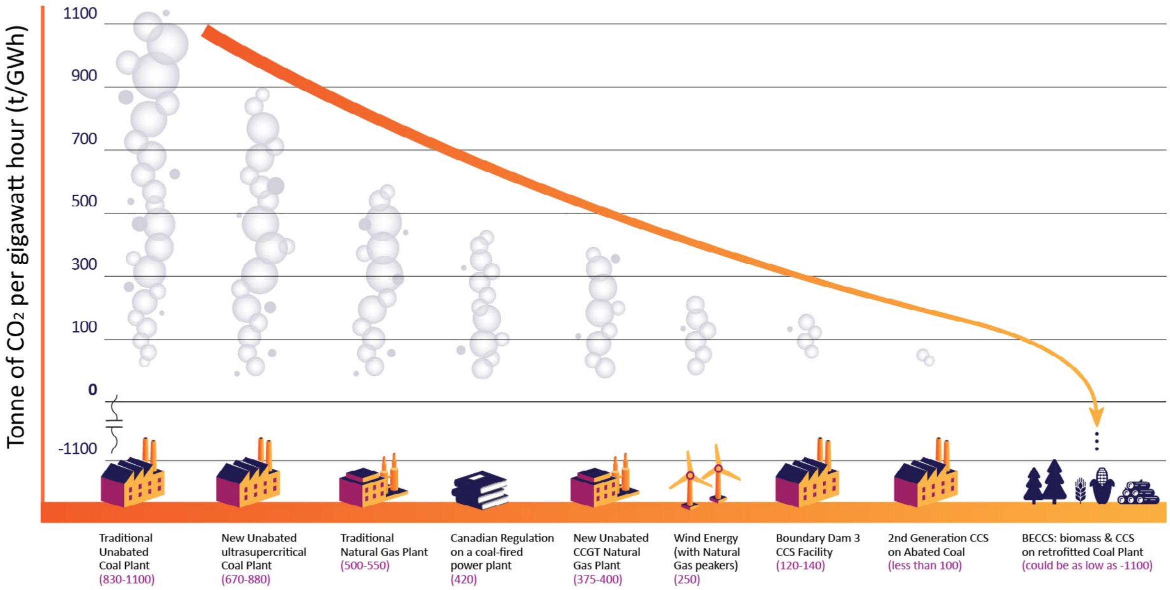
Source: Government of Canada: Fourth Biennial Report

This graph illustrates a projected decline in Canada's emissions with climate action taken across a range of sectors.

CCS AS A COMPONENT OF CANADA'S CLIMATE MITIGATION ACTIONS

Canada's climate target is ambitious, and in order to achieve emissions reductions of such magnitude, there needs to be accelerated progress in the commercial-scale deployment of CCS across a wide variety of applications, including power generation (coal and natural gas), industrial processes (like cement and steel), and fossil fuel-produced hydrogen; in addition to bioenergy production. The BR4 report lists CCS as a core climate mitigation measure for both federal and provincial governments. Furthermore, CCS is recognized as one of the measures offering the most significant impact on sectoral GHG emissions and estimated mitigation impacts for 2020 and 2030.

FIGURE 3: Power Sector CO_2 Emissions are Significantly Reduced with Large-Scale CCS



Source: The International CCS Knowledge Centre

This graph is based on power generation in Saskatchewan - demonstrating that CCS on coal emissions well exceeds the requirements of the Canadian regulations.

CURRENT STATE OF CCS SECTOR IN CANADA

OVERVIEW OF CCS

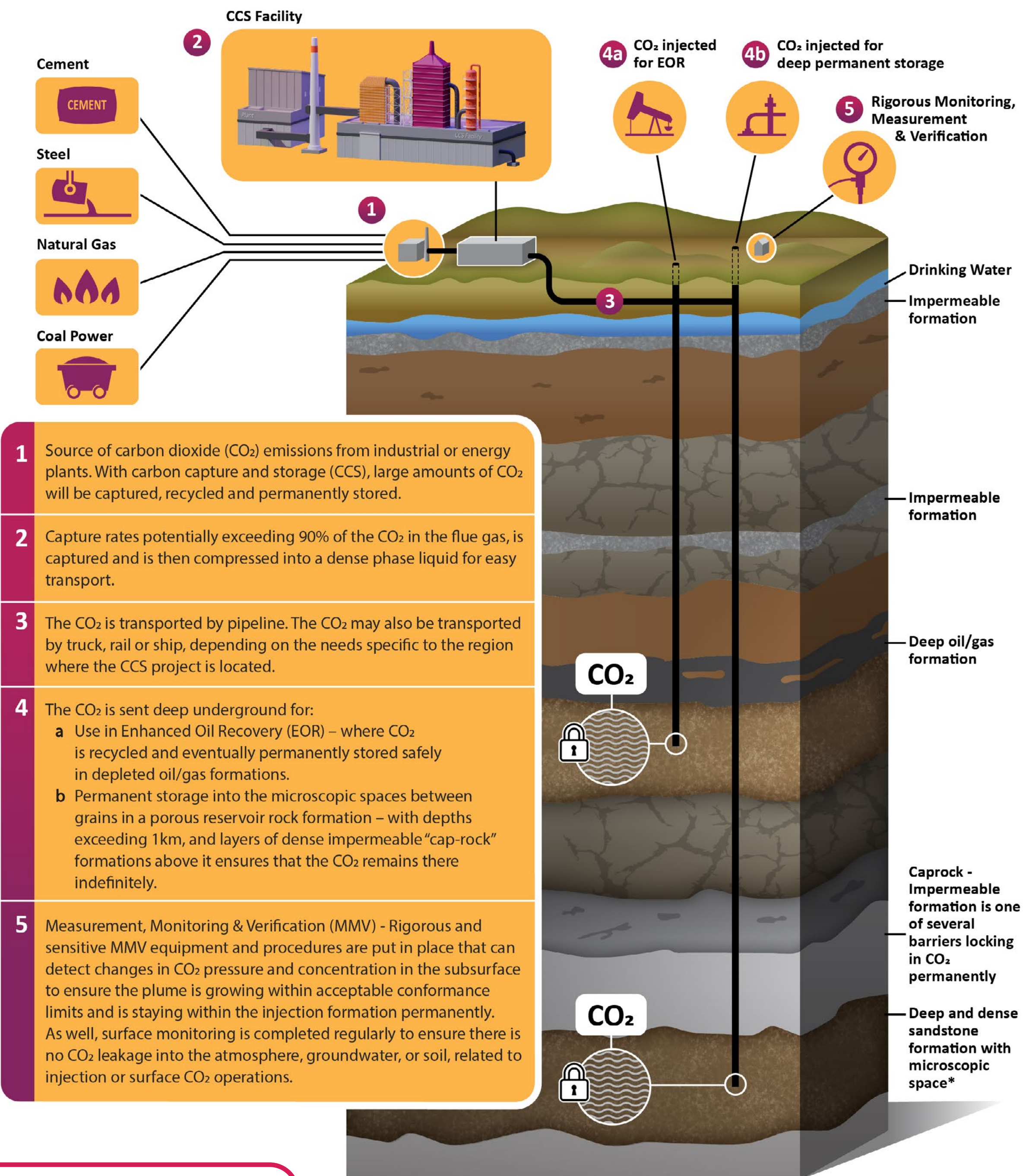
CCS is an emissions reduction process designed to prevent large amounts of CO_2 from being released into the atmosphere. It is considered a key and necessary clean energy technology to actively reduce industry driven GHGs. CCS involves three major steps: CO_2 capture, transportation, and utilization and/or storage – what is known as full-chain CCS and are the major components of a complete CCS project. CCS is also referred to as CCUS. The "U" stands for utilization. For the purposes of this paper, CCS also represents using CO_2 for enhanced oil recovery (EOR) because the CO_2 is permanently stored in the process.

Capturing CO_2 occurs when you separate CO_2 from other gases produced at facilities such as coal and natural gas power plants, oil and gas refineries, steel mills or cement plants through a process involving chemistry. Once captured and separated, the CO_2 is compressed to a liquid-like state to make it easier to transport and store (liquid takes up much less space than a gas).

The CO_2 is usually transported to a suitable geological storage site using pipelines, although some countries use ships and – for smaller amounts of CO_2 – trucks and trains can also be used. The captured CO_2 arrives at the geological storage site and is then injected deep underground where it is permanently stored. This is demonstrated at Alberta's Quest project, for example, where Shell has ensured that the CO_2 remains safely and permanently stored. A comprehensive and sophisticated monitoring system at the Quest storage site will maintain multiple levels of Measurement, Monitoring and Verification (MMV) over the life of the project to confirm that the CO_2 remains contained.[16]

It is important to note that with the quantities of CO_2 being captured from large-scale processes, other utilizations of CO_2 – while able to spur demand for CO_2 – will not be sufficient to permanently remove all CO_2 from a high-emitting process from entering the atmosphere. For large amounts of CO_2, permanent storage can also be realized through utilization via an EOR process. The Clean Air Task Force describes that the recovery of every barrel of oil produced through EOR typically involves injecting CO_2 in to the oil field to help release crude oil trapped in the pores of the source rock and in the process the CO_2 becomes trapped permanently in those pores.[17] Opportunities for sequestration and EOR in Canada are considered some of the best in the world.

FIGURE 4: Carbon Capture and Storage at A Glance
Accelerated CO_2 Emission Reduction



1 Source of carbon dioxide (CO_2) emissions from industrial or energy plants. With carbon capture and storage (CCS), large amounts of CO_2 will be captured, recycled and permanently stored.

2 Capture rates potentially exceeding 90% of the CO_2 in the flue gas, is captured and is then compressed into a dense phase liquid for easy transport.

3 The CO_2 is transported by pipeline. The CO_2 may also be transported by truck, rail or ship, depending on the needs specific to the region where the CCS project is located.

4 The CO_2 is sent deep underground for:

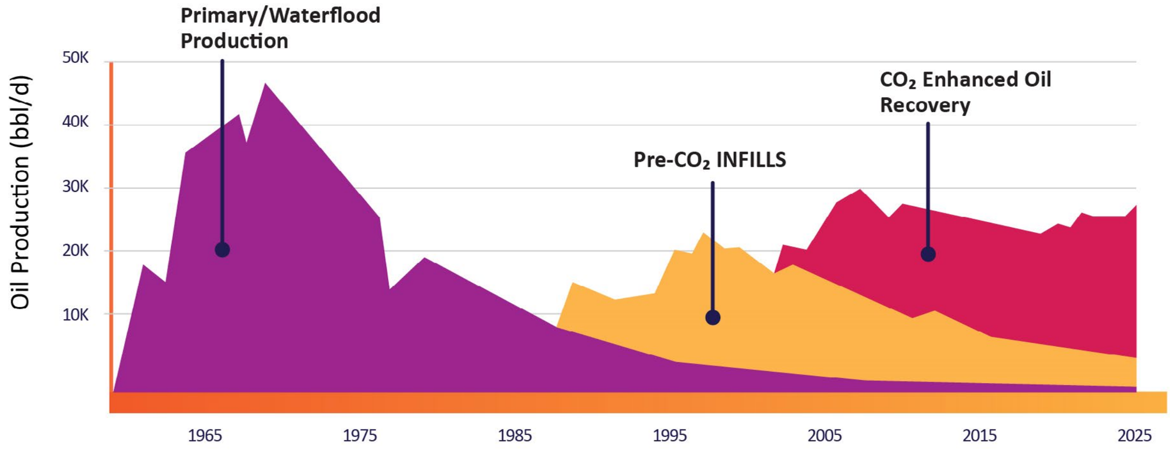
- **a** Use in Enhanced Oil Recovery (EOR) – where CO_2 is recycled and eventually permanently stored safely in depleted oil/gas formations.
- **b** Permanent storage into the microscopic spaces between grains in a porous reservoir rock formation – with depths exceeding 1km, and layers of dense impermeable "cap-rock" formations above it ensures that the CO_2 remains there indefinitely.

5 Measurement, Monitoring & Verification (MMV) - Rigorous and sensitive MMV equipment and procedures are put in place that can detect changes in CO_2 pressure and concentration in the subsurface to ensure the plume is growing within acceptable conformance limits and is staying within the injection formation permanently. As well, surface monitoring is completed regularly to ensure there is no CO_2 leakage into the atmosphere, groundwater, or soil, related to injection or surface CO_2 operations.

*The deep sandstone formation has microscopic spaces between its individual sand grains, or porosity, which allows it to hold high salinity water – that is 10 times more salty than the ocean. Due to the presence of this very salty brine, geologists refer to this type of formation as an aquifer.

Source: The International CCS Knowledge Centre

FIGURE 5: Weyburn Unit Oil Production

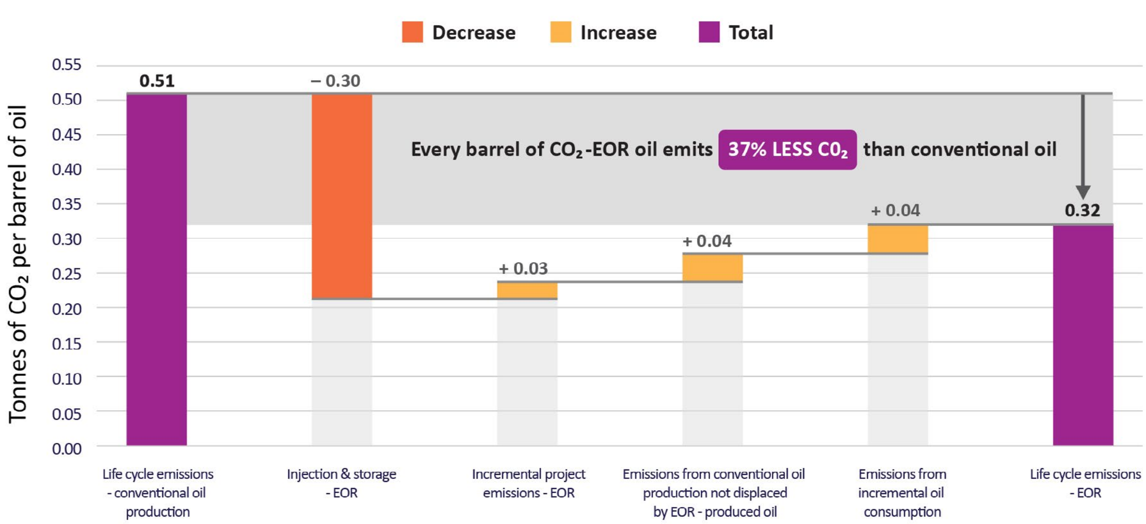


Source: Whitecap Resources

This graph shows that following both the tailing off of primary oil production in the 1990s, and that of additional 'infill' wells in the 2010s, there has been significant and sustained jump in oil production upon the extraction of oil using CO_2.

The Weyburn oil field has sequestered over 35Mt of CO_2 over two decades through EOR processes. It has generated 104 million barrels of incremental production to date, adding value to the oil field resource.[18] Allowing oil wells to use CO_2 to maximize production in a cleaner fashion than traditional extraction is a smart solution in the western provinces. Critically for Canada's oil production and its related emissions, life cycle analyses, which include impacts from potential increase in oil consumption, show that EOR results in a 37% reduction in CO_2 emissions per barrel of oil produced as compared to conventional oil production.[19]

FIGURE 6: Net CO_2 Emission Reductions from one Barrel of Oil with CO_2-EOR



Source: Clean Air Task Force

This graph shows that on a life cycle basis, every barrel of oil produced through CO_2-EOR results in a net emission reduction of 0.19 tonnes of CO_2. Compared to life cycle emissions of conventionally produced oil, EOR-produced oil emits 37% less (0.19 = 37% of 0.51 tonnes).

BENEFITS AND COSTS ASSOCIATED WITH CCS FROM THE PERSPECTIVE OF CLIMATE CHANGE MITIGATION

There is an increase in interest across energy and industrial sectors globally for the expansion of large-scale CCS activities, and that is no different in Canada. With post-COVID economic stimulus being directed towards clean development considerations and climate action, CCS is an active part of the conversation for net-zero ambitions.

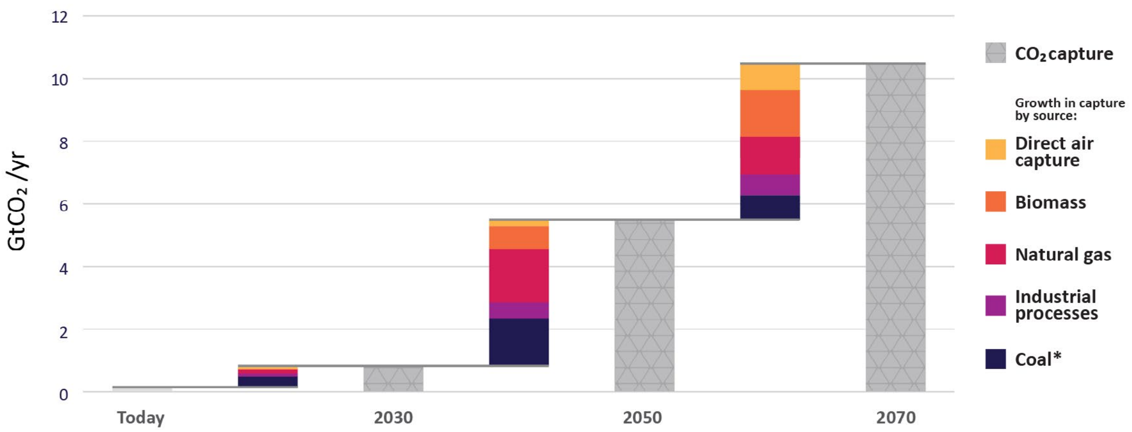
Coupled with many other clean solutions, the large impact CCS can have spans global mitigation outlooks. In fact, a sense of growing urgency for it is being felt.

The Intergovernmental Panel on Climate Change's (IPCC) *Fifth Assessment Synthesis Report Summary for Policy Makers* forecasts that the cost of climate mitigation would increase by 138% without the application of CCS technologies.[20] Technical experts around the globe agree that CCS can support an economically sustainable route to deep emissions cuts and is a required technology to achieve mid-century climate targets. CCS mitigation has been formally adopted as an environmentally sound technology, and its deployment can be accelerated if governments work together to financially sponsor demonstration projects. CCS technology should be developed and supported on a comparable basis with other no-carbon or low-carbon technologies and has a vital role to play as part of an economically sustainable route to deep emissions cuts.[21]

The IPCC's S*pecial Report on the impacts of Global Warming of 1.5°C above pre-industrial levels* provides mitigation pathways towards limiting warming to 1.5°*C* above pre-industrial levels.[22] In all pathways but that of austerity, large-scale CCS is relied upon as part of the necessary mix of required mitigation options. Each of the proposed pathways would require concerted efforts globally, whether it is through commitments in policies and regulations to drive down both energy demand/supply and consumption, or mitigating the impact of emissions growth through a combination of efforts, the efforts include low-carbon technologies and CCS.

The International Energy Agency's (IEA) *CCUS in Clean Energy Transitions* report which was recently released in September 2020, aligns its Sustainable Development Scenario with the Paris Agreement temperature goals. The report shows that in just the next ten years, global CCS deployment must increase by a factor of 20, focusing on retrofitting existing power plants and factories to capture over 800Mt by 2030.[23] This will require large increases in investment in the near term to ensure deployment later in the decade. Out to 2070, the IEA's same Sustainable Development Scenario, 85% more CO_2 must be captured to result in over 10 billion tonnes captured CO_2 requiring 90% of it being stored and only 8% being used in other applications.[24] In the IEA's Faster Innovation Case – getting to net-zero by 2050 – the world requires even more CCS in the energy mix (including more bioenergy CCS and direct air capture) with over 8 billion tonnes to be captured in that timeframe, and storing 200 times more than current levels.[25]

FIGURE 7: Growth in Global CO_2 Capture by Source and Period in the Sustainable Development Scenario

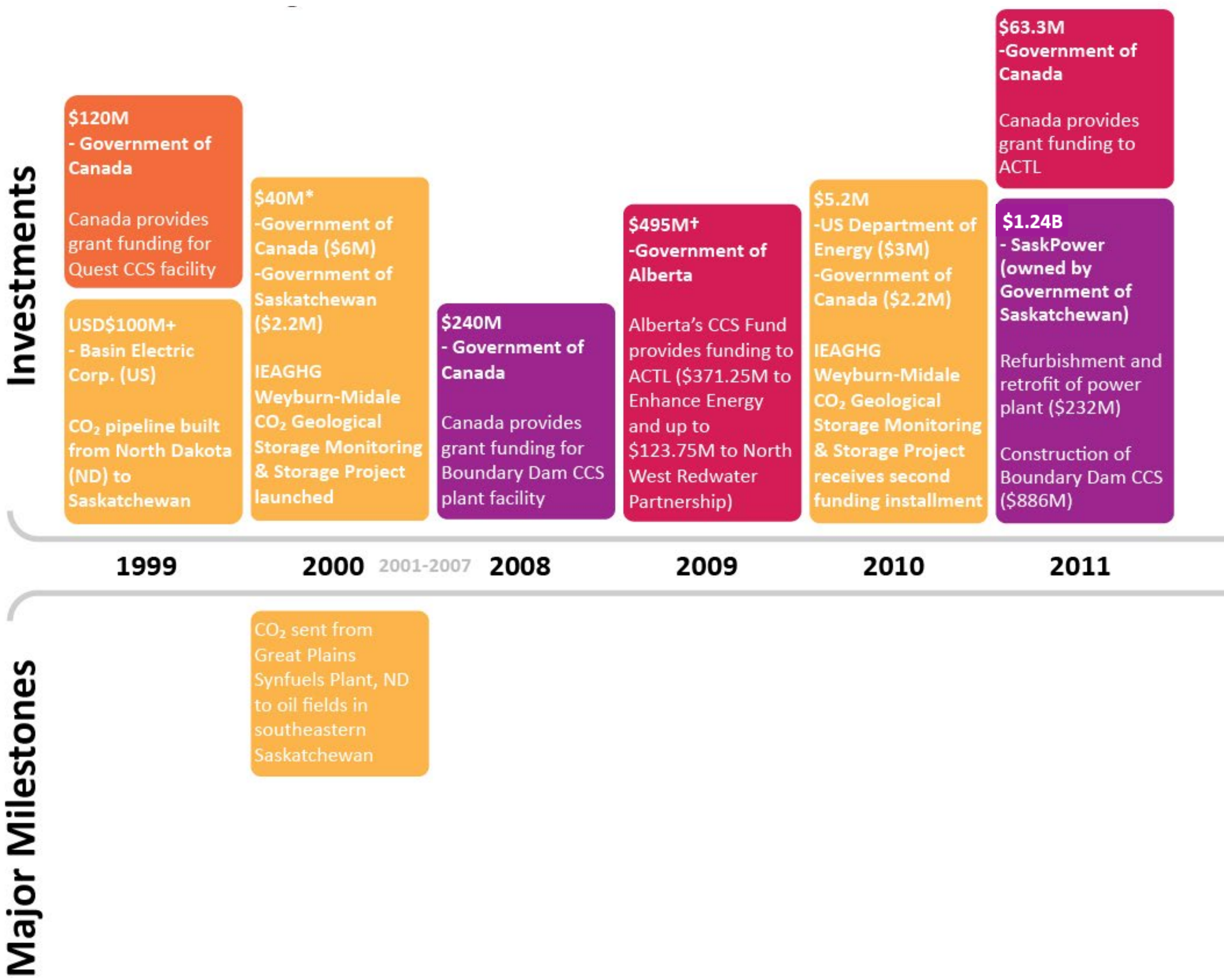


*Including from the use of oil, which represent 2% of total capture to 2070

Source: IEA 2020 Technology Perspectives 2020 Special Report on CCUS.

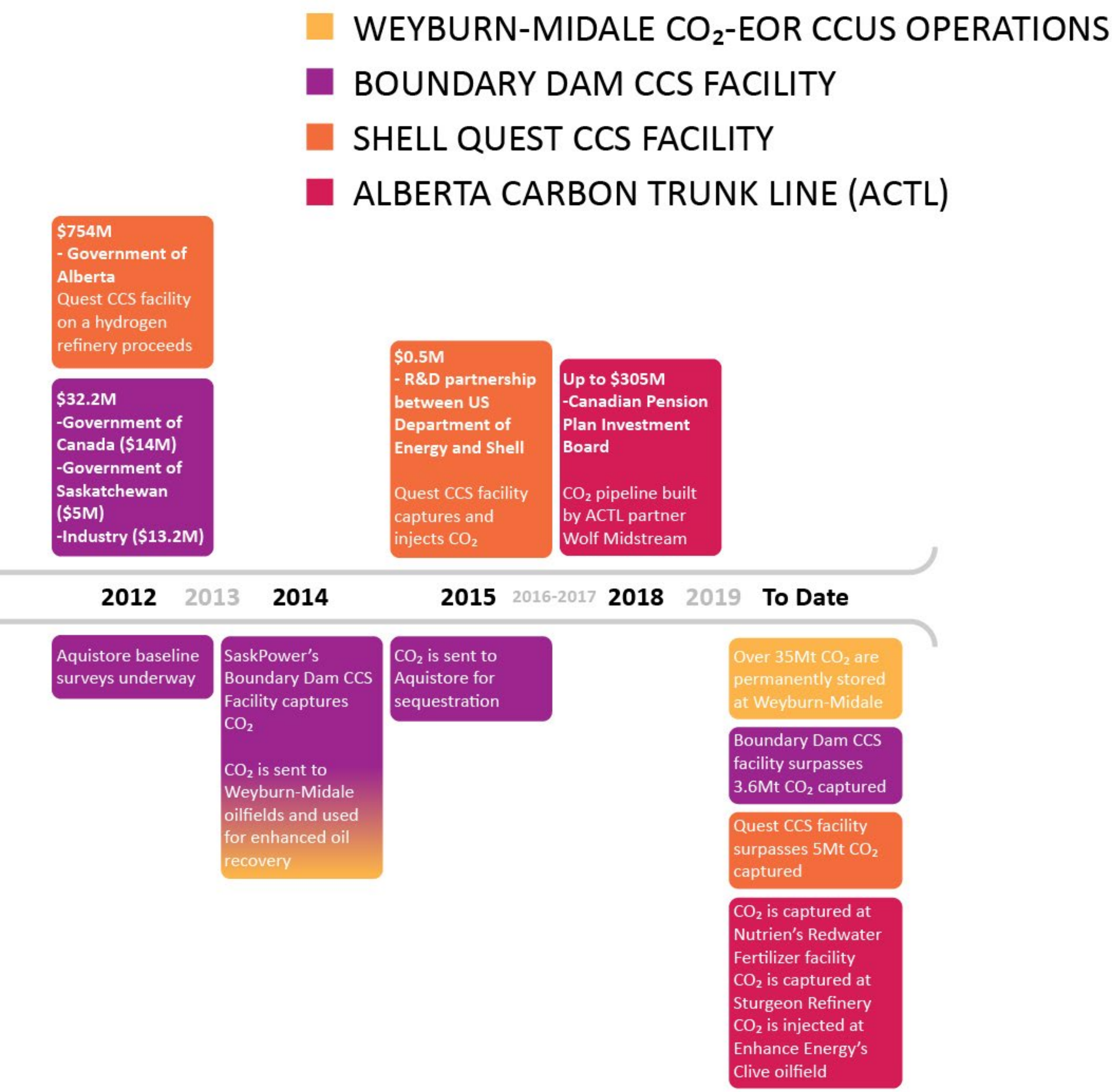
In the Sustainable Development Scenario, the role of CO_2 capture shifts from managing emissions from existing assets towards large-scale carbon removal

FIGURE 8: Investment Timeline for Large-Scale CCS Projects in Canada[26]



*Additional funds and research came from: Cenovus Energy, PTRC, US Department of Energy, Government of Saskatchewan Ministry of Industry and Resources, EnCana, BP, ChevronTexaco, Dakota Gasification Company, ENAA (Japan), Nexen, Sask-Power, TransAlta, Total (France).

†Funding was accessible based on milestone achievements complete, 40% during construction, 20% with the achievement of commercial operations which was achieved in Spring 2020 and the remaining 40% as CO_2 is injected. https://www.alberta.ca/assets/documents/carbon-capture-storage-projects-funding-agreement-actl.pdf



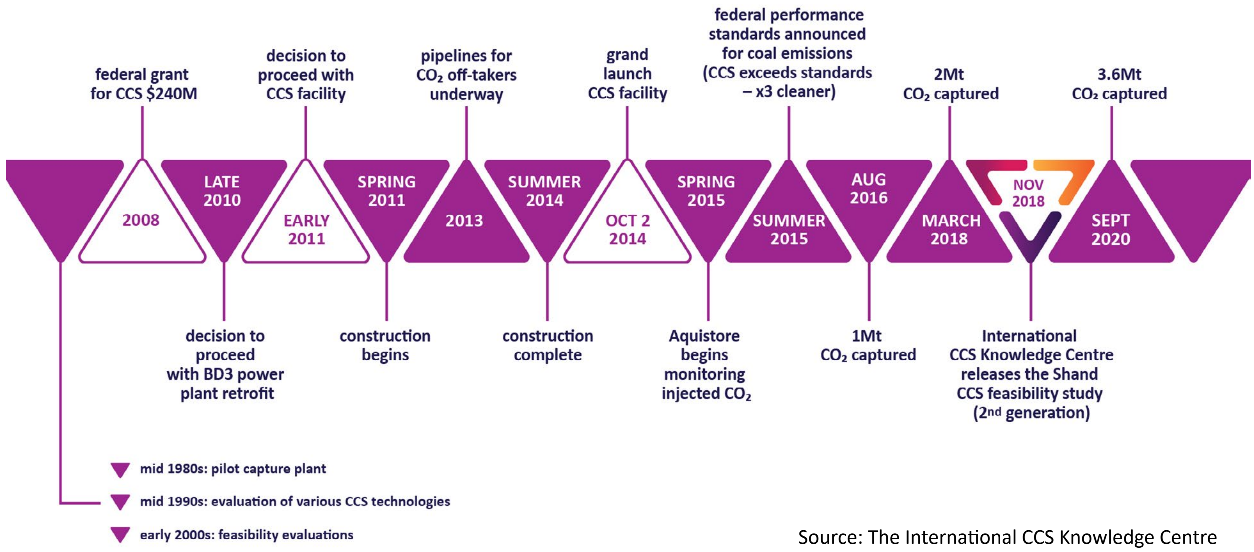
Source: The International CCS Knowledge Centre

CCS IN CANADA

Canada's record as a large-scale CCS leader dates back to the fall of 2000, when industrial-grade CO_2 traveled 330km by pipeline from the Great Plains Synfuels Plant in Beulah, North Dakota, to the Weyburn and Midale oil fields in Saskatchewan for EOR for the first time.[e] Together, these two reservoirs have approximately 40Mt of CO_2 in the reservoirs, with an additional 2.8Mt added annually, making Saskatchewan home to the largest amount of injected anthropogenic CO_2 in the world.[27] In addition to CO_2 crossing the international border from the US to Canada for the past two decades, CO_2 is also supplied to this oil field via a 66km pipeline from SaskPower's Boundary Dam CCS facility in Estevan.

From 2000-2013, an international research project studying injection and geological storage of CO_2 within the depleted Weyburn oil field enabled the development of a key global framework for implementation of CO_2 geological storage.[28] The project, managed by Saskatchewan's Petroleum Technology Research Centre (PTRC), was a major international cooperative exercise with a budget of $40 million (M) and involvement of 15 industry and government sponsors and 25 research and consulting organizations from several countries.[29]

FIGURE 9: Timeline for CCS at SaskPower's Boundary Dam Power Station



Source: The International CCS Knowledge Centre

[e] Large-scale CCS means capturing at least 800,000 tonnes of CO_2 annually for coal-fired power, and at least 400,000 tonnes of CO_2 annually for other emissions-intensive industrial facilities (including natural gas power). (As referenced from the Global CCS Institute's global CCS facilities database - CO_2RE https://co2re.co/FacilityData

Saskatchewan and its provincial utility, SaskPower, pioneered the way for large-scale CCS facilities around the world with their fully-integrated CCS project on Unit 3 of the Boundary Dam coal-fired power plant. In October 2014, the Boundary Dam CCS facility became the world's first utility-scale, fully-integrated post-combustion CCS facility on a coal-fired power plant – and is the only CCS facility currently operating on a power plant. Designed to capture 1Mt of CO_2 per year, a 90% capture rate was proposed and extended the life of the plant by 30 years. The total investment in Unit 3's retrofit and carbon capture plant was approximately $1.5B. The start-up of CCS at Boundary Dam was the culmination of a decade's worth of work by SaskPower, and the lessons learned from its operations are now shared by the International CCS Knowledge Centre.

SaskPower's Boundary Dam CCS facility has captured over 3.5Mt of CO_2 since it launched in 2014. CO_2 not sent for EOR is sent 2 kilometers (km) from Boundary Dam to the Aquistore site via pipeline where it is injected 3.4km deep in a naturally occurring layer of brine-filled sandstone for permanent storage.[30] When the offtake of the CO_2 by the oil field is not taking all the CO_2, Unit 3 of the Boundary Dam power plant remains an environmentally acceptable project because the captured CO_2 has a storage solution at Aquistore. It is the most comprehensive full-scale geological field site for CO_2 storage in the world, with leading-edge technology demonstrating the safe, reliable and economic advantages of injecting captured CO_2, whilst providing the know-how for other jurisdictions.

Aerial view of the BD3 Capture Facility at the SaskPower's Boundary Dam Power Station located near Estevan, Saskatchewan

Alberta has also been a leader for capturing and storing CO_2. The Quest CCS facility near Edmonton, Alberta, operates what is called a blue hydrogen facility at the Scotford Upgrader. Capturing and storing one third of the CO_2 emissions from a steam methane reformer process for hydrogen production, the facility uses hydrogen to turn oil sands bitumen into synthetic crude that can be refined into fuel and other products.[31] In the five years since its start up in 2015, the Quest CCS facility has captured and safely stored 5Mt of CO_2. This is the most any onshore CCS facility has stored globally – proving that "…large-scale CO_2 capture is a safe and effective measure to reduce CO_2 emissions from industrial sources."[32] As the initiator of the project, Shell is sharing the knowledge and lessons learned from building the Quest CCS facility to encourage more widespread implementation of CCS and believes that future projects would be significantly reduced due to re-using publicly available engineering and design, existing infrastructure, along with optimizing design, construction, and operations.[33,34]

The Alberta Carbon Trunk Line (ACTL) system, launched in Alberta in June 2020, is a perfect example of a CCS hub with the commendable addition of a "build it and they will come" approach to their 14.6Mt CO_2 capacity pipeline. Self-defined, the ACTL is "designed as the backbone infrastructure needed to support a lower carbon economy."[35] The ACTL currently captures CO_2 from two blue hydrogen anchor projects - Sturgeon Refinery owned by North West Redwater Partnership, and Nutrien's Redwater Fertilizer Facility – and is utilized by Enhance Energy for EOR in the Clive oil field. In the world of CCS, refineries and fertilizer facilities, depending on their operations, can be a low-hanging-fruit option for capture thanks to the relatively easy access to CO_2 – i.e. there are not as many contaminating pollutants in the emission. The win-win situation of environmental benefits with lower GHG emissions coming from EOR in Alberta's oil sands have made this project gain momentum. Combined, the anchor projects have the capacity to capture about 1.6Mt of CO_2 per year, but the ACTL pipeline itself, owned by transporter Wolf Midstream, has the capacity to see many more projects use this shared infrastructure.

Quest carbon capture and storage facility in Fort Saskatchewan Alta., shown in this 2015 file photo. (JASON FRANSON / THE CANADIAN PRESS FILE PHOTO)

ITERATIONS AND SHARED INFRASTRUCTURE BRING COSTS DOWN

With new technologies there is always room to optimize and improve development processes. Many of the common hurdles for large-scale CCS can be addressed when projects share knowledge and do not start from ground zero in their development. Next generation CCS technology will be significantly cheaper, more efficient, and integrate well with renewable energy and other sectors. For instance, Shell has stated that if the Quest CCS project were to be built today, it would cost about 30% less thanks to capital efficiency improvements.[36]

Drawing on the hands-on deployment experience at Boundary Dam CCS, the International CCS Knowledge Centre spearheaded a feasibility study to retrofit the Shand Power Station (located 12km away from the Boundary Dam CCS facility). At double the size, and double the capture capacity, the study revealed the potential to reduce the capital cost by 67% per tonne of CO_2 captured - representing a significant step forward in reducing the cost of CCS and removing a major hurdle to its deployment.[37] Many of the findings have application beyond coal to other sectors – including hard-to-abate industrial process emitters like cement and steel.

A hub of CCS activity like the ACTL is a good way to stimulate infrastructure dollars that can be actively utilized by several industries. It also may entice others who now have a nearby transportation route to the “storage” part of CCS to consider capturing carbon at their facilities.

In the same way that governments function to provide infrastructure dollars for shared road usage, a CO_2 highway with on and off ramps is a great example of where government dollars could have an exponential impact.

Financiers and the investment community are also taking note of the advantages to CCS hubs and the value to reducing costs via shared CO_2 infrastructure. Wolf Midstream’s ACTL pipeline is backed by the Canadian Pension Plan Investment Board (CPPIB) committing up to $305M to Wolf to fund the project.

CHALLENGES FACING CCS INVESTMENT IN CANADA

There was a noticeable gap in large-scale deployment of CCS projects in Canada between the Boundary Dam CCS and Quest projects, and that of the ACTL. During that time, Canada’s investment in CCS was primarily focused on research and small-scale projects, or on advancing new technologies. While it is always important to advance new research and development, it should not come at the sacrifice of deployment of proven technologies.

In Canada, consideration of other mechanisms or incentive pathways to help sectors leverage government support is required. Without the right framework in place, it is going to be challenging for sectors to make the kind of investment decision needed for large-scale CCS. If Canada is serious about achieving its net-zero target in three decades' time, it is time for a new priority around CCS and the policies needed to make it happen.[38] Western provinces in particular, have provided signals mentioning the role of large-scale CCS into the future, including major strategic documents like British Columbia's CleanBC Strategy, Alberta's Recovery Plan, and Saskatchewan's Growth Plan.[39,40,41]

Federally, the government of Canada is speaking more confidently about the need for CCS, conveying a focus on the areas where Canada can and should lead — like batteries, and its cutting-edge CCS technology.[42] The Honourable Seamus O'Regan, Minister of Natural Resources Canada has indicated that the federal government is looking at all potential solutions to reduce carbon emissions in Canada, including using CCS and employing hydrogen, geothermal and small modular nuclear reactors as alternative sources of energy.[43]

While one-time grants for first-of-a-kind projects are vital for start-up large-scale CCS projects (as was the case for Quest, Boundary Dam CCS, and the ACTL), government support remains crucial to support sectors to transition from government grants to industry uptake. Canadian industries are looking to reduce their emissions, and while companies recognize that the technology is viable and efficient, government mechanisms are needed to enable commercial CCS which could include a range of complimentary options such as: certainty in CO_2 value; a level playing field with alternative low-carbon technologies; and short-term demonstration support to drive down costs and make capital investment competitive.[44]

Beyond grants, the current federal government approach to financially supporting CCS deployment holds limited alternative options. Current potential programs that exist are Scientific Research and Experimental Development (SR&ED) credits and enhanced capital cost allowance (CCA) classes for environmental projects. These are not sufficient options for the level at which CCS is now able to be deployed.[ŧ]

Investing in advancing large-scale CCS projects improves two things: 1) a quicker acceleration of a proven, reliable and deployable technology to meet climate goals; and, 2) a retention in competitiveness (especially given US incentives with 45Q neighbouring the country). [§]

The carbon price can assist in the long run, but there is undoubtedly a gap between the start of a project and five years down the road that presents a challenge to get the math working for investors.

[ŧ]For more context, SR&ED credits only apply if there are improvements to be made or it is experimental. CCS fit the criteria for this, but the nature of having deployment of a proven technology makes this option a poor fit. And, importantly, there is indication that SR&ED is not as readily used. The enhanced CCA classes for environmental projects see a deferred $1 for $1 spent. An asset classification is required, and it is very stringent, making this option not ideal for CCS.

[§]By way of example, projects like Canada-created Carbon Engineering's Direct Air Capture are now seen pursuing a 45Q tax credit opportunity in Texas. See: Oxy Low Carbon Ventures, Rusheen Capital Management create development company 1PointFive to deploy Carbon Engineering's Direct Air Capture technology, https://carbonengineering.com/news-updates/new-development-company-1pointfive-formed/

POLICY OPTIONS AND RECOMMENDATIONS

WHY SHOULD THERE BE CCS INCENTIVES

Government policy and incentives can be effective tools at addressing challenges facing investment in and up take of CCS. Prior to looking at what other jurisdictions have delivered upon to incent CCS, and outlining potential policy options, it is important to answer the following question: under what circumstances should governments establish industry specific incentive programs which could also be appropriate for CCS deployment?

- First, the government incentive should address a specific barrier that exists that may be hindering private sector investment. Ensuring that the government incentive does not crowd out investment that otherwise would have occurred is an important factor in assessing the efficacy of an industry specific program.

- Second, does increased investment in the industry generate broader socioeconomic benefits? Investments that result in broader socioeconomic benefits such as improved environmental or health outcomes warrant government investment, which could take many forms including tax incentives or a grant program.

- The last factor that often gets overlooked in the context of an industry specific incentive program relates to timing. The intent of an industry specific incentive program is to support an industry in its early stage development and to transition the industry off of special incentives unless the socioeconomic benefits of doing so warrant a longer term approach.

In the case of CCS, it is clear that CCS will be important to addressing Canada's GHG emissions reduction targets as outlined in the previous section of the report, but there are significant barriers to investment in CCS. Furthermore, environmental benefits, while critical, are not the only reason to promote CCS. Indeed, Western Canada, particularly Alberta and Saskatchewan, has been substantially impacted by the decline in oil prices.[45] CCS has the potential to substantially lessen that impact, and support Western Canada's diversification.

CCS may very well be critical to not just facilitating Canada's transition to a low carbon economy, but in providing a sustainable future that is diverse and economically viable.

JURISDICTIONAL REVIEW

Jurisdictions around the world have used a range of government policy tools to incent the development of CCS projects including government grants and incentives in the form of tax credits. This section of the report describes at a high level notable CCS government grants and incentives.

UNITED STATES

The expanded 45Q tax credit is regarded by many as a game changer, and is the primary reason for the significant increase in the CCS deployment outlook for the US. From the perspective of incenting CCS investment, it is difficult to underestimate the effectiveness of the 45Q tax credit. It provides a performance-based tax credit for CCS projects based on the amount of carbon dioxide/monoxide captured and stored. Hence, it is a production tax credit.

Production tax credits have a history in proving to be effective environmental levers as seen in the US with past success in wind-energy projects and most recently with their 45Q incentive spurring engineering and design studies from almost 30 large-scale CCS projects.[46] The effectiveness of the 45Q tax credit is based on its design reflecting the underlying economics of CCS projects and interaction with geographic and industrial factors. The size of the tax credit – $50 per tonne for permanently storing CO_2 and $35 per tonne for capturing CO_2 to be used for EOR or other uses – is substantial and warrants the significant upfront investment in CCS projects.

CCS projects differ significantly from each other. Tying the tax credit to the capture of CO_2 and applying the credit to a wide variety of end uses reflects the variability in potential CCS projects. The entity that stores or utilizes the captured CO_2 is often different than the entity that generates the CO_2 being captured raising questions about ownership of the tax credit. Because the 45Q production tax credit is offered as a upfront cash grant, it can be transferred amongst the entities in the chain of CCS, in whole or in part. It is important to note that the success of CCS deployment in the US is also related to geographic factors and the extent of the oil and gas sector.

EUROPEAN UNION

The approach employed by the EU focuses more on direct government grants including preferential loans rather than production tax credits. Funding, including preferential loans, are provided by the European Investment Bank, Horizon 2020/ Horizon Europe, Connecting Europe Facility, EU ETS Innovation Fund and the Just Transition Mechanism.

The EU's approach to meeting its emissions reduction targets is heavily focused on establishing the overall policy architecture and framework, which includes the European Union Emissions Trading Scheme and a variety of policy directives targeted at member states, who are tasked to implement the policy directives. A detailed review of the EU's overall climate change and mitigation policy framework is well beyond the scope of this study, but CCS appears to be viewed as an important tool to help the EU meet its emissions reduction obligations.

Implementation of CCS in the EU has lagged relative to the US, but there a number of projects that are in advanced stages of development and the EU has committed substantial resources through its grant programs to incent the development of CCS projects. The EU is fortunate to have a robust and comprehensive climate change and mitigation policy framework. A production tax credit like the 45Q tax credit could be viewed as inconsistent with the EU's approach given that it already puts a price on carbon.

GRANT PROGRAMS

As in the EU, CCS projects globally have often been enabled through grant programs including preferential loans– such as the projects initiated in Canada to date. Grant programs can be particularly effective as a mechanism to fund CCS demonstration projects. This was the approach originally employed in Canada, which led to the development of some of the first large-scale, commercially operable CCS projects. While CCS is a proven technology, there is still considerable room for innovation in the application of CCS and to drive down development costs.

Direct government grants can also be structured to provide funding up front or in the early stage of development, which is where the majority of the project risk lies (similar to other capital intensive projects). In other words, direct government grants if targeted at the front end can provide funding when project risk levels are at their highest, hence, lowering the overall risk level of the project.

Grant programs can be structured in a way to provide funding to particular projects that have the most potential for success. Of course, this would require that government organizations have the capacity and ability to identify these projects. With the aid of a roadmap on CCS, identifying potential large-scale CCS projects can be relatively straightforward, given that such projects ultimately require (1) a source of emissions; (2) a place to store the captured emissions and/or an end use; and (3) infrastructure to transfer to captured CO_2.

STRENGTHS AND WEAKNESSES OF CURRENT IDENTIFIED INCENTIVE MECHANISMS

This high level jurisdictional review suggests that there are two broad options available: some form of tax credit or a direct government grant to support and incent the development of CCS projects. The table below outlines the costs and benefits of each approach in regards to CCS. There are many other enabling options from a policy standpoint – but these are considered the primary direct incentive approaches from government entities to inject funds into CCS projects. Because of the related weaknesses, and Canadian realities, recommended options for Canada actually stem beyond, or build upon, these case-dependent approaches.

	Strengths	Weaknesses
Production tax credits	• Demonstrated to have been very effective in incenting the development of CCS projects in the US • Market forces dictate projects that progress, which theoretically should lead to better projects • The incentive is directly tied to the permanent storage of CO_2 – the environmental benefit	• Not a direct form of funding – tax credit offsets taxes payable • Does not address early stage capital risk as credit is only received when the CCS project generates taxable income, which can be several years after development begins • Could be viewed as a double tax benefit in jurisdictions with carbon pricing
Government grants	• Can be structured to mitigate early stage capital cost risk by front end loading grant • Government organizations can effectively select CCS projects they view as being most appropriate to pursue	• Could crowd out private sector investment particularly in jurisdictions with an existing carbon pricing framework • Government organizations require capacity to select CCS projects • High costs to administer grant program (e.g., application process)

The following section of the report outlines recommendations regarding government incentives to promote CCS development in Canada.

RECOMMENDATIONS

While CCS is a proven technology, there are significant barriers to the deployment of CCS from a policy enabling standpoint. Large up-front capital costs and new considerations surrounding advanced deployment by companies can result in increased uncertainty for decision makers to take the initiative to deploy CCS. The benefits of deploying CCS, however, are substantial:

- Helping Canada achieve its emissions reductions;
- Spurring economic growth and development in a part of the Canada that is facing unemployment rates well above the national average (see Economic Impacts section below);
- Improving Canada's productivity, which will become an increasingly important objective once the current pandemic crisis subsides;
- Supporting the diversification of Western Canada's economy and its transition to a lower carbon future; and

Governments around the world are employing a range of policy tools and incentives including tax credits and direct government grants to address roadblocks and challenges to promote CCS projects. What should Canada do?

OPTION 1: CCS REFUNDABLE CAPITAL TAX CREDIT

The first option combines the benefits of a tax credit and grant program into one incentive. This would competitively position Canada for CCS investments, and help Canada bolster its leadership role in CCS. Capturing emissions at large emitting facilities is the goal, and the economic burden to do so is a reality - at least until there are more iterations of CCS driving cost reductions. Providing a refundable credit for capital investment addresses financial risks of deploying CCS at the source of emissions.

Because of the capital-intensive front-end-nature of CCS projects, a production tax credit which issues a credit at the back-end relating to the sequestering of CO_2 does not remedy the large investment a company makes in building a CCS facility. A commercial agreement could allow for the transfer of credits, but ultimately a back-end tax credit puts the CCS deployer at a disadvantage in having to negotiate benefits of its decisions to build. What cannot be overlooked is that without the CO_2 being captured, there would be nothing to sequester or use for CO_2 enhancing oil production.

Because of the need to enable the capture of CO_2 from large-point-sources, the option to create an incentive mechanism that can drive deployment at the capital-intensive end of the project is the recommended approach for Canada.

OPTION 1

How it could work:

- A refundable capital tax credit accessible in advance, is applied to CCS capital expenditures to provide carbon capture project developers an important source of funding at the early stage of a CCS project.
- The incentive is structured to offset future Capital Cost Allowance (CCA) deductions such that the program is nearly cost neutral over the long run. To apply to a wide range of CCS projects, a boundary for the CCS project and revenue assumptions should be developed in situations where CO_2 is stored. Revenue values can relate back to Canada's carbon pricing framework, which will be $50 per tonne in 2022.
- The amount of the refundable capital tax credit could mirror the 45Q tax credit. Higher credits are provided for CO_2 that is permanently stored. Medium credits are provided for CO_2 utilized via EOR because of the additional revenue generated, and the additional life cycle value of permanently stored carbon without oil production.
- Eligibility requirements could be established so that government organizations are able to exercise oversight over CCS projects as they are in development while maintaining market forces.
- This program must be time-bound to make it clear that the intent of the program is incent CCS project development in a near-term period, and to address concerns that this will become a permanent program - similar to 45Q.

Strengths

- Providing early stage capital, which reflects the capital intensive nature of CCS projects helps mitigate some of development risk.
- Aligning funding to the phase of the project with greater risk can help limit the possibility of public sector funding crowding out private sector investment.
- The program could be structured to be nearly cost neutral for the government because of the return of tax credits upfront.
- It is able to flexibly apply to wide range of CCS projects, and aligns with a national approach to climate change mitigation

Depending on its amount, the proposed CCS refundable capital tax credit could very well be the most competitive CCS incentive program in the world and would help Canada boost its leadership position in CCS.

The proposed CCS refundable capital tax requires some further evaluation of its efficacy and suitability, but is an ideal option because it combines aspects of familiar government grant programs and tax credits, like 45Q, to address challenges facing deployment of CCS. As such, this solution could act as a natural stepping stone that would not be far-reaching for federal government decision-makers to adopt as a form of kickstart support.

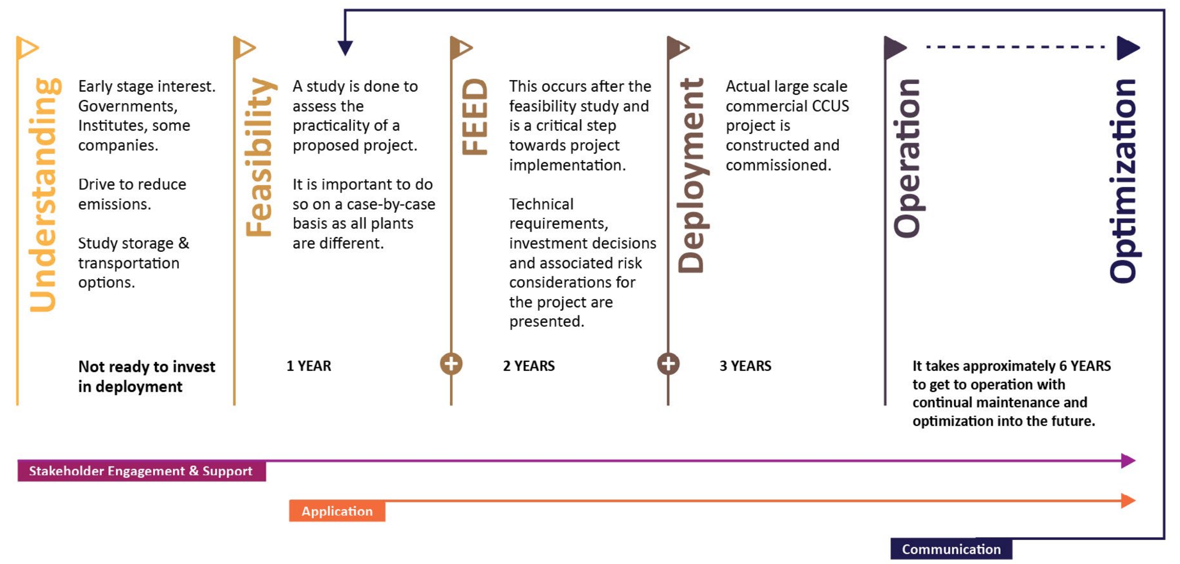
OPTION 2: CAPITAL TAX CREDIT FOR ENGINEERING AND DESIGN STUDIES

Another approach is to focus the refundable tax credit at the very early stages of a CCS project. Upfront evaluation, feasibility, planning, and front-end engineering and design (FEED) activities can require substantial investment with a high degree of uncertainty regarding whether it will pay off. In fact, such studies are not research or conceptual, they are part of the pathway to deploying a capital project which provides certainty for larger investment. Certainty takes time.

CCS facilities require several technical milestones in order to ensure appropriate deployment. Each of these steps are based on levels of risk and varying levels of acceptance and approval internal to individual organizations. Highlighted below are the technical milestones for a CCS project and the general factors to consider. Following these steps can help a project have a greater chance of success.

To date, various CCS projects that have been studied end up not proceeding – most often due to a lack of economics. As a result, FEED studies gain certainty for deployment and should act as a key component to ensuring responsible issuance of capital tax credits.

FIGURE 10: Aggressive Timeline to Deploy a CCS Project



Source: The International CCS Knowledge Centre

The objective of providing a refundable tax credit at the engineering and design stage is to reduce the risk and uncertainty faced by CCS project proponents. It could also potentially accelerate the evaluation and identification of viable CCS projects and support the development of a cluster of technical knowledge and expertise in CCS that could be particularly important to Canada exporting its capabilities in CCS to other countries.

This option would operate similarly to the CCS refundable capital tax credit, but focuses on expenditures during the study and design phase of a CCS project. The major challenge with providing a refundable tax credit at an early stage of the deployment pathway, is that some projects that are evaluated do not proceed. Accordingly, some measures could be instituted to focus the support at the FEED stage to limit this risk. Observing the grant provided for Boundary Dam CCS by the federal government of $240M during the FEED stage, and coupled with the now federally stated carbon price reaching to $50 per tonne of CO_2, this incentive option could be calculated to offset costs associated with the first five years of designed capture capacity. It would equate to the price on the projected emission reductions, and could be granted in the FEED stage to enable contracts to be secured for construction immediately post study.

OPTION 3 - RECREATE 45Q

The 45Q tax credit in the US has been remarkably effective at increasing investment in CCS projects. Another option for Canada is to simply replicate 45Q. Canada shares many of the other factors that contributed to the success of the 45Q tax credit (as discussed above):

- Abundant carbon storage capacity;
- A highly carbonized economy;
- Significant existing capabilities in CCS and related sectors and industries; and
- A number of high emitting industrial operations looking to reduce their GHG emissions.

While many CCS projects deployed in the US are related to EOR, several other business models are currently evaluating CCS projects as a result of the 45Q tax credit. The broad nature of the groups of proponents looking to develop CCS projects suggests that benefits of the 45Q tax credit are distributed across numerous sectors.

Replicating the 45Q tax credit in Canada would involve several of the same considerations listed in the first recommendation of this paper:

- Establishing a price for the permanent storage of carbon and another for the utilization of captured carbon and eligibility criteria;
- Time bounding the tax credit program (the 45Q tax credit requires construction to begin within seven years of the enactment of the tax credit and the organization would have twelve years to collect the tax credit); and
- Developing testing and verification processes and procedures.

Beyond competitiveness considerations, the benefits of Canada replicating a program like the 45Q tax credit include its effectiveness in a jurisdiction that shares many similarities to Canada from a geographic and industrial perspective and its simplicity.

OPTION 3

The main concern with this approach is the weight of benefits offered at the back-end of the CCS chain. Walking through the full chain the issue becomes highlighted under the current realities.

For example:

- Company A is a large emitter in Alberta
- Company A builds a capture facility which increases its emissions intensity through the additional energy generated via the capture process
- Company A captures the CO_2 and sells it to an oil Company B
- The Company B generates an EOR Offset (or Emission Performance Credit if it is a registered entity under Alberta's Technology Innovation and Emissions Reduction program).[47]

In this example, Company A, if going above its regulated benchmark, has to pay compliance payments on top of taking the large capital risk of deploying CCS. Company B benefits from the sale of more barrels of oil produced with lower emissions for extraction, and with a 45Q-type incentive, would also get the tax credit for the sequestration.[**] Monitoring and verification of permanent storage are very important, as are considerations of back end liability, but stacking the benefits to the back-end of the CCS chain will not incent the necessary capital required to capture the CO_2 in the first place.

Additionally, at a federal level, Canada already has a carbon pricing framework in place and the provision of an additional tax credit tied to the capture of CO_2, so utilizing CCS technology could result in a potential double tax crediting scenario. Suppose a fertilizer manufacturing plant, which is already paying a carbon tax, implements CCS technology to lower its GHG emissions to zero. In this case, it would pay no carbon tax and receive a tax credit, effectively doubling the value of the reduction in carbon emissions. Perhaps this is a way to further incent the development of CCS projects in Canada, but it could create a number of issues related to equity as opposed to other approaches to reducing carbon emissions.

[**]This does not even consider the additional benefits that could come for the oil producer with forthcoming Clean Fuel Standards.

ECONOMIC IMPACT

INTRODUCTION

Construction of the Boundary Dam CCS facility required unprecedented coordination of resources and expertise utilizing more than 60 contracted companies and employing about 1,700 contractors and SaskPower employees who worked around the clock for a total of nearly five million man-hours with no lost time injuries. As construction of the Boundary Dam CCS facility showed, CCS projects are capital intensive, and while the cost to develop these projects will decrease through iterations and shared infrastructure opportunities, they still require significant upfront outlays.

Maintenance shut-downs and the progress to completing of a construction project for CCS also spurs job creation. For instance, during a scheduled November 2019 maintenance shutdown when the project was over two thirds complete, the North West Redwater Partnership's Sturgeon Refinery, part of the ACTL, saw over 390,000 hours of employment in a variety of job functions such as pipefitters, boilermakers, and scaffolders.[48] Highly-skilled trades are an essential backbone to large-scale CCS projects.

The Carbon Capture Coalition has calculated that if CCS is commercially deployed globally to address emissions as part of a broad suite of zero- and low-carbon technologies, the carbon capture industry would "…employ between 70,000 and 100,000 construction workers and 30,000 to 40,000 facility operators in 2050", with additional employees to build and maintain a CO_2 transport and storage network.[49] In fact, CCS on a natural gas combine cycle plant retrofit could see project jobs calculated upwards of 2,000 during the project development; steel mill CCS retrofits potentially seeing over 3,000; and on the lower end, ethanol plants with around 50 potential project related jobs (due to the easier access to capturing CO_2).[50]

The impact of a CCS tax incentive in the US shows increased deployment leading to more jobs, power and emission reductions. Analyses stemming from Rhodium Group, Clean Air Task Force, and summarized by ClearPath, show that with new construction and operations jobs at existing manufacturing facilities and new power plant, 45Q could spur up to 157,000 job-years by 2035; it would see up to 52GW of extra clean power in the US by 2050 as it is able to be deployed in over 30 states (the majority of capture capacity would be in Texas); and, shows that up to 4Gt of CO_2 would be reduced by 2050.[51,52,53]

As is evident and mentioned above, while costly,

> the development of just one large-scale CCS project makes a mark – decreasing GHG emissions by a large margin and generating substantial economic impacts.

Incentives can spur many projects with far ranging economic and environmental benefits. With ample sequestration opportunities, CCS projects in western Canada in particular, are ideal. This is compounded by the current realities of related idle resources stemming from oil price decline and as a result of the pandemic.

This section of the report looks at the high level economic impact of developing CCS projects in Canada. The analysis focuses solely on economic impacts arising from the upfront construction costs associated with developing CCS projects. Ongoing economic impacts from operations or productivity benefits that could result from the deployment of CCS technology (e.g., EOR) have not been estimated. Other broader socioeconomic impacts including environmental and other benefits such as a less destabilizing transition to a lower carbon economy were not quantified. While the analysis focuses on economic impacts that could potentially arise from the construction and development of CCS projects, these broader socioeconomic impacts hold significant value.

A Primer on Economic Impact Analysis can be found in Appendix A.

METHODOLOGY TO ESTIMATE ECONOMIC IMPACT OF INCREASED CCS INVESTMENT

The methodology employed to estimate the high level, order of magnitude economic impacts from the development of CCS projects in Canada is listed below:

- Using understandings from past CCS project deployment, a high level development expenditure profile was developed characterizing the costs associated with the development and construction of the project.
- As seen in the Shand study, certain costs from first-of-a-kind projects are not included because of recognized opportunities for efficiencies and new understanding, such as engineering and design. As noted above, CCS construction and development costs decrease with every iteration of CCS technology.
- To adhere to the principal of conservatism, other cost items like construction financing costs, contingency and some owner's costs were removed from the economic impact analysis as it is unclear whether they can be considered fully incremental. This analysis was reviewed with engineers at the International CCS Knowledge Centre who have hands-on expertise from project development of CCS.
- Assumptions were then made regarding the likely number of CCS projects that could be deployed as a result of increased government financial support, and related policy signals, for CCS projects. Given the potential pipeline of projects and for the purposes of this high level economic impact analysis, it was estimated that three additional CCS projects could be developed in Canada under an improved policy environment.
- Remaining costs were then mapped to industries that would likely receive these expenditures as per the industry aggregations within the Statistics Canada Input-Output Tables. A model was then developed to estimate economic impacts for standard measures of economic activity (e.g., GDP, jobs) while taking into consideration multiplier effects.

The following section outlines economic impact results.

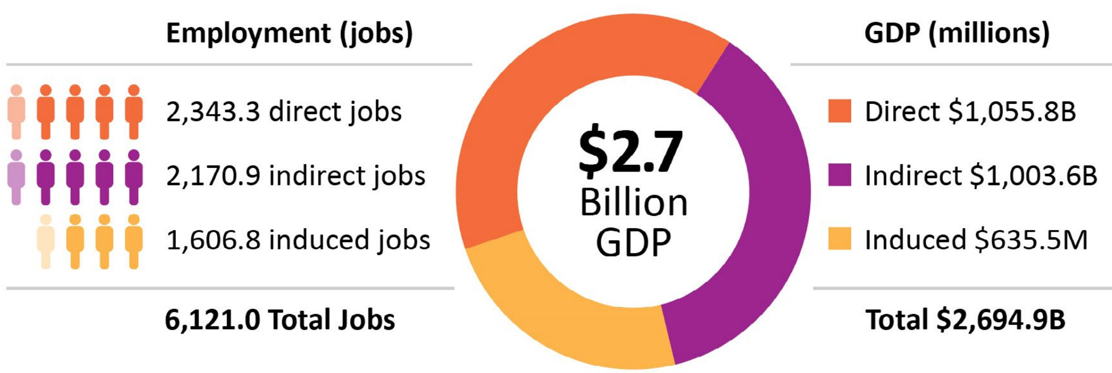
ECONOMIC IMPACT OF LARGE-SCALE CCS INVESTMENT IN CANADA

The table below shows the average annual economic impacts that could arise from the construction and development of three CCS projects. It was assumed that it would take four years to develop a large-scale CCS project.

Economic impact of increased CCS investment in Canada
(three CCS projects, over four years)

	Output (millions)	GDP (millions)	Labour income (millions)	Employment (Jobs)
Direct	$2,648.1	$1,055.8	$708.0	2,343.3
Indirect	$1,956.2	$1,003.6	$601.9	2,170.9
Induced	$1,106.9	$635.5	$302.3	1,606.8
Total	**$5,711.2**	**$2,694.9**	**$1,612.1**	**6,121.0**

FIGURE 11: Impact to GDP & Employment of Increased Large-Scale CCS Investment in Canada (for 3 projects over 4 years)



This graph shows the economic impacts, specific to GDP and employment based on the construction and development of three large-scale CCS projects over three years. This would translate to an annual GCP of $673.3M for each of the four years.

The construction and development of only three CCS projects would directly generate nearly $1.1B in GDP; roughly $2.7B when taking into consideration indirect and induced effects over the construction horizon; and support over 6,100 jobs across Canada.

Most of these jobs and economic impacts more broadly would occur in regions where large-scale CCS projects have prospects or factors encouraging the likelihood of development: such as Alberta, Saskatchewan or British Columbia. Induced impacts, which represent economic impacts from spending of employment income, would be highly localized.

Estimates in the table above represent aggregate economic impacts that would occur over the construction horizon of the CCS projects. If it takes four years to develop these projects then the annual total GDP impact would be $673.7M. Jobs are estimated on a position basis as opposed to person-year basis. Hence, the number of jobs represent the total number that would occur over the construction and development of the CCS projects.

The development several large-scale CCS projects could flow from incentives, but with just three large-scale CCS projects stemming from a kickstart support, Canada's GHG emissions would reduce substantially with the lowest amount of CO_2 capture capacity being 1.5Mt and, at the top end, over 5Mt annually depending on the size of the CCS facilities.

KEY FINDINGS

- At a high level, the construction and development of three CCS projects would generate $2.7B in GDP across Canada and support over 6,100 jobs over the construction horizon.
- A high degree of these economic impacts are viewed as being incremental given current levels of unemployment in regions where these projects would be developed.
- Productivity benefits, ongoing economic impacts from operations, environmental benefits, and other socioeconomic benefits would be incremental to economic impacts estimated above.
- With just three large-scale CCS projects, Canada's GHG emissions could be reduced by 1.5Mt to over 5Mt annually depending on the size of the CCS facilities.

APPENDIX A

PRIMER ON ECONOMIC IMPACT ANALYSIS

The basic premise behind economic impact analysis is that spending in one industry generates additional spending (i.e. multiplier effects) in other industries and potentially even in the same industry. For example, the purchase of furniture generates spending in supplying industries: manufacturing, transportation, and professional services; which, in turn source this supply from other industries such as wood, steel, and glass production and several other industries. Statistics Canada produces input-output tables that quantify the inter- and intra-dependencies of industries that comprise the economy. Economic impacts are generally estimated for the following standard measures of economic activity:

- **Gross output.** This is the gross value of all business revenue. This is the broadest measure of economic activity and indicates the total sales and transactions triggered by operations.

- **Value-added or GDP.** GDP is the value added to the economy or the unduplicated total value of goods and services. It includes only final goods to avoid double counting of products sold during an accounting period. For instance, if a producer of computer accessories sells an accessory for $100 and purchased $40 worth of goods from its suppliers to produce the accessory, then the value-added or GDP impact would be $60 for each accessory sold. Consequently, GDP is a narrower, more focused and more accurate measure of economic activity since it avoids double counting.

- **Labour income.** This is the total value of wages and salaries associated with employment inputs. Labour income is an even narrower measure of economic activity and comprises an important part of GDP.

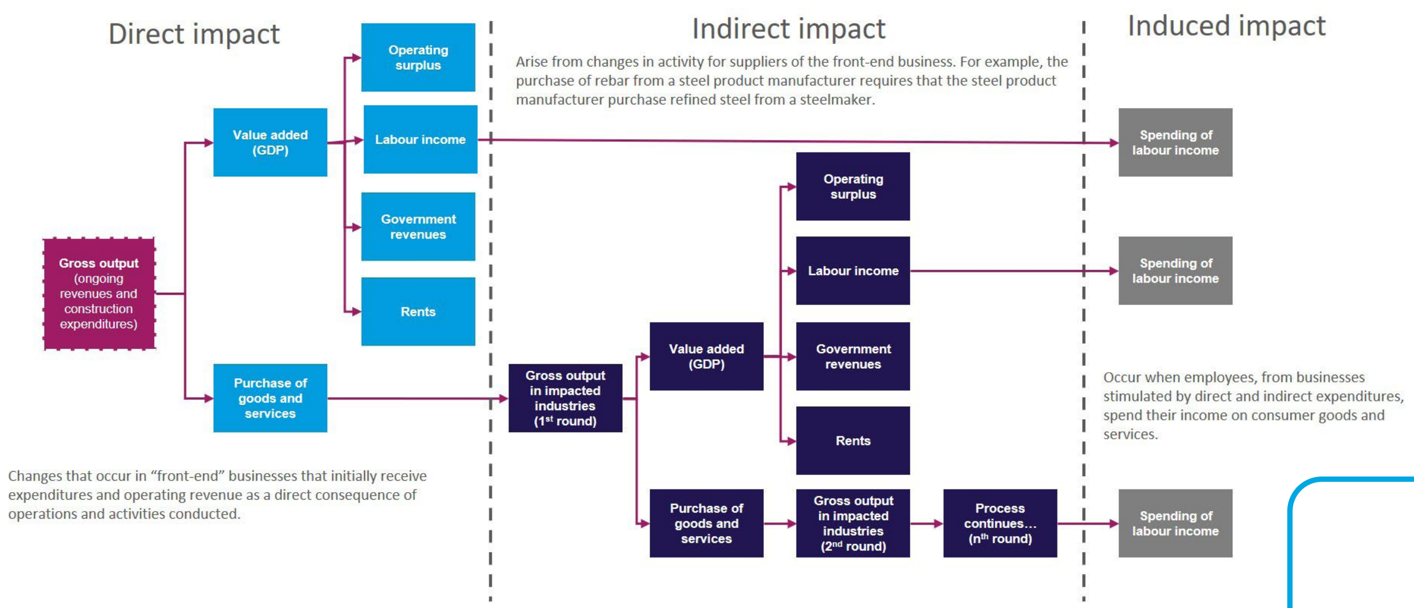
- **Employment.** It is the number of jobs created or supported. It is expressed as the number of equivalent full-time jobs indicated in person-years.

- **Government tax revenues.** The amount of tax revenues generated. In this study, total taxes are calculated leveraging relationships between GDP and tax revenues.

Economic impacts are typically estimated at three different levels: direct, indirect and induced levels. These concepts are introduced briefly and then represented diagrammatically in the figure below:

- **Direct impacts.** Changes that occur in "front-end" businesses that initially receive expenditures and operating revenue as a direct consequence of operations and activities conducted.
- **Indirect impacts.** Impacts that arise from changes in activity for suppliers of the front-end business. For example, the purchase of rebar from a steel product manufacturer requires that the steel product manufacturer purchase refined steel from a steelmaker.
- **Induced impacts.** It occurs when employees, from businesses stimulated by direct and indirect expenditures, spend their income on consumer goods and services.
- **Total economic impact.** The sum total of the direct, indirect and induced economic impact.

FIGURE 12: Level of Economic Impact: Direct, Indirect and Induced Levels



APPENDIX B

BIOGRAPHIES OF LEAD AUTHORS

BETH (HARDY) VALIAHO
Vice President
Strategy & Stakeholder Relations
International CCS Knowledge Centre

As VP of Strategy and Stakeholder Relations, Beth leads the Knowledge Centre's considerations of policies and regulations that foster CCS; and focuses on helping to link CCS knowledge with other countries to reduce locked-in investments and collaboratively support the goals of the Paris Agreement. Her understanding of complex climate change matters, capacity building requirements, and international financing concerns act as a solid basis for assisting both national and international implementation strategies for technologies that support environmental targets.

Prior to joining the Knowledge Centre, Beth worked briefly as legal counsel for the provincial Crown utility. She pairs this industrial perspective with regulatory knowledge as Acting Director of Climate Change with the Government of Saskatchewan. These positions are reflective of Beth's time with the National Round Table on the Environment and the Economy where she focused on analysing provincial/territorial climate action plans and making recommendations for low cost and sustainable pathways. Beth's legal education, teaching and practice have explored balancing energy, the environment and social implications.

ALEX KOTSOPOULOS
Partner
RSM Canada

Alex Kotsopoulos is a partner in RSM's consulting group and leads the economics and social impact practice. He advises companies, governments, regulators and national and international institutions on broad economic topics on a macro and/or industry basis, helping them assess, evaluate and prioritize investments, initiatives and strategies.

Alex specializes in cost-benefit assessments and project evaluation, economic impact assessments, market and industry analysis, demand and revenue forecasting and strategic planning. He has worked across a wide range of industries and across a variety of jurisdictions in Canada, the United States, Mexico and South America and is often called on to help enhance a client's request for government funding through independent and objective economics analysis. In this regard, he has helped his clients obtain hundreds of millions of dollars in government grants and incentives.

In addition to degrees in Economics and Finance, Alex has completed the globally recognized and rigorous CFA® Program.

MICHAEL MORRISON
Partner, Tax
RSM Canada

An experienced taxation and accounting professional, Michael specializes in advising mid- to large-sized public and private businesses on various complex tax and business matters, including income tax compliance and planning, tax accounting and reporting, tax transaction support and Canadian tax implications of cross-border structures. In his previous role, he was an integral part of a Big Four accounting firms' global compliance and reporting team, working with the firm's largest and most complex public clients and medium-to-large private clients.

Michael brings more than 15 years of experience, a background in leading high-performing teams and a proven track record of delivering top-notch client service and results and is well-respected in Calgary's tax community.

Active in the Calgary tax community, Michael maintains memberships with the Chartered Professional Accountants of Alberta, the Canadian Petroleum Tax Society, the Canadian Tax Foundation, and is a member of the Steering Committee for the Canadian Tax Foundation's Young Tax Practitioners Group.

Michael is a CPA, CA, having earned his designation in 2009, and is a graduate of Saint Mary's University in Halifax, Nova Scotia.

APPENDIX C

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