COMPARING CANADIAN AND AMERICAN FINANCIAL INCENTIVES FOR CCUS IN THE OIL SECTOR

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EXECUTIVE SUMMARY

New incentives under the U.S. Inflation Reduction Act for carbon capture, utilization, and storage (CCUS) technology are generating concerns about competitiveness for investment in the technology in Canada's oil sector. Specifically, there is a growing narrative that Canadian policies and incentives for CCUS technologies pale in comparison to those offered in the United States. However, comparisons often leave out important Canadian policies and operational differences that mean CCUS matters less to decarbonizing U.S. upstream oil production. As such, direct one-to-one policy comparisons are less useful than assessing the effectiveness of the entire suite of financial supports that incentivize investment in CCUS in the specific context of Canada's upstream oil sector.

Comparisons tend to focus on tax measures, such as Canada's proposed CCUS Investment Tax Credit, and the recently expanded 45Q tax credit in the Inflation Reduction Act which will provide significantly more support to CCUS: about C$115/tonne. But in Alberta, where the vast majority of announced CCUS projects in Canada are located, credits from the Technology Innovation and Emissions Reduction (TIER) regulation system, combined with the announced federal Investment Tax Credit and Clean Fuel Regulations credits, **will exceed the 45Q credit in 2030 with a value of at least C$135/tonne**.

Important contextual differences also mean that CCUS projects in Canadian and U.S. upstream oil sectors **will rarely compete for funding**. Due to differences in resource profiles and emissions sources in Canadian and American oil production, methane abatement is a larger and more cost competitive emissions reduction opportunity than CCUS in the United States. Also, individual U.S. oil production emissions sources are many and dispersed, so do not lend themselves well to CCUS technology.

Ultimately, a one-to-one comparison of CCUS tax credits alone **does not capture the very significant incentives for these projects through Canada's carbon pricing policies**. And, given that CCUS will not be a priority for upstream producers in the United States the way it is in Canada, the focus should be on whether the right suite of high-quality policy supports exists for CCUS in specific contexts, rather than on matching policies with the United States. Ultimately, a mix of incentives and policy can ensure that Canada's oil sands, with their high emissions intensity, begin to reduce those emissions.

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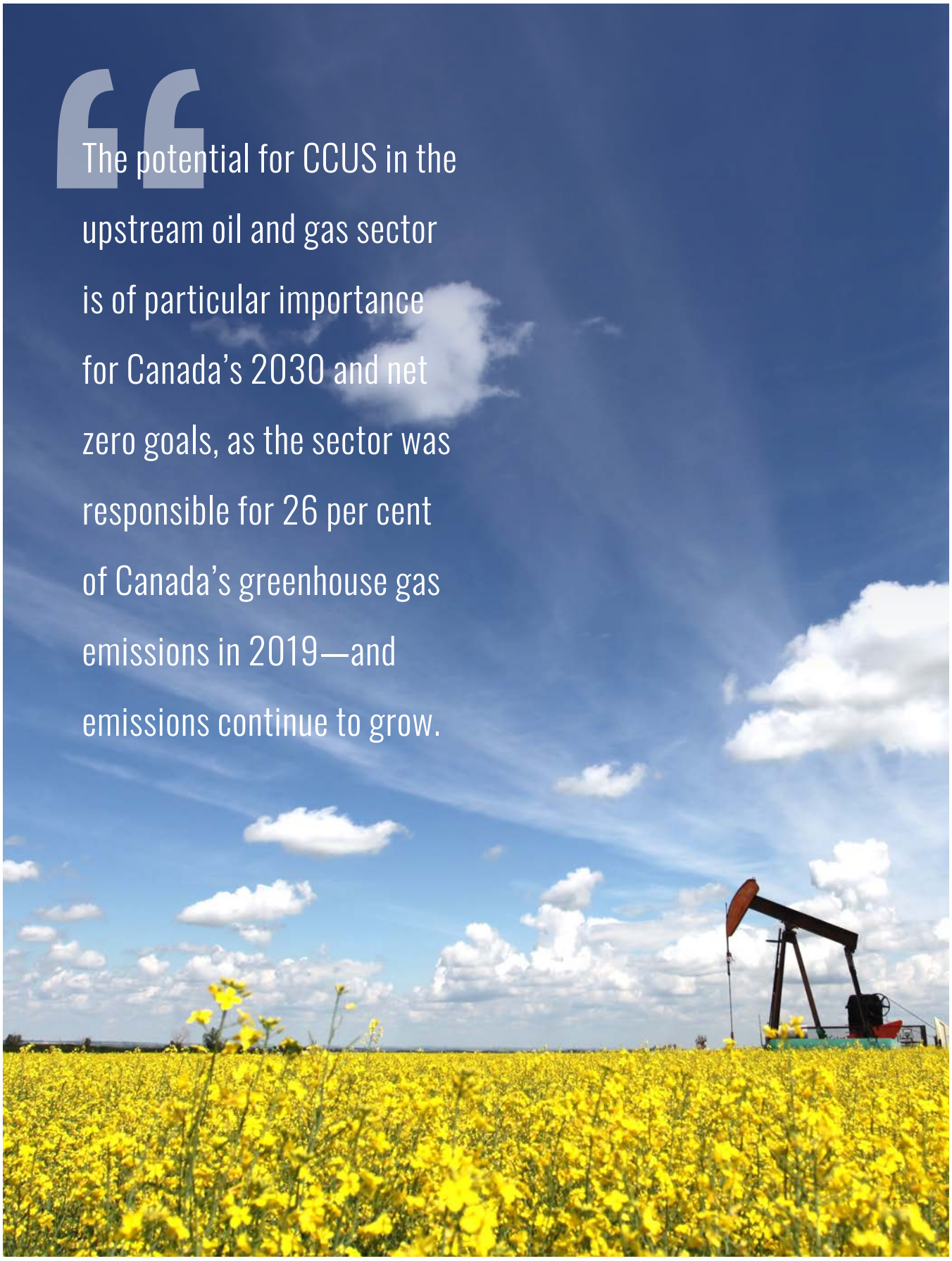

The potential for CCUS in the upstream oil and gas sector is of particular importance for Canada's 2030 and net zero goals, as the sector was responsible for 26 per cent of Canada's greenhouse gas emissions in 2019—and emissions continue to grow.

INTRODUCTION

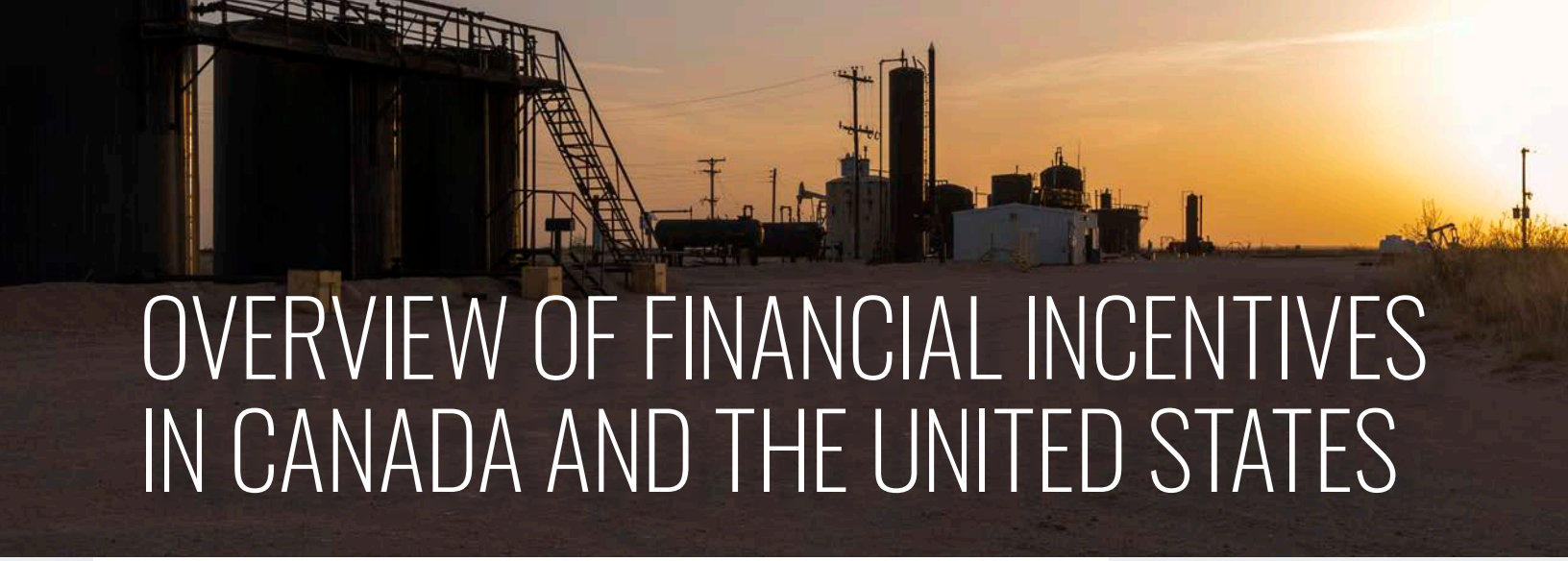
Carbon capture, utilization, and storage (CCUS) technology has been prioritized as a key decarbonization technology for Canadian industry. This focus has been spearheaded by the landmark Quest CCS project, and, more recently, by proposals for Shell's Atlas Phase 1 and the Pathways Alliance's flagship project which potentially includes a new carbon dioxide (CO_2) pipeline and 11 existing oil sands facilities that will install carbon capture.

The potential for CCUS in the upstream oil and gas sector is of particular importance for Canada's 2030 and net zero goals, as the sector was responsible for 26 per cent of Canada's greenhouse gas emissions in 2019—and emissions continue to grow. In particular, the Pathways Alliance, a group of Canadian oil sands producers, have staked their claim on CCUS as a key solution for emissions reduction. Canada's oil sands are unique globally in terms of the production methods used and emissions produced. While there is potential for CCUS in other parts of the oil and gas sector—natural gas processing has some of the lowest-cost capture available (Abramson and McFarlane 2020; Kearns et al. 2021), and enhanced oil recovery has been a focus of discussion in the United States—this report focuses on the oil sands due to the unique emissions reductions challenges associated with the sector.

In anticipation of the federal government's announced cap on oil and gas emissions, Canadian policy makers have been focused on putting together the right combination of policy supports to reverse the sector's long-term emissions growth and drive deep emissions reductions. The emissions cap will obligate Canada's oil and gas sector to reduce emissions, with CCUS as one of many technological solutions at their disposal.

The landmark Inflation Reduction Act introduced by the U.S. federal government in August 2022 sparked calls for Canada to make its industrial and climate policies more competitive or risk losing investments to the United States (Potkins 2022; von Scheel 2022). The Inflation Reduction Act is a sweeping piece of legislation and spending that aims to unlock private-sector investment across clean energy and clean technology, of which CCUS provisions are a small part. The newly expanded Section 45Q of the U.S. Internal Revenue Code provides a significant subsidy for CCUS, where facilities can claim tax credits for each tonne of carbon stored. As firms choose which projects to invest in, it is important to understand how Canada's policies stack up against its most important trading partner.

This report describes the suite of policy incentives for CCUS in the upstream oil sector in Canada. We also estimate the value of these financial supports, and how that support stacks up in relation to the Inflation Reduction Act. We then discuss what this means for investment in CCUS in both contexts, with a focus on how different types of oil resources require different types of emissions reductions solutions, including CCUS, and on the risk of cross-border capital flight due to the need to decarbonize in the short term in Canada.



OVERVIEW OF FINANCIAL INCENTIVES IN CANADA AND THE UNITED STATES

This section describes the financial incentives for oil and gas sector CCUS in Canada and the United States, focusing on comparing their primary oil producing jurisdictions, Alberta and Texas.

In Alberta, incentives for the upstream oil sector are layered but substantial, coming from both subsidies like the announced federal Investment Tax Credit but also costs and rewards through provincial carbon pricing.

Conversely in Texas, the United States provides one significant federal financial subsidy to oil and gas CCUS via a performance-based tax credit, with some additional one-off federal funding available. Texas provides no additional state incentives for CCUS in the upstream oil sector, but any petroleum exports to California may benefit from California's Low Carbon Fuels Standard.

> Policy supports and incentives for key decarbonization technologies are gaining momentum, including specific financial incentives for CCUS.

Various federal incentives target CCUS deployment in Canada

With the release of the federal government's strengthened climate plan–A Healthy Environment and a Healthy Economy, updated nationally determined contributions to the U.N. Framework Convention on Climate Change (UNFCCC), and the 2030 national Emissions Reduction Plan, policy supports and incentives for key decarbonization technologies are gaining momentum, including specific financial incentives for CCUS.

The **CCUS Investment Tax Credit** (ITC) announced in 2022, proposes to provide a 50 per cent credit for equipment associated with point-source CCUS projects, declining in 2030 and 2040 to incent early adoption (Table 1) (Finance Canada 2022a). The proposed ITC also includes a requirement for public knowledge sharing, which could provide significant cost-savings to future projects as each project learns from those that came before it (Finance Canada 2022c).

Table 1:

Proposed CCUS investment tax credit rates

Project Type	2023–2030	2031–2040	After 2040
Eligible capture equipment used in a direct air capture project	60%	30%	0%
All other eligible capture equipment	50%	25%	0%
Eligible transportation, storage, and use equipment	37.5%	18.75%	0%

Source: Finance Canada (2022a)

Canada's federal government expects to commit C$8.6 billion by 2030 to the announced ITC alone—double the funds that the U.S. federal government has earmarked for the extended 45Q tax credit in the Inflation Reduction Act by 2031 (about C$4.3 billion) (Congressional Budget Office 2022; Finance Canada 2022d).

Canada's **Clean Fuel Regulations (CFR)** allow facilities to create compliance credits using projects like CCUS that reduce the emissions intensity of fossil fuels (ECCC 2022a). CFR credits are applicable to fuels that are consumed domestically, so will typically offer fewer credits for upstream oil production because most of this production is exported. This could potentially offer very significant additional credits for refineries with CCUS, because most of their fuel production is for domestic consumption.

The new **Canada Growth Fund** also proposes a number of financing tools to accelerate the deployment of CCUS across Canada, although eligibility requirements and policy design are yet to be finalized (Finance Canada 2022b). Concessional financing means that the Canada Growth Fund will offer equity investments or loans where returns are expected to be below the market rate, but overall, the Fund's portfolio is intended to recover its investment. Carbon contracts for difference, which can be used to guarantee a minimum carbon price for a project, have been proposed as a part of the Canada Growth Fund's offerings, and can address risk and uncertainty around carbon revenues driven by shifts in carbon pricing policy, and credit market performance.

There have also been other funding supports available at the federal level, such as Natural Resources Canada's **Energy Innovation Program**, which offered funding for research, development, and demonstration projects including for CCUS.

Carbon pricing is at the core of Alberta's provincial incentives for CCUS. For years Alberta's industrial **carbon pricing** system—now called TIER—has allowed for CCUS to either reduce emissions at a regulated large emitter (if the CO_2 is stored onsite or sent for acid gas disposal) or to be eligible for emissions offsets if the CO_2 is exported offsite for geological sequestration or enhanced oil recovery. Recent updates to TIER include two additional supports for CCUS projects.

First, TIER credits can now be concurrently generated with CFR credits. This is enabled by a new class of **sequestration credits**, which can be converted from CCUS emissions offset credits (Ministry of Environment and Protected Areas 2022).

Second, those sequestration credits can be converted into **capture recognition tonnes**, the incremental value of which comes from the fact that capture recognition tonnes do not have limits on their use, as opposed to offsets or emissions performance credits. This means their value is much closer to the headline carbon price, and they offer lower-carbon revenue risk. Capture recognition tonnes allow a facility to reduce its total regulated emissions, effectively reducing its compliance obligations (Ministry of Environment and Protected Areas 2022).

Emissions Reduction Alberta's **Carbon Capture Kickstart** program also offered funding in 2022 for feasibility and engineering studies to eleven projects, including the Pathways Alliance.

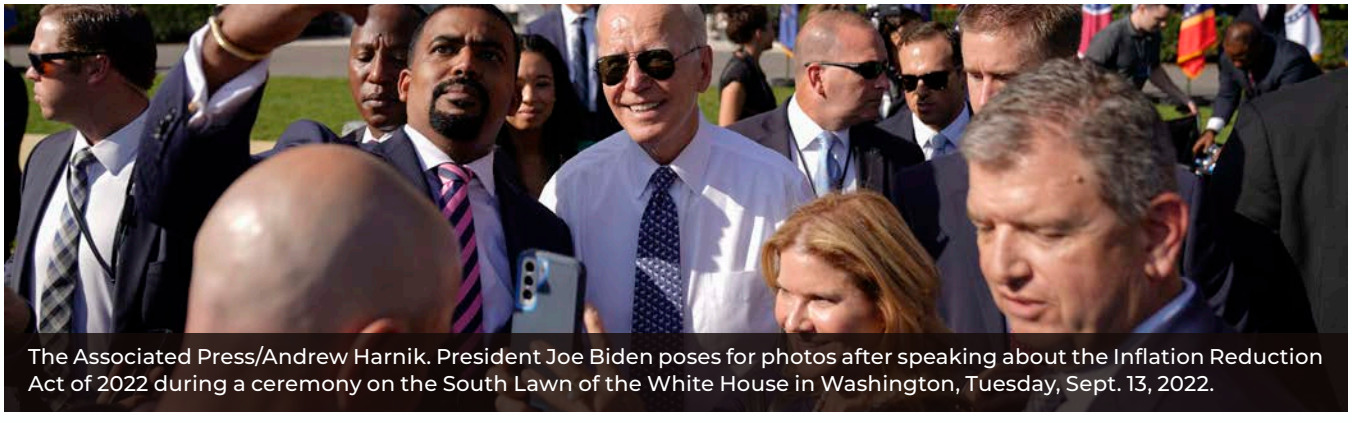
45Q tax credits make up bulk of U.S. National Incentives

First introduced in 2008, the **45Q tax credit for CCUS** was expanded and extended in the Inflation Reduction Act. It is the main policy support for CCUS in the United States, but makes up a small portion of the C$500 billion in spending earmarked for climate and energy over the next decade.

The performance-based tax credit is available at C$115/tonne for stored CO_2 if certain labour provisions are met (rates for different activities can be found in Table 2) for facilities that commence construction before 2033, and applies to the carbon that is permanently stored or used—as opposed to Canada's CCUS ITC, which applies to equipment (CATF 2022a). The credit can be claimed for sequestered carbon for 12 years, and the Inflation Reduction Act also significantly lowers the amount of CO_2 that must be captured annually to qualify, reducing the capture threshold from 100,000 tCO_2/year to 12,500 tCO_2/year in order to incentivize more projects than were previously eligible.

New provisions in the Act mean that the credit can either be returned via direct payment or transferred. With direct payment, facilities can receive a fully refundable tax credit (as opposed to offsetting an existing tax liability, which may not be large enough to match the 45Q credit). The direct payment provision is available for five of the total 12-year realization periods. The updates to 45Q also allow for a portion of the credit to be sold (and not taxed) to any tax-paying entity.

Enhanced oil recovery (EOR), where captured carbon can be injected into existing oil fields to boost oil extraction, is also eligible for 45Q. This has implications for deployment in petroleum production in the United States—storage for EOR has a lower estimated net cost than geological storage (Baylin-Stern and Berghout 2021). EOR is not eligible for Canada's ITC, but it is eligible for Canada's CFR and Alberta's TIER credits.



The Associated Press/Andrew Harnik. President Joe Biden poses for photos after speaking about the Inflation Reduction Act of 2022 during a ceremony on the South Lawn of the White House in Washington, Tuesday, Sept. 13, 2022.

Table 2:

45Q credit rates and eligibility if labour provisions met

Project Type	USD/tonne	CAD/tonne (2023)
CO_2 permanently stored	$85	$115
CO_2 used for EOR or other industrial uses	$60	$81
DAC—permanent storage	$180	$243
DAC—EOR or other industrial uses	$130	$175

Source: CATF (2022a)

Oil production exported into California is subject to **California's Low Carbon Fuel Standard (LCFS)**, which includes a Carbon Capture and Sequestration Protocol. This is included under U.S. national policies because it applies to production from a number of states that sell to California. For example, the LCFS credits carbon capture projects anywhere as long as the produced transportation fuel associated with it is sold in California (California Air Resources Board 2023b). Like Canada's CFR, credits are prorated based on the amount of fuel sold in California as a portion of total facility production. In 2022, the average monthly price of California's LCFS credits was about C$130 (California Air Resources Board 2023c). However, the vast majority of California's fuel imports come from Alaska or abroad (California Energy Commission 2023). While the LCFS can stack with the 45Q credit, there would be little additional support for most upstream production outside of Alaska. As of January 2023, all approved non-direct air capture (DAC) CCUS projects under the LCFS are located in California (California Air Resources Board 2023a).

There is also **federal funding for CCUS research and development**:

- The federal Department of Energy's Carbon Capture and Storage Program, which focuses on research and development;
- Grants for feasibility and design studies or demonstration projects through the Infrastructure Investment and Jobs Act;
- The Carbon Storage Assurance Facility Enterprise program, which focuses on developing storage projects. So far, funding has been provided to feasibility and engineering studies, although support may be available for project construction subject to availability of funds; and
- The Department of Energy Loan Program Office financing, which supports projects that avoid, reduce, or sequester greenhouse gas emissions, including but not limited to CCUS.

Texas does not offer additional incentives for CCUS projects in the oil sector. Without carbon pricing or a state-level CCUS tax credit, Texas has no additional incentives for CCUS in the upstream oil sector. However, due to the types of emissions associated with production of Texan oil resources, discussed in

detail below in our analysis of different resource profiles, it makes sense that CCUS hasn't emerged as a critical emissions reduction solution by the state's upstream producers.[1]

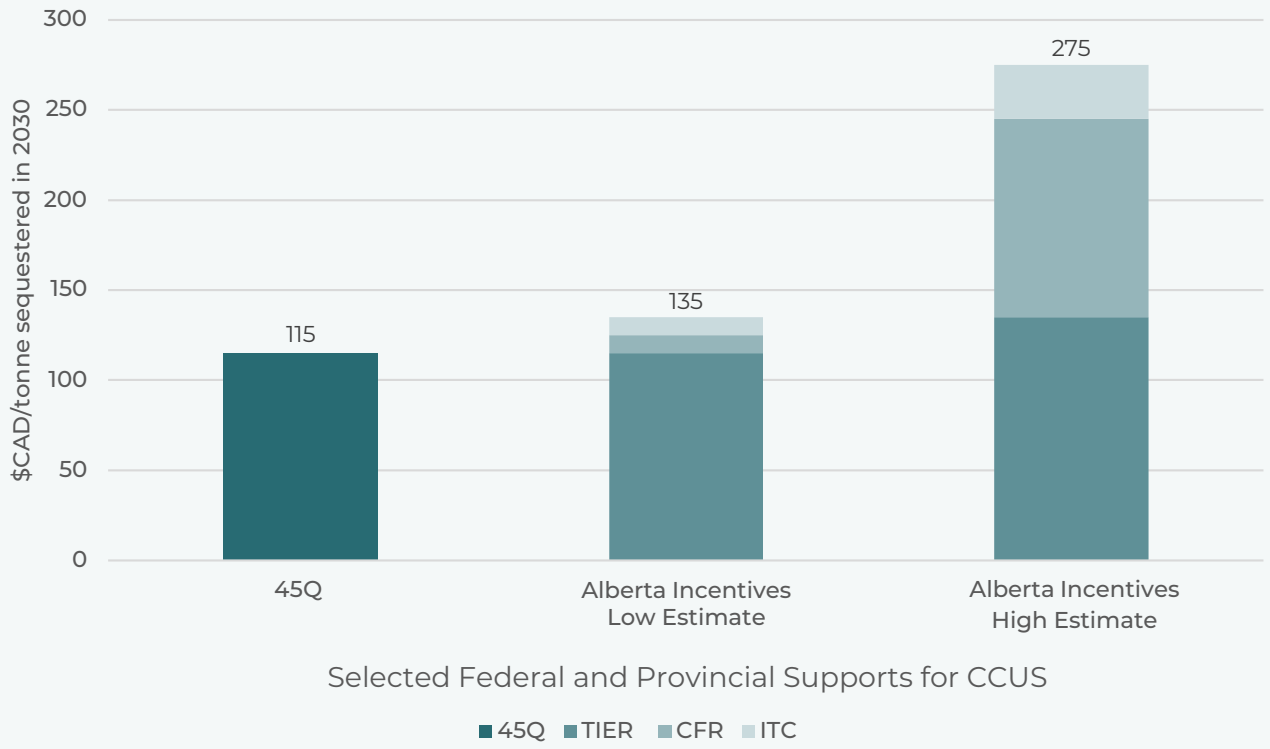
Adding up financial incentives for CCUS

As noted above in Table 2, the value of the 45Q credit is about C$115/t sequestered[2] for non-DAC geological storage. California's LCFS provides an additional incentive, but benefits are concentrated in California and Alaska.

In Canada, there is a suite of policy measures available to upstream oil sands producers in Alberta—TIER credits, CFR credits, and the ITC once it is finalized. We estimate that these stacked incentives could be worth **at least C$135/tonne** sequestered for oil sands facilities by 2030, and much higher for refineries (Figure 1).[3] The incentive added by the CCUS Investment Tax Credit could be worth an incremental 15-30 per cent of a project's lifecycle cost of capture, transportation, and storage, depending on project specifics.

Figure 1:

Estimated value of financial supports for CCUS in upstream oil production in the U.S. and Alberta (in 2030)



[1] While not relevant to the oil sector, Texas does make available a Clean Energy Tax Credit for new power generation projects that sequester at least 70 per cent of the CO_2 associated with the generation of electricity at a facility. The credit is equal to 10 per cent of the total capital cost of the project or US$100 million, whichever is lower. Additionally, there is a tax deduction available for coal power projects that include carbon capture that allows a deduction of up to 10 per cent of the amortized cost of equipment.

[2] In USD, the value for non-DAC geological storage is $85/tonne (See Table 2); in 2023 CAD, this is about $115/tonne.

[3] See Appendix for Estimation Methodology.

We estimate the value of TIER credits to be C$115-135/t CO_2e sequestered based on the carbon price schedule to 2030, an estimate of the discount of credit prices to the headline carbon price, and the potential added value of new TIER CCUS credit classes recently announced. However, policy uncertainty exists around future credit values—uncertainty that is a major barrier to investment (Allan and Bernstein 2023). One concern is that credits generated from CCUS projects and incentivized by the CCUS Investment Tax Credit could flood the market and depress prices. The Alberta government can reduce this uncertainty by taking steps to prevent oversupply and tighten the TIER credit market. Finance Canada has also proposed a number of financial tools through the Canada Growth Fund, including contracts for difference and off-take agreements, that could help insure carbon revenues that low-carbon investments depend on.

The value of CFR credits is difficult to estimate as results from the initial compliance period are not yet available. However, based on the social cost of emissions reductions included in the CFR's impact statement, we estimate a value of C$151/t CO_2e avoided—and a range between C$111-186/t CO_2e avoided (Government of Canada 2020). The actual portion of this value that could be realized by a CCUS project depends on how much of its associated fuel production is used in Canada. This means the realized CFR credit value could range from C$10-C$110/t sequestered, depending on product type and credit market dynamics.

We estimate that the CCUS ITC could be worth 15-30 per cent of the total cost of an oil sands capture project. For example, a project with a levelized cost of capture, transport, and storage of C$150/t CO_2 avoided may have access to C$10-30/t worth of CCUS ITC support.

While much attention has been paid to the U.S.'s 45Q credit and the lack of similar policy in Canada, these two contexts are not comparable, especially for the upstream oil sector. While the 45Q credit is one very meaningful financial support, Canada's existing carbon pricing systems already provide incentives for CCUS projects, especially in Alberta where most Canadian oil and gas production and geological sequestration potential are located. With TIER, the CFR and the CCUS ITC (once finalized), support for CCUS projects in 2030 is expected to be greater in Alberta—Canada's top oil producing province—than in its U.S. peer, Texas.

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WHAT DOES THIS MEAN FOR INVESTMENT IN CCUS IN CANADA'S OIL SECTOR?

When we look at how government incentives for CCUS stack up in the upstream oil sector in Canada and the United States, we can see that the form of those incentives differs, and that some Canadian policies have yet to be finalized (i.e., the CCUS ITC). Still, by 2030 the expected value of those incentives just in Alberta will meet or exceed that expected in Texas.

However, we also need to discuss where investment in CCUS is most likely and where it makes sense to focus government support. In this section, we compare the different resource profiles in Canada and the United States—and the most suitable decarbonization solutions for those resources. We will also discuss the potential for cross-border competition.

Different resource profiles require different emissions reduction solutions

From point of extraction to pump, Canada's oil production is among the world's most carbon intensive, and the resource profiles for oil sands production in Canada look very different from most U.S. shale oils (Masnadi et al. 2018; Gordon et al. 2016). There is a case for CCUS at, for instance, an oil sands in situ facility or mine—these are emissions-intensive processes which are difficult to abate, and can accommodate a large enough capture facility to achieve economies of scale. Conversely, American shale production tends to produce emissions that can be mitigated more cost-effectively in other ways, and are smaller and more geographically dispersed.

The oil sands are responsible for more than 65 per cent of Canadian oil production (EIA 2021) and its extraction and processing is particularly energy intensive. Mines require electricity, natural gas for processing heat, fuel for heavy trucks, and produce fugitive emissions (including from tailings ponds). In situ extraction makes up about half of the oil sands' emissions and requires a significant amount of natural gas for steam generation; about 40 per cent of the sector's emissions are from natural gas combustion for in situ projects (Israel 2020). Bitumen from in situ operations is usually diluted for

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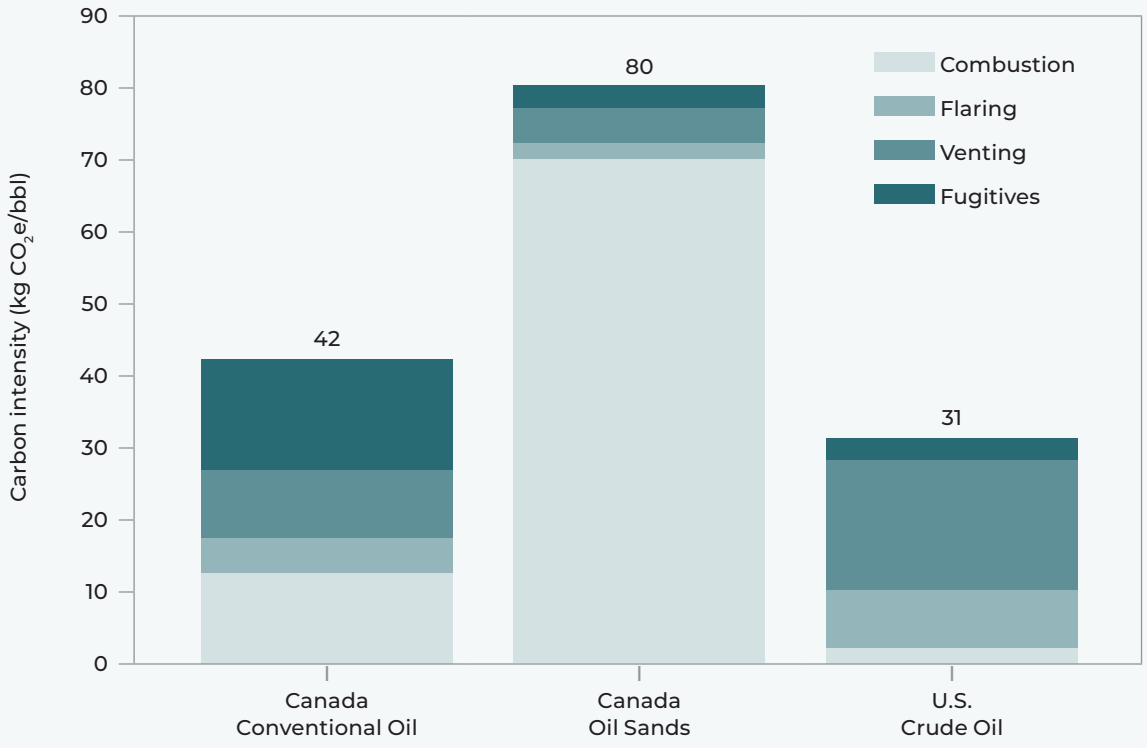
transport to high-conversion refineries that must use additional energy to process the heavier molecules and remove the diluent. Upgrading bitumen to synthetic crude oil (SCO), which is done via upgraders at or near mines, results in emissions from hydrogen production and generating process heat.

Conversely, in 2021, 64 per cent of U.S. oil production was lighter shale oil that requires less energy to extract. The emissions profile is also (broadly) different for shale oils—the primary emissions drivers associated with it are process emissions that include venting, flaring, and fugitive emissions. Extracting and processing oil from U.S. offshore projects and in California are typically more emissions intensive relative to U.S. shale, but these comprise a small share of total American oil production (California produced 3 per cent of American oil in 2022) (Gordon et al. 2016).

More than 75 per cent of the emissions associated with onshore petroleum production in the United States are emissions from associated gas venting, flaring, and fugitive emissions—compared to 12 per cent in Canadian oil sands production, as shown in Figure 2 (EPA 2020).[4] In general, there are more cost-effective ways to mitigate these emissions than through CCUS (Gorski 2021; Gorski and El-Aini 2022). Since U.S. oil production has few or no large point sources of emissions associated with upgrading, extraction, and steam injection, the installation of upstream CCUS is less applicable to U.S. oil producers.

Figure 2:

Emissions intensity by selected source type, Canada vs. US (2020)



Sources: ECCC (2022b); EPA (2020). Notes: Category calculations by authors. Combustion emissions include only fossil fuel combustion associated with the upstream production of oil, and do not include total life-cycle emissions associated with the end-use of the product.

[4] Category calculations by author.

Conventional oil production in Canada has similar emissions profiles to that of American onshore shale oil, with most emissions from associated venting, flaring, and fugitive emissions (ECCC 2022b).

CCUS in refining

While CCUS has not emerged as a preferred decarbonization solution for U.S. upstream oil producers, refiners have taken an interest. Combined cost estimates for carbon capture, transport, and storage at U.S. refineries range from C$90-135/tonne (Abramson and McFarlane 2020; Kearns et al. 2021). Some of the biggest refining firms like Valero, Marathon, and Philips 66 have all earmarked CCUS as a foundation of their decarbonization plans, and merchant hydrogen producers like Air Products have CCUS projects in operation or development at refineries and other industrial facilities around the world (McGurty 2021; Zapantis et al. 2022).

Canadian refineries may get a lot of support in the forthcoming CFR credits. Due to recent changes in Alberta's TIER regulation, Alberta's refineries in particular will benefit, because new classes of CCUS credits are eligible to earn both TIER and CFR credits. Previously, CCUS projects had to choose to generate only one of these credits. But CFR credits can only be generated in relation to fuels used in Canada. Since most products from Alberta refineries are consumed domestically, the amount of CFR CCUS credits they could claim is potentially substantial. Not so for CCUS at upstream oil sands production, because most of their crude and bitumen production is exported to the United States.

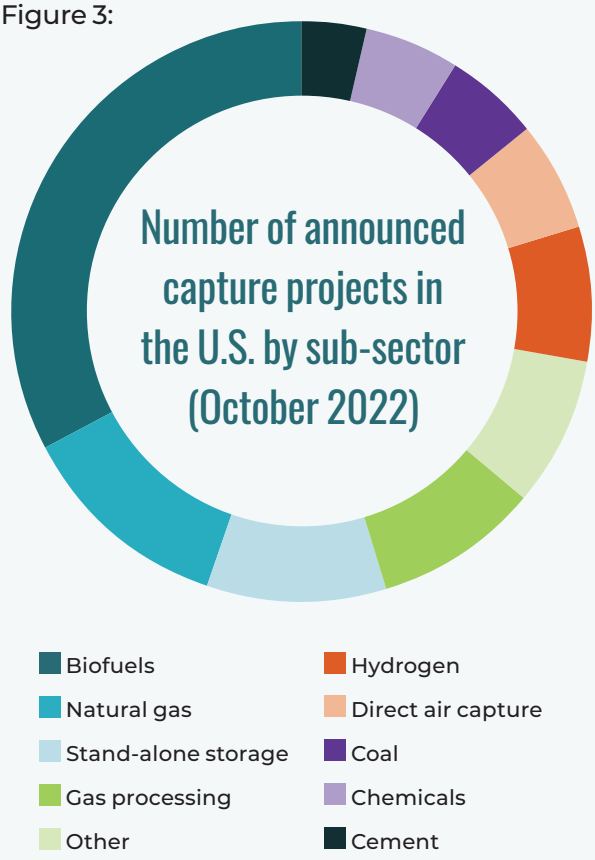
Potential for cross-border competition for capital is limited

Canadian oil sands producers have explicitly identified CCUS as a linchpin of their decarbonization plans to 2030, but likely because of the differences noted above—resource characteristics, emissions profiles, and other decarbonization solutions available. U.S. upstream oil producers have not made the same level of commitments, nor have conventional oil producers in Canada.

Of the 110 capture projects announced in the United States (as of September 2022), none are associated with upstream onshore oil production (three are associated with hydrogen production at refineries) (Figure 3). Since EOR is eligible for 45Q but not for Canada's announced CCUS ITC, there is the possibility that EOR projects may be earmarked for funding. Twelve projects are associated with enhanced oil recovery storage, in the power, cement, and biofuels subsectors (CATF 2022b).

Conversely, of the two dozen CCUS projects announced in Alberta alone, 14 are at oil sands facilities (including 11 through the Pathways Alliance CCS Hub) (Figure 3).

Figure 3:



Source: CATF (2022b)

Source: Alberta Major Projects Office

CCUS projects that attract investment in the U.S. look different from those in Canada, which means that these projects are unlikely to compete for the same capital. There may be some potential for cross-border capital flight, as firms take advantage of the EOR provisions in the Inflation Reduction Act, which is ineligible for Canada's announced CCUS ITC. However, in the context of the upcoming cap on oil and gas emissions—a key piece of the 2030 Emissions Reduction Plan—Canada's oil and gas industry will be required to reduce emissions. Producers need to find and implement decarbonization solutions that work in Canada in order to comply with that policy.

Additional incentives for CCUS investment in Canada's oil sands will increase the risk of carbon lock-in

Our focus in this paper has been on how the incentives for CCUS stack up in Canada and the United States, and what that means given important operational differences. But this analysis is part of a larger conversation about Canada "keeping up" with the Inflation Reduction Act. While cross-border competition is top-of-mind for Canadian industry, subsidies for CCUS have an opportunity cost, so it is important to strike the right balance of investment priorities. Even in the context of the Inflation Reduction Act, subsidies for CCUS are dwarfed by those for clean electricity, electric vehicles, and consumer rebates.

Adding more subsidies for fossil fuel production, on top of what has already been announced in the ITC, increases the risk of carbon lock-in, stranded assets, and lost opportunities to invest in other important clean energy technologies. With limited funds, federal and provincial governments should be careful not to over-subsidize CCUS for the oil sector. A mix of regulation and incentives is needed to ensure that the sector with the highest emissions begins to reduce those emissions.

Ultimately, non-oil sands operations will likely have an easier time decarbonizing because a lot of their emissions are from methane, which is cheaper to mitigate than via CCUS—but there are still many viable decarbonization solutions available across the oil and gas sector, and CCUS will still be a key technology for emissions-intensive resources like Canada's oil sands.

Because CCUS is a key solution for oil sands producers specifically, the question that needs answering is not necessarily how policy supports stack up in Canada versus the United States but rather do these government supports provide adequate incentives in the specific context of Canada's upstream oil sector?

The goal of such government support is ultimately to unlock private investment, and Canada's carbon pricing systems provide a well-established foundation for incentivizing decarbonization and supporting innovative technologies like CCUS, with additional layers of incentive from the CFR and the announced ITC.

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CONCLUSION

The emissions profiles in the United States onshore shale oil and Canada's oil sands are markedly different, and because of this their options for decarbonization vary depending on resource type, associated emissions, and the most cost-effective abatement technologies. Canadian oil sands production is relatively more emissions intensive and more complementary to CCUS due to the amount of stationary combustion and hydrogen production. This means there is a better case for CCUS at Canadian oil sands facilities than at U.S. shale oil facilities (or indeed at Canadian conventional oil facilities) as they have lower-cost options available and an emissions profile that is less well-matched to carbon capture.

Both Canada and the United States have stepped up policy support for CCUS in 2022 and in 2023 comparing two major oil-producing jurisdictions–Alberta and Texas–Alberta comes out ahead. Comparisons of Canada's and Alberta's policy incentives for CCUS to the U.S. often fail to consider important Canadian policies. Moreover, there are operational differences between the oil industries in the two jurisdictions. CCUS is less suitable for decarbonizing U.S. upstream oil production, which means that direct competition for investment in CCUS projects with Alberta is limited.

In Alberta, given the policy and pricing supports in TIER, the CFR, and the proposed federal ITC, there is significant government support for this technology to move forward in a big way—especially as TIER credits gain value as the headline carbon price increases to C$170/t in 2030. However, CCUS alone will not produce the deep decarbonization we need from the oil sector, and from oil sands in particular. In fact, CCUS will need to be combined with other decarbonization solutions, to ensure a clear pathway for Canada's oil sands to comply with the upcoming emissions cap and prepare for an increasingly lower-carbon global energy marketplace.

This opens up multiple avenues for future research: First, an analysis of the cost side of CCUS for the oil sands, where a significant amount of these projects are expected to break ground. Detailed analysis can deliver

CCUS alone will not produce the deep decarbonization we need from the oil and gas sector, and from oil sands in particular.

insights on the profitability of investment in CCUS in the oil sands context given existing policy supports. Second, an examination of the extent to which public supports for CCUS projects may ultimately end up subsidizing fossil fuel production, risking carbon lock-in and stranded assets is warranted. Moreover, this analysis does not consider potential interactions between the financial incentives for investment in CCUS and a cap on oil and gas emissions, and how such a cap would change the competitive landscape.

Canada has a much more layered policy environment than the United States, which relies almost entirely on subsidies to encourage CCUS. The CCUS ITC and contracts for difference policies have yet to be finalized, but together, we expect the Canadian suite of supports—a mix of regulations and subsidies—for upstream oil and gas CCUS to exceed that provided in the U.S. and provide equivalent carbon revenue certainty. CCUS will not make financial or logistical sense at every facility, but for those where it does make sense, no further government support is needed once key policy pieces like the ITC are finalized.

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APPENDIX: ESTIMATION METHODOLOGY

TIER Credits

- We estimate the value of TIER credits to be $115-135/t sequestered, based on the carbon price schedule to 2030 and historical relationship of credit prices to the headline carbon price.

Clean Fuel Regulation Credits

- The CFR establishes a credit market where fuel suppliers can meet carbon intensity requirements by creating or acquiring compliance credits in three categories:
  - Category 1: projects that reduce the lifecycle carbon intensity of liquid fossil fuels (including CCUS)
  - Supplying low-carbon fuels like ethanol
  - Supplying fuel or energy to advanced vehicle technology

- The value of CFR credits is difficult to estimate, but based on the central estimate of social cost of emissions reductions under the regulation, a reasonable estimate is $151/t (low estimate is $111/t, and high is $186/t) (Government of Canada 2020).

- The CFR does not apply to fuels that are exported from Canada, and so only fuels consumed domestically are eligible. In 2019, 75 per cent of total oil production—and more than 80 per cent of oil sands production—was exported, which accounts for the lower range of our cost estimate (Canada Energy Regulator 2022). Conversely, Canada's refineries had a capacity of 1.95 mb/d in 2021 (although have not met that capacity for several years) for domestic consumption, accounting for the higher range of our estimate (Canada Energy Regulator 2023).

- The incentive value for a CCUS project is estimated to range from $10-$110/t sequestered depending on project type and credit market dynamics.

CCUS Investment Tax Credit

- Based on the announced ITC levels, and cost estimates for capture projects at existing sites for a variety of CO_2 streams from the Great Plains Institute, we estimate that the ITC could cover 15-30 per cent of the total cost of an oil sands capture project (Abramson and McFarlane 2020).

- This range book-ends results found by varying CCUS project capital intensity, proportion of costs eligible for the ITC, and proportion of costs for transportation and storage.