INTERNATIONAL CCS KNOWLEDGE CENTRE

The NEED for FEED

A compendium document to CCS Tax Incentive Considerations in Canada

INTRODUCTION

With the inclusion of large-scale carbon capture, utilization, and storage (CCS/CCUS) in Canada's Budget 2021 (April 19, 2021) the country acknowledges CCS incentives can support Canadian industries in adopting the technology.

This briefing document describes why CCS projects need front-end engineering and design (FEED) studies. It is a compendium to the International CCS Knowledge Centre's (Knowledge Centre) guide to messaging for industry participating in Canada's budget consultation period, and acts to highlight how FEED dollars are not specifically accounted for in the budget.

Large-scale CCS technology can have a sizeable impact to climate mitigation, and it can bring with it a sizable financial commitment. As for any large capital investment, proceeding with a project requires smart and informed decisions.

A FEED study is an essential step in providing certainty, minimizing risk, and enabling decision makers to feel confident in final investment decisions (FID).

WHAT IS A FEED STUDY?

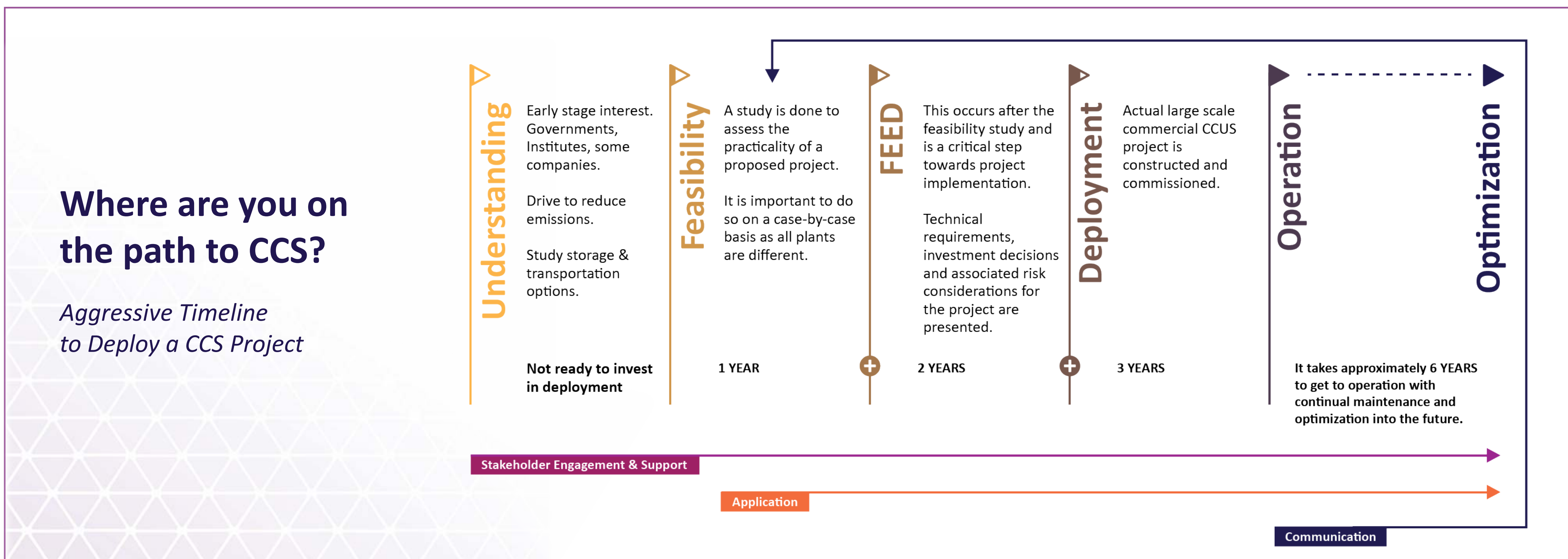
Major capital projects, such as those required to construct large-scale CCS facilities require several stages of approval by the owner/decision maker to proceed to an FID. Each of these steps require additional investment and results in reducing the uncertainty regarding project risk, cost, scope, and schedule. A FEED study is the important final stage gate that leads to the FID by the owner/decision maker.

FEED studies are not research or conceptual studies. They are a necessary part of the pathway to deploy a capital project which provides certainty for larger investment. It encompasses much of the actual engineering and design work that can be the basis of the CCS project. It is similar to the blueprints for a house – sometimes going as far as even selecting the builder.

Essentially, a FEED study examines a project in sufficient detail to enable informed FIDs.

FEED studies for major projects require significant engineering effort and often include probability analysis to support the probability associated with the cost model for decision makers. In some cases, the FEED study will take the project development far enough that major contracts are ready to be awarded at the time of the FID.

As a FEED study is comprehensive, its substantiveness takes time and significant cost – up to 5% of the project value (which includes 50% of the engineering costs and are typically 10% of the total project). Therefore, it is important to acknowledge and follow specific stage gates on a CCS project timeline. As noted in the illustration, it is recommended that each of these steps happen successively to help potential projects move towards more certainty. The goal of early FEED studies is to mitigate future issues down the road. Following these steps can help a project have a greater chance of success.



WHAT COMES BEFORE FEED?

Prior to achieving a FEED study stage, projects would most likely have completed a feasibility study - the first step in determining if a project is viable and can validate a business case for it.

Given the urgency of development to meet climate targets, there have been considerations (though not always advised) for projects to skip the feasibility stage and go directly into the FEED stage. This means owners/decision makers ought to consider the commencement of FEED early in the process. It must be kept in mind, however, that if a FEED is initiated sooner in the process, the owner/decision maker would need to ensure pre-requisite criteria are also completed in advance, as readiness to enter FEED may impact the ability for it to qualify for FEED funding dollars.

The three precursors to FEED are:

1. **A High-level Cost and Benefit Comparison** – A company looking to determine whether to advance to FEED, can look at their business case, their climate ambitions, carbon pricing, regulatory regimes, and potential incentives. Depending on individual factors from project to project, this analysis may be sufficient at a high level or require more detail, as those garnered from a formal feasibility study. (To receive funding for FEED and as part of the cost-benefit considerations, the United States [US] Department of Energy requires: preliminary summaries of: Techno-economic Analysis[1] [TEA], Environmental Justice Analysis, Economic Revitalization and Job Creation Outcomes Analysis).

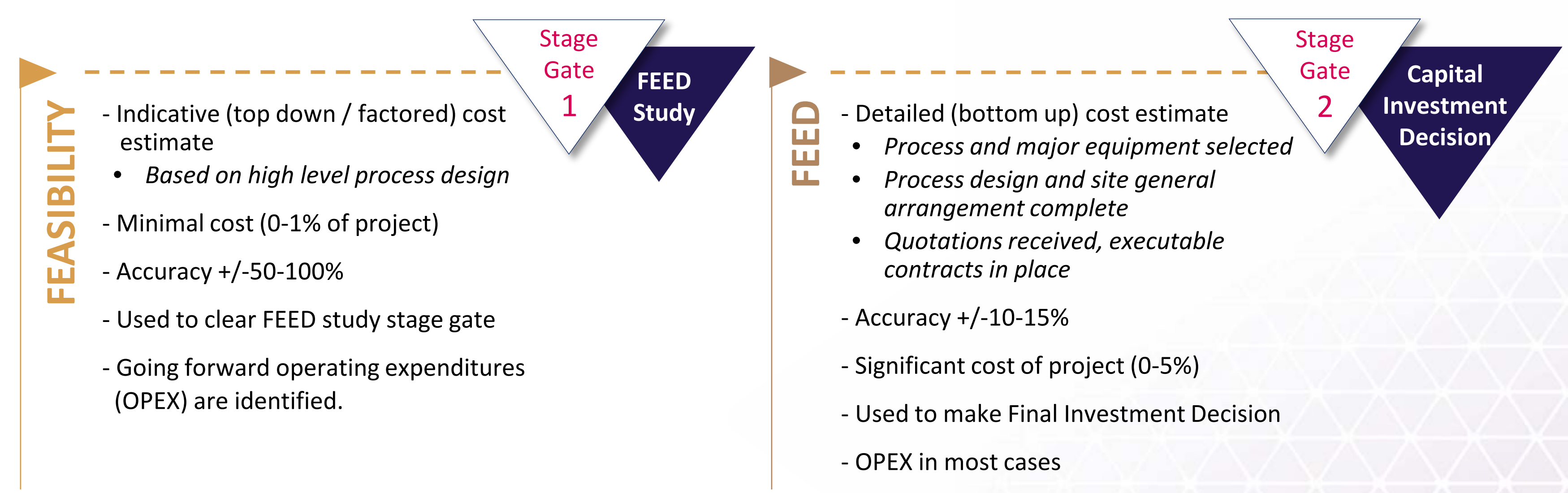
2. **An Acceptable Technology Readiness Level (TRL)** - The capture technology for any given project would need be understood based on its suitability and readiness level. There is more assurance and less risk in technologies which have a higher TRL. (For an overview of TRL assessment key capture technologies, see Global CCS Institute's *Technology Costs & Readiness of CCS* (March 2021)).

3. **A Project Overview** – The variable portion of a CCS project cost-estimate consists of site-specific conditions in site selection. This includes the industrial plant description and carbon capture system integration (proximity of capture equipment to the emission source, availability of utilities (gas, water, power, etc.). The project overview should also include consideration for carbon dioxide (CO_2) offtake, transportation, and storage options.

Feasibility vs. FEED

For replicable projects, a feasibility study can be very straightforward, as a +/-50% cost estimate can be determined by simply factoring recently completed projects for similar scope. Completion of a feasibility study may require up to 1% of the final project cost and is considered an operating expense for the organization.

Following completion of the feasibility study, the business case would be reviewed and if the project meets the needs of the owner/decision maker, the first stage gate would be approved, authorizing completion of a FEED study.



1. The intent of the TEA is to demonstrate economic feasibility and identify economic and design hurdles that can be addressed with future research development and demonstration.

FEED STUDIES LOCK IN CERTAINTY

Advancing to a FEED study means the project is undergoing serious consideration. FEED can be a significant investment up to 5% of the project cost. In many ways, the cost of FEED is like an assurance investment in that it offsets costs for the project by creating assurances and minimizing risk.

A typical guideline is that to achieve a FEED estimate accuracy of +/- 10-15 %, the FEED study requires the detailed engineering tasks to be up to 50% complete (AACE Class 3 and partial Class 2 – see figure 1.). By comparison, a FEED estimate accuracy of +/- 20-30% requires detailed engineering tasks to be 20-30% complete.

Figure 1. Cost Estimate Classification Matrix for the Process Industries

	Primary Characteristic	*Secondary Characteristic*			
ESTIMATE CLASS	**LEVEL OF PROJECT DEFINITION** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]	**PREPARATION EFFORT** Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate of Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Source: AACE International Recommended Practice No. 18R-97 *Cost Estimate Classification System – As Applied in Engineering Procurement, and Construction for the Process Industries* (2005)[i]

An FID generally requires an AACE Class 3 (10-40% of engineering completed). In cases where detailed engineering tasks are completed to 50% and the owner/decision maker decides to have major contracts ready to award, this work would include the certainly associated with a partial AACE Class 2.

INVESTMENT IN FEED NEEDED FOR CANADIAN CCS

Front-end capital expenses for any CCUS project can be a huge barrier to projects going forward. It is important to recognize the FEED stage as distinct and to allocate funds accordingly. Yet in Canada's Budget2021, consideration for FEED financing was not specifically articulated.

Deploying large-scale CCS projects are considerable investments, and through consultations it is wise for industry to engage in the question of how FEED studies will be financed.

In the past, Canada has provided funds to support FEED studies for CCS projects. This grant funding, provided at the FEED stage, was done so to enable and advance the CCS projects and allow for FID certainty. For instance, the Boundary Dam 3 CCS Facility, received $240M from the Canadian government, which was used to support its FEED study, well in advance of any FID being made. The Quest CCS Facility also received a $120M grant from the Canadian government.[ii]

One of the questions that the Knowledge Centre has been asked by proponents is whether FEED support can come from the announced CCUS Investment Tax Credit (ITC).

The Knowledge Centre's recommendation is that FEED dollars should come from other funding avenues (such as the Strategic Innovation Fund, the Canadian Infrastructure Bank, and corporate lending amongst others); however, there may be some projects where FEED dollars could be supported through an ITC.

The challenge for funding FEED through an ITC is the nature of how a FEED study interconnects engineering design and capital advancement. Actively spending dollars towards advancing a capital project, like purchasing large equipment, making site modifications, or securing contracts during the FEED study can be considered a strong indicator of the intent for a project to proceed. This would reflect the capital outlay criterion required for the ITC refund.

However, on the global scale, there are more cases than not, where FEED studies have not proceeded through to a deployed project. Thus, allocating FEED dollars as part of the capital of a project, can create accounting issues if the project does not proceed. With an ITC, this could be difficult to rectify, since any associated credit may need to be refunded to the federal government if it were outlaid for FEED but the project did not materialize.

CCS FEED INVESTMENT FROM AROUND THE GLOBE

Many countries around the world have committed ambitious emission reduction goals via CCS and have backed that commitment with investments in FEED studies. **For Canada to remain a global leader and remain competitive, government support is essential until market barriers can be overcome, and costs can be reduced**. Leadership is being demonstrated around the globe and specifically in the US, the United Kingdom (UK), Norway, and Australia. The below information attempts to characterize where FEED dollars have been provided by these countries. (This is not an overview of all CCUS spending that is expected for either research and development or deployment of CCUS projects.)

In the United States

The well-known 45Q tax incentive in the US provides a performance-based tax credit for CCS projects based on the amount of CO_2 captured and stored. The size of the credit ranges with $50/tonne (t) for permanently storing CO_2 and $35/t for capturing CO_2 to be used for enhanced oil recovery (EOR) or other uses. **What may be less familiar to Canadians, is that this incentive does not stand alone** – the US actively invests in FEED studies.

Support from the US Department of Energy (DOE) beyond 45Q contributes to the growing number of projects in the US. In 2020, Congress appropriated $217.8M for CCS. Using this and other prior fiscal year funds, the US DOE committed or awarded more than $270M USD in co-funding agreements: FEED studies, for technologies to capture CO_2 from industrial and natural gas sources, direct air capture, CO_2 utilisation and geological storage.[iii]

Such DOE funding provides for CCS projects in various early stages of the deployment path. Government dollars allocated specifically related to FEED, or storage studies needed for FEED, since late 2019 include (in USD$):

- $55.4M from a $131M announcement for FEED in the power sector (September 2019)[iv]
- $20M for regional initiatives in CCS (December 2019)[v]
- $85M for storage related studies in connection with capture projects (April 24, 2020)[vi]
- $6M per applicant FEED for carbon capture systems (April 5, 2021)[vii]

In the United Kingdom

The UK sees CCUS as an integral part to its Green Industrial Revolution. Supporting CCUS innovation and efficient UK supply chains will drive growth and seize commercial opportunities both domestically and abroad. Since 2011, over £130M has been invested through various levels of support to develop CCUS in the UK.[viii] Such support continues through the UK's Department of Business, Energy & Industrial Strategy (BEIS), spending up to £100M from the BEIS Energy Innovation Programme to support industry and CCS innovation and deployment in the UK.

In 2019, nine projects were awarded £26M (CAD$44.3M) in funding from BEIS as part of the UK's plan to advance CCS. Three projects won funding from the £20M Carbon Capture and Utilisation Demonstration programme, and six won funding from the £24M Call for CCUS Innovation programme.[ix] The government views CCS as a key technology in decarbonizing the UK's industrial base. Utilizing Contracts for Difference, a strike price is agreed per tonne of CO_2 abated, based on expected costs of building and operating, so project development activity such as FEED may be supported through that policy lever.[x,xi]

In Norway

There is up to $35 billion in CCS development spending available in Europe specifically targeted for projects in the North Sea in Norway, the UK, Denmark, and the Netherlands.[xii] To make way for CCS projects in Norway, in May 2018, the Norwegian Government proposed to fund FEED studies for large-scale CCS with $80M NOK (CAD$11.6M) with total funding for the demonstration project in 2018 amounted to $280M NOK (CAD$406M).[xiii]

In its efforts to reduce its carbon footprint, Norway sees full-scale CCS as in investment worth supporting. In July 2020, the Norwegian Government announced that it would also fund over 80% of the estimated budget of two carbon capture installations.[xiv] The total investment by Norway on the two installations will be €2.1 billion (B) (CAD$3.09B), with the overall project spend being €2.57B, these figures being inclusive of 10 years of operating costs. For the Longship program, the state's share of the costs is estimated to be $16.8B NOK. This means that the state covers around two thirds of the costs of the project.[xvi]

In Australia

In 2012, Australia's government introduced a carbon tax with a plan to eventually transition to a cap-and-trade emissions trading scheme, in an effort to reduce the country's high emissions. Even though the scheme cut carbon emissions significantly, the tax was repealed in 2014 with the election of a new government. Then in 2016, the Australian Government contributed (through a grant) AUD$8.775M towards the feasibility/FEED study stage on a particular project – the CTSCo project in the Surat Basin. Government dollars also supported the Gorgon project.

In March 2021, the Australian Government announced AUD$50M through its CCS Development Fund for grants over three-years to support projects progress towards commercial operations.[xvii] And in April 2021, Australia further announced AUD$539.2M to support new investments in clean hydrogen production and carbon capture technologies.[xviii] The country is still committed to its Paris Agreement target of a 28% reduction from 2005 levels by 2030, with investments in renewable, hydrogen, CCS and CCUS, as shown in the recent funding for six projects on June 1, 2021.

Note: Project capital cost estimates are not always publicly available for projects that have made a positive financial investment decision; similarly for many projects undertaking feasibility or FEED studies, the full costs of these studies are not always in the public domain. The industry funding contribution to project development may, therefore, be understated, perhaps significantly.

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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 (GHG) emissions. Through experience-based guidance, the Knowledge Centre provides the know-how to implement and optimize large-scale CCS projects through the base learnings from both the fully-integrated Boundary Dam 3 CCS Facility and the comprehensive second-generation CCS study, known as the Shand Study. The Knowledge Centre was founded in 2016 as a non-profit organization by BHP and SaskPower.

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