INTERNATIONAL CCS KNOWLEDGE CENTRE

The NEED for FEED

(Summer 2023)

A revised briefing document to explain why front-end engineering and design (FEED) studies are a necessary step in reaching final investment decisions on CCUS projects.

INTRODUCTION

With continued support for large-scale carbon capture, utilization, and storage (CCS/CCUS) in Canada's Budget 2023 (March 8, 2023) and the accompanying proposed Draft Legislation and Regulations for the CCUS Investment Tax Credit (CCUS-ITC) (August 4, 2023) 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 and offers updates in the Canadian policy and program landscape since its first release in 2021. This briefing document is updated from *The Need for FEED* briefing documents (December 15, 2021).

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).

While FEED dollars are not specifically accounted for under the proposed CCUS-ITC, projects will require these in-depth engineering design studies, which require financial commitments in order to be sufficiently completed.

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 result 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.

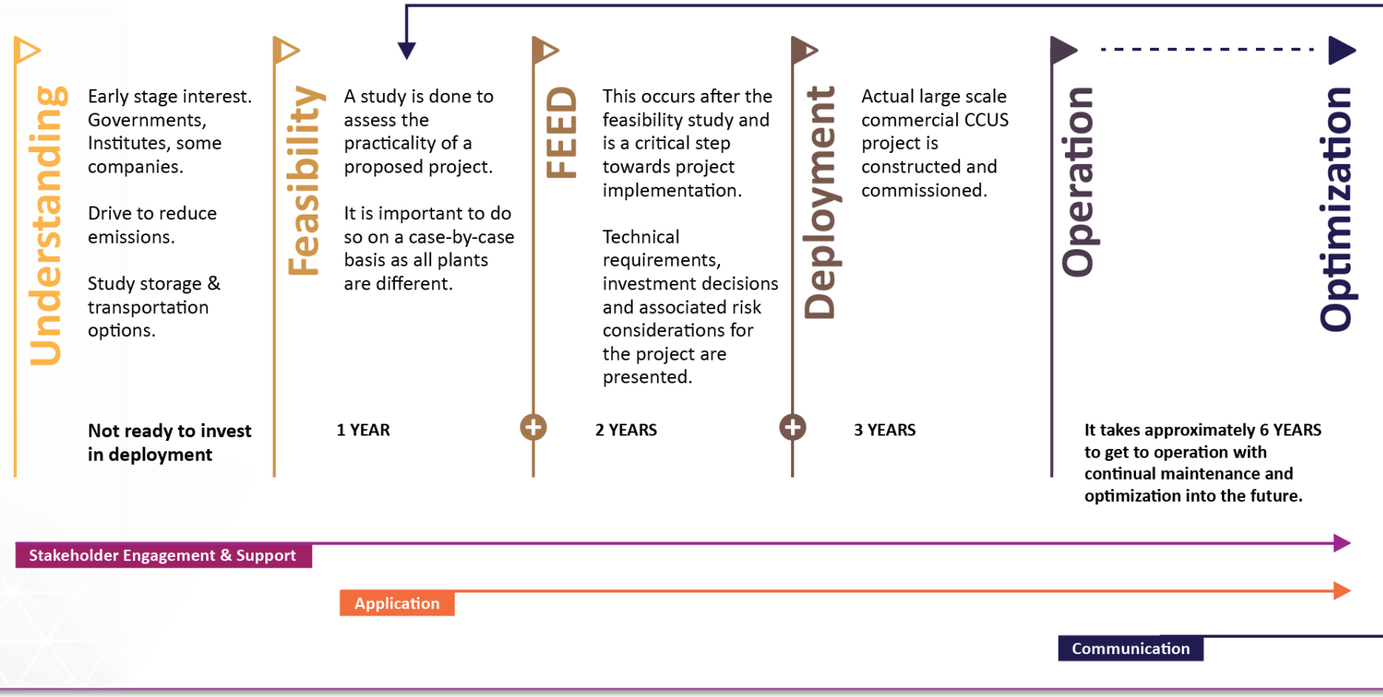
FEED studies are not research or conceptual studies. They are a necessary part of the pathway to deploy a capital project which provides certainty for larger investment. It encompasses much of the actual engineering and design work that can be the basis of the CCS project.

FEED studies for major projects require significant engineering effort and often include 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.

Where are you on the path to CCS?

Aggressive Timeline to Deploy a CCS Project



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 study 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).

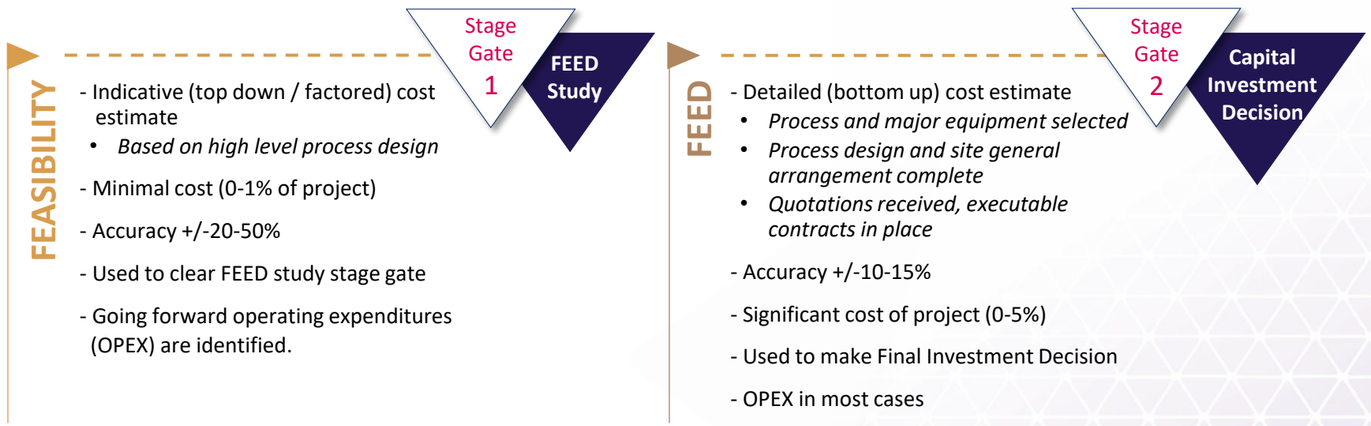
2. **An Acceptable Technology Readiness Level (TRL)** - The capture technology for any given project would need be understood based on its suitability and readiness level. There is more assurance and less risk in technologies which have a higher TRL. (For an overview of TRL assessment key capture technologies,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

On the global scale, there are cases where FEED studies did not result in deployed projects. Thus, allocating FEED dollars as part of the capital of a project can create accounting issues if the project does not proceed, as any associated credit would need to be refunded.

For projects that have proceeded, the capital cost estimates are not always publicly available; similarly for many projects undertaking FEED studies, the full costs of these studies are not always made public. Industry funding contributions to project development may, therefore, be understated, perhaps significantly in any public information.

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 CCUS-ITC, consideration for FEED studies are not eligible for the credit.

In the past, Canada has provided funds to support FEED studies for CCS projects. This grant funding, provided at the FEED stage, was done to enable and advance the CCS projects and allow for FID certainty. For instance, the Boundary Dam Unit 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]

> *According to the proposed language of the legislation, project plans are required to be submitted to Natural Resources Canada under the CCUS-ITC requirements in order for a project to be approved as eligible for the credit. The project plan will reflect the FEED study conducted for the project (and other information specified in the yet-to-be released guidelines).*

It is often the case that some capital advancement activities will occur on the same timeline as FEED execution. Differentiating these activities, and the associated costs, from FEED costs will be necessary to ensure the CCUS-ITC is applied appropriately. Capital expenditures to advance projects at the same time as FEED will be necessary to maintain schedule and have large-scale CCS facilities operational by 2030. An example of this includes paying long-lead equipment vendors to progress design, and potentially procure materials (with an agreed-upon cancellation clause), to manage supply chain challenges. Or, for example, taking advantage of scheduled outages or seasonal restrictions to modify existing facilities to allow for CCUS integration.

These expenditures align with the capital outlay criterion required for claiming CCUS-ITC. Despite occurring at the same time as FEED execution, costs directly related to project actualization reflect the proponent's commitment to the project and ultimately will be reflected in the project plan. Specific "preliminary CCUS work" that will not be included in the CCUS-ITC is defined under the (draft) *Income Tax Act* (below) and its disallowance noted in section 127.44(8)(b)(iii).

- Obtaining permits or regulatory approvals
- Performing design/engineering work, including FEED studies
- Conducting feasibility studies or pre-feasibility studies
- Conducting environmental assessments
- Clearing or excavating land

RECENT CCS FEED INVESTMENT IN CANADA

After the release of the 2021 version of this document, funding for feasibility and FEED studies were announced through other channels in Canada via specific funding calls and programs.

Successful Programs

The Canadian federal and some provincial governments have allocated funds for FEED studies related to CCS projects to foster project initiation and champion technological innovation. In the fiscal year 2021-22, Natural Resources Canada (NRCan) announced a contribution of up to $50 million for CCUS FEED Studies under its Energy Innovation Program, benefiting 11 successful applicants. This federal contribution is harmonized with provincial efforts, such as Emissions Reduction Alberta's (ERA) Capture Kickstart program, which dedicated $40 million to aid pre-FEED endeavors for 11 projects throughout the province. Notably, five projects secured support from both NRCan's and ERA's programs. These combined investments highlight a concerted effort across multiple government levels to advance carbon capture and storage technologies in Canada.

FEEDing Access to Funding Opportunities

To qualify for significant funding and incentives aimed at backing CCS projects, FEED studies are indispensable. As stipulated by the Draft Legislation and Regulations for the CCUS-ITC, aspirants must present a project plan that mirrors critical details found in the project's FEED study (or its equivalent). This project plan necessitates approval from NRCan. Comprehensive guidelines elucidating these prerequisites will be rolled out by NRCan for the CCUS-ITC.

Additionally, prominent funding entities, such as the Strategic Innovation Fund overseen by Innovation, Science, and Economic Development Canada, can expedite the evaluation, processing, and final funding verdict when applications incorporate the support of a FEED study.

The Canadian Infrastructure Bank's Project Acceleration Support

The Canadian Infrastructure Bank (CIB), a crown entity, has earmarked $500 million to accelerate key infrastructure projects across key sectors. This includes a focus on the support of FEED studies essential for energy transition ventures in Canada including CCUS. Through this initiative, the CIB intends to bridge the financial chasm faced during FEED stages, propelling projects towards a faster final investment decision (FID). However, to qualify for this acceleration funding, projects must meet stringent criteria: they must present a robust commercial value, exhibit the potential for GHG reductions, utilize proven low-risk technology, be ready to embark on a FEED study, have secured initial funding, and stand a good chance of reaching FID.

While the CIB can financially support FEED capital, there are limits. It can cover up to 50% of FEED costs, excluding other contributions from governments. Importantly, it's worth noting that the CIB isn't authorized to bestow grants for projects. The process to tap into the project acceleration funding commences with an expression of interest, advances through a screening stage, culminating in a full-fledged application and a commercial dialogue. Through such strategic financial frameworks and rigorous criteria, the CIB aims to expedite and robustly support the next generation of energy transition projects in Canada.

REFERENCES

i. AACE International. “Cost Estimate Classification System – As applied in Engineering, Procurement, and Construction for the Process Industries; TCM Framework: 7.3 – Cost Estimating and Budgeting” (2005), https://www.costengineering.eu/Downloads/articles/AACE_CLASSIFICATION_SYSTEM.pdf

ii. Canada Infrastructure Bank, “Project Acceleration” (2023), https://cib-bic.ca/en/sectors/project-accelaration/

iii. Canada Infrastructure Bank, “Acceleration Funding for Front-end Engineering and Design Capital” (2023), https://cdn.cib-bic.ca/files/Investment/EN/2023-CIB-FEED-Public-Handout.pdf

iv.Emissions Reduction Alberta. “Over $40 Million Investment To Kickstart $20 Billion In Carbon Capture Projects” (July 13, 2022), https://www.eralberta.ca/media-releases/over-40-million-investment-to-kickstart-20-billion-in-carbon-capture-projects/

v. Finance Canada. *Budget 2023: A Made in Canada Plan* (March 8, 2023), https://www.budget.canada.ca/2023/pdf/budget-2023-en.pdf

vi.Finance Canada. “Legislative Proposals Relating to the Income Tax Act and the Income Tax Regulations” (2023), https://fin.canada.ca/drleg-apl/2023/ita-lir-0823-l-2-eng.pdf

vii. Global CCS Institute, *Technology Costs & Readiness of CCS* (March 2021), https://www.globalccsinstitute.com/wp-content/uploads/2021/04/CCS-Tech-and-Costs.pdf

viii.Innovation, Science and Economic Development. “Program Guide: Strategic Innovation Funding” (2023), https://ised-isde.canada.ca/site/strategic-innovation-fund/en/about-program/program-guide

ix.International CCS Knowledge Centre. *Incentivizing Large-Scale CCS in Canada* (2020), https://ccsknowledge.com/pub/Initiatives/Incentivizing_Large_Scale_CCS_In_Canada_(FINAL_2021-06-11).pdf

x.International CCS Knowledge Centre. The Need for FEED (December 15, 2021), https://ccsknowledge.com/pub/Initiatives/The_NEED_for_FEED_Dec._15_2021.pdf

xi.Natural Resources Canada. “Energy Innovation Program – FEED Studies for Carbon capture, utilization and storage” (2023) https://natural-resources.canada.ca/science-and-data/funding-partnerships/funding-opportunities/funding-grants-incentives/energy-innovation-program-feed-studies-for-carbon-capture-utilization-and-storage/energy-innovation-program-feed

INTERNATIONAL CCS KNOWLEDGE CENTRE

The International CCS Knowledge Centre (Knowledge Centre) is a non-profit organization founded in 2016 by BHP and SaskPower to advance large-scale carbon capture and storage (CCS) projects as a critical means of managing greenhouse gas emissions and achieving the world’s ambitious climate goals. The Knowledge Centre provides independent, expert advisory services for CCS projects across heavy-emitting industries based on our team’s unique experience developing the world’s first fully integrated post-combustion CCS facility on a coal-fired power plant. We have a proven track record of helping our clients lower costs, reduce risk and improve the performance of CCS projects across industries and technology platforms using the latest knowledge and lessons learned from major projects across the globe.

Contact us at:
198-10 Research Drive, Regina, SK, Canada, S4S 7J7 | 1-306-565-KNOW (5669) |
info@ccsknowledge.com

ccsknowledge.com