geoconvention
Calgary • Canada • May 15-17 2023

Subsurface methodologies and CCS: similarities and differences

Lee Hunt lhunt@carbonalpha.com, Eric Street, Graham Hack, Carbon Alpha

Summary

In 2022, the Government of Alberta (GOA) entered into negotiations with 25 project teams to potentially approve storage hubs for the timely and safe permanent underground storage of carbon dioxide (CCS). [1] This puts these 25 projects—and likely others that have not yet been announced—in the early stages of the CCS project timeline. This is a very interesting situation for geoscientists as the early stages of CCS projects involve a specific and heavy need for certain kinds of subsurface knowledge. Moreover, although organizations like National Energy Technology Laboratory (NETL) and the CSA Group have published generalized workflows and standards, respectively, for CCS projects, there is not a wide history for the development of carbon hubs. [2] [3] Geoscientists may well wonder how to most efficiently implement these general workflows, but this lack of history leaves them with little to refer to. The Shell Quest carbon storage project is one such example, however it was one of the first of its kind and enjoyed tremendous governmental financial support—a level of support that most current projects cannot expect. [4] Carbon hubs under current development will likely manage their projects somewhat differently from the methods of Quest. This lack of relevant history illuminates the exigency for discussing how the geosciences will be conducted in these new projects—particularly for the early project phases that we know so many groups are currently working through.

This talk explores some of the key challenges that geoscientists will encounter in the early stages of a CCS project, and further seeks to leverage knowledge from other branches of the energy industry to describe some of the possible solutions. In particular, we look at numerous aspects of oil and gas exploration and development and examine how it applies to CCS. How is CCS similar? How is it different? And why.

Early stages of a CCS projects

CCS projects have long timelines by business standards—spanning several decades in many cases, and even longer if we consider post-closure stewardship. This project longevity is necessitated by several factors, including:

- The expense of the project infrastructure, planning, regulatory processes, and building, requires a long, stable, project life.
- Projects are tied into key human activities, such as complex and inter-related energy systems—which, as popular as the word ‘disrupter’ may be, are not generally well served by extremely transitory solutions.
- The permanence of the planned-for storage.

And so, even the early stages of a CCS project can span several years. Figure 1, below, is a rendition of the generalized CCS workflow. Of importance is the final investment decision milestone (FID) wherein the choice is made for the project to go forward or not. For the purposes of this talk, we define the early stages off a CCS project as all the work that occurs prior to FID. In the language of NETL, we are referring to the Site Screening, Site Selection, and Characterization steps. Focusing on these stages is necessary for this talk as the subsurface paradigm changes in the Develop and later times of the project, where operational activities proceed and measurement, monitoring and verification (MMV) activities take on a dominant role.

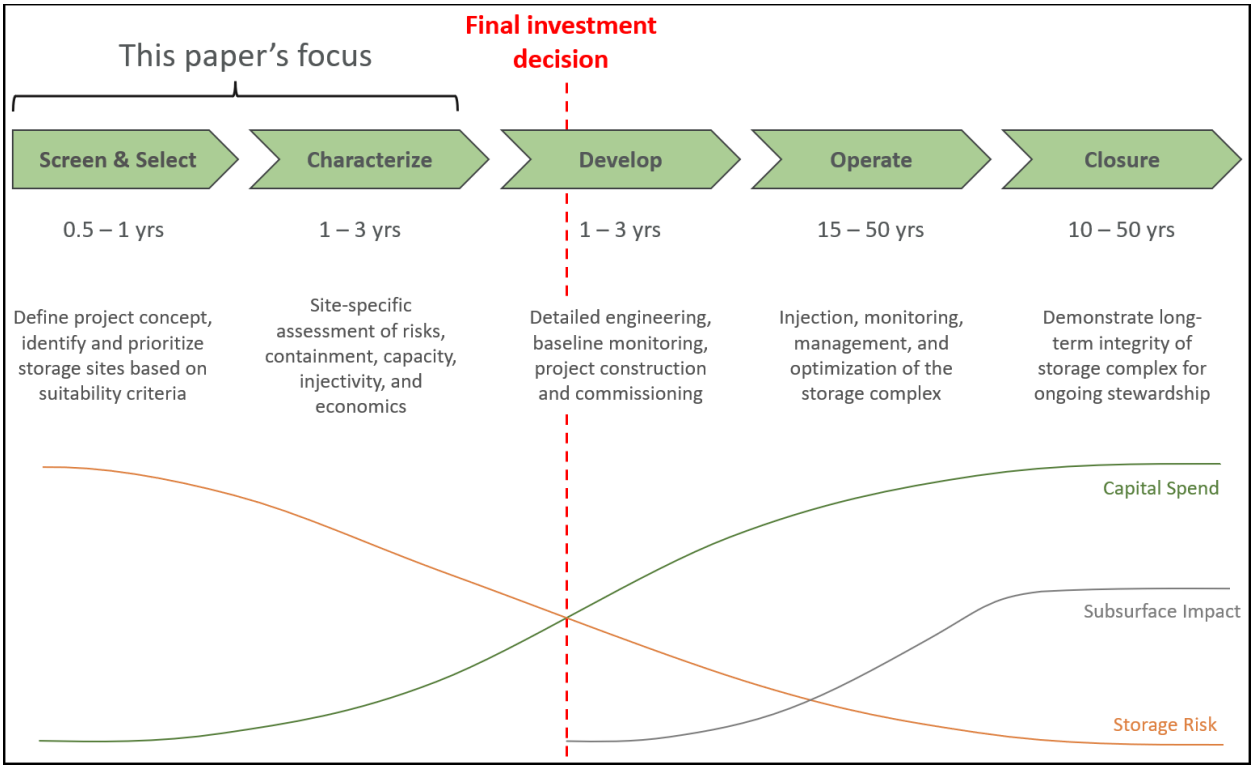

Figure 1, a generalized flow-chart for a CCS project life through the Closure stage. Numerous projects are currently working through the early stages, prior to FID. It is likely that many of the 25 projects that the GOA is currently negotiating with are currently in the Characterization stage.

Figure 2 shows a conceptual zoom-in on the pre-FID stages of a CCS project. Each stage has its own level and type of work to be done, and often comes with a milestone report. In the case of the recent GOA process, the requested expression of interest (EOI) more or less conformed with the Site Screening stage, though some operators may have been into Site Selection. The subsequent governmental request for full project proposals approximately aligns with feasibility reports and the conclusion of the Site Selection stage. [1] To this stage in a CCS project, much

of the geosciences work involves publicly available data, though some projects will have invested in some amount—modest, most likely—of seismic data.

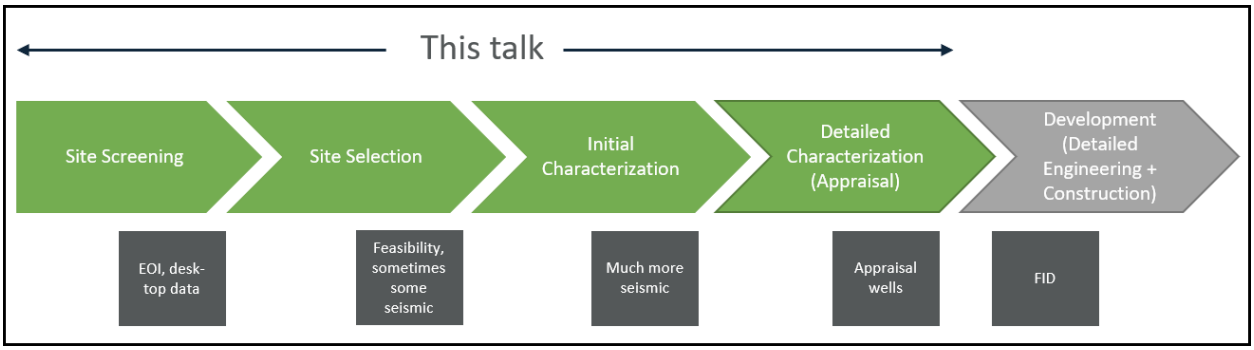

Figure 2, a more resolved look at the initial stages of a CCS project. The dark boxes represent reporting milestones and key data types that are typically invested in at each stage.

It is in the Characterization phase, broken into Initial and Detailed elements, that more significant investments are made in new geoscientific data. This can take the form of additional purchases of seismic data and the drilling of evaluative wells (often called Appraisal wells). Figure 3 is a modified version of a NETL Initial Characterization depiction, and captures some of these activities. The demand for detailed specific subsurface analysis is much larger as this is the stage that leads to FID, where tremendous amounts of capital may be committed. As such, significantly greater amounts of seismic may be licensed or even acquired, and later in Detailed Characterization, wells may be drilled. Coming out of these stages, subsurface uncertainties must be reduced and a ranked set of risks must be mitigated. Ultimate questions of the storage complex's storage capacity, sealing capability, geomechanical properties, geochemical and hydrogeological parameters must be well understood.

The stages that precede Characterization ask many of the same questions of the subsurface, though typically to a lighter degree, and with less investment in new data. [2]

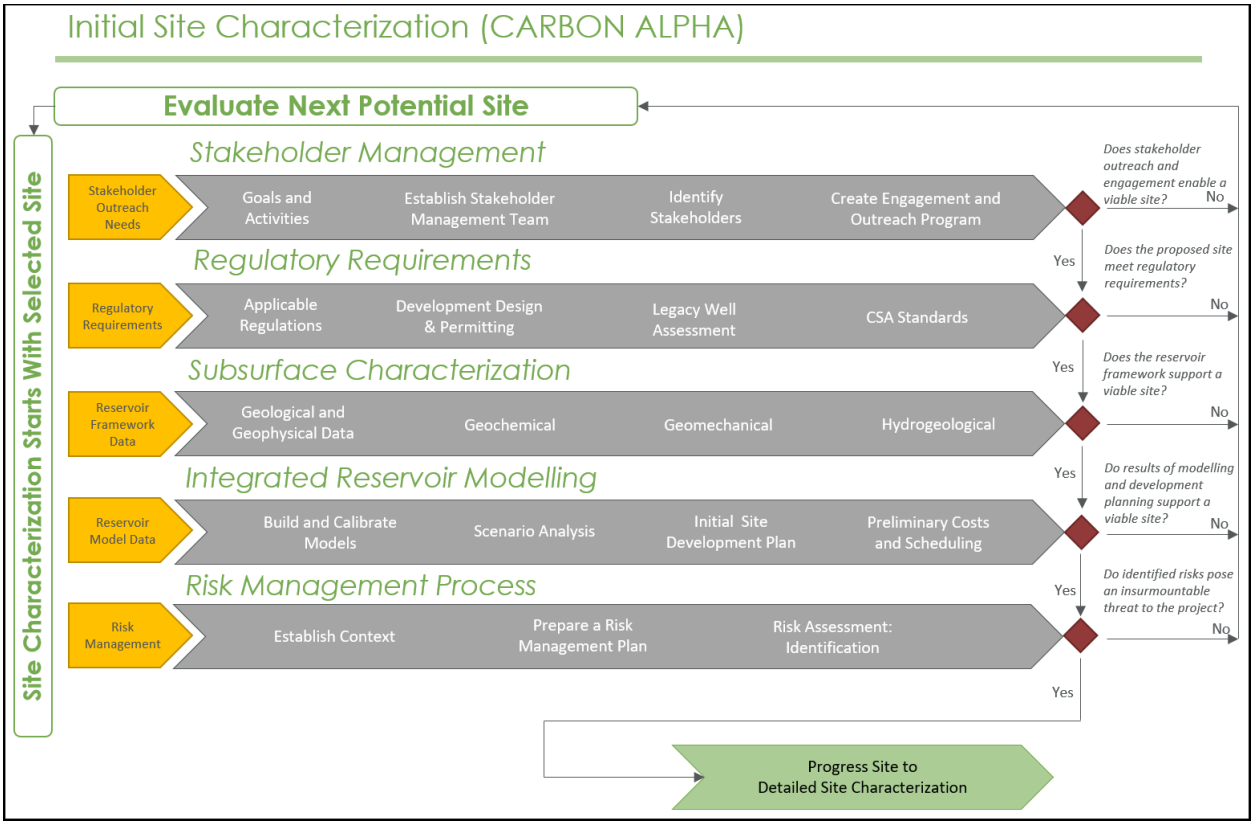

Figure 3, a customized version of NETL's initial characterization figure. This is the stage of the pre-FID activities in which most of the seismic investment is commonly made. The information from initial and detailed Characterization are used to make the FID, so this subsurface analysis is critical for decision makers.

Comparisons with oil and gas: what questions are we going to ask?

These charts and diagrams from NETL or other sources are very thoughtfully put together, but the chart alone does not instruct geoscientists and engineers how to do the job. Nor can those visual tools tell anyone how to conduct their jobs in the most efficient and effective way possible. Bringing the early-stage CCS activities into practice requires serious consideration, and we would argue—experience. Given the relative lack of experience in the CCS field, it makes sense to compare CCS activities with roughly analogous ones from other geoscientific endeavors.

Table 1 shows some of the comparisons that can be made. It begins with the Shell Quest CCS project, which in many ways, *is* a good historical example for those projects currently being developed. Examining the relevant similarities will and what they mean for geoscientists will be helpful. Almost as useful will be examining the differences between the new projects and Quest. How and why would a new project conduct its geosciences program differently? Sometimes it is the difference that is the thing that leads to better efficiency.

We will conduct a discussion of the similarities and differences in the other key sub-categories in the table. This will be the focus of the talk, and will involve audience participation.

Comparison of current early stage CCS projects versus:	Rank most alike	Rank most different	What is similar?	What is different ?	Key learning from the comparison
Shell Quest					
International Exploration					
Pre-1990's Canada E&P					
Modern unconventional tight gas exploitation					
CO2 EOR					
Steamflood heavy oil					
Value of 2D seismic versus 3D seismic					

Table 1 showing the oil and gas sub-categories to be compared with current early stage CCS business and geosciences activities. The audience will participate in the discussion and ranking.

Results

This talk asks some very basic, but fundamentally necessary questions, about the use of geosciences and engineering in the early stages of a CCS project. Given the unprecedented number of projects being considered for governmental approval for CCS rights, this discussion is likely happening in some form across the CCS industry. We have taken the approach of short cutting our collective lack of history with CCS projects by leveraging expertise within the energy industry. Our leveraging occurs through the use of analogic and critical reasoning.

Results and novel value

The authors wish to thank Carbon Alpha for their support with this presentation.

References

[1] Government of Alberta, 2022, Carbon Sequestration Tenure Management, https://www.alberta.ca/carbon-sequestration-tenure-management.aspx

[2] National Energy Technology Laboratory, 2017, Best Practices: Site Screening, Site Selection, and Site Characterization for Geologic Storage Projects, DOE/NETL-2017/1844

[3] CSA Group, 2022, Geologic storage of carbon dioxide, Z741-12, CSA Group

[4] Crouch, Syrie, 2011, Quest Storage Development Plan, Quest CCS Project, https://open.alberta.ca/dataset/46ddba1a-7b86-4d7c-b8b6-8fe33a60fada/resource/5555eb2e-6d86-4419-97a3-8d3de7c5b702/download/storagedevelopmentplan.pdf