CCS Project Risk Management

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Project Risk: Definition

Possible Deviations from Objectives

Mission of Risk Management

To Suppress Possible Unfavourable Deviations (Threats)

To Enhance Possible Favourable Deviations (Opportunities)
Key Questions

Possible Deviations from CCS Objectives

Question #1: What Are Typical CCS Project Objectives?

Question #2: Where Deviations Might Come from?
## Typical CCS Project Objectives & Baselines

<table>
<thead>
<tr>
<th>CCS Objective</th>
<th>CCS Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Capacity</td>
<td>Amount of CO\textsubscript{2} Captured, Transported, Stored &amp; Sold</td>
</tr>
<tr>
<td>Incremental Oil</td>
<td>Incremental Oil Produced Due to CO\textsubscript{2}-EOR (if applicable)</td>
</tr>
<tr>
<td>CapEx</td>
<td>Approved Capital Expenditure Budget</td>
</tr>
<tr>
<td>OpEx</td>
<td>Net Present Value of Approved Operating Budget</td>
</tr>
<tr>
<td>Profitability</td>
<td>Approved Level of Profitability</td>
</tr>
<tr>
<td>Schedule</td>
<td>Approved Project Completion Date</td>
</tr>
<tr>
<td>Environmental</td>
<td>No Negative Environmental Impact</td>
</tr>
<tr>
<td>Health &amp; Safety</td>
<td>No H&amp;S Impact on Workers and General Public</td>
</tr>
<tr>
<td>Reputation</td>
<td>Reputational Benefits; No Negative Impacts on Stakeholder Relations</td>
</tr>
</tbody>
</table>

**Lesson Learned #1:** The Better CCS Objectives and Baselines Developed, the Smaller Room for Risks
## Risk Breakdown Structure: Where Risks Might Come from?

<table>
<thead>
<tr>
<th>RBS Category</th>
<th>RBS Sub-Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regulatory &amp; Stakeholders</strong></td>
<td><em>Applicable Regulations</em>&lt;br&gt;<em>Approval Process &amp; Permits</em>&lt;br&gt;<em>General Public</em></td>
</tr>
<tr>
<td><strong>Organizational</strong></td>
<td><em>Adopted Project Development Procedures</em>&lt;br&gt;<em>Project Team Structure &amp; Skills</em></td>
</tr>
<tr>
<td><strong>Economics &amp; Agreements</strong></td>
<td><em>Commodity Market and Sales Agreements</em>&lt;br&gt;<em>Incremental Oil (CO₂-EOR)</em>&lt;br&gt;<em>Infrastructure in Place</em>&lt;br&gt;<em>Funding, Grants and Investments</em>&lt;br&gt;<em>Taxes and Credits</em>&lt;br&gt;<em>Profitability &amp; Phasing</em>&lt;br&gt;<em>Acceptance Criteria</em></td>
</tr>
<tr>
<td><strong>Project Development &amp; Execution</strong></td>
<td><em>Front End Loading</em>&lt;br&gt;<em>Reservoir Characterization &amp; Source – Sink Match</em>&lt;br&gt;<em>EPC</em> of Capture, Transportation &amp; Storage*&lt;br&gt;<em>Capture – Transportation - Storage Integration</em>&lt;br&gt;<em>Commissioning &amp; Start-up</em></td>
</tr>
<tr>
<td><strong>Operations</strong></td>
<td><em>Capture Operations</em>&lt;br&gt;<em>Transportation</em>&lt;br&gt;<em>Injectivity &amp; Accepted Capacity</em>&lt;br&gt;<em>CO₂-EOR</em>&lt;br&gt;<em>Measurement, Monitoring, Verification (MMV)</em>&lt;br&gt;<em>Seismic/ Tectonic &amp; Cap Rock Integrity</em>&lt;br&gt;<em>Asset Integrity</em></td>
</tr>
</tbody>
</table>

*EPC = Engineering, Procurement, Construction*
Risk Management vs. Front End Loading (FEL)

**Lesson Learned #3:** Business Case (FEL1) and Alternative’s Selection (FEL2A) Phases Are Most Critical Phases for Success of a CCS Project

**Rule #1:** Project Moves to a Next Phase only When Objectives of a Previous Phase Met

**Lesson Learned #2:** Violating FEL Logic Is a Major Organizational Risk

*EPC=Engineering, Procurement, Construction*
Crucial Importance of Business Case (FEL1) Phase

Goal: Development of a CCS Project Business Model that Marries

- Monetary and Non-Monetary Benefits of Project Owners as For-Profit Organizations and Good Corporate Citizens

with

- Smart Application of Carrots & Sticks

**CCS Project Owner’s Benefits**
- CCS Leadership
- Reputational Benefits
- Technology Licensing
- Incremental Oil
- Overall Profitability

**CCS Carrots & Sticks**
- Grants
- Credits
- Taxes
- Standards & Regulations
- Infrastructure in Place
- CO₂ Market in Place

**Lesson Learned #4:** Most of CCS Project Failures Stem from Mismatch of the Benefits and Carrots & Sticks (Pull vs. Push Mismatch)
Crucial Importance of Alternative’s Selection (FEL2A) Phase

Goal: Selection of a Project Alternative that Meets Two Criteria

- Most Optimal Economics, Geology, Technology, Location, etc. (Multiple Criteria Decision Analysis (MCDA*))
- Lowest Project Uncertainty & Risk Exposure**

Lesson Learned #5: It Is Much Easier to Manage Risks of a CCS Project Alternative That Is Least Risky First Place

Conclusion

Although Managing CCS Technical and Project Execution Risks Is Important

Mutual Understanding and Exploitation of Industry’s and Government’s Drivers Are Most Crucial (Pull vs. Push Equilibrium)

Role of CCS Risk Management:

• Assist with Finding the Equilibrium as an Objective
• Manage Deviations from The Equilibrium
• Ensure Successful CCS Project Execution