STORAGE READY

Planning saline reservoir storage developments – the importance of getting started early

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Abstract

Finding suitable storage sites and securing industry participation in geological storage of carbon dioxide (CO_2) is critical to the successful development of every integrated carbon dioxide capture and storage (CCS) project, although there is often poor understanding by stakeholders of the process, time, costs, and business risks involved in the assessment and development of geological storage sites, especially for saline reservoirs. A systematic stage gate process, methodology and work programme for the storage life cycle is presented. A major consideration for saline reservoirs is the requirement for new exploration and appraisal activities at the site identification and characterisation stages to prove sites in a practical sense. This may involve seismic reprocessing, 2D/3D seismic acquisition and drilling new wells, coring and injection tests. The amount of time required from initial screening to the project investment decision could take more than ten years for some sites depending on data availability, the status of licensing and regulatory frameworks and the pace of stakeholder approvals. The costs may also be substantial with expenditure up to millions of dollars. CO_2 capture and transportation investments will need to progress in parallel, but it will be prudent for a geological storage site to be proven with high certainty prior to physically locating any capture plant or pipeline system. A significant risk is that a viable site may not be confirmed by such site assessment work and the entire CCS chain development could be put at risk. This is analogous to exploration and appraisal risk for oil and gas exploration. Although the quantification of storage exploration risk has not yet been calibrated, there are examples from ongoing geological storage activities where site characterization activities have not yielded positive results that meet the anticipated outcomes of earlier screening studies. Providing storage solutions for CCS deployment and capture by major emitters is widely described as a new business opportunity for potential investors. New business models for geological storage will need to be developed providing remuneration for the storage provider from CCS value chains, commensurate with the additional risk involved. A number of technical, business, policy and regulatory risks impact the risk/reward balance and attractiveness of geological storage as a business opportunity. These include the uncertain and long term nature of monitoring obligations and carbon policies, uncertainties around long-term liabilities, exploration risk in saline reservoirs and potentially low returns. These considerations provide further justification for developing policies for CO_2 storage. Because of the potentially extended timescales, it is essential to get an early start on saline reservoir storage opportunities and for the risks to be appropriately addressed by policymakers and by carbon emitters who require storage services.

The overall project goals, the generalised scope of activities involved, and time required in a storage project are presented for each stage in Figure 1, together with the major milestones. Storage activities such as site characterisation, selection, and monitoring plans as required in emerging regulatory frameworks are incorporated, along with drilling and seismic activities. Through the successive stages the technical objective is to reduce or better quantify geological uncertainty and risk associated with the prospectivity assessment of the storage site capacity, injectivity, containment and integrity. A major consideration for saline reservoirs is the requirement for new exploration and appraisal activities to address the technical and environmental objectives for site characterisation and project approval and injection permitting by regulators and to provide the confidence required to commit to long term CO_2 offtake / storage contracts that will underpin the upstream capture and transport investments. The timeframes for each stage are based on the types of activity involved and include experience from existing projects. The timeframes in Figure 1 are generic in nature, and actual timeframes for specific projects will depend on the site characteristics, scope of activities required, regulatory frameworks and the industry environment as well as public attitudes to the project and how long it takes to gain public acceptance. The storage activities and project development timeline will need to be fully integrated with and to proceed in step with capture and transportation.

Figure 1: Stage Gate Framework for Storage activities in Saline Reservoirs

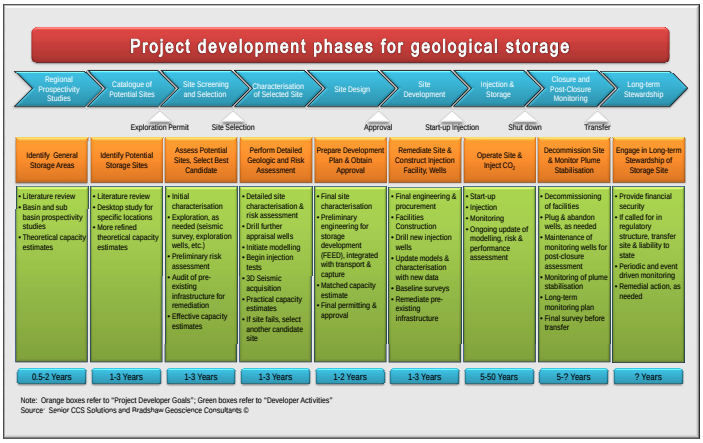

Illustration of Graduated Levels of Requirements for a CO_2 Storage Ready Plant

	Component	CCS Ready Level 1	CCS Ready Level 2	CCS Ready Level 3
CO_2 Storage Ready Plant	Storage Site Selection	Estimate total amount of CO_2 to be captured and stored for all years of CCS operation of the plant, and identify one or more feasible storage sites expected to accommodate the captured CO_2	In addition to Level 1 requirement, obtain contractual options to one or more appropriate storage sites	In addition to Level 2 requirement, obtain rights to one or more appropriate storage sites
	Verifying Injectivity, Capacity and Integrity of Storage Site	Review existing regional prospectivity studies and show that the required capacity is theoretically available	In addition to Level 1 requirement, conduct desktop study of injectivity, capacity, and integrity of storage location(s), and show that "Effective" capacity is available	In addition to Level 2 requirement, conduct geological exploration to screen and select specific site(s) for more detailed characterisation. Estimate "Practical" capacity and conduct initial modeling of long-term reservoir behavior
	Design of Storage Facility	Prepare preliminary design for storage facility, including monitoring and verification	Prepare technical feasibility study for storage facility, including monitoring and verification	In additional to Level 2 requirement, prepare a Design Basis Memorandum (DBM) for storage site facility, including monitoring and verification
	Conflicting Uses and Rights	Identify any conflicting surface and subsurface uses, as well as feasibility of access to site(s)		Resolve any issues with conflicting surface and sub-surface uses, and site access
	Cost Estimate for Storage Facility	Prepare preliminary economic analysis for storage facility including capital and operation and maintenance costs, and estimate the cost of storage for the capture plant	Conduct preliminary economic feasibility study based on technical feasibility study, including the cost of storage for the capture plant	In addition to Level 2 requirement, prepare follow-on economic feasibility study based on technical information provided in DBM
	Environmental, Safety and Other Approvals for Storage Site	Identify all approvals that will need to be obtained for storage site	Conduct feasibility studies for obtaining all approvals for storage site	Prepare key documents for obtaining all approvals for storage site
	Public Awareness and Engagement Related to CO_2 Storage Site	Notify public of eventual storage site via web site and other actions	Seek public engagement in storage site planning	In addition to Level 2 requirement, encourage public engagement in storage site approval process
	Sources for Equipment, Materials and Services for Storage Site	None	Compile list of companies who can supply equipment, materials and services needed for construction and operation of storage site	Contact companies and negotiate nonbinding letters of intent to bid on project
	Ongoing Obligations	File periodic reports with regulators on status of storage ready		In addition to Level 2 requirement, respond to mandatory trigger mechanism to develop storage site for injection

Source: ICF International

Conclusions

The systematic framework for storage activities presented in this paper can be used to improve understanding of the work programme, project stages, time, costs, technical and business risks involved in geological storage site assessment and development. The initial stages of screening activity for saline reservoirs, both of which will generally be required ahead of exploration permitting, may take between 1.5 and 5 years. Once permitting and licensing regimes for saline reservoirs are in place and exploration permits are awarded, a further 3 - 8 years may be required ahead of project approval and storage permitting. Exploration and appraisal activities are likely to be required for most saline reservoir CO_2 storage opportunities due to the limited data and geological understanding after initial screening. The storage aspects of CCS Ready are of particular importance due to the long timeframe and necessary investment in geological assessments. In summary, in the current policy environment developing storage sites may be an uncertain, potentially time-consuming, costly and risky business opportunity. If CCS is to be deployed at industrial scale to mitigate climate change, these limitations will need to be rapidly resolved by policy makers and so provide industry with the appropriate incentives to proceed. Delay in implementing these policies and incentives will hamper the development of a commercial storage industry, further putting CCS technology development at risk.

Storage Screening Studies - Duration, Effort and Costs at Different Scales in Australia

ASSESSMENT SCALE /CATEGORY	WORLD	COUNTRY	PROVINCE (STATE)	BASIN	SUB-BASIN
WORK YEARS	0.5 (200)	6 (120)	8	2	4
COST	$50K	$1 Mill	$2 Mill	$1 Mill	$0.75 Mill
LEVEL	BASIN	BASIN	BASIN / PLAY	PLAY / SITE	PLAY / SITE (SCREENING)
GOVERNMENT, INDUSTRY	GOVERNMENT	GOVERNMENT	GOVERNMENT	GOVERNMENT, INDUSTRY	INDUSTRY
DURATION (YRS)	0.25	2	1	0.5	1

Potential exploration and appraisal drilling and seismic costs to prove a storage site in saline reservoirs ($AUS)

Anticipated costs for geological storage in saline reservoirs		Item	Number From	Number To	Cost ($mill AUS) From	Cost ($mill AUS) To	Total ($mill AUS) From	Total ($mill AUS) To	Comment
Onshore	Exploration	Well	1	5	3	5	3	25	
		Seismic 2D	1	1	3	5	3	5	
						Sub-Total	6	30	
	Appraisal	Well	2	10	5	5	10	50	Dependent on the location, many more wells may be required
		Seismic 3D	1	1	3	5	3	5	More localised, and/or higher resolution seismic survey
						Sub-Total	13	55	
						TOTAL	19	85	
Offshore	Exploration	Well	1	5	15	30	15	150	
		Seismic 2D	1	1	3	5	3	5	
		Seismic 3D	1	1	5	15	5	15	
						Sub-Total	23	170	
	Appraisal	Well	2	3	15	30	30	90	Dependent on the location, many more wells may be required
		Seismic 3D	1	1	5	10	5	10	More localised, and/or higher resolution seismic survey
	Note: Based on likely costs, activities and experience from geological storage operations in Australia for drilling and seismic acquisition for saline reservoirs.					Sub-Total	35	100	
						TOTAL	58	270	

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