Steps to achieve storage readiness for European industrial CO_2 source clusters, ALIGN-CCUS

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Abstract

Full-chain CCUS projects require storage capacity that is assured and available to contain the volume of CO_2 captured and transported to a storage site at a rate, volume and timing determined by the source. Storage capacity for an industrial and power cluster must receive varying and increasing volumes of CO_2. Operators and their financiers must have the confidence to invest in the storage service, within an integrated chain of components, and certainty on the cost to deliver low-risk storage capacity.

Estimates of theoretical capacity and pre-characterisation storage appraisals indicate an overabundance of potential storage sites in the North Sea, e.g. CO_2Stored.co.uk, with CO_2 transport assumed to reuse extensive offshore oil and gas infrastructure. However, additional capacity to serve the developing demand for storage by the low-carbon industrial source clusters, beyond the existing planned CCS projects, has not been defined and the resources needed to bring it to the proven resource level are not known.

Understanding the existing levels of storage readiness and activities to achieve contingent resource status by learning from already appraised sites, will reduce the time and cost to develop a storage site in Europe. The objective is to reduce developer cost for the initial site screening and increase confidence to invest in the development of the cost-effective storage for a CCS project.

Considerable national, EC and industry resources have been invested in the appraisal of individual European storage sites, sufficient to either apply for (Goldeneye and Endurance stores, UK) or be awarded (Sleipner and Snøhvit fields, Norway, and the Netherlands P18-4 Field) a storage permit. Pre-characterisation of prospective North Sea sites based on existing available data, supported by governments, EC and industry, mostly indicate the technical feasibility of individual stores and, exceptionally, also an indication of cost. Permits awarded for operating CO_2 storage sites on the Norwegian Continental Shelf, based on petroleum production laws and regulations, address the additional challenge of close proximity to and constraint by ongoing petroleum operations. At the present stage of CCS deployment, most prospective operators do not know the activities, their duration and the resources needed to take potential sites from feasible to permit-ready status and so assure storage for their project development plans. Oil and gas companies use resource management systems, developed for hydrocarbon field development planning, to establish the investment needed to reach the higher levels of storage readiness. Such systems have not yet been widely applied to CO_2 storage to assess the resources needed to achieve contingent level, the step preceding storage permit-readiness.

The ALIGN-CCUS project (Accelerating Low CarboN Industrial Growth through Carbon Capture Utilisation and Storage) has determined the steps for storage site characterisation, the timescale and level of resources needed for a feasible store to become a contingent storage resource by:

- Presenting standardised, benchmarked definitions of European 'Storage Readiness Levels'(SRL)
- Defining the readiness steps to achieve a contingent storage resource
- Determining the level of resources and timescale needed to achieve each step

The classification framework (Figure 1) describes the level of appraisal achieved on the pathway to the Final Investment Decision (FID) and defines the steps between SRL 1 (basic assessment), through SRL 7 (contingent resource) and SRL 9 (storage site operational). The steps take account of the process of site appraisal, they are complementary to existing published storage capacity classification schemas and the developing industry storage resource classification led by the Society of Petroleum Engineers.

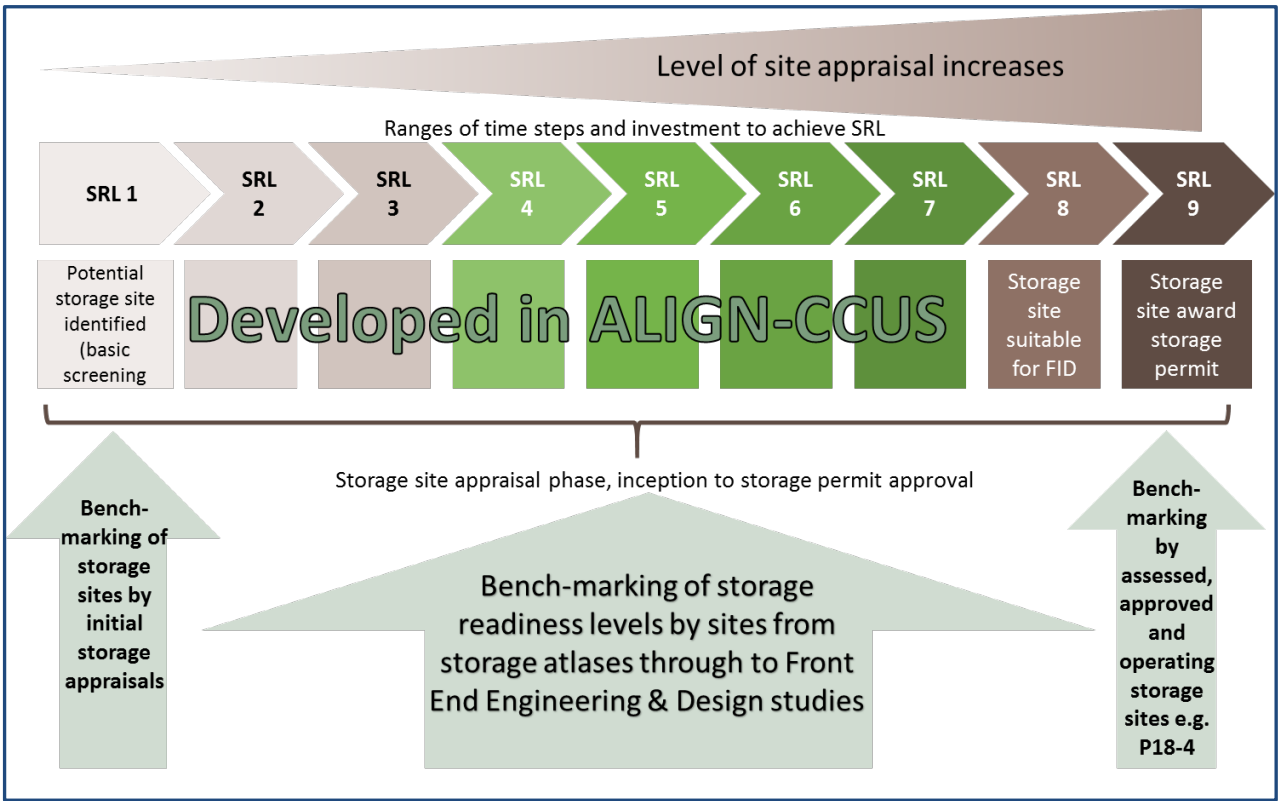

Figure 1. Storage Readiness Levels (SRL) developed in the ALIGN-CCUS project

Site appraisal experts, storage developers, policy- and decision-makers and financiers have reviewed the classification framework and their views are incorporated into the SRLs. Importantly, whilst other schemes focus on the volumetric pore space available to store CO_2, the SRLs are the steps needed to reach contingent storage resource level prior to the FID rather than a categorisation of storage capacity.

The SRLs have been benchmarked against existing and prospective Europe storage sites which have undergone detailed storage site appraisal. The P18-4 Field in the Netherlands is the benchmark for the highest SRL as, currently, the field operator holds the only CO_2 storage permit issued under the EU Storage Directive. The detailed Front-End Engineering Design studies for the planned UK hydrocarbon Goldeneye Field and saline aquifer Endurance structure sites benchmark the steps for contingent resource. The injection permits for the two operating Norway CO_2 storage sites at Sleipner and Snøhvit were awarded under the petroleum production laws and regulations. A review of the steps taken by the operators (and licence groups) to achieve FID for the Norwegian storage sites

includes consideration of the associated oil and gas operations. Close proximity to ongoing petroleum operations, due to the continuity of hydraulically connected pore space within the storage strata, will place additional constraints on the extension of CO_2 storage capacity beyond existing appraised sites. The potentially wide-spread effects of pressure changes due to storage operations, whether in depleted fields or saline aquifer formations, must not adversely impact hydrocarbon production. The definition of SRLs takes such constraints into account.

The internationally benchmarked classification framework of Storage Readiness Levels presented allows the level of site appraisal of a potential CO_2 storage site to be quickly understood by decision makers, storage operators and developers, financiers and academics. Practical and realistic estimates are given of the timescale and resources needed for potential storage capacity in fields and aquifer sandstones to become ready for the investment decision for a full storage permit application. The estimates will be applied to the options identified for future storage needed from existing North Sea industrial source cluster in ALIGN-CCUS. The objective is to reduce the uncertainty perceived by capture operations and investors, associated with timely and cost-effective provision of storage.

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