

An international guideline for assessing  
and validating CO<sub>2</sub> geological storage  
sites from selection to closure

# The world's most comprehensive guideline to assess and validate geological storage sites for CO<sub>2</sub>



To maximise the global potential of Carbon Capture and Storage (CCS), trusted and effective procedures are needed to guide the selection and management of storage sites. To date this has been a missing link in the effort to speed up the large scale application of CCS.

This is why leading engineering, oil & gas, energy and service companies - with valuable support from government agencies - have developed a guideline to support all stakeholders. The developed

procedural framework in the guideline mirrors best practices within the oil & gas and energy industries. It reflects existing and emerging regulations, codes and standards relevant for geological storage of CO<sub>2</sub> internationally - drawing on learnings from R&D and pilot CCS projects around the world.

The development of the CO2QUALSTORE guideline has been coordinated by the independent risk management company DNV.



## Support for project developers and regulators

The CO2QUALSTORE guideline will help those directly involved in the implementation and permitting of individual CO<sub>2</sub> storage projects to reach agreement in key areas. It is aimed at individual project developers, operators and local authorities, as well as regulators and policy makers, at national and international level.

**Operators** are provided with:

- A transparent basis for examination and decision-making to meet internal milestones and decision gates
- A guide to set performance targets that will enable the granting of relevant

permits for individual sites, including permits for Exploration, Storage and Transfer of Responsibility

- Predictable operating conditions and consistency and efficiency in project development based on regulatory frameworks, best engineering practice and best available technology.

**Regulators and national authorities** are provided with:

- A guide to verify that sites have been selected and assessed to be suitable for geological storage of CO<sub>2</sub> in line with a standardised and globally recognised procedure

- A standardised reference for permitting and verification
- A technical basis for development of national regulations for storage of CO<sub>2</sub> aligned with industry best practice and national regulations.

**Public and third parties** are provided with:

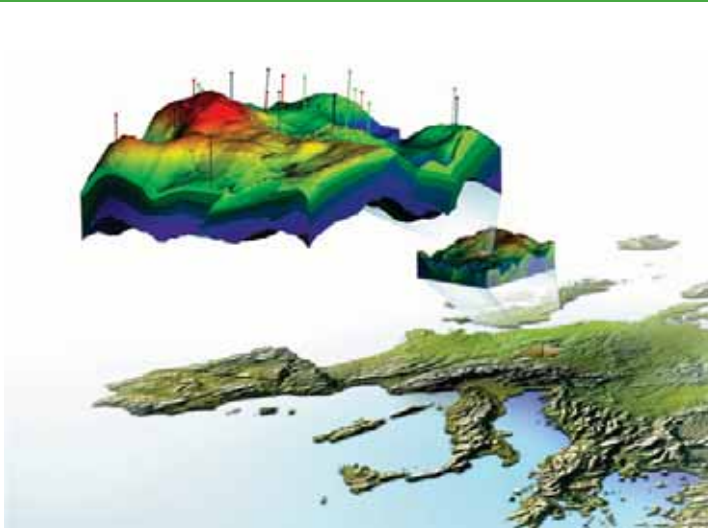
- Assurance that a verified storage site is selected based on a recognised process, that it will be safely and responsibly managed according to recommended practices for sustainable CO<sub>2</sub> storage, and that it is in compliance with regulations, codes and standards.

# Agreed best practice for the entire lifecycle of a project

A comprehensive, systematic approach covering site screening, selection, operation and closure — supporting permitting and verification

## Screen

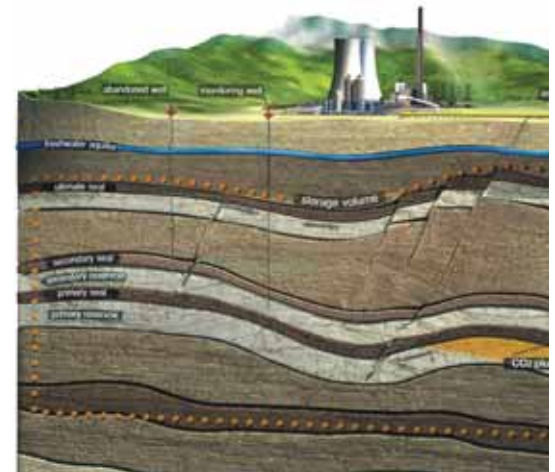
The screening process identifies potential storage sites in a given region that, based on a preliminary high level evaluation, are anticipated to serve as secure sites for long-term storage of CO<sub>2</sub>. The output from this stage is a list of identified sites that are considered eligible for further characterisation based on geological, environmental and commercial considerations.



Site screening at progressively smaller scales: regional screening (country/state-scale) basin-scale and site-scale, with the latter showing location of wells.

## Assess and select

The objective of this stage is to characterise a storage site in sufficient detail to enable site and engineering concept selection and storage permit application. This is achieved by obtaining the geological evidence needed to provide confidence that the site has sufficient accessible storage capacity and can provide long-term effective CO<sub>2</sub> containment.



Storage volume (volume schematically bounded by yellow-dotted line) for containment of CO<sub>2</sub> is enhanced through a possible multiple sequence

The guideline provides a procedural framework to support communication between operators, regulators and other stakeholders in all stages of the lifecycle of a CO<sub>2</sub> geological storage project. Activities and deliverables associated with each stage are explained and defined: from initial site screening, through tailored site assessment and storage permit application; from responsible operation based on tailored monitoring and verification; to preparation for site closure and transfer of responsibility from the operating entity to national or state authority. The framework is based on a risk-based approach to selection and qualification of

potential storage sites that takes into account the need to evaluate each site based on its unique characteristics.

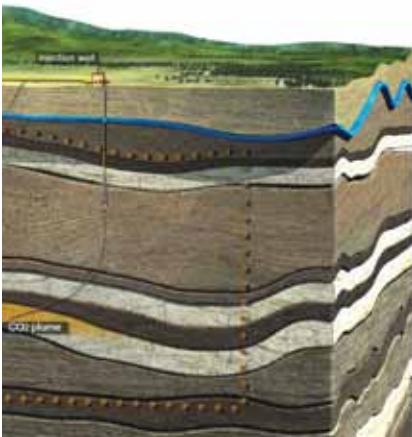
Learnings are drawn from CCS projects around the world, current best practice in the oil & gas and energy industries, and dialogue with regulators on how best to support assessment and evaluation of projects. The generic procedural workflows give enhanced traceability and streamlined implementation, which should help to avoid project delays and budget overruns.

## Operate and permit

The objective of this stage is to verify that the CO<sub>2</sub> storage project has been operated in compliance with regulations and permit conditions, and that the storage site provides and will continue to provide safe, long-term storage of CO<sub>2</sub>.

## Close

This stage defines a workflow to guide the process of providing evidence to support transfer of responsibility and liability from the operator to a national or state authority. This stage also guides communication between operators and regulators to establish confidence that the conditions for transfer of responsibility have been met.



(line) for an onshore example. The figure illustrates how  
ence of seals and attenuating formations.



CO<sub>2</sub> has to be stored for hundreds of years. The responsibility must be transferred to future generations.

## Keeping the guideline relevant

Full copies of the guideline are available from [www.dnv.com/co2qualstore](http://www.dnv.com/co2qualstore).

With the world of CCS developing rapidly, the CO2QUALSTORE guideline will be updated periodically to keep pace with changes.

The Joint Industry Partnership will set up a CO2QUALSTORE User Forum to further collaborate regarding use of the guideline and to create future updates based

on experience. The intention is to open the forum to new members.

This CO2QUALSTORE guideline specifically covers CO<sub>2</sub> geological storage. Other parts of the CCS value chain are addressed in three additional Joint Industry Projects. These include guidelines for the qualification of CO<sub>2</sub> capture technology; for the safe, reliable and cost-effective transmission of CO<sub>2</sub> in pipelines; and for the re-qualification of wells for CO<sub>2</sub> injection.



## CCS in context

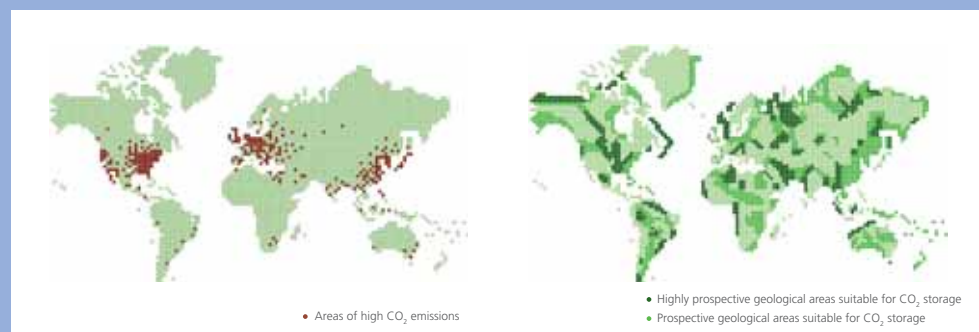
**20%** of emissions reductions could come from CCS

It is estimated that CCS could provide 20% of the emissions cuts necessary by 2050 to mitigate the worst effects of global warming. It is also estimated that upwards of 3,000 industrial scale CCS installations will be needed to meet that target. (source: IEA CCS Roadmap 2009)

CCS will not solve the climate challenge alone, but it is a necessary part of the global mitigation strategy. The world's energy demand cannot be met in the short-term without continued use of fossil fuels. CCS is the only mature technology that has the potential to provide significant reduction of CO<sub>2</sub> emissions from combustion of fossil fuels, and is therefore a key bridging technology to a renewable energy future.

Enabling the geological storage of CO<sub>2</sub> is central to making this happen. There is estimated to be sufficient capacity to store centuries-worth of CO<sub>2</sub> through CCS in the subsurface, much of it in locations close to the emitting sources. The challenge lies in identifying, selecting, characterising and managing potential sites.

Maps showing correlation between sources of high CO<sub>2</sub> emissions (left hand map) and prospective geological areas suitable for CO<sub>2</sub> storage (right hand map).





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