CCS safety and risk assessment: Guideline for selecting and qualifying CO_2 geological

EPPM Program: Seminar on CCS Awareness & Networking of Petroleum Geoscience, Bangkok 16-17 November, 2009

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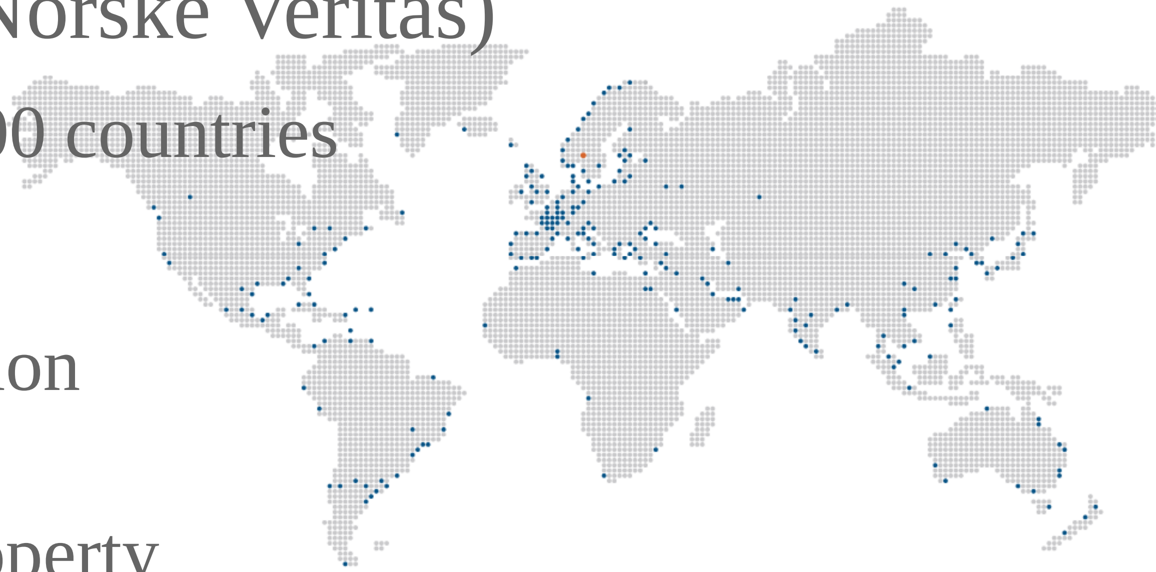

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Carbon Capture and Storage – The solution?

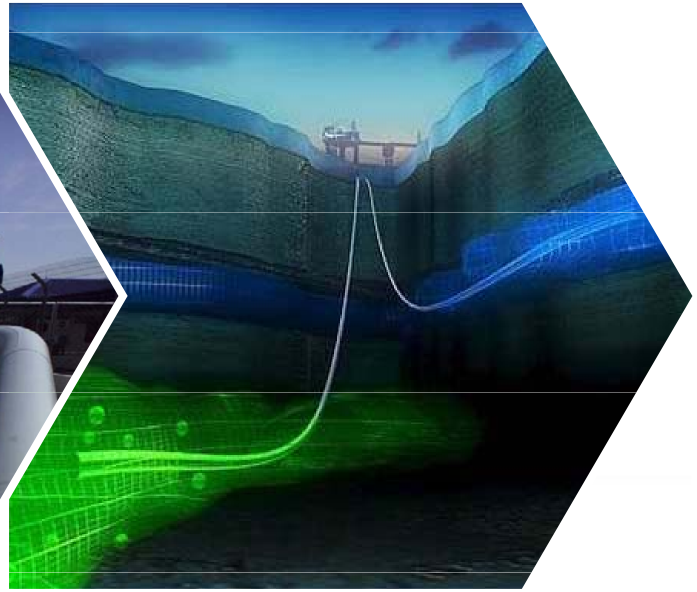
Capture

- Fossil power plants
- Natural Gas CO_2 reduction
- Other industrial processes

Transport

- Pipelines
- Ships

Storage



- Empty oil or gas reservoirs
- Saline aquifers
- Enhanced Oil Recovery

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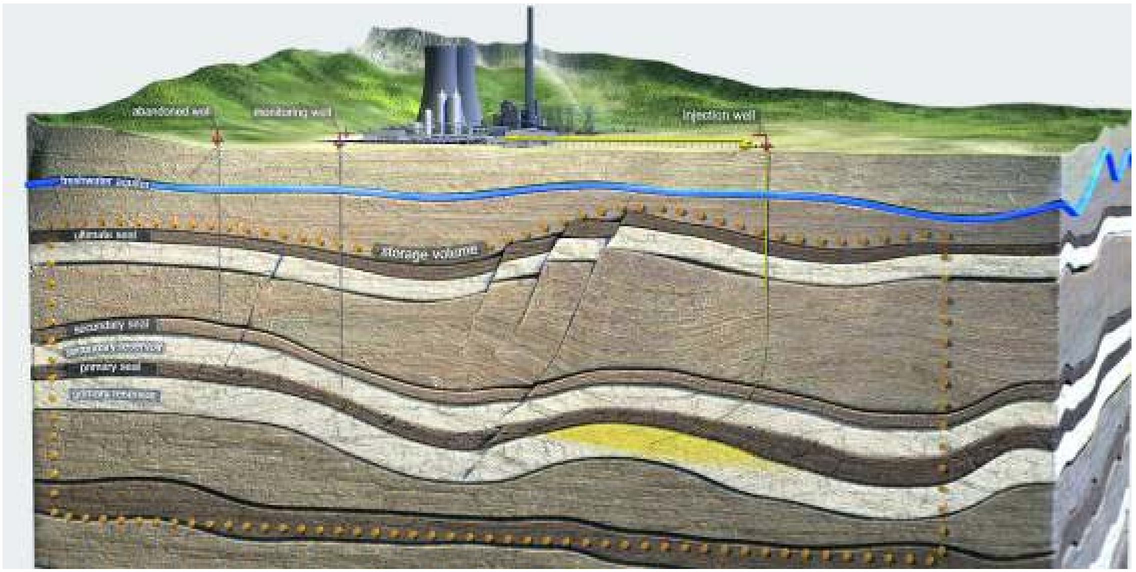
Topics of the presentation

- Introduction
  - Some major challenges in the realization of CO_2 geological storage
  - Why risk-based approach?
- The CO_2 storage guideline
  - The objectives of the CO_2QUALSTORE Joint Industry Project
  - Basic principles of the guideline
    - The qualification principles
    - The three-stage approach to risk acceptance
  - A thought case



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Introduction: Challenges in the realisation of CO_2 storage

- Legal and regulatory framework not yet in place
- Public awareness of CCS as a safe and important means to mitigate global warming
- Trust between the stakeholders: Regulators / Operators / Public
- Hand-over of liability from Operator to Government after closure of storage site
- Convincingly ensure containment of CO_2 for thousands of years

… and more

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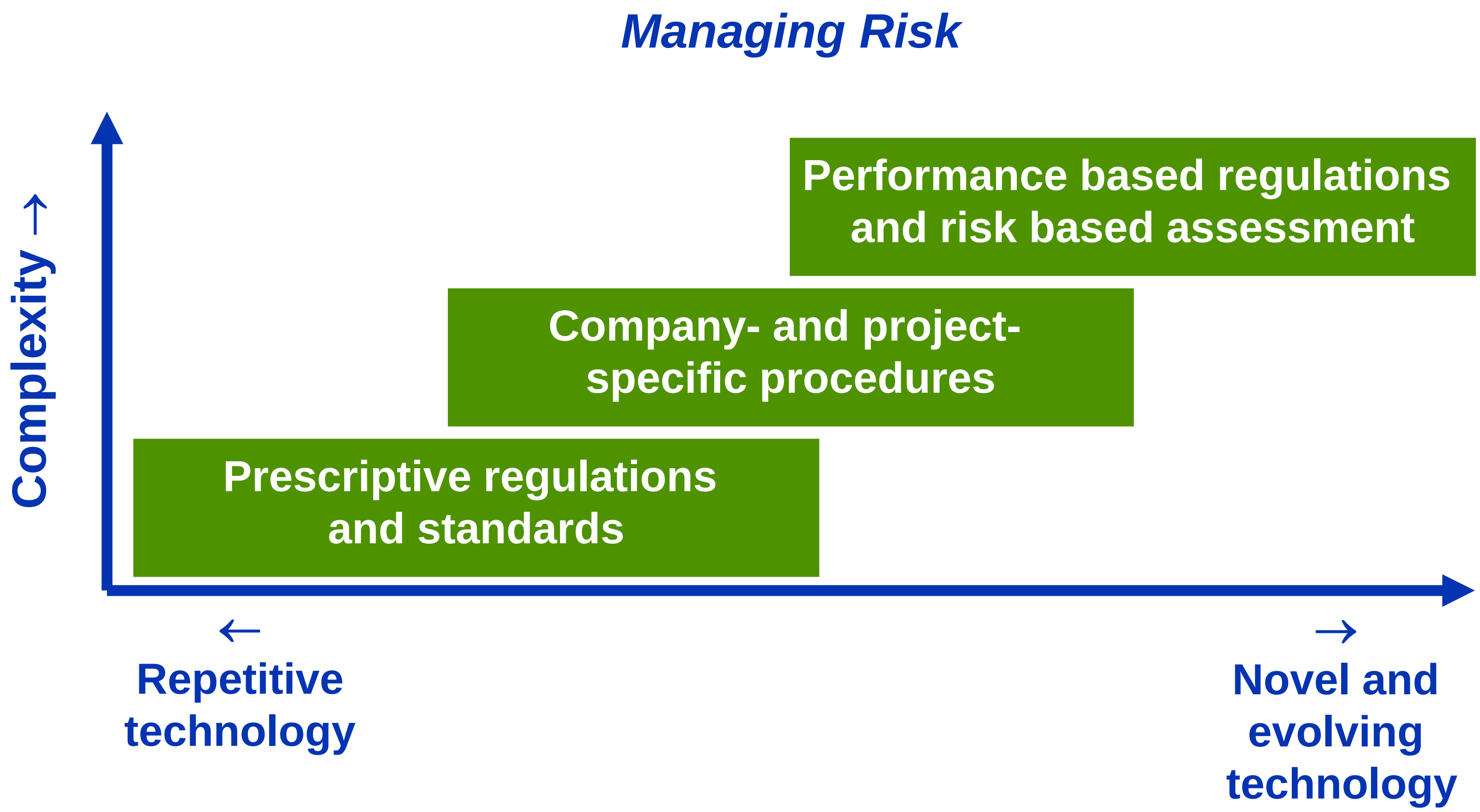
Introduction: Why a risk-based approach?



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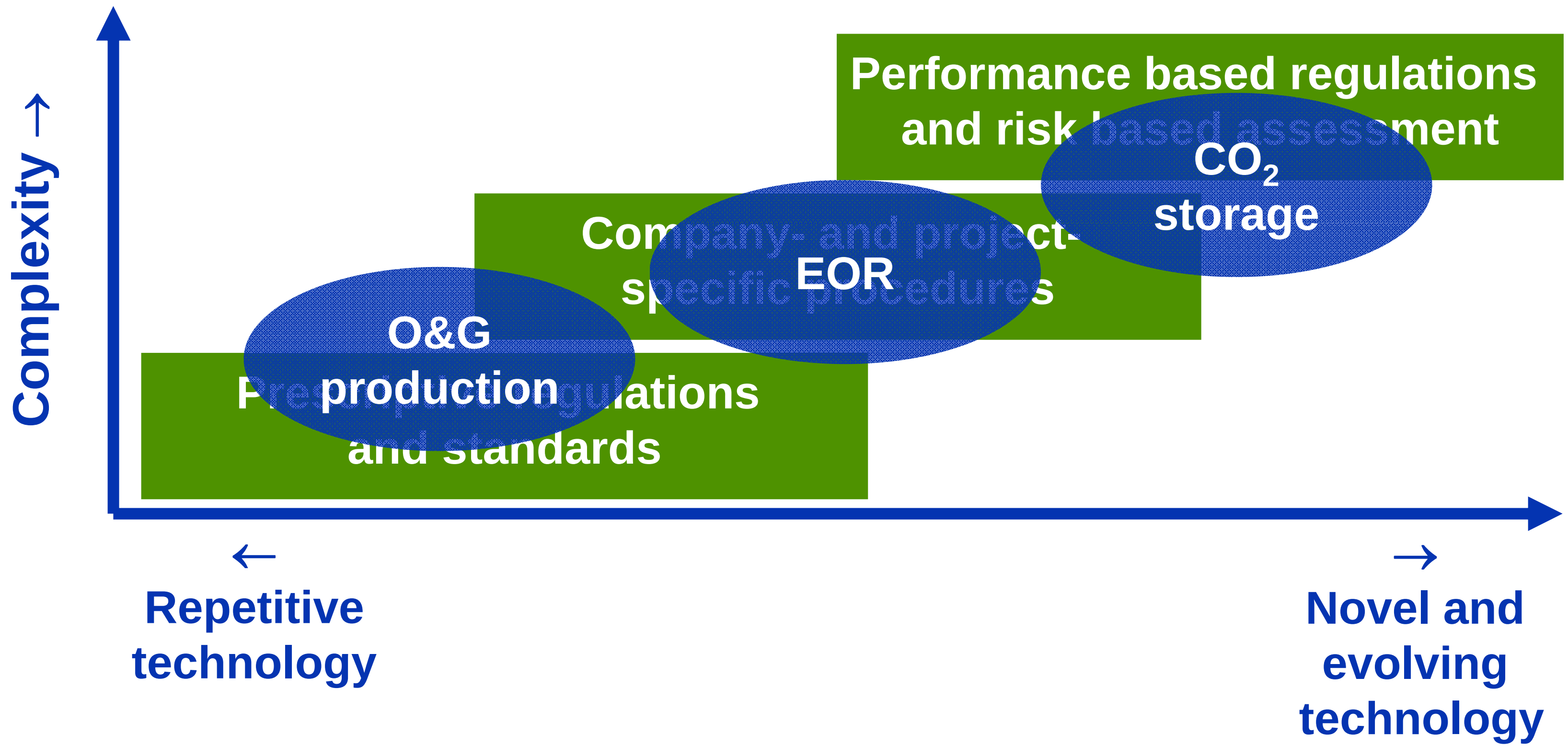
Introduction: Why a risk-based approach?

Managing Risk



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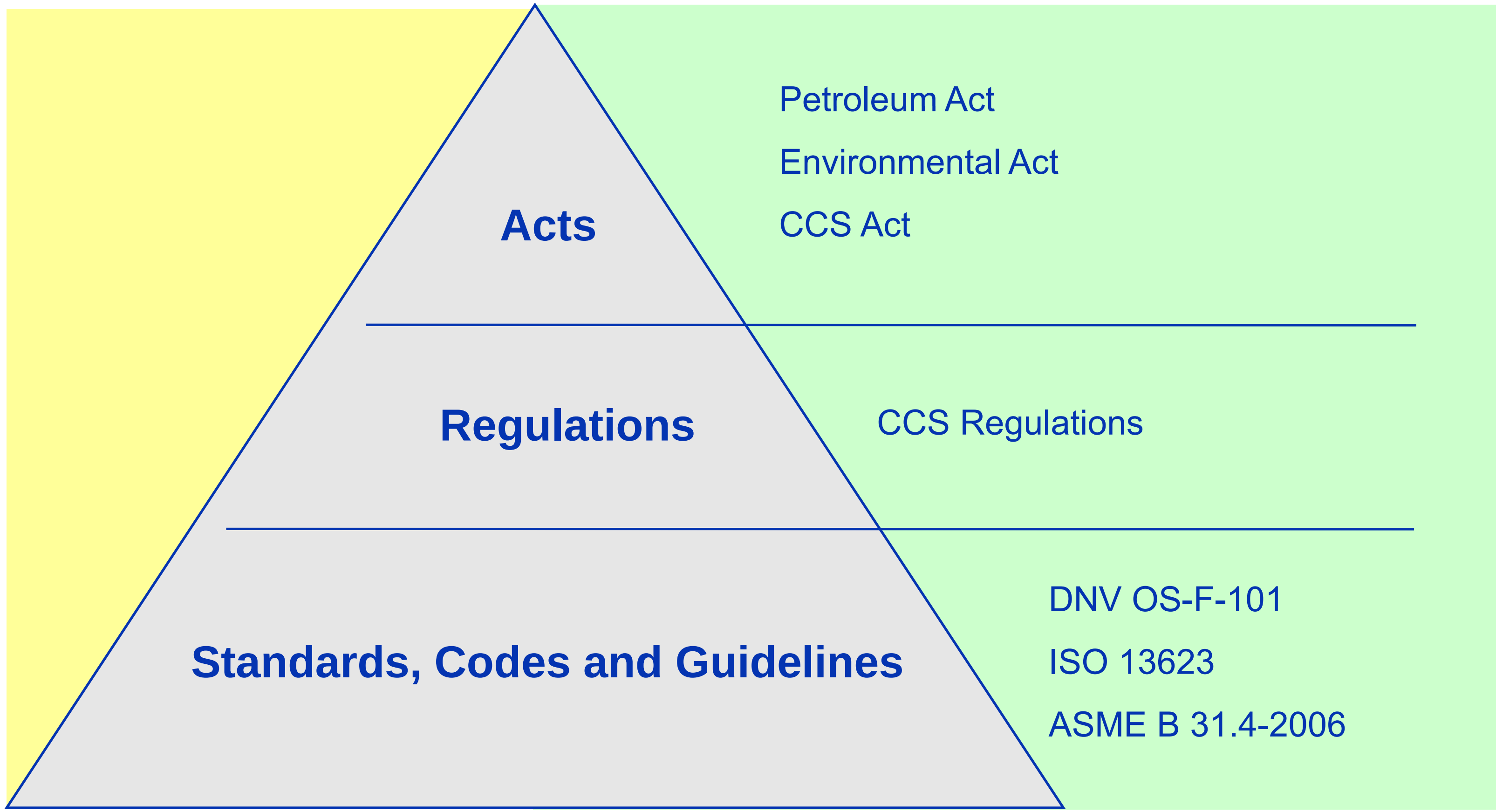
Role of CCS guidelines/standards/RPs



Facilitate efficient, safe and responsible implementation of industry best practice in compliance with regulatory CCS frameworks

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CO_2QUALSTORE JIP: Motivation

- Goal 1: Unified industry practice
  - Recognized **best practice** guidelines for global use that support **regulations**
  - Efficient implementation of **legal and regulatory CCS frameworks** internationally
  - Using concurrent **best engineering practice** and BAT (best available technology)
  - **Manage risks** (and uncertainties) **throughout storage life**
- Goal 2: Accelerate implementation – move from demos to large scale CCS
  - Define **predictable operating conditions**
  - Convert **current knowledge and experience** from R&D and Pilots into recommended practice and guidelines.
  - **Learn by doing** through risk based qualification and verification processes.
  - **Identify knowledge** gaps and help prioritise further R&D.
- Goal 3: Public acceptance
  - **Confidence in CCS** as a trustworthy option to mitigate global warming
  - **Predictable and transparent implementation** to meet expectations of stakeholders
  - Balance and communicate **benefits and risks**

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CO2QUALSTORE JIP: Objectives

CO2QUALSTORE has developed a guideline for selection and qualification of sites and projects for geological storage of CO2

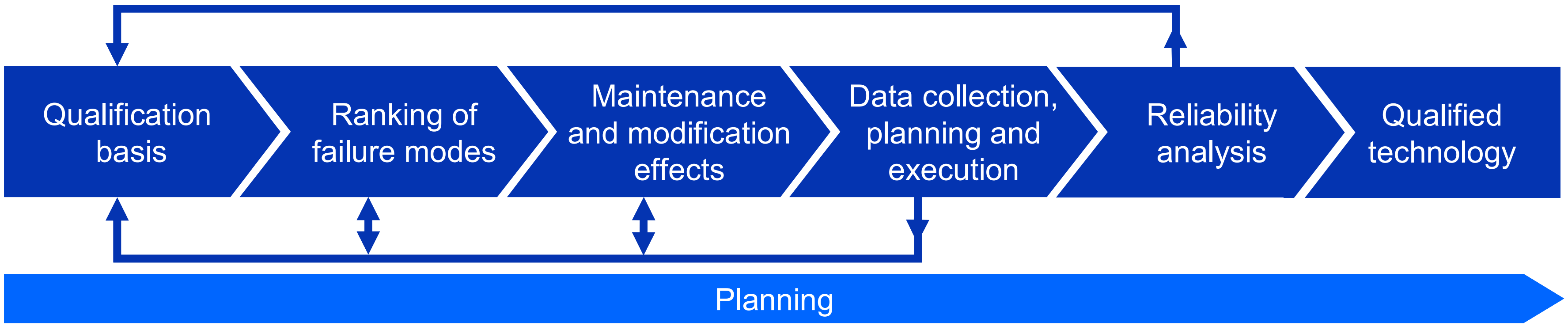
Will be made publicly available in April 2010 as a DNV Recommended Practice (RP).

Main objectives of the guideline:

- provide developers, regulators and independent verifiers with a **common protocol** for assessing the safety and reliability of geological storage sites for CO_2
- provide a **structured and transparent approach** to decision making that documents the basis for granting a storage permit
- be **performance based** with a sufficient level of detail to be a useful working guide for industry actors
- be **consistent with regulations** that are emerging for governing CO_2 storage in Europe, the USA, Canada and Australia
- **guide the dialogue** between project developers and regulators, relevant stakeholders and third parties

Basic principles for the guideline

- **Risk based approach** that aims to provide an appropriate level of assurance with respect to the amount of information available
- **Site-specific approach** – every storage site is unique
- **Qualification** allows flexibility to adapt selection and verification approaches to site-specific conditions.
- Principles of **Technology Qualification** applied to selection and qualification of geological storages: *"Systematic process of providing evidence that a technology will function reliably within specific limits*."



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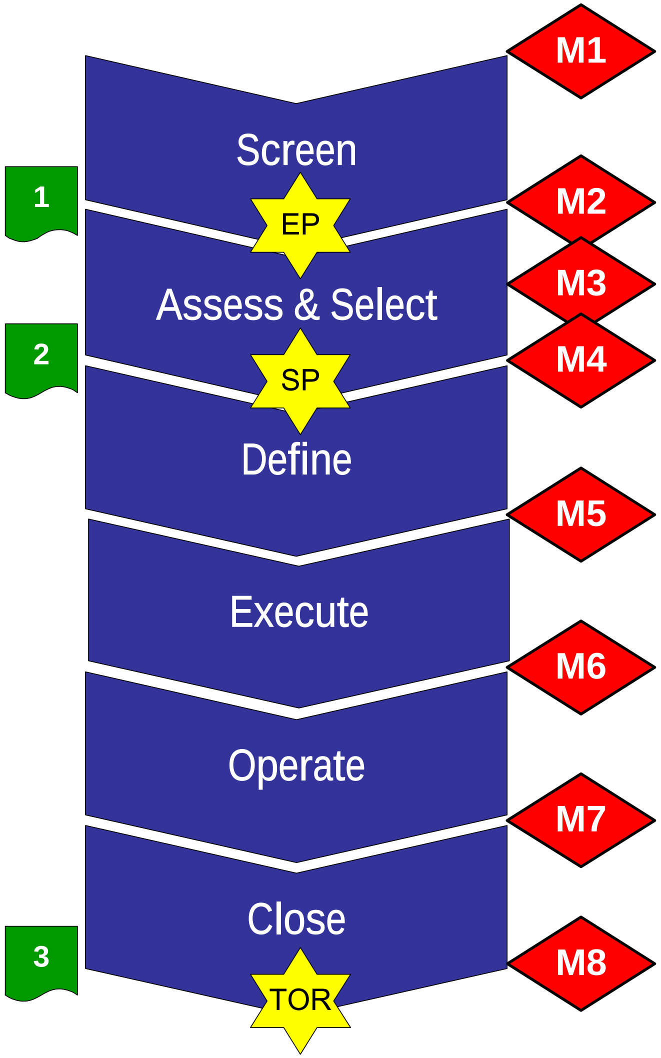
QUALIFICATION STAGES



Milestones

1) Begin site screening
2) Shortlist storage sites
3) Select site & engineering concept
4) Storage permit application
5) Initiate construction
6) Initiate CO_2 injection
7) Qualify for site closure
8) Initiate decommisioning

Qualification Statements

1) Statement of storage feasibility
2) Certificate of fitness for storage
3) Certificate of fitness for closure

Permits issued by Regulator

EP – Exploration Permit
SP – CO_2 Storage Permit
TOR – Transfer of Responsibility

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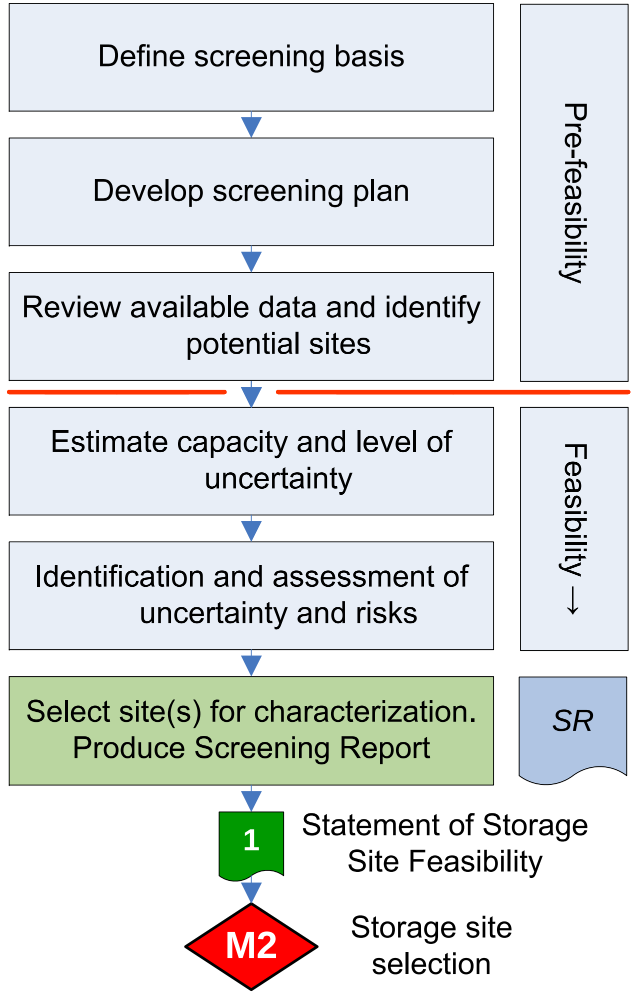
Screening stage

- Pre-feasibility largely based on existing data
- Early stage risk and uncertainty assessment
- Build common understanding of opportunities and risks
- Statement of storage site feasibility (SR) – regulator, entity acting on behalf of regulator or third party verifier

Guideline recommends involvement of regulator



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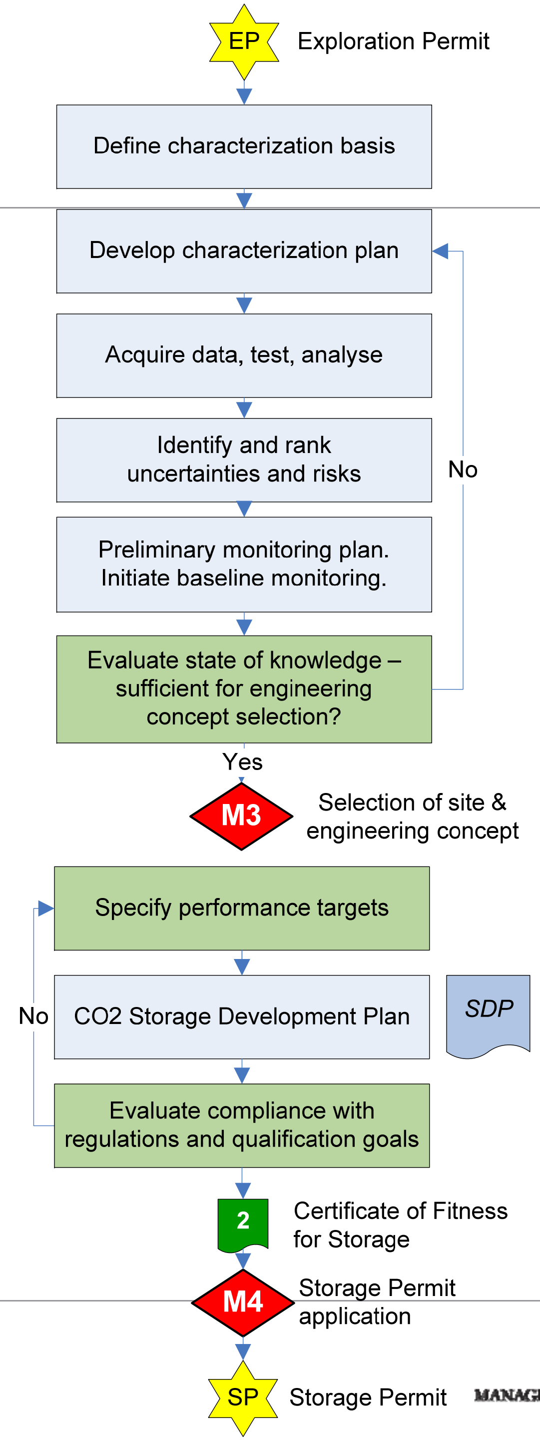
Characterization stage

- Collect and assess data – define criteria for demonstrating "fitness for storage".
- Risk assessment:
  - Identify and assess risks and uncertainties.
  - Identify and assess of safeguards
  - Rank risks: insignificant, contingent acceptable and unacceptable
- State of knowledge - present alternatives prior to final site & concept selection
- Select site and engineering concept
- Specify performance targets – agree with regulator on acceptable level of risk
- Define site development plan
- Evaluate if site meets criteria for storage
- Submit storage permit application



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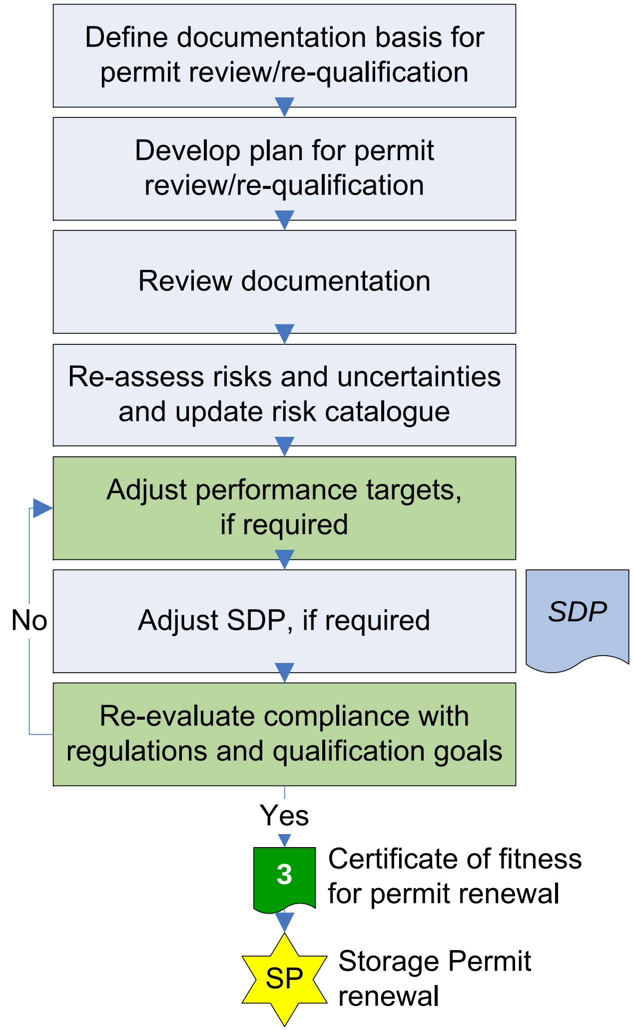
Operation/Permit review

- Operation = injection + post-injection

- The Storage Permit is reviewed and updated throughout the lifecycle of the project.
  - Re-qualification – initiated by events or new information
  - Routine permit review to assess compliance with storage permit

- By end of injection the performance targets for closure have to be agreed with regulator



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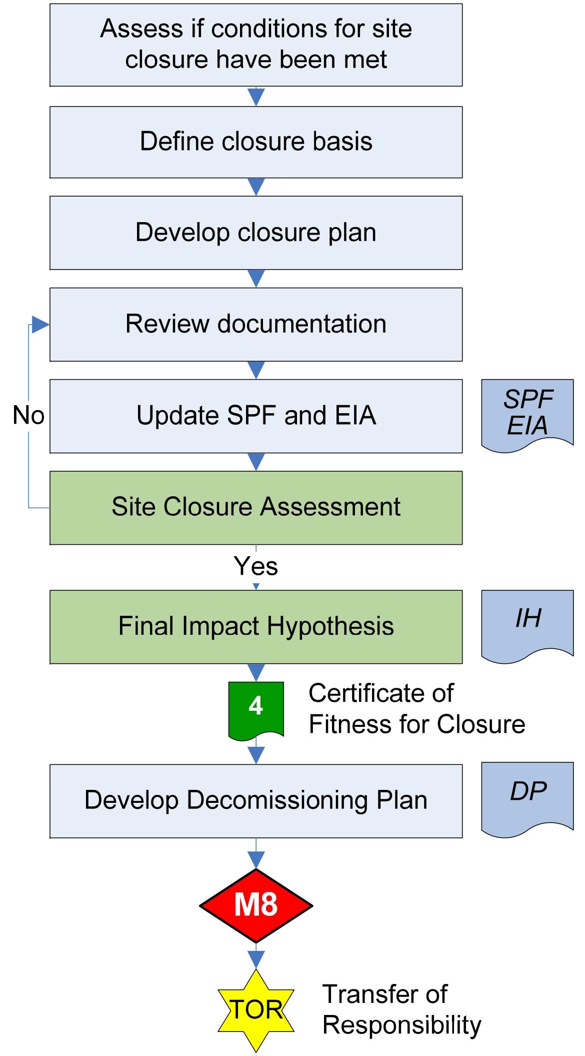
Site Closure

- Site closure stage:
  - Site closure qualification
  - Decommissioning
  - Transfer of responsibility

- Final Impact Hypothesis
  - Future negative impacts on human health and environment unlikely
  - Document reasonably degree of certainty in simulation models
  - Communicate with stakeholders

- Liability may be transferred to the authorities after decommissioning and granting of closure permit.



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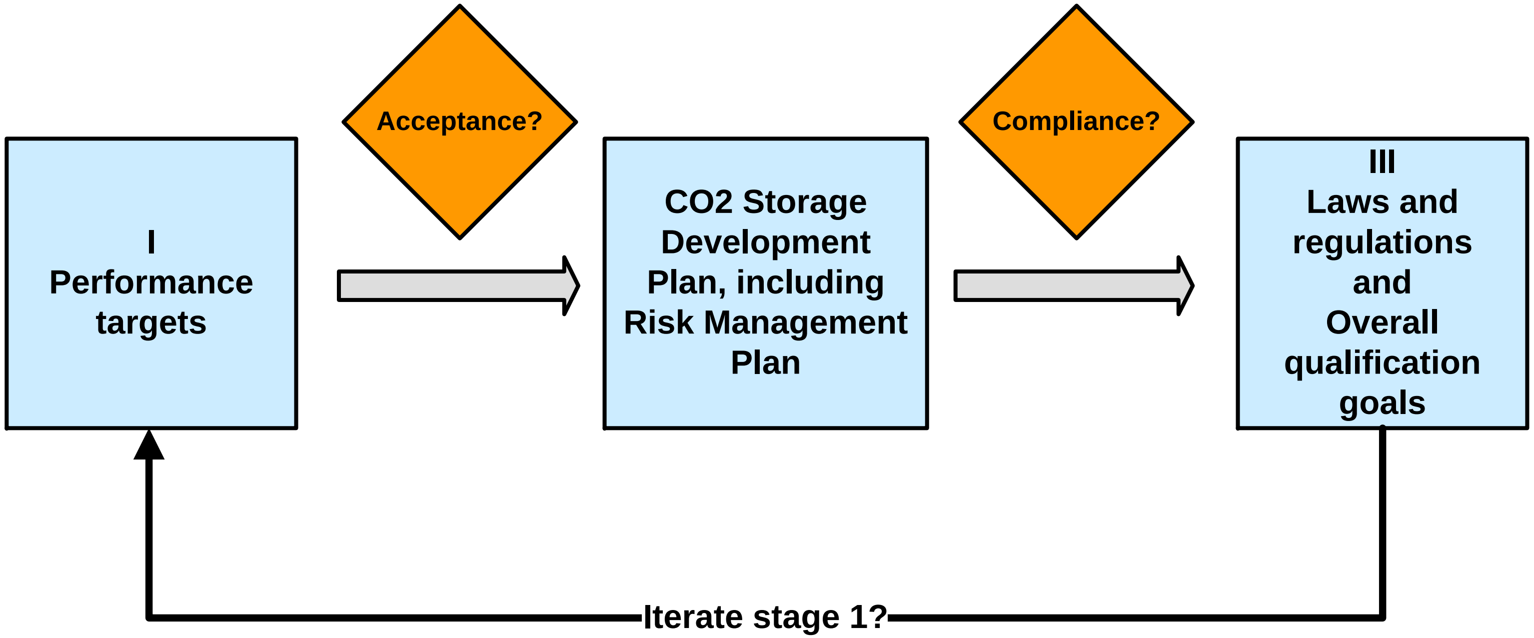
Three-stage approach to risk acceptance

- Guideline proposes a three-stage approach to **guide dialogue** between a project developer and the relevant CGS regulator concerning acceptable levels of risk for a CGS project.
- In particular on how to specify and evaluate project specific **performance targets for risks and uncertainties** that relate to the storage leg of the CCS value chain.
- Basis for defining MVAR requirements and regulatory approval of the storage project.



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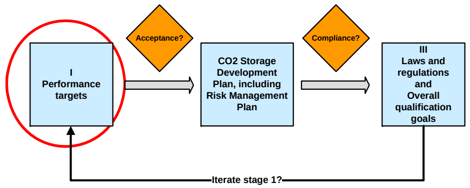
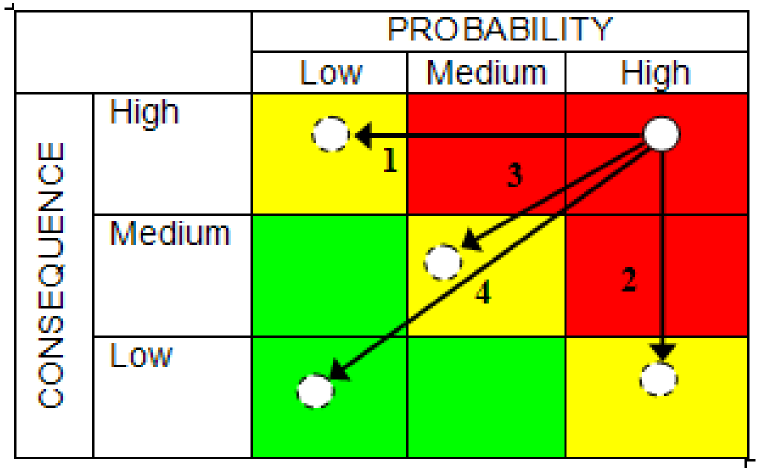
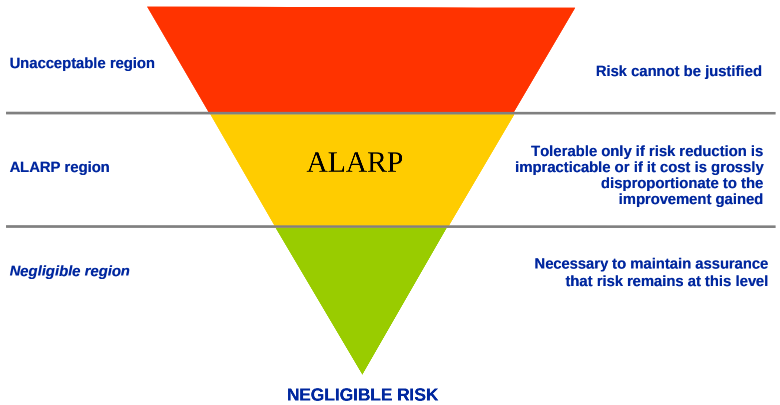
Performance targets



“a targeted level of risk/uncertainty reduction achieved through implementation of a defined risk/uncertainty reducing measure, or range of such measures.”



- No pre-defined acceptance level
- Cost-benefit approach for different risk and uncertainty reducing measures
- Performance target should be agreed in dialogue with regulators
- Preliminary performance targets for site closure should be addressed



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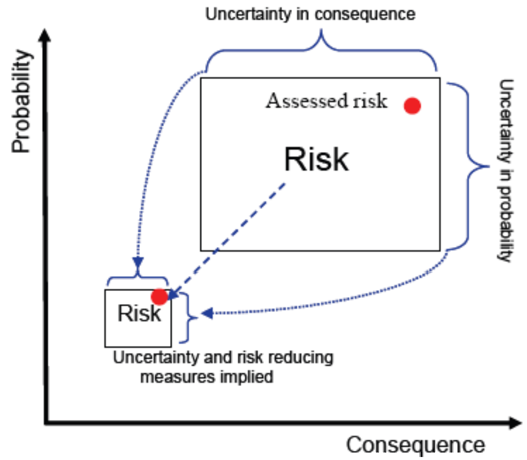
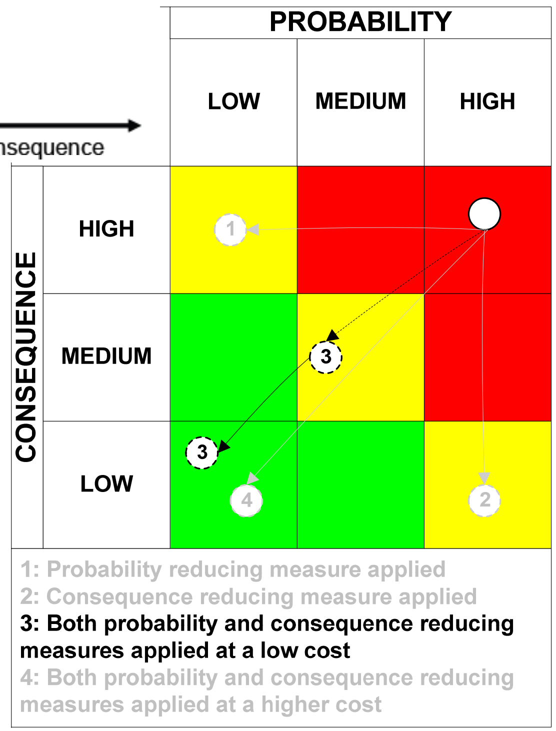
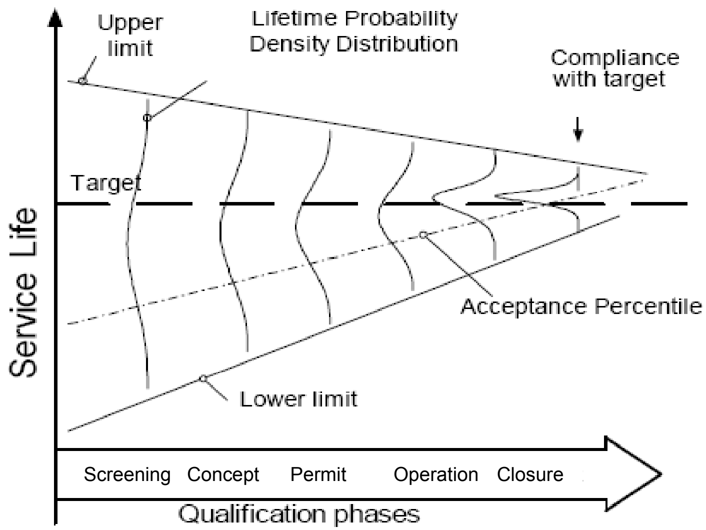
Relation between operational performance targets and performance targets for closure

- Qualification allows uncertainties to be systematically reduced throughout the life-cycle.
- Criterion for transfer of liability: Level of knowledge supports performance targets.



Conservative risk ranking implies that proper management of uncertainty will effectively reduce assessed risk.





Acceptance percentile: There should be a higher level of confidence in the future performance of a CO_2 storage site at the time of closure than at start of injection

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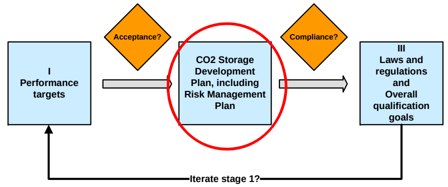


CO2 Storage Development Plan

CO_2 Storage Development Plan

Characterization Report

Injection and Operating Plan

Storage Performance Modelling, Assessment and Forecasting

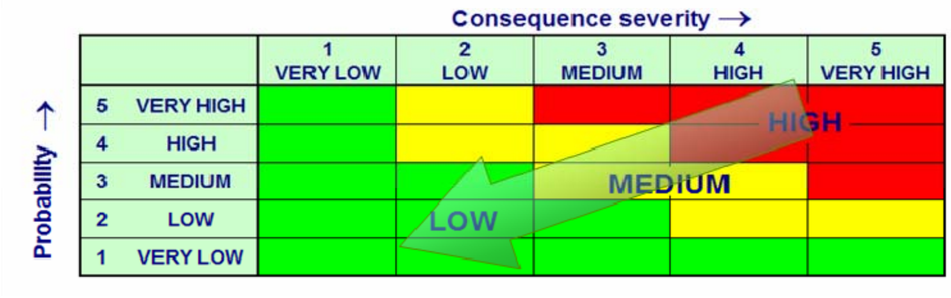
- *SPF*
- *EIA*

Risk Management Plan

- *Impact Hypothesis*
- *Contingency Plan*

Monitoring, Verification, Accounting and Reporting Plan

- Impact Hypothesis (IH) is based on recommendations from OSPAR guideline.
- The IH shall present an overall project risk evaluation for base case scenario based on the performance targets agreed between the regulator and the project developer.
- Contingency Plan (CP) provides a risk management plan for alternative scenarios.
  - Document that conceivable but unexpected features, events or processes can be controlled



Risk reduction

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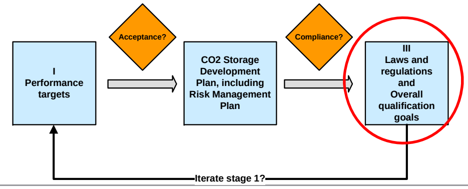
Regulations and high-level goals



Qualification goals:

1. Compliance with prevailing laws and regulations
2. The project shall have a *climate benefit*, i.e., it shall store CO_2 in subsurface geological formations that would otherwise be emitted to the atmosphere.
3. The project shall *not have significant adverse consequences* for the environment, human health, and should preferably not negatively impact economic resources or potential for other legitimate uses of the surface area or subsurface volume.
4. High level of confidence among the key stakeholders that the above objectives will be met with a *reasonable degree of certainty*.

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THOUGHT CASE: Leakage through an abandoned well

Situation:

- Abandoned well within the permit area in an onshore storage project
- CO_2 plume will probably intersect well after 10 years of injection
- Comprehensive well records exist from time of abandonment (1982)
- Well integrity considered to be good.

Regulators initial view:

- All abandoned wells that may come in contact with the CO2-plume must be re-abandoned.

Developers initial position:

- No leakage during injection period – well will be re-abandoned if leakage occurs.

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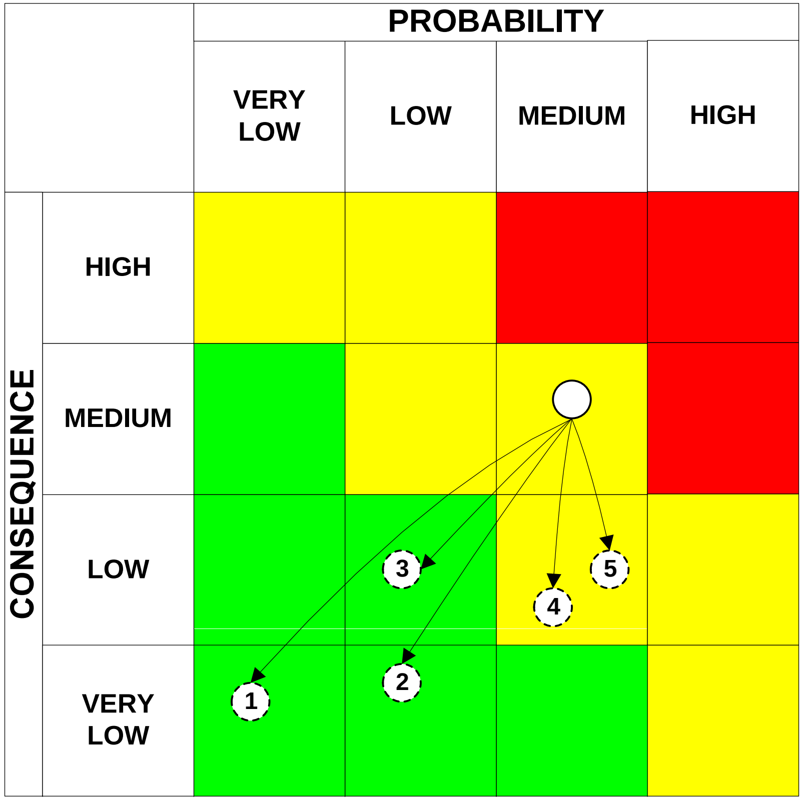
THOUGHT CASE: Performance targets – risk matrix

1. Re-abandon well
2. Monitoring well for early signs of leakage – re-abandon if detected
3. Monitoring well for early signs of leakage – re-design injection strategy if detected
4. Monitoring of surface or sea-floor – re-abandon well if leakage
5. Monitoring surface or sea-floor – assess impact of leakage and re-design injection strategy. Re-abandon if significant leakage



Associated performance targets for site closure should reflect the degree of confidence that can be achieved by proper risk management: meeting performance targets and implementing contingency measures if necessary.

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Final remarks

- The guideline developed in CO2PIPETRANS represents a consensus between industry partners how to select and qualify subsurface geological storage sites for CO_2.
- The guideline will be made public as a DNV Recommended Practice by April 2010 with the intention to
  - Give a unified industry practice
  - Accelerate implementation of CCS
  - Contribute to trust between stakeholders and public acceptance of CCS to combat global warming

Thank you for your attention

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