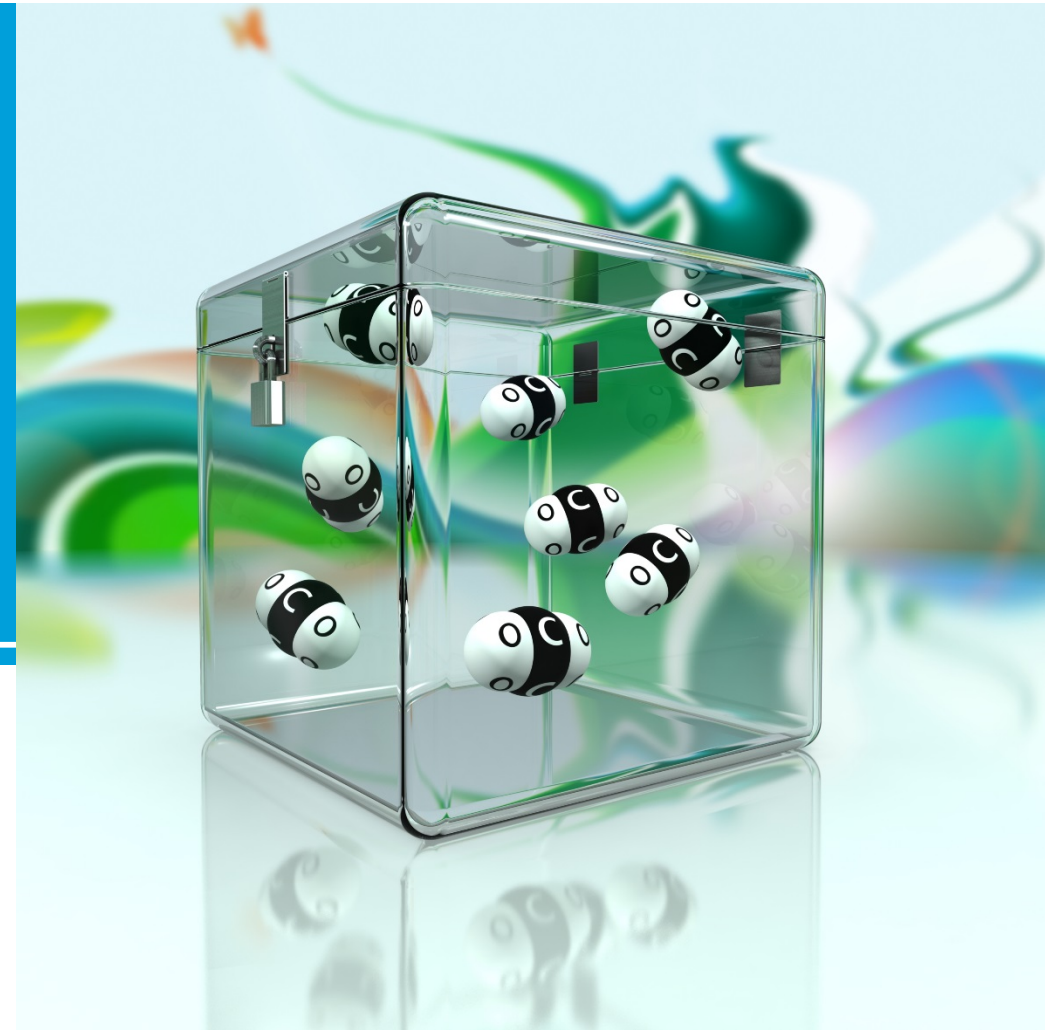


Quality assurance of CO₂ storage

Verification against ISO 27914:2017

Jørg Aarnes

18 February 2020



Copyright: DNVGL/DGS AS

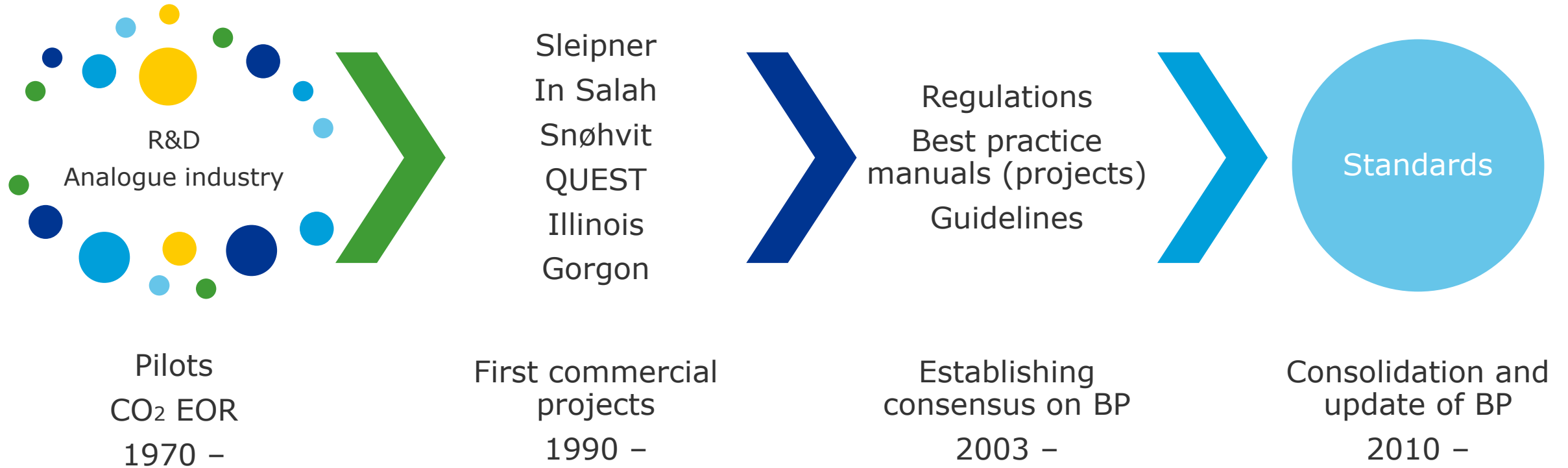
Towards a global best practice?

- What defines «best practice» (BP)?
 - Deployed by industry
 - Recognized by stakeholders
 - Consensus
- Is there a common BP for CCS?
 - For CO₂ storage?
- How do you demonstrate BP?
 - Why would you do it?
 - Who needs assurance?
 - Who should do it?



Source: <http://www.seeksafely.org/wp-content/uploads/2014/01/best-practices.gif>

Experience is needed to establish best practice and standards



- **Objective:**
 - Provide recommendations for the safe and effective storage of CO₂ in subsurface geologic formations.
- Applies to injection of CO₂ into geologic units **for the sole purpose of storage.**
- **Does not apply to** [...] storage of CO₂ that occurs in association with CO₂ *enhanced* hydrocarbon recovery.
- Does not address accounting of emissions stored or avoided.
- Developed over 4 (7) years by ~100 individuals from 10+ countries.

INTERNATIONAL
STANDARD

ISO
27914

First edition
2017-10

**Carbon dioxide capture,
transportation and geological
storage — Geological storage**

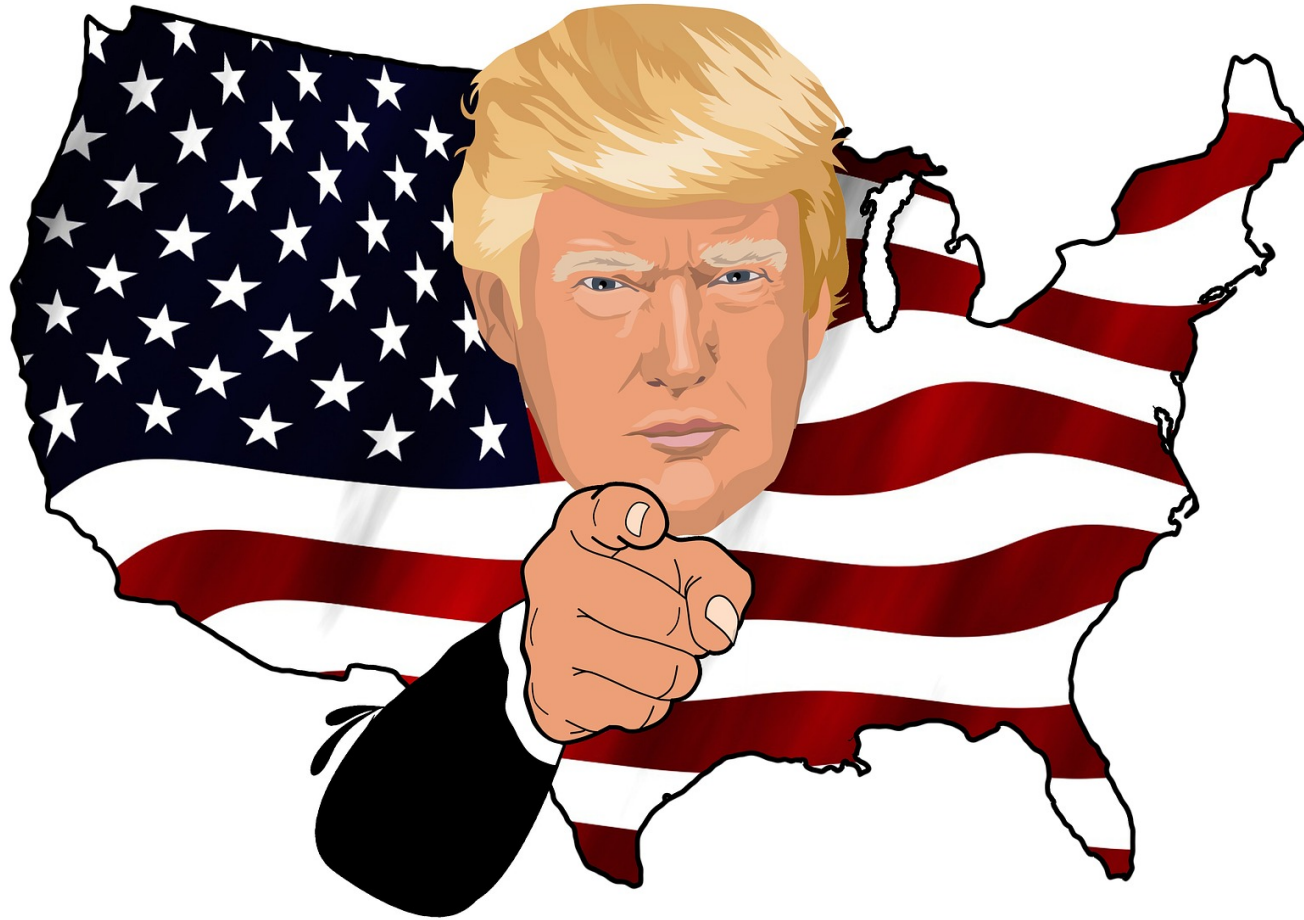
*Capture, transport et stockage géologique du dioxyde de carbone —
Stockage géologique*

Questions I will address

- **Why** certify ISO 27914 conformance?
- **Who** may use ISO 27914?
- **Which** applications?
- **What** value does it provide for these applications?
- **How** can it be used in practice?

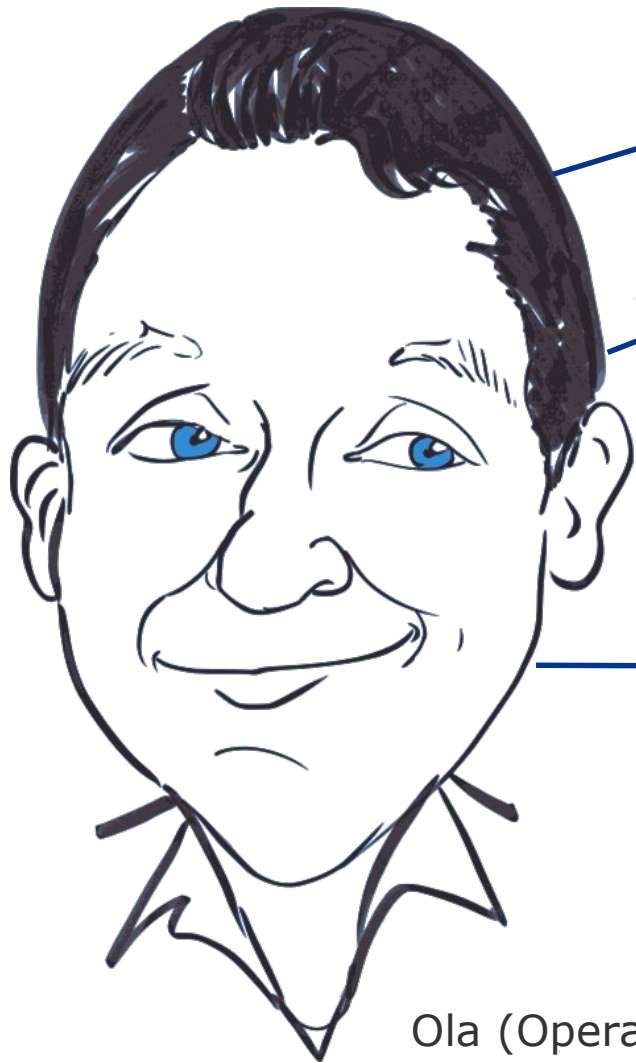


The case for certification



**Are YOU
ISO 27914
compliant?**

Conversation 1 – Regulator (without verified compliance)



Ola (Operator)

I'm in compliance with your regulations

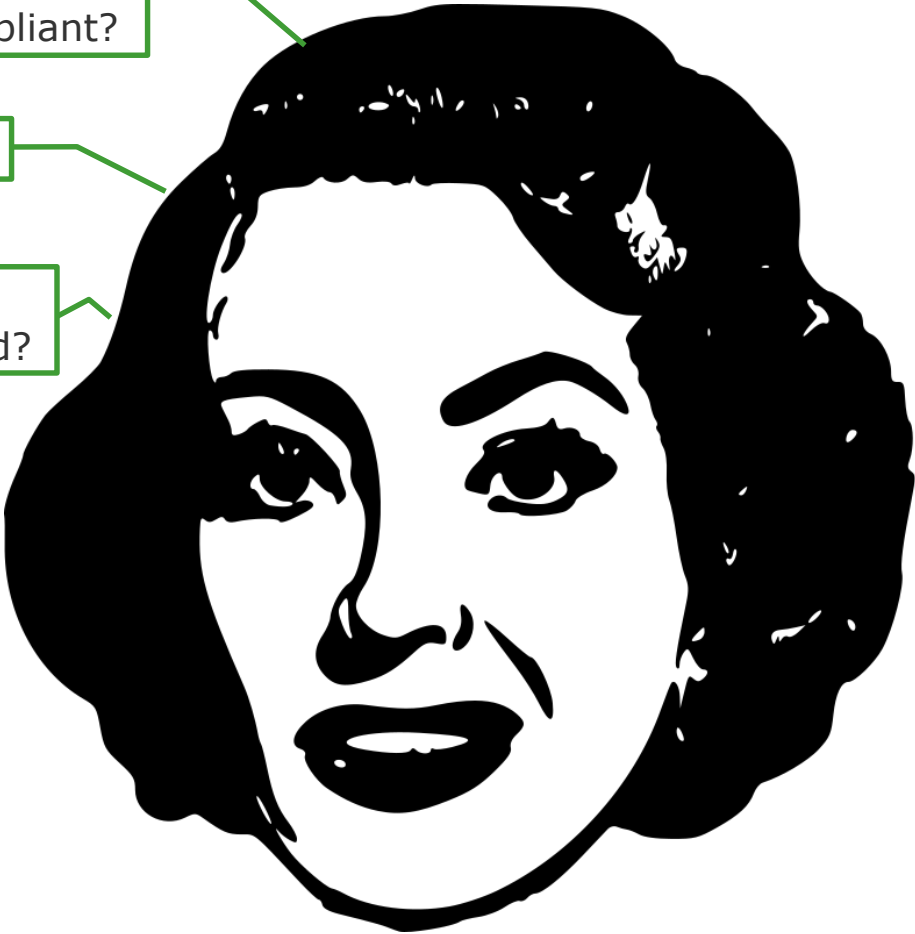
Compliant with most of the relevant requirements (internal assessment)

Demonstrating compliance adds cost
Standard not aligned with project milestones – must pre-select requirements to demonstrate

Are you ISO 27914 compliant?

Yes, but ...

Is this documented?



Ophelia (Regulator)

Conversation 2 – Public (with verified compliance)



ODA

Are you storing CO₂ under my house?

Is it safe?

Why should I believe you?

Ok, good to know. I am assured

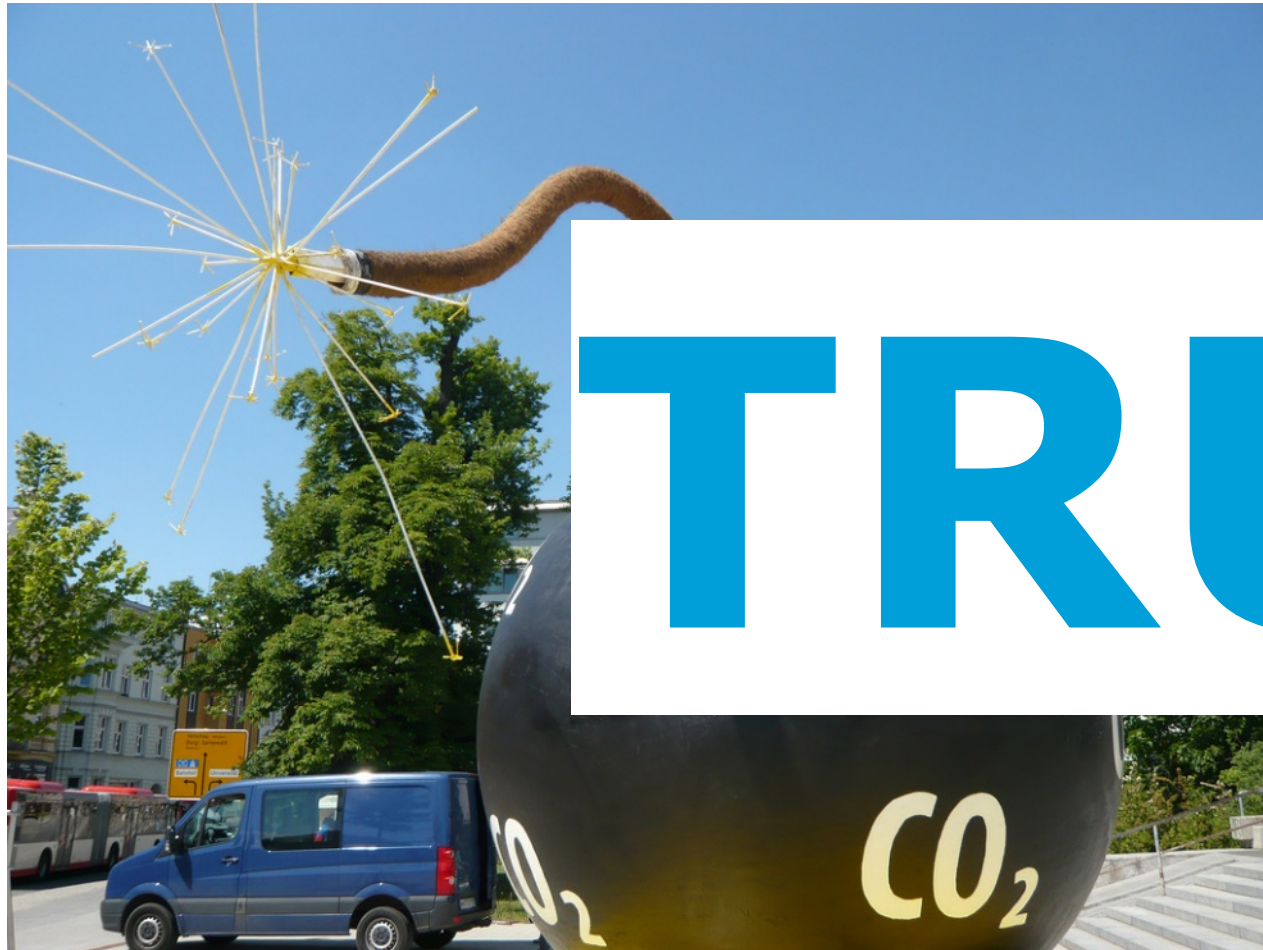
You bet

You bet

Because CO₂ storage is a mature technology and we are certified to be compliant with the international standard ISO 27914 for safe geological storage of CO₂.



What's on the table?



INTERNATIONAL
STANDARD

ISO
27914

TRUST

First edition
2017-10

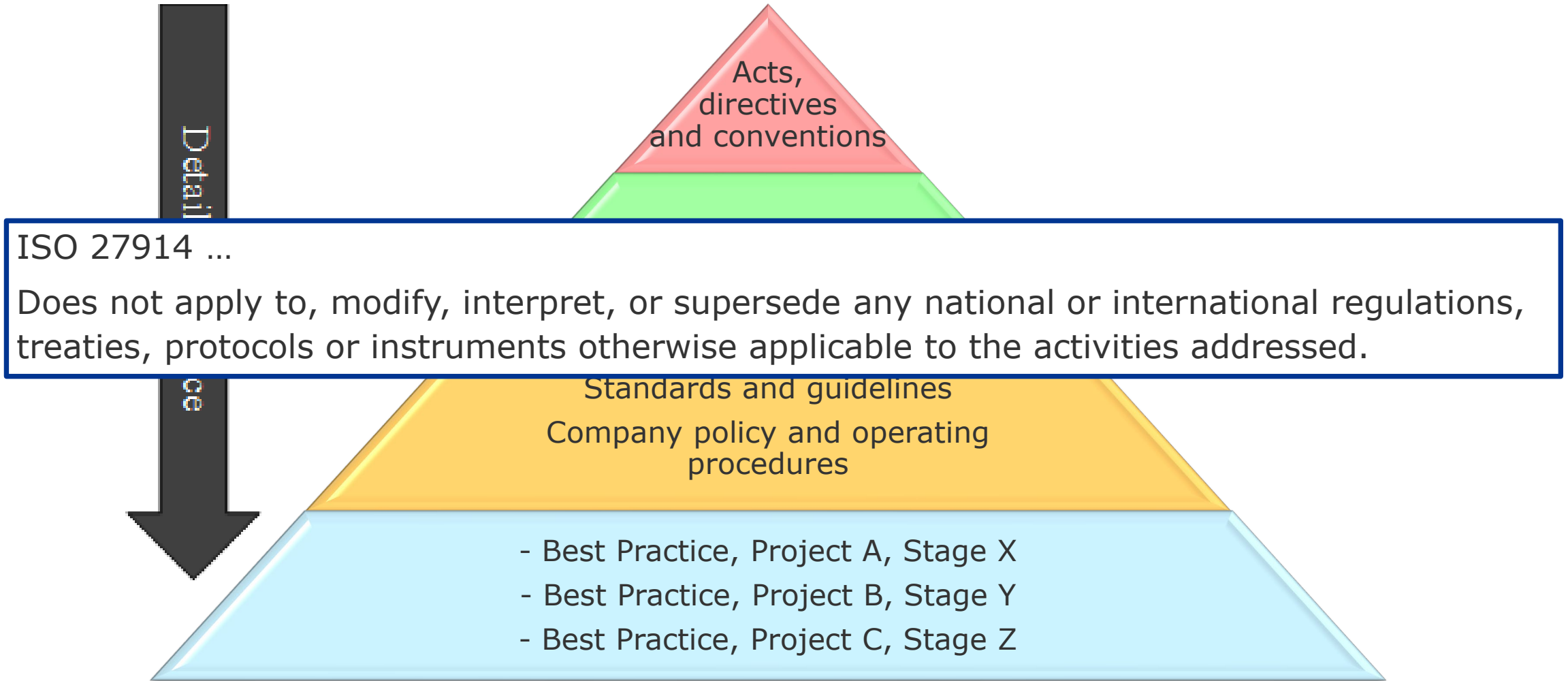
**Carbon dioxide capture,
transportation and geological
storage — Geological storage**

*Capture, transport et stockage géologique du dioxyde de carbone —
Stockage géologique*

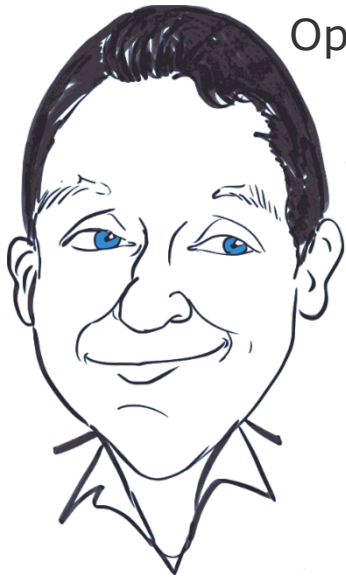
Demonstration in Cottbus, Germany against Vattenfall's CCS plans, primarily storage.

Credit: GuenterHH, flickr.com

Role of standards



Value for users



Operator

- Project execution
- Reference for dialogue with
 - Regulators
 - Partners
 - Investors
 - Public



Regulator

- Additional guidance relative to regulations
- Sanctioning of projects in absence of regulations

Investor
Venture partner
Emitter

- Technical 'due diligence' for investment decision
- Understand management of risk and uncertainty



Policy makers

- Developing regulations
- Apply for funding support for CCS projects

Which requirements in ISO 27914 should be met when ...?

Operator



... applying for storage permit?

Regulator



... providing injection permit?

Investor
Emitter



... making FID with operator?

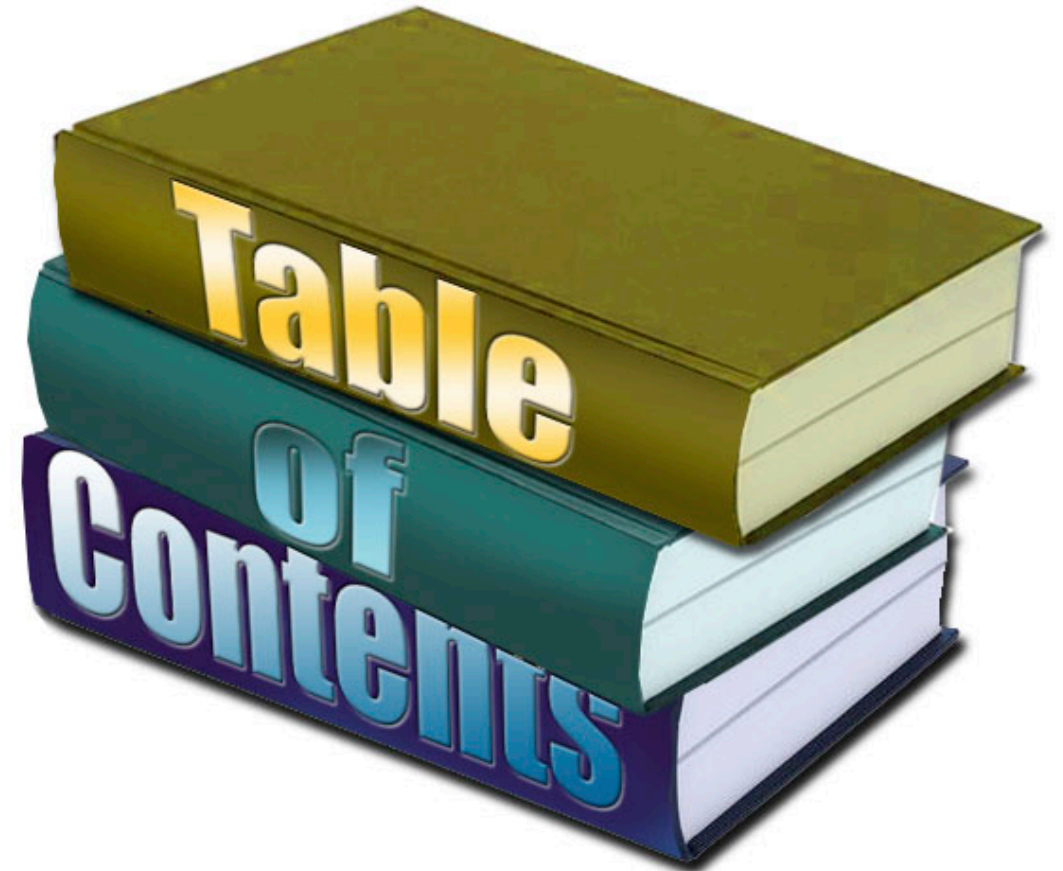


... granting an exploration permit?

Policy makers

Clauses

1. Scope
2. Normative references
3. Terms and definitions
4. Management systems
5. Site screening, selection and characterization
6. Risk management
7. Well infrastructure
8. CO₂ storage site injection operations
9. Monitoring and verification
10. Site closure



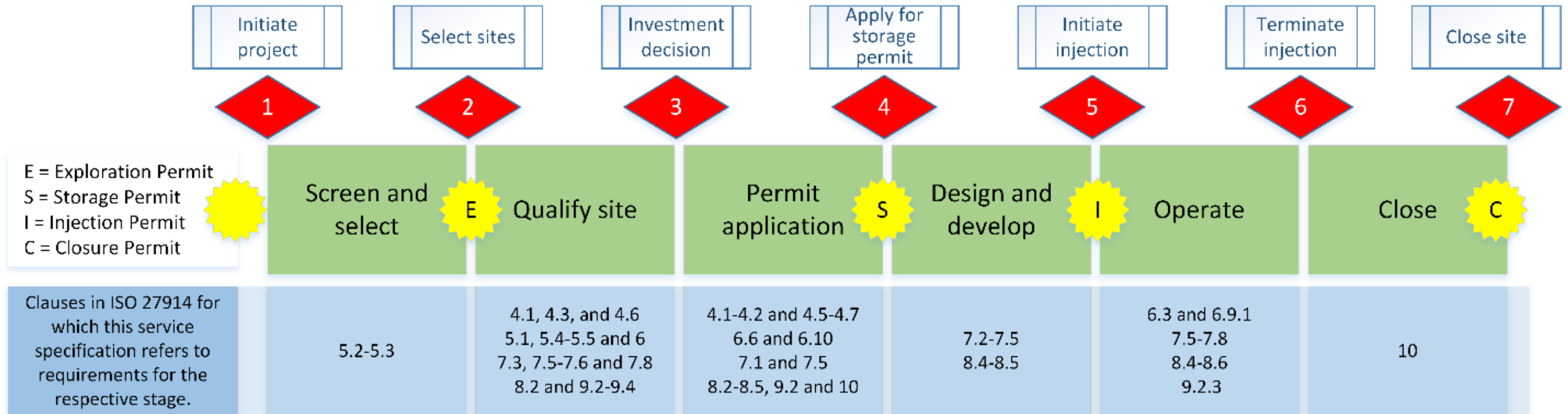
Bilde: <http://mrmcdanielsteacherpage.wikispaces.com/>

Example: Norwegian regulatory requirements for storage permit (Transposed from EU CCS Directive – Reflective of requirements in Europe)

	Clause in ISO
a) Characterization of storage site and complex and storage risk assessment	5.4-5.5, 6.7
b) Description of injection strategy and proposed site development, and criteria for project decisions	7.3, 7.5, 8.2-8.5
Description of <ul style="list-style-type: none"> • geoscientific and reservoir circumstances, • total volume of CO₂ to be injected and stored, • expected CO₂-sources and methods of transport, • rate of injection and pressure circumstances, 	
c) <ul style="list-style-type: none"> • injection facility locations 	5.4-5.5
d) Composition of CO ₂ -stream	8.2.4.2
e) Description of technical solutions with expected energy consumption and access, including measures to prevent significant irregularity	6.6-6.8
f) Description of management systems, including information about planning, organization and execution of the development of the storage site	4
g) Information about operation and maintenance	8.2-8.5
n) Proposed monitoring plan	9.3-9.4
o) Proposed plan for corrective actions to significant irregularities	6.6 and 6.8
p) Proposed plan for post injection site care	10.3

Certification framework DNVGL-SE-0473

- Certification framework (DNVGL-SE-0473) designed to guide verification of conformity with ISO 27914 at generic milestones in project life-cycle
- Requirements in ISO 27914 mapped to align with milestone 2-7 in figure below.



“Statements” from reviewers of certification framework (individuals – not official views from companies they represent)

- **BP:** Useful mapping of ISO Clauses to CVP timeline - formalizes and makes more coherent, the application of ISO Clauses to a commonly used project management process.
- **CSIRO:** Very helpful to have scattered requirements in ISO collected in a useful operation way.
- **Shell:**
 - Good initiative to facilitate certification of various stages of a CCS project.
 - Provides guidance to an operator on how to implement ISO 27914. It could provide value and facilitate engagement with stakeholders, e.g. when applying for closure certificate at Quest.
- **Equinor:** Easier to demonstrate/check compliance.
 - Good that requirements and recommendations from ISO 27914 are grouped according to their relevance for decision gates.
 - Good that requirements are systematically separated from recommendations (which in ISO sometimes occur in the same paragraph).

Process and deliverables

- Performed by a review team
 - Consisting partly or wholly of non-DNV GL resources.

- Evaluation positive:
 - Certificate of conformity and verification report.

- Evaluation negative:
 - Verification report with nonconformity observations.



DNV-GL
Statement No:

CERTIFICATE OF CONFORMITY - SITE FEASIBILITY


Project operator: XX



DNV-GL
Statement No:

CERTIFICATE OF CONFORMITY - SITE ENDORSEMENT

Project operator: XX
Storage project: <Name, location and boundaries>



DNV-GL
Statement No:

CERTIFICATE OF CONFORMITY - STORAGE SITE

Project operator: XX
Storage project: <Name and organizational and operational boundaries (ISO 27914, Clause 4.2)>
Storage site: <Name, location and boundaries>
Project goal: <annual and total mass of CO2 to be stored>

This is to certify:
That DNV GL considers that the project operator has developed an appropriate storage development plan /3/ to allow safe and effective geological storage at the <Name> storage site in accordance with /1/ and project objectives. The storage development plan /3/ comprises the following project specific plans:
 - risk management plan;
 - Monitoring and Verification (M&V) plan;
 - plan for public and stakeholder engagement;
 - storage facility design plan;
 - Operations and Maintenance (O&M) plan.
 - provisional closure plan.

Certification involvement:
DNV GL has verified that the storage development plan /3/ is in accordance with /1/ and /2/, and checked conformity with the criteria listed in /2/ Section 3.2.3. The verification report /4/ includes a description of the verification process, conclusions from the evaluations, and deviations, if any, from recommendations listed in /2/ Table 3-3 and Table 3-5.

Validity:
This statement is valid on the date of issue.



DNV-GL
Statement No:

CERTIFICATE OF CONFORMITY - SITE DEVELOPMENT

Project operator: XX



DNV-GL
Statement No:

CERTIFICATE OF CONFORMITY - SITE OPERATIONS

Project operator: XX
Storage project: <Name and organizational and operational boundaries (ISO 27914, Clause 4.2)>



DNV-GL
Statement No:

CERTIFICATE OF CONFORMITY - SITE CLOSURE

Project operator: XX
Storage project: <Name and organizational and operational boundaries (ISO 27914, Clause 4.2)>
Storage site: <Name, location and boundaries>
Project goal: <annual and total mass of CO2 to be stored>

This is to certify:
That the criteria for site closure in /1/, Clause 10.2 have been met for the <Name> storage site, and that the closure qualification process /4/ has been performed in accordance with /1/ and /3/. DNV GL thereby confirms that the risk of future leakage of injected CO₂ conforms to the following acceptance criteria established for the project in accordance with /1/, Clause 6.8 a):

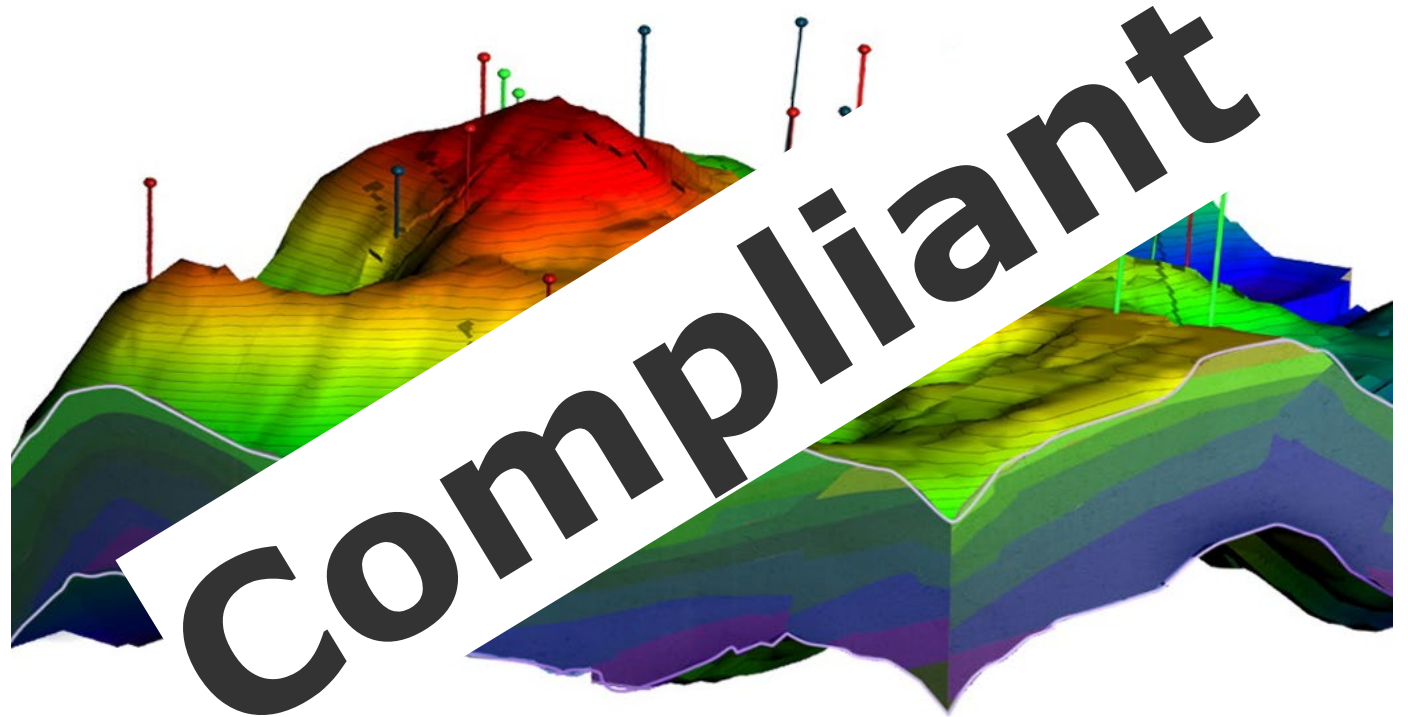
<Acceptance criteria pertaining to risk of leakage of injected CO2 after site closure at the Name storage site>

Certification involvement:
DNV GL has verified that the <Name> storage site is qualified for site closure in accordance with /1/ and /2/, and checked conformity with the criteria referenced in /2/ Section 3.2.6. The verification report /5/ includes a description of the verification process, conclusions from the evaluations, and deviations, if any, from recommendations listed in /2/ Table 3-10.

Validity:
This statement is valid on the date of issue.

Our experience in review and certification of storage projects

- QUEST: Review, and issuance of
 - Statement of Fitness for Purpose of QUEST Storage Development Plan
- CarbonNet: Review/verification relative to DNV-RP-J203, and issuance of:
 - Statement of Feasibility
 - Statement of Conformity – Appraisal plan
 - Verification of documentation to support Declaration of Storage site
- Gorgon: Review commissioned by the Western Australia D. of Mines and Petroleum





**Are YOU
ISO 27914
compliant?**

Thank you for your attention!

Questions?

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