# Applying ISO Standards to Geologic Storage and EOR Projects

**IEAGHG Technical Report: 2022-11**

April 19, 2023

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# A global assurance and risk management company

| 159 | ~13,000 | ~100,000 | 100+ | 5%+ |
|---|---|---|---|---|
| years | employees | customers | countries | of revenue in R&D |


**Certify, verify & test**

against standards, specifications and regulatory requirements


**Qualify and assure**

new technologies, systems, data, platforms, supply- and value chains

**Give expert advice**

on safety, technology and commercial risk, and operational performance

**Co-create and share**

new rules, standards, software and recommended practices



DNV

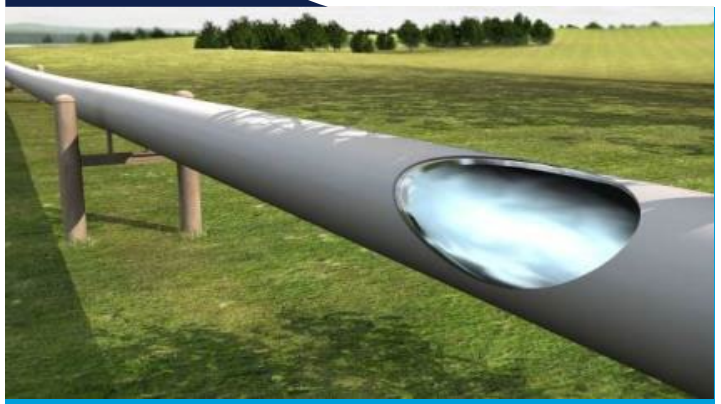
# Helping scale CCS – 200+ projects in past 10 years

## CAPTURE

- Fossil power plants
- Natural gas $CO_2$ reduction
- Other industrial processes

- Cost estimations
- Introduction of new technologies
- Technology review and benchmarking
- Up-scaling risk assessment
- HSE risk assessment
- Accidental release and dispersion
- Value of avoided $CO_2$

## TRANSPORT



- Pipelines
- Ships

- Corrosion
- Material selection and structural design
- Flow assurance and operational issues
- Accidental release and dispersion
- Concept design for $CO_2$ ships
- Requalification of infrastructure

## STORAGE

- Depleted oil or gas reservoirs
- Saline aquifers
- Enhanced oil recovery (EOR)

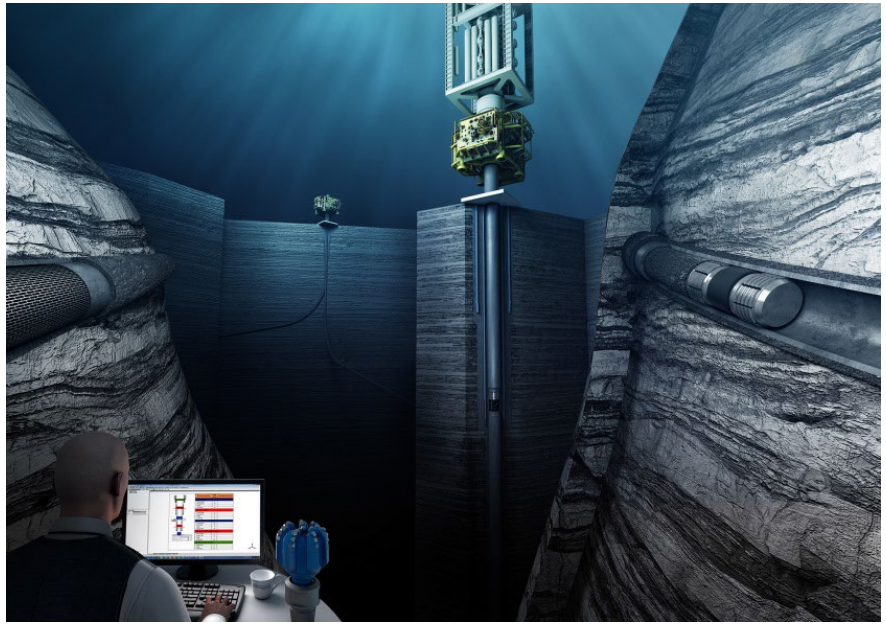
- Verification of storage sites
- Permanence of storage
- Risk management
- Monitoring and verification
- Public concern
- Transfer of responsibility

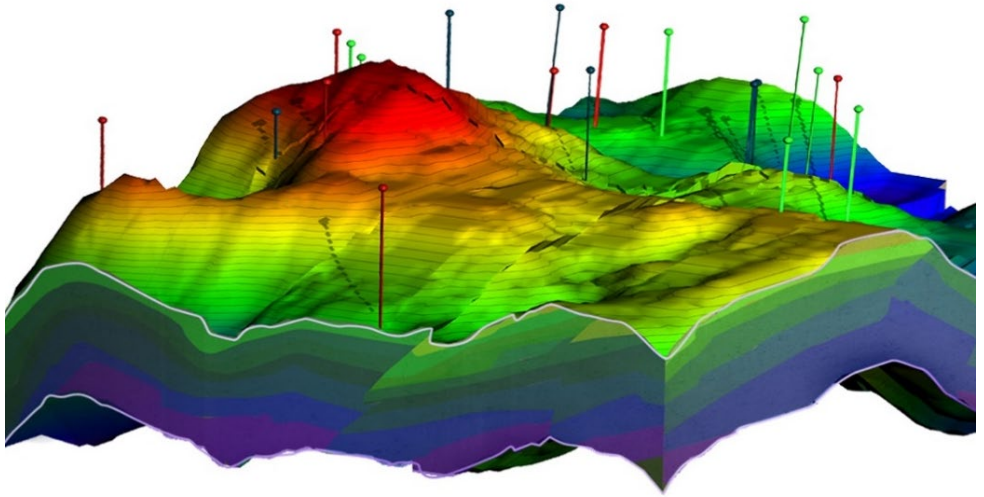


DNV

# DNV CO2 Storage focuses

- Qualification, verification  and certification: Independent review and certification of storage projects
- Technical assurance, advisory and risk management
- Test sites and labs: Spadeadam, Groningen, and Columbus



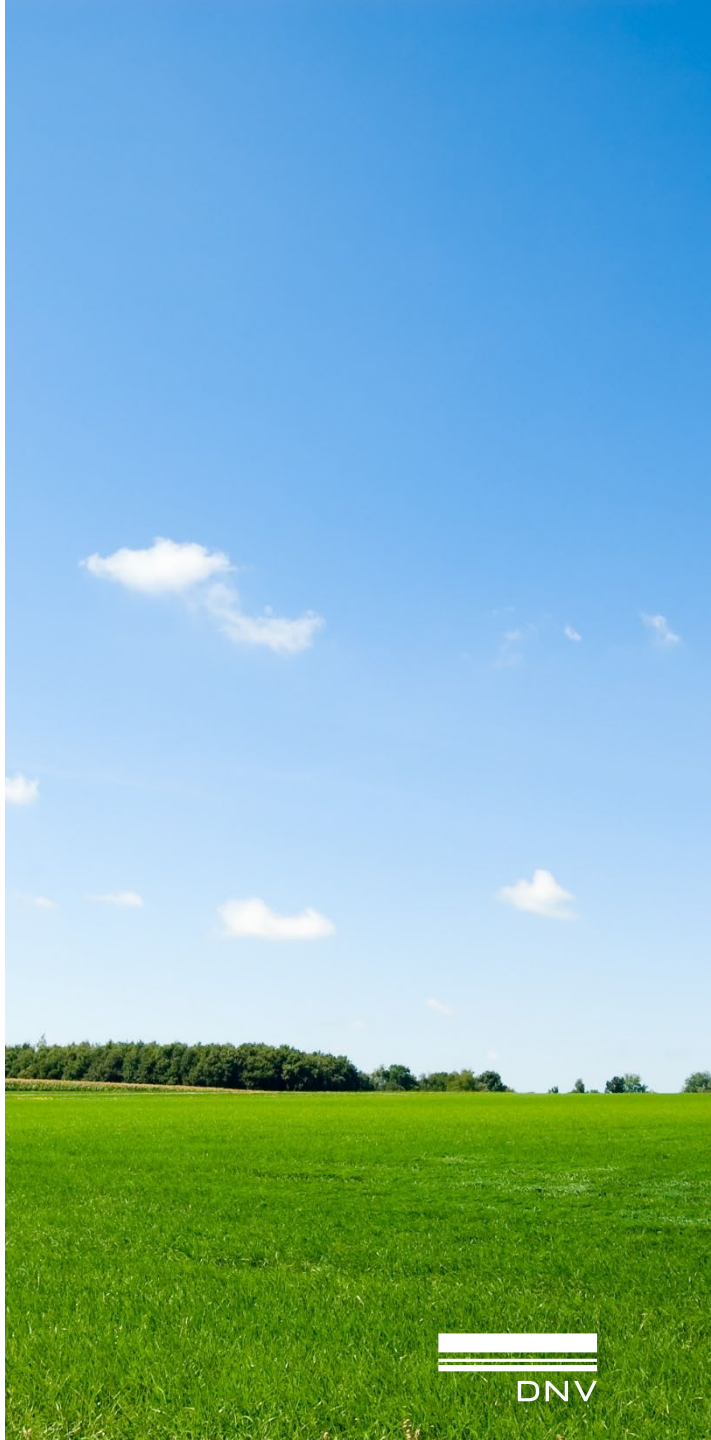


# Study intro, scope and method

# Objective

For new $CO_2$ storage and $CO_2$-EOR projects, the applicability of international standards towards regulatory and project development was sought out.

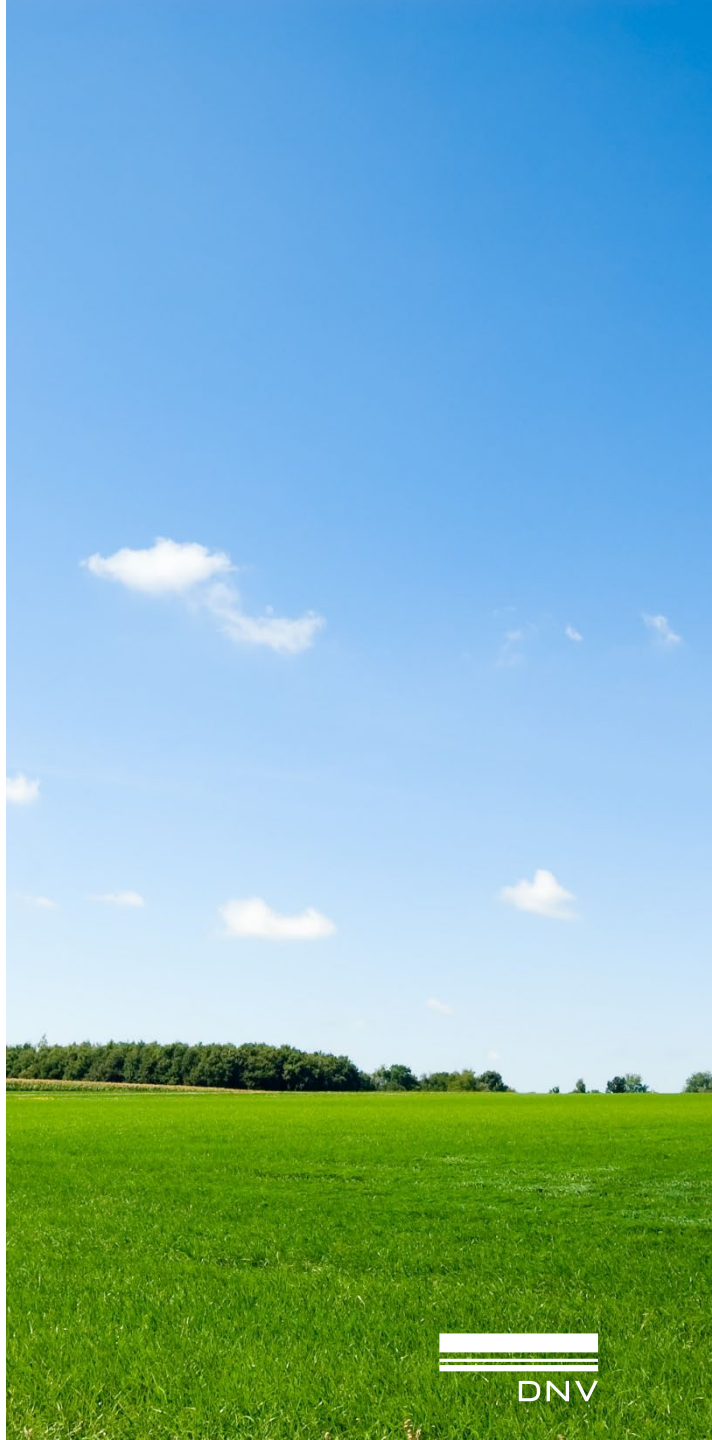
International ISO standards are available as well as industry recommended practices for guiding project development and risk management and align with regulatory framework and regimes.



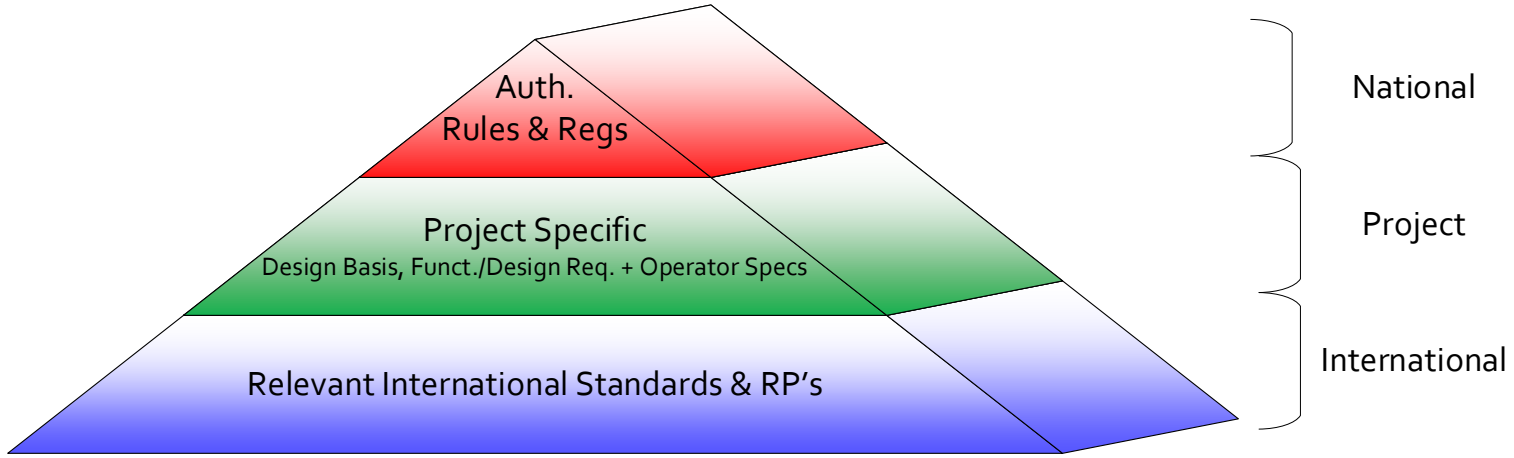
# Introduction

**This work focused on providing insight into the applicability of the standards by:**

- Summarizing and comparing them
- Contrasting them with regulatory frameworks
- Analyzing case studies
- Presenting case studies illustrating use of standards, both for cases with and without existing regulatory regimes



# Standards Background




**The International Standards Organization (ISO) published standards:**

- **ISO 27914:2017** 'Carbon dioxide capture, transportation and geological storage — Geological storage'.

- **ISO 27916:2019** 'Carbon dioxide capture, transportation and geological storage — Carbon dioxide storage using enhanced oil recovery ($CO_2$-EOR)'.

**Other important industry guidance:**

- **DNV RP-J203:2019** 'Geological storage of carbon dioxide'.

# Method

**#1: Performed a synthesis and comparison of standards/RP**

Performed a synthesis and comparison of the ISO standards and DNV RP with a focus on $CO_2$ storage project development.

**#2: Standards to supplement existing regulations**

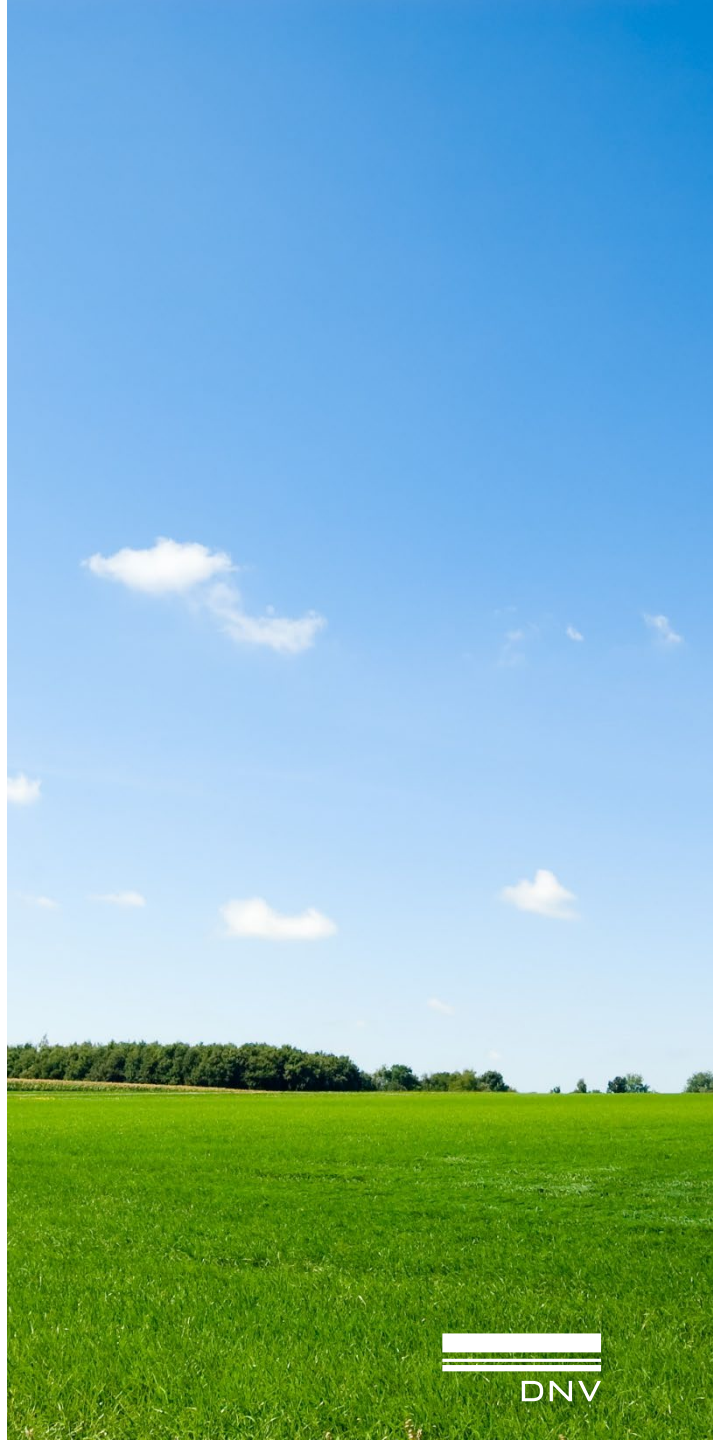
Described the application of the ISO standards and DNV RP where existing $CO_2$ storage regulations are in-place.

**#3: Case Studies for real projects**

Described the application of the ISO standards and DNV RP where existing regulations are in-place.

**#4: Concepts for using ISO standards in locations without regulations**

Evaluate application and case studies for countries without existing $CO_2$ storage regulations in-place.



# Technical Discussion & Findings

# #1: Summarizing and comparing

**ISO 27914 and ISO 27916 are complimentary with minimal overlap:**

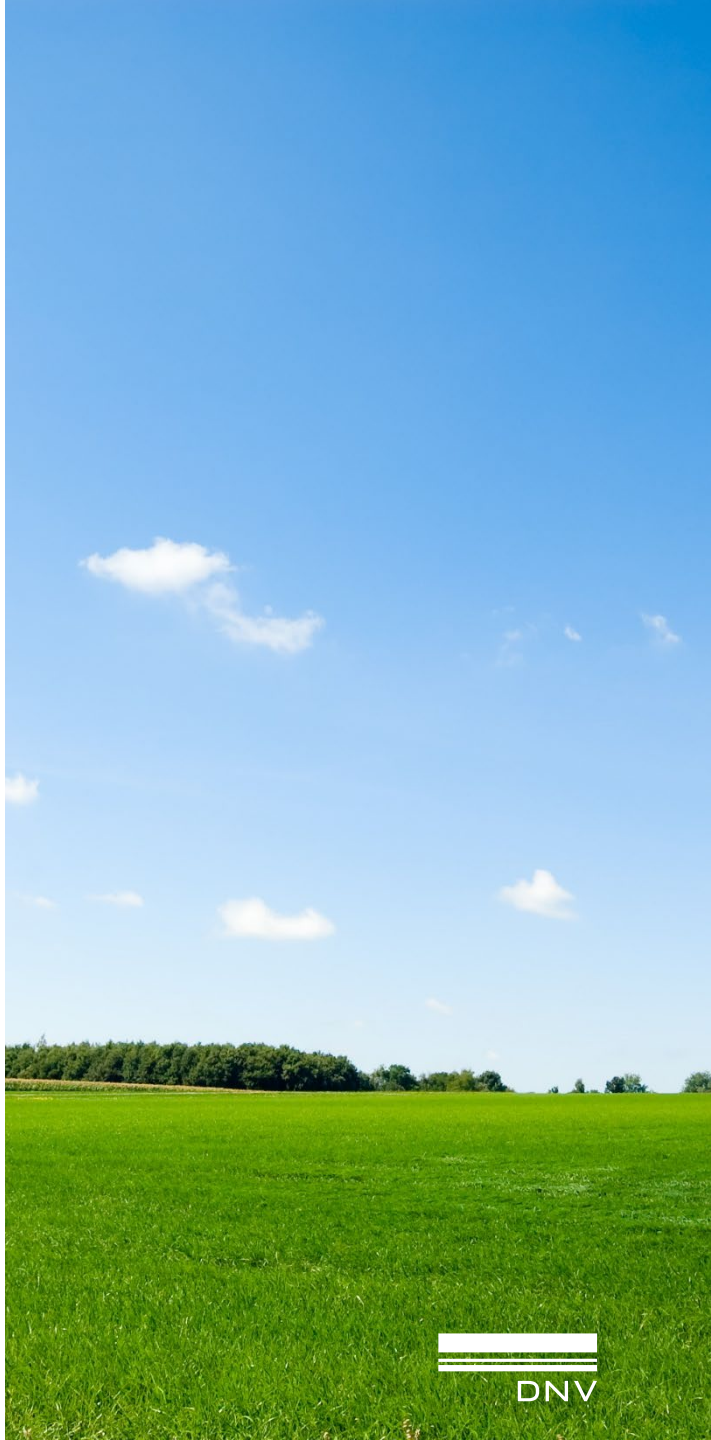
ISO 27914 applies only to $CO_2$ storage projects and
ISO 27916 applies only to $CO_2$-EOR projects.

**The purpose of ISO 27914:**

- Promote commercial, safe long-term containment of $CO_2$ in geological storage sites
- Minimize risk to environment, natural resources and health.

**The purpose of ISO 27916:**

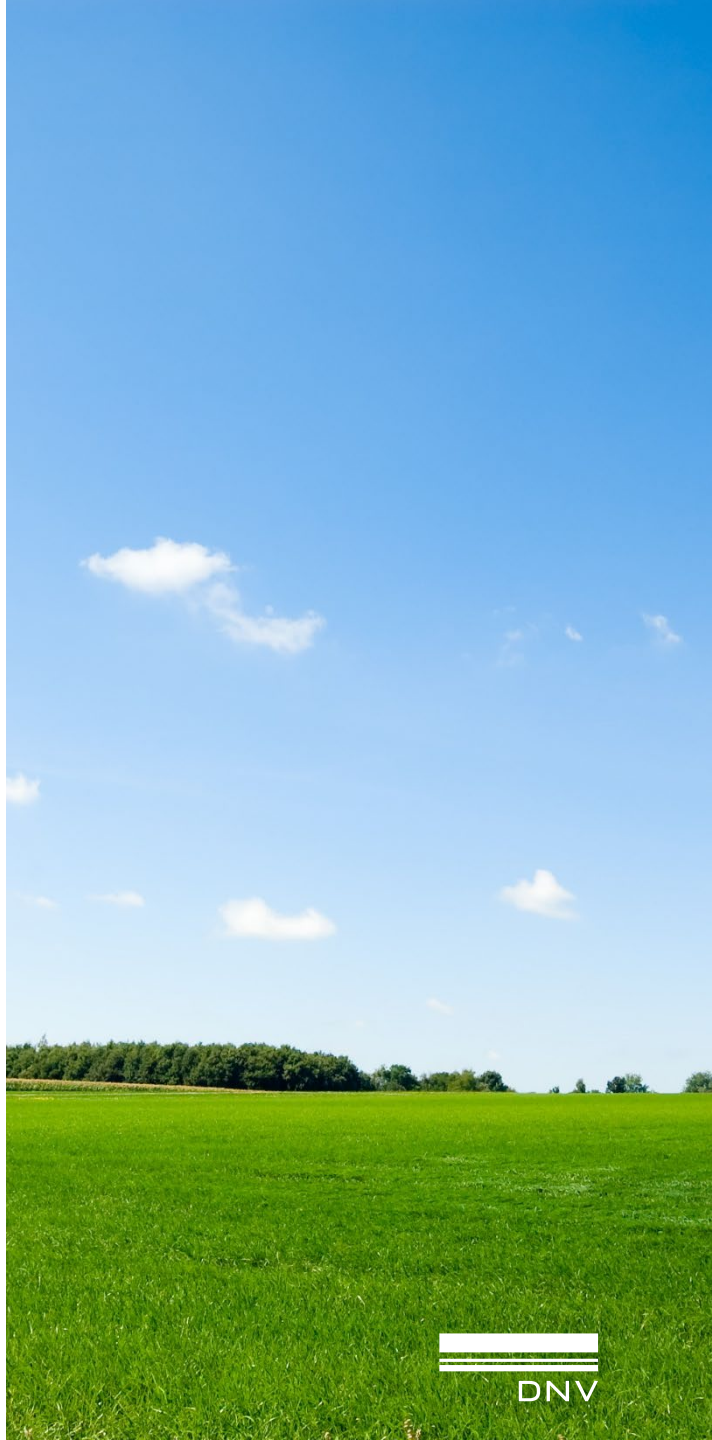
- Promote use of geological storage associated with $CO_2$-EOR
- A common process for assuring safe, long-term containment
- Quantification and documenting amount of $CO_2$ stored from $CO_2$-EOR projects.



# Synthesis of applicability of ISO 27914 and ISO 27916 for different objectives 1/2

| Topic | ISO 27914 | ISO 27916 | DNV-RP-J203 |
|---|---|---|---|
| **Management systems** | Clause 4 (+ e.g. 6.5 and 8.3) | Operations management plan, and requirements for documentation and record-keeping (Clause 4 and 9) | |
| **Risk management** | Clause 6 | Mentioned, but very limited guidance on how to manage risks. Mainly Clause 6. | Clause 6 |
| **Well infrastructure** | Clause 7 | Very high level, limited guidance | Clause 7 |
| **Operations** | Clause 8 | Some high-level guidance in Clause 6.1 | |
| **Monitoring** | Clause 9 | Some high-level guidance in Clause 6.2 | Clause 5.4.7 |

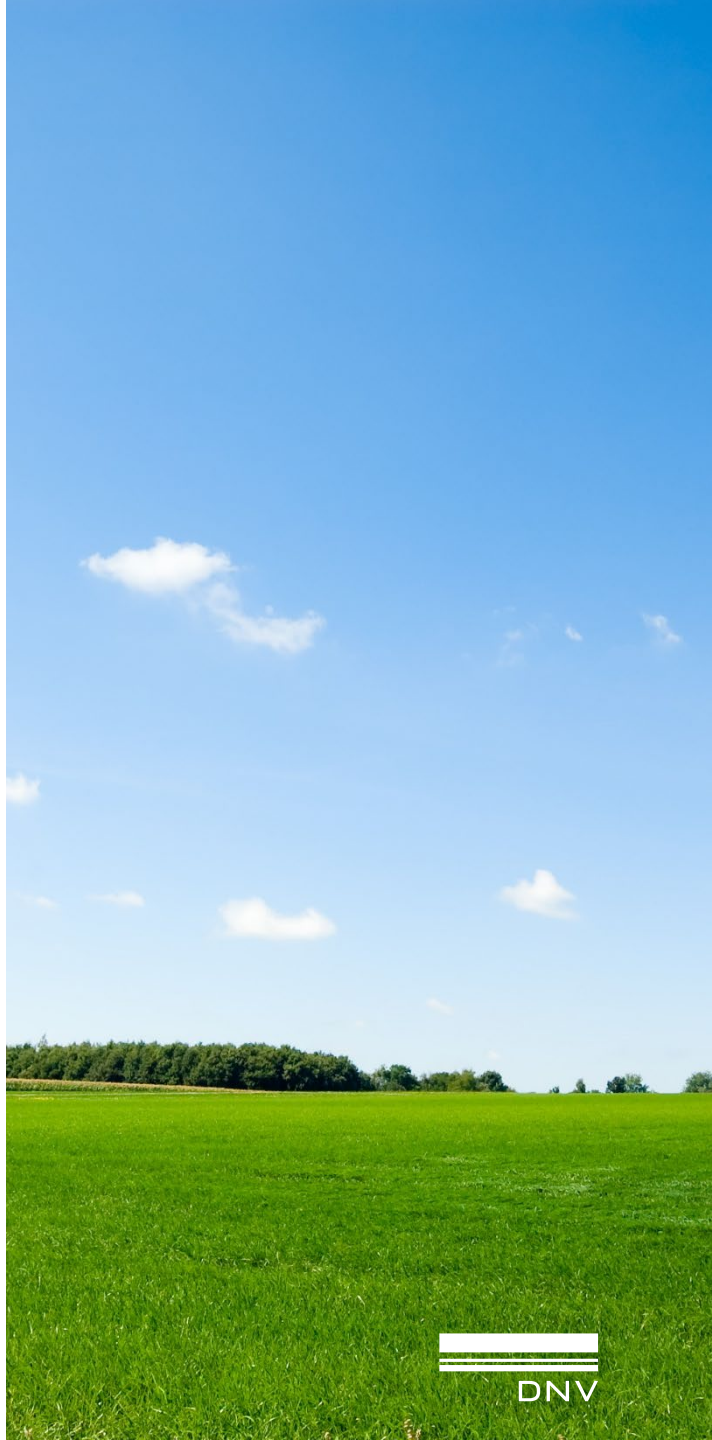
Green signals applicability, yellow signals partly applicability and red signals not addressed.



# Synthesis of applicability of ISO 27914 and ISO 27916 for different objectives 2/2

| Topic | ISO 27914 | ISO 27916 | DNV-RP-J203 |
|---|---|---|---|
| **Site closure/Project termination** | Clause 10 | Clause 10 | Clause 5.5 |
| **Quantification of GHG emissions** | | Clause 8, quantification of $CO_2$ stored | Clause 5 & 6, imbedded in permitting and risk management framework |
| **Permitting** | | | Clause 5 |
| **Stakeholder consultation/communication** | High level guidance in Clause 4.1.3 and 4.6 + guidance on risk communication and consultation in Clause 6.10 | | Clause 5, high level guidance on communication and involvement in permitting process |
| **Environmental (impact) assessment** | | | Clause 5.4.4 Environmental statement |
| **$CO_2$ composition** | Limited guidance, e.g. Clause 5.4.4 | | Limited guidance, e.g. Clause 7.4.2 |
| **Post closure/termination** | | | Limited guidance in risk management framework |

Green signals applicability, yellow signals partly applicability and red signals not addressed.



# Comparison of ISO 27914 with existing regulation for $CO_2$ storage

While ISO 27914 *does not apply to, modify, interpret, or supersede any national or international regulations, treaties, protocols or instruments otherwise applicable to the activities addressed*, ISO 27914 does provide additional guidance on matters dealt with under the regulations.

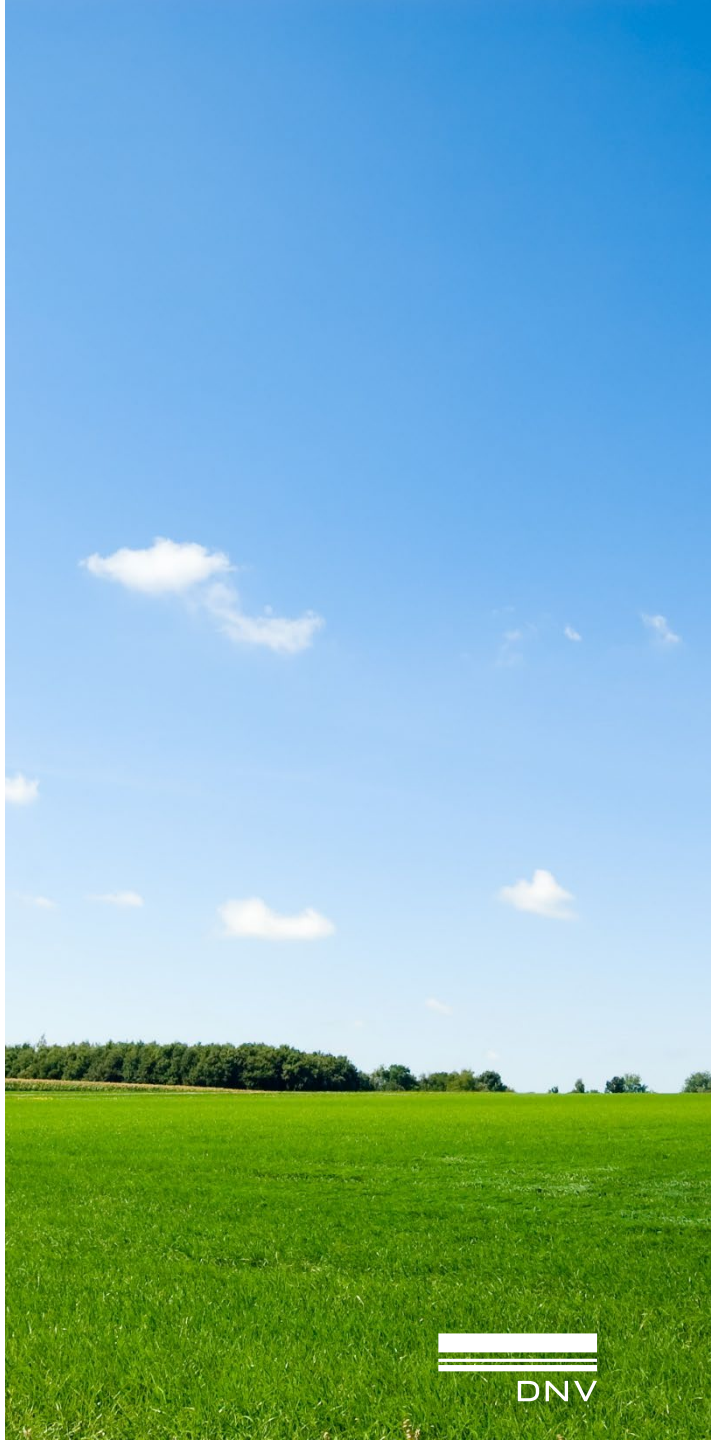
The paper highlights examples of the comparison of the application of ISO 27914 with regulations

- **EU CCS Directive**
- **US Class VI Rules**
- **Australian Offshore GHG Storage Act + regulations**

Topics with overlap includes:

- **Site screening, risk management, operations, monitoring and verification (M&V), site closure**

  - Varying degree of alignment
  - Overall, feasible application for cases where regulations exist



# Comparison of ISO 27916 with existing regulation for $CO_2$ EOR

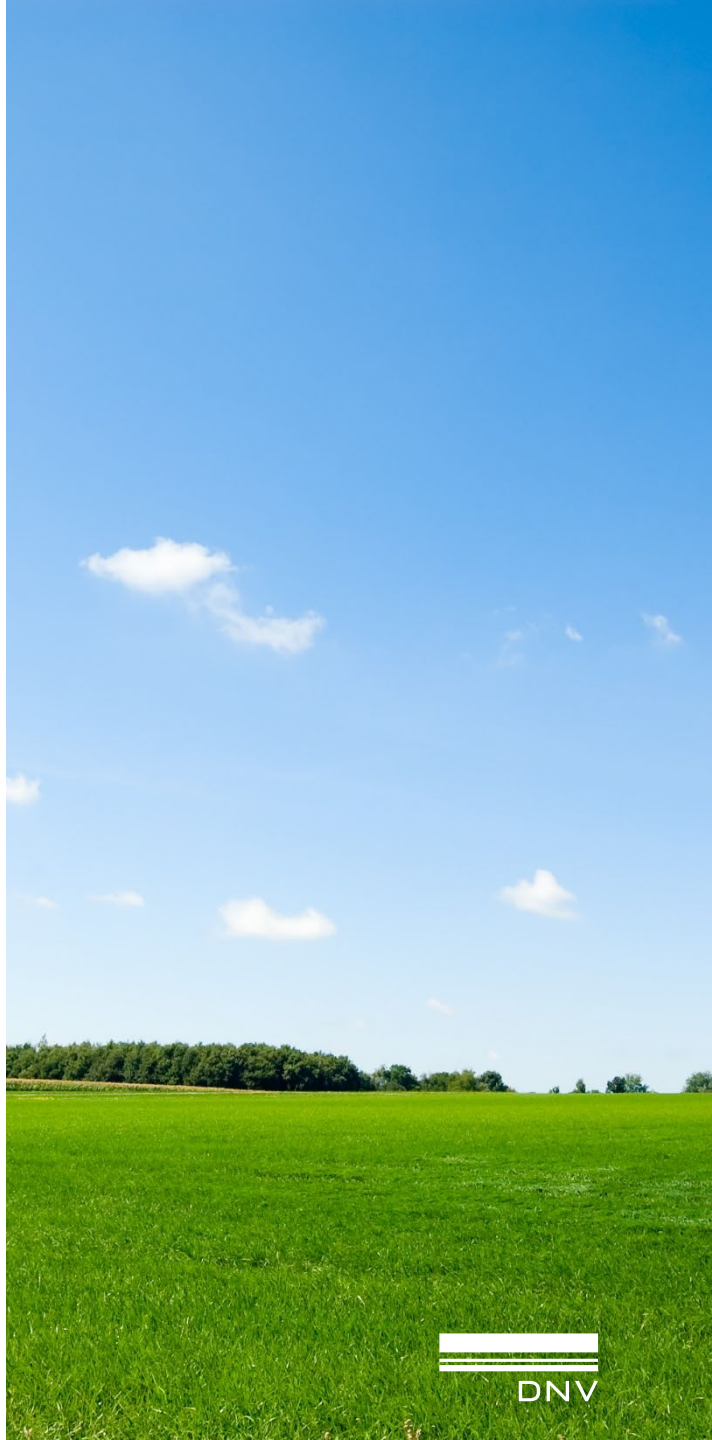
For ISO 29716, the application is comparative to

- **US Class II Rules**

Topics with overlap include:

- **EOR complex characterization and containment assurance**
- **Monitoring**
- **Well construction and well intervention**
- **Project termination**

  - Some overlap, with US Class II Rules generally dictating more detailed prescriptive requirements.

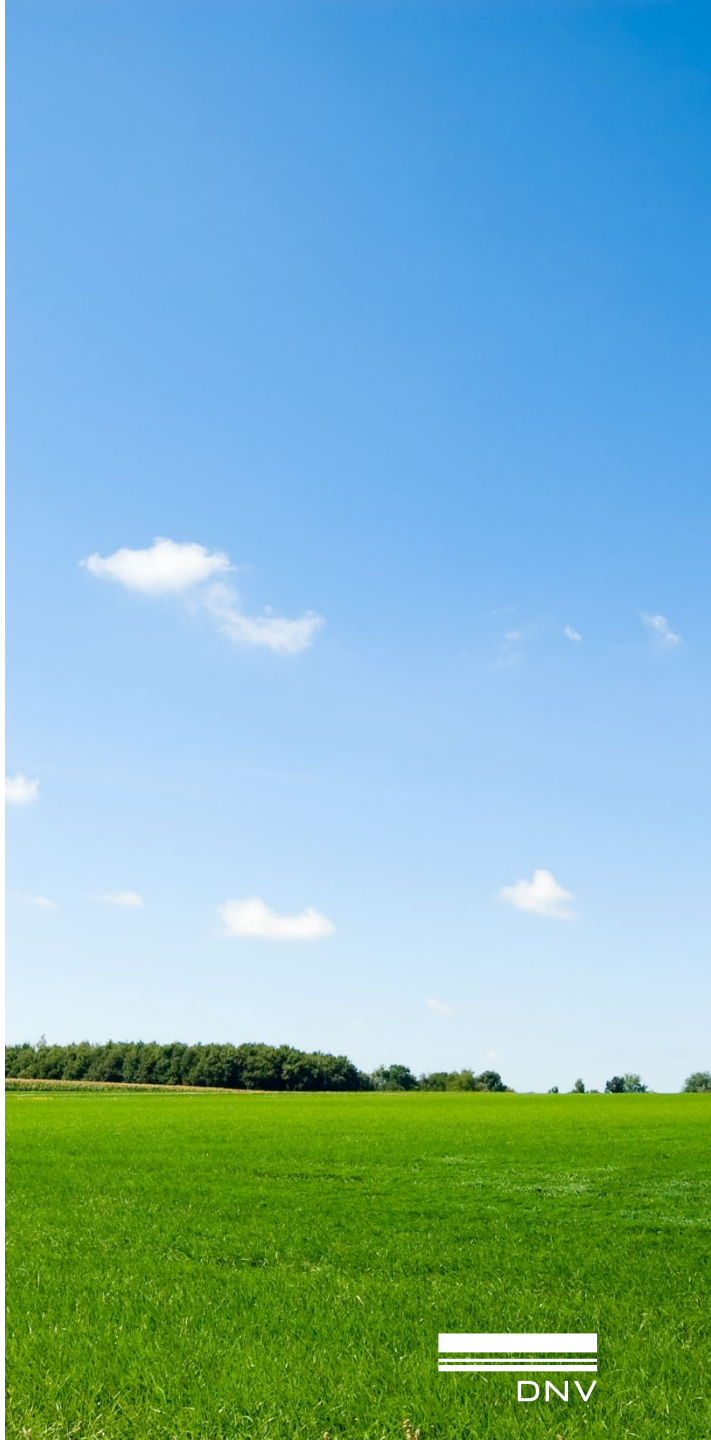


# #2: Applicability of standards to supplement existing regulations

**Application of ISO 27914 to support storage site permitting:**

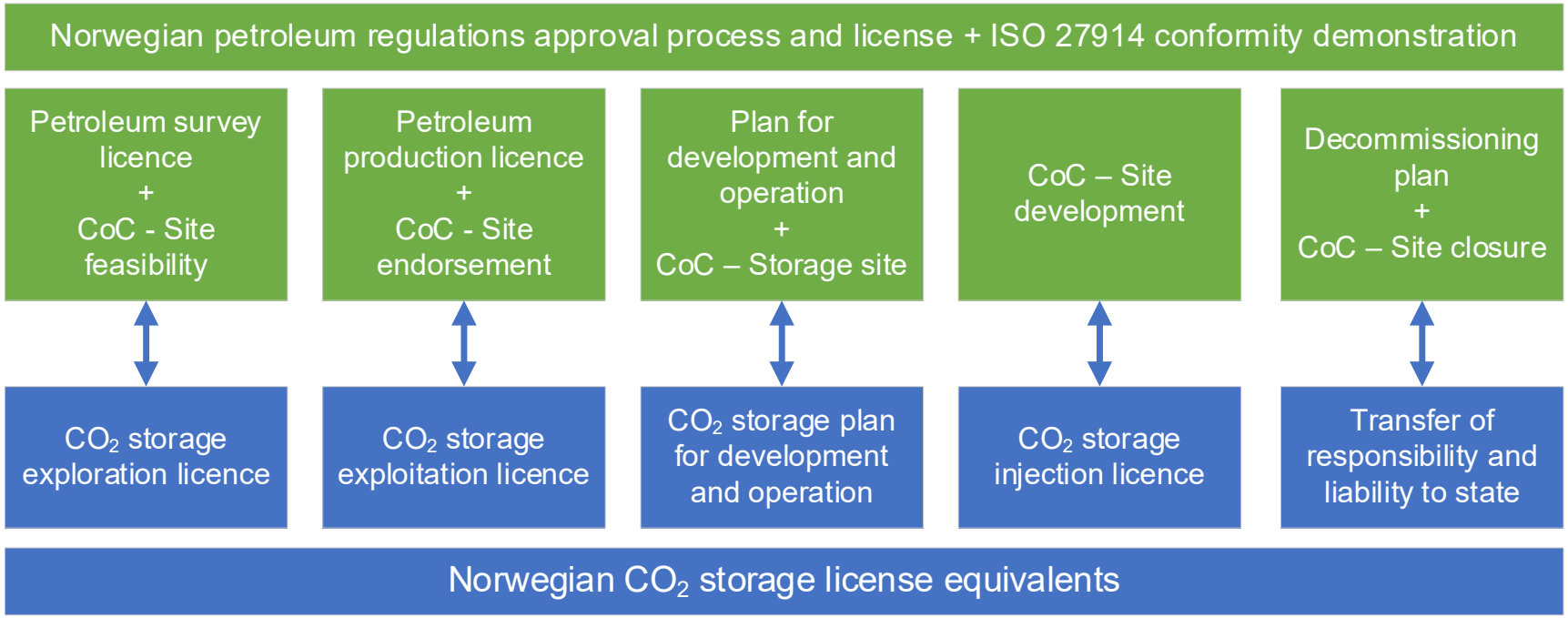
- An exploration or evaluation permit
- A storage permit or sequestration lease
- An injection permit
- Closure certificate and transfer of responsibility

**Alternatively, DNV RP J203 can be used as a technical guide to supplement existing regulations for $CO_2$ storage projects**

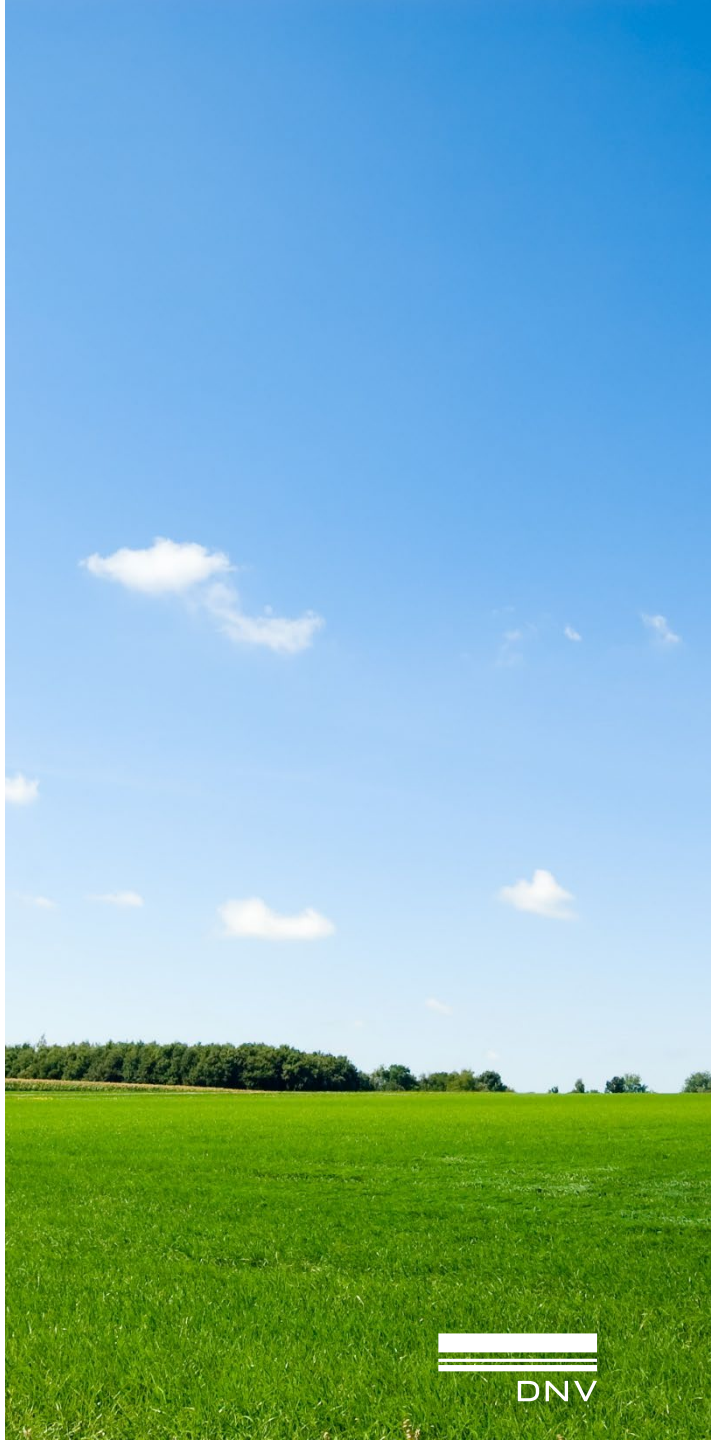


# Application of ISO 27914 for permitting $CO_2$ storage projects

**Example of ISO certification combined with petroleum regulations (Norway)**
**CoC = Certification of Conformity with ISO 27914 at different project stages**



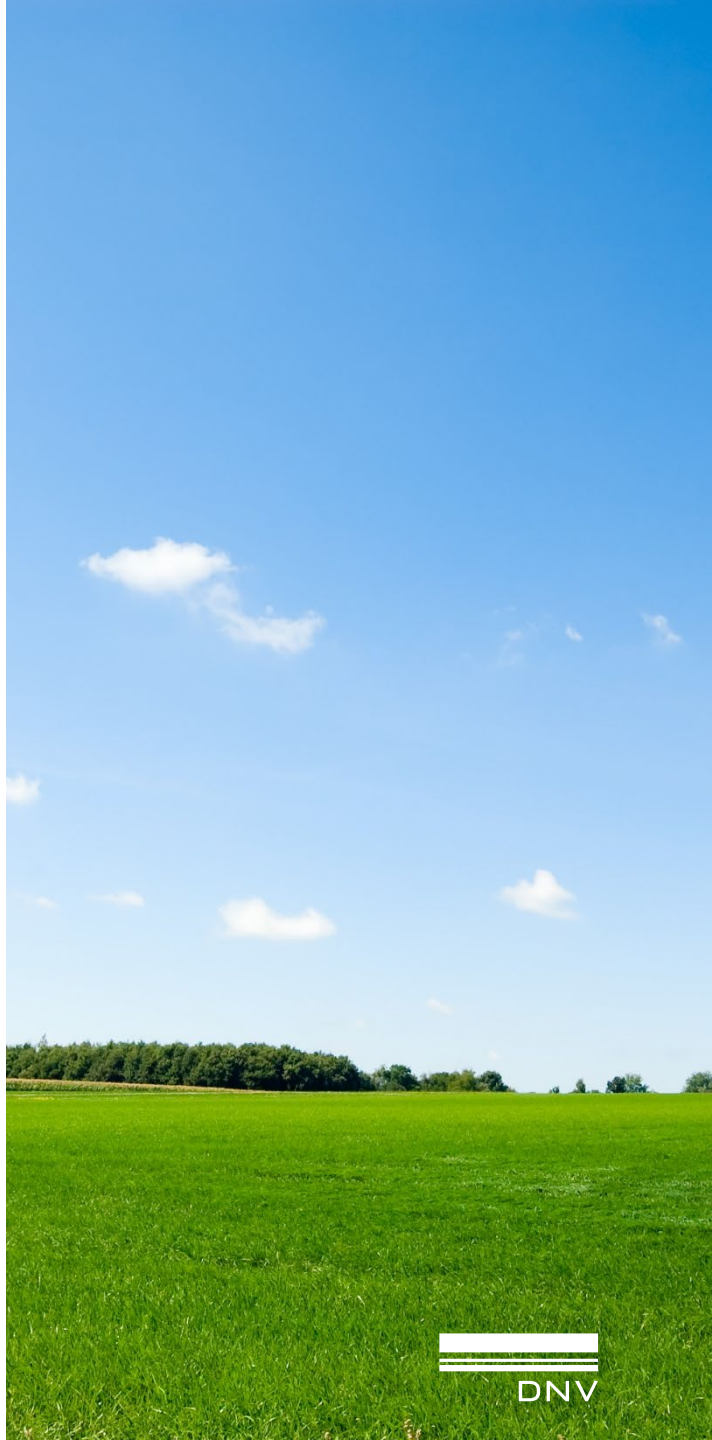


# Application of ISO 27916 to support emission accounting

ISO 27916 Clause 8 establishes methods and requirements for quantification of mass of CO2 stored and lost associated with CO2-EOR operations.

| **ISO 27916** | **EU: EU Monitoring and Reporting Guidelines (MRG)** | **California: California Air Resources Board Low Carbon Fuel Standard (LCFS)** | **Alberta: The Alberta quantification protocol for CO2 capture and permanent storage** |
|---|---|---|---|
| **Focus:**<br>• Quantification of net stored $CO_2$. | **Focus:**<br>• Quantification of emitted $CO_2$. | **Focus:**<br>• Quantification of net GHG emission reductions. | **Focus:**<br>• Quantification of net GHG emission reductions. |
| **Quantification of stored $CO_2$** | Not aligned. | Somewhat aligned. | Somewhat aligned. |
| **Quantification of $CO_2$ lost** | Overlapping / aligned | Overlapping / aligned | Overlapping / aligned |



# #3: Case studies illustrating use of standards

**1: Verify conformance with industry best practice on site feasibility**

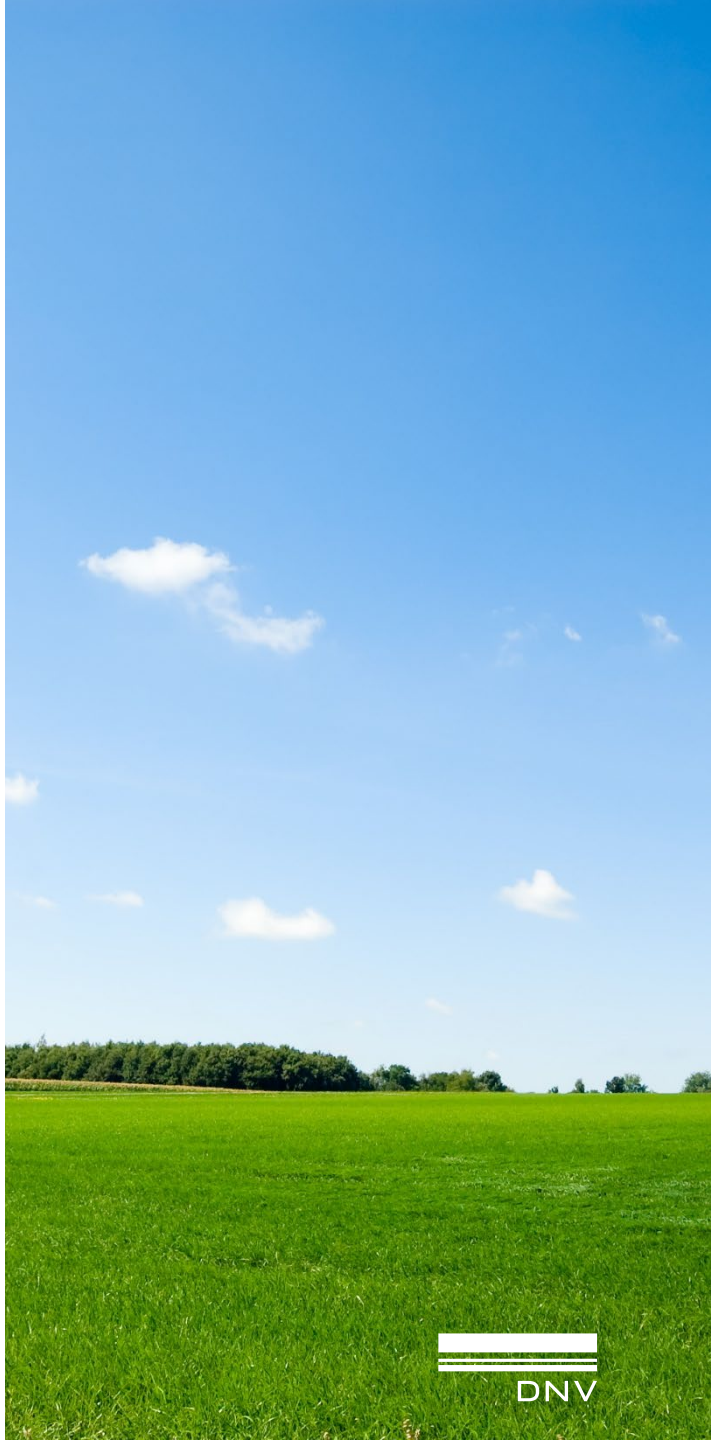
DNV-RP-J203 and ISO 27914 were used to determine site feasibility for $CO_2$ storage for the CarbonNet Project (Victoria, Australia) and Project Greensand (Denmark).

**2: Support re-qualification of wells at $CO_2$ storage sites**

Illuminating how existing standards and previous work in $CO_2$ storage projects provide guidance for re-use and proper re-qualification of wells for $CO_2$ storage purposes.

**3: Development of risk-based M&V program (storage or $CO_2$ EOR)**

Existing standards, guidelines and industry knowledge and experience provide sufficient guidance for monitoring and verification (M&V) programs to meet regulatory objectives in different regions of the world.



# Case study 1 – Site Feasibility

**CarbonNet, Offshore Victoria, Australia**

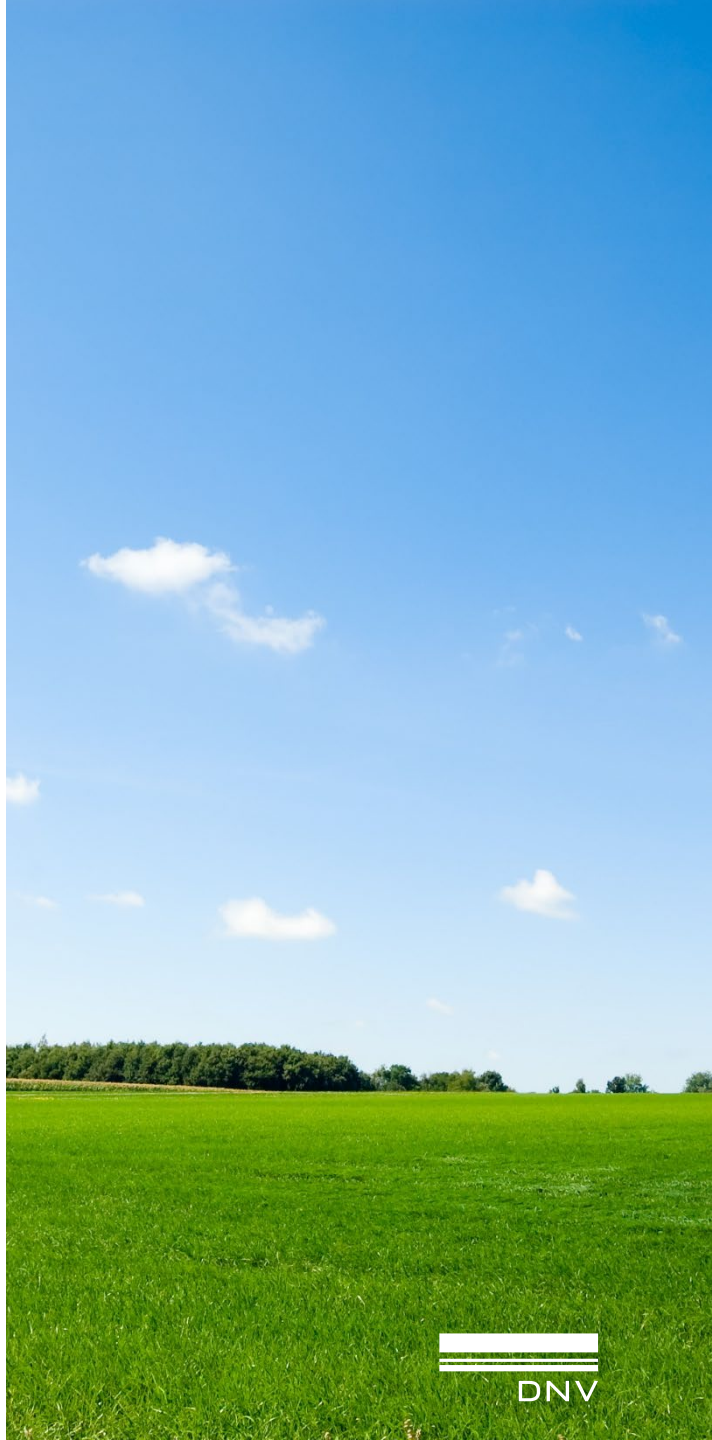
Feasibility of prospective sites for the CarbonNet Project was determined through application of the certification framework described in DNV-SE-0617 [5] and the technical guidance provided in DNV-RP-J203

The technical requirements to site feasibility build on the process laid out in the CO2QUALSTORE guideline

**Greensand, Offshore Denmark**

Project Greensand's feasibility and site selection process was aligned with ISO 27914 rather than DNV-RP-J203.

Notably in this project, there are no mandatory requirements (shall statements) to be evaluated for feasibility in ISO 27194. All criteria listed in both 5.2 and 5.3 are recommendations (should statements).

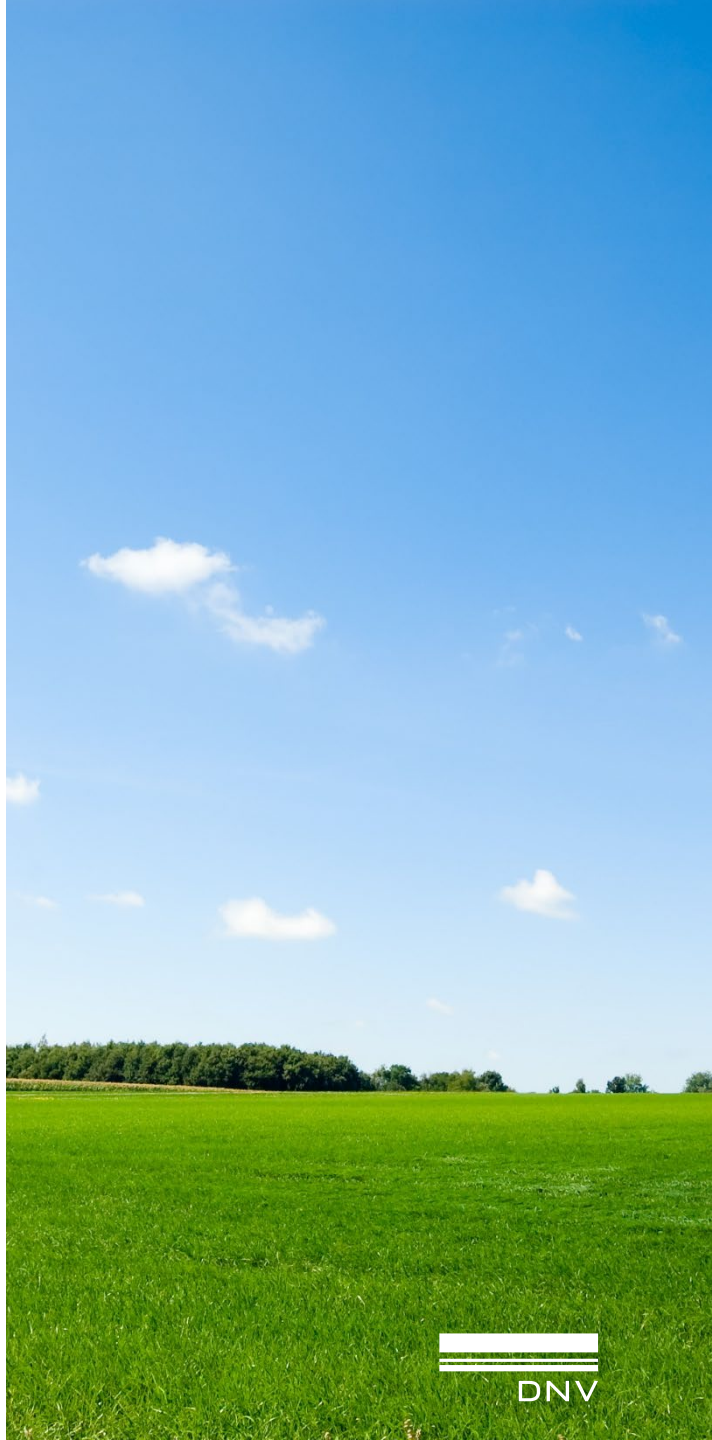


# Case study 2 – Well Re-qualification

**ISO 27914 and DNV-RP-J203 provide guidance for well re-qualification**

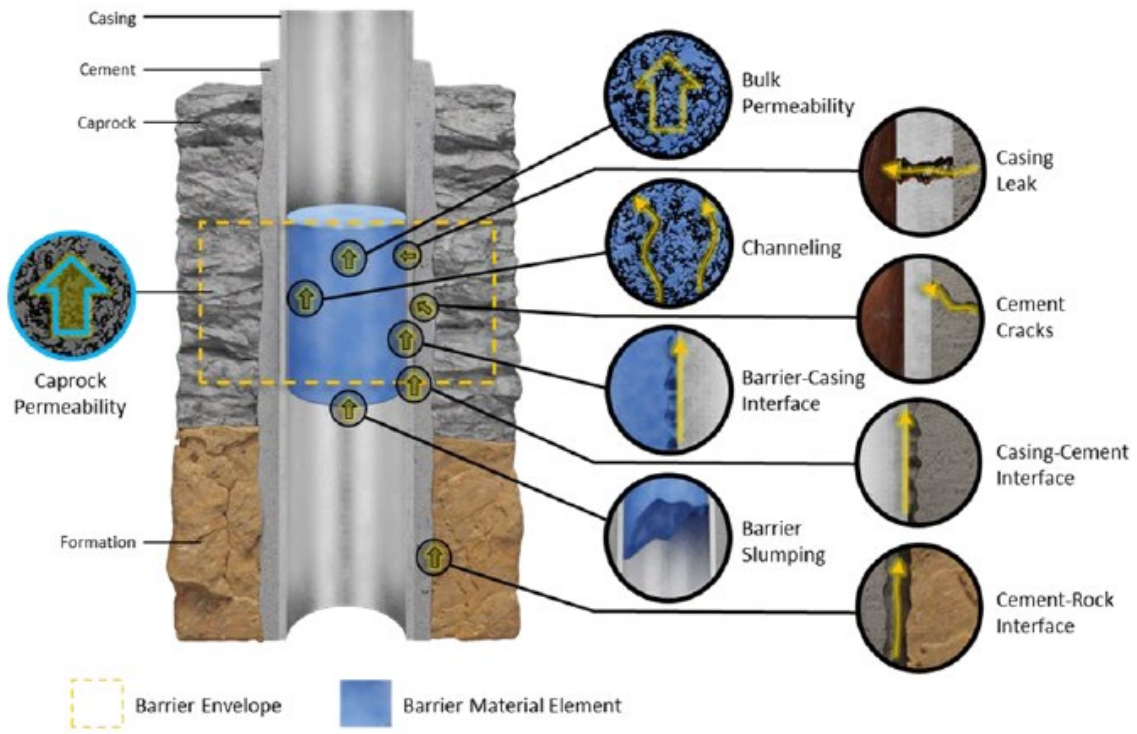
Technical aspects include: well design, tubulars, casing and conductor design, completion design, cementing design, material selection, wellbore integrity, annulus pressure management, re-completion and workover, well abandonment, competence requirement for well qualification

- ✓ Research initiatives, screening tools, project evaluations have been performed on a wide industry basis.
- ✓ Background cases, such as evaluating wells for Plug and Abandonment (P&A) could provide evidence for sufficient well integrity.
- ⚠ Project Kingsnorth 2011 showed wells were not suitable for CO2 injection and storage
- ⚠ Other cases of well re-qualification for CO2 injection and storage have yet to be realized.



# Legacy Wells Challenges

- Interaction with legacy wells in the storage complex for CO2 storage is an important consideration, both for:
  - Already P&A'ed historic wells from E&P
  - Current production wells that may
- Quantifying the well integrity risk towards containment is key
- Framework is available in:
  - DNV-RP-E103 "Risk-based abandonment of wells"
  - DNV- RP-J203 "Geological storage of carbon dioxide"
  - ISO 27914 "Carbon dioxide capture, transportation and geological storage — Geological storage"
- Main principles focus on:
  - Well barrier integrity
  - Uncertainty management (clarifying what is known/unknown)
  - Assessing risk in qualitative and quantitative methods

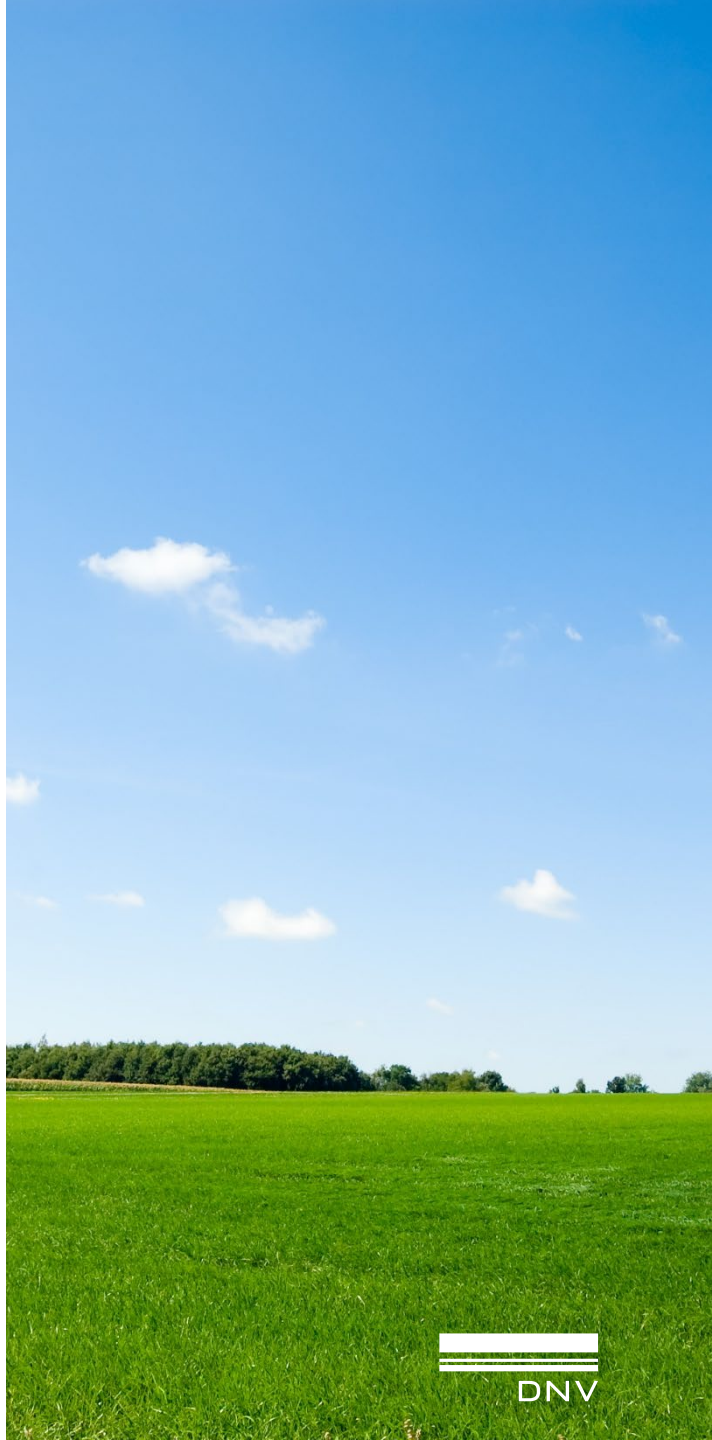



Source: OEUK Well Decommissioning for CO2 Storage Guidelines [2022]

# Case study 3 – Development of risk-based M&V program

## Based on ISO 27914, USA Subpart RR Rules, DNV-RP-J203

| Topic | ISO 27914 | RR Rules | DNV-RP-J203 |
|---|---|---|---|
| **Objective of monitoring plan** | M&V plan to be project specific with site specific considerations to manage health, safety, and environmental risks, and to assess storage performance. | Provide guidance and requirements for operators when applying for M&V plans and applying for approval. | Describe the purpose, monitoring targets and performance requirements for monitoring and explain how these will be achieved through the M&V plan. |
| **Pre-injection monitoring** | Determine project vulnerabilities and baseline against which monitoring outputs (and storage performance) are compared | Establishment of baseline for comparison | No specific differentiation of monitoring for different operational phases of the project.<br>Screen and select monitoring techniques based on risk management process.<br>Include contingency plans for monitoring, verification and follow-up.<br>Relative to closure period monitoring, it is stated that the monitoring plan should demonstrate requirements for site closure. |
| **Injection period monitoring** | - Control HSE risks<br>- Provide sufficient information on integrity<br>- Calibrate injectivity performance | - Monitor performance of $CO_2$ injection (amounts, quality and location)<br>- Identify leak potential for injected $CO_2$ and provide means for quantification of leakage | |
| **Closure period monitoring** | Manage leakage risks and demonstrate storage performance to meet site closure criteria | - Identify potential leakage pathways and means for quantifying leaks of injected $CO_2$ | |
| **Post-closure monitoring** | No specific guidance provided. | No specific guidance provided. | |

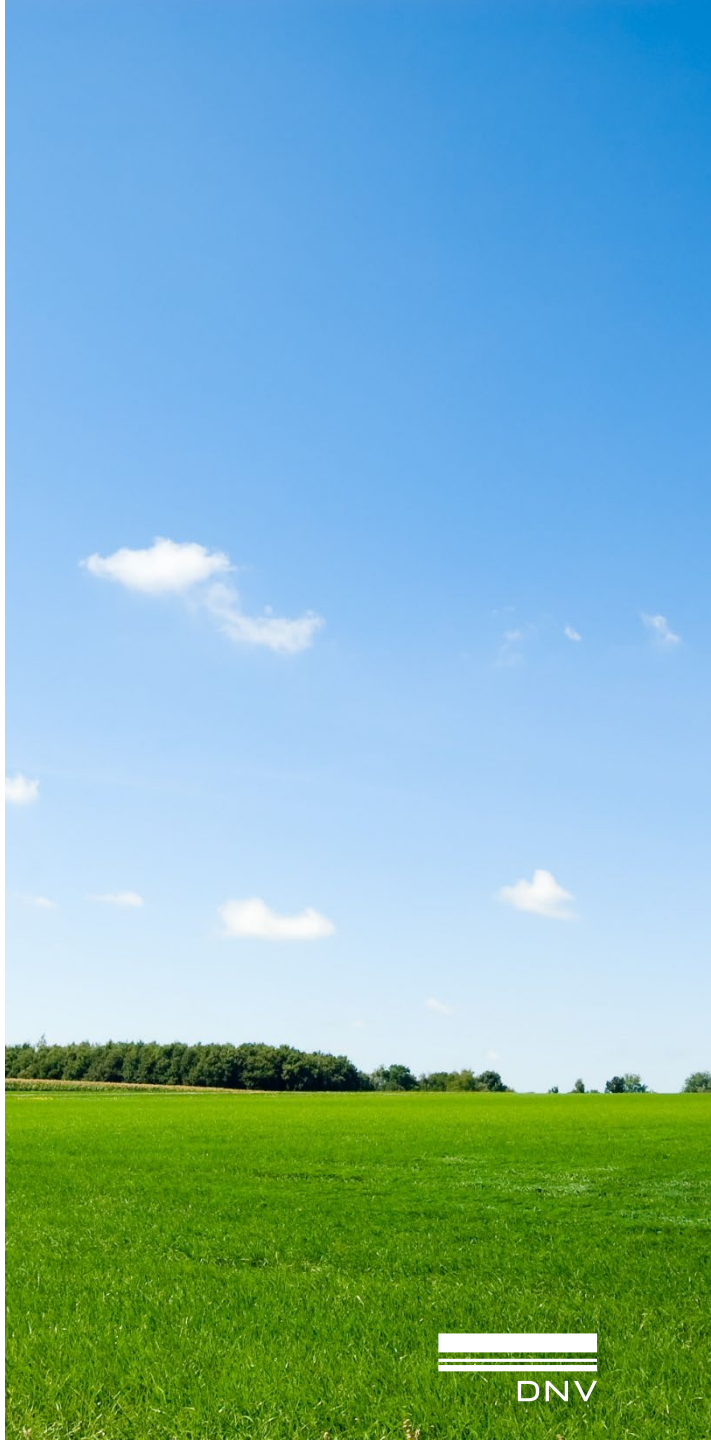


# #4: Concepts for using ISO standards in locations without regulations

The Global CCS Institute developed a CCS Legal and Regulatory Indicator (CCS-LRI) with a broad range of factors that represent critical elements of the regulation of CCS technology. The CCS-LRI relate point scores to 55 countries' legal and regulatory frameworks related to how well they satisfy 5 categories and 29 sub criteria representing the critical elements of a CCS regulation.

The ISO standards provide limited specific support for legal and regulatory elements related to:

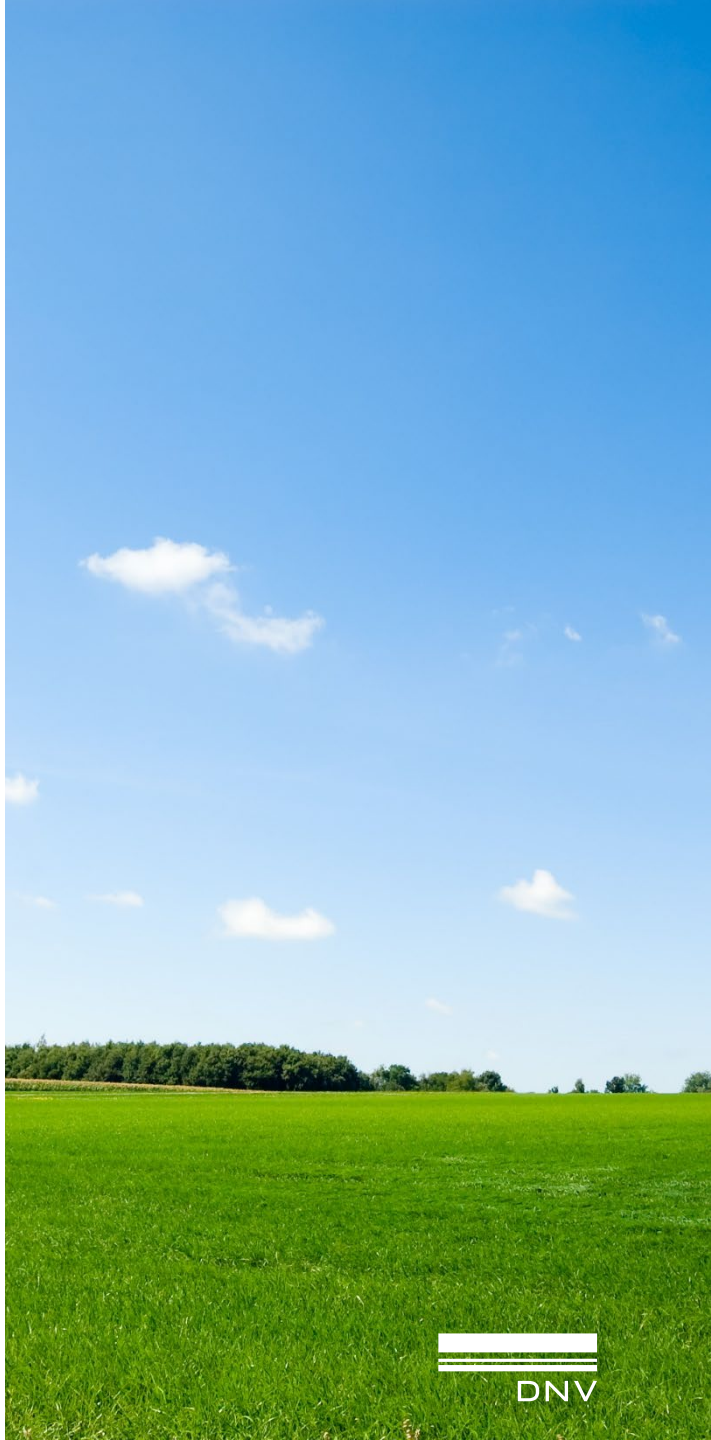
- the CCS approval process,
- ownership definitions,
- governmental agencies' roles and responsibility,
- ownership regime of the sub-surface,
- transportation of CO2 (including transboundary movement of CO2), and
- dispute resolution mechanisms.



# Concepts for using ISO standards in locations without regulations

The ISO standards also support in a general manner the legal and regulatory elements related to

- definition of the CO2 stream,
- identification and accounting for CO2 leakage,
- monitoring, storage and siting, closure,
- reporting and verification,
- public engagement and
- risk assessments.

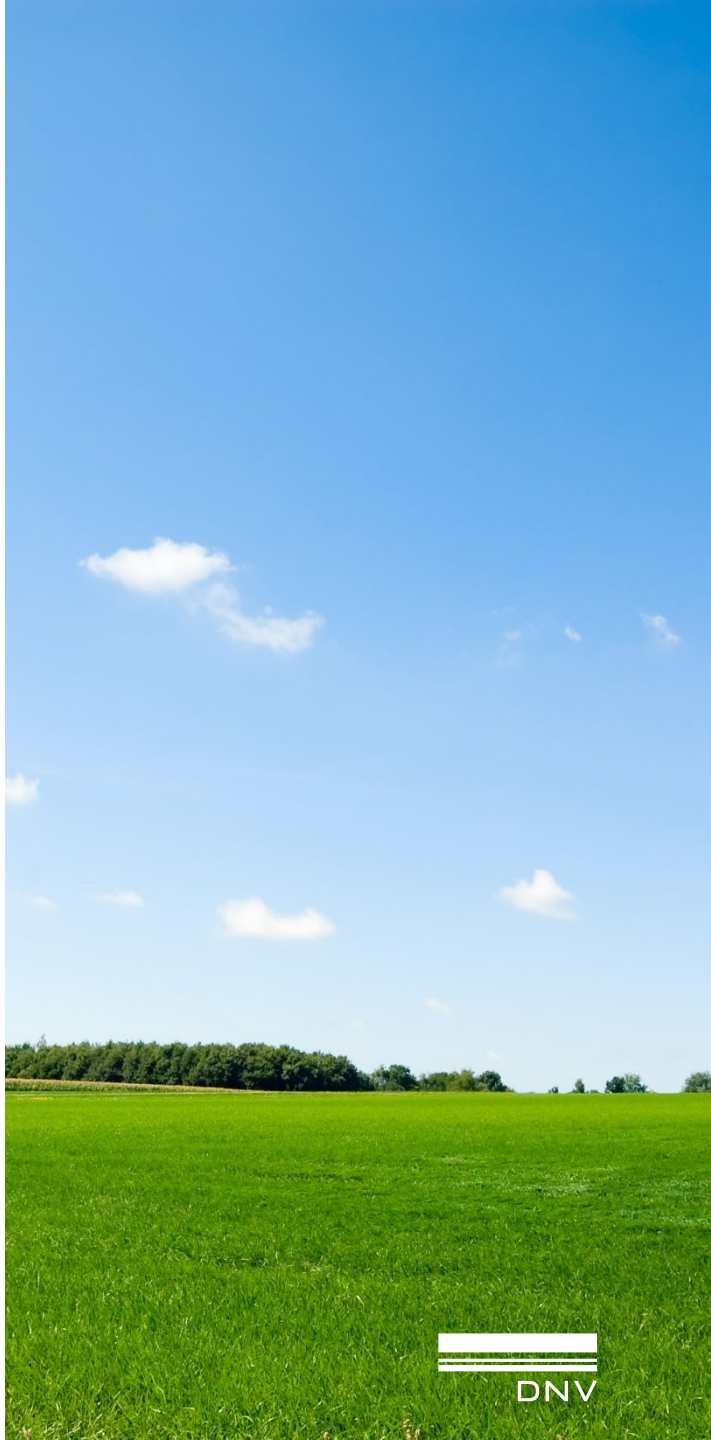


# Concepts for using ISO standards in locations without regulations

Additionally, many oil and gas producing countries have technical potential to accommodate CCS projects, but currently lack CCS specific regulations. Maturity in:

- Angola
- Mozambique
- Trinidad and Tobago
- Thailand and Indonesia

➢ indicate feasible approach using the ISO standards in combination with alternative local regulatory frameworks.



# Discussion and Conclusions

# Applicability to supplement regulations

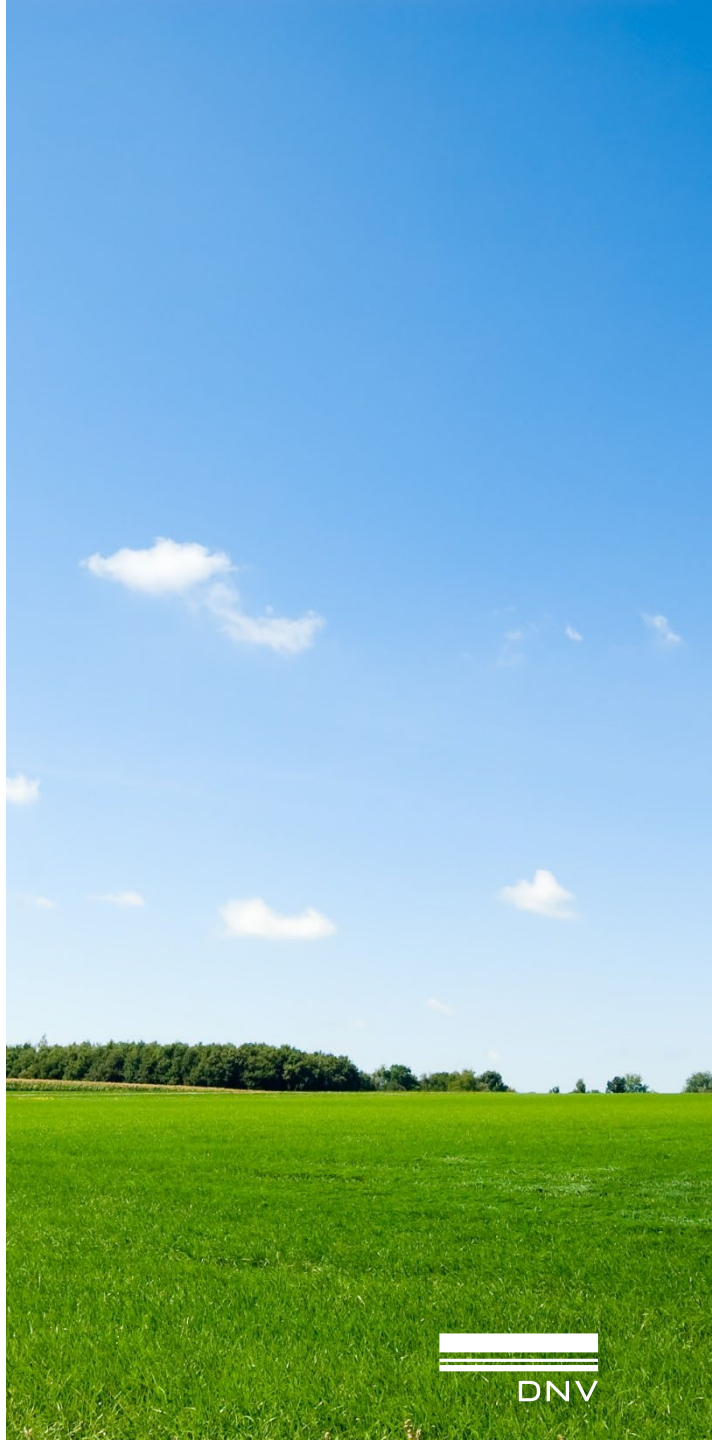
ISO 27914 and ISO 27916 together with other industry guidelines can support CCS project development and permitting.

- Development of plan for development and operation
- Demonstration of conformity with criteria for site closure
- Support emission accounting.

The existing petroleum licensing regime, complemented by standards setting specific requirements for $CO_2$ storage projects may be combined to contribute to the development of a licensing regime for $CO_2$ storage projects.

Regulatory areas that are not covered by ISO 27914 and ISO 27916:

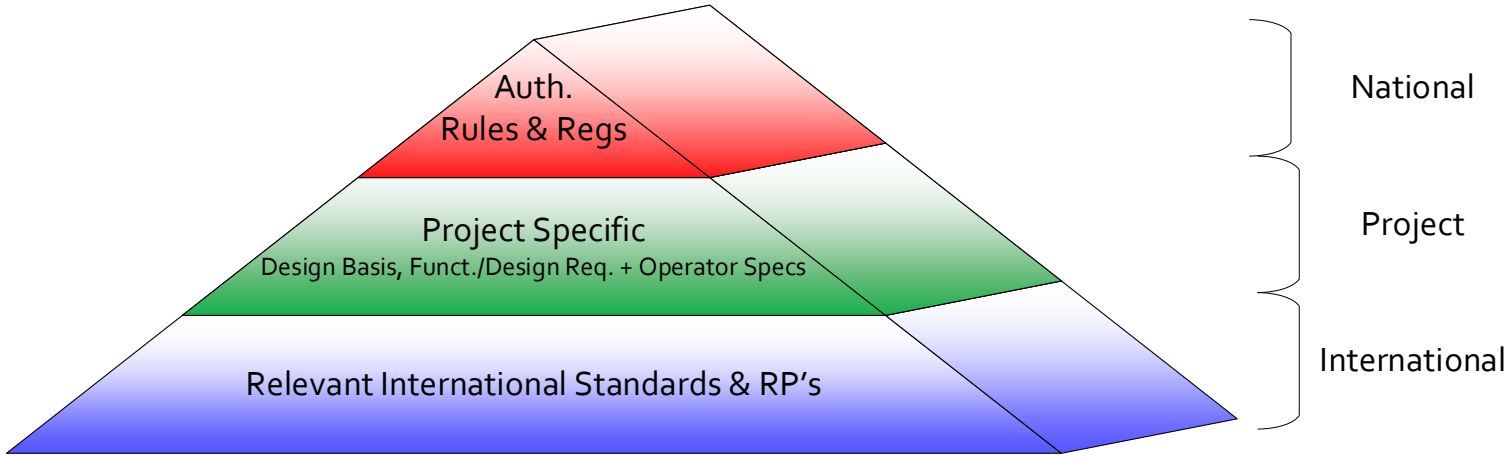
- The management of long-term liability
- The regulatory approval processes – in detail.

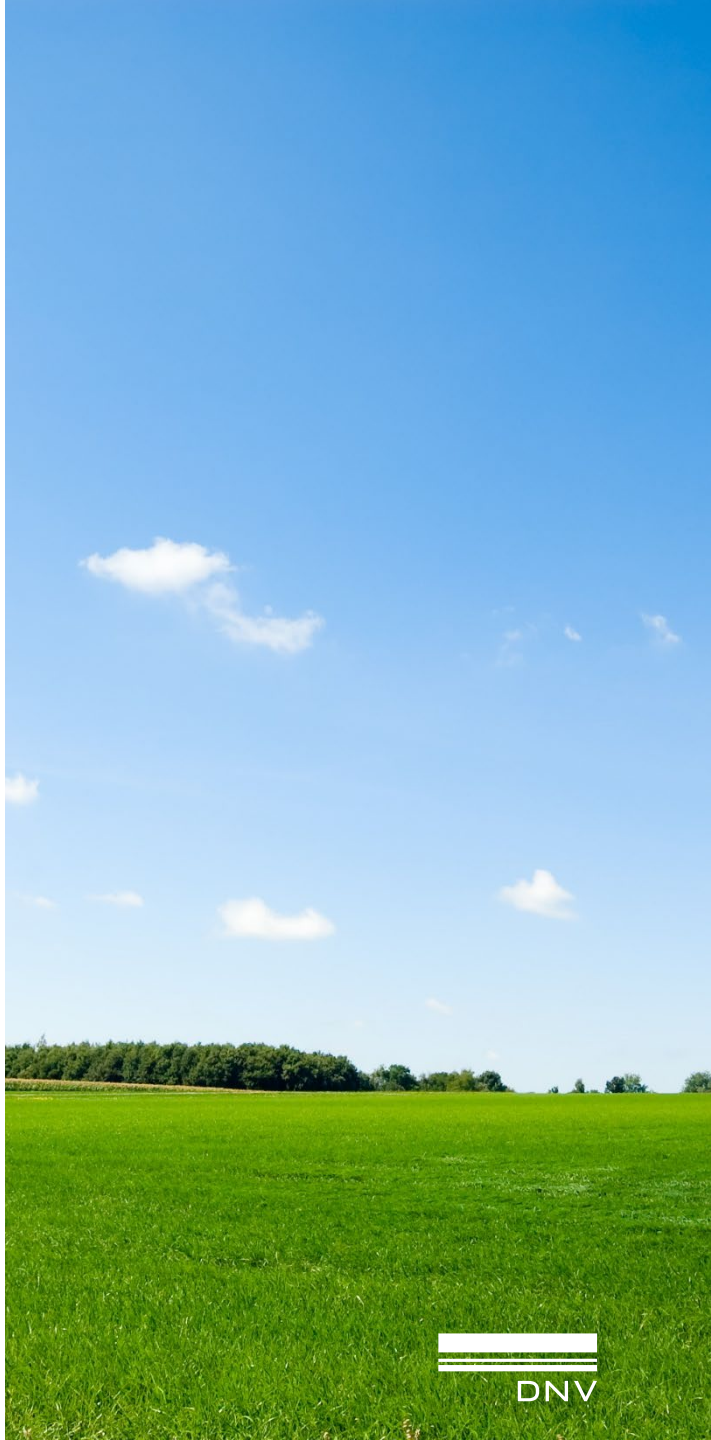


# Applicability to supplement regulations

## Hierarchy and Implementation

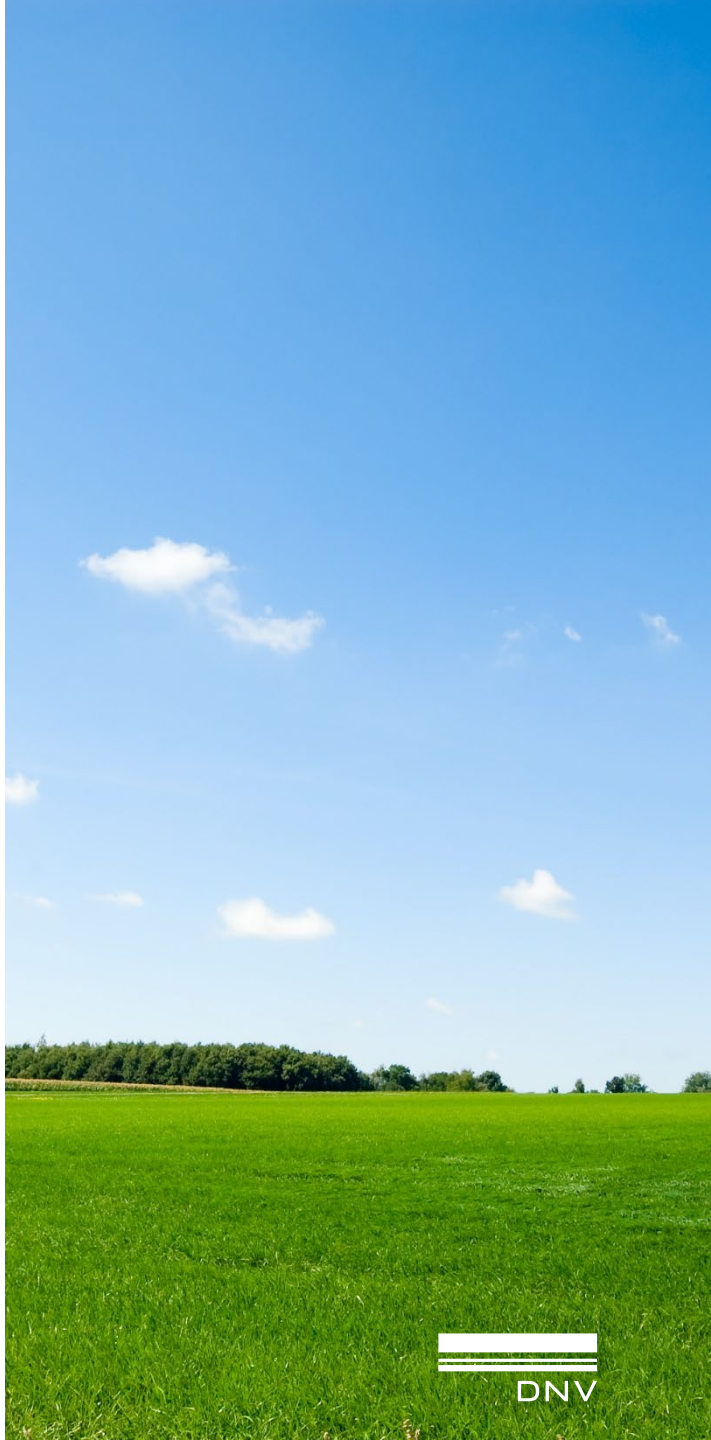
When national regulations do not exist or are not sufficient, the ISO standards provide a framework and technical guidance.



# Takeaways

- For new $CO_2$ storage and $CO_2$ -EOR projects, ISO 27914 and ISO 27916 are very much complementary, with minimal overlap
- The two ISO standards are designed to serve quite different purposes
  - ISO 27914 – commercial safe, long-term containment of $CO_2$
  - ISO 27916 – promote processes for $CO_2$ EOR
- ISO 27914 and ISO 27916 together with other industry guidelines can support CCS project development and permitting and approval.
- There are many similarities between activities related to the exploration, development, production and decommissioning of oil and gas (O&G) fields, and activities required for exploration, development, operation and closure of $CO_2$ storage sites.



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