Energistyrelsen

# Guidance on the content of $CO_2$ storage permit applications in Denmark

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# Content

# 1. Introduction and general information

Towards the end of the Exploration Phase of a Licence for exploration and storage of $CO_2$ ($CO_2$ storage licence) the Licensee has the option to submit a Storage Permit Application in order to extend the licence period and progress into the Storage Phase. Alternatively, an application for a possible extension of the exploration phase must be submitted or the licence must be relinquished. The Storage Permit Application must be submitted prior to the expiration of the $CO_2$ storage licence. Processing of the application by the Competent Authority (CA) can take place after expiration of the $CO_2$ storage licence.

Guidance on the documentation required for the Storage Permit Application is provided in the **EU guidance documents** (Table 1-2), the Danish Subsoil Act and the Danish CCS Executive Order**.** This document provides *further detail* on some of the documentation required for a Storage Permit Application and together with the **ISO standard** (Table 1-2)**, the DNV Recommended Practise** (Table 1-2) and the **EU guidance documents**, represent the current best understanding of what is needed for the Danish Energy Agency to assess such an application.

The Danish Energy Agency (DEA) may seek independent verification on review of the Storage Permit Application documents. Where the DEA is not in agreement with the information, analysis, plans or justifications provided, the DEA, where appropriate, will advise on any necessary changes, which should be implemented by the Licensee. During the evaluation process the Licensee will be expected to update and amend the Storage Permit Application as appropriate.

This document is a guideline. The DEA can at any time request additional material and documentation from the Applicant. Updates to this guideline will be made by the DEA as appropriate, in accordance with further experience and/or legislative changes

**Table 1-1 List of Abbreviations:**

| Abbreviation | Definition |
|---|---|
| CA | Competent Authority |
| CCS | Carbon Capture and Storage |
| $CO_2$ | Carbon Dioxide |
| DEA | Danish Energy Agency |
| EIA | Environmental Impact Assessment |
| FIT | Formation Integrity Test |
| FTP | File Transfer Protocol |
| MMV | Monitoring, Measuring and Verification |
| P&A | Plugged & Abandoned |
| PP&A | Permanently plugged and abandoned |
| PVT | Pressure, volume, temperature |
| Q&A | Questions and Answers |
| TRL | Technology Readiness Level |
| UTM | Universal Transverse Mercator |
| (X)LOT | (Extended) Leak Off Test |

Table 1-2 Political agreements, legislation and standards*

| Term used in this document | Legal name | English translation | Legislative reference |
|---|---|---|---|
| **CCS Directive** | Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide | | |
| | https://eur-lex.europa.eu/eli/dir/2009/31/oj/eng | | |
| | https://eur-lex.europa.eu/eli/dir/2009/31/oj/da | | |
| **Danish CCS executive order** | Bekendtgørelse om geologisk lagring af $CO_2$ m.v. | Consolidated Act on geological storage of $CO_2$ etc. | BEK nr. 825 af 26/06/2024 |
| | https://www.retsinformation.dk/eli/lta/2024/845 | | |
| **Danish Subsoil Act** | Bekendtgørelse af lov om anvendelse af Danmarks Undergrund | Executive Order on the use of Denmark's subsurface | LBK nr. 1461 af 29/11/2023 |
| | https://www.retsinformation.dk/eli/lta/2023/1461 | | |
| **The Danish Working Environment Authority (WEA) guideline 65.1.2** | Arbejdstilsynet, The Danish Working Environment Authority (WEA) guideline 65.1.2. on The ALARP principle in connection with offshore oil and gas operations | | |
| | https://offshore.at.dk/en/regulations/wea-guidelines/alarp-principle | | |
| **The Environmental Impact Assessment Act** | Bekendtgørelse af lov om miljøvurdering af planer og programmer og af konkrete projekter (VVM) | The law on environmental assessment of plans and programmes and of specific projects (EIA). | LBK nr. 4 af 03/01/2023 |
| **EU Guidance Document no 1** | Guidance document 1, $CO_2$ storage life cycle and risk management framework, European Commission, Directorate-General for Climate Action, 2024 | | |
| | https://climate.ec.europa.eu/document/download/951d14ea-ce0f-4753-92dd-35ba88920888_en?filename=gd1_en.pdf | | |
| **EU Guidance Document no 2** | Guidance document 2, Characterisation of the storage complex, $CO_2$ stream composition, monitoring and corrective measures | | |
| | https://climate.ec.europa.eu/document/download/6f19cb98-b791-466d-8f3c-32c5bb12be2d_en?filename=ccs-implementation_gd2_en.pdf | | |
| **Vejledning for boring og brøndoperationer på land i Danmark 2024,** Guideline 1.3.I | Guidelines for onshore drilling and well operations in Denmark, Guideline 1.3.I | | |
| | https://ens.dk/en/energy-sources/legislation-and-guidelines | | |
| **ISO Standard** | ISO 27914:2017 Carbon dioxide capture, transportation and geological storage – Geological Storage | | |
| | https://www.iso.org/standard/64148.html | | |

| | | |
|---|---|---|
| **DNV Recommended Practise** | DNV-RP-J203 Geological storage of carbon di-oxide | |
| | https://www.dnv.com/energy/standards-guidelines/dnv-rp-j203-geological-storage-of-carbon-dioxide/ | |
| **NORSOK** | NORSOK D-010 | |
| | https://www.online.standard.no/en/norsol-d-010-2021ac2-2021ac--2024 | |
| **OEUK** | Well Decommissioning for $CO_2$ Storage, Guide-lines, Issue 1, Nov. 2022 | |
| | https://oeuk.org.uk/product/oeuk-well-decommissioning-for-co2-storage-guidelines/ | |

**) please refer to the most recent version of legislation, standards and guidelines referenced in the table*

## 1.1 Submission of documents

Application letter, company information and application documents incl. appendices should be submitted to the DEA via the agency's FTP-site 'Filkassen'. Access for the uploading of documents will be granted upon request. Please contact your DEA licence supervisor via email or send an email to ccs-lagring@ens.dk (alternatively ens@ens.dk) to be granted access.

All submitted application documents and supporting material will be made readily available to the European Commission, according to Directive 2009/31/EC of the European Parliament and of the council (CCS directive).

## 1.2 General requirements

The following general requirements apply to the application documents:

- The application documents should be written in a clear and concise language (Danish or English).
- Abbreviations and acronyms
  - use only if the abbreviation/acronym is conventional
  - spell out the full term at its first mention, indicate it's abbreviation in parenthesis and use the abbreviation/acronym from then on; repeat for each main section
- Prior to submission the Applicant should ensure that there is consistency in the content across all parts of the application documents, use of nomenclature is consistent throughout, that all references to sections are specific and all references to figures and tables are correct.
- All significant[1] references should be made available along with the application documents.
- All figures and maps should be of good resolution and be legible.
- All maps should have coordinates as well as scale. Contours and scale bars should be annotated, contour interval (c.i.) should be stated on maps and annotations should be legible.

[1] Any documents that are referenced in support of claims regarding the safety and integrity of the storage site must be clearly and fully referenced, and, if not publicly available, provided as appendices to the application

- The size of maps should be either a full A4 page or as wide as the page (excl. margins). The captions associated with tables, maps and figures should clearly describe the content and the relevant observations that can be made from them.
- All maps provided in the application material should also be supplied in a high resolution digital format (all significant details should be readable)
- If a subject is covered in multiple parts of the application documents, consistency with the primary description should be ensured and a reference made to the relevant section.
- The application documents should be in a searchable format.

***If, based on an initial screening, it is assessed that the general requirements are not adhered to, the DEA may decide to return the application.***

# 2. Contents of the Storage Permit Application

The Storage Permit Application is made up of an **official application letter** and **six application documents.** These are:

- Storage Project Overview (1)
  - General information, project background and summary
  - Technical Capacity
  - Financial Capacity
- Storage Site and Complex Characterisation (2)
- Containment risk assessment & preventive measures description (3)
- MMV-plan (4)
  - Monitoring Plan
  - Corrective Measures Plan
  - Provisional Post-Closure Plan
- Storage Development Plan (Plan for Development, Execution, Operation and Injection) (5)
- Provisional Decommissioning Plan (6)

An Environmental Impact Assessment (EIA) of the storage project must also be submitted, preferably at the same time as, or subsequent to, submittal of the Storage Permit Application (for offshore projects). *Please refer to Section 3.1 for how the EIA impacts the processing timeline of the Storage Permit Application*.

- Environmental Impact Assessment (7)

This guidance document covers documents (1) to (6). For guidance on the contents of document (7), please refer to Appendix A.

The above list of documents (1-6) is a requirement as per the Danish Subsoil Act, the Danish CCS Executive Order, and the CCS Directive. Document (7) is a requirement as per the Environmental Impact Assessment Act. Please refer to Table 1-2 for more information on legislation.

## 2.1 Storage Project Overview

The Storage Project Overview should provide all relevant background information on the project and a summary of the essential features of the proposed storage site development, including:

a) a brief but clear definition and delineation of the storage *site*[2] and storage *complex* including a location map
b) the location of the injection facilities[3]
c) a proposed date for when operations will commence

[2] the storage site is the volume area within the storage complex that will, at any time, be exposed to the $CO_2$ injected; and associated surface and injection facilities. The definition and delineation must be accompanied by maps and cross-sections and a table with UTM-coordinates.

d) the total quantity that is to be injected and stored[3]
e) the proposed injection rates and pressures[3]
f) the reservoir pressure limits and the maximum injection rates and pressures
g) the prospective sources and transport methods[3]
h) the composition of the $CO_2$ that is to be injected[3]
i) financial capacity of the applicants
j) technical capacity of the applicants

For items (a) to (h) please include a table or reference list of where this information is derived and covered in detail in the application material.

## 2.2 Storage Site and Complex Characterisation

This is a critical part of the Storage Permit Application as it informs the Storage Development Plan, Containment Risk Assessment, Monitoring and Corrective Measures plan. The objective is for the Applicant to demonstrate that the containment, capacity, injectivity and monitorability of the storage site, complex and surrounding area has been sufficiently assessed and to demonstrate that there is no significant risk of leakage from the storage site that may pose risk to human health or the environment. Please refer to Bilag 1 of the Danish CCS Executive Order or ANNEX 1 of the **CCS Directive** for areas that must be addressed.

Information on the subsurface **data base** (seismic data, well data and other types of data) that was used for the storage complex characterisation should be provided. This includes relevant internal or purchased studies that were used such as (but not limited to) reprocessing of seismic, special geophysical studies, geochemical studies, structural studies, fault seal analysis / leakage studies and geomechanical studies. All studies should be clearly referenced. How the data were used, and any new interpretations and applications derived from the studies should be described. Any well data (e.g. log, core, FIT, (X)LOT) should be accompanied by information on data coverage with respect to reservoir(s) and sealing formation(s). The presentation should be supported by a table for overview.

**Geological Overview** must be provided and should include a brief description of the regional geology and setting, covering the area's primary stratigraphic, lithological and structural features, timing of faults, fractures and salt mobilisation, if applicable. As a minimum the following figures should be provided: Chrono- and lithostratigraphic columns with indications of the primary and, if any, secondary storage complex(es), maps showing the regional extent of the relevant formations (primary reservoir and seal) including cross-border areas, maps showing the structural framework.

**Definition of the storage site and complex** in terms of geological formations, spatial extent and rationale as defined in the Danish CCS Executive Order §1 and the CCS Directive Article 3 must be described and include:

a. The proposed storage formation(s), and the storage site and complex seals
b. Summaries of the lithologies and the geological sequences and their lateral extents into a regional extent

[3] In accordance with the Danish CCS executive order §3(4) and the CCS Directive Article 7(4)

c. The underburden stratigraphy.

A description of the **seismic interpretation and mapping** (incl. the seismic data used for interpretation, which horizons were mapped, well-to-seismic tie incl. synthetics, well correlations, depth conversion methodology, etc.) that was undertaken for the reservoir(s) and sealing formation(s) must be provided, including regional extent, trap type, critical aspects such as closure, spill points and any natural features potentially compromising the integrity of the storage complex. Maps and/or cross-sections of the relevant mapped horizons, isochores, attribute maps, etc. should be presented, clear indication of spill points given where relevant. The structural framework must be presented (including estimates of uncertainty), using appropriate maps and sections, whether faulting may compromise or whether it may not compromise the integrity of the storage complex must be documented, using maps and cross-sections as relevant.

The **geological interpretation** should cover sedimentological studies, facies analysis, conceptual geological model and fault seal. If analogues are used for the characterisation of the storage complex relevant information on these should be included here. If applicable and available descriptions from core and image logs should be presented. The reservoir properties of the storage site and any permeable units in the overburden should be described. Poro-perm relationships and if applicable porosity-depth trends may be included here or in the petrophysics section. Characterisation of sealing units must be sufficient to assess their ability to effectively contain the stored $CO_2$ and to assess risks such as seal fracturing, risk of $CO_2$ entering the seal, sealing rates and potential geochemical reactions between $CO_2$ and the sealing formation. A list of the data used for the geological characterisation should be provided.

The **petrophysical interpretation** should be documented and the data used in the evaluation should be described and/or listed. Available routine or special core analysis tests relevant for the study should be referenced. Fluid composition analysis of containment units (primary and/or via migration/leakage) should be included. PVT modelling should be described. If applicable saturation-height modelling used for the assessment of fluid contacts should be included and fluid contacts (such as oil-water, gas-water and gas-oil contacts) should be described.

A description of the analysis and interpretation of the **pore pressure regime** of the storage site and complex, including the evolution of pore pressure over the lifetime of the storage site and post injection (until end injection +1000 years) should be included. If the site is a depleted hydrocarbon field the change in pore pressure since the onset of production should be documented. The impact of pressure changes on other subsurface activities outside the licence area (such as other potential $CO_2$ storage sites, deep geothermal activities, salt caverns and cross border effects) must also be covered and should be referenced in the geomechanics and dynamic modelling sections, respectively.

A section on **geochemistry** must be provided. It should cover geochemical data and analysis in terms of rocks and in-place fluids. Short and long term effects of $CO_2$ (incl. impurities) interaction with caprock(s), injectivity, mineralisation and dissolution rates, interaction with well cement, thermal effects, etc. must be covered.

The identification and characterisation of **potential leak paths** (both natural and man-made) must be covered in a dedicated section. This includes faults and fractures as well as wells located within the

area of the storage complex. Structural and stratigraphic spill points and potential leak paths should be identified. The probability of migration or leakage across or along faults should be assessed and described; faults cross-cutting the site should be evaluated for their stability and sealing capacity. Uncertainty assessment of the analysis and interpretation should be included. Documentation of well history, including how a well was abandoned and whether the method of plugging is sufficient to prevent leakage from a future storage site, should be provided. This includes placement and length of cement plugs (incl. length above top of the hydraulic storage unit), whether the plugs were tagged and pressure tested. This information should be summarised in a well schematic also including information on casing strings, annular cement, calculated height of annular cement, annular and well fluids, penetrated formation, equipment left in the well (incl. fish, completion, control lines or cables), verification data for cement plugs and annular cement (pressure tests, tagging or logging) and fracture pressure of penetrated formation. If some of the above data are not available a plan for how to obtain them or remedial work should be included. The quality of cement, the effects of exposure to $CO_2$ and what it means in relation to potential leakage should also be described[4]. Further guidance on potential leak paths can be found in EU Guidance Document no. 2, Section 3.3.7. Further guidance on well characterisation can be found in (**ISO standard 27914:2017**, **Section 5.4.6** and **Section 7.6.2)**. Leakage modelling should be covered in the dynamic modelling section and referenced in the section on potential leak paths.

A description of natural **seismicity** should be provided including an assessment of the level of risks it exerts on the integrity of the storage site and complex.

Result of **geomechanical studies** must be included and should cover aspects such as principal stress orientation, local fracture gradient, rock fabric and fault reactivation studies. Details of **geomechanical models** should be provided, including which parameters are modelled and an analysis of the associated uncertainties. An explanation as to how the results are incorporated into the dynamic model should be given.

**Static geological modelling** of the candidate storage complex, including the caprock and the hydraulically connected areas and fluids is a requirement as per the Danish CCS Executive order and the CCS Directive. Please refer to the specific requirement listed in Bilag 1 (trin 2 and trin 3) of the Danish CCS Executive order or Annex I (step 2 and 3) of the CCS Directive.

D**ynamic modelling** of the storage dynamic behaviour, sensitivity characterisation and risk assessment is a requirement as per the Danish CCS Executive order and the CCS Directive. Please refer to the specific requirement listed in Bilag 1 (trin 2 and trin 3) of the Danish CCS Executive order or Annex I (step 2 and 3) of the CCS Directive.

A detailed account of how both the (range of) static and the dynamic models are constructed, the data they are based on, and the results derived from them should be provided. In order to demonstrate the quality and reliability of the modelled results, comparison of input / background data and results should be presented. Uncertainty assessment must be reported. It must include parameters varied, ranges applied and the rationale behind the choices made.

[4] The geochemistry section should cover the effect of exposure to CO2 on the cement. This section should cover the consequences of that effect in terms of potential leakage from the wells. A clear reference between the two sections should be made.

Reporting of pore volume: The static model must characterise the complex in terms of **pore volume** (incl. porosity distribution). The pore volume should be reported separately for a. trap and b. connected aquifer. Outlines of both trap and connected aquifer should be illustrated on a map with clear indication of spill points (depth annotated). Calculated pore volume for **the trap** (down to spill or other clearly defined delimiting boundary) should be reported in table format by giving the model derived gross rock volume, net rock volume and pore rock volume with resulting model average net-to-gross and model average porosity. It should be shown how the latter two match relevant well averages or explained/justified if they don't. Whether the aquifer is modelled explicitly as part of the 3D model or as an analytical aquifer should be clearly explained. If modelled as part of the 3D model the aquifer pore volume should be reported in the same manner as for the trap. If modelled as an analytical aquifer the average properties chosen and the rationale behind them should be clearly explained. Aquifer pore volume located within the licence area and outside the licence area should be reported separately. Histograms of porosity and permeability distributions for input and model (a. trap, b. aquifer) incl. mean and standard deviation should be presented.

Plume migration: Forecast of plume migration and $CO_2$ saturations should be reported and supported by maps/illustrations. For time steps see Section 2.5. In addition, the documentation should demonstrate when the plume is expected to arrive at potential leakage and/or spill points (if relevant) and any other significant developments.

Leakage modelling: Where insufficient documentation is available on the condition of an abandoned well, dynamic scenario modelling should be undertaken to estimate the potential consequences, should leakage take place via that well. In line with the ALARP principle the scenario modelling should include a worst-case scenario, e.g. an open hole case / a case with no plug (depending on what information is lacking), although this may be a purely theoretical case. For specific guidance on well requirements, please refer to standards **NORSOK** (NO) and **OEUK** Well Decommissioning for $CO_2$ Storage (UK). A clear reference should be made to the description in the section on potential leak paths.

Further guidance on site and complex characterisation can be found in **ISO standard 27914:2017**, **Section 5.4.** Further guidance on what should be included in the 3D modelling can be found in **EU guidance document no. 2, Section 3.4 and 3.5**. and **ISO standard 27914:2017**, **Section 5.5**.

## 2.3 Containment Risk Assessment and Preventive Measures

Risk management must demonstrate that geological storage of $CO_2$ within the licensed area can be done safely (**CCS Directive**, Article 1(2) and Article 4(4)). A structured and systematic approach should be taken. This process should be initiated early in the exploration phase of the licence and continue throughout the life time of the storage project.
The process for risk management must be described and documented in the application documents (**ISO standard 27914:2017**, **Section 6)**. The risk assessment must be done in accordance with the ALARP-principles (see **The Danish Working Environment Authority (WEA) guideline 65.1.2**) and documented. Please refer to Bilag 1 of the Danish CCS Executive Order or ANNEX 1 of the **CCS Directive** for what the risk assessment must comprise.

## 2.4 MMV-plans

The Measuring, Monitoring and Verification (MMV) plans cover the monitoring plan, the corrective measures plan and the provisional post-closure plan. The requirement to include these plans follows from the Danish CCS executive order §3(8) and the CCS Directive Article 7(8).
All aspects of **ANNEX II** of the **CCS directive** must be addressed in the MMV-plans. Guidance on requirements for the monitoring plan is given in the **EU Guidance Document no. 2**, Section 5 with reference to **ANNEX II**. Guidance on requirements for the corrective measures plan is given in the **EU Guidance Document no. 2**, Section 6. The Applicant should consult the referenced EU guidance documents. The DEA recommends that the Applicant involves the DEA early in the process of establishing the monitoring plan. Especially if novel technologies are included (see paragraph on 'choice of monitoring technology' below in this section).
The **Monitoring Plan**[5] must be risk based and thus, there should be a clear link between the Monitoring Plan and the Risk Assessment and the Preventive Measures Plan. The Monitoring Plan must address all major risks identified. It must state what is monitored, the methodology to be applied and the monitoring frequency. It should contain definition of:

a. the normal background level
b. an alert situation incl. threshold
c. a significant irregularity incl. threshold

An example template that covers these aspects is given in **Table 3** of the **EU Guidance Document no. 2**. Such a table should be included in the monitoring plan. For any contingent monitoring it should be specified what triggers it.

Further very useful guidance on the monitoring plan can be found in **Section 5 of the EU Guidance Document No. 2**.

With regards to **choice of monitoring technology** the Applicant is expected to implement the best available technology. Technology readiness level should be high (TRL = 9)[6]. It is important that the proposed technology is mature, proven in an operational setting and proven in connection with $CO_2$ storage and containment. Any novel or unproven technology should be supplemented by a proven technology until such time that the Applicant can provide sufficient documentation (peer reviewed or third-party verification) that the technology is suitable for monitoring of $CO_2$ storage sites and complexes in an operational setting.

The **Corrective Measures Plan** should be closely integrated with the Risk Assessment, Preventive Measures and the Monitoring Plan. The plan should cover actions, measures or activities that will be taken to correct significant irregularities (as defined in the monitoring plan) or to close leakages in order to prevent or stop the release of $CO_2$ from the storage complex. The corrective measures plan should for each major risk identified list what actions will be taken and the time frame for mobilising and correcting the situation. If using 'stop injection' as a 'last resort' corrective measure, it should be

[5] The monitoring plan shall be updated as per the requirements in ANNEX II at least every 5 years (CCS Directive Article 13(2))

[6] Annex G of the General Annexes

documented that this is sufficient to stop leakage to the environment, when the leakage will be stopped and assess how much (tons) $CO_2$ will be emitted to the environment in the interim.

The **Provisional Post Closure Plan**[7] should cover all activities, including monitoring and modelling, that are planned to take place post site closure. Provisional timing of various activities should be provided. The purpose of the planned activities is to prove that the injected $CO_2$ is developing towards a stable situation in accordance with modelling forecasts.

## 2.5 Storage Development Plan (SDP)

The Storage Development Plan should be based on the results and outcomes of the storage site and complex characterisation and on the $CO_2$ transportation and facilities concepts selected by the Licensee. Where there is overlap between the SDP and other parts of the application, the SDP should contain sufficient information to provide an overview; clear and specific reference to the relevant plan and section/subsection where the topic is described in more detail should be made.

The SDP should contain the project description and plan for development, execution, operation and injection and relevant background information. This should include:

- the **full development concept**, including the $CO_2$ supply chain from capture and liquefaction, transport, interim storage, offloading and injection facilities and cover who is responsible for establishing and operating each part of the supply chain
- provide **specification** for the **$CO_2$ stream** and demonstrate how full control over $CO_2$ composition of the injected liquid at the point of injection is ensured
- **metering and allocation** through all parts of the $CO_2$ supply chain, including back allocation to emitters and accounting for any 'loss' throughout the process
- a description of **technical solutions**, preferably including a **Life Cycle Analysis**[8] of the project (what is injected versus what is emitted during the project execution and operation)
- the **containment analysis** (an overview of the reservoir characterisation, seal capacity including geomechanical modelling, geochemical modelling and thermal effects), storage capacity, plume migration and pressure development (pre-injection, end injection, end injection +20 years, end injection +100 years, end injection +1000 years)
- a description of wells to be drilled or re-used and other wells within the storage complex, incl. wells that are or will be P&A'ed prior to injection start (please see paragraph below in this section for further detail)
- a list of wells beyond the storage complex that may be affected by pressure increase (risk of leakage of formation water to the seabed).
- injection facility location, injection strategy (incl. total quantity to be stored, injection rates and pressures) and site development

[7] Shall be updated prior to closure of the storage site and submitted to the DEA for approval as the definitive post-closure plan (CCS Directive Article17(3))

[8] Currently there are no guidelines on how to perform an LCA, thus it is up to the applicant how best to perform an analysis. Note that it is not a legal requirement to include an LCA in the storage permit application.

- information regarding Operation & Maintenance, including how the wells will be worked over and a description of how future development wells can be drilled safely after $CO_2$ injection has taken place
- **management systems**, including information regarding planning, organisation and execution of the development phase of the storage site, decision criteria
- risk management, risk assessment and MMV-plans
- decommissioning plan, incl. PP&A of the wells
- post closure plan and handover to the Competent Authority
- **co-existence** and/or synergies with nearby licences (production, storage, geothermal, wind-farms, etc.) or cross border effects. The following should be documented: plume migration, pressure propagation, limitations associated with data acquisition
- schedule & budget

The site development should include a description of surface and subsurface facilities: a description of existing infrastructure to be re-used and infrastructure to be established as part of the execute phase should be provided.

A detailed account of any legacy wells to be re-used for the injection project (injection or monitoring) should be included, the integrity of the wells should be described, necessary modification for converting wells to $CO_2$ storage project wells should be described, covering equipment, program and method (in accordance with the **Danish Subsoil Act** §28(1)), well barrier schematics post conversion, incl. well barrier verification, well completion and well integrity monitoring programme should be included. The integrity of legacy wells, that are or will be P&A'ed prior to the injection operations commencing, should also be documented (in accordance with **Guidelines for onshore drilling and well operations in Denmark** (1.3.I). See Section 2.3 on Risk Assessment for further detail. Any overlap with Section 2.2 (e.g. section on potential leakage paths) should be managed through appropriate cross-referencing.

Operation and Maintenance should include well integrity monitoring programmes, specific to each well, including timing and/or frequency. Any contingent activities should include what triggers it.

## 2.6 Provisional Decommissioning Plan

Submission of a provisional decommissioning plan along with the Storage Permit Application is a requirement according to the Danish Subsoil Act, §32a. The provisional decommissioning plan must cover all installations and wells belonging to the storage licence. Specific requirements for decommissioning of $CO_2$ wells should be included and a reference to which standard is applied (Table 1-2: Guidelines for onshore drilling and well operations in Denmark, Guideline 1.3.I). A high-level account of environmental aspects of the decommissioning plan must be included (a full EIA is not required until a final decommissioning plan is submitted). The plan must contain an overview of the expected cost associated with the decommissioning activities and a description of how the Licence holder will ensure that the necessary funds are available at the time of decommissioning (§32a (2)).

# 3. Additional guidance information

## 3.1 EIA and approval timeline

The time required to complete the environmental assessment proces may have significant influence on the time required for the DEA to finalise a draft storage permit.

### 3.1.1 Scoping Process

The first step in an EIA evaluation process is a scoping procedure, which is mandatory for onshore licences and voluntary for offshore licences. The scoping procedure is initiated by a dialogue between the EIA authority and the Applicant. Following this dialogue the Applicant will forward application material related to the project to the EIA Authority, in accordance with the EIA Act. The EIA Authority will evaluate the material and hold a public hearing. Based on the hearing responses the EIA Authority will issue a scoping statement.

In the event that the project may have transboundary effect, an international hearing is required. Please refer to Section 3.1.3.

### 3.1.2 EIA Process

Based on the scoping statement the Applicant can prepare an EIA report and submit it to the EIA authority. For offshore projects where the Applicant has not asked for a scoping statement, the EIA should be submitted at the same time as the storage permit application.

Once a fully clarified[9] EIA has been submitted, the CA will prepare a (second) public hearing. The legal minimum duration of a public hearing is 30 days. However, the hearing period must correspond to the material forwarded. Given the considerable amount of material included in an EIA it is the DEA's expectation that the hearing will be closer to 6-8 weeks

Based on the hearing responses the EIA authority will in cooperation with the Applicant prepare a consultation document that summarises the hearing process. The EIA Authority will then prepare a draft decision regarding the EIA and hereby conclude the environmental impact assessment process.

### 3.1.3 International hearing (Espoo)

If the project may have transboundary effect, it must undergo an international hearing process in parallel with the national hearings described in Section 3.1.2.

This involves a notification process where relevant parties are invited to participate in the EIA process. Interested parties will be included in the second round and invited to submit hearing responses.

The duration of the hearing must be at least as long as the duration of the national hearing. All hearing responses from other countries must be addressed and no unsettled issues with international hearing parties may remain prior to closing the hearing. Several rounds of Q&A may take place. For each round of Q&A, the receiver in a neighbouring country is usually given two weeks to respond and there

[9] A document is considered 'fully clarified' when it contains all required information at the required level of detail

may be additional time needed to translate before sending to other countries and after the reception of a new response. If there are more than one round of Q&A it may be necessary to formulate a consultation report. The hearing process is finally closed once the Danish Minister of Environment has given his/her consent.

### 3.1.4 EIA processing time

Current experience with **onshore projects** suggests an average processing time of around 18-24 months from when the application to the EIA authority (in accordance with the EIA Act) is fully clarified[9]. This includes time for the Applicant to do the EIA after the scoping statement has been given by the EIA authority.

For **offshore projects** current experience suggests an average processing time of approximately 12 months from when the EIA (and the storage permit application) is fully clarified. If the applicant requires a scoping statement from the DEA (EIA authority offshore), additional time will be needed for this process.

## 3.2 Draft storage permit

Once processing of the EIA and storage permit application has been concluded and a storage permit has been drafted, the draft permit will, subject to internal approval, be forwarded to the Applicant for a hearing period of 5-10 working days. This may be followed by one or more rounds of comments and/or change requests between the Applicant and the DEA. The DEA will decide when to conclude this process.

Prior to submission to the EU Commission the draft permit will be translated into English and the translation reviewed by the DEA.

## 3.3 The EU Commission

The **EU Commission** will review all application material incl. the draft permit and may take **up to four months** to issue a **non-binding opinion**.

The DEA must process the non-binding opinion and address any misalignment with the EU Commission prior to presenting the final storage permit to the Minister of Climate and the Environment for final approval prior to issuing a storage permit.

The time required for the post-processing of the permit will depend on the nature of the comments in the non-binding opinion and the subsequent ministerial process. The post-processing is estimated to take no less than two months. It may be necessary to adjust and/or amend the permit.

## 3.4 Total processing time of a storage permit application

Once the storage permit application and the EIA are fully clarified[9] it is the expectation of the DEA that the **minimum** processing time for issuing a storage permit will be:

- Offshore licences: 18 months

- Onshore licences: 24 months (depending on the authorities involved in the application)

[This includes the CA's processing time pre-submission to the EU Commission, four months for the EU Commission to issue their non-binding opinion, the DEA's post-processing time and ministerial process]

**How the Applicant can influence the DEA's processing time:**

**EIA**:

- Submit a fully clarified[9] EIA, thus eliminating (or reducing) the time from submission until the EIA is ready for public consultations.
- If necessary, consult with the DEA well in advance of submission.
- Adhere to the general requirements in Section 1.2 of this guideline.
- Follow the suggestions outlined in appendix A.

**Storage Permit Application**:

- Adhere to the requirements in this guide (including referenced material) to ensure that the application is fully clarified (this will reduce the likelihood of requests for additional material and updates to the application itself).
- Share risk assessment (especially related to legacy wells) with the DEA as early as possible
- If necessary, consult with the DEA well in advance of submission.

**General**:

- Reply to the DEA **without undue delay** in all matters related to the application material.
- Ensure that all questions/requests by the DEA are addressed.
- It is recommended that the Applicant keeps a Q&A log in order to ensure that all questions and request by the DEA are addressed.

Please note that the EIA should be closely linked with the MMV-plans, which again are closely linked with the risk assessment that is linked to the site characterisation. Thus, **the EIA is an integral part of the storage permit application**.

## 3.5 Changes to the development concept post submission

Changes to the development strategy post submission will most certainly cause delays in the processing of the application and should be avoided. If however, unavoidable the following considerations should be made by the applicant:

**Consult with the DEA as early as possible** in order to determine which updates and additional material will have to be submitted and to understand how it will impact the evaluation process.

Changes that impact the EIA (e.g. changes to installations, monitoring programme & technology, etc.) could cause significant delays, especially if the EIA has already passed through the various hearings (they may need to be rerun). Estimate of delay: weeks to several months.

Changes related to injection volumes and pressures: if the changes are within an already documented capacity of the storage site: new injection profiles, description and illustrations of plume migration, $CO_2$ saturation and pressure development should be provided; updates to when the plume will reach potential leakage and/or spill points, changes to monitoring plans (if any) as a result of this (note: this could have a knock-on effect on the EIA). If the volumes/rates go beyond what has been documented as within the capacity of the storage site an update to the documentation must be provided that supports that the higher rates/volumes can be achieved without compromising the integrity of the storage site and complex. Estimate of delay: weeks to several months.

If the DEA has already submitted a draft permit to the EU Commission for their non-binding opinion, we *expect* that the process with the Commission will have to be halted. Worst case it may have to start anew once all necessary material has been provided and evaluated by the DEA, and the DEA has made all necessary changes to the draft permit. Estimate of delay: several months.