Recommended guideline
for
the implementation of
Carbon dioxide Capture and Storage projects
(JOGMEC CCS guideline)

Executive Summary

Version 1

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Preface and Chapter 1

1. Background and purpose

JOGMEC hereby presents a guideline (hereinafter "CCS guideline") to enable appropriate implementation of carbon dioxide capture and storage (CCS) projects, calculation of carbon dioxide (CO2) storage resources, and calculation of greenhouse gas (GHG) reduction. This is one of JOGMEC's actions to support national and international CCS project implementation by Japanese business entities. The CCS guideline has been set to harmonize with current international standards and is NOT intended for regulatory purposes. The objective of this guideline is to provide recommendations for 1) the design of a geological CO2 storage projects, 2) evaluation of CO2 storage resources, and 3) calculation of the amount of GHG reduction generated from CCS projects.

JOGMEC commits to the continuous verification and improvement of the CCS guideline through its business activities. Furthermore, with the aim of developing it into an internationally recognized guideline, JOGMEC continues to promote international cooperation and strengthen its support to Japanese entities who develop global business.

2. Scope

The CCS guideline covers the project stages, from screening and selection of a storage site until the termination of the injection stage, as shown in Figure 1. Similar to the scope in the ISO27914 [1], an international standard for the geological storage of CO2, the CCS guideline does not cover a post-closure stage after the transfer of the facility to local authorities.

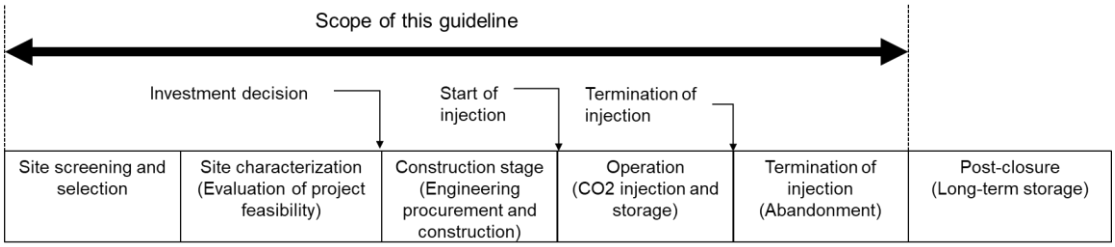

Figure 1: The project stages of a CO2 storage project and scope of the CCS guideline based on ISO27914 (2017)[1] and NETL (2017) [2].

3. Description of this executive summary

This executive summary describes the essence of the recommended guideline for planning of a geological CO2 storage project (Chapter 2), CO2 storage resources evaluation (Chapter 2), and GHG reduction calculation (Chapter 3) in the main body of CCS guideline. The table of contents of the CCS guidelines is provided in the Appendix.

Chapter 2
Geological CO2 storage project planning and evaluation of CO2 storage resources

1. Fundamental concepts for project planning and evaluation of CO2 storage resources

1.1. Introduction

This chapter describes JOGMEC's recommended guidelines for storage project operators in designing a CO2 storage project plan and evaluating CO2 storage resources.

This chapter is mainly based on ISO27914[1], an international standard for the geological storage of CO2 published by a special committee, the ISO/TC265 established in May 2011. The CCS guideline provide recommendations for the design of CO2 storage projects by specifying the corresponding sections of ISO27914.

Along with the ISO27914, the "Best practice manuals" published by the National Energy Technology Laboratory (NETL)[2][3][4] and other scientific publications, are also referenced for technical considerations and project stages of a storage project.

For the evaluation of CO2 storage resources, the CO2 storage resources management system (SRMS)[5] published by the Society of Petroleum Engineers (SPE), is referenced as an example. The SRMS was established to construct comprehensive storage resource categories as employed by the Petroleum Resources Management System (PRMS), also published by the SPE, and widely used in the oil and gas industries. Nevertheless, considering that the SRMS was published in 2017, it is considered a draft version that was prepared based on the PRMS; the SRMS should be revised to remain current with the future developments in geological CO2 storage projects.

1.2. Project stages

The following six project stages are defined for a geological CO2 storage project:

(1) Site screening and selection: a stage at which potential CO2 storage sites are evaluated and selected[2].

(2) Site characterization: a stage at which the characterization of the selected site(s) is being performed. Initial characterization refers to a series of technical evaluations based on existing datasets of the selected site(s). When this is followed by extensive technical evaluations using existing and new datasets, it is termed detailed characterization. The project development plan for CO2 storage projects is prepared and finalized based on detailed characterization to prepare for a final investment decision (FID)[2].

(3) Construction stage: the stage after the FID, in which the facilities required for the project are constructed.

(4) Operation (CO2 injection and storage) stage: the stage where CO2 is injected and stored in a geological formation. Site characterization, by the project operator, continues in this stage using new data acquired during the CO2 injection operation to update and optimize the project development plan.

(5) Termination of injection: the stage in which CO2 injection is terminated, and the abandonment of wells and infrastructure is commenced. This stage commences at the time of the site closure by the operator until the post-closure long-term storage site is transferred to a local authority.

(6) Post-closure long-term storage: the stage after the transfer of the post-closure long-term storage site to a local authority. Monitoring of the CO2 storage site should continue to ensure long-term safe storage.

A schematic of the above project stages and their relationships is shown in Figure 2. The corresponding sections in the CCS guideline are also shown in the figure.

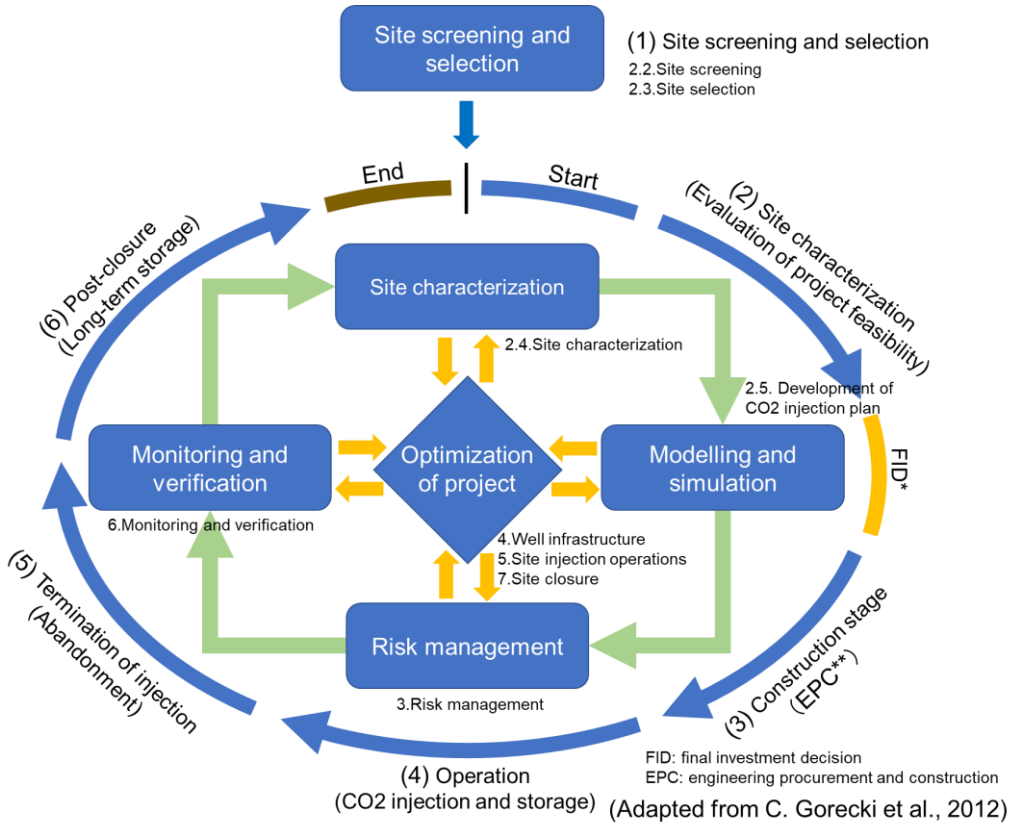

Figure 2: Schematic of project stages and recommended practices. Based on Gorecki et al. (2012)[6].

1.3. Technical validity of a storage project plan

The project plan should be reviewed based on the following six aspects to ensure the technical validity of a storage project plan:

(1) Validity of site selection

(2) Validity of a CO2 injection plan

(3) Validity of a risk management plan

(4) Validity of a well construction and remediation plan

(5) Validity of an operational plan

(6) Validity of a monitoring plan

1.4. CO2 storage resources

CO2 storage resources refers to the amount of CO2 that will be stored and is based on the project plan whose technical validity was ensured from the six aspects in Section 1.3. The uncertainty of CO2 storage resources is determined in accordance with the data availability at each project stage.

In general, data availability improves as the project stage progresses. Figure 3 shows the evolution of the storage resources classifications of the SRMS along with the six stages of a CO2 storage project.

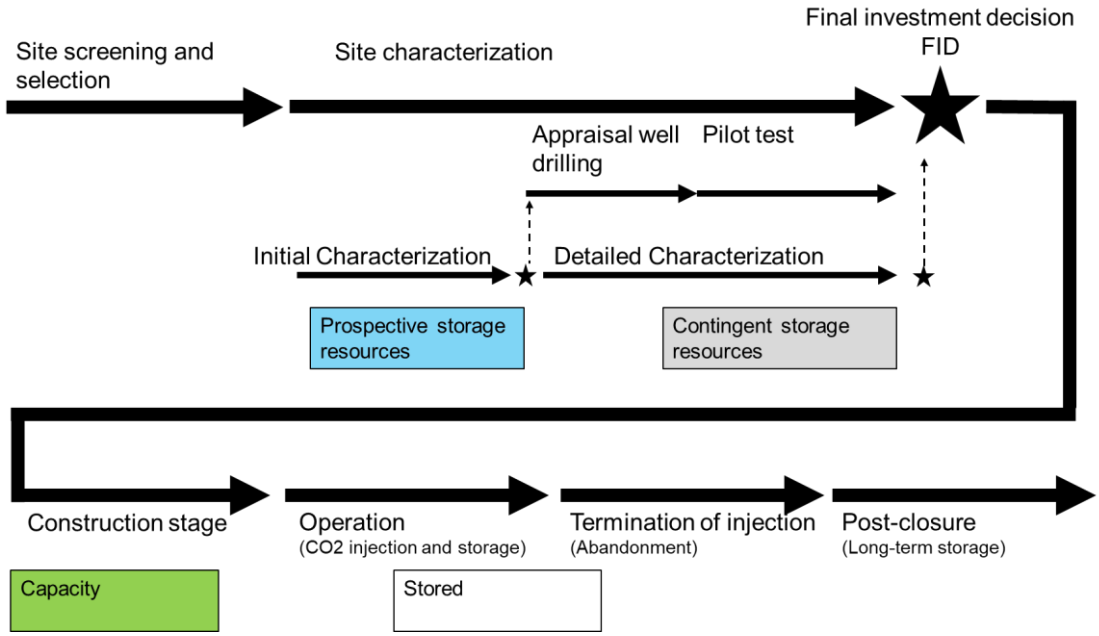

Figure 3: Evolution of the storage resources classifications of the SRMS along with the six stages of a CO2 storage project. Based on NETL (2017) and SRMS (2017).

2. Development of a CO2 injection plan and evaluation of CO2 storage resources

This section examines the validity of the site selection and CO2 injection plan for a CO2 storage project. CO2 storage resources are also evaluated in the section.

Site selection validity is examined through a site screening and site selection process. This is followed by a site characterization of the selected site(s) to develop a CO2 injection plan. The descriptions in Sections “4. Well infrastructure” and “5. CO2 injection operation” are also referred to in the development of a CO2 injection plan.

3. Risk management

This section examines the validity of a risk management plan in terms of the risks arising from the CO2 storage project. The CCS guideline recommends following the general risk management process presented in the ISO27914, which is based on ISO31000.

Furthermore, since the risk management process of an actual CO2 storage project must be suitable for a specific storage project, references to the case studies of earlier global CCS projects are also provided. The CCS guideline recommends using the best practices of these earlier projects as a reference when undertaking the risk management process .

4. Well infrastructure

This section examines the validity of a well construction and remediation plan. The validity of materials, designs, and drilling programs should be compliant with the standard practices used in the oil and gas industries. Additional technical considerations are described in the CCS guideline.

5. CO2 injection operation

This section examines the validity of an operational plan. The operational plan should comply with the relevant laws and regulations, and standard practices in the oil and gas industries. Additional technical considerations are described in the CCS guideline.

6. Monitoring and verification

This section examines the validity of a monitoring plan. Monitoring and verification are performed against the potential risks identified in the risk management process, and it is performed as a part of the process. The results of monitoring and verification is used to ensure the effectiveness of CO2 storage, i.e., it provides technical justification to ensure the amount of CO2 reduction by the project.

The CCS guideline presents references to case examples of monitoring techniques used in earlier international CCS projects. The CCS guideline recommends employing cost-effective monitoring techniques using the knowledge acquired by earlier international CCS projects.

7. Site closure

This section examines if a site closure plan, prepared by an operator, is to the standard that is required by a local authority. The validity of a well construction and remediation plan, operation plan, and monitoring plan is used in this assessment.

Although the post-closure stage is not covered in the CCS guideline, it recommends obtaining confirmation of the long-term storage site transfer, post-closure, to a local authority, including the

monitoring of CO2 storage to ensure long-term safe storage.

Chapter 3
Quantifying CO2 emissions reduction from CCS projects

1. Fundamental concept for calculating CO2/GHG emissions reduction from CCS projects

The net CO2/GHG emissions reduction from the CCS project is the amount of CO2 separated and captured in the CCS project, minus the amount of CO2 generated externally to obtain the energy required for capture, transportation, and injection, and the amount of CO2/GHG leakage in the process.

Therefore, to calculate the amount of reduction, it is necessary to calculate the amount of CO2 separated and captured, in addition to the amount of CO2/GHG emissions generated by the CCS implementation and the amount of leakage. The following formula is used for its calculation:

CO2 /GHG emission reduction =
amount of captured CO2 − emissions from fuel and electricity consumption) − amount of leakage

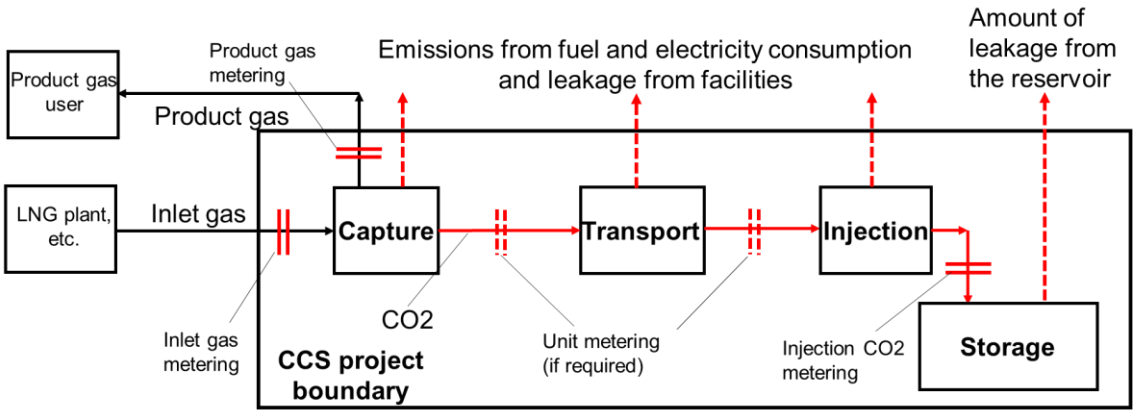

Figure 4: Schematic of the calculation of net CO2/GHG reduction.

In this guideline, the basic concept of the calculation method for CO2/GHG emissions is presented for the project planning and execution phase. For the specific methodologies of these items, the "JOGMEC's recommended work guidelines for GHG and carbon intensity calculation (GHG/CI Guidelines)", which are being prepared in parallel with these guidelines, is also referred to.

2. Guidelines at the project planning stage

For the project planning phase, basic guidelines on the required calculation targets, calculation of major emission sources, and validation are provided.

3. Evaluation guidelines at the project execution stage

For the project execution phase, the project should be monitored after confirming the results of the measurement and the presence or absence of leakage at the measurement points and potential leakage points determined during planning Furthermore, the measured and calculated data should be consistently managed, reported, and verified.

Additionally, this guideline provides recommended work guidelines for data management, reporting, and validation processes.

References

[1] International Organization for Standardization, *ISO27914 Carbon dioxide capture, transportation and geological storage — Geological storage*, vol. First edit. 2017.

[2] National Energy Technology Laboratory, "BEST PRACTICES: Site Screening, Site Selection, and Site Characterization for Geologic Storage Projects 2017 REVISED EDITION," 2017, [Online]. Available: https://www.netl.doe.gov/coal/carbon-storage/strategic-program-support/best-practices-manuals.

[3] National Energy Technology Laboratory, "BEST PRACTICES: Risk Management and Simulation for Geologic Storage Projects 2017 REVISED EDITION," p. 114, 2017, [Online]. Available: https://www.netl.doe.gov/sites/default/files/2018-10/BPM_RiskAnalysisSimulation.pdf.

[4] National Energy Technology Laboratory, "BEST PRACTICES: Monitoring, Verification, and Accounting (MVA) for Geologic Storage Projects 2017 REVISED EDITION," p. 88, 2017, [Online]. Available: https://www.netl.doe.gov/coal/carbon-storage/strategic-program-support/best-practices-manuals.

[5] Society of Petroleum Engineers, "CO2 Storage Resources Management System," 2017.

[6] C. D. Gorecki, J. A. Hamling, J. Ensrud, E. N. Steadman, and J. A. Harju, "Integrating CO2 EOR and CO2 Storage in the Bell Creek Oil Field," in *Carbon Management Technology Conference*, Apr. 2012, vol. 2, pp. 801–812, doi: 10.7122/151476-MS.

Appendix: Table of contents of CCS guideline