-NEW METHODOLOGY-
The capture of CO2 from natural gas processing plants and liquefied natural gas (LNG) plants and its storage in underground aquifers or abandoned oil/gas reservoirs

Presentation

Workshop on Clean Development Mechanism (CDM) Methodological Issues in regard to Carbon Dioxide Capture and Storage (CCS)

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CONTENTS

1. SUMMARY DESCRIPTION

The natural gas produced from underground gas fields contains some acid gas components, such as CO_2, H_2S, and water. In the natural gas processing plants and the liquefied natural gas (LNG) plants, the acid gas components are removed from the natural gas using amine solvents to meet the acid gas content limitations for products (e.g., sales gas, natural gas liquid (NGL) and LNG) and to avoid possible plugging of equipment by CO_2 freezing in the liquefaction process. If the concentrations and/or amounts of some acid gas components are likely to exceed the limitations prescribed in local environmental regulations or requirements, the separated acid gas is processed in acid gas incinerators to dispose of the H_2S and hydrocarbon gases in a safe manner in order to meet the regulations or requirements. At most plants, the acid gas containing CO_2 is released to the atmosphere either directly or after processing in the acid gas incinerators.

The project activity comprises compression of the non-processed acid gas containing CO_2 into supercritical form, its transportation through pipelines, and the injection of the supercritical CO_2 through injection wells into secure aquifers or abandoned oil and gas reservoirs where it is stored.

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) （1）

2.1 Applicability

This methodology is applicable to CCS projects under the following conditions:

① The CO2 source is acid gas containing CO2 from acid gas removal facilities of natural gas processing plants and liquefied natural gas (LNG) plants.

② The acid gas containing CO2 is stored in geological formations which are saline aquifers or abandoned oil/gas fields. The methodology is not applicable to CCS with enhanced oil/gas recovery, to storage in unmineable coal beds, or to ocean storage.

③ The host country has no regulations with regards to CO2 emissions prior to the adoption by the COP of the “Modalities and procedures for a clean development mechanism” (CDM M&P) (decision 17/CP.7, 11 November 2001).

④ The CO2 is transported from the source (acid gas removal facilities) to the injection site via pipeline systems.

⑤ Only projects that source and store CO2 in the same host country, are applicable for this methodology.

⑥ The project meets the conditions as outlined below in regards to the integrity of the storage (geological) formation:

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued （2）

-The reservoir must be deep enough to maintain injected CO2 in a supercritical phase ,

-A geological site report has been prepared and sufficient data has been collected before the CO2 injection to ensure the geological stability, storage capability, and safety of the CO2 storage. The data to show the integrity of the storage formation is selected on a site specific basis using the elicitation from experts.; and,

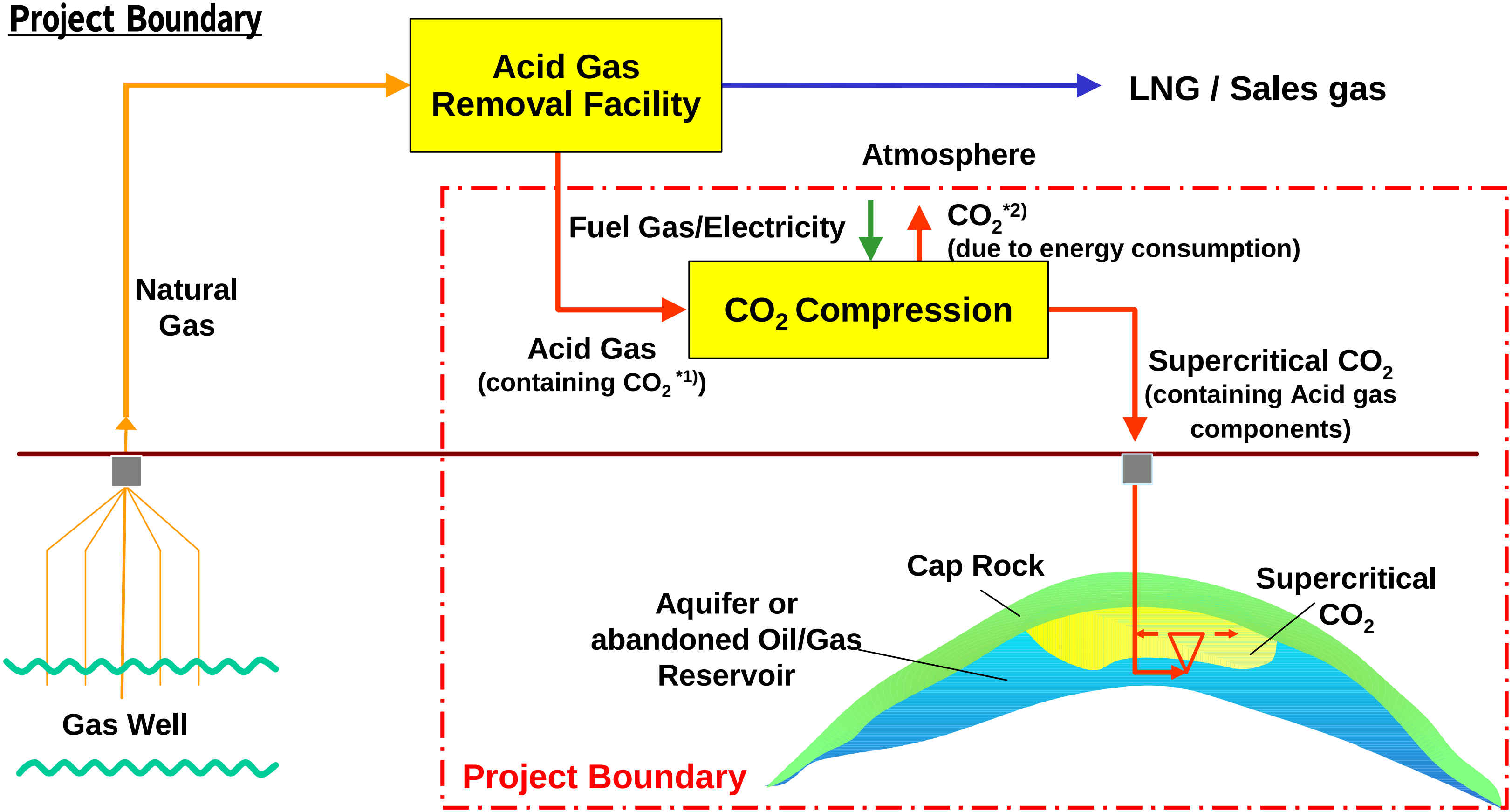
-Short-term and long-term reservoir simulations shall be undertaken to demonstrate that CO2 is to be injected into "appropriately selected and managed geological reservoirs", in which the fraction retained is very likely to exceed 99% over 100 years, and is likely to exceed 99% over 1,000 years . The simulation models shall be validated by a qualified third party (research institute, governmental organization, etc).

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued (3)

2.2 Project Boundary

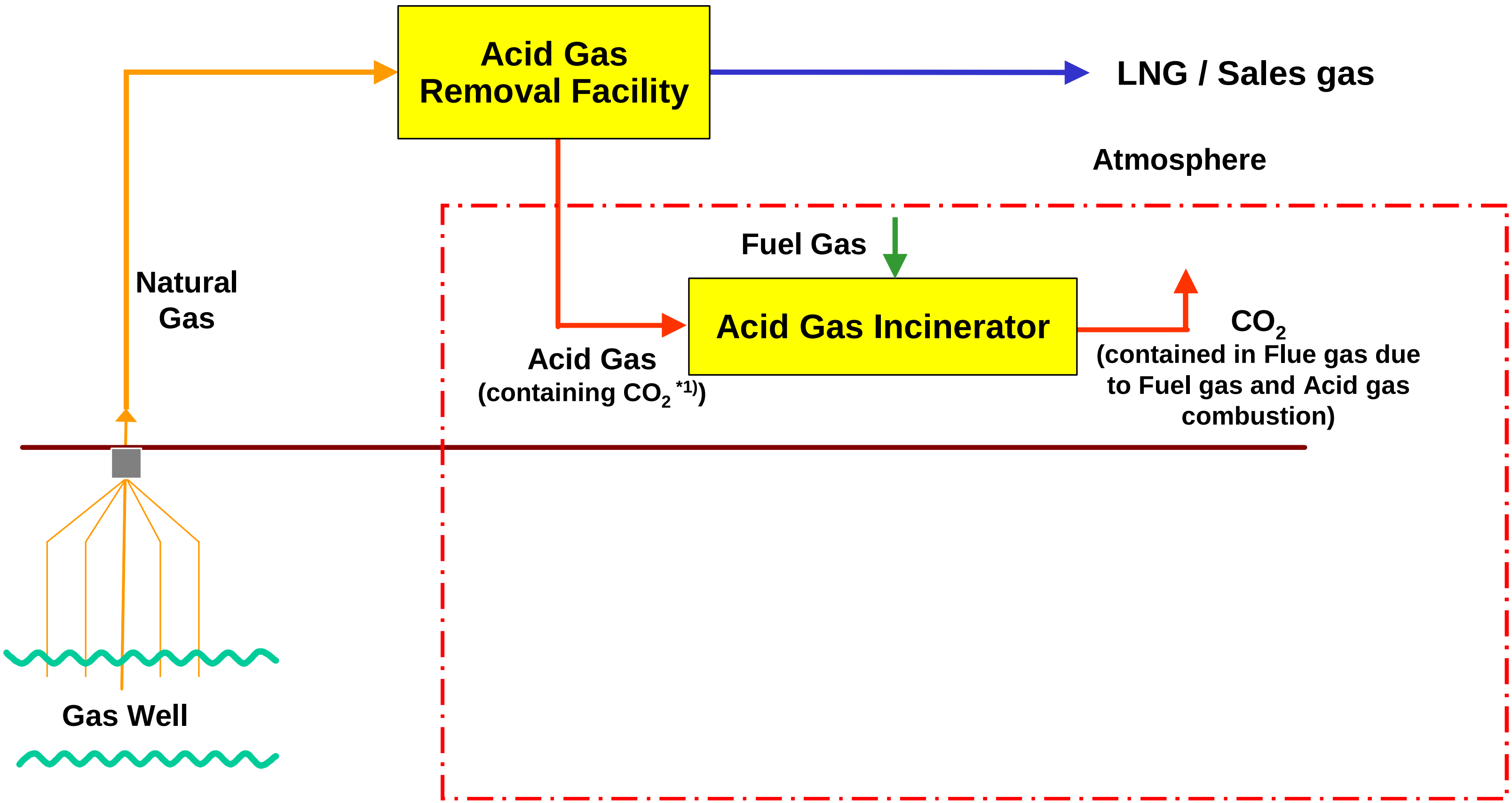
These diagrams show the project boundary and baseline scenario (project boundary : area inside the dot-lined box):

<u>Project Boundary</u>



2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued (4)

Baseline Scenario



*1) CO_2 concentration of the acid gas is approximately 95 wt%.
*2) Includes indirect CO_2 emission due to use of electricity supplied from outside the boundary.

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued （5）

2.3 Baseline Scenarios

The methodology consists of three steps to determine the baseline scenario. The outline of each step is described below.

①Identification of plausible baseline scenarios options

The project proponent shall identify all plausible alternative scenarios to the project activity. Natural gas production and acid gas removal from the natural gas will take place regardless of the CDM project, so the treatment of the removed CO_2 included in the acid gas is the main issue for the determination of the baseline scenario. Alternative scenarios which are plausible may include,

Alternative scenario 1: The acid gas (containing CO_2) is released to the atmosphere directly, resulting in CO_2 emission.

Alternative scenario 2: The acid gas (containing CO_2) is released to the atmosphere after incineration in the acid gas incinerators, resulting in CO_2 emission.

Alternative scenario 3: CO_2 capture and storage takes place using CCS technology outside of the CDM scheme.

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued （6）

Alternative scenario 4: CO_2 is captured and utilized for other purposes, such as industrial use or sold on the market.

②Evaluation of scenarios in terms of legal compliance and economic feasibility

After all plausible scenarios are identified, the project proponent shall evaluate each scenario in terms of legal compliance and economic feasibility.

Since there are little economic incentives to capture and store CO_2 without revenue from CERs, scenario 3 is not likely to take place outside of the CDM scheme (demonstrated in depth in the following steps). Scenario 4 will be assessed considering the demand for CO_2 (for chemical uses, for soft drink production, etc.) and its price. If there is no demand nearby, or the price of CO_2 is low compared to the capturing cost, scenario 1 or 2 will be determined as the baseline scenario, which will be selected considering the environmental regulations.

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued （7）

③Additionality assessment

The methodology applies the "tool for the demonstration and assessment of additionality" provided by the CDM Executive Board to determine whether the project activity is additional. Guidance to apply the additionality tool for the proposed methodology is provided as below:

Step 0: Preliminary screening based on the starting date of the project activity

No additional guidance.

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Plausible scenarios are described in ① above.

Step 2: Investment analysis

The projects require significant investment for the installment of equipment as well as data collection for the site selection. If there is no demand for CO_2 near the project, simple cost analysis can be applied since it is evident that there are no economic benefits other than CDM related income.

If there is any demand for CO_2 nearby, investment comparison analysis or benchmark analysis shall be made to compare the economical benefit from CO_2 sales to CER revenues.

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued （8）

Step 3: Barrier analysis

Plausible barriers may include,

- Technological barriers. Although the storage of CO2 in deep geological formations uses many of the same technologies that have been developed in the oil and gas industry, there are only a few instances of the application of those technologies for CCS projects.
- Barriers due to prevailing practice, since there are only a few CCS projects under operation around the whole world.

Step 4: Common practice analysis

Other activities similar to the proposed project activity may include,

- Ocean storage

Step 5: Impact of CDM registration

No additional guidance.

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued (9)

2.4 Baseline Emissions

Envisaged baseline scenario

The acid gas containing CO2 is separated from the natural gas at the acid gas removal facilities of a natural gas processing plant or a LNG plant, and is emitted directly to the atmosphere or through the acid gas incinerators. CO2 generated due to the operation of the acid gas incinerators is also emitted to the atmosphere. In case the regulations do not require any incinerator in the baseline scenario, the CO2 associated with the operation of the incinerator is set as zero.

The baseline emissions

The baseline emissions in a year y (CO2_BASE y) are expressed as the summation of the direct emission of CO2 contained in the acid gas separated in the acid gas removal facility (CO2_EMIy) and the emission of CO2 from combustion of the fuel gas in the operation of the acid gas incinerators (CO2_INC y), if required by the regulation:

$$CO2\_BASE\ y = CO2\_EMI\ y + CO2\_INC\ y \qquad [t\text{-}CO2/y]$$

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued (10)

2.5 Project Activity Emissions

The project scenario

The acid gas containing CO2 is separated from the natural gas in the acid gas removal facilities of a natural gas processing plant or an LNG plant, and is compressed into a supercritical state. The supercritical CO2 is transported through pipelines, and is then injected and stored in a secure aquifer or an abandoned oil/gas reservoir. In this project activity, the incineration in the acid gas incinerators which is considered in the baseline scenario is not required and the CO2 emission from the incinerators can be avoided, although CO2 is emitted due to the operation of equipment installed for the project activity.

The project emissions

The project emissions include CO2 emissions from the energy consumption due to the compression, transportation and injection of CO2, and any escape from the pipeline, the injection well and the reservoir. The energy consumption can be divided into two components; fuel consumption and electricity consumption.

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued (11)

The project emissions in a year y (CO2_PRJ y) are expressed as below.

$$CO2\_PRJ\ y = CO2\_PF\ y + CO2\_PE\ y + CO2\_ESCPI\ y + CO2\_ESCRES\ y \quad [t\text{-}CO2/y]$$

CO2_PF y = CO2 emissions from fuel consumption
CO2_PE y = CO2 emissions from electricity consumption
CO2_ESCPI y = CO2 escape from the pipeline and injection well
CO2_ESCRES y= C2 escape from the reservoir

2. PROPOSED NEW METHODOLOGY: BASELINE (CDM-NBM) – continued (12)

2.6 Leakage

There is no leakage involved in this methodology. Migration effect is included in the accounting of the project emissions.

2.7 Emissions Reductions

The emission reductions ER_y are calculated as below.

$$ER_y = CO2\_BASE_y - CO2\_PRJ_y \qquad [t\text{-}CO_2/y]$$

3. PROPOSED NEW METHODOLOGY: MONITORING (CDM-NMM) （1）

3.1 Applicability

Same as CDM-NBM

3.2 Envisaged Baseline Scenario

Same as CDM-NBM

3.3 The Project Scenario

Same as CDM-NBM

3. PROPOSED NEW METHODOLOGY: MONITORING (CDM-NMM) – continued (2)

3.4 Monitoring Items

The Monitoring Methodology requires the monitoring of the following items to determine emissions in the baseline scenario and the project scenario:

①Injected CO_2

1)The total amount of injected acid gas measured at the inlet of the pipeline.

2)The concentration of CO_2 in the acid gas is measured at the inlet of the pipeline.

②CO_2 emission from fuel/electricity consumption

1)Fuel consumption due to the equipment installed for the project activity.

2)Carbon number and molecular weight of the fuel gas.

3)Electricity consumption by the equipment installed for the project activity.

4)Carbon emission factor of the electricity.

3. PROPOSED NEW METHODOLOGY: MONITORING (CDM-NMM) – continued (3)

③CO_2 escapes from the pipeline and the injection wells

1)Pipeline pressure (both of the flow pressure and the static pressure at the inlet of the pipeline)
2)Wellhead pressure (both of the flow pressure and the shut in pressure at the head of the wells)
3)Annular pressure between the casing and the tubing of the injection wells
4)Emission factor in regards to CO_2 escaping from the pipeline
5)Emission in regards to CO_2 escaping from the injection wells

④CO_2 escapes from the reservoir

1)Three dimensional (3D) seismic survey
2)Downhole monitoring (the flow pressure and temperature, the shut-in pressure and temperature)

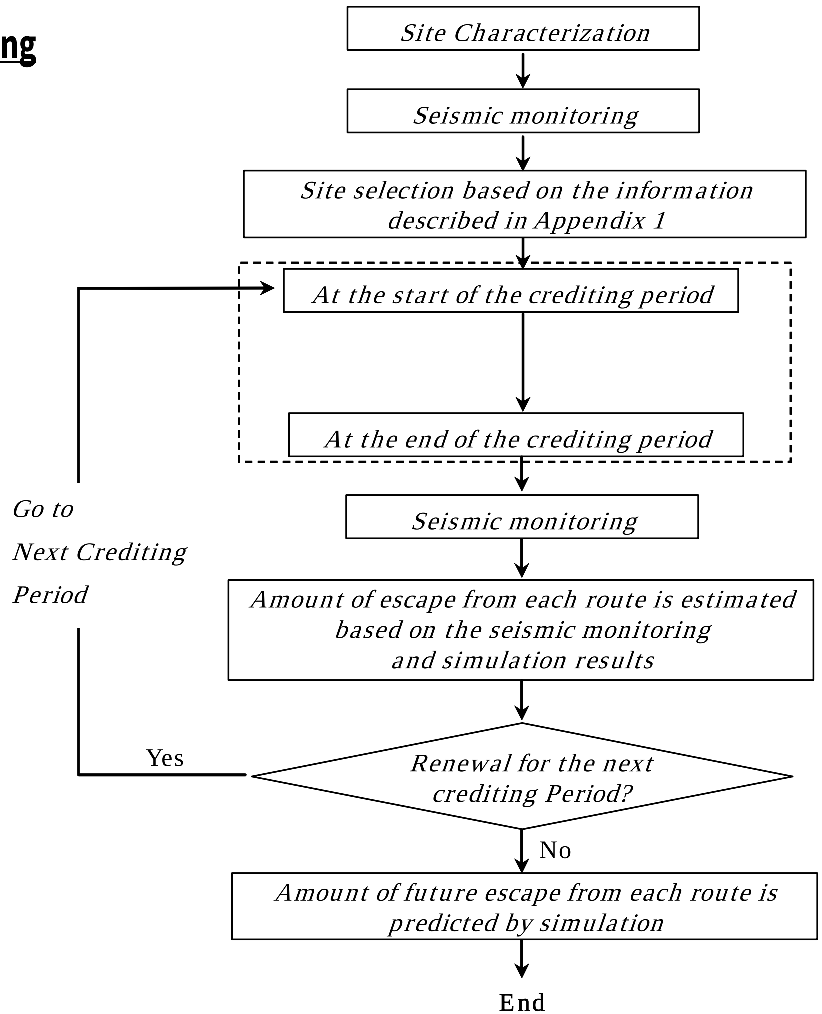
The most significant emission in the baseline scenario is the CO_2 emissions from the acid gas removal facility. In this methodology, the amount of the CO_2 emission from the acid gas removal facility is considered to be regarded as equal to the amount of CO_2 injected, which is directly measured at the inlet of the pipeline by flow meters. Therefore, the most accurate and proven instruments (e.g., Coriolis flow meters) to measure mass flow rate of the acid gas (containing CO_2) to be injected should be applied in order to reduce the uncertainty in the monitoring of the baseline emissions.

The emission factor in regards to CO_2 escaping from the pipeline can be determined specifically based on some measurements or industrial standards or IPCC factors depending on the availability of site specific data.

3. PROPOSED NEW METHODOLOGY: MONITORING (CDM-NMM) – continued （4）

3.5 Flow Charts

Flow chart of the monitoring



3. PROPOSED NEW METHODOLOGY: MONITORING (CDM-NMM) – continued （5）

Flow chart to consider escape